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Ko te Aitanga Pepeke
o Aotearoa

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**Fauna of New Zealand
Ko te Aitanga Pepeke o Aotearoa**

Number / Nama 61

Lucanidae

(Insecta: Coleoptera)

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**Manaaki
Whenua
P R E S S**

**Lincoln, Canterbury, New Zealand
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POPULAR SUMMARY

HE WHAKARĀPOPOTOTANGA

Class **Insecta**Order **Coleoptera**Family **Lucanidae****Stag beetles**

The Lucanidae is a small diverse family distributed worldwide, with about 110 genera and about 1300 described species. The New Zealand lucanid fauna comprises 39 species of which 35 are endemic and belong in 5 endemic genera, and 4 are foreign, 3 being from Australia and 1 originating from Taiwan. Two of the Australian species are known to be breeding in New Zealand, but it is very unlikely that the third Australian species and the one from Taiwan are established here.

When first described and until almost the end of last century most of the New Zealand species were assigned to the Australian genera *Ceratognathus* and *Lissotes*, and to the mainly northern hemisphere genus *Dorcus*, because of superficial morphological similarities. However, in the late 1990s comparative studies of the male and female genitalia and elytral surface structures indicated that the New Zealand species were not congeneric with the Australian species nor with those in *Dorcus* so 3 new genera, *Geodorcus*, *Holloceratognathus* and *Paralissotes* were established for some of the species and the remainder were placed in the reinstated New Zealand genus *Mitophyllus*. These 4 genera encompass 34 of the 35 endemic species. The remaining species is in *Dendroblax*, a particularly interesting genus because it belongs in the very small subfamily Lampriminae found only in the southern hemisphere. *Geodorcus* and *Paralissotes* belong in the large, worldwide subfamily Lucaninae and *Holloceratognathus* and *Mitophyllus* are in Aesalinae, a much smaller subfamily represented in both hemispheres. The New Zealand genera are not morphologically very close to others in their subfamilies.

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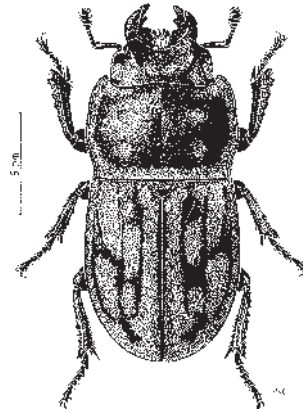


Illustration / Whakaahua: Male *Paralissotes reticulatus* (Illustrator / Kaiwhakaahua: D. W. Helmore).

Ngā pītara whai rei

He whānau iti, otirā he whānau whārahi, a ngāi Lucanidae, kitea ai puta noa i te ao. He āhua 110 ngā puninga, 1300 pea ia nei ngā momo. I Aotearoa nei, e 39 ngā momo lucanid, e 35 o ēnei kei tēnei whenua anahe e kitea ana, nō roto anō i ngā puninga e 5 nō konei taketake ake. E 4, he rāwaho, ā, e toru o ērā nō Ahitereiria, kotahi nō Taiwan. O ngā momo o Ahitereiria, e rua e mōhiotia ana kei te whakaputa uri i Aotearoa, engari ko tērā atu o ē Ahitereiria, me tō Taiwan, karekau pea.

I te wā i whakaahuatia tuatahitia ai ēnei ngārara, ā taka rawa mai ki te paunga o tērā rautau, i meatia te nuinga o ngā momo o Aotearoa kia taka ki raro i a ngāi *Ceratognathus* me *Lissotes*, he puninga nō Ahitereiria, me ngāi *Dorcus*, he puninga kitea nuitia ai i te tuakoi raki. I pēnei ai nā te ōrite o ngā hanga ki ērā ina kirimoko noa te titiro. Otirā, i ngā tau whakamutunga o ngā 1990, ka tū ētahi rangahau whakatairiterite i ngā hemahema o ngā toa me ngā uha, tae atu ki ngā kahu parirau, ā, kitea ana i reira ehara kau ana nō aua puninga ngā momo o Aotearoa. Nā konā, ka hangaia ētahi puninga hou e 3, ko *Geodorcus*, ko *Holloceratognathus* me *Paralissotes*, ā, ka whakaaraha ake anō a *Mitophyllus*, he puninga nō Aotearoa. O ngā momo e 35 nō Aotearoa taketake ake, e 34 kei ēnei puninga e whā. Ko tērā atu momo, nō te puninga *Dendroblax*. Ko te mea kē o tērā puninga, nō tētahi whānau iti tino pakupaku ko Lampriminae te ingoa, kitea ai i te tuakoi tonga anahe. Ko *Geodorcus* rāua ko *Paralissotes*, nō ngāi

(haere tonu)

In some parts of the world, especially in the northern hemisphere and tropics, the family includes large spectacular species, easily recognised as stag beetles by the long tusk-like or antler-like mandibles of males. Many people living in these areas are familiar with them because on hot summer evenings they often fly to lights and enter houses. Consequently stag beetles have become an important part of the folklore and artistry of some European countries, and in parts of Asia they may even be kept as pets. The endemic New Zealand stag beetles by comparison are inconspicuous and rather cryptic, most spending their entire lives in native habitats and having to be searched for to be seen. They are neither brightly coloured nor shiny, instead have dullish brown or black integument, sometimes with tufts or patches of yellowish or brown scales or hairs. The genus *Geodorcus* has the largest specimens, some males measuring 44 mm in length including mandibles and about 34 mm excluding mandibles, but the maximum length of males in the other genera is about 20 mm. The overall length of females is usually much less than that of males of the same species mainly because their mandibles are shorter. All the species of *Geodorcus* and *Paralissotes* and females of 1 species of *Mitophyllus* are unable to fly because their wings are reduced to vestiges, but the other New Zealand lucanids have fully functional wings.

Fully winged adults of a few species of *Mitophyllus* are occasionally found out in the open in the vicinity of houses and well away from forests. They have been able to extend their ranges into parks and gardens because their larvae can develop in dead trunks and branches of cultivated native trees such as species of *Pittosporum* and in exotics such as figs and apples. The trees are considered to be the hosts but the species of fungi developing inside their branches have a more important role to play because they convert the wood to a substrate that will sustain the larvae throughout their development. Without having the right species of fungi the wood will not be attractive to the beetles. Nothing is known about the food of *Mitophyllus* adults but it is likely to be nectar. Adults of *Geodorcus* spend their entire lives in total darkness or twilight conditions, staying in cool damp places under logs and rocks or in accumulated damp leaves during the day and emerging at night or sometimes on dull rainy days to feed on exudations either from tree trunks or from low-growing plants. Their larvae are subterranean and consume vast quantities of soil. Spectacular size ranges of adults in some *Geodorcus* species probably result from the quality and abundance of larval food, the largest males of the most widespread species, *G. helmsi*, for example, being found on islands where their larvae live in soils that are greatly enriched by abundant sea bird guano.

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Lucaninae, he whānau iti nui tonu, kei ngā tōpito katoa o te ao. Ko ngā *Hollocerato gnathus* rāua ko *Mitophyllus*, nō te whānau iti pakupaku Aesalinae, kei ngā tuakoi e rua o te ao. Heoi anō, kāore ngā momo o Aotearoa i te tino ōrite ā-hanga nei ki ērā atu o ngā uri o ō rātou whānau iti.

I ētahi moka o te ao, pērā i te tuakoi raki me ngā takiwā pārūrū, he rahi tonu ētahi o ngā huānga o te whānau. He māmā te tautohu i a rātou, i te mea he mārāma te kite atu i ngā waha ko te rei, ko te pihiringa rānei te rite ki te titiro atu. E mōhio pai ana ngā iwi kāinga ki ēnei pepeke i te mea i ngā pō mahana o te raumati kua whakawaia e ngā rama i rō whare, kua tomo atu ki roto. Me te aha, kua noho mai ngā pītara rei nei ki ngā pakiwaitara, ki ngā mahi toi o ētahi o ngā iwi o Ūropi. Waihoki, i ētahi takiwā o Āhia, tērā tonu ka whakamōkaitia. Heoi anō, ko ngā momo taketake ake o Aotearoa nei, me uaua ka kitea, ka mutu, he kirihuna anō hoki. Ko te nuinga, ka noho whāiti ki ō rātou kāinga noho māori, ā, mā te āta rapu rawa e kitea ai. Kāore i muramura ngā tae, kāore hoki i mōhinuhinu – he parauri, he pango te kiri mārō, me ōna anō wekuweku, ōna anō āpure unahi, huruhuru rānei he kōwhai, he parauri pea te tae. Kei te puninga *Geodorcus* ngā mea rahi rawa, ko ētahi o ngā toa ka tupu kia 44 mm te roa ina uru mai te waha ki te inenga, ki te kore, ka 34 mm te roa. Engari i ērā atu puninga, ka 20 mm noa te roa. Ka poto noa ake ngā uwaha i ngā toa o te momo kotahi, i te mea he poto ake ngā waha. Katoa ngā momo o *Geodorcus* me *Paralissotes*, tae atu ki ngā uwaha o tētahi momo o te puninga *Mitophyllus*, he rerekore, i te mea he toenga parirau noa iho ō rātou. Engari arā anō ētahi lucanid o Aotearoa nei he parirau tūturu tonu kē ō rātou.

Arā ētahi momo torutoru o ngā *Mitophyllus* kitea ai i ōna wā anō i ngā wāhi mārakerake e tawhiti tonu ana i te ngahere, i te takiwā o ngā kāinga tāngata. Kua horapa anō ki ngā papa tākaro me ngā māra, i te mea ka whanake pai ngā torongū i ngā kōhiwi me ngā manga o ngā rākau māori kua mate, he mea āta whakatipu e te tangata, pērā i ētahi *Pittosporum*, tae atu ki ētahi rākau rāwaho pērā i te piki me te āporo. Engari ahakoa e kīia ana ko te rākau te pou whakaora mō ēnei hanga, kei ngā momo harore kē e tipu ana i roto i ngā manga te tino orangea mō rātou. Ko tā aua harore, he huri i te kiko o te rākau ki tētahi hanga e taea ana e ngā torongū te kai. Ki te kore e noho mai te momo harore tika ki te rākau, kua kore ngā kātua e piri atu ki taua rākau. Kāore i te paku mōhiotia he aha ngā kai a ngā kātua o ngā *Mitophyllus*, engari e whakapaetia ana he ngongo te kai. Ko te pō uriuri, ko te rikoriko te kāinga o ngā kātua o ngā *Geodorcus*. Noho ai rātou ki ngā wāhi haukū, mātao, ki raro pea i te poro rākau, i te toka, i te putunga rau, ā, kia pō, kia mōkinokino rānei te rangi, kua puta ki te ao ki te kai i ngā wai ka papī mai i ngā kōhiwi, i ngā tipu hakahaka.

(haere tonu)

The geographical distribution of the endemic species depends to some extent on whether they are fully winged or flightless, but other factors such as the time spent and area covered searching for specimens and the chances of being in the right place at the right time, have to be kept in mind when distribution maps are being viewed. At the present time, *Mitophyllus irroratus* and *M. parrianus* are the only stag beetles found in the North and South Islands and in Stewart I. *M. irroratus* is present as well on the Kermadec Islands. Of the remaining *Mitophyllus* species 4 have been found in the North and South Islands, 4 are known only from the North Island, 3 only from the South Island, and 1 is found only in the Chathams. One species of the fully winged genus *Holloceratognathus* has been collected in the North and South Islands, 1 is found in both islands and in the Chathams, and the 3rd, associated with ants, is known only from a small area in the south of the North Island. The single species of *Dendroblax* is distributed from Northland to the Otago Lakes area. All the *Paralissotes* species are flightless. The most common and wide ranging species, *P. reticulatus*, has been found from the Bay of Plenty to South Canterbury, but the remaining 6 species are much less widespread, 1 being found only in the Three Kings, 4 only in the North Island, and 1 is confined to the north of the South Island. Apart from *Geodorcus helmsi*, already mentioned, whose range extends down the western side of the South Island to the muttonbird islands south of Stewart Island most *Geodorcus* species have even more restricted ranges. Two are endemic to islands in the Chatham archipelago, 4 are confined to the North Island, and 3 to the South Island, and within these generalised areas some species are known only from single mountain tops or islands. As the adults are unable to fly to new sites, entire populations or even species may be wiped out if their habitat is disturbed by forest clearance or fires. As well, because the adults are large-bodied, slow moving, and nocturnal they are attractive and easy prey for rodents. Further threats to their survival come from collectors interested in having rare insects merely to own or to trade. Two *Geodorcus* species have been given legal protection but it would be desirable to apply the same protection to all the flightless stag beetles and to other flightless endemic insects as well. These unique at risk insects should have the same status as kiwi, tuatara, and other protected endemic species.

Very little is known about the biology and life histories of the New Zealand stag beetles. When we look at a stag beetle either alive and in the open or as a specimen in a cabinet it is good to ponder its life. The beetle had parents that had to find one another and a mother who could select the right substrate for the egg and larva. When fully developed the larva had to find the right place to pupate

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Ka noho kē ā rātou torongū ki te poho o Papa, he kai oneone, he tāparu oneone te mahi. E whakaarotia ana ko te kaha rerekē o te rahi o ngā kātua o ētahi momo o te puninga *Geodorcus*, e hono ana ki te rahi me te pai o te kai ka wātea ki ngā torongū. Inā rā, ko ngā toa rahi katoa o te momo kua tino kaha te pirara, o *G. helmsi*, kei ngā moutere e noho ai ngā torongū ki ngā oneone kua mōmona katoa i te tiko o ngā manu tai.

Ko tētahi mea e whakatau ana i te kaha o te pirara haere o ngā momo o konei taketake ake, ko te āhei ki te rere. Engari ina tirohia ngā mahere whakaatu i ngā wāhi kua kitea tēnā me tēnā momo, me mahara anō te kaupānui arā ētahi atu āhuatanga tērā e whakakotiti ana i ngā kitenga, pērā i te poto o te wā e kimihia ana ngā hanga nei, i te iti o te wāhi i tāwhaitia, me te waimarie, te wairuatoa rānei o te kaihāhau. I tēnei wā, ko *Mitophyllus irroratus* rāua ko *M. parrianus* anahe e kitea ana i Te Ika a Māui, i Te Waka a Māui, me Rakiura. Ā, kei ngā Kermadec anō a *M. irroratus*. O ērā atu momo o ngāi *Mitophyllus*, e 4 kua kitea i Te Ika me Te Waka a Māui, e 4 tērā pea kei Te Ika a Māui anahe, e 3 tērā pea kei Te Waka a Māui anahe, ā, kotahi kei Wharekauri. Kotahi te momo o ngāi *Holloceratognathus*, he puninga whai parirau tūturu, kua kitea i Te Ika me Te Waka a Māui, kotahi anō kua kitea i aua moutere e rua tae atu ki Rakiura, ā, he momo anō, he momo noho tahi ki te pōpokoriki, e whakaarotia ana kua noho whāiti mai ki tētahi takiwā i te pito tonga o Te Ika a Māui. Ko te momo kotahi o ngāi *Dendroblax*, kei te nuku o te whenua mai i Te Tai Tokerau ahu atu ki ngā Roto o Ōtākou. Katoa ngā *Paralissotes*, he rerekore. Ko te momo e ngaruru ana, kua kaha anō te horapa, ko *P. reticularis*. Kua kitea tērā mai i Te Moana a Toi ki te Pito Tonga o Waitaha. Engari ko ērā atu momo e 6 o taua puninga, kāore i pirara ki tawhiti. Kotahi te momo kei Te Tātua anahe, e 4 kei Te Ika a Māui anahe, 1 kei te raki o Te Waka a Māui anahe. Atu i a *Geodorcus helmsi*, ko tōna rohe pōtae mai i Te Tai Poutini ki ngā moutere tītī ki te tonga o Rakiura, ko te nuinga o ngāi *Geodorcus*, kei te noho ki ngā rohe whāiti ake. E 2 e kitea ana i ngā tini moutere o Wharekauri, e 4 kei Te Ika a Māui anahe, e 3 kei Te Waka a Māui anahe, ā, arā anō ētahi kua kitea e whāiti mai ana ki te kōtihi kotahi, ki te moutere kotahi rānei. I te kore o ngā kātua e āhei ki te rere ki wāhi kē, tērā ka orotā te taupori, te momo tonu rānei ki te raru tō rātou kāinga noho i ngā mahi whakarake whenua, i te ahi rānei. Waihoki, i te mea he nui te hanga o ngā kātua, he pōturi anō te haere, ā, he haere pō, he kai māmā noa hei kapo mā te kiore. Ko tētahi atu āhuatanga i noho mōrearea ai ngā pepeke nei, ko te hiahia o ngā kaikohi pepeke ki ngā pepeke onge mō ā rātou ake kohinga, hei hoko rānei. E rua ngā momo o ngāi *Geodorcus* kua tiakina e te ture, engari ko te painga atu mēnā ka

(haere tonu)

and the resulting adult may have found food and a mate. Most of these activities probably resulted from tactile and chemical processes. Systematists have a responsibility to draw attention to structures that may be sites of pheromone release or reception, for example setiferous sex patches or spectacularly developed antennal club segments of some males, on the off chance that researchers in other disciplines will be inspired to investigate them. The tufts and clusters of setae on the legs of some species of *Paralissotes* and *Geodorcus* have not been examined with a scanning electron microscope but it is likely that they are associated with pheromones which could be spread on the ground or other substrates as scent trails. Published observations on life cycles, particularly mating, oviposition sites, number of eggs laid over what period of time, and also the longevity of flightless species, would make a significant contribution towards understanding the family.

I hope the morphological section and keys will be helpful even for those with only a general entomological knowledge and that others, who may never expect to see a stag beetle, will enjoy looking at the illustrations and be able to appreciate the amazing diversity of the unique New Zealand lucanid fauna.

Contributor **Beverley Anne Holloway** was born in Lower Hutt, New Zealand in October 1931 and received her early education at Stokes Valley School and Wellington Girls' College. In 1952, with a BSc from the University of New



(continued overleaf)

whakawhānuitia atu tēnei pākai kia noho haumarua ai ngā pītara rei katoa kāore e rere, me ērā atu pepeke rerekore ko Aotearoa anahe tō rātou kāinga. E tika ana anō kia rite te mana o ēnei pepeke ki tō te kiwi, te tuatara, me ērā atu o ngā momo kua rāhuitia i raro i te ture.

He tino iti te mōhio ki te koiara me te oranga o ngā pītara whai rei o Aotearoa. Ina titiro koe ki te pītara rei e ora ana, e moe mai ana rānei ki te kāpata rokiroki, me whai whakaaro anō pea ki tāna noho ki te ao. He mātua anō ōna i tūtaki i hea rā, ā, mokori anō i kitea e tana whaea he wāhi pai mō te whānau hua i ora ai te torongū. Nō te pakaritanga, ka tahuri te torongū ki te kimi wāhi pai e huri ai ia hei ngeti, ā, nōna ka pakeke, tērā ka kitea he kai māna, he hoa anō mōna i whakaputa ai ia i ōna ake uri ki te ao. Nā tana āta whāwhā rawa i te taiao, nā ngā āhuatanga matū anō pea i tutuki pai ai ēnei mahi katoa. He kawenga kei runga i ngā kaitātai whakapapa ki te āta whakaatu i ngā wāhi o te tinana koia pea kei te tuku, kei te kapo rānei i ngā kakara e kīia nei he pheromone, hei tauira, ko ngā āpure huruhuru taihema, ko ngā wāhanga rānei i ngā pūhihi o ngā toa e rite ana ki te patu. Ki te whakatāirihia e ngā kaitātai whakapapa ēnei mea, tērā ka tahuri mai ngā kairangahau o ētahi atu pekanga pūtaiao ki te wūhura. Kāore anō kia matawaia ki te karu whārahi irahiko ngā wekuweku me ngā pūrei huruhuru i ngā waewae o ētahi o ngāi *Paralissotes* me *Geodorcus*, engari tērā tonu kei reira ētahi kakara ka āta pania atu ki te papa, ki tētahi atu mata rānei, hei ara kakara. Mēnā i puta he tuhinga mō ngā mataora, mō te whakaputa uri, mō ngā wāhi e whakanōhia ai ngā hua, te maha o ngā hua, te wā e whānau hua ana, tae atu ki te roa e ora ana ngā momo rerekore, he koha nui tēnā e kaha ake ai tō tātou mārama ki te āhua o tēnei whānau.

Ko te tūmanako, ka āwhina ngā kōrero whakamārama i te hanga o ngā pepeke nei me ngā ara tautohu i te tangata, ahakoa te hōhonu o tana mōhio ki ngā aitanga pepeke. Me te tūmanako anō ka pārekareka ngā whakaahua ki te hunga e kore rawa pea e kite i tētahi pītara rei, ka rekareka anō rātou i te huhuatanga me te ahurei o ngā pītara rei o Aotearoa.

I whānau mai te kaituhi nei, a **Beverley Anne Holloway**, i Te Awakairangi, Aotearoa, i te Whiringa ā-nuku 1931. I kuraina ki te Kura o Kōrauni me te Kāreti o Pōneke mō ngā Kōtiro. Ka whakawhiwhia ki te BSc e te Whare Wānanga o Aotearoa, i Pōneke, ā, i te tau 1952 ka tīmata tana mahi i te Whare Taonga Tōminiana (ko Te Papa Tongarewa tēnei iāianā), hei Kaiāwhina Mātai Pepeke. E kawē tonu ia i ētahi kaupapa i te Whare Wānanga, ā, i te tau 1954, ka whakawhiwhia ki te MSc, Hōnore Pae Tuatahi, Mātauranga Kararehe. I te tau o muri mai ka
(haere tonu)

Zealand in Wellington, she joined the staff of the Dominion Museum, now Museum of New Zealand Te Papa Tongarewa, as the Assistant Entomologist. While there she attended the University as a part-time student and was admitted to the degree of MSc with First Class Honours in Zoology in 1954. A Fulbright Grant awarded in 1955 paid her return travel to Cambridge, Massachusetts, USA where she spent 3 years at the Harvard Biological Laboratories working on a Ph.D. in Biology, conferred in 1959. While at Harvard she was elected to The Society of the Sigma Xi and to Phi Beta Kappa. On her return to New Zealand Beverley was appointed Entomologist at the Dominion Museum, a position she held until joining the DSIR Entomology Division in Nelson in 1962. In 1963 she took a 10 year break from paid research to be a full-time mother maintaining her interest in Lucanidae and Anthribidae at a hobby level. She joined the Systematics Section of DSIR in Auckland in 1974 to work on Diptera and her research on Coleoptera was put on hold until 1981 when she was asked to prepare a volume on Anthribidae for the *Fauna of New Zealand* series. In 1990 she was awarded a New Zealand Commemoration Medal for services to New Zealand as a scientist. Shortly before her retirement in 1991 she put plans in place to prepare an updated volume on Lucanidae for the *Fauna* series, the earlier revision based on her Ph.D. thesis having been published in 1961. The present volume is the result of research carried out at home as a hobby that had to fit in with family commitments and domesticity. Beverley has a special interest in the configurations of the male and female genitalia of Lucanidae and Anthribidae, particularly their importance as indicators of genera. She is married to weevil specialist Willy Kuschel and they have 2 daughters and a son, and 4 grandchildren.

whiwhi ia i te Karahipi Fullbright, i utua ai tana rere ki Cambridge, Massachusetts, USA. Ka 3 ana tau ki reira e mahi ana i tana Tohu Kairangi Koiora i ngā Whare Pūtaiao Koiora o Harvard. Nō te tau 1959 tēnei i uhia ai ki runga i a ia. I a ia i Harvard, ka pōtihia ia ki te Society of the Sigma Xi me te Phi Beta Kappa. Nōna ka hoki mai ki Aotearoa ka whakatūria a Beverley hei Kaimātai Pepeke i te Whare Taonga Tōminiana. Kātahi ia ka neke ki te Wāhanga Mātai Pepeke o te DSIR i Whakatū, i te tau 1962. Mai i te 1963, ka ngahuru ngā tau e whakapau kaha ana ia ki te whakatipu i ana tamariki, engari me te noho tonu o ngāi Lucanidae me Anthribidae hei kaupapa runaruna māna. Ka whakauru atu ia i te Wāhanga Tātai Whakapapa o te DSIR i Tāmaki i te tau 1974, ko ngāi Diptera tāna kaupapa. Waiho ana āna mahi rangahau i a ngāi Coleoptera ki tahaki, ā, taka rawa ki te tau 1981. He mea inoi ia i taua tau kia tuhi kōrero e pā ana ki a ngāi Anthribidae mō te hautaka *Ko te Aitanga Pepeke o Aotearoa*. I te tau 1990 ka uhia ki runga i a ia te Mētara Whakamānawa o Aotearoa mō ana whakapaunga kaha ki ngā mahi pūtaiao i Aotearoa. Nō mua tata i te unuhanga ōna i tana mahi i te tau 1991, ka taka i a ia te whakaaro kia whakahoutia e ia ngā kōrero mō ngāi Lucanidae, mō te hautaka *Aitanga Pepeke*. Ko te whakahounga o mua atu, i takea mai i ngā kitenga o tana Tohu Kairangi, ā, nō te tau 1961 tērā. Ko tēnei tuhinga te hua o ana rangahau i te kāinga i kawea tahitia me ana mahi hāpai i te whānau. Ko tētahi o ana arotahinga matua, ko te āhua o ngā taihemahema o ngāi Lucanidae me Anthribidae – toa mai, uwaha mai – me te wāhi ki ēnei hei tautohu i te puninga o tēnā, o tēnā. He tohunga mātai wīwhara tana hoa rangatira, a Willy Kuschel. E 2 ā rāua tamāhine, kotahi te tama, ā, e 4 ngā mokopuna.

Translation by **H. Jacob**
Tāmaki-makau-rau / Auckland

Dedicated to the memory of Dr E. A. Chapin, specialist in Coccinellidae, who in 1957 introduced me to the study of male and female genitalia in Coleoptera.

*“Without the whole the parts are lost,
and without the parts, there is no whole.
Both lie within the same plane.”*

Masanobu Fukuoka 1985
“The Natural Way of Farming”
Revised Edition, 1987, p. 120



Frontispiece. Pare (door lintel) in the New Zealand Arthropod Collection / Ko te Aitanga Pepeke o Aotearoa, featuring a male of *Geodorcus helmsi*. The pare, measuring 1.5×0.9 metres, was carved in the style of the Ngati Whatua tribe by Denis Conway in 1990.

ABSTRACT

The morphology of New Zealand's stag beetles (Insecta: Coleoptera: Lucanidae) is discussed and illustrated. New information is presented about the structure of the labium and profemoral setiferous patches in the family. All the genera and previously known species are redescribed and morphological structures including male and female genitalia are illustrated for the endemic species and, when appropriate, for the exotic species. The composition and relationships of the New Zealand lucanid fauna are discussed, and the known distribution and altitudinal ranges of the species are summarised and mapped. Habitats and the food of adults and larvae are discussed in general terms and in detail under each species. Keys for the identification of subfamilies, genera, and species of lucanids found in New Zealand are provided.

Thirtyfive endemic and 4 foreign species are recognised. They belong in 9 previously described genera representing 4 subfamilies: AESALINAE – *Holloceratognathus* Nikolaev, 1998 (3 species), *Mitophyllus* Parry, 1843 (14 species); LAMPRIMINAE – *Dendroblax* White, 1846 (1 species), *Lamprima* Latreille, 1807 (1 species); LUCANINAE – *Geodorcus* Holloway, 1996 (10 species), *Paralissotes* Holloway, 1996 (7 species), *Ryssonotus* MacLeay, 1819 (1 species), *Serrogathus* Motschulsky, 1861 (1 species); SYNDESINAE – *Syndesus* MacLeay, 1819 (1 species).

Seven new endemic species are described, 2 species are reinstated, and 1 species becomes a transferred synonym: AESALINAE: *Mitophyllus angusticeps* Broun, 1895, reinstated species, *M. arcuatus* new species, *M. falcatus* new species, *M. fuscus* (Broun, 1886) reinstated species, new combination, *M. mandibularis* Broun, 1917, transferred synonym of *M. angusticeps* Broun, 1895, *M. solox* new species; LUCANINAE *Geodorcus alsobius* new species, *G. montivagus* new species, *G. servandus* new species, *G. sororum* new species.

The 4 foreign species are: LAMPRIMINAE – *Lamprima aurata* Latreille, 1817 (from Australia, probably not established); LUCANINAE *Ryssonotus nebulosus* (Kirby, 1818) (from Australia, established), *Serrogathus sika* (Kriesche, 1921) (from Taiwan, unlikely to be established), *Syndesus cornutus* (Fabricius, 1801) (from Australia, established).

The following 3 species are deleted from the New Zealand fauna: LUCANINAE: *Figulus modestus* Parry, 1863 (= *F. fissicollis* Fairmaire, 1849, from the Pacific, incorrectly labelled), *Figulus monilifer* (= *F. sublaevis* (Palisot de Beauvois, 1805), from Africa, incorrectly labelled), *Lissotes desmaresti* Deyrolle, 1881 (from Tasmania, incorrectly labelled; Holloway (1961) incorrectly treated *L. desmaresti* as a synonym of *Dorcus* (= *Geodorcus*) *capito*).

There is special concern for the survival of some of the large bodied, flightless species of *Geodorcus* that have been found only on islands or isolated mountain tops. These beetles should have the same status as flightless birds in the New Zealand biota and be given the equivalent protection from habitat destruction, rodent predation and unauthorised collectors.

Keywords: Coleoptera, Lucanidae, systematics, keys, morphology, relationships. Holloway, B. A. 2007: Lucanidae (Insecta: Coleoptera). *Fauna of New Zealand* 61, 254 pp.

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CHECKLIST OF TAXA

All the genera and species in this list are endemic to New Zealand, apart from the 4 foreign genera and their species, marked with an asterisk (*).

Family LUCANIDAE Latreille, 1804

Subfamily AESALINAE MacLeay, 1819 27

Genus *Holloceratognathus* Nikolaev, 1998 28*Neoceratognathus* Nikolaev, 1998*cylindricus* (Broun, 1895) 30*helotoides* (Thomson, 1862) 31*areolatum* (Westwood, 1865)*passaliformis* (Holloway, 1962) 33Genus *Mitophyllus* Parry, 1843 35*Ptilophyllum* Guérin-Méneville, 1845*albuguttatus* (Bates, 1867) 39*crisatellus* Broun, 1917*sexpustulatus* (Bates), Gemminger & Harold

1868, nomen nudum

angusticeps Broun, 1895, **reinstated species** 41*mandibularis* 1917, **transferred synonymy***arcuatus* **new species** 43*dispar* (Sharp, 1882) 46*comognathus* Broun, 1903*falcatus* **new species** 48*foveolatus* (Broun, 1880) 50*fusculus* (Broun, 1886), **reinstated species, new****combination** 52*gibbosus* (Broun, 1885) 54*tuberculatus* Broun, 1893*insignis* Broun, 1923 56*irroratus* Parry, 1843 58*curvidens* Broun, 1904*godeyi* (Guérin-Méneville, 1845)*macrocerus* (Broun, 1886) 61*parrianus* Westwood, 1863 62*marmoratus* Waterhouse, 1874*zealandicus* (Broun, 1877)*reflexus* Broun, 1909 65*solox* **new species** 67

Subfamily LAMPRIMINAE MacLeay, 1819 69

Genus *Dendroblax* White, 1846 69*earlii* White, 1846 70*acutangulus* Arrow, 1935Genus *Lamprima** Latreille, 1807 71*aurata** Latreille, 1817. **Not known to be****established in New Zealand** 72

Subfamily SYNDESINAE MacLeay, 1819 73

Genus *Syndesus** MacLeay, 1819 73*cornutus** (Fabricius, 1801) 74

Subfamily LUCANINAE Latreille, 1804 75

Genus *Geodorcus* Holloway, 1996 75*alsobius* **new species** 79*auriculatus* (Broun, 1903) 81*capito* (Deyrolle, 1873) 83*dispar* (Broun, 1910)*helmsi* (Sharp, 1881) 85*acmenus* (Lewis, 1902)*aemulus* (Broun, 1893)*ithaginis* (Broun, 1893) 88*montivagus* **new species** 91*novaezealandiae* (Hope, 1845) 93*abditus* (Broun, 1881)*caviceps* (Westwood, 1855)*punctulatus* (White, 1846)*philpotti* (Broun, 1914) 95*servandus* **new species** 97*sorum* **new species** 99Genus *Paralissotes* Holloway, 1996 102*mangonuiensis* (Brookes, 1927) 104*oconnori* (Holloway, 1961) 105*planus* (Broun, 1880) 107*reticulatus* (Westwood, 1844) 109*cicatricosis* (Burmeister, 1847)*squamidoris* (White, 1846)*zealandicus* (Blanchard, 1847)*rufipes* (Sharp, 1886) 110*elegans* (Broun, 1893)*stewarti* (Broun, 1881) 112*triregius* (Holloway, 1963) 114Genus *Ryssonotus** MacLeay, 1819 115*nebulosus** (Kirby, 1818) 116Genus *Serrognathus** Motschulsky, 1861 118*sika** (Kriesche, 1921). **Not known to be****established in New Zealand** 120

SPECIES DELETED FROM THE NEW ZEALAND LUCANIDAE

Figulus modestus Parry, 1862 (= *F. fissicollis* Fairmaire, 1849 from the Pacific) and *F. monilifer* Parry, 1862 (= *F. sublaevis* (Palinot de Beauvois, 1805) from Africa) apparently labelled from New Zealand in error, see page 14.

Lissotes desmaresti Deyrolle, 1881. Labelled in error from New Zealand, treated as a synonym of *Dorcus capito* Deyrolle, 1873 by Holloway (1961), now recognised as a Tasmanian species (Moore & Cassis 1992).

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I congratulate and thank Dr Greg Sherley and Keith Owen of the New Zealand Department of Conservation for organising and participating in surveys of several *Geodorcus* species and for keeping me informed by sending specimens and reports.

During the long period that I have worked at home on this project Trevor Crosby has been extremely helpful having, among other things, taken responsibility for loans of material that were made to me from various institutions. I am especially appreciative of a New Zealand Lottery Board grant made to me in 1991 to assist in purchasing the microscope and drawing tube used for completing this revision. Special thanks go to my daughter, Gerda, for her willingness to help me with my computer problems. Finally I thank most sincerely the referees who went meticulously through the manuscript and suggested ways to improve the text.

INTRODUCTION

The Lucanidae is a relatively small family with about 1300 described species worldwide (Franciscolo 1997; Bartolozzi *et al* 1998; Bartolozzi & Sforzi 2005). The usually robust body, clubbed and often geniculate antennae and, in many males, the disproportionately large and ornate mandibles are distinctive features that make lucanids some of the most easily recognised beetles.

In Europe and parts of the world where Europeans have settled, lucanids are known popularly as stag beetles or flying stags or a title that translates to these names, e.g. Hirschkäfer in German, cervo volante in Italian, cerf volant in French. It is generally assumed that these are old names chosen because of the often antler-like mandibles of males, but the comparison with stags is actually relatively recent.

Cameron (1980) found that the name *Lucanus* has been applied to lucanids since at least the first century B.C. at which time it had an association with elephants, not stags. The following extracts are from his paper. ‘*Lucanus* is a Latin word meaning “coming from Lucania” [present day Basilicata in southern Italy].....Pliny the Elder [23–79] says [N[aturalis] H[istoria] 11.34.97], “In one large kind of insect there are very long horns, toothed with two pronged forceps, which come together at the tips for pinching. These beetles are hung around the necks of children for amulets. Nigidius calls them Lucani.” The Nigidius whom Pliny mentioned was.....Nigidius Figulus, an encyclopaedist of the first century B.C., whose work survives only in fragments. In order to understand why Nigidius called them Lucanian beetles, we must appeal to Roman history, and to.....Latin military slang, which developed during Rome’s wars with King Pyrrhus of Epirus. At the battle of Heraclea in Lucania (280 B.C.) the Romans first saw war elephants.....The soldiers began to call these unfamiliar, huge, tusked beasts “Lucanian cows”.....and it soon became a commonplace expression.....Nigidius Figulus, contemplating the great size and tusklike mandibles of these insects, called them “Lucanian beetles” by way of saying “elephant beetles”. The name endured, thanks to Pliny, although the metaphor was forgotten, and replaced in the Renaissance with a comparison to a stag.’

Major F.J.S. Parry, an entomologist in England, was the first person to record stag beetles from New Zealand. In 1843 he published the description of *Mitophyllus irroratus*, new genus, new species, from two specimens collected at Port Nicholson (now Wellington Harbour). Shortly after, descriptions of *Lucanus* (now *Paralissotes*) *reticulatus* Westwood, 1844 and *Lucanus* (now *Geodorcus*) *novaezealandiae* Hope, 1845 were published and although the type specimens are stated to be merely from New

Zealand it is likely that they also were collected in the vicinity of Port Nicholson, where both species can still be found. The type locality of *Dendroblox earlii* White, described in 1846 is the Hutt River, at Port Nicholson. For the next 50 years many new species of New Zealand lucanids were described, some by coleopterists living in Europe, and others by Major Thomas Broun who was working in relative isolation in New Zealand. Frequently the species were based on single specimens and as at that time very little was known about sexual dimorphism and morphological variation in the New Zealand lucanid fauna some of the names were later found to be synonyms. The first edition of the Coleopterorum Catalogus Lucanidae (Roon 1910) recorded 27 valid New Zealand species spread among the two endemic genera, *Dendroblox* White, 1846 and *Mitophyllus* Parry, 1843 and in the Australian genera *Lissotes* Westwood, 1855 and *Ceratognathus* Westwood, 1838. The second edition of the catalogue (Benesh 1960) recorded 35 New Zealand species (including in error the Australian species *Lissotes basilaris* Deyrolle, 1881) placed in *Dendroblox*, *Lissotes*, and in *Ceratognathus*, under which *Mitophyllus* appeared as a synonym.

My previous revision of the New Zealand Lucanidae (Holloway 1961) recognised 24 endemic species, assigned to *Dendroblox*, *Dorcus* MacLeay, 1819, *Lissotes*, and *Ceratognathus*, and referred to the paper by Gourlay (1954) which reported the establishment in Gisborne of the Australian lucanid, *Ryssonotus nebulosus* (Kirby, 1818).

Since 1961 two more endemic species have been described (Holloway 1962, 1963a), and two new endemic genera, *Geodorcus* Holloway, 1996 and *Paralissotes* Holloway, 1996 have been established for the species previously placed in *Dorcus* and *Lissotes* respectively (Holloway 1996). The New Zealand lucanids that had been assigned to *Ceratognathus* have been shown not to belong in that genus (Holloway 1997); three of the species are now in the endemic genus *Holloceratognathus* Nikolaev, 1998 created initially as a subgenus of *Ceratognathus*, and the remainder have been transferred to the reinstated endemic genus *Mitophyllus* (Holloway 1998). Two more Australian lucanids have been added to the New Zealand list; one of these, *Syndesus cornutus* (Fabricius, 1801), has become established here (May 1963), the other, *Lamprima aurata* Latreille, 1807 is known only from a single live specimen found in a rural situation in 1990 (Holloway 1997).

For several years the New Zealand fauna was thought to include *Figulus modestus* and *F. monilifer*. Parry (1862) described these as New Zealand species without knowing that their provenance was in doubt and that names had already been applied to both species. *Figulus modestus* was actually a synonym of *F. fissicollis* Fairmaire, 1849

from the Pacific and *F. monilifer* was a synonym of the African species, *F. sublaevis* (Palinot de Beauvois, 1805). The synonymic errors were rectified by Parry (1864a, 1875) and doubts about the New Zealand records were indicated by Parry himself (1864a) and by Sharp (1884). Neither species has subsequently been found here so it is reasonable to conclude that the supposed New Zealand association resulted from mislabelling of specimens. Benesh (1960) sensibly deleted New Zealand from the range of *Figulus*.

The present revision deals with adults of the 39 species that have been found in outdoor situations in New Zealand. Thirtyfive of the species are endemic and belong in five endemic genera representing three widely distributed subfamilies: *Dendroblax* (Lampriminae), *Geodorcus* and *Paralissotes* (Lucaninae), and *Holloceratognathus* and *Mitophyllus* (Aesalinae). Of the remaining four species, the three from Australia, *Lamprima aurata* (Lampriminae), *Ryssonotus nebulosus* (Lucaninae), and *Syndesus cornutus* (Syndesinae), have already been mentioned and the fourth is a Taiwanese species, *Serrognathus sika* (Kriesche, 1921). Three males of this large lucanine were found outdoors in a residential area of Auckland during the summer of 2000–2001 and to date these are the only known New Zealand specimens. In Asia where the genus is widely distributed large males of some of the species are often kept as pets, and it is likely that the specimens found in New Zealand were brought here for that purpose.

This revision records three new species of *Mitophyllus* and four of *Geodorcus*. In addition, two species of *Mitophyllus* are reinstated. There are no new synonymies but one transferred synonymy. While some of the New Zealand lucanids are widely distributed and relatively common others are known from just a few localities, and several are represented in collections by only one or two specimens. Undoubtedly new species, particularly of the genus *Geodorcus*, await discovery on remote and less accessible mountains in the South Island, and perhaps on some offshore islands. The genus *Mitophyllus* has produced several surprises in the present study, including the discovery of two new species that are “look alike” of the common and widely distributed *M. parrianus* Westwood with which they are sympatric. The most obvious external differences between these three species are in the shape of the mandibles in males, but to the naked eye, especially in the field, these features could easily be overlooked. However, a $\times 10$ hand lens provides enough magnification to recognise each of the species and, as well, will allow field identification of most of the other New Zealand stag beetles.

For centuries artistically creative people have featured stag beetles in paintings and books, on jewellery, bronzes,

and porcelain, and more recently as larger-than-life plastic models that are available in toy departments. Beautiful coloured plates showing some of these items, dating from the 16th century to the present day, are included in the magnificent book “Il Cervo Volante (Coleoptera Lucanidae)” edited by Giorgio Taroni (1998). New Zealand has its own example, carved in kauri wood: a male of the large, flightless lucanid, *Geodorcus helmsi*, is one of the insects depicted on the spectacular pare (door lintel) at NZAC, Landcare Research, Auckland. A representation of the pare appears on the title page of all *Fauna of New Zealand* volumes published since 1990, the year in which the carving was unveiled. Photographs of the pare and a male of *G. helmsi* are shown in the frontispiece of the present volume. Eva Sprecher and Giorgio Taroni (2004) have recently published “*Lucanus cervus* depictus” a most wonderfully illustrated book with the text in both Italian and English on the mythology, superstition and legend of the European stag beetle *Lucanus cervus*.

SYSTEMATICS

Family Lucanidae Latreille, 1804a: 149

In the two major catalogues of Lucanidae (Roon 1910; Benesh 1960) authorship of the family is attributed to MacLeay (1819) but Lawrence & Newton (1995) have traced the first usage of Lucanidae to Latreille (1804a) and this is the citation that I am using here. It is possible that an even earlier date may be available because Latreille (1804b) stated that he had proposed the family several years before in his paper entitled “Précis des caractères génériques des Insectes” (Latreille 1796) (which I have not seen). He goes on to say that from considerations afterwards he had been compelled to reunite Lucanidae with Scarabaeidae (see Latreille 1802) but that a subsequent scrutiny brought him back to the first idea and he therefore re-established the family.

Characterisation of the family

Adult lucanids can be recognised as members of the superfamily Scarabaeoidea by the following characters (based mainly on Lawrence & Britton 1991):

- antennal club with 3–8 segments (Fig. 1);
- pronotum large (Fig. 1, 2);
- ventral portion of pronotum (hypomeron) on each side joined directly to the prosternum at the notosternal suture (Fig. 2, 50, 51), there being no visible propleuron and therefore no notopleural suture;
- fore coxae very large, transverse or conical, projecting below the prosternum and with posteriorly closed cavities (Fig. 2, 50);

fore tibiae somewhat flattened, with 1 or more teeth on the dorsal (outer) edge, and a single apical spur (Fig. 1, 63);

tarsi with 5 distinct segments, none of these lobed (Fig. 1).

The New Zealand lucanids are distinguished from Scarabaeidae and Trogidae, the other scarabaeoids in New Zealand, by the following combination of characters (partly from Lawrence & Britton 1991 and Klimaszewski & Watt 1997):

head never completely concealed by the pronotum, and never with conspicuous horns nor with very large tubercles;

mandibles well developed, extending forward horizontally beyond the frons, sexually dimorphic, those of males usually larger and more elaborately toothed than those of females;

antennae relatively long, 10-segmented;

antennal club segments thick, somewhat cylindrical in cross section, never leaf-like, always capable of at least some separation (Fig. 1);

scape long, slender, clearly visible when the antenna is extended laterally;

mid coxal cavities open laterally (Fig. 2), that is, partly closed by the mesepimera in contrast to cavities which are closed laterally by the broad meeting of the meso- and metasterna (see Klimaszewski & Watt 1997, fig. 43 for cavities which are closed laterally);

abdomen with 5 ventrites (Fig. 2).

Lucanid larvae are typically scarabaeiform (Klimaszewski & Watt 1997, fig. 98) with a C-shaped body, a strongly sclerotised and deeply pigmented head, long antennae, and well developed legs. They differ from other scarabaeoid larvae in having a stridulatory apparatus consisting of a patch of fine asperities (the *pars stridens*) on the mid coxae and a row of larger asperities (the *plectrum*) on the hind coxae, by lacking transverse folds on the abdominal terga and in having a longitudinally oval pad on either side of the vertical anal opening. Stridulatory structures and other lucanid larval features in a range of species including some found in New Zealand are discussed and illustrated in Alderson (1975), Lawrence (1981a), and Francisco (1997).

Classification of the Lucanidae

Historically the classification of the family has been very controversial with from 3 subfamilies (Sharp & Muir 1912) to 10 subfamilies (Didier & Séguéy 1953) being proposed, and with equal confusion about the assignment of genera to the subfamilies (Holloway 1960). A detailed study of the

external morphology and male genitalia of species representing several key lucanid genera (Holloway 1960, 1968, 1969, 1972) resulted in a proposal to divide the family into 4 subfamilies, Aesalinae, Lampriminae, Lucaninae, and Syndesinae, and this classification continues in general to be followed by recent workers (D'Hotman & Scholtz 1990; Nel & Scholtz 1990). Howden & Lawrence (1974) increased the number to 5 by establishing Nicaginae to contain *Nicagus* Leconte and *Ceratognathus* Westwood, which I had treated as aesalines. I do not think the differences they have emphasised warrant the creation of a separate subfamily and until a more detailed study has been made of all the genera involved I prefer to treat *Nicagus* and *Ceratognathus* as aesalines (Holloway 1998). A separate subfamily, Penichrolucaninae, was proposed by Arrow (1950) for the few species of *Penichrolucanus* Deyrolle, 1863 but it is likely that this mainly tropical genus belongs in Lucaninae.

Together the 3 subfamilies Aesalinae, Lampriminae, and Syndesinae comprise only about 100 species compared with the approximately 1200 species in Lucaninae. As a group the 3 subfamilies are easily separated from Lucaninae by their partially or non-geniculate antennae (compared with the geniculate antennae of Lucaninae), their entire (undivided) eyes (rather than the partially or completely divided eyes of Lucaninae), the apical (rather than basal or central) position of the labium on the mentum, the highly unusual sclerotised prementum that looks superficially like a segment of the labial palp, (compared with the "normal" membranous prementum of Lucaninae) (see Fig. 7–12), and the eversible internal sac (rather than a permanently everted internal sac) of the male genitalia. Howden & Lawrence (1974) consider the eyes of *Aesalus* Fabricius not to be entire, but the structure they interpret as a canthus is not actually joined to the eye, instead it merely overlies it (see Holloway 1969 for a discussion on the canthus).

The conspicuous sexual dimorphism and allometry that are features of many stag beetles especially those in Lucaninae have created problems in delimiting species. At the generic level difficulties are likely to arise because of convergence, very similar external features being conspicuously present in otherwise completely different and unrelated lucanids. The group with which I am especially familiar in this category is the *Serrognathus* complex. In the process of identifying *S. sika* (Kriesche) for this revision I was able to examine a small range of species, all of which are currently placed either in *Serrognathus* Motschulsky or in *Dorcus* MacLeay. Externally they share a number of prominent features. They are large, rather flattened, shiny, black lucanids with very broad rectangular heads and broad rectangular pronota, and the males all have long, somewhat similarly dentate

mandibles, but a study of both the male and the female genitalia and a subsequent detailed examination of less conspicuous external structures (mentum, antenna, 5th ventrite) has indicated that 5 different genera are represented in this group of species (see section on *Serrogathus* in this volume). The configurations of both the male and the female genitalia provide the most reliable features for distinguishing genera throughout Lucanidae (e.g., see fig. 22–38 in Holloway 1998). Having grouped specimens according to these configurations it is easy to find additional generic characters on external parts of the body. Considering the present uncertainties about limits of genera and subfamilies in Lucanidae the category “tribe” seems to me to be meaningless and misleading, and I do not use it.

COMPOSITION AND RELATIONSHIPS OF THE ENDEMIC LUCANIDAE

Three subfamilies, Aesalinae, Lampriminae, and Lucaninae, are represented in the endemic fauna.

Subfamily Aesalinae MacLeay, 1819 currently comprises about 55 species placed in 7 genera. The New Zealand representatives belong in 2 endemic genera, *Holloceratognathus* Nikolaev, 1998 with 3 species and *Mitophyllus* Parry, 1843 with 14 species. Of the remaining genera, *Aesalus* Fabricius, 1801 has 6 species that range from Europe eastward to Japan and southeast Asia and 3 species in Central America; *Ceratognathus* Westwood, 1838 has about 14 species in Australia and Tasmania; *Hilophyllus* Paulsen & Mondaca, 2006 has 2 species in Chile and a 3rd found in both Chile and Argentina (Paulsen & Mondaca 2006); *Echinoaesalus* Zelenka, 1993 has about 9 species, all in southeast Asia; *Lucanobium* Howden & Lawrence, 1974 has a single species in Venezuela; and *Nicagus* Leconte, 1861 has 2 in the eastern United States and 1 in Japan (Araya *et al.* 1997; Franciscolo 1997; Bartolozzi *et al.* 1998; Paulsen & Smith 2005). Distinctive features of the subfamily are: elytral vestiture which always includes linear or ovate or fan-shaped scales, and the lack of paired struts inside the basal piece of the male genitalia. *Holloceratognathus* has more features in common with *Nicagus* than with any of the other genera, especially in the configurations of the male and female genitalia, but also in the ultrastructure of the elytral pits. *Mitophyllus* has uniquely distinctive elytral scales but has some features of *Ceratognathus* and *Holloceratognathus*. The front tibial teeth and the male antennae in some of its species are like those in *Hilophyllus*. External and internal morphological similarities and differences among *Ceratognathus*, *Holloceratognathus*, and *Mitophyllus* are discussed and figured in Holloway (1997, 1998). Descriptions and illustrations of the *Hilophyllus* species are provided in

Paulsen & Mondaca (2006).

Subfamily Lampriminae MacLeay, 1819 is the smallest subfamily with 5 genera and about 11 currently recognised species, all confined to the Southern Hemisphere. *Dendroblax* White, 1846 with a single species is endemic to New Zealand; *Streptocerus* Fairmaire, 1850 has 1 species in South America; and *Homolamprima* MacLeay, 1885 with 1 species, *Lamprima* Latreille, 1807 with about 5 species, and *Phalacrognathus* MacLeay, 1885 with 1 species are mostly in the greater Australian region and New Guinea (Moore & Cassis 1992; Franciscolo 1997; Bartolozzi *et al.* 1998; Bartolozzi & Sforzi 2005). The structure of the elytral surface in lamprimines is extremely distinctive and perhaps unique within Lucanidae. The surface lacks dense vestiture, having instead sparse simple, undivided linear setae or scales, each with a large pore close to its base (Holloway 1997). *Dendroblax* is set apart from the other 4 genera by its very convex, scarabaeid-like body with uneven, dull, brown integument dorsally (not smooth, shiny, iridescent or black integument), almost negligible sexual dimorphism, small mandibles in both sexes, strongly fossorial legs, and dense, long setae on the underside of the body (not sparse, short setae).

Subfamily Lucaninae Latreille, 1804 with approximately 100 genera and 1200 species (Franciscolo 1997; Bartolozzi *et al.* 1998; Bartolozzi & Sforzi 2005) is the dominant subfamily. Lucanines are the “typical” stag beetles, often large-sized, usually with conspicuous sexual dimorphism, frequently exhibiting allometric growth in males, and with antennae that are distinctly geniculate and eyes that are completely or partially divided by a canthus. The subfamily is distributed worldwide but is especially abundant in the tropics. The New Zealand representatives belong in 2 endemic genera: *Geodorcus* Holloway, 1996 with 10 species and *Paralissotes* Holloway, 1996 with 7 species. In both genera all the species are flightless, have incompletely divided eyes, a sclerotised point or hook on the apex of the lacinia on the maxillae, and an expanded apex on the permanently everted internal sac of the male genitalia, these combined characters separating them from the majority of lucanines. *Geodorcus* is morphologically more similar to *Apterodorcus* Arrow, 1943 from Chile than to any other lucanine I have examined. Important shared characters of the two genera are the dendritic elytral setae with tapering apices, the lateral bridge and sclerotised sides of the penis in males, and the styli and a crescentic spermatheca in females. *Paralissotes* has features in common with both *Lissotes* Westwood, 1855 from Australia and Tasmania and *Pycnosiphorus* Solier, 1851 from Chile but the morphological similarities of *Lissotes* and *Pycnosiphorus* are much greater than those shared by either genus with *Paralissotes*. The fan-shaped, ribbed elytral

scales of *Paralissotes* are unlike any other lucanid scales known to me and contrast markedly with the elytral setae divided into numerous truncate-tipped “fingers” that are present in *Lissotes* and *Pycnosiphorus*. The elytral vestiture and other morphological features of these 3 genera are illustrated and discussed in Holloway (1996, 1997).

GENERAL MORPHOLOGY, TERMINOLOGY, AND MEASUREMENTS

“In fact, many of the tiny bristles or hairs that occur to one degree or another on most insects are sense organs.” Matthews, R. W. & Matthews J. R. 1978 “Insect Behavior” p.268.

This morphological account uses New Zealand examples. For the morphology of some exotic species see Holloway (1960, 1968, 1969), Nel & Scholtz (1990), D’Hotman & Scholtz (1990), and Franciscolo (1997). Figures 1 and 2 show the basic morphology of adult lucanids and are mostly self-explanatory. Figures 3 to 74 show other morphological features that are referred to below or elsewhere in the text. Where necessary, the manner in which measurements have been taken is indicated on the figures. The terminology is mainly that used in my previous papers especially Holloway (1960, 1961, 1969) and is based to a large extent on the pioneering reference works of Snodgrass (1935) and Lindroth (1957).

HEAD The **labrum** (Fig. 1, 3) is by definition (Snodgrass 1935) the preoral lobe of the head. Usually it is separated from the rest of the head by the **labral suture**, the only visible suture on the dorsal surface of the lucanid head. This suture is obsolete or even absent in some species. While the limits of the **clypeus**, **frons**, and **vertex** can be determined internally from muscle attachments and tentorial pits, externally they are rather vaguely defined. I do not attempt to delimit the **clypeus**, by definition the facial area of the cranium just above the labrum. Instead I refer to the entire front section of the head extending from the base of the mandibles to the level of the posterior margin of the eyes as the **frons**, the area posterior to the frons as the **vertex**, and any integumental extension between the frons and the labrum as the **intermandibular projection**. The intermandibular projection, which almost certainly includes part of the clypeus, varies from extremely short to conspicuously long and may extend obliquely rather than horizontally to the labrum, sometimes not being visible at all in dorsal aspect (Fig. 5). The region I term the frons probably also includes part of the clypeus and should perhaps be more accurately termed **frontoclypeal region**. In most species the integument above the antennal insertion is raised as the **supra-antennal brow** (Fig. 3) which varies from

slightly convex to conspicuously arched. The **eyes** vary greatly in size and shape and are either entire or divided. The eye is termed **entire** when the anterodorsal angle of the eye lies on the lateral margin of the head (Fig. 1), and **divided** when an integumental projection, the **canthus**, intrudes into the front of the eye separating the eye into upper and lower parts and displacing the anterodorsal angle from the margin to a submarginal position (Holloway 1969). Most commonly the canthus extends only partly across the eye (Fig. 2–4) but in a few species it divides the eye completely into upper and lower parts (Fig. 5). In some species a very short canthus extends forward into the eye from the postocular margin.

The **mouthparts** consist of the **epipharynx**, **labium**, **maxillae**, and **mandibles**. The **epipharynx** is the membranous or partly sclerotised inner lining of the labrum. It forms the roof of the preoral cavity and bears tactile hairs and taste organs on part of its surface (Fig. 6). The floor of the preoral cavity is formed by the **labium** (Fig. 7–12) consisting of the **mentum**, **prementum**, **ligula**, and **labial palps**. The **mentum** is a strongly sclerotised, immovable, somewhat quadrangular plate articulating on the **gula** (Fig. 4). On its internal surface it typically bears the **prementum** which provides support for the ligula and labial palps. In Lucaninae the prementum consists of a pair of pale, rather weakly sclerotised, elongate plates lying against the sides of the ligula, near the middle of the mentum (Fig. 7). Aesalinae, Lampriminae, and Syndesinae do not have these plates and therefore appear to lack a prementum but, as will be shown below, the prementum in these subfamilies is represented by a pair of sclerites at the apex of the mentum (Fig. 9–12). The **ligula** is variably developed but is always setose to some extent. Its apex may be deeply divided (Fig. 7), shallowly notched (Fig. 9, 10), or entire (Fig. 11). In Lucaninae the **labial palps** are clearly 3-segmented and the integument of their segments is smooth and sparsely setose. The base of the 1st labial palp segment in this subfamily is movable on the distal end of the prementum, concealed in ventral aspect by the mentum (Fig. 7), and the intersegmental membrane between the segment and the prementum is conspicuously broad, stiff, and transparent. Nel & Scholtz (1990) consider the labial palps to be 4-segmented in Aesalinae, Lampriminae, and Syndesinae but I disagree with their interpretation. The so-called “basal” or “first” segment in these apparently 4-segmented palps is short, broad, somewhat ring-like, immovably attached to the apical region of the mentum, and at least partly visible in ventral aspect (Fig. 8). Its integumental texture and vestiture are like those of the mentum and not at all like those of the other palp segments, its medial edge is pressed against the sides of the ligula and the intersegmental membrane connecting it to the adjoining

palp segment is like the distinctive membrane between the prementum and 1st palp segment in Lucaninae. In my earlier publications (Holloway 1960, 1961, 1968) I considered this “basal segment” to be part of the mentum because of its position and appearance. Having re-examined the labium in a range of species I now consider the pair of “basal segments” in Aesalinae, Lampriminae, and Syndesinae to be the highly modified prementum, and confirm that the labial palps are 3-segmented throughout Lucanidae. The **maxillae** lie between the mentum and the mandibles. Several types of maxillae are shown in Fig. 13–17. The **maxillary palps** are always 4-segmented. Sexual and generic differences are sometimes apparent in the form of the **galea** and **lacinia**, and in the size of the palp segments. The galea always has brushes or bands of long setae on its medial edge and apically, and a few sclerotised hooklets may be present among the setae (Fig. 13). The apex of the lacinia can be developed as a strongly sclerotised hook (Fig. 13) or a blade (Fig. 14) but more commonly it is unarmed and entirely setose (Fig. 15–17). The **mandibles** form the outer lateral margin of the preoral cavity (Fig. 4, 6). Their exposed distal part has teeth or lobes whose shape and position provide important characters for identifying and sexing specimens. The proximal part of the mandible, partly concealed within the head capsule, may have a variably developed lobe, the **mola**, on its medial edge (Fig. 6). In phytophagous beetles the mola is used for crushing and grinding plant material but its function is unclear in stag beetles as they mostly feed exclusively on sap and nectar. The mandibles are almost always larger and more ornate in males than in females of the same species. However, in several New Zealand species, e.g., *Holloceratognathus cylindricus* (Broun) and *H. passaliformis* (Holloway), the mandibles in both sexes are small and extremely similar in appearance. Mandibles of some *Geodorcus* males are strikingly allometric, becoming disproportionately larger with the increase in body size in individuals of the same species. Short, crescentic mandibles are typical of most lucanid females (Fig. 2–4) but not all (Fig. 5).

The mouthparts of several exotic lucanids and 2 New Zealand species are described and illustrated by Nel & Scholtz (1990) in a very comprehensive survey of these structures in Scarabaeoidea.

The **antennae** are set in the **antennal fossae** located ventrally between the eye and the outer margin of the mandible (Fig. 2, 4). They are 10-segmented in all the New Zealand species (Fig. 1, 18–20) and in most other lucanids. Depending on the way in which the 2nd segment (**pedicel**) articulates on the 1st segment (**scape**), the antennae are termed **geniculate**, **non-geniculate**, or **partially geniculate** (Holloway 1960). In geniculate antennae (Fig.

18) the scape is almost straight not arched, considerably widened distally, and the pedicel articulates dorsally a short distance from the distal end of the scape and can be held at a right angle to it. In non-geniculate antennae (Fig. 19) the scape is strongly arched, approximately uniformly wide throughout its length, and the pedicel articulates on the whole distal end of the scape and cannot be held at a right angle to it. The scape of this type of antenna frequently has on its dorsal or posterodorsal surface a row of long setae and an associated short groove. Partially geniculate antennae (Fig. 20) have a slightly arched scape that is not conspicuously widened distally, and the pedicel articulates somewhat dorsally on or very close to the oblique distal end of the scape and can be held almost at a right angle to it. In this type of antenna the scape may have a row of setae and an associated groove on its posterodorsal surface. The **antennal club** consists of 3–7 segments which are recognisable as belonging to the club by their partially or completely pubescent or densely setose surface and not necessarily by being different in shape and size from the preceding segments. Club segments may be stout to slender, rather rigidly opposed or loose and free, but never lamellate. Males usually have larger club segments than females and in some e.g. *Mitophyllus irroratus* Parry the segments have spectacularly long setae. The 5 segments between the pedicel and club comprise the **funicle**.

THORAX External thoracic structures are shown in Fig. 1 and 2. The discal surface of the **pronotum** and **elytra** occasionally has tubercles but mostly the integument is smooth. A broad horizontal or reflexed **brim** is present on the lateral margin of the pronotum in some species and there may be a narrower brim on the sides of the elytra. The pronotal and **elytral integument** in lucanids always has some **punctures** and usually **setae** or **scales** on it. Punctures in the brim are often larger than those elsewhere on the body and are the best ones for showing the floor and wall structure, under a stereomicroscope. The density and size of the punctures and the colour pattern and angle of inclination of the vestiture are usually distinctive for species. The ultrastructure of the elytral vestiture and of the associated pits (punctures), pores, and adjacent integument includes characters that can be used to define genera and even one of the subfamilies (Lampriminae). Examples of the diverse **elytral ultrastructure** found in Lucanidae are shown in Fig. 21–42. The micrographs (Fig. 31–42) are of the elytral surface immediately anterior to the elytral declivity, and the drawings (Fig. 21–30) are of vestiture also from this part of the elytra.

A typical lucanid **wing** is shown in Fig. 43. The terminology applied to the veins is that used in my paper on New Zealand lucanid wings (Holloway 1963b). In flying species the wings range from 1.6–2.1× the elytral length.

All the species of *Geodorcus* and *Paralissotes* have vestigial wings ranging from 0.2–0.8× the elytral length (Fig. 46–49), depending on the species. *Mitophyllus fuscus* (Broun), is the only flightless species in the genus and only its females are vestigial winged. The wings are 1.7× longer than the elytra in the males but in the females they are the same length as the elytra (Fig. 45). The actively flying species *Holloceratognathus cylindricus* (Broun) and *H. helotoides* (Thomson) have “normal” wings that are respectively about 1.8× and 1.6× the elytral length and have a “normal” anal area while those of *H. passaliformis* (Holloway) which is found in ants nests are about 1.5× the elytral length and have shortened anal veins (Fig. 44).

Features of the ventral surface of the thorax are shown in Fig. 2 and Fig. 50–52. The **prosternal process** is on the midline of the prosternum, between the coxal cavities. In the New Zealand lucanines this process is very broad, widely separating the coxae (Fig. 2, 50). In the New Zealand examples of the other subfamilies the process is narrow and the medial edges of the coxae almost touch on the midline (Fig. 51, 52). I refer to the legs on the pro-, meso-, and metathorax as the **fore** or **front**, **middle**, and **hind legs** respectively but when appropriate I apply the prefixes pro-, meso-, and meta- to parts of the legs. The **procoxal process** is a ventrally directed lobe on the anteromedial edge of the procoxa. In general, species with a broad prosternal process lack a procoxal process (Fig. 50) while those with a narrow prosternal process may have either a large procoxal process (Fig. 51) or one that is quite small (Fig. 52). The profemur in all lucanids has a conspicuous patch of orange or yellow setae on its anterior surface. I refer to this as the **femoral setiferous patch**. Some other scarabaeoids also have this patch, usually in a reduced form. Associated with the femoral setiferous patch is a broad band of setae, here termed the **procoxal fringe patch**, which is on the posterior surface of the opposing procoxa. The fine structure of both patches seems not to have been investigated previously so I have included details of these as seen with a scanning electron microscope (Fig. 53–58) and with a stereomicroscope (Fig. 59–62). Most commonly the femoral patch is on the proximal half of the femur and is about half its length (Fig. 53, 59) but it may be considerably larger (Fig. 61) or smaller (Fig. 62). Its setae are long, soft, appressed, overlapping, and directed ventrally (Fig. 53). Their bases are set in sockets (Fig. 54) and throughout their length the setae are grooved (Fig. 55). No glandular openings are present on the floor of the patch (Fig. 54). The procoxal fringe patch is a rather broad band of setae located close to the ventral margin on the posterior surface of the procoxa (Fig. 56, 60). The band is similar in length to that of the associated femoral patch. The apices of some of the procoxal patch setae project beyond the

ventral margin to form a distinct fringe (Fig. 56, 59–62). In colour, length, and angle of inclination the procoxal fringe and patch setae are like those in the femoral patch except that in addition to being grooved they are barbed, sparsely on their basal and middle regions (Fig. 57) and densely towards the apex (Fig. 58). No glandular openings are present on the floor of the procoxal fringe patch (Fig. 58). When the profemur is extended outwards at a right angle to the ventral midline of the body its anterior surface is pressed against the posterior surface of the procoxa. In this position the barbed setae of the coxal fringe spread across the grooved setae of the femoral patch and the apices of both types of setae are directed ventrally. Whether the setae interlock in a “velcro” type of arrangement has not been determined. As there are no glandular openings associated with their bases both types of setae are unlikely to be involved in dispersing chemicals. Perhaps their role is to position the procoxa against the profemur, e.g., during walking, although why a special mechanism should be required is not clear. The procoxae of *Holloceratognathus passaliformis* are unusual in having a crescentic integumental flange that covers the fringe patch (Fig. 62) and also overlies the femoral patch when the femur is extended outwards.

In the New Zealand lucanids the **protibiae** have 2 main dentition patterns, either with numerous variably or similar-sized small teeth, a large apical tooth, and a somewhat smaller mid dorsal tooth (Fig. 1), or with fewer teeth, all rather broad-based, which increase in size from the proximal end of the tibia to its apex (Fig. 59, 63). The **mid dorsal tooth** is often located near the middle of the protibia but sometimes lies closer to the apex. Some species have a mid dorsal tooth as well on the tibiae of the middle and hind legs (Fig. 1). If the **tibial teeth** are sharply pointed they look like spines and may be referred to by that term. Structurally they are rather plate-like, often curved, with their underside concave at the base and overhanging a shallow depression containing a small seta or scale. I am unaware of any detailed study that has been made on the tibial teeth in lucanids and other scarabaeoids but in some Diptera very similar looking tibial units have a glandular opening in the concave floor and are known to be sites of pheromonal release (Schlein *et al.* 1980).

The tarsi of all the legs have 5 **tarsomeres** and a pair of **claws**. The **arolium** (Fig. 63) lying between each pair of claws consists of a long or short rod with 2 or more setae arranged on either side of its apex.

ABDOMEN There are 5 visible **ventrites** (Fig. 2). The 5th ventrite in males differs in length from that in females and its apex is notched, truncate, or narrowly convex, not broadly convex as it usually is in females.

Male genitalia. The terminology applied to the various structures is that used in my previous papers (Holloway

1960, 1961, 1998). Terms in parentheses are those used by D'Hotman & Scholtz (1990). The male genitalia consist of the **9th abdominal segment** (genital segment) and the **aedeagus**. The 9th abdominal segment comprises a stalked **sternite** (ventral plate), a sessile **tergite** (dorsal plate), and a pair of stalked **pleurites** (lateral plates) (Fig. 64, 67) that together form a cylinder around the aedeagus when it is in repose. Most commonly the 9th abdominal segment is bilaterally symmetrical (Fig. 64), but in a few species it is asymmetrical (Fig. 67). The aedeagus is composed of a **basal piece**, a pair of **parameres**, the **penis** (median lobe), an **internal sac** continuous with the **ejaculatory duct** and, in some species, a **pair of struts** (temones) which articulate on the base of the penis. The basal piece and parameres together comprise the **tegmen**. In Lucaninae (Fig. 65, 66) the penis rests on the distal end of the basal piece and a pair of struts articulates on a dorsal or dorsolateral **cross bar** at its base (Fig. 66). The internal sac in this type of genitalia is permanently everted and has the form of either a strap-shaped or lobed structure (Fig. 65) or terminates in a flagellum. In the other subfamilies the penis does not rest on the end of the basal piece but instead is enclosed to some extent within it (Fig. 68), a pair of struts may be present or absent (Fig. 68) at the base of the penis, and the internal sac is eversible, lying within the penis when in repose but emerging through the aperture (**ostium**) at the distal end of the penis during copulation. The form of the male genitalia is constant within genera and is also indicative of subfamilies. Illustrations and descriptions of the male genitalia in a range of lucanids are available in Holloway (1960, 1968, 1969, 1998) and in the comprehensive paper on the male genitalia of Scarabaeoidea by D'Hotman & Scholtz (1990) who consider the function and phylogenetic significance of the various components.

Female genitalia. These consist of the well sclerotised **tergite**, paired **pleurites**, and divided **sternite** of the **9th abdominal segment**, the strongly sclerotised **hemisternites** of the **10th abdominal segment**, and the weakly sclerotised **internal genitalic structures**. Two types of genitalia, depicted in the customary ventral aspect, used throughout this revision, are illustrated in Fig. 69 and Fig. 70. Unfortunately, important specific and generic features of the tergite and pleurites of the 9th segment (Fig. 71–74), visible dorsally, cannot be seen in this aspect, and probably warrant a separate study at a later date. The 9th abdominal segment and hemisternites are always bilaterally symmetrical even in species whose males have asymmetrical genitalia. The shape and configuration of the softer internal structures are extremely important for delimiting species and genera but seem not to be useful for distinguishing subfamilies. The **spermatheca**, **spermathecal gland**, and **spermathecal duct** are easily recognised (Fig. 69, 70).

The **bursa copulatrix** may be large and saccate, or bilobed, or developed as a small pouch but regardless of its shape it is recognisable because the spermathecal duct inserts on its wall. Very rarely, as in *Dendroblox earlii*, the bursa copulatrix is developed only as a tube continuous with the spermathecal duct from which it is indistinguishable. The **bursal duct** is joined to the **vagina** and extends from the base of the **median oviduct** to the bursa copulatrix. It may be very much narrower than the vagina (Fig. 70) or equal in width to it (Fig. 69). An **accessory gland** if present arises on the side of either the vagina (Fig. 69) or the bursal duct. The genitalia shown in Fig. 70 lack an accessory gland. The vagina continues distally to the **vulva**, a transverse slit in the membrane between the hemisternites.

Terminology of the vestiture and punctures The curvature and angle of inclination of the setae and scales are shown in Fig. 75. I refer to elements of the vestiture that are approximately circular in cross section as **setae** and those that are either laterally compressed or dorsoventrally flattened as **scales**. In descriptions of the gross morphology of the integument it is customary to refer to the depression surrounding the socket in which a seta or scale is located as a **puncture**. At the ultrastructural level punctures are more accurately termed **pits** to give recognition to their physiological significance (Holloway 1997). In referring to the size of punctures and vestiture and their density I have used vernacular terms, small, short, dense, etc. The approximate measurements that these translate into, using a calibrated ocular micrometer, are given below.

Puncture diameter: minute, less than 0.02 mm; small, 0.02–0.1 mm; moderately large, 0.1–0.2 mm; large, more than 0.2 mm.

Puncture density (distance between margins of adjacent punctures): very dense, less than 0.02 mm; dense, 0.02–0.1 mm; moderately dense, 0.1–0.2 mm; sparse, more than 0.2 mm.

Seta/scale length: minute, less than 0.02 mm; short, 0.02–0.1 mm; moderately long, 0.1–0.2 mm; long, more than 0.2 mm.

BIOLOGY

No detailed behavioural or life history studies have been made for any of the stag beetles found in New Zealand. The currently available information comes mainly from label data accompanying the specimens examined and from a few published observations (Hudson 1934; Sherley *et al.* 1994; Thorpe 2001).

Habitats of adults and larvae

With the exception of *Dendroblox earlii*,

Holloceratognathus helotoides, and a few species of *Mitophyllus*, adults and larvae of the endemic lucanids are confined to areas of predominantly indigenous vegetation or places where the forests have disappeared but large rotting logs remain on the ground. Adults of *D. earlii* have most frequently been collected in the vicinity of native forests but a few specimens have been found in pastures and gardens where their larvae are thought to be feeding on roots of grasses. Adults of *H. helotoides* are usually associated with native trees but on several occasions have been found inside hardwood poles, and the few *Mitophyllus* species that can extend their range into suburban or rural areas have larvae that are able to develop in rotting branches and logs of some exotic trees. The two Australian species established in New Zealand, *Ryssonotus nebulosus* and *Syndesus cornutus*, seem not to invade our native forests, the larvae of *R. nebulosus* develop in large rotting stumps of several species of introduced trees (Thorpe 2001) and those of *Syndesus cornutus* also have been found in dead wood of exotic trees as well as in structural timber (Lawrence 1981b). Adults of all of the above species are attracted to lights and may enter buildings at night or become entangled in spider webs on outside walls. Adults of the remaining endemic species are unlikely to be seen near dwellings unless there are stands of native vegetation close by. During the day, they shelter in and under rotten logs, under stones, under loose bark on tree trunks, in leaf litter, among dead leaves trapped in the branches of living trees, and in other similar places. Damp, cool habitats that limit desiccation seem to be preferred by larvae and adults of most of the New Zealand lucanids. Large logs left isolated on open grassy hillsides where previously there was forest may still contain adults and larvae of some species of *Paralissotes* and *Mitophyllus* if the logs are in contact with the ground and retain some moisture. The larvae of *Geodorcus* live in soil that is enriched with humus, sometimes close to the surface if they are under a rotting log, or several centimetres below the surface especially in soil containing guano of burrowing sea birds. Throughout the family it is not unusual for adults and larvae of the same species to be found in close proximity to each other. Adults of *Mitophyllus gibbosus* and also of *M. macrocerus* have been observed flying in groups near shrubby vegetation in hot sunshine and those of *Holloceratognathus cylindricus* and *Dendrobax earlii* are known to fly at dusk. Information about the flight activity of *H. helotoides* and most of the other species of *Mitophyllus* is not available but specimens have occasionally been collected in Malaise traps. The slow moving adults of *Geodorcus* and *Paralissotes* are essentially nocturnal but are sometimes active during the day in misty or rainy conditions.

Food of adults and larvae

Adult stag beetles anywhere in the world are rarely seen feeding but it is generally assumed from the structure of the mouthparts that their diet consists mostly of liquids. Exceptions are some Australian lamprimines that eat soft eucalypt and acacia leaves (Britton 1970). The food preferences of adults of *Dendrobax earlii*, the New Zealand lamprimine, are not known. In the genitalia preparations I have examined of this species and of the other New Zealand lucanids, I have never seen any solid material in the hindgut. Of the many genitalia preparations of exotic lucanids that I have made only two had solids in the hindgut and in both instances the solids had apparently been ingested involuntarily while the beetles were feeding on liquids; the hindgut of a male of *Aegus chelifera* MacLeay, 1819 from Laos contained conidia of several kinds of fungi, including those of *Capnobotrys* sp., a sooty mould, which would have been growing on the honey dew presumably ingested by the beetle, and the hindgut of a male of *Lissotes menalcas* Westwood, 1855 from Tasmania contained chlorococcalean (green algae) cells of *Oocystis* sp., possibly *O. solitaria*, a species that is associated with fresh water which the beetle may have been drinking. I am indebted to Dr Gary Samuels for identifying the fungi and Dr Vivienne Cassie for identifying the algae, and I am especially grateful for the associated information they both provided. *Geodorcus helmsi* adults have been observed feeding on sappy exudations on tree trunks (Holloway 1961; Sherley *et al.* 1994) and those of *G. novaezealandiae* held in captivity were seen applying their mouthparts to pieces of apple (Holloway 1961). Some places where *Geodorcus* and *Paralissotes* adults have been collected have had no trees or shrubs nearby so it is unclear what, if anything, these specimens were eating. I am unaware of any observations that have been made on adult feeding habits of *Holloceratognathus*, *Mitophyllus*, and *Paralissotes*. There are no records of any of the New Zealand lucanids taking nectar from flowers but some stag beetles in Australia are nectar feeders (Britton 1970).

Rotting wood at or above ground level is the most common food source for lucanid larvae in general but a few species are subterranean, feeding either on roots or on enriched humus. *Dendrobax earlii* is the only New Zealand stag beetle whose larvae seem to be root feeders. Interestingly, larvae of lamprimines elsewhere in the world develop in rotten wood. Circumstantial evidence suggests that larvae of the unrelated South African lucanine genus *Colophon* Gray, 1935 are root feeders (Endrödy-Younga 1988), and also that those of the lucanine *Sphaenognathus oberon* Kriesche, 1922 feed on roots (Bartolozzi & Onore 1993). The gut of the subterranean larvae of *Geodorcus*

contains vast quantities of humus. Undoubtedly the quantity and quality of nutrients in the ingested material will influence the size achieved by the larvae and ultimately that of the adults into which they develop. The very large size of some *G. helmsi* adults from Bauza Island, Solander Island, and mutton bird islands around Stewart Island is likely to be attributable to the abundant, peaty, guano-enriched soil in which their larvae developed. Larvae of only a few species of *Paralissotes* are known. Those of *P. reticulatus* have been found in decayed wood lying on the ground or partly buried especially when the wood is in the soft, red stage of decay (Hudson 1934). Judging from where adults have been collected it seems likely that larvae of some other *Paralissotes* species, e.g. *P. stewarti* and *P. triregius*, ingest firmer dead wood in fallen trunks of trees such as manuka (*Leptospermum scoparium*) and kanuka (*Kunzea ericoides*). *Holloceratognathus* larvae are mostly associated with well decayed wood on the ground or on standing trees, but as noted above, those of *H. helotoides* may develop in hardwood poles. In New Zealand, larvae of *Ryssonotus nebulosus* consume rotten wood of privet (*Ligustrum lucidum*) and *Acacia* (Thorpe 2001) and probably also of *Eucalyptus* (Gourlay 1954), and those of *Syndesus cornutus* have been found in old posts, probably of *Eucalyptus* and, based only on the presence of adults, probably also in dead *Pinus radiata*, *Macrocarpa*, and in milled timber. Larvae of *Mitophyllus* have mostly been found in damp powdery wood in and under fallen logs of a wide range of native trees and of several exotics. Some of the smaller species of this genus are able to develop in well rotted twigs and thin branches on standing trees and shrubs. Wood decay is classified into brown, white, and soft rot, based on physical and chemical properties, and the decay types do not depend on the species of wood but on the fungi causing the decay (Araya 1993a). Experiments carried out in Japan on the lucanine *Prismognathus angularis* Waterhouse, 1874 revealed that the dry weights of adults whose larvae developed in brown rotten wood were significantly less than the weights of adults whose larvae fed on white rotten wood (Araya 1993b). It was further found that while *P. angularis* is a decay type generalist another Japanese lucanid, *Ceruchus lignarius* Lewis, 1883, is a brown rot specialist (Araya 1993c). No comparable New Zealand information is currently available so it would be useful in future to record decay types very precisely when observing or collecting lucanids in rotten wood.

Life cycles

There is no published information about oviposition, larval and pupal duration, and the life span of adults of any New Zealand stag beetles. Adults of most of the species have been collected all year round. Some *Mitophyllus* adults

can be found deep inside rotten logs throughout the year and when handled they are very inactive, suggesting that they may be in some sort of hibernation state. It is also possible that, until the food supply is exhausted or the substrate becomes unsuitable several consecutive generations may be produced without the adults ever leaving the original larval site. Remains of dead adults are often present in rotten wood that contains larvae. For several years wood samples containing *Mitophyllus* larvae were maintained in the laboratory of the New Zealand Arthropod Collection and it was found from these that larvae of various sizes were present at all times of the year and that adult emergence also occurred throughout the year. In some *Geodorcus* adults the fore tibial teeth have become blunt tipped which may indicate that the specimens have lived for a long time but equally it could be that the teeth are worn down because the beetles have been burrowing through very hard soil. Copulation has been observed taking place in *Geodorcus novaezealandiae* in mid October (Holloway 1961), in *G. alsobius* in January (Sherley *et al.* 1994), in *Paralissotes reticulatus* in November (Holloway 1961), and in *P. rufipes* in January (present volume).

GEOGRAPHIC DISTRIBUTION AND ALTITUDINAL RANGE

The New Zealand subregion is mapped on **page 250**. No lucanids have been found on any of New Zealand's subantarctic islands. *Mitophyllus irroratus* is the only stag beetle known from the Kermadec Islands. This species is the most widespread New Zealand lucanid having been found in numerous North and South Island localities and in the northern half of Stewart Island, but not on the Chatham Islands. Specimens of *M. irroratus* have been collected from the northern tip of the North Island and from a few northern offshore islands but so far none have been found elsewhere in Northland nor from the mainland Auckland area or Coromandel Peninsula. Interestingly, in these areas it is replaced by *M. arcuatus*, a very similar looking species. Only 1 lucanid species, *Paralissotes triregius* is known from the Three Kings Islands. It is endemic to these islands and, like others in the genus, is vestigial-winged. The 6 other species of *Paralissotes* have somewhat limited distributions and altitudinal ranges that are mostly below 1000 m. *Paralissotes mangonuiensis* and *P. oconnori* have been found only in Northland, *P. planus* occurs from Northland to the Bay of Plenty, and the range of *P. stewarti* is from Northland to Wellington. *Paralissotes reticulatus* is the most widespread species in the genus, having been collected from the Bay of Plenty to South Canterbury. The rather similar looking *P. rufipes* is confined to the north of

the South Island (Nelson, Marlborough including the Sounds, and Buller). In the material examined the altitudinal range of *P. rufipes* is from sea level to about 950 m, but Hudson (1934) found specimens between 2500 feet and 4000 feet (762 m and 1219 m) on the slopes of Mt Arthur in northwest Nelson.

The 10 species of *Geodorcus* are flightless. *G. helmsi* is the most widespread having been collected from Karamea in Nelson, down the west coast of the South Island, along the southern margin of the South Island, and on the eastern side of the South Island as far north as Tapanui in Southland. It also has been found on several islands in Fiordland, as well as on Solander Island, and on Stewart Island and some of the mutton bird islands, including Big South Cape Island. Adults of this species have been collected from near sea level to 1400 m. The geographic and altitudinal ranges of the other 9 species are mostly more limited. *Geodorcus philpotti* is known only from the southwest corner of the South Island but has a relatively wide altitudinal range, from near sea level to 1372 m; *G. auriculatus* has been found from near sea level to about 950 m in several localities in the southern part of the Coromandel Peninsula and on Mt Te Aroha and its environs; and *G. novaezealandiae*, a lowland species found from near sea level to 365 m, occurs in the Wairarapa and greater Wellington areas. The remaining species of *Geodorcus* appear to be restricted to islands or to mountain tops. *Geodorcus ithaginis*, initially known from an islet close to the main island of the Mokohinau group in Northland is now surviving only on nearby Stack H; *G. capito* and *G. sororum* occur on several islands of the Chathams archipelago; *G. alsobius* has so far been found only on Mt Moehau in the north of the Coromandel Peninsula, between 500 m and 875 m; *G. servanus* is known only from the summit, 1122 m, of Mt Tuhua in Westland; and *G. montivagus* is based on a single female specimen found at an altitude of 1220 m on the Victoria Range in the Buller region.

Mitophyllus, with 14 species, is New Zealand's largest lucanid genus. *M. fuscus*, has vestigial winged females but fully winged males and has so far been found only in southern parts of the South Island, but the remainder all have well developed wings and, apart from *M. reflexus* which is confined to the Chatham Islands, are relatively widespread. The extensive range of *M. irroratus* has already been mentioned. Four species, *M. arcuatus*, *M. gibbosus*, *M. macrocerus*, and *M. solox*, are at present known only from North Island localities and 3 species, *M. foveolatus*, *M. insignis*, and *M. fuscus* have not been found outside the South Island. Five species, *M. alboguttatus*, *M. angusticeps*, *M. dispar*, *M. falcatus*, and *M. parrianus* are present in both the North and South Islands. The range of *M. parrianus* extends south to Stewart Island. *Mitophyllus insignis* is the only species of the genus that so far has not

been found near sea level, its altitudinal range in the specimens examined is from 600–1370 m. In the material examined 7 species, *M. arcuatus*, *M. falcatus*, *M. fuscus*, *M. gibbosus*, *M. macrocerus*, *M. reflexus*, and *M. solox* have not been collected above 500 m; *M. irroratus* has occurred up to 645 m, but the 6 other species (*alboguttatus*, *angusticeps*, *dispar*, *foveolatus*, *insignis*, and *parrianus*) have been found at least 1000 m above sea level, the greatest recorded altitude, 1750 m, being for *M. alboguttatus*.

Of the remaining endemic species, *Dendroblox earlii* and *Holloceratognathus cylindricus* are present in both the North and South Islands from sea level to about 600 m; *H. helotoides* has been collected in the North, South, and Chatham Islands from sea level to 1500 m; and *H. passaliformis*, an inquiline in nests of the endemic ant, *Prolasius advena*, has so far been found only in the Wellington district, from near sea level to about 450 m.

Auckland and Gisborne cities have been the places of entry for the 4 exotic species recorded in New Zealand. *Ryssonotus nebulosus* is known to have been in Gisborne since 1950 and in Auckland since 1967 and appears not to have colonised other areas, but in the 40 years since it was first noticed in the same two cities, *Syndesmus cornutus* has become widespread in lowland parts of the northern half of the North Island, including Mayor Island off the east coast of the Coromandel Peninsula. A record of this species from Waitangi in the Chatham Islands (Emberson 1998) is based on a single specimen probably taken to the island in the hardwood pole in which it was found. In spite of extensive recent collecting on the Chathams no further specimens have been found so it appears that the species has not established there (Emberson, personal communication). The *Lamprima aurata* record comes from one male found 28 km northwest of Gisborne. The latest arrival, *Serrognathus sika*, is known from 3 males collected in the Auckland suburb of Pakuranga from December 2000 to April 2001.

The distribution of Lucanidae in New Zealand is summarised in Appendix 1, p. 128.

STUDY METHODS

Preparation of material

Most New Zealand lucanids are large enough to be pinned. Those too small for pinning should be mounted on cardboard points, using a water soluble glue, and positioned so that the entire left side of the body can be seen.

Specimens from which genitalia preparations are to be made must be simmered gently until the body softens and glue, if present, dissolves. A few drops of detergent can be added to clean greasy specimens or those coated with soil. The abdomen has to be removed from the body in one

piece and macerated in a small tube containing a 10 percent solution of potassium hydroxide kept warm, but never boiled, in a waterbath. Maceration takes from 10 minutes to 30 or more minutes depending on the size of the specimen. When macerated the abdomen should be transferred to a small dish of water on the stage of a stereomicroscope. It can then be held with forceps and rinsed several times, using a swirling motion, to get rid of as much of the macerated tissue as possible. A cut should then be made along the upper left margin of the abdomen so that the entire dorsal integument can be moved to one side and the genitalia lifted out as a single mass. Usually some tracheae will remain attached to the genitalia and these have to be removed using forceps and fine pins. This procedure requires great care, especially if the preparation is from a female, to avoid damaging ducts and other weakly sclerotised structures. In females, the spermatheca is usually easily recognised because it is pigmented and more strongly sclerotised than other structures. It is best to do the final cleaning in 70 percent ethanol in which structures are more sharply defined. Drawings of both the male and female genitalia should be made from preparations transferred to a dish of clean alcohol and held in place with small overlying pins. The genitalia should not be slide mounted because they become flattened and distorted. They should be stored in a small amount of thinned glycerine in a corked minivial placed under the labels accompanying the pinned specimen. If it is possible to fit the empty abdomen in the minivial the genitalia can be enclosed in this for added protection. Empty abdomens that are too large to be put in a minivial can either be glued back on the specimen or glued on a card that is then pinned below the label data.

The elytral surface structures shown in this volume are from the apical half of the elytron, above the declivity. The micrographs were obtained using a Philips 505 scanning electron microscope and gold-coated pieces of elytra, some of which had been previously cleaned by overnight soaking, then sonicated in a small tube of water containing a few drops of an ammonia-based household cleaner (Holloway 1997). The line drawings of elytral vestiture were made from individually plucked scales and setae taken from above the elytral declivity, slide-mounted in glycerine and examined and drawn under oil immersion (Holloway 1997). The micrographs of structures on the forelegs are from uncleaned gold-coated preparations and were obtained using the same electron microscope.

Illustrations

The illustrations are at the end of the text. All scale lines are equal to 1.0 mm unless otherwise indicated.

The habitus drawings were prepared by Des Helmore,

scientific illustrator at Landcare Research. All the line drawings were made by me using either a camera lucida or a drawing tube. The vestiture has been omitted from some of these, especially on the tibiae where rows of setae are usually indicated by broken longitudinal lines. Paul Sutherland of HortResearch Institute, formerly of DSIR Plant Protection, Auckland prepared the scanning electron micrographs, and Birgit Rhode prepared the automontaged images.

Material examined

More than 2500 specimens have been examined for this revision. They are deposited in the collections of the following institutions, which are referred to throughout the text by the four-letter abbreviations proposed initially by Watt (1979).

- AMNZ Auckland Institute and Museum, Auckland, N.Z.
- BMNH The Natural History Museum, London, U.K.
- CMNZ Canterbury Museum, Christchurch, N.Z.
- LUNZ Entomology Research Museum, Lincoln University, Lincoln, N.Z.
- MNHN Muséum National d'Histoire Naturelle (Paris Museum), Paris, France.
- MONZ Museum of New Zealand, Te Papa Tongarewa, Wellington, N.Z.
- NZAC New Zealand Arthropod Collection, Landcare Research, Auckland, N.Z.

Increasing family responsibilities have considerably limited the time available for me to do entomological research at home. Consequently I have not been able to examine every specimen in the various collections within New Zealand and elsewhere. The main source of material for this revision has been the widely representative collection of New Zealand Lucanidae in NZAC.

The label data, sex, and repository of every specimen examined, as well as of some specimens referred to in my earlier revision (Holloway 1961) and subsequent papers but not re-examined, are recorded on species data sheets which are deposited in the New Zealand Arthropod Collection and can be seen by arrangement with the Curator. Individual entries from the sheets are included in this volume only for type material. For all other material the data have been combined and summarised to give an overall picture of distribution, monthly incidence, and other biological information for each species. The two-letter area codes used to denote the species distributions are those proposed by Crosby *et al.* (1998). Locality records are marked on the distribution maps that are given for all the species. The solid circles include general areas from which specimens

have been recorded in the past but from which they may now have disappeared because of habitat destruction or rodent predation.

KEY TO THE SUBFAMILIES OF LUCANIDAE IN NEW ZEALAND

(This key applies to species in New Zealand and not necessarily the entire world fauna.)

01 Eyes divided partially (Fig. 3) or completely (Fig. 5) by canthus; antennae completely geniculate (Fig. 18); procoxal process absent (Fig. 50); prementum on either side of ligula elongate, flattened, weakly sclerotised, situated near middle of mentum and not visible when head is viewed from below (Fig. 7); base of 1st segment of labial palp concealed by mentum (Fig. 7); penis articulating on posterior (distal) end of basal piece (Fig. 66); internal sac of male genitalia permanently everted either as a flagellum or a strap-shaped structure (Fig. 65) **Lucaninae**

—Eyes entire, not divided by canthus (Fig. 1); antennae non-geniculate (Fig. 19) or partially geniculate (Fig. 20); procoxal process present (Fig. 51, 52); prementum short, broad, cylindrical, strongly sclerotised, situated near apex of mentum and partly visible when head is viewed from below (Fig. 8, 9); base of 1st segment of labial palp exposed beyond anterior margin of mentum (Fig. 8); penis not articulating on posterior end of basal piece, instead partly enclosed by basal piece (Fig. 68); internal sac of male genitalia eversible (Fig. 68) 02

02(01) Body stout and broad; integument of dorsal surface uniformly chocolate brown or metallic green; elytra not conspicuously parallel-sided, their width together about 0.8× elytral length; mandibles of females very deep and with a small inwardly or forwardly directed ventral tooth at or near base; protibiae somewhat fossorial, gradually expanded from base to apex (Fig. 63); protibial teeth increasing gradually in size from base to apex of segment (Fig. 63); arolia with more than 2 setae or bristles apically; elytral vestiture consisting of simple setae that are sometimes compressed apically, each seta with a large pore near its base (Fig 31, 32) **Lampriminae**

—Body rather slender; dorsal surface black, reddish brown, yellowish brown, or mottled brown and black; elytra distinctly parallel-sided, their width together about 0.6× elytral length; mandibles of females not very deep, not with basal ventral tooth; protibiae (New Zealand species) moderately or very slender and approximately parallel-sided throughout their length (Fig. 1) (exception: protibiae paddle-shaped in the inquiline species,

Holloceratognathus passaliformis); protibial teeth comprising a large apical tooth, a large mid dorsal tooth and numerous small similar-sized teeth (Fig. 1), or a large apical tooth, a large mid dorsal tooth and mixed small and large teeth, or a large apical tooth and somewhat alternating large and small teeth (no mid dorsal tooth); arolia with no more than 2 apical setae or bristles; elytral vestiture consisting of barbed setae (Fig. 33) or narrow to broad scales (Fig. 39–41), none with associated basal pores 03

03(02) Antennal club 7-segmented; elytra conspicuously striate, each stria containing a row of large, close, sharply defined, similar-sized, deep, concave, circular punctures with a minute, barbed, horizontal seta on anterior wall (Fig. 33); male genitalia with a pair of struts articulating on base of penis **Syndesinae**

(only *Syndesus cornutus* present in New Zealand)

—Antennal club 3-segmented; elytra mostly non-striate, striae if present inconspicuous, either lacking punctures, or containing more than 1 row of punctures, or with a single row of small, weakly defined, shallow, rather unevenly spaced punctures that have their floor artificially raised by glassy exudate, any vestiture associated with striae squamose, not barbed (Fig. 39–41); male genitalia without struts at base of penis

..... **Aesalinae**

KEY TO NEW ZEALAND GENERA OF AESALINAE

Dorsal edge of protibia with large apical tooth, large mid dorsal tooth (slightly beyond middle), and numerous small, equal-sized teeth elsewhere (Fig. 1); elytral punctures (pits) with raised, flat-topped floor, walls and floor of pits with similar polygonal sculpturing, not masked by exudate (Fig. 41, 42); integumental surface between elytral punctures very finely granulose (Fig. 42); dorsal surface of elytral scales with dense reticulum of longitudinal ridges and short crossbars (Fig. 30, 41); basal piece of male genitalia (or basal piece region if basal piece is fused to parameres) with a suture on or near ventral midline (Fig. 629); bursa copulatrix of female genitalia bilobed (Fig. 70) (p. 35)... **Mitophyllus**

—Dorsal edge of protibia with large apical tooth, large mid dorsal tooth (beyond middle), and numerous variably sized teeth elsewhere (Fig. 183), the differences in size of latter teeth very slight in *Holloceratognathus passaliformis* which is distinctive in having paddle-shaped tibiae (Fig. 194); elytral punctures (pits) with concave floor, walls and floor with similar polygonal sculpturing (Fig. 39, 40), but in many punctures floor

artificially raised by varying amounts of smooth glassy exudate; integumental surface between elytral punctures polygonally sculptured (Fig. 39, 40); dorsal surface of elytral scales with slightly anastomosing entire and fragmented longitudinal ribs (Fig. 29, 39), scales in *H. passaliformis* minute and apparently reduced to a single rib and with scarcely any lamina (Fig. 40); basal piece of male genitalia lacking suture on ventral surface (Fig. 586); bursa copulatrix of female genitalia consisting of a single sac (Fig. 688) ... (p. 28)... *Holloceratognathus*

KEY TO GENERA OF LAMPRIMINAE IN NEW ZEALAND

- Upper surface of body chocolate brown; ventral surface of body clothed with erect, long, wavy, orange-yellow setae; outer margin of mandibles strongly convex (Fig. 382, 383); spur at apex of protibia conical in both sexes (Fig. 63)..... (p. 69)... *Dendroblax*
- Upper surface of body metallic green or bronze or blue; ventral surface of body clothed with decumbent, moderately long, straight, cream setae; outer margin of mandibles more or less straight or barely rounded (Fig. 79, 391); spur at apex of protibia conical in females (Fig. 396), flattened and fan-shaped in males (Fig. 395) (p. 71)... *Lamprima*
(only *L. aurata* in New Zealand, not established)

KEY TO GENERA OF LUCANINAE IN NEW ZEALAND

- 01 Mandibles with dense setae on medial surface (Fig. 88); antennal club with 5 or 6 segments (Fig. 561); eyes completely divided into upper and lower parts by conjoined anterior and posterior canthi (Fig. 5); elytral surface velvety, mottled in shades of brown (Fig. 163) (p. 115)... *Rysonotus*
(only *R. nebulosus* in New Zealand)
- Mandibles with few if any setae on medial surface (Fig. 84, 87, 89); antennal club with 3 segments (Fig. 569); eyes only partially divided by canthi (Fig. 464, 524) (in females of *Serrognathus sika* (Fig. 568) the anterior and posterior canthi touch or almost touch but are not conjoined) 02
- 02(01) Medial (anterior) edge of funicle lacking setae on 2nd and 4th segments, instead with either 1 or a pair of long setae on 3rd segment, and with 2 long setae (females) or up to 10 very long setae (males) on a conspicuous, narrow, sharply pointed projection on the 5th segment (Fig. 569, 570); anterior and posterior canthi meeting or nearly meeting in eyes of females (Fig. 568) distinctly separated in males (Fig. 565); interocular surface of

head with a pair of low tubercles in females (Fig. 568), without tubercles in males; mentum of males with broad transverse band of dense, erect, long, broad, partly furled, brown scales on distal half (Fig. 571)

- (p. 118)... *Serrognathus*
(only *S. sika* in New Zealand, not established)
- Medial (anterior) edge of funicle with a seta on 4th segment and usually with 1 on 2nd, 3rd, and 5th segments, 5th segment never with a tuft of 2 or more long setae and never with a sharp, conspicuous angulation (Fig. 466) but a rounded projection may be present, especially if other funicle segments are markedly asymmetrical (Fig. 457); anterior and posterior canthi distinctly separated (Fig. 524, 534); interocular surface of head without tubercles; mentum of males more or less uniformly and only moderately setose 03
- 03(02) Front margin of head in dorsal aspect deeply and broadly indented (Fig. 524, 543); postocular margin of head in males straight, never lobed (Fig. 514); elytral vestiture consisting of appressed to erect fan-shaped scales (Fig. 37, 38); right mandible with apex of tooth nearest base on medial surface shallowly divided into 2 rounded lobes (Fig. 524, 543) ... (p. 102)... *Paralissotes*
- Front margin of head in dorsal aspect straight or very slightly indented (Fig. 436, 437); postocular margin of head in males with either 1 or 2 variably developed lobes (Fig. 436); elytral vestiture consisting of standing, deeply divided, dendritic setae (Fig. 35, 36); right mandible with apex of tooth (when present) nearest base on medial surface either undivided or divided into 2 sharply pointed processes separated by a deep or shallow incision (Fig. 436, 437) ... (p. 75)... *Geodorcus*

DESCRIPTIONS

Subfamily AESALINAE MacLeay, 1819: 102

The key to the subfamily is on **page 26**.

RECOGNITION CHARACTERS OF NEW ZEALAND AESALINAE Small to medium-sized, usually convex, non-metallic, brown or black lucanids; length including mandibles approximately 6–19 mm. Maxillae lacking hooks and hooklets in males and females. Mentum not covering base of 1st segment of labial palp. Paired elements of prementum strongly sclerotised, ring-like, located on apex of mentum and visible in ventral aspect. Antennae not geniculate; scape with variably developed dorsal or posterodorsal, longitudinal groove and associated row or group of erect setae or scales; club composed of 3 loose segments. Eyes lacking canthi. Legs rather slender, not

fossorial. Elytra not conspicuously striated, their vestiture mostly squamose. Wings fully developed in most species, if reduced, their length no less than elytral length. Male genitalia with penis lacking struts at its base and not articulating on basal piece, instead being partly enclosed by it; internal sac eversible, rather broad, not flagellate; parameres narrowing apically and not conspicuously lamellate. Female genitalia with sclerotised hemisternites and elements of 9th segment rather weakly sclerotised; styli very narrow, with minute setae at apex; spermatheca variably curved, annulate on at least its proximal 1/2.

For information on the worldwide composition and distribution of Aesalinae see page 17.

The subfamily is represented in New Zealand by 2 endemic genera, *Holloceratognathus* and *Mitophyllus*, which may be separated using the key on page 26.

Genus *Holloceratognathus* Nikolaev

Holloceratognathus Nikolaev, 1998: 55 (as subgenus of *Ceratognathus* Westwood). Holloway 1998: 650 (as genus *Holloceratognathus* Nikolaev **new status**). Type species *Ceratognathus helotoides* Thomson, 1862, by original designation.

Neoceratognathus Nikolaev, 1998: 56 (as subgenus of *Ceratognathus* Westwood). Holloway 1998: 650 (**new synonymy**). Type species *Ceratognathus passaliformis* Holloway, 1962, by original designation and monotypy.

Diagnosis. Small to moderately large aesalines (length including mandibles 6–15 mm) with unicolourous black or brown, glossy integument; sexual dimorphism always apparent in mandibles, sometimes apparent in antennae and eyes. Integumental pits (punctures) of dorsal and ventral surfaces numerous, minute to large, with well defined margins and polygonally sculptured floor (sculpturing visible only at very high magnifications), floor structurally concave but appearing convex in pits that are partially or completely filled with glassy exudate. Vestiture of dorsal surface consisting of minute to large, fully expanded, cream, yellow, or brown, ribbed, elongate-oval or linear scales and thickened setae. Elytral surface finely striated. Legs rather slender; dorsal edge of front tibia with 2 large teeth and numerous smaller teeth of varying sizes; middle and hind tibiae very spiny on dorsal surface, their posteromedial surface flattened and almost bare.

Redescription based on Holloway (1998).

Head. **Anterior margin** varying from concave to convex, with or without a rim, not tuberculate. Preocular margin short, not laminate. **Mandibles** punctate, setose; in males rather short, laterally curved, approximately same width throughout their length, sometimes with an erect cusp; in

females short, elongate-triangular, with apical tooth, sub-apical dorsal tooth, and subapical ventral tooth which is large on left mandible, very small on right mandible. Maxillae with short, broad galea and minute lacinia. Mentum small, approximately semicircular, setose. Ligula small, apex convex. Intermandibular projection short, often extremely short, wider than long, descending anteroventrally or receding. Labral suture present; labrum short, wider than long, setose, directed anteroventrally or horizontally, apex truncate or slightly convex. Frons concave or flattened, not with conspicuous triangular depression between eyes, not tuberculate. **Antennal club** segments stout or slender, with dense, rather short, uniformly distributed setae, if stout, then very similar in males and females, if slender, considerably larger in males. Supra-antennal brow short, only slightly arched. **Eyes** weakly protruding, small to moderately large, outer margin unevenly convex in dorsal aspect. Postocular margins moderately long, slightly concave to slightly convex, neither lobed nor tuberculate, sometimes convergent posteriorly.

Thorax. **Pronotum** wider than long; front angles acute to obtuse, blunt or sharp; disc smooth or uneven, sometimes depressed anteriorly on midline, with or without pair of tubercles; sides of disc descending vertically to lateral margin which is serrated and almost straight; brim very broad or absent; hind angles obtuse, blunt or sharp. Scutellum triangular or semicircular, its length greater or less than its width. **Elytra** parallel-sided; surface almost smooth or with 4 broad, raised interstriae on each elytron; at least 5 punctate striae visible at low magnifications on each elytron; humeral angles and sutural margins low; outer margin with low punctate rim containing scales or setae; brim either strongly developed on distal 1/3rd of each elytron or entirely absent; pits (punctures) minute to large, polygonally sculptured on floor and walls, floor concave but often covered with mound of hard, glossy exudate which meets pit wall at an acute angle (the exudate is not separated from wall by a conspicuous horizontal groove); each pit containing either relatively large curved scales or minute erect setae, both set slightly off-centre in floor, scales elongate-oval or linear, sharply pointed, their dorsal surface with either a single rib or several interconnected longitudinal ribs, setae with divided or undivided tips and often obscured by exudate; integument between pits polygonally sculptured. **Wings** fully developed or with slightly reduced anal area. **Prosternal process** very narrow, concealed by procoxae. Mesosternal process narrow, smooth. **Legs** moderately long and slender; procoxal process well developed; femora with numerous narrow scales, front femur about 2× longer than wide, its setiferous patch large or small, reaching almost 3/4 or barely 1/4 the distance along femur, the associated punctures present on only upper

part of patch; tibial vestiture composed of standing setae or very narrow scales, some with their bases concealed by an overhanging tooth or spine; front tibia narrow or rather broad, straight or slightly arched; dorsal edge with large apical tooth, large tooth beyond the middle, and numerous variably sized smaller teeth elsewhere (size variation of these very slight in *passaliformis*); middle and hind tibiae gradually expanding from base to apex and lacking setiferous sex patches, their vestiture mostly aligned in 7 longitudinal grooves that are evenly distributed on all surfaces except posteromedial which is flattened and almost bare; dorsal surface of middle and hind tibiae with about 3 longitudinal rows of variably sized spines (teeth), (in *passaliformis* the dorsal surface is very narrow and all spines are small); ventral surface of tarsomeres 1–4 with short or long setae, either sparse and apical or numerous and covering most of surface; **arolium** with a bristle on either side of apex.

Abdomen. Lateral margins of ventrites with or without a flange; distal margin of **5th ventrite** emarginate or angulate in males, truncate or slightly convex in females.

Male genitalia. **9th abdominal segment** moderately slender, symmetrical; distal margin of sternite entire and setose. **Tegmen** (basal piece + parameres) symmetrical or very slightly asymmetrical, parameres separated from basal piece by very narrow, rigid, membranous strip. **Basal piece** short, broad, somewhat cylindrical, surrounding less than 1/2 length of penis; dorsal surface divided longitudinally at or near midline; dorsomedial edges touching over part of their length or widely separated from each other; ventral surface of basal piece undivided. **Parameres** longer than basal piece, symmetrical or asymmetrical, conical, tapering; tip rounded or pointed; medial surface smooth, not ribbed. **Penis** symmetrical or very slightly asymmetrical, cylindrical, broad, moderately long, its apex not reaching as far as tips of parameres; ostium terminal; internal sac broad, about as long as penis, clothed with colourless and brown spinules of varying sizes.

Female genitalia. **Accessory gland** absent. **Bursal duct** short or moderately long, relatively broad. **Bursa copulatrix** saccate. Spermathecal duct long, arising on or near base of bursa copulatrix, close to bursal duct, its insertion point widely separated from base of median oviduct. **Spermatheca** relatively large. Spermathecal gland very long, slender, conspicuously demarcated from its duct which is of variable length; combined length of duct and gland very much greater than length of spermatheca.

Range. New Zealand.

Remarks. A list of 36 adult character states in *Holloceratognathus*, *Mitophyllus*, and the Australian genus *Ceratognathus*, and illustrations of diagnostic external and genitalic features in the 3 genera are available elsewhere (Holloway 1998). In summary, *Holloceratognathus* spe-

cies are readily distinguishable externally from those of both *Mitophyllus* and *Ceratognathus* by the variably sized smaller teeth on the dorsal edge of the front tibiae, the spiny dorsal surface and flattened, almost bare posteromedial surface of the middle and hind tibiae and the structurally concave floor of the elytral pits. They are further separable from *Mitophyllus* species by their partially striate elytra and by the small number of ribs with very few anastomoses on the dorsal surface of their elytral scales. The absence of frontal tubercles in males and females and lack of hind tibial setiferous sex patches in males are additional characters for separating *Holloceratognathus* from *Ceratognathus*. Distinctive genitalic features that separate *Holloceratognathus* from *Mitophyllus* are, in males, the ventrally undivided basal piece and, in females, the saccate bursa copulatrix. In *Ceratognathus* males the basal piece is undivided ventrally but differs from that of *Holloceratognathus* in being membranous dorsally rather than sclerotised, and in *Ceratognathus* females the bursa copulatrix is bilobed, not saccate. The genus that is morphologically closest to *Holloceratognathus* is *Nicagus* LeConte which has 2 species in North America and 1 in Japan (Holloway 1998; Paulsen & Smith 2005). *Holloceratognathus* is also a small genus, with only 3 species.

KEY TO THE SPECIES OF *Holloceratognathus*

- 01 Body flattened and passalid-like (Fig. 189); pronotum and distal 1/2 of elytra with broad horizontal brim on their outer margins; tibiae very strongly compressed, conspicuously expanded distally, paddle-like (Fig. 194, 196, 197); dorsal surface of middle and hind tibiae narrow, not conspicuously spiny; found in nests of the formicine ant *Prolasius advena*
.....(p. 33)... *passaliformis*
- Body convex and bostrychid-like (Fig. 76); pronotum and elytra lacking brim; tibiae “normally” compressed, not conspicuously expanded distally, not paddle-like (Fig. 183, 185, 186); dorsal surface of middle and hind tibiae distinctly broad and very spiny; not associated with ants 02
- 02(01) Integument reddish-brown; pronotum entirely covered with dense, curved, very narrow, yellowish scales (Fig. 76) (p. 30)... *cylindricus*
- Integument black; pronotum with bilaterally symmetrical patches and tracts of moderately broad, curved, mainly creamish yellow scales, the intervening integument smooth, shiny, and lacking punctures (Fig. 92, 93) ...
.....(p. 31)... *helotoides*

***Holloceratognathus cylindricus* (Broun)**

Fig. 11, 15, 76, 90, 91, 167–176, 580–583, 687. Map 1
cylindricus Broun, 1895: 199 (*Mitophyllus*). Benesh 1960:
 19 (*Ceratognathus*). Holloway 1961: 91, frontispiece
 18, fig. 90, 183–186, 200, 213 (*Ceratognathus*); 1963b:
 110, fig. 28 (*Ceratognathus*); 1998 (December): 652
 (*Holloceratognathus* new generic status). Nikolaev 1998
 (January): 56 (*Ceratognathus* new subgenus
Holloceratognathus).

Diagnosis. Length: males (including mandibles) 6.3–7.8 mm, (excluding mandibles) 6.0–7.3 mm; females (including mandibles) 8.4–10.4 mm, (excluding mandibles) 8.0–9.9 mm. Width: males 2.7–3.5 mm; females 3.4–4.1 mm. Sexual dimorphism very slight, most apparent in mandibles. Body (Fig. 76, 90, 91) rather stout, very parallel-sided, moderately convex dorsally. Integument uniformly reddish-brown. Punctures on dorsal surface small, dense, concave, at least some containing varying amounts of a smooth, glassy exudate forming an artificially raised floor easily seen at $\times 45$ with a stereomicroscope. Most pronotal punctures containing very narrow, yellow, standing scales, remainder lacking scales. Each elytron with about 10 longitudinal rows of non-squamose punctures alternating with rows of punctures containing scales like those on pronotum. Mandibles short, vaguely triangular, their medial edges concave, outer edges slightly arched in females, very strongly arched in males.

Redescription

Head. (Fig. 167, 168) wider than long, widest across eyes. **Dorsal surface** moderately glossy; frons flattened or very slightly depressed, its anterior margin with low rim; vertex smooth, flattened; **punctures** well defined, shallow, small, uniformly dense, containing moderately long, very narrow, appressed to erect, yellow scales; preocular margin very slightly rounded; supra-antennal brow low, its outer surface sloping gradually to eye; postocular margin very short, sides straight and convergent. **Labrum** short, about 3 \times wider than long, strongly convex dorsally, very setose. Labral suture distinct. Intermandibular projection very short, vertical or receding, concealed below front margin of head. **Mandibles** short, simple, somewhat triangular, concave on medial edge, deep dorsoventrally in males, not very deep in females, outer edge uniformly convex in females, conspicuously bent inwards almost at a right angle near middle in males; mandibular teeth approximately the same in males and females, both mandibles with strong apical tooth directed anteromedially, short, broad, slightly erect subapical dorsal tooth, left mandible with small, subapical ventral tooth, right mandible with minute subapical ventral tooth in females, not in males. **Antennae** (Fig. 169, 170) more robust in males than in females otherwise similar; scape slightly arched; pedicel with a strong, erect seta

on dorsal surface; funicle short, broad, 1st segment symmetrical, about 1.6 \times wider than long in males, about 1.2 \times longer than wide in females, 2nd segment symmetrical, 3rd–5th segments asymmetrical; club slightly longer than wide, setae short and dense. **Eyes** moderately protruding, width together about 0.5 \times interocular distance. **Mentum** with slightly convex surface; 4th segment of maxillary palp (Fig. 15) about 3.8 \times longer than wide (males) or 4.2 \times (females); 3rd segment of labial palp (Fig. 11) about 3.0 \times longer than wide (males) or 3.4 \times (females).

Thorax. Pronotum glossy, 1.3–1.4 \times wider than long, about 1.5 \times wider than head in males, 1.6–1.8 \times wider in females; punctures well defined, small, shallow, dense, almost all containing moderately long, decumbent to strongly curved, very narrow, yellow scales about 9 \times longer than wide; brim absent; sides sloping gradually from disc; front angles slightly acute to right-angled, very close to eyes; lateral margins serrated, very slightly convex near middle; hind angles obtuse. **Elytra** together about 1.2 \times wider than pronotum, 1.6 \times longer than wide; punctures and scales structurally like those on pronotum but differently distributed; each elytron with about 10 longitudinal rows of non-squamose punctures, rows separated from each other by either a single row or 2 rows of punctures containing strongly curved scales whose tips overlap base of following scale so integument appears longitudinally ridged but is actually smooth; humeral angle barely raised; sutural margin not raised; elytral declivity sloping gently; sides of elytra almost vertical; brim absent except near humeral angle where it is very narrow; outer rim of each elytron very narrow, almost vertical, with single row of punctures containing very narrow, curved translucent scales. **Wing** about 1.8 \times longer than elytron. **Front tibia** (Fig. 171) slightly to moderately broadened beyond mid dorsal tooth; with 3–5 denticles between mid dorsal and apical teeth, and 10–14 between mid dorsal tooth and base of segment, denticles of mixed sizes; mid dorsal tooth narrow at base; protarsomeres 2 and 3 (Fig. 172) with setae covering distal 1/2 of their ventral surface. **Middle tibia** (Fig. 173) strongly curved, without distinct mid dorsal tooth but with 3 longitudinal rows of conspicuous denticles dorsally. **Hind tibia** (Fig. 174), not curved; dorsal surface like that of middle tibia except denticles are smaller and less dense, and females have small cluster of very small denticles dorsally near apex. **Prosternum** slightly convex, not keeled. Mesosternum convex, not tuberculate. Metasternum marked off from mesosternum by suture; midline area flattened; scales mostly appressed, very narrow.

Abdomen. Ventrites (Fig. 175, 176) moderately glossy; lateral margins rimmed but not conspicuously deflected; punctures small, dense; scales suberect, very narrow; apex of 5th ventrite truncate or very slightly emarginate in males,

truncate or slightly convex in females.

Male genitalia (Fig. 580–583) with some asymmetrical components. **9th abdominal segment** (Fig. 580) slightly asymmetrical, broad; stem of the sternite very broad. **Penis** (Fig. 581–583) symmetrical, short, broad, flask-shaped, convex dorsally and ventrally, its base close to proximal end of basal piece, sides smooth; ostium terminal, very broad; internal sac broad, lined with dense, brown spinules. **Parameres** very slightly asymmetrical, blade-like, very deep dorsoventrally, slightly movable on basal piece, marked off from it completely by suture; medial surface concave; apical 1/3rd strongly upturned. **Basal piece** symmetrical, almost 1/2 length of parameres.

Female genitalia (Fig. 687). **Hemisternites** slender, elongate-triangular; medial edges almost straight, widely separated over most of their length; styli slender, about 3× longer than wide, lacking apical setae. **Bursa copulatrix** long, saccate; bursal duct short, broad, not distinctly demarcated from bursa copulatrix. **Spermathecal duct** very long, conspicuously widened where it joins bursa copulatrix, then gradually tapering to become very narrow on distal 2/3rds; spermatheca elongate, pear-shaped, about 3× longer than wide; spermathecal gland very long, tubular.

Type data. The holotype, in BMNH, is one of two specimens found in Wellington, WN (41° 17'S, 174° 46'E) under bark of rimu (*Dacrydium cupressinum*) by J. H. Lewis. It is the only specimen examined by Broun who considered it to be a female. I examined the holotype in 1958 at which time I was unaware of the mandibular differences in males and females. Broun described the mandibles of the type as being “much curved apically” which suggests that the specimen is actually a male. The whereabouts of the second specimen collected by Lewis is unknown.

Material examined. Holotype and 33 non-type specimens (16 males, 14 females, 3 sex undetermined) (BMNH, MONZ, NZAC).

Distribution (Map 1). From near sea level to about 610 m. Northernmost record: Little Barrier I, CL (latitude 36° 12'S); southernmost record: Hooker River, Mt Cook, MK (latitude 43° 44'S).

AK, CL (including Great Barrier, Little Barrier, and Mayor Islands), RI, WI, WN / NN, MK.

Biology. Adults have been collected in May and August and from November to February in rotten logs, light traps, and flying at dusk. Hudson (1934) reported finding larvae and adults in well decayed wood.

Remarks. The only lucanid in New Zealand with which *H. cylindricus* might be confused because of its small size and reddish-brown integument is the introduced Australian syndesine, *Syndesus cornutus*, but that species is immediately recognisable by its 7-segmented antennal club

and elongate, straight-sided mandibles. The general habitus of *cylindricus* is very different from that of *H. passaliformis* but the two species share distinctive antennal features (a very short funicle, compact club, and a long seta on the dorsal surface of the pedicel) and their males have the apical 1/2 of the mandibles strongly incurved.

Holloceratognathus helotoides (Thomson)

Fig. 29, 39, 74, 92, 93, 177–188, 584–587, 688. Map 2
helotoides Thomson, 1862: 434 (*Ceratognathus*). Parry 1863: 452 (*Ceratognathus*); 1870: 99 (*Ceratognathus*). Broun 1880: 254 (*Ceratognathus*). Roon 1910: 56 (*Ceratognathus*). Brookes 1925: 291 (*Ceratognathus*). Benesh 1960: 19 (*Ceratognathus*). Holloway 1961: 69, fig. 65–67, 160, 161, 204–206; 1963b: 110, fig. 28 (*Ceratognathus*); 1997: 57, 63, fig. 31, 69, 70 (*Ceratognathus*); 1998 (December): 650, fig. 3, 6, 9, 12, 15, 18, 21, 25, 29, 32, 36 (*Holloceratognathus* new generic status). Nikolaev 1998 (January): 56, fig. 1A (*Ceratognathus* new subgenus *Holloceratognathus*). *areolatum* Westwood, 1863: 430, pl. 14, fig. 2 (as *Sinodendron*?). Parry 1864b: 6 (synonym of *Ceratognathus helotoides*). Boileau 1913: 268 (*Ceratognathus areolatus*).

Diagnosis. Length: males (including mandibles) 10.5–14.0 mm, (excluding mandibles) 9.9–13.0 mm; females (including mandibles) 11.4–15.6 mm, (excluding mandibles) 11.0–15.1 mm. Width: males 3.8–5.4 mm; females 4.0–5.9 mm. Sexual dimorphism conspicuous, mostly involving features of the head. Body (Fig. 92, 93) stout, cylindrical, parallel-sided, moderately convex dorsally. Integument usually black, occasionally dark brown (possibly teneral specimens). Punctures on dorsal surface small to moderately large, deeply concave if they contain no exudate, but always some containing smooth, glassy exudate which may build up to the level of the rim; punctures absent on a few bilaterally symmetrical smooth, elevated areas on pronotum, sparse on the 4 or 5 raised longitudinal ribs on each elytron, remainder dense, most with scales, a few with hairs, none with microsetae; pronotal and elytral scales appressed or strongly curved, long, mostly dark or pale brown, also varying numbers of inconspicuous yellow scales. Frons deeply concave in males, slightly concave in females. Mandibles of males rather short, somewhat straight-sided, with a conspicuous erect or recurved subapical dorsal tooth; mandibles of females short, vaguely triangular, with uniformly curved outer edge. Pronotum of males with a pair of tubercles near anterior margin.

Redescription

Head. (Fig. 177, 178) wider than long, widest across eyes in males, across or behind eyes in females. **Dorsal surface** glossy; frons in males deeply concave, the excavation

broadly scoop-shaped with small crescentic apical rim, in females shallowly concave, the excavation V-shaped with broad, shiny, raised margin; anterior margin of head smooth or with broad, unevenly raised rim; vertex, short, convex; **punctures** well defined, deep, moderately large and moderately dense on frons, smaller and denser on vertex, sparser in females, those on vertex with short, appressed, extremely narrow, translucent yellow scales, remainder with very long, erect, fine, brownish scales, some specimens, mostly females, also with some wider yellowish scales; preocular margin angulate (males) or truncate (females) above base of scape; supra-antennal brow high in males, low in females, its outer surface sloping to eye sharply in males, gradually in females; postocular margins short, sides straight and convergent in males, slightly convex or straight and parallel in females. **Labrum** short and very setose, flattened and about 3× wider than long in males, convex and about 2× wider than long in females. Labral suture distinct. Intermandibular projection short, vertical or oblique and exposed in males, extremely short, horizontal and partly covered by anterior margin of head in females. **Mandibles of males** short, deep dorsoventrally, almost parallel-sided, interlocking apically when closed (Fig. 179), with large apical tooth directed medially, extremely large, broad-based, erect or recurved subapical dorsal tooth with rounded, medially directed tip, and very large, subapical ventral lamina with convex medial edge; **mandibles of females** short, robust, not conspicuously broad at base, external margin uniformly convex, medial edge concave, both mandibles with broad apical tooth, short, broad-based, subapical dorsal tooth and similar but smaller subapical ventral tooth. **Antennae** (Fig. 180, 181) with broad, slightly arched scape; pedicel lacking setae; funicle short, broad, 1st segment approximately symmetrical, about 1.2× longer than wide (females), or with length and width equal (males); 2nd segment approximately symmetrical, 3rd–5th segments asymmetrical; club about 4.8× wider than long (males) or about 1.9× (females), setae dense and much shorter than diameters of individual club segments. **Eyes** moderately protruding, width together 0.3–0.4× interocular distance. **Mentum** with outer surface slightly convex; 4th segment of maxillary palp about 5× longer than wide (males) or 4.3× (females); 3rd segment of labial palp about 4.6× (males) or 3.7× (females) longer than wide.

Thorax. Pronotum (Fig. 182) glossy, 1.3–1.4× wider than long (males) or 1.2–1.3× (females), about 1.5× wider than head (males) or 1.6–1.7× (females); surface raised and lacking punctures on a broad, complete or incomplete median band and on 2 pairs of bilaterally symmetrical, broad, irregular bands, 1 pair branching off median band near middle of pronotum and running forward in a straight line to anterior margin of pronotum where, in males, it terminates in a pair

of conspicuous tubercles, other pair arising laterad to median band and running forward obliquely from posterior margin of pronotum; remaining pronotal surface with small to moderately large, well defined, dense, deeply concave punctures with appressed and curved, narrow, brown scales from 5–10× longer than wide, and larger, mostly appressed, yellow scales, 4–5× longer than wide, brown scales usually but not always more numerous than the yellow ones in the material examined; brim absent; sides sloping almost vertically from disc; front angles sharply acute to right-angled, moderately close to eyes; lateral margins serrated, very slightly convex near middle, sometimes slightly flared at hind angles which are obtuse or right-angled. **Elytra** together about 1.1× wider than pronotum (males) or 1.2× (females) and 1.5–1.6× longer than wide (males) or 1.6–1.7× (females); each elytron with broad, raised sutural band and 4 other similar longitudinal bands distributed evenly across surface, all bands sparsely and irregularly punctate, intervening areas with dense or moderately dense punctures; punctures and scales (Fig. 29, 39) structurally similar to those on pronotum; most specimens examined with predominantly brown scales and few if any yellow scales but several with conspicuous patches of yellow scales on raised bands; humeral angle low; sutural margin raised; elytral declivity moderately steep; sides of elytra almost vertical; brim absent; outer rim of each elytron very narrow, vertical, with single row of punctures containing extremely narrow, curved, translucent brown scales. **Wing** about 1.6× longer than elytron, 2.7× longer than wide. **Front tibia** (Fig. 183) slightly widened beyond mid dorsal tooth, with 2–4 denticles between mid dorsal and apical teeth and 12–15 between mid dorsal tooth and base; mid dorsal tooth broad based; protarsomeres 2 and 3 with setae on ventral surface confined to an irregular apical row (Fig. 184). **Middle tibia** (Fig. 185) slightly curved; dorsal surface with large mid dorsal tooth, 6–10 moderately small denticles distributed in 2 longitudinal rows, and row of about 10 much smaller denticles. **Hind tibia** (Fig. 186) not curved; dorsal surface lacking conspicuous mid dorsal tooth but with about 8 large teeth distributed in 2 longitudinal rows; females with conspicuous cluster of denticles dorsally near apex. **Prosternum** with sharp or rounded median keel. Mesosternum flattened or slightly convex, not tuberculate. Metasternum marked off from mesosternum by very weak suture; midline area flattened; scales decumbent, all very narrow.

Abdomen. Ventrites (Fig. 187, 188) glossy, with lateral rim only on 5th ventrite; punctures small, dense, very shallow; scales decumbent, very narrow; apex of 5th ventrite deeply and broadly emarginate in males, slightly convex or almost truncate in females.

Male genitalia (Fig. 584–587) symmetrical. **9th**

abdominal segment (Fig. 584) elongate, slender. **Penis** (Fig. 585–587) broad, flask-shaped, rather elongate, convex dorsally and ventrally; base close to proximal end of basal piece; sides smooth; ostium terminal; internal sac moderately broad, lined with dense, brown spinules. **Parameres** blade-like, not very deep dorsoventrally, separated from basal piece by narrow, rigid membrane; medial surface concave; apical region straight, not upturned. **Basal piece** more than 1/2 length of parameres.

Female genitalia (Fig. 74, 688). **Hemisternites** slender, weakly sclerotised, mostly non-pigmented; medial edges widely separated; styli slender, about 3× longer than wide, with a few minute apical setae. **Bursa copulatrix** large, almost spherical; bursal duct short, rather narrow, distinctly demarcated from bursa copulatrix. **Spermathecal duct** short, moderately broad where it joins bursa copulatrix, distal 1/2 narrowing slightly; spermatheca elongate pear-shaped, about 3× longer than wide; spermathecal gland long, tubular.

Type data. Thomson described *Ceratognathus helotoides* from a single female, stated merely to be from New Zealand. Typographical errors in the original description give the erroneous impression that he may also have had a male. According to Miller (1956) Thomson's collection was sold to Oberthür and is now in the Paris Museum, but a search by Museum staff has failed to find the holotype of *helotoides*. I have examined the holotype of *Sinodendron? areolatum* Westwood which is in the Hope Department, Oxford. The specimen is a female measuring 11.9 mm x 5.0 mm, including the mandibles, and is accompanied by the following labels: (1) unlettered small red label; (2) female, Nov Zeland; (3) Dr Howitt, NH; (4) TYPE, WESTWOOD, Trans. Ent. Soc. 1863, P. 430, T.14, fig. 2, Coll. Hope Oxon. (5) TYPE COL; 338 *Ceratognathus areolatus* Westw. HOPE DEPT OXFORD.

Material examined. Holotype female of *Sinodendron? areolatum* Westwood and 142 non-type specimens (67 males, 75 females). (AMNZ, BMNH, CMNZ, LUNZ, MONZ, NZAC, Hope Department, Oxford).

Distribution (Map 2). From near sea level to about 1500 m. Northernmost record: 24 km north of Gisborne, GB (latitude 38° 28'S); southernmost record: West Plains, SL (latitude 46° 22'S).

GB, TO / NN, MB, BR, NC, WD, MC, SC, OL, DN, SL / CH (Chatham I, Mangere I, Pitt I, Rangatira I (=South East I)).

Biology. Adults in the material examined were collected from September to June in unspecified rotten logs, in dead and rotten wood of *Olearia traversii* (akeake), *Nothofagus* sp. (tawai), and *Coprosma chathamica*, under bark of *Corynocarpus laevigatus* (karaka), and in Australian hard-

wood poles. Adults were reared in the laboratory from larvae present in a stump of *Hymenanchera chathamica*, boles of *Myrsine coxii*, and dead wood of *Pseudopanax chathamica*, *Myrsine chathamica*, and *Dracophyllum arboreum*. Several specimens were obtained by beating unspecified dead branches and one was found near an ant nest. Emberson (1998) collected adults of *helotoides* on the Chatham Islands in January, July, November, and December.

Remarks. *Holloceratognathus helotoides* is widespread in the South Island but has been found in only a few North Island localities. It is extremely abundant on the Chatham Islands. The species can be recognised easily in the field by its cylindrical black body with distinctly ribbed elytra. As noted in my earlier publication (Holloway 1961) some males of *helotoides* have the apices of the pronotal tubercles and of the erect teeth of the mandibles worn down indicating they must have been tunneling through wood. When the mandibles of males are closed (see Fig. 179) they interlock to form a deep "blade" which perhaps is used to push debris from tunnels.

Holloceratognathus passaliformis (Holloway)

Fig. 40, 44, 62, 94, 95, 189–199, 588–591, 689. Map 3
passaliformis Holloway, 1962: 69, fig. 1–5 (*Ceratognathus*); 1963b: 110, fig. 28 (*Ceratognathus*); 1997: 61, fig. 68 (*Ceratognathus*); 1998 (December): 652 (*Holloceratognathus* new generic status, new combination). Grehan 1980: 171, fig. 1 (*Ceratognathus*). Nikolaev 1998 (January): 56, fig. 1B (*Ceratognathus* new subgenus *Neoceratognathus*).

Diagnosis. Length: males (including mandibles) 6.5–7.3 mm, (excluding mandibles) 6.2–6.9 mm; females (including mandibles) 6.2–7.0 mm, (excluding mandibles) 5.9–6.6 mm. Width: males 2.3–2.5 mm; females 2.3–2.5 mm. Sexual dimorphism very slight, most apparent in mandibles and 5th abdominal ventrite. Body slender, very parallel-sided, flattened (Fig. 94, 95, 189). Integument jet black or reddish black, very glossy. Punctures on dorsal surface dense, minute to small, moderately deeply convex when not containing exudate, always some punctures partially or completely filled with smooth, glassy exudate visible at a magnification of ×45 with a stereomicroscope; most punctures with barely discernible, minute or very short, erect, extremely narrow (almost setose), tapering, creamish or brown scales, some of the punctures on each elytron aligned in about 7 shallow, longitudinal striae. Front margin of head with prominent, laminate, scalloped, vertical rim. Mandibles short, vaguely triangular; medial edges strongly concave; outer edge slightly arched in females, strongly arched in males. Tibiae strongly compressed, paddle-like, inconspicuously spiny.

Redescription.

Head. (Fig. 190, 191) wider than long, widest across eyes.

Dorsal surface glossy; frons with deep transverse groove near anterior margin, integument then ascending obliquely to level of eyes; vertex moderately long, flattened, sometimes with “lumpy” surface; **punctures** well defined, moderately deep, small but larger than those elsewhere on body, dense, containing very short, erect, fine scales; preocular margin very short, obtusely angulate or rounded; supra-antennal brow very low, not ridged, outer surface sloping gradually to eye; postocular margins moderately long, straight, slightly convergent. **Labrum** not visible in dorsal aspect, consisting of short horizontal basal section and longer, vertically descending, triangular, apical section; surface slightly uneven, very sparsely setose. Labral suture distinct. Intermandibular projection short, vertical, not visible in dorsal aspect. **Mandibles** short, simple, somewhat triangular, concave on medial edge; deep dorsoventrally in males, not very deep in females, outer edge uniformly convex in females, conspicuously bent inwards almost at right angle near middle in males; teeth about same in males and females, both mandibles with large, inwardly directed apical tooth, small, subapical dorsal tooth; left mandible with small, subapical ventral tooth; right mandible in females with minute subapical ventral tooth, this tooth absent in males. **Antennae** (Fig. 192, 193) about the same in males and females; scape slightly arched, very strongly expanded distally; pedicel broad, with a strong, erect seta on dorsal surface; funicle short, broad, 1st segment symmetrical, about 1.2× wider than long in males, about 1.2× longer than wide in females, 2nd segment approximately symmetrical, 3rd–5th segments slightly asymmetrical; club about 1.3× wider than long (males) or 1.2× (females), setae very dense and much shorter than diameters of individual club segments. **Eyes** only slightly protruding, their width together about 0.3× interocular distance (males) or 0.2× (females). **Mentum** with outer surface strongly convex on proximal 1/2; 4th segment of maxillary palp about 4× longer than wide; 3rd segment of labial palp about 3.6× longer than wide (males) or 3.7× (females).

Thorax. Pronotum about 1.3× wider than long (males) or 1.2× (females); 1.7–1.8× wider than the head; punctures like those on head but smaller, dense on anterior 1/2 of pronotum, less dense posteriorly, all apparently containing a minute, erect, tapering, yellowish or brown, extremely narrow scale; brim very broad, horizontal anteriorly and posteriorly, slightly upturned near middle; disc flattened, sides descending steeply to brim; front angles obtuse, not close to eyes; lateral margins irregularly serrated, almost parallel on posterior 1/2, slightly convergent anteriorly; hind angles obtuse. **Elytra** flattened, together 1.0–1.2× wider than the pronotum, 1.6–1.8× longer than wide; punctures

and scales structurally similar to those on pronotum but differently distributed; each elytron with about 7 shallow, longitudinal punctate striae, interstriae with 2 irregular longitudinal rows of punctures; most punctures containing a visible standing scale but SEMs show that microsetae with divided tips are also present (Fig. 40); many punctures containing glassy exudate which may conceal scales; humeral angle barely raised; sutural margin not raised; elytral declivity sloping gently; sides of elytra almost vertical; brim narrow on anterior 1/2 of elytron then gradually widening to become very broad at apex; outer rim of each elytron wide, almost vertical, somewhat grooved, with single row of minute punctures containing very short, fine, erect, brownish scales. **Wing** (Fig. 44) about 1.5× longer than elytron; anal veins shortened. All **tibiae** strongly compressed, conspicuously broadened distally. All tarsomeres sparsely setose, tarsomeres 1–4 very short, arolium and claws very small. Fore legs with very small femoral setiferous patch and crescentic flange on adjacent coxa (Fig. 62). **Front tibia** (Fig. 194) with 1–4 denticles between mid dorsal and apical teeth and 12–15 denticles between mid dorsal tooth and base; denticles of mixed sizes; mid dorsal tooth very broad-based; ventral surface of protarsomeres 2 and 3 with 1–3 minute setae in each of 2 apical groups (Fig. 195). **Middle tibia** (Fig. 196) slightly curved, dorsal surface with narrow band of very small denticles and moderately large postmedian tooth. **Hind tibia** (Fig. 197) not curved, dorsal surface like that on middle tibia but lacking mid dorsal tooth; dorsal band in females widened near apex and with numerous rows of very small denticles. **Prosternum** with sharp keel. Mesosternum very slightly convex, not tuberculate. Metasternum marked off from mesosternum by suture; midline area unevenly raised; scales very short, narrow, mostly semi-erect.

Abdomen. Entire abdominal surface (tergites, pleurites and ventrites) very strongly sclerotised, deeply pigmented, glossy. **Ventrites** (Fig. 198, 199) with somewhat laminate, downwardly deflected lateral margins; punctures small, shallow, dense; scales very fine, short, mostly semi-erect; apex of 5th ventrite angulate in males, uniformly convex in females.

Male genitalia (Fig. 588–591) symmetrical, extremely strongly sclerotised, deeply pigmented. **9th abdominal segment** (Fig. 588) very broad; stem of sternite wide with pair of pale brown, divergent “wings” near middle; pleurites with a membranous dorsolateral patch. **Penis** (Fig. 589–591) moderately long, flask-shaped, broad proximally, constricted near middle, tapering and flattened from side to side on distal 1/2 with dorsal surface and ventral midline on this section membranous; base close to proximal ventral edge of basal piece; sides smooth; ostium terminal; internal

sac broad with dense, brown spinules on part of its wall. **Parameres** blade-like, very deep dorsoventrally, slightly movable on basal piece, completely marked off from it dorsally and ventrally by suture; medial surface flat; apical 1/3rd slightly upturned with a few minute, inwardly directed setae on dorsal margin. **Basal piece** about 1/2 length of parameres; ventral surface uniformly sclerotised (without a suture), but easily ruptured on or near the midline in macerated preparations.

Female genitalia (Fig. 689). **Hemisternites** moderately broad, somewhat triangular; medial edges almost straight, close together; styli slender, about 2.5× longer than wide, with about 3 minute apical setae. **Bursa copulatrix** moderately long, saccate; bursal duct very short, broad, not distinctly demarcated from bursa copulatrix. **Spermathecal duct** very short, rather narrow except for slightly wider section where it joins bursa copulatrix; spermatheca elongate, pear-shaped, about 3× longer than wide; spermathecal gland very long with moderately long, narrow duct.

Type data. The holotype male is in the Museum of New Zealand (formerly National Museum of New Zealand). It was collected at Jacobs Ladder in the Orongorongo Valley, WN (41° 19'S, 174° 59'E) by B. A. Holloway on 25 January 1961. The holotype and 12 paratypes all from Jacobs Ladder, were found in nests of *Prolasius advena*, an endemic formicine ant, under beech logs. Two of the paratypes, a male and a female, were later gifted to NZAC.

Material examined. Holotype male, 4 male and 8 female paratypes, and 4 non-type specimens (3 males, 1 female) (MONZ, NZAC).

Distribution (Map 3). WN from near sea level to about 450 m. Northernmost record: Wright Street Reserve, Wainuiomata (latitude 41° 16'S) (Grehan 1980); southernmost record: Jacobs Ladder, Orongorongo Valley (latitude 41° 19'S). The only other known locality is Butterfly Creek, Eastbourne (41° 18'S, 174° 55'E) (Grehan 1980). At all these localities the beetles were associated with *Prolasius advena*, in or under partly buried beech logs.

WN / —

Remarks. *H. passaliformis* is so far known only from a small forested area on the eastern side of the Wellington Harbour although the ant with which it is associated is widespread throughout New Zealand. In spite of its small size, this stag beetle is easily identified in the field because of its parallel-sided, flattened, shiny, black passalid-like body. The scales on the head, pronotum, and elytra are extremely fine and inconspicuous but those on the scutellum are broader, distinctly tapering, and similar in structure to those of *H. cylindricus* and *H. helotoides*. The

paddle-like legs of *passaliformis* are very different from those in the other 2 species. In particular, the small denticles on the front tibiae are unusual because they all are about the same length, but evidence of their derivation from mixed-sized denticles is apparent in their varying basal widths. *H. passaliformis* and *H. cylindricus* have almost identical mandibles and similarly shaped antennal clubs and the males in both species have a broad, robust 9th segment and parameres that are very deep dorsoventrally. The female genitalia and setae on the ventral surface of the protarsomeres in *passaliformis* are more similar to those in *helotoides* than in *cylindricus*.

Genus *Mitophyllus* Parry

Mitophyllus Parry, 1843: 362; 1845: 55. Burmeister 1847: 324 (as synonym of *Ceratognathus* Westwood). Holloway 1998: 643 (*Mitophyllus* Parry reinstated). Type species *Mitophyllus irroratus* Parry, by original designation.

Ptilophyllum Guérin-Méneville, 1845: 439; 1846: xcvi. Lacordaire 1856: 41 (as synonym of *Ceratognathus* Westwood). Type species *Ptilophyllum godeyi* Guérin-Méneville, by original designation.

Diagnosis. Small to moderately large aesalines (length including mandibles 6–18 mm) with black or brown, dull or glossy integument; conspicuous sexual dimorphism in mandibles, antennae, and eyes. Integumental pits (punctures) on dorsal and ventral surfaces sparse to dense, small to very large, with well defined margins and polygonally sculptured walls and floor (sculpturing usually visible under a stereomicroscope), the floor raised, flat-topped, separated from the walls by a groove. Vestiture on dorsal surface consisting of variably sized, fully expanded, white, yellowish, brown or black, ribbed, rather blunt-tipped, oval scales and microscopic setae. Elytra not uniformly striated, instead smooth, or with depressed areas, or indistinctly ribbed; vestiture sometimes arranged in longitudinal tracts. Legs slender; dorsal edge of front tibia with 2 large teeth and numerous small, similar-sized teeth; middle and hind tibiae not very spiny, rather cylindrical in cross section, with evenly spaced longitudinal rows of vestiture.

Redescription based on Holloway (1998)

Head. Anterior margin varying from shallowly indented to strongly protruding, with or without rim, tuberculate on midline in some species. Preocular margin short, not laminate. **Mandibles** punctate, setose, sometimes also with scales; in males moderately long, either laterally curved and approximately the same width throughout their length, or somewhat triangular, sometimes with erect cusps; in females short, elongate-triangular, with apical tooth and subapical dorsal tooth, left mandible with subapical ventral tooth, the right mandible lacking this tooth. Maxillae

with elongate galea and minute lacinia. Mentum small, approximately semicircular, setose. Ligula small, notched apically. Intermandibular projection short, extremely short in some species, wider than long, descending vertically, or anteroventrally, or receding. Labral suture present; labrum short, wider than long, setose, directed anteroventrally or anterodorsally, with indented to convex apex. Frons with distinctly demarcated, elongate, depressed or slightly raised, triangular area extending to level of posterior margin of eyes; not tuberculate. **Antennal club** segments stout or slender, vestiture consisting of dense, short or long setae either uniformly distributed over entire surface or absent from base or medial surface; segments stouter and vestiture shorter in females. Supra-antennal brow variably developed. **Eyes** protruding, small to very large, usually much larger in males, in dorsal aspect broadest near middle and with uniformly convex outer margin. Postocular margins very short to very long, often much longer in females, slightly concave to slightly convex, neither lobed nor tuberculate, sometimes convergent posteriorly.

Thorax. **Pronotum** wider than long; front angles acute to obtuse, blunt or sharp; disc smooth or uneven, often depressed on part of midline, with or without pair of tubercles; sides of disc descending gradually to lateral margin which is convex, serrated, with horizontal brim; hind angles obtuse or right-angled, blunt or sharp. Scutellum triangular or semicircular, length greater or less than its width. **Elytra** parallel-sided; surface smooth, or with a few broad ribs, or with depressed oval areas; no more than 2 striae visible on each elytron and these if present barely discernible; humeral angles and sutural margins either low or conspicuously arched; outer margin with low, punctate rim containing scales or setae; brim narrow; pits (punctures) small to large, polygonally sculptured on floor and walls, floor raised, flat-topped, and separated from walls by conspicuous, horizontal groove; each pit containing either a large appressed or standing scale or a minute, erect seta, both types of vestiture arising anteriorly in floor, scales oval, rather blunt-tipped, with very dense, interconnected, irregular, longitudinal ribs on their dorsal surface, setae with divided tips; integument between the pits extremely finely granulose. **Wings** fully developed or vestigial. **Prosternal process** very narrow, concealed by procoxae. Mesosternal process narrow, smooth or tuberculate. **Legs** long and slender; procoxal process well developed; femora with numerous setae or scales; front femur about 3× longer than wide, with large setiferous patch reaching to about middle of femur, associated punctures dense only on upper part of patch; tibial vestiture consisting of standing scales and setae, most with their bases concealed by an overhanging denticle; front tibia narrow, straight or slightly arched, dorsal edge with large apical tooth, similarly-sized

mid dorsal tooth (beyond middle), and numerous uniformly small teeth; middle and hind tibiae gradually expanded from base to apex, lacking setiferous sex patches, their vestiture mostly aligned in 7 longitudinal rows evenly distributed around the segment which is approximately circular in cross-section; dorsal surface of middle and hind tibiae with denticles, with or without dorsal tooth beyond middle; ventral surface of tarsomeres 1–4 with short or long setae either numerous and covering most of surface or sparse and apical; arolium with a bristle on either side of apex.

Abdomen. Lateral margins of the ventrites flanged; distal margin of **5th ventrite** truncate, angulate, or emarginate in males, truncate to strongly convex in females.

Male genitalia. Sometimes with asymmetrical components. **9th abdominal segment** rather slender, symmetrical or asymmetrical; distal margin of sternite entire and setose. **Tegmen** (basal piece + parameres) symmetrical or asymmetrical, parameres separated from basal piece by narrow, rigid, membranous strip or partially continuous with basal piece, or completely continuous with it. **Basal piece** or basal piece region short, broad, somewhat cylindrical, surrounding less than 1/2 length of penis, divided longitudinally by a suture at or near midline both dorsally and ventrally, dorsomedial edges either touching for all or part of their length or narrowly separated from each other, ventromedial edges narrowly separated from each other. **Parameres** much longer than basal piece, symmetrical or asymmetrical, somewhat conical, tapering; tip rounded, pointed, or slightly expanded; medial surface smooth, not ribbed. **Penis** symmetrical or asymmetrical, cylindrical, narrow or moderately broad, long, its apex approximately in line with tips of parameres; ostium dorsal, ventral, or terminal; internal sac longer or shorter than penis, clothed with spinules and minute setae.

Female genitalia. **Accessory gland** absent. **Bursal duct** short or long, narrow or broad. **Bursa copulatrix** bilobed, one lobe always large, the other very small to moderately large. Spermathecal duct very short to moderately long, arising in various positions on smaller lobe of bursa copulatrix and always widely separated from base of median oviduct. **Spermatheca** small to large. Spermathecal gland long and slender, not strongly demarcated from its duct of varying length, combined length of duct and gland much greater than length of spermatheca.

Range. New Zealand.

Remarks. *Mitophyllus* adults are easily distinguished from those of *Holloceratognathus* by the close-set, uniformly small teeth extending along the dorsal edge of the front tibia on either side of the mid dorsal tooth, the raised, flat-topped, polygonally sculptured floor of the elytral pits, the numerous cross-bars connecting the close-set ribs of

the elytral scales, and the very finely granulose surface between the elytral pits. The male genitalia of *Mitophyllus* are extremely diverse but their distinctive feature is the longitudinal suture on or near the midline on the ventral surface of the basal piece, or basal piece region in species that have the parameres and basal piece conjoined. Functionally it is probably unimportant whether the parameres are fused with the basal piece or whether they are free because the membrane when present is so rigid that the parameres are immovable on the basal piece anyway. Some differences and similarities among the 2 genera and the Australian genus *Ceratognathus* are mentioned in the Remarks for *Holloceratognathus* and are listed in Holloway (1998).

Mitophyllus is the largest genus of lucanids in New Zealand with 14 species, of which 13 are fully winged in both sexes, and 1 that has fully winged males but flightless females.

KEY TO SPECIES OF *Mitophyllus* MALES

- 01 Width of eyes together in dorsal aspect equal to at least interocular distance (Fig. 355); sides of pronotum with strongly upturned brim (p. 65)... *reflexus*
 —Width of eyes together in dorsal aspect less than interocular distance (Fig. 238); pronotal brim when present not upturned 02
- 02(01) Mandibles about 1/4 length of head and not at all ornate; front margin of head with small, erect, conical tubercle on midline (Fig. 326) ... (p. 61)... *macrocerus*
 —Mandibles at least 1/2 length of head and somewhat ornate; front margin of head without erect median tubercle but sometimes with forwardly directed, horizontal tubercle 03
- 03(02) Pronotum with pair of large tubercles on centre of disc; elytral shoulders and middle 1/3rd of elytral suture conspicuously raised; front margin of head with forwardly directed tubercle on midline (Fig. 292) (p. 54)... *gibbosus*
 —Pronotum not tuberculate; elytral shoulders and suture not conspicuously raised; front margin of head not tuberculate 04
- 04(03) Mandibles in dorsal aspect somewhat sickle-shaped with concave medial edge (Fig. 227); space between mandibles when closed circular or broadly oval05
 —Mandibles in dorsal aspect somewhat triangular with medial edge more or less straight (Fig. 315), space between mandibles when closed rectangular or very narrowly oval09
- 05(04) Eyes large, protruding prominently beyond postocular margin of head, their length 0.6–0.7× head length, their width together in dorsal aspect 0.6–0.7× interocular distance06
 —Eyes small, protruding slightly beyond postocular margin, their length 0.3–0.5× head length, their width together in dorsal aspect 0.3–0.4× interocular distance07
- 06(05) Apex of both mandibles with rather small, medially directed apical, subapical dorsal, and subapical ventral teeth; broad-based erect tooth present behind the subapical dorsal tooth (Fig. 227); antennal club 7–8× wider than long (Fig. 231); elytra with clay-coloured decumbent scales and a few tufts of creamish, decumbent or semi-erect scales ... (p. 43)... *arcuatus*
 —Apex of both mandibles with large, medially directed apical, subapical dorsal, and subapical ventral teeth; no erect tooth present behind subapical dorsal tooth (Fig. 252); antennal club about 2.3× wider than long (Fig. 256); elytral scales all clay-coloured and decumbent (p. 48)... *falcatus*
- 07(05) Mandibles 1.5× length of head and with erect subapical dorsal tooth (Fig. 302); elytra with inconspicuous, decumbent, clay-coloured scales in addition to about 5 small, loose tufts of erect, dull, yellowish scales on each elytron ... (p. 56)... *insignis*
 —Mandibles about 0.6× as long as head and with horizontal, inwardly directed subapical dorsal tooth (Fig. 238); elytra with conspicuous, decumbent, yellow or clay-coloured and brown scales and lacking tufts of scales08
- 08(07) Proximal 1/2 of mandibles almost straight-sided externally; front margin of head deeply and narrowly notched on midline (Fig. 238); pronotum and elytra with only clay-coloured and dark brown scales (p. 46)... *dispar*
 —Proximal 1/2 of mandibles slightly but distinctly curved externally; front margin of head shallowly and broadly indented on midline (Fig. 214); pronotum and elytra with only pale yellow scales ... (p. 41)... *angusticeps*
- 09(04) Eyes large, their width together in dorsal aspect 0.6–0.7× interocular distance (Fig. 315) 10
 —Eyes small, their width together in dorsal aspect 0.2–0.3× interocular distance (Fig. 266)12
- 10(09) External margin on proximal 1/2 of mandibles uniformly convex, not developed as projecting lobe separated by notch from distal part of margin (Fig. 368); elytral surface uneven and lumpy with shaggy unkempt vestiture (p. 67)... *solox*

- External margin on proximal 1/2 of mandibles with projecting, angulate or rounded lobe separated from distal part of margin by distinct shallow or deep notch (Fig. 339); elytral surface essentially smooth although traces of a few ribs may be present; vestiture smooth and tidy 11
- 11(10) External lobe on proximal 1/2 of mandibles small and acute-angled (Fig. 315); antennal club 7–9× wider than long (Fig. 319) (p. 58)... *irroratus*
- External lobe on proximal 1/2 of mandibles large and obtusely rounded (Fig. 339); antennal club about 2.4× wider than long (Fig. 344) (p. 62)... *parrianus*
- 12(09) Elytral vestiture consisting of appressed, overlapping, yellow scales grouped in large, widely separated, shallow, oval integumental depressions (Fig. 275); antennal club about 3× wider than long (Fig. 272) (p. 50)... *foveolatus*
- Elytral vestiture consisting of appressed or curved or erect, brown scales that do not overlap, and small tufts of erect, cream or yellowish scales; antennal club less than 2× wider than long 13
- 13(12) Elytral integument black; elytra with broad longitudinal tracts of dense punctures containing appressed or curved, brown scales alternating with broad, more sparsely punctate tracts each with 4 or 5 small, widely spaced, conspicuous, rather compact tufts of erect, cream or yellowish scales (Fig. 96) (p. 39)... *alboguttatus*
- Elytral integument dark brown; elytra with uniformly dense punctures containing erect or suberect, brown scales except for 4 narrow longitudinal bands with fewer brown scales and 4 or 5 very small, widely spaced, rather inconspicuous loose tufts of cream or yellowish scales (Fig. 108) (p. 52)... *fuscus*

KEY TO SPECIES OF *Mitophyllus* FEMALES

- 01 Elytral shoulders and middle 1/3rd of elytral suture conspicuously raised; centre of pronotal disc with pair of large tubercles (p. 54)... *gibbosus*
- Elytral shoulders and elytral suture not conspicuously raised; pronotal disc not tuberculate 02
- 02(01) Elytral surface with very distinct, large, oval, shallow concavities containing groups of overlapping, appressed, yellow scales, each elytron with at least 8 such concavities (Fig. 107) (p. 50)... *foveolatus*
- Elytral surface smooth, or uneven, or faintly ribbed, not with isolated, oval concavities containing groups of appressed yellow scales 03

- 03(02) Elytral scales predominantly minute, very narrow, almost threadlike (Fig. 361) (p. 65)... *reflexus*
- Elytral scales moderately large, not threadlike, instead either elongate-oval or somewhat fan-shaped (Fig. 332) 04
- 04(03) Anterior margin of the head with small, median, erect tubercle (Fig. 327); scales on pronotal disc all creamish white, teardrop-shaped, arranged sparsely in curved lines and very small groups (Fig. 331) (p. 61)... *macrocerus*
- Anterior margin of head smooth, or rimmed, not with erect median tubercle; scales on pronotal disc not creamish white, instead mostly shades of yellow, orange, or brown and not teardrop-shaped, arranged in large, dense groups 05
- 05(04) Most elytral scales erect or strongly curved, their apices not touching elytral surface 06
- Most elytral scales appressed or decumbent, their apices more or less touching elytral surface 07
- 06(05) Elytral punctures closely spaced, in somewhat honeycomb pattern (Fig. 284); elytral scales very broadly fan-shaped, their lengths mostly less than diameter of their punctures; wings vestigial (p. 52)... *fuscus*
- Elytral punctures relatively widely spaced, not at all in honeycomb pattern (Fig. 309); elytral scales elongate-oval, their lengths mostly at least equal to diameter of their punctures; wings fully developed (p. 56)... *insignis*
- 07(05) Front margin of head, behind labrum, projecting forward conspicuously and horizontally between mandibles (Fig. 316) 08
- Front margin of the head, behind labrum, not projecting forward conspicuously and horizontally between mandibles, instead either straight or slightly convex (Fig. 203) 09
- 08(07) Mandibles dark reddish-brown, their external edge with narrow-based, pointed lobe near base, this lobe projecting conspicuously beyond rest of external edge (Fig. 316) (p. 58)... *irroratus*
- Mandibles black, their external edge with broad-based, obtusely rounded lobe near base, this lobe projecting only slightly beyond rest of external edge (Fig. 228) (p. 43)... *arcuatus*
- 09(07) Mandibles with their medial edge between base and level of subapical dorsal tooth smooth, concave, without teeth or indentations (Fig. 203); width of eyes together in dorsal aspect 0.2–0.3× interocular distance 10

- Mandibles with their medial edge between base and level of subapical dorsal tooth not uniformly smooth and concave, instead notched and with 1 or 2 small teeth (Fig. 340); width of eyes together in dorsal aspect 0.5–0.6× interocular distance12
- 10(09) Head almost 2× wider than long; postocular margin shorter than length of eye; mandibles about 0.75× head length (Fig. 203)(p. 39)... *alboguttatus*
- Head at least as long as wide; postocular margin much longer than length of eye; mandibles 0.3–0.4× head length (Fig. 215)11
- 11(10) Front margin of head with a wavy rim (Fig. 215); mandibles elongate, almost as long as postocular margin; elytral scales yellow(p. 41)... *angusticeps*
- Front margin of head not rimmed (Fig. 239); mandibles short, about 1/2 as long as postocular margin; elytral scales brown and clay-coloured(p. 46)... *dispar*
- 12(09) Setae in fringe along sides of 2nd and 3rd protarsomeres varying in length, short at proximal end of the segments, increasing in length towards distal end (Fig. 349); scales on metasternum narrow, about 5× longer than wide, not very dense (Fig. 352)(p. 62)... *parrianus*
- Setae in fringe along sides of the 2nd and 3rd protarsomeres all same length, long (Fig. 260); scales on metasternum mostly broad, about 2–4× longer than wide, rather dense (Fig. 263)13
- 13(12) Elytral surface uneven and lumpy, with shaggy, unkempt-looking vestiture; scales on pronotal disc numerous, dense, about 2× longer than wide; scales on metasternum about 2× longer than wide (Fig. 379)(p. 67)... *solox*
- Elytral surface even, not at all lumpy, instead with neatly appressed vestiture; scales on pronotal disc rather sparse, about 4× longer than wide; scales on metasternum 3–4× longer than wide (Fig. 263)(p. 48)... *falcatus*

Mitophyllus alboguttatus (Bates)

Fig. 10, 17, 67, 68, 70, 96, 97, 200–213, 592, 593, 690.
Map 4

alboguttatus Bates, 1867: 54 (*Ceratognathus*). Parry 1870: 67 (*C. sexpustulatus* attributed to Bates by Gemminger and Harold, 1868: 967 is a nomen nudum of *C. alboguttatus*, and the type locality of Moreton Bay, given for *C. alboguttatus* by Gemminger and Harold, is incorrect and should be Canterbury Province). Benesh 1960: 19 (has additional references, *Ceratognathus*). Holloway 1961: 86, fig. 15, 19, 85–87, 199, 211 (*Ceratognathus*); 1963b: 110, fig. 30 (*Ceratognathus*); 1998: (December):

650 (*Mitophyllus*). Nikolaev 1998 (January): 56 (*Ceratognathus* new subgenus *Holloceratognathus*). *cristatellus* Broun, 1917: 391 (*Mitophyllus*). Benesh 1960: 19 (*Ceratognathus*). Holloway 1961: 86 (synonym of *C. alboguttatus*).

Diagnosis. Length: males (including mandibles) 6.9–10.5 mm, (excluding mandibles) 6.3–9.4 mm; females (including mandibles) 7.2–8.6 mm, (excluding mandibles) 6.9–8.0 mm. Width: males 3.0–4.2 mm; females 3.2–4.0 mm. Sexual dimorphism moderately conspicuous, most apparent in eyes and mandibles. Body (Fig. 96, 97) rather slender, somewhat flattened dorsally. Integument in males black dorsally, dark brown ventrally, in females entirely dark brown. Punctures on dorsal surface small to large, their raised floor easily seen at ×45 with a stereomicroscope. Pronotum with tracts and patches of appressed to suberect, short to moderately long, narrow to moderately broad, brown scales, with a few compact tufts of erect, larger, yellowish scales and a median and several bilaterally symmetrical non-squamose areas. Elytra with conspicuous, sharply demarcated, longitudinal tracts of short, appressed to suberect, narrow or moderately wide, brown scales alternating with longitudinal bands that are non-squamose except for few conspicuous, compact tufts of erect, moderately long, yellowish scales. Mandibles approximately triangular, their medial edges somewhat parallel in males, concave in females. Ventral margin of front tibia concave. Setae on underside of 2nd and 3rd protarsomeres confined to row at apex.

Redescription

Head. (Fig. 200–203) wider than long, widest across eyes. **Dorsal surface** glossy; frons slightly concave in males, flattened in females; vertex smooth, slightly convex; **punctures** well defined, shallow, mostly moderately large, uniformly dense, those near eyes and some on frons and vertex containing moderately long, brown or creamish, standing scales, remainder devoid of scales but with microsetae that are mostly too small to be seen with a stereomicroscope. Preocular margin acutely to obtusely rounded or angulate; supra-antennal brow low, outer surface sloping very gradually to eye in males, sloping more steeply in females; postocular margins short, sides straight and convergent in males, slightly convex in females. **Labrum** horizontal, relatively long, about 1.2× wider than long and not very setose in males, 1.1–1.3× wider than long and very setose in females. Labral suture distinct. Intermandibular projection moderately long, receding or vertical, or directed forward in males, very short and receding in females. **Mandibles** triangular, not deep dorsoventrally; mandibles of males (Fig. 200–202, 204) with strong apical tooth directed anteromedially, short, erect subapical dorsal tooth with slightly recurved tip, variably developed

dorsomedially directed lamina on inner edge of mandible behind subapical dorsal tooth, narrow, horizontal lamina extending about 3/4 of distance along inner margin from base of apical tooth, and large, somewhat triangular, external basal lobe with upwardly directed outer margin (Fig. 204), teeth and lobes greatly reduced in some small specimens (Fig. 201, 202); mandibles of females (Fig. 203) slightly concave on dorsal surface, obtusely rounded externally at base, with large apical tooth, small subapical dorsal tooth, and in left mandible a small subapical ventral tooth. **Antennae** (Fig. 205, 206) very similar in males and females; scape slightly arched, moderately broad, broader in males; funicle short, broad, 1st segment about 1.5× wider than long in males, about 1.3× longer than wide in females, 2nd segment symmetrical, 3rd–5th segments asymmetrical; club about 1.2× wider than long in males and females, setae dense and shorter than diameters of individual club segments. **Eyes** protruding moderately beyond postocular margin in males, barely beyond margin in females, their width together about 0.3× interocular distance. **Mentum** with slightly convex surface; 4th segment of maxillary palp (Fig. 17) 6.6–7.1× longer than wide (males) or 3.8–5.1× (females); 3rd segment of labial palp (Fig. 10) 4.9–5.8× longer than wide (males) or 3.4–3.5× (females).

Thorax. Pronotum moderately glossy, 1.6–1.8× wider than long and 1.6–1.7× wider than head in males, about 1.5× wider than long and 1.7–1.8× wider than head in females; punctures well defined, rather shallow, mostly moderately large, largest near lateral margins, dense on squamose areas and sparser or absent on non-squamose areas in males, uniformly dense over most of surface in females; raised floors of punctures clearly visible under a stereomicroscope; scale pattern as in Fig. 207, the brown scales appressed to suberect and about 4× longer than wide in males, subdecumbent and about 5× longer than wide in females; microsetae present in some punctures; brim narrow in males, narrow or absent in females; disc with non-squamose areas slightly depressed in males, slightly raised and darker than surrounding integument in females; sides sloping gently from disc; front angles obtuse, rather close to eyes; lateral margins serrated, slightly convex near middle; hind angles obtuse. **Elytra** together 1.1–1.2× wider than pronotum and 1.4–1.5× longer than wide; punctures and scales resembling those on pronotum except that brown scales are appressed in females; in males and females scales arranged in 5 longitudinal, mostly broad tracts on each elytron (Fig. 208), these tracts alternating with 4 sparsely punctate bands (darker than adjacent integument in females) with microsetae in their punctures and 3 to 7 compact, variably sized, conspicuous tufts of large, yellowish or nearly white standing scales; discal surface smooth except that squamose tracts are slightly raised

and humeral angle is prominent; sutural margin flattened; elytral declivity sloping gently; sides of elytra almost vertical; brim absent except near humeral angle where it is extremely narrow; outer rim of elytra almost horizontal with single row of punctures containing erect to subdecumbent scales. **Wing** about 2.1× longer than elytron. **Front tibia** (Fig. 209) moderately broad beyond mid dorsal tooth, with 6–9 denticles between mid dorsal and apical teeth in males, or 6–7 in females and 12–17 denticles between mid dorsal tooth and base (males) or 9–11 (females); ventral margin slightly curved in males, more strongly curved in females; setae on ventral surface of protarsomeres 2 and 3 (Fig. 210) arranged in a complete or broken transverse row near apex. **Middle tibia** with small mid dorsal tooth and few smaller teeth dorsally. **Hind tibia** (Fig. 211) not curved, dorsal surface lacking large teeth but with varying numbers of small teeth, those in females slightly larger with a few in cluster near apex of tibia, teeth on mid and hind tibiae more numerous in some small males. **Prosternum** slightly keeled. Mesosternum smooth, not at all tuberculate. Metasternum marked off from mesosternum by suture; midline area depressed; scales appressed, very narrow towards midline, broader at sides.

Abdomen. Ventrites (Fig. 212, 213) glossy; punctures small, moderately dense; scales appressed, narrow near midline, slightly wider elsewhere; apex of 5th ventrite slightly convex to slightly concave in males, truncate in females.

Male genitalia (Fig. 592, 593) asymmetrical. **9th abdominal segment** (Fig. 67) narrow; stem of sternite strongly curved to left side of body. **Penis** (Fig. 68) slightly asymmetrical, narrowly flask-shaped, slightly concave on dorsal surface, slightly convex on ventral surface; base close to proximal end of basal piece; sides not grooved; ostium terminal; internal sac broad, very long, with dense brown spinules. **Parameres** strongly asymmetrical, immovable on basal piece but marked off from it dorsally and ventrally by suture; medial surface concave with pale, oval, excavated area near base; right paramere with short, narrow, dorsomedial flange about midway along its length; distal part of both parameres curved, broad, slightly tapered, directed medially. **Basal piece** strongly asymmetrical, more than 1/2 length of parameres.

Female genitalia (Fig. 70, 690). **Hemisternites** moderately slender; medial edge almost straight; styli straight, rather broad, about 2× longer than wide. **Bursa copulatrix** broad throughout its length; smaller lobe very long; bursal duct very long, narrow, distinctly demarcated from bursa copulatrix. **Spermathecal duct** long, broad, conspicuously widened where it joins smaller lobe of bursa copulatrix and distant from apex of this lobe; spermatheca broad, pear-shaped, about 2× longer than wide.

Type data. The holotype of *Ceratognathus alboguttatus* Bates has not been located. The specimen, a male, was collected in the Canterbury Province, MC, by R. W. Fereday. I have been able to examine a male, sent on loan from the Paris Museum, that was compared by Major F. J. S. Parry with the holotype of *alboguttatus* and is labelled as follows: "(1) N. Zeald. Auckland (2) *Ceratognathus alboguttatus* Bates rather more thickly clothed with brown scales, the type being abraded (3) Ex Musaeo Parry (4) MUSEUM PARIS 1952 Coll R Oberthür".

The holotype male of *Mitophyllus cristatellus* Broun is in the BMNH. Its details, given in the original description, are "Routeburn, north of Lake Wakatipu [OL, (44° 44'S, 168° 20')]. One found by Mr T. Hall, under a log, minus an antenna, on the 10th February, 1914".

Material examined. The male specimen compared by Parry with the type of *Ceratognathus alboguttatus* Bates, the holotype male of *M. cristatellus* Broun, and 47 non-type specimens (30 males, 17 females) (AMNZ, BMNH, CMNZ, LUNZ, MNHN, MONZ, NZAC).

Disribution (Map 4). From near sea level to about 1750 m. Northernmost record: Auckland, AK without a precise locality, (selected latitude 36° 52'S); southernmost record: Fiordland National Park, FD (latitude 45° 45'S).

AK, GB, TK, WN / NN, KA, BR, NC, MC, MK, OL, FD

Biology. Adults have been collected from November to March under logs and bark of dead trees, on moss at night in *Nothofagus* forest, and by sweeping.

Remarks. *Mitophyllus alboguttatus* is easily recognised by its small size, black or brown integument, and conspicuous tufts of yellowish-cream standing scales on the pronotum and elytra. *M. insignis* Broun, which is usually much larger than *alboguttatus*, also has tufts of scales on the elytra and pronotum but they are less conspicuous, looser, and brownish rather than cream. In both species the integument of the dorsal surface is brown in females and black in males but to the naked eye some males appear to be brown if the brown scales are very dense. In males and females of *alboguttatus* the size of the brown scales on the dorsal surface and their angle of inclination are extremely variable and independent of the size of the specimens and their geographic locality, and in males, the length of the mandibles in relation to head length and the size of the mandibular teeth are also variable. In some but not all of the small males (Fig. 201, 202) the mandibles are only 1/2–3/4 the length of the head and their teeth and lobes are small, whereas in the largest males the mandibles are at least as long as the head and their teeth and lobes are strongly developed (Fig. 200), but regardless of this variation the mandibles always are recognisably triangular in

contrast to the laterally arcuate mandibles of *insignis*. Confirming specific characters for both sexes are present on the 2nd and 3rd tarsomeres of the front legs: in *alboguttatus* the setae on the ventral surface of these segments are confined to a row near the apex while in *insignis* they are arranged in a triangular patch on the distal 1/2 of the segments.

In my earlier revision (Holloway 1961) I treated *Ceratognathus fuscus* Broun as a synonym of *alboguttatus* but I have since found that it is a distinct species.

Mitophyllus angusticeps Broun reinstated species

Fig. 98, 99, 214–226, 594–597, 691, 692. Map 5

angusticeps Broun, 1895: 199. Benesh, 1960: 19 (*Ceratognathus*). Holloway 1961: 93 (incorrectly treated as a synonym of *Ceratognathus dispar* Sharp), fig. 187–190, 201, 214 (all labelled as *dispar* but actually *angusticeps*); 1963b: 110, fig. 29 (referred to as *dispar* but includes *angusticeps*). REINSTATED SPECIES.

mandibularis Broun, 1917: 390 (*Mitophyllus*). Benesh 1960: 20 (*Ceratognathus*). Holloway 1961: 93 (treated incorrectly as a synonym of *C. dispar*). TRANSFERRED SYNONYMY.

Diagnosis. Length: males (including mandibles) 7.0–7.6 mm, (excluding mandibles) 6.5–6.9 mm; females (including mandibles) 6.7–7.9 mm, (excluding mandibles) 6.4–7.6 mm. Width: males 2.9–3.2 mm; females 3.4–3.5 mm. Sexual dimorphism most apparent in features of head. Body (Fig. 98, 99) moderately stout, convex dorsally. Integument black or brownish black. Punctures on dorsal surface small to moderately large, their raised floor very conspicuous at ×15 in even the smallest punctures. Pronotum and elytra with broken tracts and clusters of pale brownish yellow, appressed scales. Head of males with anterior margin shallowly notched on midline; external margin of supra-antennal brow not upturned and not protruding forward; frons depressed, with small, sparsely punctate patch anteriorly. Head of females elongate and much narrower than pronotum, its anterior margin strongly convex, wavy, and with low rim. Mandibles triangular and rather long in females, crescentic with uniformly convex external margin in males. Ventral margin of front tibia curved. Setae on underside of 2nd and 3rd protarsomeres long, evenly spaced in a row on distal margin.

Redescription

Head. (Fig. 214, 215) wider than long in males, longer than wide in females, widest across eyes in males, widest postocularly in females. **Dorsal surface** glossy, frons in males slightly concave with a small lenticular sparsely punctate median patch, in females slightly uneven and densely punctate; anterior margin in males inconspicuously

notched on midline and not rimmed, in females prominently convex, wavy, and with broad, low, irregular rim; vertex flattened or slightly convex; **punctures** well defined, moderately deep, mostly small and dense, denser in females, a few on frons and in band running from preocular margin along medial edge of eye to pronotal margin containing decumbent to erect pale yellow scales and pale setae, remaining punctures devoid of scales but apparently with microsetae; preocular margin obtusely rounded, moderately protruding, not laminate; supra-antennal brow moderately arched in males, barely arched in females, outer surface sloping gradually to eye; postocular margin moderately long (males) or very long (females), sides slightly convergent in males, obtusely rounded near posterior margin in females. **Labrum** short, about 2× wider than long, partly visible in dorsal aspect in males, fully visible in females, horizontal and very setose in males, obliquely upturned and with only marginal setae in females. Labral suture distinct. Intermandibular projection very short, directed anteroventrally, in dorsal aspect concealed below anterior margin of frons. **Mandibles of males** (Fig. 214, 216) long, porrect, rather deep dorsoventrally, uniformly convex, not lobed on external margin, with strong apical tooth and horizontal subapical dorsal tooth, both directed medially, small subapical ventral tooth, and low, dorsal flange extending from subapical dorsal tooth almost to base of mandible. **Mandibles of females** (Fig. 215) relatively long, triangular, curved on medial edge, rounded externally at base, strongly concave dorsally, with elongate apical tooth, short subapical dorsal tooth and, only on the left mandible, a moderately large subapical ventral tooth. **Antennae** (Fig. 217, 218) with scape broad, moderately arched, dorsal groove well defined; funicle short and broad in males, long and slender in females, 1st segment about as long as wide in males, almost 2× longer than wide in females, 2nd–4th segments approximately symmetrical, 5th segment asymmetrical; club about 1.8× wider than long in males, about 1.1× wider than long in females, setae dense, much shorter than diameters of individual club segments. **Eyes** moderately protruding, width together about 0.4× interocular distance. **Mentum** with outer surface convex in males, slightly concave in females; 4th segment of maxillary palp about 5× longer than wide (males) or about 3× (females); 3rd segment of labial palp about 3.5× longer than wide (males) or about 3× (females).

Thorax. Pronotum (Fig. 219) glossy; 1.5–1.6× wider than long and about 1.8× wider than head in males, 1.5× wider than long and at least 2.5× wider than head in females; disc moderately convex, slightly raised on midline in some specimens; punctures well defined, deep, mostly dense, largest and most dense towards sides of pronotum, absent on raised median strip on posterior 1/2 of pronotum; vestiture

consisting of sparse, appressed or curved, widely spaced scales, about 7× longer than wide, brownish in males, pale yellow in females, arranged in small bilaterally symmetrical groups separated by extensive non-squamose areas; microsetae apparently present in non-squamose punctures; brim absent; sides sloping gently from disc; front angles obtuse, moderately distant from eyes (males) or very distant (females); lateral margins uniformly serrated, convex near middle; hind angles obtuse. **Elytra** together about 1.1× wider than pronotum (males) or 1.2–1.3× (females), 1.4–1.5× longer than wide; integument glossy; punctures small, dense, evenly distributed; scales similar in size, colour, and angle of inclination to those on pronotum but much more numerous, denser in males than in females, arranged in broad tracts and large groups, separated by small punctate patches with almost invisible microsetae, and forming a somewhat reticulate pattern (Fig. 220); humeral angle moderately raised; discal surface smooth; sutural margin not raised; elytral declivity and sides of elytra sloping almost vertically; brim absent; outer rim of elytron narrow, oblique, with single row of very small, decumbent scales. **Wing** about 2× longer than elytron. **Front tibia** (Fig. 221, 222) slightly broadened beyond mid dorsal tooth (males) or barely broadened (females), with 6 or 7 denticles between mid dorsal and apical teeth (males) or 5–7 (females) and 12–15 denticles between mid dorsal tooth and base (males) or 10–15 (females); apical tooth moderately long and slightly curved in males, extremely long and conspicuously curved in females; mid dorsal tooth short in relation to apical tooth; ventral margin very slightly curved in males, moderately curved in females; ventral surface of protarsomeres 2 and 3 (Fig. 223) with about 6 long setae in subapical row. **Middle tibia** with or without mid dorsal tooth, with 3 longitudinal dorsal rows of small spine-like denticles that have associated setae at their bases. **Hind tibia** (Fig. 224) not very curved, dorsal surface with 2 longitudinal rows of denticles but no large teeth, apex in females conspicuously expanded and with numerous additional denticles. **Prosternum** keeled on midline. Mesosternum flattened between and in front of mesocoxae. Metasternum separated on midline from mesosternum by suture; midline area depressed; scales appressed, mostly dense, minute near midline, short at sides.

Abdomen. Ventrites (Fig. 225, 226) glossy; punctures small, dense; scales appressed, very narrow on median 1/3rd, much wider towards sides; apex of 5th ventrite shallowly emarginate in males, convex in females.

Male genitalia (Fig. 594–597) with some asymmetrical components. **9th abdominal segment** (Fig. 594) slightly asymmetrical, narrow; the stem of sternite slightly oblique. **Penis** (Fig. 595–597) cylindrical, broad, slightly asymmetrical, its apex directed towards left side of body;

dorsal surface very slightly concave; ventral surface convex; base reaching to anterior end of basal piece; ostium dorsal; internal sac with conspicuous dark brown spinules.

Parameres asymmetrical, immovable, either with no visible suture between them and basal piece or with suture represented by complete or incomplete, weakly impressed groove; medial surface flattened and closely applied to penis; tips slightly twisted to left side of body and directed slightly dorsally, neither paramere with dorsomedial flange; “midline” suture on ventral surface of **basal piece** located slightly off centre and represented by a weakly impressed, slightly oblique line (Fig. 596).

Female genitalia (Fig. 691). **Hemisternites** broad, somewhat rectangular; styli rather narrow, parallel-sided, about 1.6× longer than wide. **Bursa copulatrix** twisted and rotated almost 180 degrees where it joins bursal duct so that the positions of its 2 lobes are reversed in comparison with those in other *Mitophyllus* species except for *M. dispar* (Sharp); smaller lobe about 1/4 length of larger lobe; bursal duct moderately long, broad, sharply demarcated from bursa copulatrix. **Spermathecal duct** short, broad basally, arising ventrally on the smaller lobe of bursa copulatrix either close to bursal duct (Fig. 691) or short distance from it (Fig. 692) (this variation seen in specimens collected together from same site); spermatheca somewhat cylindrical, curved, about 4× longer than wide; combined length of spermathecal gland and its duct rather short, not greater than 3× length of spermathecal duct.

Type data. The holotype female of *M. angusticeps* was collected in Wellington, WN (41° 17'S, 174° 46') and given to Broun by G. V. Hudson. The specimen is not in the Broun Collection at BMNH and I have not located it among the material I have examined. Fortunately details of the head, elytra, and tibiae included in Broun's description allow the species to be recognised with certainty.

The holotype of *M. mandibularis* Broun is in BMNH. Broun did not mention the sex of the specimen in the original description but the head features he described are of a male. The 3 labels handwritten by Broun accompanying the holotype and the red Type circle are (1) 3847 male (2) Point Hill Decr 1914 (3) *Mitophyllus mandibularis*. According to the original description the specimen was collected by Mr T. Hall at Point Hill, west of Mt Algidus, MC (43° 14'S, 171° 21'E) at an altitude of 3500 feet in December 1913, not 1914.

In my 1961 lucanid revision I treated *M. angusticeps* Broun and *M. mandibularis* Broun as synonyms of *Ceratognathus dispar* Sharp. This confusion resulted from Sharp having wrongly associated the female of *M. angusticeps* with the male of *C. dispar* (see details of this in Type Data of *M. dispar*). *Mitophyllus angusticeps* is now reinstated and *M. mandibularis* becomes a transferred synonym of this species.

Material examined. Holotype male of *M. mandibularis* and 21 non-type specimens (8 males, 13 females) (BMNH, LUNZ, MONZ, NZAC).

Distribution (Map 5). From near sea level to about 1067 m. Northernmost record Wellington, WN (latitude 41° 17'S); southernmost record Kinloch, OL (latitude 44° 51'S). The Wellington record is based solely on the provenance of the holotype of *M. angusticeps*.

WN / MB, BR, NC, WD, MC, OL.

Biology. Adults have been collected in and under rotten logs and under stones from October to January.

Remarks. All the specimens of *M. angusticeps* that I have examined are from the South Island where they are sympatric with *M. dispar* (Sharp). Both species are similarly small and have no striking external differences when viewed with the naked eye so they could easily be misidentified in the field. The most readily visible difference is in the colour of the scales on the pronotum and elytra, pale yellow in *angusticeps*, a mix of brown and clay-coloured in *dispar*. Some other external differences are mentioned in the Remarks section of *dispar*. Without having specimens of both species side by side under the microscope differences in the size of the antennal club and of the mid dorsal tooth of the front tibia may not be obvious but hopefully they can be appreciated by comparing specimens with their illustrations. The male terminalia are asymmetrical in both *angusticeps* and *dispar* but the asymmetry is less pronounced in *angusticeps*.

Mitophyllus arcuatus new species

Fig. 100, 101, 227–237, 598–600, 693. Map 6

Diagnosis. Length: males (including mandibles) 8.6–11.8 mm, (excluding mandibles) 7.8–10.6 mm; females (including mandibles) 8.3–11.3 mm, (excluding mandibles) 7.9–10.8 mm. Width: males 3.2–4.2 mm; females 3.4–4.3 mm. Sexual dimorphism moderately pronounced, mostly involving features of head. Body (Fig. 100, 101) slender, conspicuously parallel-sided, convex dorsally; integument dark reddish-brown. Punctures on dorsal surface small, their raised floor not visible at ×45 with a stereomicroscope in those containing scales but visible in non-squamose punctures. Pronotum and elytra with extensive areas of appressed, moderately large, elongate-oval, yellowish-brown scales, elytra additionally with tufts of decumbent to erect, pale yellow scales, the areas of appressed scales interrupted by dark, non-squamose blotches, those on elytra arranged in longitudinal rows. Mandibles of males curved laterally, each with 4 relatively small, approximately similar-sized teeth at apex; external margin uniformly convex. Mandibles of females triangular, outer edge with in-

conspicuous, approximately obtuse-angled projection near base. Lateral surface of supra-antennal brow sloping gradually towards eye.

Description

Head. (Fig. 227, 228) wider than long, widest across eyes. **Dorsal surface** moderately glossy; frons shallowly concave; anterior margin concave at bases of mandibles, extending forward between mandibles as truncate-tipped projection; vertex smooth, slightly convex; **punctures** well defined, deep, mostly small and dense, absent or sparse near anterior margin, those near eyes and on supra-antennal brow, and some centrally between eyes containing long, yellowish, decumbent to erect scales, the squamose areas larger in females; remaining punctures devoid of scales but with microsetae that are not easily seen with a stereoscope; preocular margin obtusely angulate or truncate; supra-antennal brow rather low in females, moderately high in males, outer surface sloping gradually to eye; postocular margin short, straight or slightly convex. **Labrum** short, about 2× wider than long; horizontal, exposed and very setose in females, extremely small, concealed between mandibles and only with apical setae in males. Labral suture distinct. Intermandibular projection extremely short, almost vertical, concealed under strongly protruding anterior margin of head. **Mandibles of males** (Fig. 227, 229, 230) deep dorsoventrally, curved laterally, each with relatively small, incurved apical, subapical ventral, and subapical dorsal teeth, a slightly larger, incurved, erect tooth behind subapical dorsal tooth (these 2 dorsal teeth sometimes fused in small specimens), upturned obtuse-angled lobe near middle of external margin, and 3 small, blunt cusps on medial surface near base. **Mandibles of females** (Fig. 228) triangular, not deep dorsoventrally, concave on dorsal surface, with relatively inconspicuous, obtuse-angled projection externally near base, large apical tooth, small subapical dorsal tooth, and in left mandible only, a small subapical ventral tooth. **Antennae** (Fig. 231, 232) with scape strongly arched and broad distally in males, slightly arched and moderately broad distally in females; pedicel broad in males, slender in females; funicle long and slender in males, short and broad in females, 1st segment 2.6–2.8× longer than wide in males, about 1.1× longer than wide in females, 5th segment strongly asymmetrical, 2nd to 4th segments symmetrical in males, 2nd segment symmetrical and 3rd and 4th segments asymmetrical in females; club about 7.8–8.4× wider than long in males, about 2.0–2.6× wider than long in females, setae dense, their length up to about 3× diameter of individual club segments in males, up to 1/2 diameter in females. **Eyes** strongly protruding in males, moderately protruding in females, width together about 0.7× interocular distance (males) or 0.5× (females). **Mentum** conspicuously convex in females, depressed on

midline and with conspicuous tubercle on either side of depression in males; 4th segment of maxillary palp 5.3–5.8× longer than wide (males) or 4.6–5.0× (females); 3rd segment of labial palp 4.5–5.2× longer than wide (males) or 3.9–4.2× (females).

Thorax. Pronotum (Fig. 233) very glossy, about 1.7× wider than long and 1.3–1.7× wider than head in males, 1.4–1.5× wider than long and 1.4–1.8× wider than head in females; punctures well defined, deep, very uniformly small and dense except on median band where they are moderately dense or absent; vestiture consisting of large, elongate-oval, yellowish or yellowish-brown, appressed or decumbent scales 2–3× longer than wide, and microsetae that are not easily seen with a stereomicroscope; disc moderately convex, surface virtually smooth, with dark, non-squamose, fragmented band on midline and extensive paired, dark, non-squamose areas on either side of midline; brim moderately broad in males, narrower in females, horizontal, distinctly demarcated from steeply sloping sides of disc; lateral margins serrated, slightly rounded near middle; front angles approximately right-angled, rather close to eyes; hind angles obtuse. **Elytra** 1.0–1.1× wider than pronotum (males) or 1.1–1.2× (females) and 1.5–1.6× longer than wide; punctures similar to those on pronotum; scales mostly yellowish-brown, appressed, elongate-oval, moderately large, about 6× longer than wide; squamose areas broken up on each elytron by 3 or 4 longitudinal rows of dark, non-squamose, irregularly rectangular or oval patches, most patches within each row separated by tufts of decumbent or semi-erect, broad, yellowish scales; humeral angle very slightly raised; discal surface smooth except some of non-squamose patches are slightly depressed; sutural margin not raised; declivity rather steep; sides of elytra vertical; brim absent; outer rim of elytra sloping, with single row of punctures containing semi-erect scales. **Wing** about 1.9× longer than elytron. **Front tibia** (Fig. 234) distinctly broadened beyond mid dorsal tooth, with 7–12 denticles between mid dorsal and apical teeth and 12–20 denticles between mid dorsal tooth and base; ventral margin strongly concave; ventral and lateral setae of protarsomeres 2 and 3 directed anteroventrally, absent on proximal 1/3rd of each segment, short but increasing very slightly in length towards distal end of segments. **Middle tibia** with small mid dorsal tooth and few smaller teeth dorsally, all teeth usually larger in females. **Hind tibia** (Fig. 235) not curved, lacking mid dorsal tooth but with numerous denticles dorsally and in females a conspicuous cluster of denticles near apex. **Prosternum** with low, median keel. Mesosternum with low, rounded tubercle in front of mesocoxae. Metasternum marked off from mesosternum by suture; midline area flattened; scales appressed, dense, very narrow near midline, much broader at sides.

Abdomen. Ventrites (Fig. 236, 237) glossy; punctures small, dense; scales appressed, very narrow in males, slightly wider in females; apex of 5th ventrite shallowly but distinctly emarginate in males, slightly convex in females.

Male genitalia (Fig. 598–600) symmetrical. **9th abdominal segment** (Fig. 598) moderately broad. **Penis** (Fig. 599, 600) cylindrical, with waist-like constriction near middle of its length, prominently concave near middle on dorsal surface, very slightly concave on ventral surface; base very close to proximal end of basal piece; sides not grooved; ostium terminal; internal sac broad and with spinules. **Parameres** fused to basal piece, without visible suture; medial surface rather flattened, with short, dorsally directed flange applied to “waist” of penis; dorsal surface with barely discernible short, oblique ridge above base of flange; distal part of parameres moderately broad, tapering, straight, with very slight preapical constriction and dorsally directed tip.

Female genitalia (Fig. 693). **Hemisternites** slender, weakly indented on medial edge; styli straight, moderately elongate, 2.0–2.5× longer than wide. **Bursa copulatrix** relatively broad throughout its length; smaller lobe moderately long, with pair of subapical, pale brown, plate-like sclerites that are joined dorsally; bursal duct moderately long, distinctly demarcated from bursa copulatrix. **Spermathecal duct** very long, slender, slightly broadened where it enters bursa copulatrix dorsally between pair of bursal sclerites; spermatheca broad, curved, somewhat pear-shaped, about 3.5× longer than wide; spermathecal gland duct short, combined length of spermathecal gland and its duct about 1.3× the length of spermathecal duct.

Type data. Holotype male, length including mandibles 10.4 mm, width 4.2 mm, Lynfield, AK (36° 56'S, 174° 43'E), 12 April 1980, G. Kuschel (NZAC). The holotype has a small integumental growth on the left elytron. Paratypes: See Appendix 2, p. 128.

Material examined. Holotype male and 136 paratypes (85 males, 51 females) (MONZ, NZAC).

Distribution (Map 6). From near sea level to about 300 m. Northernmost record: Aupori Peninsula, near Paparore, ND (35° 00'S); southernmost record: Waipuna Reserve, Waitomo, WO (38° 16'S).

ND, AK (including Noises Is, Rangitoto I, Waiheke I), CL (including Little Barrier I, Great Barrier I), WO, BP / —

Biology. Adults in the type series were collected in October and December and from January to June in unspecified dead and rotten wood, in dead stems of *Ulex europaeus* (gorse), dead rotten branches of *Corynocarpus laevigatus* (karaka), dead branches of *Ficus macrophylla* (Moreton Bay fig), and rotten wood of *Meliclytus ramiflorus* (mahoe),

in tunnels in a *Eucalyptus* log, in a power pole, and a fence post, in a pit trap, a light trap, and a Malaise trap, at lights inside houses, and on flowers of *Kunzea ericoides* (kanuka). Larvae have been found from September to December in dead stems of *Ulex europaeus*, an old stump of *Leptospermum* (manuka), well rotted branch of a standing oak tree, rotten branch of *Corynocarpus laevigatus*, rotten wood of *Meliclytus ramiflorus*, and a rotten branch of *Weinmannia sylvicola* (tawhero) and adults emerged 2–6 months later in the laboratory from these samples.

Remarks. Apart from the conspicuously different mandible of males, specimens of *M. arcuatus* are not easily distinguished from those of *M. irroratus* and in my earlier revision (Holloway 1961, p. 74 and fig. 69 and 73) I treated *arcuatus* as an allopatric northern form of *irroratus*. The two species are now known to have some overlap in their ranges but have not been collected side by side in any one locality. *M. arcuatus* has so far only been found in the northern half of the North Island.

The most easily appreciated external differences between *arcuatus* and *irroratus* are as follows: mandibles of *arcuatus* males are curved laterally, have no recurved teeth near the apex and no external projection near the base while those of *irroratus* are somewhat triangular with a straight medial edge, have a huge recurved tooth near the apex, and a conspicuous triangular projection externally near the base; mandibles of *arcuatus* females have a relatively inconspicuous obtuse-angled projection externally at the base while in *irroratus* the corresponding projection is conspicuous and acute-angled; the outer surface of the supra-antennal brow slopes gradually to the eye in *arcuatus*, but in *irroratus* it descends almost vertically; the first 3 funicle segments of the male antenna are relatively short and broad in *arcuatus* but very long and slender in *irroratus*, and the 3rd and 4th funicle segments in females are distinctly asymmetrical in *arcuatus* but virtually symmetrical in *irroratus*. Genitalic differences are, in females, the spermathecal duct is long and slender and the sclerites in the bursa copulatrix are relatively conspicuous in *arcuatus* but in *irroratus* the spermathecal duct is shorter and broader and the bursal sclerites are very weak, and in males of *arcuatus* the ninth abdominal segment and penis are broader and the parameres more slender apically than in *irroratus*.

Etymology. The specific epithet alludes to the laterally arched mandibles of males.

***Mitophyllus dispar* (Sharp)**

Fig. 102, 103, 238–251, 601–604, 694. Map 7

dispar Sharp, 1882: 82 (*Ceratognathus*). Broun 1893: 1111 (*Ceratognathus*). Benesh 1960: 19 (*Ceratognathus*). Holloway 1961: 93 (partly *dispar*, partly *angusticeps*), fig. 91, 92, (labelled incorrectly *dispar*, actually *angusticeps*) (*Ceratognathus*); 1963b: 110, fig. 29 (labelled *dispar* but includes *angusticeps*) (*Ceratognathus*); 1998 (December): 650 (*Mitophyllus*). Nikolaev 1998 (January): 56 (*Ceratognathus* new subgenus *Ceratognathus*).

comognathus Broun, 1903: 616 (*Mitophyllus*). Roon 1910: 56 (as *M. coniognathus*). Benesh 1960: 19 (as *Ceratognathus coniognathus*). Holloway 1961: 93 (as synonym of *C. dispar*).

Diagnosis. Length: males (including mandibles) 5.9–8.0 mm, (excluding mandibles) 5.5–7.4 mm; females (including mandibles) 7.4–8.8 mm, (excluding mandibles) 7.2–8.6 mm. Width: males 2.9–3.4 mm; females 3.3–3.4 mm. Sexual dimorphism most apparent in features of the head. Body (Fig. 102, 103) moderately stout, convex dorsally. Integument black or brownish black. Punctures on dorsal surface small, their raised floor very conspicuous, visible even in smallest punctures at $\times 45$. Pronotum and elytra with tracts and clusters of brown and clay-coloured, appressed and curved scales. Head of males with anterior margin relatively broadly and deeply notched on midline; external margin of supra-antennal brow prominently upturned and protruding forward; frons slightly depressed, entire depressed area sparsely punctate. Head of females elongate and much narrower than pronotum, anterior margin strongly convex, wavy, and not rimmed. Mandibles of males approximately straight-sided externally on proximal 1/2, curved inwards distally. Mandibles of females short, triangular. Front tibia with ventral margin slightly curved; apical tooth very large in females. Setae on underside of the 2nd and 3rd protarsomeres long, evenly spaced in row on distal margin.

Redescription

Head. (Fig. 238, 239) wider than long in males, slightly longer than wide in females, widest across the eyes in males, widest postocularly in females. **Dorsal surface** dull in males, glossy in females; frons slightly concave and almost devoid of punctures in males, slightly uneven and sparsely punctate in females; anterior margin lacking a rim, conspicuously notched on midline in males, prominently convex in females; vertex flattened or slightly convex; **punctures** well defined, moderately deep, mostly small and dense in males, mostly moderately large and dense in females, a few on frons and in band running from preocular margin along medial edge of eye to pronotal margin containing erect clay-coloured scales and pale setae, remaining punctures devoid of scales but apparently containing

minute microsetae; preocular margin prominently obtusely rounded, somewhat laminate, and upturned in males, oblique and slightly concave or sinuate in females; supra-antennal brow moderately arched in males, barely arched in females, outer surface sloping gradually to eye; postocular margin moderately long (males) or very long (females), sides slightly convergent in males, obtusely angulate beyond middle in females. **Labrum** short, about $2\times$ wider than long, fully visible in dorsal aspect in females, partly visible in males, horizontal and very setose in males, obliquely upturned and with marginal setae in females. Labral suture distinct. Intermandibular projection very short, directed anteroventrally, in dorsal aspect concealed below anterior margin of frons. **Mandibles of males** (Fig. 238, 240, 241) long, porrect, rather deep dorsoventrally, not lobed externally, external margin almost straight on basal half, arched distally, with strong medially directed apical tooth, medially directed horizontal subapical dorsal tooth, small subapical ventral tooth and broad-based, erect, large tooth (large males, Fig. 238, 240) or small lobe (small males, Fig. 241) behind subapical dorsal tooth. **Mandibles of females** (Fig. 239) rather short, triangular, curved on medial edge, rounded externally at base, strongly concave dorsally, with moderately long apical tooth, short subapical dorsal tooth, and on left mandible moderately large subapical ventral tooth. **Antennae** (Fig. 242, 243) with broad, moderately arched scape; dorsal groove well defined; pedicel broad in males, narrow in females; funicle short and broad in males, long and slender in females, 1st segment about as long as wide (males) or about $2\times$ longer than wide (females), the 3rd to 5th segments in males and the 4th and 5th segments in females asymmetrical, remaining segments approximately symmetrical; club about $2.3\times$ wider than long in males, about $1.4\times$ in females, setae dense, slightly shorter than diameters of individual club segments (males) or very much shorter (females). **Eyes** slightly protruding (males) or barely protruding (females), their width together $0.3\text{--}0.4\times$ interocular distance. **Mentum** with strongly convex ventral surface; 4th segment of maxillary palp about $6\times$ longer than wide (males) or $5\times$ (females); 3rd segment of labial palp about $5\times$ longer than wide (males) or $4\times$ (females).

Thorax. **Pronotum** dull, in males $1.6\text{--}1.7\times$ wider than long and $1.8\text{--}1.9\times$ wider than head in males, about $1.5\times$ wider than long and $2.1\text{--}2.3\times$ wider than the head in females; punctures well defined, deep, mostly small and dense, largest and most dense towards sides of pronotum; disc strongly convex in males, less convex in females, slightly raised on midline in some specimens; vestiture consisting of bilaterally symmetrical tracts, rows, and clusters of sparse, appressed, sometimes strongly curved, dark brown and clay-coloured scales about $4\times$ longer than wide, den-

sity of scales varying intraspecifically but agreeing in overall pattern with that shown in Fig. 244; microsetae apparently present in non-squamose punctures; brim narrow and approximately horizontal in males, absent in females; sides sloping from disc moderately steeply (males) or very weakly (females); front angles obtuse, moderately distant from eyes (males) or very distant (females); lateral margins variably serrated, convex near middle; hind angles obtuse.

Elytra together 1.1–1.2× wider than pronotum, 1.3–1.4× longer than wide; integument dull; punctures small, dense, evenly distributed; scales similar in size, colour, density, and angle of inclination to those on pronotum, arranged in tracts, lines, and small indistinct clusters (Fig. 245) all separated by large areas of non-squamose punctures which apparently contain microsetae; humeral angle very slightly raised; discal surface smooth; posterior 1/2 of sutural margin raised in males, not raised in females; declivity and sides sloping almost vertically; brim absent; outer rim of elytron narrow, rounded, oblique, with single row of very small decumbent scales. **Wing** about 2× longer than elytron.

Front tibia (Fig. 246, 247) slightly widened beyond mid dorsal tooth, with 4–7 denticles between this tooth and apical tooth, and 12–15 denticles between mid dorsal tooth and base (males) or 10–13 (females); apical tooth very long and curved in females, short and straight in males; mid dorsal tooth relatively long in relation to length of apical tooth; ventral margin almost straight in males, curved in females; ventral surface of protarsomeres 2 and 3 with about 8 long setae in subapical row (Fig. 248). **Middle tibia** with variably developed mid dorsal tooth and 3 longitudinal rows of small denticles that have associated setae at their bases. **Hind tibia** (Fig. 249) not very curved; dorsal surface with 2 longitudinal rows of denticles but no large teeth; apex in females slightly expanded and with small patch of denticles. **Prosternum** keeled. Mesosternum flattened between and in front of mesocoxae. Metasternum separated from mesosternum on midline by suture; midline area depressed; scales appressed, mostly narrow, sparse near midline, dense at sides.

Abdomen. Ventrites (Fig. 250, 251) glossy; punctures small and dense; scales appressed and very narrow on median 1/3rd, appressed or decumbent and slightly wider near sides; apex of 5th ventrite truncate or very slightly emarginate in males, convex in females.

Male genitalia (Fig. 601–604) asymmetrical. **9th abdominal segment** (Fig. 601) slightly asymmetrical, narrow; stem of sternite moderately oblique. **Penis** (Fig. 602–604) cylindrical, broad, strongly asymmetrical; apex directed towards left; dorsal surface concave; ventral surface convex; base reaching to anterior end of basal piece; ostium dorsal; internal sac with conspicuous dark brown spinules. Tegmen strongly asymmetrical, almost as long as penis.

Parameres asymmetrical, immovable, either with no sign of suture between them and basal piece or with position of suture indicated by complete or incomplete, weakly impressed groove; medial surface flattened and closely applied to penis; tips strongly twisted towards left and directed slightly dorsally; neither paramere with dorsomedial flange. **Basal piece** with “midline” suture on ventral surface located well to right of midline and represented by very weakly impressed, slightly oblique line that is deeply pigmented for a short distance anteriorly.

Female genitalia (Fig. 694). **Hemisternites** broad, somewhat rectangular; styli rather broad, parallel-sided, about 1.3× longer than wide. **Bursa copulatrix** twisted almost 180 degrees where it joins bursal duct so that positions of its 2 lobes are reversed in comparison with those in other *Mitophyllus* species except for *M. angusticeps*; smaller lobe about 1/3rd length of larger lobe; bursal duct moderately long, narrow, sharply demarcated from bursa copulatrix. **Spermathecal duct** very short, broad basally, arising ventrally near middle of smaller bursal lobe; spermatheca somewhat cylindrical, straight, about 4× longer than wide; spermathecal gland and duct long, their combined length almost 6× length of spermathecal duct.

Type data. The lectotype male of *Ceratognathus dispar* referred to as the type in my earlier revision (Holloway 1961) is in the BMNH. Details of the type locality, collector, and date of collection were not published by Sharp in the original description but the card on which the specimen is mounted is labelled in Sharp’s handwriting “*Ceratognathus dispar* male Type D.S. Greymouth [BR (42° 27’S, 171° 12’E)]. Helms. 1881.” The specimen is accompanied by printed labels (1) Greymouth, New Zealand, Helms; (2) Sharp Collection. 1905–313; (3) a red circle Type-label. A few fragments of a male, badly damaged by an *Anthrenus* larva, are in NZAC, having previously been in the A.E. Brookes Collection. This specimen is accompanied by printed labels identical with those on the lectotype and a handwritten label, probably in Sharp’s writing, “*Ceratognathus dispar* Sharp co-type”. Sharp’s original description includes a brief description of a single female he took to be that of *C. dispar*, noting however that it was very unlike the male “even as regards colour, sculpturing, and clothing”. This specimen has not been located but in my 1961 revision I assumed it had been correctly assigned to *dispar*. Now that I have seen additional material I can confirm that the colour, sculpturing, and vestiture are the same in both sexes of *dispar*. The female that Sharp saw is likely to have been a specimen of *M. angusticeps* described by Broun 13 years later.

The holotype of *Mitophyllus comognathus* Broun is in the BMNH. It bears the following labels: (1) a red circle

Type label; (2) 2182 male [Broun's handwriting]; (3) New Zealand, Broun Coll 1922–182; (4) Westport [BR (41° 45'S, 171° 36')] 1902 [Broun's handwriting]; (5) *Mitophyllus comognathus* [Broun's handwriting]. The collector's name, J.J. Walker, is given in the original description but is not on the labels accompanying the type.

Material examined. Lectotype male and fragments of a paralectotype male of *Ceratognathus dispar* Sharp, holotype male of *Mitophyllus comognathus* Broun, and 12 non-type specimens (8 males, 4 females) (BMNH, LUNZ, MONZ, NZAC).

Distribution (Map 7). From near sea level to about 1750 m. Northernmost record: Waimarino, TO (latitude 38° 57'S); southernmost record: Tuatapere, SL (latitude 46° 08'S).

TO, TK, WN / BR, WD, MC, OL, SL.

Biology. Adults have been collected from October to January in and under rotten logs including those of *Weinmannia racemosa* (kamahi). A male was collected in Arthurs Pass National Park on snow at 1750 m in December.

Remarks. In size and overall appearance *M. dispar* is very similar to *M. angusticeps* but the species are readily distinguishable by their pronotal and elytral vestiture. In *dispar* the scales are rather broad, mainly brown, with a few that are clay-coloured whereas in *angusticeps* all the scales are rather narrow and pale yellowish. Also, in *dispar* the scales are not very dense, leaving large areas of the integument without any visible vestiture (microsetae may be present), while in *angusticeps* the scales form a rather dense cover on the pronotum and elytra. The males of *dispar* have mandibles that are almost straight sided externally at the base and have 3 conspicuous dorsal teeth on their apical half compared with the more uniformly curved mandibles in *angusticeps* that have only 2 distal teeth and an elongate flange that extends well towards the mandible base. The strongly projecting, somewhat laminate lobe in front of the eyes is a distinctive feature of *dispar* males. Females of *dispar* have shorter mandibles and less protruding eyes than *angusticeps* females. Both species have asymmetrical male terminalia and a rotated bursa copulatrix in the female genitalia. *M. dispar* is sympatric with *angusticeps* over part of its range.

Mitophyllus falcatus new species

Fig. 104, 105, 252–265, 605–607, 625. Map 8

Diagnosis. Length: males (including mandibles) 12.7–15.7 mm, (excluding mandibles) 11.4–13.9 mm; females (including mandibles) 13.2–16.2 mm, (excluding mandibles) 12.2–15.1 mm. Width: males 4.8–6.2 mm; females 5.8–6.7 mm. Sexual dimorphism apparent mostly in features of the head.

Body (Fig. 104, 105) stout, convex dorsally. Integument dark reddish- or blackish-brown. Punctures on dorsal surface mostly small, their raised floor visible at $\times 45$ with a stereomicroscope. Pronotum and elytra clothed with extensive areas of large, elongate, oval, yellowish-brown, appressed scales broken into a somewhat chequered pattern on elytra by dark, almost square, non-squamose areas. Mandibles sickle-shaped in males, triangular in females. Setae on underside and lateral margins of the 1st–4th protarsomeres long, all about same length.

Description

Head. (Fig. 252, 253) wider than long, widest across eyes in males, widest across or behind eyes in females. **Dorsal surface** very glossy; frons flattened or slightly convex, with slightly raised, triangular, median area in males, smooth apart from a V-shaped ridge anteriorly in females; anterior margin not rimmed, slightly concave in males, notched on midline in females; vertex smooth, in males flattened or slightly convex, in females slightly concave; **punctures** well defined, deep, small, dense, those near medial edge of eyes and some on sides of vertex containing long, yellowish brown, appressed to suberect scales, remainder devoid of scales but containing microsetae that are mostly not visible with a stereomicroscope; preocular margin obtusely rounded or truncate; supra-antennal brow high in males, low in females, outer surface sloping almost vertically to eye; postocular margin rather short, straight or convex, convexity greater in females. **Labrum** short, about 2 \times wider than long, sloping in males, horizontal in females, very setose distally; labral suture distinct. Intermandibular projection not visible below anterior margin of head. **Mandibles of males** (Fig. 252, 254, 255) sickle-shaped, with strong apical tooth directed anteromedially, very large subapical dorsal tooth and small subapical ventral tooth directed medially; outer margin of mandible uniformly convex and slightly raised. **Mandibles of females** (Fig. 253) triangular, elongate, very concave on dorsal surface, obtusely rounded externally at base, with large apical tooth, small subapical dorsal tooth, 2 relatively large teeth on ventral, medial edge, and in left mandible a small subapical ventral tooth. **Antennae** (Fig. 256, 257) with slightly arched, moderately broad scape; funicle short, broad, 1st segment about 1.4 \times longer than wide in males, about 1.6 \times in females, 4th and 5th segments asymmetrical, 2nd and 3rd segments approximately symmetrical; club about 2.3 \times wider than long in males, about 1.6 \times in females, setae dense, shorter than diameters of individual segments. **Eyes** moderately protruding, width together about 0.6 \times interocular distance (males) or 0.5 \times (females). **Mentum** with outer surface flattened; 4th segment of maxillary palp 7.0–7.6 \times longer than wide (males) or about 5.3 \times (females); 3rd segment of labial palp about 5.8 \times longer than wide (males) or about 4.6 \times (females).

Thorax. Pronotum (Fig. 258) moderately glossy, about 1.7× wider than long and about 1.5× wider than the head in males, 1.5–1.6× wider than long and 1.9–2.0× wider than the head in females; punctures well defined, deep, uniformly dense except on posterior 1/2 of median band where they are sparse, small on disc, moderately large on brim; vestiture consisting of large, elongate-oval, yellowish-brown, appressed scales approximately 3–7× longer than wide, and microsetae that are mostly invisible with a stereomicroscope; disc moderately convex, surface slightly uneven, with extensive, rather broad, dark, non-squamose areas varying in shape, size, and position except that they are always present as a conspicuous, but rather narrow band on most or all of midline and on posterior 3/4 of disc as pair of somewhat Y-shaped bands whose “stalks” meet posterior margin almost at right-angle; brim horizontal, very broad in males, narrow in females; sides sloping gently from disc; front angles acute or right-angled, not very close to eyes, especially in females; lateral margin serrated, obtusely angulate near middle; hind angles obtuse. **Elytra** about 1.6× wider than pronotum, 1.4–1.8× longer than wide; punctures small, dense, scales similar to those on pronotum except a few are decumbent; squamose areas extensive but broken up on each elytron by small, almost square, non-squamose patches (with microsetae in their punctures) arranged in about 4 longitudinal rows and producing a somewhat chequered pattern; humeral angle very low; sutural margin slightly raised on posterior 1/2; discal surface smooth except for some slightly depressed, non-squamose areas; elytral declivity sloping gently; sides almost vertical; brim absent except near humeral angle where it is very narrow; outer rim of elytron almost horizontal, with single row of punctures containing appressed and decumbent scales. **Wing** about 2.1× longer than elytron. **Front tibia** (Fig. 259) not expanded beyond mid dorsal tooth, with 8–10 denticles between mid dorsal and apical teeth, and 16–20 denticles between mid dorsal tooth and base; protarsomeres 2 and 3 (Fig. 260, 261), with their ventral and lateral setae directed ventrally, setae absent on very small proximal section of each segment, all setae long and about same length. **Middle tibia** with conspicuous mid dorsal tooth and scarcely any denticles. **Hind tibia** (Fig. 262) not very curved, denticles on dorsal surface small and sparse, none clustered near apex. **Prosternum** rounded or weakly keeled. Mesosternum with very narrow, low tubercle in front of mesocoxae. Metasternum marked off from mesosternum by conspicuous suture; midline area flattened; scales appressed and moderately dense, narrow near midline, wider towards sides (Fig. 263). **Abdomen. Ventrites** (Fig. 264, 265) glossy; punctures small, dense; scales appressed, very narrow near midline of each ventrite, broader at sides; apex of 5th ventrite deeply

notched in males, obtusely rounded in females.

Male genitalia (Fig. 605–607) symmetrical. **9th abdominal segment** (Fig. 605) rather slender. **Penis** (Fig. 606, 607) cylindrical; dorsal surface slightly concave; ventral surface slightly convex; base close to proximal end of basal piece; sides with numerous conspicuous, rather short, oblique grooves near middle; ostium terminal; internal sac broad, with some armature. Tegmen about same length as penis. **Parameres** immovable on basal piece but marked off from it dorsally and ventrally by suture; medial surface concave with very narrow flange; dorsal surface with extremely short, oblique ridge near middle; tips very slender, tapering, slightly curved, directed ventrally. Basal piece about 1/2 length of parameres.

Female genitalia (Fig. 695). **Hemisternites** triangular, very broad with straight medial edge; styli slender, slightly curved, about 2× longer than wide. **Bursa copulatrix** very large, broad throughout its length; smaller lobe very short, other lobe extremely long; bursal duct relatively long, not sharply demarcated from bursa copulatrix. **Spermathecal duct** very short, broad, conspicuously widened at juncture with bursa copulatrix; spermatheca curved, narrow except for spherical apex; spermathecal gland and duct very long, their combined length about 6× length of spermathecal duct.

Type data. Holotype male, length including mandibles 15.7 mm, width 6.1 mm, Lynfield, AK (36° 56'S, 174° 43'E), 3 August 1980, Malaise trap site 4, G. Kuschel (NZAC). Paratypes See Appendix 2, p. 129.

Material examined Holotype male and 14 paratypes (7 males, 7 females) (NZAC).

Distribution (Map 8). From near sea level to about 400 m. Northernmost record: Spirits Bay, ND (latitude 34° 26'S); southernmost record: Nelson city, NN (latitude 41° 16'S). The Nelson record is based on a single specimen.

ND, AK / NN.

Biology. Adults have been collected from April to November in litter, Malaise traps, and rotten wood, including an old stump of *Leptospermum* (manuka). A larva found in unspecified rotten wood in September 1976 was kept in the laboratory and the adult emerged in July 1977.

Remarks. *Mitophyllus falcatus* is similar in size and general appearance to *M. parrianus* and *M. solox*. Its males are easily recognised by their sickle-shaped mandibles. Males and females of *falcatus* are distinguishable from those of *parrianus* by the long setae, all of similar length, on their 2nd and 3rd protarsomeres. The smooth, decumbent vestiture on the pronotum and elytra distinguishes males and females of *falcatus* from those of *solox*. Distinctive genitalic features in *falcatus* males are the very slender, almost straight tips of the parameres and the extremely

short ridge on the dorsal surface of the parameres, and in females the broad hemisternites, relatively long bursal duct, and very short smaller lobe of the bursa copulatrix. In the Lynfield area of Auckland this species is found side by side with *M. parrianus*.

Etymology. The specific epithet alludes to the sickle-shaped mandibles in males.

Mitophyllus foveolatus (Broun)

Fig. 71, 106, 107, 266–279, 608, 609, 696. Map 9
foveolatus Broun, 1880: 253 (*Ceratognathus*); 1893: 1112 (*Mitophyllus*). Roon 1910: 57 (*Mitophyllus*). Benesh 1960: 19 (*Ceratognathus*). Holloway 1961: 81, frontispiece (fig. 19), fig. 80–82, 173, 174, 197, 209; 1963b: 110, fig. 31; 1998 (December): 650 (*Mitophyllus*). Nikolaev 1998 (January): 56 (*Ceratognathus* new subgenus *Holloceratognathus*).

Diagnosis. Length: males (including mandibles) 11.6–15.2 mm, (excluding mandibles) 10.5–13.4 mm; females (including mandibles) 12.5–15.2 mm, (excluding mandibles) 11.5–14.4 mm. Width: males 4.8–6.1 mm; females 5.3–6.2 mm. Sexual dimorphism most apparent in features of the head. Body (Fig. 106, 107) stout, convex dorsally. Integument black or dark reddish-brown. Punctures on dorsal surface minute to moderately large, their raised floor discernible, even in smallest punctures, at $\times 25$ with a stereomicroscope. Pronotum and elytra with large, conspicuous, widely separated, circular, oval or rectangular patches containing long, oval, appressed or decumbent yellow scales. Mandibles in both sexes more or less triangular, their medial edges slightly sinuous. Eyes small, not very protruding.

Redescription

Head. (Fig. 266, 267) wider than long, widest across eyes in males, widest behind eyes in females. **Dorsal surface** very glossy; frons flattened or very slightly concave; anterior margin not rimmed, protruding slightly between mandibles; vertex with V-shaped, raised area, with few punctures and no scales; **punctures** well defined, deep, mostly small and dense, those in Y-shaped group on frons and in longitudinal band running from medial edge of eyes to pronotum containing large, yellowish, appressed scales, remainder devoid of scales but some with hairs and others with microsetae; preocular margin obtusely angulate in males, obtusely rounded in females; supra-antennal brow arched in males, barely raised in females, outer surface sloping gradually to eye; postocular margin long, almost straight in males, convex in females. **Labrum** short, about $2.3\times$ wider than long (males), or about $1.6\times$ (females), sloping and slightly setose distally in males, horizontal and copiously setose in females; labral suture distinct. Intermandibular projection extremely short, horizontal,

barely visible below protruding anterior margin of head. Mandibles more or less triangular, not deep dorsoventrally; **mandibles of males** (Fig. 266, 268–271) with strong apical tooth directed anteromedially, slightly larger, erect, recurved, subapical dorsal tooth, small subapical ventral tooth in some specimens, 2 small blunt cusps on medial edge near base of mandible, a variably developed, obtusely rounded, upturned lobe externally near base and, in some specimens, an inwardly directed, variably sized lamina on medial edge (Fig. 270); **mandibles of females** (Fig. 267) very concave on dorsal surface, obtusely rounded externally at base, with large apical tooth, small subapical dorsal tooth, 1 or 2 very small teeth on medial edge, and in left mandible a small subapical ventral tooth. **Antennae** (Fig. 272, 273) with scape moderately broad, slightly arched; funicle short, broad; 1st segment about as long as wide (males) or about $1.4\times$ longer than wide (females), 4th and 5th segments strongly asymmetrical in males, 5th and sometimes 4th segments asymmetrical in females, 2nd and 3rd segments approximately symmetrical; club about $3.4\times$ wider than long (males), or about $1.3\times$ (females), setae dense and shorter than diameters of individual segments. **Eyes** small, short, somewhat truncate posteriorly in dorsal aspect, slightly protruding in males, barely protruding in females, width together about $0.4\times$ (males) or $0.3\times$ (females) interocular distance. **Mentum** with outer surface slightly concave (males) or slightly convex (females); 4th segment of maxillary palp $5.6\text{--}6.2\times$ longer than wide (males) or $4.4\text{--}4.6\times$ (females); 3rd segment of labial palp $4.3\text{--}4.9\times$ longer than wide (males) or $4.2\text{--}4.3\times$ (females).

Thorax. Pronotum (Fig. 274) very glossy, in males $1.5\text{--}1.6\times$ wider than long and about $1.7\times$ wider than head in males, about $1.5\times$ wider than long and $1.9\text{--}2.0\times$ wider than head in females; punctures well defined, deep, those containing scales small and dense, those in non-squamose areas minute or small and sparse or very sparse; vestiture consisting of large, elongate, oval, yellowish, appressed scales about $3\times$ longer than wide and microsetae that cannot be seen easily with a stereomicroscope; disc moderately convex, surface smooth except for deep, pear-shaped depression anteriorly on midline, pair of shallower, linear, oblique depressions on either side of midline posteriorly, and slightly depressed, large, rectangular or oval area in each of 4 corners of pronotum; brim very narrow, especially in males, oblique, sloping rather steeply from disc; sides serrated, obtusely rounded near middle; front angles almost right-angled, very distant from eyes; hind angles slightly obtuse. **Elytra** (Fig. 275) $1.1\text{--}1.2\times$ wider than pronotum, about $1.5\times$ longer than wide; punctures small, those containing scales dense, remainder mostly moderately dense; scales similar to those on pronotum, most confined to shallow, oval or circular depressions arranged

in 4 longitudinal rows separated from one another by longitudinal ribs. The scale pattern varies individually and may differ on each elytron in same specimen. Humeral angle moderately raised; sutural margin slightly raised and with some scales; sutural stria punctate; vestiges of up to 3 more punctate striae discernible elsewhere on disc; elytral declivity sloping gently; sides of elytra almost vertical; brim developed as narrow channel running almost whole length of elytron; outer rim oblique, with single row of punctures containing strongly curved, very narrow scales. **Wing** about $2.1\times$ longer than elytron. **Front tibia** (Fig. 276) rather broad beyond mid dorsal tooth, with 7 or 8 denticles between mid dorsal and apical teeth and 11–18 denticles between mid dorsal tooth and base; ventral margin almost straight; ventral and lateral setae of protarsomeres 2 and 3 rather sparse, confined to distal 1/2 of segments, all rather short, directed distally, not visible as fringe in dorsal aspect. **Middle tibia** with conspicuous mid dorsal tooth and a few small denticles dorsally. **Hind tibia** (Fig. 277) not very curved, lacking large mid dorsal tooth, but with 1–6 denticles dorsally near middle; females with conspicuous cluster of denticles near apex. **Prosternum** with low keel. Mesosternum with conspicuous, compressed, forwardly directed tubercle between and in front of mesocoxae. Metasternum fused to mesosternum, suture between them represented by fine, slightly depressed line; middle area slightly concave; vestiture consisting of broad, overlapping, appressed, yellow scales laterally and moderately dense, very narrow, standing, yellowish scales elsewhere.

Abdomen. Ventrites (Fig. 278, 279) very glossy; punctures moderately large, mostly conspicuously elongate-oval, those on median 1/3rd with long, narrow, curved, pale scales, those elsewhere with broad, appressed yellow scales; apex of 5th ventrite conspicuously notched in males, weakly emarginate to slightly convex in females.

Male genitalia (Fig. 608, 609) symmetrical. **9th abdominal segment** (Fig. 608) rather slender. **Penis** (Fig. 609) cylindrical, slender; dorsal surface strongly concave; ventral surface strongly convex; base distant from proximal end of basal piece; sides smooth; ostium terminal, enclosed by pair of sclerotised lateral lobes and a recurved subapical beak-like process; internal sac broad, with some armature. Tegmen much longer than penis. **Parameres** immovable on basal piece but marked off from it dorsally and ventrally by conspicuous suture; medial edge concave but with protruding, slightly laminate margin on proximal 2/5ths; distal part of parameres tapering but expanded slightly, flattened, and bent outwards at tip. **Basal piece** slightly less than 1/3rd length of parameres.

Female genitalia (Fig. 71, 696). **Hemisternites** moderately slender; medial edge convex; styli straight,

elongate, $1.5\text{--}2.0\times$ longer than wide. **Bursa copulatrix** with larger lobe saccate, smaller lobe extremely short; bursal duct very long, distinctly demarcated from bursa copulatrix. **Spermathecal duct** long, broad over most of its length; spermatheca elongate, slightly curved, very narrow at base, gradually widening apically; spermathecal gland much longer than duct, combined length of gland and duct slightly greater than length of spermathecal duct.

Type data. The present location of the holotype is unknown. Broun described this species from a male 6 lines long (12.7 mm) lacking the legs and antennae. A male minus its legs and antennae and bearing the number 448 assigned to it by Broun that I examined in 1960 and mentioned in my 1961 revision was almost certainly this specimen. It was one of the Broun duplicate specimens in the A.E. Brookes collection acquired in the 1950s by Plant Diseases Division of the DSIR and later incorporated in the NZAC. Unfortunately the specimen is not among the NZAC material I have studied for this revision. According to the original description the holotype “was found by Mr T.F. Cheeseman in January, 1878, in the mountainous region near Nelson [NN]”.

Material examined. 33 non-type specimens (17 males, 16 females) (AMNZ, BMNH, MONZ, NZAC).

Distribution (Map 9). Northernmost record: Cobb Valley, NN (latitude $41^{\circ} 06'S$); southernmost record: Hunter Mountains, FD (latitude $45^{\circ} 40'S$). From near sea level to about 1500 m.

— / NN, BR, WD, MC, OL, FD.

Biology. Adults have been found from November to April, usually on mountains. Collecting details are lacking for most of the specimens. A female from Makarora (OL) was caught in a Malaise trap and a male from the Cobb Valley (NN) was collected “ex *Nothofagus cliffortioides* [tawhairauriki]”. G.V. Hudson (1934) reported this species as being common on Mt Arthur (NN) and thought it was probably attached to alpine beeches.

Remarks. The patches of bright yellow, appressed scales on the shiny black integument of the dorsal surface make *M. foveolatus* the most colourful and easily identifiable New Zealand aesaline. In size and general form it resembles *M. parriamus* but unlike this species and others of that group, *foveolatus* is unusual in having very small eyes in males. Unique features of the male genitalia are the pair of lobes and recurved “beak” surrounding the ostium, and the flattened, slightly expanded tips of the parameres. The lamina on the medial edge of the parameres is greatly reduced compared with that in most other *Mitophyllus* species. The female genitalia of *foveolatus* are of the type found in *parriamus*, *falcatus*, and *solox* but are distinctive in having a saccate large lobe and a very short small lobe in the bursa copulatrix, and a broad spermathecal duct.

***Mitophyllus fuscus* (Broun)** reinstated species, new combination

Figures 45, 108, 109, 280–291, 610–612, 697. Map 10
fuscus Broun, 1886: 837 (*Ceratognathus*). Roon 1910: 57
 (*Mitophyllus*). Benesh 1960: 19. (*Ceratognathus*).
 Holloway 1961: 86 (synonym of *Ceratognathus*
alboguttatus Bates).

Diagnosis. Length: male (including mandibles) 8.4 mm, (excluding mandibles) 7.8 mm; females (including mandibles) 7.8–10.7 mm, (excluding mandibles) 7.3–10.1 mm. Width: male 3.5 mm; females 3.4–4.5 mm. Sexual dimorphism moderately conspicuous, most apparent in the eyes and mandibles. Body (Fig. 108, 109) rather broad, somewhat flattened dorsally. Integument uniformly dark brown. Punctures on dorsal surface small to moderately large, somewhat polygonal, very dense, their raised floor clearly visible at $\times 25$ with a stereomicroscope. Vestiture consisting of erect and suberect scales, mostly short, broad, and brown but including some small, irregular tufts of larger yellowish scales. Pronotum with scales in most of its punctures. Elytra with mostly conspicuous brown scales but with several poorly defined linear tracts that have non-squamose patches and small, irregular tufts of yellowish scales. Outer brim of elytra narrow but conspicuously deep especially near humeral angle. Wings fully developed in male, vestigial in females. Mandibles approximately triangular, their medial edges somewhat parallel. Eyes large in male, small in females. Ventral margin of front tibia straight in male, curved in females.

Redescription

Head. (Fig. 280, 281) wider than long, widest across eyes.

Dorsal surface glossy; frons very slightly concave; anterior margin slightly wavy, rimmed; vertex slightly uneven, flattened; **punctures** very well defined, shallow, moderately large, the largest conspicuously polygonal, very dense, most with short, broad, erect scales, the few without scales apparently containing microsetae; medial edge of eyes with a few erect, yellowish scales; preocular margin sharply angulate immediately in front of eye, slightly obtuse at supra-antennal brow which is low and has its outer surface sloping steeply to eye; postocular margin short, slightly convex. **Labrum** relatively large, about $2\times$ wider than long, horizontal, setose; labral suture distinct. Intermandibular projection moderately long, vertical. **Mandibles of male** deep, vaguely triangular; dorsal surface slightly concave with large, obtusely rounded lateral lobe that has upturned margin; apex with inwardly directed, horizontal ventral tooth which is large on left mandible, very short and not visible in dorsal aspect on right mandible, and an inwardly directed, slightly erect, recurved dorsal tooth; medial surface smooth, concave, with dorsal and ventral edges straight

and somewhat laminate. **Mandibles of females** not deep dorsoventrally, distinctly triangular, concave on dorsal surface, with obtusely angulate lobe externally at base, large apical tooth, small, blunt, subapical dorsal tooth, and in left mandible a small subapical ventral tooth. **Antennae** (Fig. 282, 283) with very slightly arched, rather broad scape; funicle short, rather broad, its 1st segment about $1.3\times$ longer than wide in females, length equal to width in male, 2nd segment symmetrical, 3rd segment slightly asymmetrical, 4th and 5th segments strongly asymmetrical; club about $1.5\times$ wider than long in male, about $1.2\times$ wider than long in females, setae dense and about same length as diameters of individual club segments. **Eyes** in male moderately large, protruding, width together about $0.3\times$ interocular width; eyes in females small, slightly protruding, width together about $0.2\times$ interocular distance. **Mentum** with outer surface strongly convex; 4th segment of maxillary palp about $6.2\times$ longer than wide in male, about $3.8\times$ longer than wide in females; 3rd segment of labial palp about $6.0\times$ longer than wide in males, about $3.4\times$ longer than wide in females.

Thorax. Pronotum glossy, $1.7\times$ wider than long and $2.0\times$ wider than head in male, $1.5\text{--}1.6\times$ wider than long and $2.0\text{--}2.1\times$ wider than head in females; punctures well defined, circular and polygonal, mostly circular in male, mostly polygonal in females, shallow, moderately large, largest in brim and in females, uniformly very dense; scales short, broad, about $2\times$ longer than wide, yellowish-brown and erect or suberect except for very small clusters of longer, yellowish, subdecumbent scales in front and hind angles, on either side of midline on hind margin, and near middle of lateral margins; non-squamose punctures very few in number, not arranged symmetrically, instead scattered singly or in groups of up to about 4 on disc and sides of pronotum; disc flattened, slightly or strongly depressed on posterior $1/2$ of midline; brim horizontal, very broad in male, moderately broad in females; front angles obtuse and close to eyes in male, right-angled and distant from eyes in females; sides sloping gently from disc; lateral margins very coarsely serrated, very convex near middle, conspicuously convergent posterad in male, slightly convergent in females; hind angles obtuse. **Elytra** uniformly densely punctate, together $1.1\times$ wider than pronotum and $1.4\times$ longer than wide in male, about $1.2\times$ wider than pronotum and $1.3\times$ longer than wide in females; punctures mostly circular, deeper and much smaller than those on pronotum, most with short, erect, yellowish-brown scales, others with only microsetae (Fig. 284); each elytron with about 5 discernible longitudinal tracts of punctures containing short scales alternating with about 4 tracts of punctures containing microsetae and no scales apart from 4 or 5 widely

spaced, loose tufts of erect, long, yellowish scales, the tufts most conspicuous in the 2 outermost tracts; discal surface uneven, especially near humeral angle which is conspicuously convex; sutural margin flattened; elytral declivity sloping gradually; sides of elytra almost vertical; brim very narrow but conspicuously deep especially near humeral angle; outer rim oblique, with single row of punctures containing curved scales. **Wing** in male normal, $3.1\times$ longer than wide and $1.7\times$ longer than elytron; wing in females (2 examined) vestigial (Fig. 45), $2.7\times$ longer than wide, and same length as elytron, all usual veins present but weakly sclerotised, membranous area beyond radial recurrent very short. **Front tibia** (Fig. 285, 286) straight in male, slightly arched in females, widened slightly beyond mid dorsal tooth, with 7 or 9 denticles between mid dorsal and apical teeth in male, with 5–7 denticles in females, and 12–14 denticles between mid dorsal tooth and base; ventral margin straight in male, very slightly curved in females; setae on underside of protarsomeres 2 and 3 sparse, arranged in broken row near apex (Fig. 287). **Middle tibia** (Fig. 288) with small mid dorsal tooth and numerous slightly smaller teeth dorsally. **Hind tibia** (Fig. 289) not curved; dorsal surface with numerous small teeth but lacking distinct mid dorsal tooth and without cluster of denticles near apex. **Prosternum** convex, not keeled. Mesosternum slightly convex, not tuberculate. Metasternum marked off from mesosternum by weak suture; midline area shallowly depressed, with or without a groove; scales mostly appressed and very slender.

Abdomen. Ventriles (Fig. 290, 291) glossy; punctures moderately large, teardrop-shaped; scales appressed, slender; apex of 5th ventrite convex in females, almost truncate in males.

Male genitalia (Fig. 610–612) strongly asymmetrical. **9th abdominal segment** (Fig. 610) narrow; stem of sternite strongly curved to left side of body; apical margin of sternite with row of long setae. **Penis** (Fig. 611, 612) almost symmetrical, flask-shaped; dorsal surface slightly concave; ventral surface slightly convex; base reaching beyond proximal end of basal piece; sides not grooved; ostium terminal; internal sac broad, very long, with dense, brown spinules. **Parameres** narrow, strongly asymmetrical, immovable on basal piece but marked off from it dorsally and ventrally by sutures; medial edge concave; left paramere very much longer than right paramere, apices tapering and directed medially. **Basal piece** strongly asymmetrical, about $1/2$ length of parameres.

Female genitalia (Fig. 697). **Hemisternites** rather slender; medial edge straight; styli straight, slender, about $2.5\times$ longer than wide. **Bursa copulatrix** very broad; smaller lobe rather short; bursal duct long, rather narrow,

very distinctly demarcated from bursa copulatrix. **Spermathecal duct** moderately long, very narrow throughout its length, inserted well before apex of smaller lobe of bursa copulatrix; spermatheca extremely large, about $3\times$ longer than wide, elongate-oval; spermathecal gland about equal in length to its duct from which it is scarcely demarcated, combined length of gland and duct about $2\times$ length of spermathecal duct.

Type data. Broun described *fuscus* from two females collected together on a kowhai (*Sophora*) log at Taieri, DN ($46^{\circ} 04'S$, $170^{\circ} 11'E$) by Sydney W. Fulton. The specimen in the BMNH I am here designating as the lectotype in order to fix this taxonomic concept of *fuscus* Broun. The second specimen has not been located; it is not in the Broun Collection in BMNH nor in the Broun Duplicate Collection incorporated in NZAC.

Material examined. Lectotype female and 3 non-type specimens (1 male, 2 females). (BMNH, LUNZ, NZAC).

Distribution (Map 10). Northernmost record: Moeraki, DN (latitude $45^{\circ} 21'S$); southernmost record: Hunter Hills, Catlins State Forest, SL (latitude $46^{\circ} 27'S$). From near sea level to 550 m.

— / DN, SL.

Biology. As mentioned above the 2 syntype females were collected on a *Sophora* (kowhai) log, no date given. The other female and a male were collected together under bark of *Nothofagus* (tawai) in Catlins State Forest on 5 November 1982.

Remarks. In my 1961 revision I treated *fuscus* as a synonym of *Ceratognathus alboguttatus* Bates because the colour, punctures, and vestiture of the *fuscus* syntype female seemed to agree with those described by Bates for *alboguttatus*. I did not examine the genitalia or wing of the specimen. Having now re-examined the lectotype of *fuscus*, as well as the genitalia and wings of females from Moeraki and Catlins State Forest, and the genitalia and wings of the male from Catlins I have found distinctive features that certainly validate the species. Among these are, in males and females, the uniformly dark brown integument with dense, mostly polygonal punctures, the vestigial wings and exceptionally large spermatheca in females, and the strongly asymmetrical ninth abdominal segment and parameres in males. *Mitophyllus fuscus*, is the only member of the genus in which wing reduction has occurred. Furthermore it is highly unusual, perhaps unique, within Lucanidae in having the wings differently developed in males and females.

***Mitophyllus gibbosus* (Broun)**

Figures 43, 110, 111, 292–301, 613–616, 698. Map 11
gibbosus Broun, 1885: 385 (*Ceratognathus*); 1886: 928
 (*Ceratognathus*). Roon 1910: 57 (*Mitophyllus*). Benesh
 1960: 19 (*Ceratognathus*). Holloway 1961: 96, frontis-
 piece 19, fig. 93, 94, 191, 192, 202, 215 (*Ceratognathus*);
 1963b: 106, fig. 16, 31 (*Ceratognathus*); 1998 (Decem-
 ber): 650 (*Mitophyllus*). Nikolaev 1998 (January): 56
 (*Ceratognathus* new subgenus *Ceratognathus*).
tuberculatus Broun, 1893: 1111 (*Mitophyllus*). Benesh 1960:
 20 (*Ceratognathus*). Holloway 1961: 96 (as synonym of
Ceratognathus gibbosus).

Diagnosis. Length: males (including mandibles) 6.4–10.5 mm, (excluding mandibles) 5.9–9.5 mm; females (including mandibles) 9.1–10.0 mm, (excluding mandibles) 8.6–9.5 mm. Width: males 3.3–5.5 mm; females 4.5–5.1 mm. Sexual dimorphism rather inconspicuous in mandibles but conspicuous in other head features, and especially noticeable in colour and size of scales on the dorsal surface of body. Body (Fig. 110, 111) broad, very convex dorsally, strongly hump-backed in middle of elytra. Integument black and dark reddish-brown. Punctures on dorsal surface small to extremely large, smallest ones with floor distinctly raised and clearly visible at $\times 25$ with a stereomicroscope, largest with floor greatly stretched so that it is barely raised, sometimes even flattened; distance between punctures on most of dorsal surface very much less than diameters of punctures. Pronotum and elytra with brown, chestnut, and cream scales in differing amounts and size depending on sex of specimens; centre of pronotal disc with pair of prominent, conical, squamose tubercles in males, with pair of low, rounded, squamose mounds in females; elytral shoulders and suture strongly raised, ridged, and squamose. Mandibles vaguely triangular, concave on medial edge. Eyes small, not very protruding.

Redescription

Head. (Fig. 292, 293) wider than long, widest across eyes in males, behind eyes in females. **Dorsal surface** dull in males, glossy in females; frons concave in males, flattened or slightly uneven in females; anterior margin rimmed in females, not rimmed in males, protruding forward horizontally in middle as triangular projection in males, as short, truncate or slightly rounded projection in females; vertex smooth, slightly convex or slightly concave; **punctures** well defined, moderately deep, mostly moderately large and dense in males, mostly small and dense in females, a few on frons and vertex and in band running from medial edge of eye to posterior margin of head containing mainly appressed, moderately long scales, brown in males, cream in females, remainder devoid of scales but apparently containing microsetae; preocular margin obtusely angulate in males, slightly concave in females; supra-antennal brow

extremely arched and almost vertical in males, only slightly raised in females, outer surface sloping almost vertically to eye; postocular margin long, sides slightly convergent in males, strongly divergent in females. **Labrum** short, setose, very slightly convex, horizontal except apically where it descends vertically, about $2.1\times$ wider than long in males, about $2.7\times$ in females; labral suture distinct. Intermandibular projection receding, short in males, very short in females. Mandibles somewhat triangular, barely concave dorsally on proximal $1/2$; **mandibles in males** deep, convex but not lobed on outer edge, concave on medial edge, with strong apical tooth, large subapical dorsal tooth, and short subapical ventral tooth, left mandible with small tooth behind subapical ventral tooth, all teeth directed medially; **mandibles of females** slightly convex externally, with very large apical tooth, very small subapical dorsal tooth, left mandible with very small subapical ventral tooth. **Antennae** (Fig. 294, 295) with scape strongly arched and moderately broad in males, less arched and more slender in females; funicle short and broad in males, long and slender in females, 1st segment about $1.4\times$ wider than long in males, about $1.8\times$ longer than wide in females, all funicle segments short, asymmetrical and conspicuously oblique-ended in males, 1st–3rd segments symmetrical and 4th and 5th segments asymmetrical in females; club about 6.3 – $9.6\times$ wider than long in males, about $1.6\times$ wider than long in females, setae dense, much longer than diameters of individual segments in males, much shorter than diameters in females. **Eyes** slightly protruding beyond postocular margin (males) or not protruding (females), width together about $0.3\times$ interocular distance (males) or $0.4\times$ (females). **Mentum** concave on outer surface; 4th segment of maxillary palp about $4.3\times$ longer than wide (males) or about $4.2\times$ (females); 3rd segment of labial palp about $5.0\times$ longer than wide (males) or about $3.6\times$ (females).

Thorax. Pronotum about $1.6\times$ wider than long and 1.8 – $1.9\times$ wider than head in males, 1.4 – $1.5\times$ wider than long and 2.0 – $2.2\times$ wider than head in females; integument moderately glossy (males) or extremely glossy (females); disc strongly convex, with pair of squamose, conical tubercles (males) or low, rounded integumental swellings (females) located centrally on either side of midline; punctures well defined, rather shallow, small to moderately large, dense or very dense; vestiture consisting of appressed or decumbent, mostly broad scales arranged in a bilaterally symmetrical pattern and covering much of integument; scales of males short, about 1.3 – $1.5\times$ longer than wide, a few cream but mainly brown or chestnut, scales forming tufts on tubercles brown, moderately long and about $6\times$ longer than wide; scales of females moderately long, very broad, about $1.2\times$ longer than wide, chestnut and cream, the cream scales very numerous on sides of pronotum, those forming

tufts on pair of discal swellings similar to those in discal tufts of males; non-squamose punctures rather numerous in males, less numerous in females, their microsetae easily seen with a stereomicroscope at a magnification of $\times 45$ in largest punctures; sides descending from disc very steeply (males) or moderately steeply (females); front angles acute, distant from eyes; brim broad, horizontal in females, concave and with strongly upturned margin in males; lateral margins serrated, strongly convergent on anterior 3/5ths, slightly convergent on posterior 2/5ths; hind angles sharply acute. **Elytra** about $1.9\times$ wider than pronotum (males) or $1.8\times$ (females), $1.1\text{--}1.3\times$ longer than wide; punctures small to very large, extremely dense over entire surface, margins of some of largest fragmented, these "stretched" punctures very shallow; scales of males mostly appressed, but some subdecumbent, the appressed scales mostly chestnut or brown, short, about $2\times$ longer than wide, arranged in a reticulum, with slightly narrower cream scales scattered among them, the subdecumbent scales mostly cream, short, about $2\times$ longer than wide, arranged in 3 or 4 evenly spaced sutural clusters and in 2–4 clusters on lateral margin of each elytron; scales of females much larger, more numerous and more overlapping than in males, mostly appressed, a few erect, appressed ones mostly cream and chestnut, short to moderately long, about $2\times$ longer than wide, and covering most of integument, erect ones mostly cream, narrower than the other scales, arranged in clusters as in males; discal surface smooth except for strongly raised sutural margin; humeral angle strongly raised and ridged; sides of elytra almost vertical; elytral declivity sloping steeply; brim broad and convex on posterior 1/3rd of elytra, absent elsewhere; outer rim of elytron almost vertical with single row of punctures containing strongly curved cream or brown scales. **Wing** (Fig. 43) about $1.9\times$ longer than elytron. **Front tibia** (Fig. 296, 297) very slightly widened beyond mid dorsal tooth, with 8–12 denticles between mid dorsal and apical teeth and 17–26 denticles between mid dorsal tooth and base; ventral margin not curved; setae on undersides of protarsomeres 2 and 3 (Fig. 298) long, dense, forming elongate, triangular patch on apical 3/4 of segments. **Middle tibia** lacking mid dorsal tooth; denticles if present few, sparse, barely discernible. **Hind tibia** (Fig. 299) slightly curved, lacking mid dorsal tooth and without denticles apart from cluster dorsally near apex in females. **Prosternum** strongly keeled. Mesosternum with elongate tubercle between mesocoxae. Metasternum fused to mesosternum without visible suture on midline; median area concave; most scales appressed or curved, very narrow on middle 1/3rd, much wider towards sides.

Abdomen. Ventrites (Fig. 300, 301) very glossy; punctures small dense; vestiture a mixture of very long, strongly curved, extremely narrow scales and shorter, broader,

appressed scales; apex of 5th ventrite approximately truncate in males, moderately convex in females.

Male genitalia (Fig. 613–616) with some asymmetrical components. **9th abdominal segment** (Fig. 613) strongly asymmetrical, very broad; stalk of sternite curved and oblique, pleurites extremely small. **Penis** (Fig. 614–616) slightly asymmetrical, broad, flask-shaped, slightly concave dorsally, slightly convex ventrally; base level with proximal end of basal piece; sides grooved; distal 1/3rd tapering, rather weakly sclerotised, with pair of very small, pigmented, conical papillae dorsally close to ostium; internal sac very broad, much of its wall lined with dense brown spinules. Tegmen very slightly asymmetrical, about equal in length to penis. **Parameres** slightly asymmetrical, completely fused to basal piece without trace of suture; medial surface concave and closely applied to sides of the penis; dorsomedial edge with conspicuous flange; tips rounded, expanded, their medial edge with strongly sclerotised beak-like projection directed towards papillae adjacent to ostium. **Basal piece** with wide suture on dorsal midline but suture on ventral midline indicated only by weakly impressed, incomplete, slightly oblique line.

Female genitalia (Fig. 698). **Hemisternites** short, vaguely triangular; medial edge strongly convex; styli straight, narrow, very long, about $3\times$ longer than wide. **Bursa copulatrix** slightly constricted on either side of junction with bursal duct, its smaller lobe long, almost 2/3rds length of larger lobe; bursal duct short, broad, not sharply demarcated from bursa copulatrix. **Spermathecal duct** very short, entering smaller lobe of bursa copulatrix through small, stiffened, bifurcate process on the side of lobe; spermatheca small, swollen apically; spermathecal gland long, narrow, not strongly demarcated from its very short duct, combined length of gland and duct about $5\times$ length of spermathecal duct.

Type data. The holotype female of *Ceratognathus gibbosus* is in the BMNH. The specimen was collected at Parua, Whangarei Harbour, ND ($35^{\circ} 46'S$, $174^{\circ} 27'E$) by Mr Crisp, no date given.

The holotype male of *Mitophyllus tuberculatus*, also in the BMNH, was collected at Clevedon, AK ($36^{\circ} 59'S$, $175^{\circ} 03'E$) by Mr G. Munroe, no date given. The original description of *gibbosus* is brief but Broun provided a more detailed description a year later (Broun 1886).

Material examined. Holotype female of *gibbosus*, holotype male of *tuberculatus*, and 12 non-type specimens (9 males, 3 females)(BMNH, MONZ, NZAC).

Distribution (Map 11). From near sea level to about 300m. Northernmost record: Paihia, ND ($35^{\circ} 17'S$); southernmost record: Karori, WN ($41^{\circ} 17'S$).

ND, AK, GB, TK, WN / —

Biology. Adults have been collected from December to March. The material examined includes a specimen collected in a Malaise trap, several collected flying in hot sunshine, and some collected by beating dead vegetation.

Remarks. *Mitophyllus gibbosus* is immediately recognised by the pair of tufted tubercles or mounds on the pronotum, and the strongly raised humeral angle and sutural margin of the elytra. The scales on the dorsal surface show striking sexual dimorphism. In females they are pale, broad, overlapping, and obscure most of the integumental surface while in males they are dark, narrow, scarcely overlapping, and leave much of the black integumental surface uncovered. It is not surprising that Broun considered males and females to represent different species. The punctures on the elytra are larger than those in any other species of *Mitophyllus*, some being “stretched” to the extent that their perimeters are reduced to fragmented, extremely narrow rims. The male genitalia have several unique features, especially the very broad, asymmetrical ninth segment, the “bird-headed” apices of the parameres, and the minute conical papillae adjacent to the ostium. Also in the male genitalia, the mid-line suture on the ventral surface of the basal piece in *gibbosus* is in its most highly modified form for the genus. A somewhat similar, but less modified suture is present in *M. dispar*. The female genitalia of *gibbosus* have some resemblance to those of *M. macrocerus* because in both species the spermathecal duct enters the smaller lobe of the bursa copulatrix through a small pouch.

Conservation status. *Mitophyllus gibbosus* is listed as ‘Data Deficient’ by Hitchmough (2002).

Mitophyllus insignis Broun

Fig. 112, 113, 302–314, 617–619, 699. Map 12
insignis Broun, 1923: 687. Benesh 1960: 19 (*Ceratognathus*).
Holloway 1961: 89, fig. 88, 89, 181, 182 (*Ceratognathus*); 1963b: 110, fig. 29 (*Ceratognathus*); 1998 (December): 650 (*Mitophyllus*). Nikolaev 1998 (January): 56 (*Ceratognathus* new subgenus *Holloceratognathus*).

Diagnosis. Length: males (including mandibles) 10.5–13.4 mm, (excluding mandibles) 9.1–11.2 mm; females (including mandibles) 9.8–11.2 mm, (excluding mandibles) 9.0–10.5 mm. Width: males 4.2–5.4 mm; females 4.5–4.8 mm. Sexual dimorphism prominent in head and pronotum. Body (Fig. 112, 113) rather slender, conspicuously flattened in males, convex in females. Integument black in males, dark blackish- or reddish-brown in females. Punctures on dorsal surface small to moderately large, their raised floor easily seen at $\times 25$ with a stereomicroscope. Pronotum with tracts and patches of appressed or subdecumbent, moderately long, narrow, yellowish-brown scales, a few loose tufts of erect, slightly larger, yellowish-brown scales, and several

bilaterally symmetrical non-squamose areas. Elytra with rather inconspicuous longitudinal tracts of short, narrow, yellowish-brown scales, mainly appressed in males, suberect in females, alternating with tracts that are non-squamose except for a few, rather inconspicuous, loose tufts of erect, slightly larger, dull yellowish scales. Mandibles of males, not triangular, instead narrow basally, and somewhat sickle-shaped; mandibles of females triangular, their medial edges slightly concave. Eyes barely protruding in males, moderately protruding in females.

Redescription

Head. (Fig. 302, 303) wider than long, widest across eyes in males, widest across or behind eyes in females. **Dorsal surface** glossy; frons conspicuously concave in males, flattened or very slightly convex in females; anterior margin not rimmed, slightly concave in males, protruding forward slightly in females; vertex smooth, slightly convex; **punctures** well defined, shallow, mostly moderately large, uniformly dense in females, irregularly dense in males, those near eyes and a few on frons and vertex with moderately long, brown, standing scales, remainder devoid of scales but with microsetae that mostly cannot be seen with a stereomicroscope; preocular margin obtusely rounded or truncate; supra-antennal brow high in males, low in females, outer surface sloping gradually to eye; postocular margin short, straight or slightly convex in males, more strongly convex in females. **Labrum** short, about $2\times$ wider than long, sloping and not very setose in males, about $1.5\times$ wider than long, horizontal and very setose in females; labral suture distinct. Intermandibular projection relatively long, vertical. Mandibles not deep dorsoventrally; **mandibles of males** (Fig. 302, 304) strongly arched laterally, more or less same width throughout their length, with short apical tooth directed anteromedially, erect, recurved, subapical dorsal tooth, feebly bilobed, erect lamina behind subapical dorsal tooth, 1 or 2 small, subapical ventral teeth, very large, triangular lamina directed anteroventrally at base, and dorsomedially directed lamina extending from base to about middle of outer edge of mandible; **mandibles of females** triangular, slightly concave on dorsal surface, obtusely rounded externally at base, with large apical tooth, small subapical dorsal tooth, and in left mandible a small subapical ventral tooth. **Antennae** (Fig. 305, 306) with slightly arched, moderately broad scape; funicle short, broad, 1st segment about $1.1\times$ longer than wide in males, about $1.3\times$ longer than wide in females, 2nd and 3rd segments approximately symmetrical, 4th and 5th segments prominently asymmetrical; club about $2.1\times$ wider than long in males, about $1.2\times$ wider in females, setae dense, shorter than diameters of individual club segments. **Eyes** in males very slightly convex but protruding beyond postocular margin; prominently convex but barely protruding

beyond expanded postocular margin in females; width of eyes together about $0.3\times$ interocular distance. **Mentum** irregularly convex in females, with low, transverse tubercle near middle in males; 4th segment of maxillary palp about $7.8\times$ longer than wide (males) or $4.7\text{--}5.7\times$ (females); 3rd segment of labial palp $5.5\text{--}5.7\times$ longer than wide (males) or $6.6\text{--}6.7\times$ (females).

Thorax. Pronotum (Fig. 307) $1.5\text{--}1.6\times$ wider than long and $1.6\text{--}1.7\times$ wider than head in males, $1.3\text{--}1.4\times$ wider than long and $1.8\text{--}2.0\times$ wider than head in females; integument glossy; punctures well defined, rather shallow, moderately large, largest near lateral margins, dense in squamose areas, sparser or absent in non-squamose areas; vestiture in males consisting of small, bilaterally symmetrical patches of narrow, moderately long, mostly appressed, yellowish-brown scales about $5\times$ longer than wide and some broader, more yellowish, standing scales, about $4\times$ longer than wide, in loose tufts on either side of midline on anterior and posterior margins and in hind angles; vestiture in females consisting of larger patches of slightly wider and mostly suberect, yellowish-brown scales, about $4\times$ longer than wide, and loose tufts of larger, yellowish, standing scales, about $3\times$ longer than wide, distributed in front and hind margins and hind angles as in the males; microsetae present in non-squamose punctures; disc in males flattened or convex, non-squamose areas markedly raised; disc in females convex, non-squamose areas slightly raised and much darker than surrounding integument; brim absent or very narrow in females, broad anteriorly and narrow posteriorly in males; sides sloping steeply from disc in males, sloping gently in females; front angles obtuse, rather close to eyes; lateral margins serrated, strongly convex near middle; hind angles obtuse. **Elytra** (Fig. 308, 309) $1.1\text{--}1.2\times$ wider than pronotum, $1.5\text{--}1.7\times$ longer than wide (males) or $1.4\times$ (females); punctures and scales similar to those on pronotum, the more numerous smaller scales arranged in 4 longitudinal tracts on each elytron, tracts well defined and broad in females, less defined and narrower in males; these squamose tracts alternating with 4 sparsely punctate bands (in females these bands much darker than adjoining integument) each with some microsetae and about 5 loose tufts of large, pale, standing scales (Fig. 309); discal surface smooth except for slightly raised squamose tracts; humeral angle prominent; sutural margin slightly raised posteriorly; sides of elytra almost vertical; elytral declivity sloping gently; brim absent except near humeral angle where it is extremely narrow; outer rim of elytra almost horizontal, with single row of punctures containing suberect scales. **Wing** about $2.1\times$ longer than elytra. **Front tibia** (Fig. 310) moderately broad beyond mid dorsal tooth, with 7 or 8 denticles between mid dorsal and apical teeth (males) or 4–7 (females), and 16–18 denticles between mid dorsal tooth

and base (males) or 13–16 (females); ventral margin straight; setae on underside of protarsomeres 2 and 3 (Fig. 311) mostly long, arranged in triangle on distal 1/2 of segments.

Middle tibia with conspicuous mid dorsal tooth and several small teeth dorsally. **Hind tibia** (Fig. 312) not curved, dorsal surface lacking mid dorsal tooth but with numerous denticles, a cluster of these conspicuous near apex in females. **Prosternum** rounded on midline anterior to coxae. Mesosternum slightly convex between mesocoxae, not tuberculate. Metasternum marked off from mesosternum on midline by weak suture; median area concave; scales dense, appressed or decumbent, very narrow near middle of sternite, broader near sides.

Abdomen. Ventrites (Fig. 313, 314) glossy; punctures small, moderately dense; scales appressed to subdecumbent, very narrow near midline, broader at sides; apex of 5th ventrite almost truncate in males, slightly convex in females.

Male genitalia (Fig. 617–619) asymmetrical. **9th abdominal segment** (Fig. 617) narrow, moderately asymmetrical, stalk of sternite slightly oblique. **Penis** (Fig. 618) broadly flask-shaped, almost symmetrical; dorsal surface slightly concave; ventral surface slightly convex; base close to proximal end of basal piece; sides not grooved; ostium terminal; internal sac broad, very long, with dense brown spinules. Tegmen strongly asymmetrical, about as long as penis. **Parameres** strongly asymmetrical, immovable on basal piece but separated from it dorsally and ventrally by suture; medial surface with large, pale, excavated, oval patch near base; neither paramere with flange; right paramere curved distally, left paramere straight; apical region broad, scarcely tapered, directed medially. **Basal piece** (Fig. 618, 619) strongly asymmetrical dorsally and ventrally, about 1/3rd length of parameres.

Female genitalia (Fig. 699). **Hemisternites** moderately slender, somewhat rectangular; medial edge almost straight; outer edge sinuate; styli straight, narrow, about $3\times$ longer than wide. **Bursa copulatrix** broad, especially larger lobe; smaller lobe very long; bursal duct moderately long, narrow, distinctly demarcated from bursa copulatrix. **Spermathecal duct** long, very wide where it enters apex of smaller lobe of bursa copulatrix; spermatheca relatively narrow, oval, about $3\times$ longer than wide; spermathecal gland long, duct short, combined length of gland and duct about $2\times$ length of spermathecal duct.

Type data. The holotype of *Mitophyllus insignis* is in the BMNH. It was collected on Gordon's Pyramid, NN ($41^\circ 11'S$, $172^\circ 41'E$) by Mr A.C. O'Connor, probably in January 1918. (In the original description Broun states that Mr O'Connor "found another in January, 1918, at a height of 4000 ft.).

Material examined. Holotype male of *insignis* and 16 non-type specimens (10 males, 6 females). (BMNH, LUNZ, MONZ, NZAC).

Distribution (Map 12). From about 600 m to about 1370 m. Northernmost record: Lake Sylvester, NN (latitude 41° 06'S); southernmost record: Lake McKenzie area, Humboldt Mts, OL (latitude 44° 47'S).

— / NN, BR, OL

Biology. Adults have been collected from November to April under stones and under bark including that of *Nothofagus* (tawai), in a rotten branch, and in a tarn at 1000 m.

Remarks. This species, apart from its larger size, has many features in common with *M. alboguttatus*. In particular, the colour of the integument and the scale patterns on the pronotum and elytra are very similar although the tufts of erect scales in *insignis* are yellowish-brown, smaller, and much less conspicuous than the bright cream, larger tufts of *alboguttatus*. Males of *insignis* are easily identified by their large, laterally arcuate mandibles with a conspicuous triangular lobe medially at the base. In *alboguttatus* males the mandibles are triangular, with a very large lobe externally at the base. Distinguishing external features of *insignis* females compared with those of *alboguttatus* are the larger, rather bulging eyes, anterior margin of the head protruding between the mandibles, strongly convex postocular margin, straight ventral edge of the front tibia (compared with the strongly curved margin in *alboguttatus*), triangular patch of setae on the underside of the 2nd and 3rd protarsomeres and convex apex of the 5th ventrite. Features of the genitalia also show similarities between the two species. In males of both species the tegmen and ninth abdominal segment are similarly asymmetrical, the internal sac is very long, broad, and entirely clothed with dense brown spinules, and the parameres have a pale excavation basally on their medial surface and simple, broad, barely tapering apices. The flange on the medial edge of the parameres that is a feature of most *Mitophyllus* species is weakly developed on the right paramere and absent on the left paramere of *alboguttatus* and absent on both parameres of *insignis*. The only significant differences in the female genitalia of the two species are in the length of the bursal duct and the insertion position of the spermathecal duct on the bursa copulatrix.

Mitophyllus irroratus Parry

Fig. 114, 115, 315–325, 620–622, 700. Map 13.

irroratus Parry, 1843: 362; 1845: 56, pl 1, fig. 4a–4l, 4k, 4m, 4n; 1875: 29. White 1846: 9, pl. 2, fig. 3, 4. Burmeister 1847: 326 (*Ceratognathus*). Broun 1880: 253 (*Ceratognathus*). Roon 1910: 57 (*Mitophyllus*). Benesh

1960: 19 (*Ceratognathus*). Holloway 1961: 73, fig. 68, 70, 71, 72, 162, 195, 207 (*Ceratognathus*); 1963b: fig 26 (*Ceratognathus*, erroneously includes *M. arcuatus*); 1997: 57, fig. 67 (*Ceratognathus*); 1998 (December): 650, fig. 1, 4, 7, 10, 13, 16, 19, 22, 26, 30, 33 (*Mitophyllus*). Nikolaev 1998 (January): 56 (*Ceratognathus* new subgenus *Ceratognathus*).

curvidens Broun, 1904: 50 (*Mitophyllus*). Benesh 1960: 20 (as synonym of *Ceratognathus irroratus*). Holloway 1961: 73 (incorrectly as a new synonym of *C. irroratus*). *godeyi* Guérin-Méneville, 1845: 439 (named but not described as the type species of *Ptilophyllum* new genus, for which a description is given); 1846: xcvi (generic and species descriptions). Lacordaire 1856: 41 (as synonym of *M. irroratus*).

See Benesh (1960) for additional references.

Diagnosis. Length: males (including mandibles) 9.1–13.1 mm, (excluding mandibles) 8.5–11.8 mm; females (including mandibles) 9.3–11.7 mm, (excluding mandibles) 8.8–11.1 mm. Width: males 3.6–4.8 mm; females 3.5–4.6 mm. Sexual dimorphism most apparent in features of head. Body (Fig. 114, 115) slender, conspicuously parallel-sided, convex dorsally. Integument dark reddish-brown. Punctures on dorsal surface small, their raised floor not visible with a stereomicroscope at $\times 45$ in those containing scales, but visible in non-squamose punctures. Pronotum and elytra clothed with moderately large, elongate, oval, yellowish-brown, appressed scales, elytra also with tufts of decumbent to erect, pale yellow scales, the areas of appressed scales interrupted by dark, non-squamose blotches, those on elytra arranged in longitudinal rows. Mandibles of males straight, not laterally curved, each with inwardly directed short, apical tooth and very large, erect, recurved, subapical dorsal tooth; external edge with sharply pointed triangular projection near base. Mandibles of females with small but conspicuous acute-angled projection externally near base. Outer surface of supra-antennal brow descending almost vertically towards eye.

Redescription

Head. (Fig. 315, 316) wider than long, widest across the eyes. **Dorsal surface** very glossy; frons deeply concave in males, flattened in females; vertex smooth, slightly convex; **punctures** well defined, deep, mostly small and dense, absent or sparse near anterior margin, those near eyes, on supra-antennal brow, and some centrally between eyes containing long, yellowish, decumbent to erect scales, squamose areas larger in females, remaining punctures devoid of scales but with microsetae not easily seen with a stereomicroscope. Preocular margin obtusely angulate; supra-antennal brow moderately arched in females, strongly arched in males, outer surface descending vertically to eye; postocular margin short, straight or slightly curved. **Labrum** short, about 2 \times wider than long, horizontal, fully

exposed and very setose in females, partly concealed by anterior margin of head and setose only apically in males; labral suture distinct. Intermandibular projection extremely short, horizontal, concealed below strongly protruding anterior margin of head. **Mandibles of males** (Fig. 315, 317, 318) very deep dorsoventrally, straight, somewhat triangular; medial surface slightly concave or flattened; both mandibles with strong apical tooth directed anteromedially, very large erect, recurved, subapical dorsal tooth, vestigial subapical ventral tooth joined to long lamina on medial edge of mandible, and near base a dorsal and a ventral cusp on medial surface and a sharply pointed triangular projection on outer edge. **Mandibles of females** (Fig. 316) triangular, not deep dorsoventrally, concave on dorsal surface, with strongly protruding, acute-angled projection externally near base, large apical tooth, small subapical dorsal tooth, 1 or 2 rudimentary teeth on ventral medial edge; left mandible only with small subapical ventral tooth. **Antennae** (Fig. 319, 320) with scape strongly arched and broad distally in males, slightly arched and rather slender in females; funicle long and slender in males, shorter and broader in females, 1st segment 2.2–3.4× longer than wide in males, about 1.2× longer than wide in females, 5th segment strongly asymmetrical, other segments approximately symmetrical; club about 7.6–8.7× wider than long (males), or about 1.5–1.8× females, setae dense, their length up to 3× diameter of individual club segments in males, about 1/2 the diameter in females. **Eyes** protruding strongly (males) or moderately (females); width together 0.6–0.7× interocular distance (males) or about 0.5× (females). **Mentum** with flat or slightly convex surface; 4th segment of maxillary palp 5.8–6.7× longer than wide (males) or 4.0–4.3× (females); 3rd segment of labial palp 5.6–6.4× longer than wide (males) or 3.5–4.2× (females).

Thorax. Pronotum (Fig. 321) very glossy, about 1.6× wider than long and 1.3–1.4× wider than head in males, about 1.5× wider than long and 1.6–1.7× wider than head in females; punctures well defined, deep, mostly small, dense to moderately dense except on median band where they are sparse or absent; vestiture consisting of large, elongate, oval, yellow or yellowish-brown, appressed scales about 3× longer than wide, and microsetae not easily seen with a stereomicroscope; disc moderately convex, surface virtually smooth, with dark, non-squamose, fragmented band on midline and extensive paired, dark, non-squamose areas on either side of midline; brim moderately broad in males, narrower in females, horizontal, distinctly demarcated from steeply sloping sides of disc; lateral margins serrated, straight or very slightly convex near middle; front angles approximately right-angled, rather close to eyes; hind angles obtuse. **Elytra** 1.0–1.1× wider than pronotum and 1.5–1.8× longer than wide in males, about 1.2× wider than the pronotum and 1.6–1.7× longer than wide in fe-

males; punctures similar to those on pronotum; scales moderately large, elongate, oval, mostly yellowish-brown, appressed, 3–6× longer than wide (see Holloway 1997, fig. 67); squamose areas on each elytron broken up by 3 or 4 longitudinal rows of dark, non-squamose, irregularly rectangular or oval patches, most of the patches in each row separated by tufts of broad, yellowish, decumbent or erect scales; discal surface smooth except some of non-squamose patches are slightly depressed; humeral angles very slightly raised; sutural margin flat on anterior 1/2, raised posteriorly; sides vertical, elytral declivity rather steep; brim absent except near humeral angle where it is very narrow; outer rim sloping, with single row of punctures containing semi-erect scales. **Wing** about 2× longer than elytron. **Front tibia** (Fig. 322) only slightly widened beyond mid dorsal tooth, with 6–12 denticles between mid dorsal and apical teeth and 16–23 denticles between mid dorsal tooth and base; ventral margin distinctly concave; setae on ventral surface and sides of protarsomeres 2 and 3 directed anteroventrally, absent on proximal 1/3rd of each segment, short on distal 2/3rds. **Middle tibia** with small mid dorsal tooth and a few denticles dorsally, all denticles usually larger in females. **Hind tibia** (Fig. 323) straight, lacking mid dorsal tooth but with numerous denticles dorsally; a cluster of denticles conspicuous near apex in females. **Prosternum** with low sharp keel. Mesosternum not tuberculate but slightly rounded in front of mesocoxae. Metasternum with either a vestigial suture or no suture separating it from mesosternum; midline area slightly concave; vestiture consisting of closely spaced, appressed scales, narrow near midline, moderately broad towards sides.

Abdomen. Ventrites (Fig. 324, 325) glossy; punctures small, dense; scales decumbent, very narrow; apex of 5th ventrite truncate or barely emarginate in males, very slightly convex in females.

Male genitalia (Fig. 620–622) symmetrical. **9th abdominal segment** (Fig. 620) moderately broad. **Penis** (Fig. 621, 622) cylindrical, with waist-like constriction near middle of its length, prominently concave near middle on dorsal surface, very slightly concave on ventral surface; base close to proximal end of basal piece; sides not grooved; ostium terminal; internal sac broad, lacking armature. Tegmen longer than penis. **Parameres** fused to **basal piece** without visible suture; medial surface rather flattened, with short, dorsally directed flange applied to “waist” of penis; dorsal surface with very short, oblique ridge above base of flange; parameres moderately broad, straight, tapering apically, tip directed dorsally.

Female genitalia (Fig. 700). **Hemisternites** moderately broad; medial edge strongly indented; outer edge notched; styli straight, elongate, 1.4–2.0× longer than wide. **Bursa copulatrix** broad throughout its length;

smaller lobe moderately long, with pair of colourless, circular, subapical sclerites partially joined together dorsally; bursal duct short, broad, distinctly demarcated from bursa copulatrix. **Spermathecal duct** rather short, broad, conspicuously widened where it enters bursa copulatrix subapically between the pair of sclerites; spermatheca broad, somewhat pear-shaped; spermathecal gland and duct both moderately long, their combined length about 1.4× length of spermathecal duct.

Type data. The lectotype male of *Mitophyllus irroratus* is in the Hope Collection, Oxford University; length including mandibles 11.3 mm, width 4.0 mm, with the following labels: (1) "Port Nicholson [WN, 174° 46'S, 41° 17'E], N. Zealand" [on a green label with black marginal and submarginal lines on three sides]; (2) "LECTOTYPE *Mitophyllus irroratus* Parry 1845 [sic] male. Det. B.A. Holloway 1991". The dissected maxillae, labial palps, and mentum are glued on a card pinned below the specimen. Paralectotype female, also in the Hope Collection, with the following labels: (1) "Port Nicholson [sic] N. Zealand" [on a green label with black marginal and submarginal lines on three sides]; (2) "PARALECTOTYPE *Mitophyllus irroratus* Parry 1845 [sic] female Det B.A. Holloway 1991". The dissected mandibles, mentum, and one maxilla are glued on a card pinned below the specimen, and one wing is mounted on the card with the specimen. All that remains of the antennae of this specimen is one scape. The club segments were mentioned in the original description but interestingly when the specimen was figured by White (1846) it had apparently lost all of the antennal segments except both scapes. When I received the specimens for examination they were not labelled as syntypes. In a letter to me dated 11 March 1991 Dr I. Lansbury said he had sent these two specimens "which may be types as they are from the type locality, however when the lucanid types were catalogued many years ago they were not apparently regarded as syntypes". I consider these to be the specimens on which *M. irroratus* was based because they agree with the description and illustrations. In particular, the dissected mouthparts of the male are exactly as Parry (1845) depicted them in Fig. 4d and 4e.

The holotype of *Ptilophyllum godeyi* Guérin-Ménéville is a male. I have been unable to locate this specimen. The type locality was given merely as New Zealand.

The lectotype male of *Mitophyllus curvidens* Broun is in the BMNH. It was collected in Karori, WN (41° 17'S, 174° 44'E) by G.V. Hudson. The original description includes details of a female but I have not been able to locate that specimen. Broun can be excused for considering this to be a new species because the male he used for comparison had been identified for him 30 years previously by Dr David Sharp as *irroratus* when in fact it was a specimen of the then undescribed *M. arcuatus*.

Material examined. Lectotype male and paralectotype female of *M. irroratus*, lectotype male of *M. curvidens* and 168 non-type specimens (105 males, 63 females) (BMNH, LUNZ, MONZ, NZAC).

Distribution (Map 13). Northernmost New Zealand record: Spirits Bay, ND (latitude 34° 26'S); southernmost record: Rakeahua Valley, SI (latitude 46° 59'S), from near sea level to about 645 m. Broun (1910a) was the first to record this species from the Kermadecs (from Sunday I., now known as Raoul I (29° 16'S, 177° 55'E)).

KE / ND (including Poor Knights Is), CL (known only from Red Mercury and Cuvier Is), WO, BP, GB, TO, TK, HB, WI, WA, WN / SD, NN, KA, WD, MC, CO, SL, SI.

Biology. Adults probably are active throughout the year as collecting dates given in the material examined are from January to April, June to August, and October to December. They have been taken in and under rotten logs, on tree trunks at night, in dead and decaying wood of *Myrsine kermadecensis*, *Metrosideros kermadecensis* (pohutukawa), *Coprosma foetidissima* (naupiro), oak, quince, under bark of *Ascarina lanceolata* (hutu), at molasses bait traps, in pit traps in pasture, in pan traps in beech forest, on sand dunes, inside houses, at lights, and at mercury vapour lamps. Larvae have been collected in January, April, and October in rotten wood or dead branches of *Corynocarpus laevigatus* (karaka), *Coprosma foetidissima*, *Plagianthus betulinus* (manatu), *Coriaria arboria* (tupakihi), *Melicytus ramiflorus* (mahoe), *Pennantia corymbosa* (kaikomako), *Hedycarya arborea* (porokaiwhiri), *Kunzea ericoides* (kanuka), *Pittosporum eugenioides* (tarata), and elm. Adults reared from these in the laboratory, emerged within 4–6 months from the date the wood samples were collected. Broun (1881a) described the larva and pupa of *irroratus* from specimens cut out of *Coriaria sarmentosa* (tutu). Hudson (1934) who provides a more detailed larval description and an illustration found larvae in "damp, powdery, decayed wood under fallen logs of hinau, karaka, and other trees".

Remarks. *Mitophyllus irroratus* closely resembles *M. arcuatus* and the differences and similarities between the two have already been discussed in *arcuatus* Remarks. The sharp, angular projection externally near the base of the mandibles in both sexes is the easiest recognition character of *irroratus*. The range of *irroratus* is the greatest of any New Zealand stag beetle, extending from the Kermadec Islands to Stewart Island. Interestingly *irroratus* has so far not been found in the greater Auckland area nor in parts of Northland where in both places it is replaced by *arcuatus*. The two species are sympatric in the Bay of Plenty, *irroratus* having been collected at Mt Te Aroha and *arcuatus* at Okauia, and in Waikato where both species have been found at Waitomo and at Karamu, near Pirongia.

Mitophyllus macrocerus (Broun)

Fig. 77, 116, 117, 326–338, 623–626, 701. Map 14
macrocerus Broun, 1886: 837 (*Ceratognathus*). Roon 1910:
 57 (*Mitophyllus*). Benesh 1960: 20 (*Ceratognathus*).
 Holloway 1961: 98, fig. 95, 96, 193, 203, 212
 (*Ceratognathus*); 1963b: 106, fig. 30 (*Ceratognathus*);
 1998 (December): 650 (*Mitophyllus*). Nikolaev 1998
 (January): 56 (*Ceratognathus* new subgenus
Ceratognathus).

Diagnosis. Length: males (including mandibles) 5.5–8.5 mm, (excluding mandibles) 5.4–8.1 mm; females (including mandibles) 6.8–7.4 mm, (excluding mandibles) 6.6–7.1 mm. Width: males 2.6–3.7 mm; females 3.0–3.3 mm. Sexual dimorphism slight in mandibles but conspicuous in other head features. Body (Fig. 77, 116, 117) slender, delicate, moderately convex dorsally. Integument black. Punctures on dorsal surface minute to small, their raised floor visible at a magnification of $\times 45$ in largest punctures, barely or not visible at this magnification in smallest punctures; distance between punctures equal to or greater than puncture diameters. Pronotum and elytra lacking vestiture except for sparse, rather evenly distributed cream or white, decumbent to erect, teardrop-shaped scales arranged singly or in loose groups of up to about 6 scales. Mandibles of males and females short, approximately triangular, concave on medial edge. Front margin of head with small erect tubercle on midline.

Redescription

Head. (Fig. 326, 327) slightly wider than long, widest across eyes in males, widest behind eyes in females; **dorsal surface** glossy or dull; frons very strongly concave in males, slightly concave in females; anterior margin rimmed in females, not rimmed in males, with small but variably developed, erect tubercle on midline; vertex smooth, slightly convex; **punctures** well defined, deep, mostly small and dense, a few near anterior margin, near inner edge of eyes, and on sides of frons and vertex with long, yellowish, erect or semi-erect scales, remainder devoid of scales but with microsetae that mostly cannot be seen with a stereomicroscope; preocular margin obtusely angulate or truncate in males, sinuous in females; supra-antennal brow strongly arched in males, slightly arched in females, outer surface sloping almost vertically to eye in females, sloping at steep oblique angle in males; postocular margin long, slightly convex in females, almost straight in males. **Labrum** short, setose, very slightly convex, horizontal proximally, descending vertically distally, about $1.8\times$ wider than long (males), or about $2.5\times$ (females); labral suture distinct. Intermandibular projection short, descending vertically in males, directed anteroventrally in females. Mandibles somewhat triangular, not deep dorsoventrally; **mandibles of males** relatively small, with strong apical tooth

directed medially, short, broad-based, erect, subapical dorsal tooth, subapical ventral tooth small on left mandible, minute on right, and relatively large, rounded or obtusely angulate external basal lobe with deeply concave dorsal surface; **mandibles of females** shallowly concave on dorsal surface, slightly rounded or angulate externally at base, with large apical tooth, very small subapical dorsal tooth, and in left mandible a very small subapical ventral tooth.

Antennae (Fig. 328, 329) with scape strongly arched and bulky in males, slightly arched and moderately broad in females; funicle slender, all segments asymmetrical and conspicuously oblique-ended in males, in females 1st–3rd segments approximately symmetrical and 4th and 5th segments slightly asymmetrical, none oblique-ended in females; club in males about $6.1\text{--}9.2\times$ wider than long with setae moderately dense and very much longer than diameters of individual club segments, about $1.8\times$ wider than long in females with setae very dense and shorter than diameters of individual club segments. **Eyes** strongly protruding beyond postocular margin in males, not protruding in females, their width together about $0.6\times$ interocular distance (males) or $0.5\times$ (females). **Mentum** with slightly uneven surface; 4th segment of maxillary palp about $4\times$ longer than wide (males) or $5\times$ (females); 3rd segment of labial palp about $3\times$ longer than wide (males) or $3.3\times$ (females).

Thorax. Pronotum (Fig. 330, 331) glossy or dull, $1.5\text{--}1.6\times$ wider than long and $1.7\text{--}1.9\times$ wider than head in males, about $1.6\times$ wider than long and about $2\times$ wider than head in females; punctures well defined, rather deep, mostly minute, sparse or moderately dense on disc, small and dense on sides; vestiture consisting of appressed to suberect, cream scales arranged symmetrically, the scales about $4\times$ longer than wide and solitary in males, about $2\times$ longer than wide and in groups of 3–5 in females; microsetae present in remaining punctures; disc slightly convex, smooth; brim broad, concave and with upturned margin in males, narrow and horizontal in females; sides sloping gently from disc; front angles distant from eyes; lateral margins serrated, convergent on anterior 1/2 and parallel or slightly divergent on posterior 1/2 in males, almost uniformly convex in females; hind angles right-angled in males, obtuse in females. **Elytra** (Fig. 332) $1.1\text{--}1.2\times$ wider than pronotum and $1.4\text{--}1.6\times$ longer than wide; punctures minute to small, mostly dense or moderately dense, evenly distributed; scales mostly cream, a few sometimes brownish, decumbent to suberect, all or many in clusters of 2–7 aligned in 5 rows on each elytron, each row with 4 or 5 widely spaced clusters; females and some males with solitary scales on sutural margin and between rows of clusters; discal surface smooth except for raised sutural margin and moderately raised humeral angles; sides of elytra almost verti-

cal; brim absent in small specimens, narrow in large specimens; outer rim almost horizontal, with single row of punctures containing stiff, decumbent, brown setae. **Wing** about 2× longer than elytron. **Front tibia** (Fig. 333, 334) not widened beyond mid dorsal tooth (males) or slightly widened (females), with 9–13 denticles between mid dorsal and apical teeth (males) or 7 or 8 (females) and 11–18 denticles between mid dorsal tooth and base (males) or 12 or 13 (females), ventral margin slightly curved; setae on underside of protarsomeres 2 and 3 long, all about same length, dense over entire surface (Fig. 335). **Middle tibia** lacking mid dorsal tooth but with 3 longitudinal rows of very small, equal-sized denticles, each denticle closely associated with a seta. **Hind tibia** (Fig. 336) not curved; dorsal surface lacking large denticles but with 2 longitudinal rows of minute denticles in males, 3 rows of minute denticles in females a few of these more dense near apex but not in cluster. **Prosternum** strongly keeled. Mesosternum conspicuously tuberculate between coxae. Metasternum fused to mesosternum without visible suture; midline area flattened or concave; scales erect or curved, very narrow on median 1/3rd, appressed and increasing markedly in width towards sides of segment.

Abdomen. Ventrites (Fig. 337, 338) glossy; punctures small and dense; scales appressed to suberect, very narrow; apex of 5th ventrite slightly emarginate in males, slightly convex in females.

Male genitalia (Fig. 623–626) asymmetrical. **9th abdominal segment** (Fig. 623) strongly asymmetrical; stalk of sternite obliquely curved. **Penis** (Fig. 624–626) very slightly asymmetrical, narrow, not flask-shaped; dorsal surface slightly concave; ventral surface slightly convex; base distant from proximal end of basal piece; sides not grooved; distal 1/4 tapering, sclerotised and pigmented ventrally, colourless but stiffened dorsally; ostium terminal; internal sac not examined. Tegmen asymmetrical, much shorter than penis. **Parameres** strongly asymmetrical, their lengths very different, completely fused to basal piece without indication of suture, medial surface slightly concave and closely applied to sides of penis, neither paramere with dorsomedial flange, their apices tapered and directed medially. **Basal piece region** with short oblique suture on both dorsal and ventral surfaces (Fig. 624, 625).

Female genitalia (Fig. 701). **Hemisternites** triangular, broad basally, convex on medial edge, notched on outer edge; styli straight, narrow, about 2.5× longer than wide. **Bursa copulatrix** conspicuously constricted on either side of its junction with bursal duct so the 2 lobes are “stalked”; smaller lobe extremely short; bursal duct long, narrow, distinctly demarcated from bursa copulatrix. **Spermathecal duct** very short, entering smaller lobe of bursa copulatrix through minute conical projection on side of lobe;

spermatheca extremely small, about 3× longer than wide, approximately cylindrical; spermathecal gland very long, poorly demarcated from its duct, combined length of gland and its duct about 10× length of spermathecal duct.

Type data. The holotype of *Ceratognathus macrocerus* is in the BMNH. Stated by Broun to be a female, because of its small, rather simple mandibles, the specimen is in fact a male (Holloway, 1961). The type locality is Helensville, AK (36° 41'S, 174° 27'E).

Material examined. Holotype male of *C. macrocerus* and 16 non-type specimens (13 males, 3 females) (AMNZ, BMNH, LUNZ, NZAC).

Distribution (Map 14). Northernmost record: Unuwahao, near Spirits Bay, ND (latitude 34° 26'S); southernmost record: Walkers Bush, Waitakere Range, AK (latitude 36° 54'S), from near sea level to about 460 m.

ND, AK /—

Biology. Adults have been collected from December to March in a Malaise trap, by beating and sweeping shrubs, in litter and leafmould, and in a dead twig of *Kunzea ericoides* (kanuka) in which larvae were also found. Four males that I collected at Mt Manaia, ND on 21 January 1981 were part of a large group of specimens flying and landing on shrubs in hot sunshine at midday.

Remarks *Mitophyllus macrocerus* is a very small delicate-looking black lucanid with sparse, whitish scales on the dorsal surface. The scales are arranged singly or in small clusters and are more numerous in females. A unique feature in both sexes is the small but easily seen erect tubercle near the midline of the anterior margin of the head. The species is one of four in *Mitophyllus* that have the parameres of the male genitalia fused to the basal piece without any indication of a suture. The basal piece region in *macrocerus* is indicated by the short oblique “midline” sutures dorsally and ventrally near the base of the tegmen. *M. macrocerus* is most similar morphologically to *M. gibbosus* and shares with that species the apparently unusual habit of flying in hot sunshine.

Mitophyllus parrianus Westwood Parry's stag beetle

Figures 1, 8, 9, 16, 19, 30, 41, 42, 51, 60, 72, 78, 118, 119, 339–354, 627–630, 702. Map 15.

parrianus Westwood, 1863: 432, pl. 15 (fig. 3, 3a–3d). Roon 1910: 57 (as *parryanus*). Hudson 1934: 161, pl. 16 (fig. 3, 3a) (*parryanus*). Benesh 1960: 20 (*Ceratognathus parryanus*). Holloway 1960: 349, fig. 2, 5, 91–100 (*Ceratognathus parrianus*); 1961: 77, frontispiece 15, 16, fig. 2, 9, 74–79, 165–172, 196, 208 (*Ceratognathus*); 1963b: 110, fig. 25 (*Ceratognathus*); 1997: 57, fig. 32, 63–66 (*Ceratognathus*); 1998 (December): 650 (*Mitophyllus*). Nikolaev 1998 (January): 56 (*Ceratognathus* new subgenus *Holloceratognathus*).

marmoratus Waterhouse, 1874: 8 (*Mitophyllus*). Boileau 1913: 267 (synonym of *M. parryanus*).
zealandicus Broun, 1877: 372 (*Ceratognathus*); 1880: 253; 1893: 1112 (synonym of *M. parryanus*).

Diagnosis. Length: males (including mandibles) 11.2–20.0 mm, (excluding mandibles) 10.4–18.0 mm; females (including mandibles) 13.8–19.0 mm, (excluding mandibles) 13.0–17.6 mm. Width: males 4.8–7.5 mm; females 5.3–7.5 mm. Sexual dimorphism of head features moderately pronounced. Body (Fig. 1, 78, 118, 119) stout, convex dorsally. Integument dark reddish-brown. Punctures on dorsal surface small to moderately large, their raised floor easily seen with a stereomicroscope at $\times 45$. Pronotum and elytra with areas of large, elongate-oval, yellowish-brown, appressed scales broken up by dark non-squamose patches. Mandibles triangular; males with large, conspicuously protruding, obtusely rounded basal lobe externally and tall, erect, subapical dorsal tooth. Setae on underside and lateral margins of protarsomeres 1–4 short near proximal end of segments, gradually increasing in length towards distal end.

Redescription

Head. (Fig. 339, 340) wider than long, widest across eyes in males, widest across or behind eyes in females. **Dorsal surface** moderately glossy; frons slightly concave to slightly convex, but with large, slightly raised, triangular median area, more prominent in males; anterior margin not rimmed, straight in males, protruding forward slightly in females; a variably developed, median, crescentic ridge behind anterior margin in females; vertex smooth, flattened to slightly convex; **punctures** well defined, deep, mostly small and dense, those near eyes and a few on frons with long, yellowish-brown, appressed or semi-erect scales, remainder devoid of scales but with microsetae mostly not visible with a stereomicroscope; preocular margin rounded or truncate; supra-antennal brow low, outer surface sloping gradually to eye; postocular margin short, straight or slightly convex. **Labrum** short, about $2\times$ wider than long, sloping forward in males, horizontal in females, very setose distally; labral suture distinct. Intermandibular projection extremely short, barely visible below anterior margin of head. Mandibles triangular, not deep dorsoventrally; **mandibles of males** (Fig. 339, 341, 342) with strong apical tooth directed anteromedially, large, broad, erect, subapical dorsal tooth with slightly recurved, broad, blunt tip, 1 or 2 very small teeth along medial edge of mandible and large, obtusely rounded, external, basal lobe with upwardly directed lateral margin; **mandibles of females** (Fig. 340, 343) very concave on dorsal surface, obtusely rounded to slightly angulate externally at base, with large apical tooth, small, subapical dorsal tooth, 1 or 2 very small teeth on ventral medial edge, left mandible with small subapical ventral tooth. **Antennae** (Fig. 19, 344, 345) with scape slightly

arched, moderately broad; funicle short, broad, 1st segment about $1.1\times$ longer than wide (males), or about $1.2\times$ (females), 2nd and 3rd segments approximately symmetrical, 4th and 5th segments asymmetrical; club about $2.4\times$ wider than long (males) or about $1.4\times$ (females), setae dense and shorter than diameters of individual segments. **Eyes** moderately protruding in females, more strongly protruding in males, width together about $0.6\times$ interocular distance (males) or $0.5\times$ (females). **Mentum** smooth, not tuberculate; 4th segment of maxillary palp (Fig. 16) $5.7\text{--}6.4\times$ longer than wide (males) or $4.3\text{--}5.0\times$ (females); 3rd segment of labial palp (Fig. 8, 9) $5.1\text{--}5.8\times$ longer than wide (males) or $3.4\text{--}4.0\times$ (females).

Thorax. Pronotum (Fig. 78, 346, 347) moderately glossy, $1.5\text{--}1.7\times$ wider than long and $1.5\text{--}1.6\times$ wider than the head in males, $1.5\text{--}1.6\times$ wider than long, and $2.0\text{--}2.1\times$ wider than head in females; punctures well defined, deep, mostly dense, moderately large, largest and most dense in brim, least dense on areas lacking scales, very sparse or absent on posterior 1/2 of glossy median band; vestiture consisting of large, elongate-oval, yellowish-brown, appressed scales 3 or 4 times longer than wide, and microsetae not easily seen with a stereomicroscope; disc moderately convex, surface slightly uneven, with extensive, dark, non-squamose, somewhat bilaterally symmetrical areas varying in shape, size and position but always present as a conspicuous, rather broad band on midline and laterally as pair of slightly convergent, rather fragmented, narrow bands running obliquely to posterior margin of pronotum; brim moderately broad, horizontal; sides sloping gently from disc; front angles acute or right-angled, rather close to eyes; lateral margins serrated, obtusely angulate near middle; hind angles obtuse. **Elytra** about $1.2\times$ wider than pronotum, $1.5\text{--}1.6\times$ longer than wide; punctures moderately dense, small to moderately large, scales similar to those on pronotum (Fig. 30, 41); squamose areas extensive, broken up on each elytron by dark, elongate, somewhat rectangular, non-squamose patches with microsetae in their punctures (Fig. 42), patches arranged in about 4 longitudinal rows and producing chequered pattern; humeral angle barely raised; sutural margin slightly raised; discal surface smooth except some of non-squamose patches are slightly depressed; brim absent except very narrow near humeral angle; outer rim of elytra almost horizontal, with single row of punctures containing semi-erect scales. **Wing** about $2\times$ longer than elytron. **Front tibia** (Fig. 60, 348) very broad beyond mid dorsal tooth, 6–11 denticles between mid dorsal and apical teeth and 15–23 denticles between mid dorsal tooth and base; ventral margin of tibia very slightly concave; setae on ventral and lateral surfaces of protarsomeres 2 and 3 (Fig. 349, 350) directed anteroventrally, absent on about proximal 1/3rd of each

tarsomere, visible in dorsal aspect as a broad fringe on the sides of tarsomeres, setae gradually increasing in length towards distal end of each segment. **Middle tibia** with conspicuous mid dorsal tooth and a few denticles dorsally. **Hind tibia** (Fig. 351) almost straight, dorsal surface lacking conspicuous mid dorsal tooth but with several variably sized denticles, a cluster of small denticles near apex in females. **Prosternum** (Fig. 51) slightly convex on midline. Mesosternum slightly tuberculate immediately in front of mesocoxae. Metasternum marked off from mesosternum on midline by conspicuous suture; midline area flattened or depressed over most of its length; scales (Fig. 352) appressed, very narrow near midline, widening towards sides.

Abdomen. Ventrites (353, 354) glossy; punctures small, moderately dense; scales appressed, very narrow near midline, broader at sides; apex of 5th ventrite shallowly notched in males, convex in females.

Male genitalia (627–630) symmetrical. **9th abdominal segment** (Fig. 627) broad. **Penis** (Fig. 628–630) cylindrical, slightly concave on dorsal surface, slightly convex ventrally; base distant from proximal end of basal piece; sides with a few weak, oblique ridges dorsally near middle; ostium terminal; internal sac broad, with some armature. Tegmen much longer than penis. **Parameres** immovable on basal piece but marked off from it dorsally and ventrally by entire or fragmented sutures; medial surface concave but with large, broad, dorsally directed flange that is truncate distally; dorsal surface with short, oblique ridge near middle; apical 1/3rd slender, tapering, tip strongly curved, directed ventromedially. **Basal piece** about 1/2 length of parameres.

Female genitalia (Fig. 72, 702). **Hemisternites** triangular, very broad basally, slender apically; medial edge straight; lateral margin weakly indented; styli straight, elongate, 2–4× longer than wide. **Bursa copulatrix** broad throughout its length, smaller lobe moderately long; bursal duct moderately long, broad, distinctly demarcated from bursa copulatrix. **Spermathecal duct** very short, relatively broad, slightly widened where it enters apex of smaller lobe of bursa copulatrix; spermatheca narrow, cylindrical except for spherical apex; spermathecal gland much longer than duct, combined length of gland and duct about 5× length of spermathecal duct.

Type data. The types of *Mitophyllus parrianus* and *Ceratognathus zealandicus* have not been located. Parry (1875) stated that the type of *M. parrianus* was in his own collection but the specimen has not been found in material held in the Hope Department at Oxford. Both species were described from males and the descriptions are sufficiently detailed to leave no doubts as to their identity. Waterhouse described *marmoratus* from a male and a fe-

male. The lectotype male is in the BMNH but the whereabouts of the paralectotype female are unknown to me. For both *parrianus* and *marmoratus* the type locality was given only as New Zealand. Broun listed Canterbury, Stoke Point, and Coromandel as localities where *zealandicus* had been collected.

Material examined. Lectotype male of *M. marmoratus* Waterhouse and 243 non-type specimens (119 males, 124 females) (AMNZ, BMNH, CMNZ, MONZ, NZAC).

Distribution (Map 15). Northernmost record: Ngaitonga Saddle, South Russell, ND (latitude 35° 19'S); southernmost record: Big South Cape I., SI (latitude 47° 14'S), from near sea level to about 1200 m.

ND, AK (including Waiheke I), CL (including Great Barrier I), WO, BP, GB, TO, TK, HB, RI, WI, WN / NN, SD (including D'Urville I), MB, BR, MC, SC, OL, FD (including Resolution I and Secretary I), DN, SL, SI (including Big South Cape I and Solomon I),

Biology. Adults have been collected throughout the year, in rotting logs and branches of native trees including *Nothofagus fusca* (tawhairaunui), *Nothofagus* sp. (tawai), *Senecio reinoldii* (puharetaiko), *Olearia* sp. (taraheke), *Melicetyus ramiflorus* (mahoe), *Olea cunninghamii* (maire), *Kunzea ericoides* (kanuka), *Beilschmiedia rawarora*, *Wienmannia racemosa* (kamahi), *Podocarpus totara* (totara), *Dacrydium cupressinum* (rimu), and *Metrosideros robusta* (rata), and also in hardwood poles and a rotten stump of *Prunus persica* (plum). They seem not to be active during the day but at night they have been collected on tree trunks and on foliage of *Dracophyllum longifolium* (inanga), *Macropiper excelsum* (kawakawa), *Hebe* spp. (koromiko), *Phormium* sp. (haraheke), and *Stilbocarpa lyalli* (punui). Some of the specimens examined had been attracted to lights, including light traps, and a few were caught in Malaise traps. Larvae found from April to November in rotten wood of trees including *Beilschmiedia rawarora* and *Kunzea ericoides* continued their development in the laboratory and emerged 3–6 months after the wood samples were collected.

Remarks. *Mitophyllus parrianus* is widespread throughout New Zealand but has not been found on the Chatham Islands. In size, colour, and overall appearance it is extremely similar to *M. falcatus* and *M. solox*, two of the new species described in this volume. Males of the three species are easily separated by the shape of their mandibles but females lack an equivalent unique character and have to be identified by protarsal and pronotal features common to both sexes. Within the group of three, *parrianus* is distinctive in having the setae on the underside of the 2nd and 3rd protarsal segments increasing in length from the proximal to the distal ends of these segments. Unique fea-

tures of its pronotum are the almost complete absence of punctures on the posterior half of the shiny, non-squamose, longitudinal, median band, and the conspicuously oblique juncture of the adjacent posterolateral shiny bands with the hind margin of the pronotum. Distinctive genitalic features of *parrianus* compared with those in the other two species are, in males, the long, erect, truncate-tipped flange on the medial edge of each paramere, the strongly curved tips of the parameres, the weak, oblique ribbing on the sides of the penis, and the considerable distance between the base of the penis and the proximal end of the basal piece, and in females, the elongate, slender hemisternites, moderately long smaller lobe of the bursa copulatrix, and very sharply defined bursal duct.

Mitophyllus reflexus Broun

Fig. 120, 121, 355–367, 631–633, 703. Map 16

reflexus Broun, 1909: 148. Benesh 1960: 20 (*Ceratognathus*).

Holloway 1961: 84, fig. 83, 84, 175, 176, 198, 210 (*Ceratognathus*); 1963b: 110, 114 (*Ceratognathus*); 1998 (December): 650 (*Mitophyllus*). Nikolaev 1998 (January): 56 (*Ceratognathus* new subgenus *Holloceratognathus*).

Diagnosis. Length: males (including mandibles) 9.9–13.4 mm, (excluding mandibles) 9.6–12.8 mm; females (including mandibles) 10.4–12.4 mm, (excluding mandibles) 9.9–11.8 mm. Width: males 3.7–5.0 mm; females 4.0–5.1 mm. Sexual dimorphism conspicuous in eyes, antennae and pronotum but relatively inconspicuous in mandibles. Body (Fig. 120, 121) rather slender, somewhat flattened dorsally. Integument brown. Punctures on entire dorsal surface small, their raised floor easily seen at $\times 45$ with a stereomicroscope, uniformly dense on head and elytra and on most of pronotum, many containing short, inconspicuous, very narrow, appressed or decumbent, pale yellow scales, punctures lacking scales with microsetae that mostly are not visible with a stereomicroscope. Pronotum with brim very broad and reflexed in males, narrow and horizontal in females. Mandibles of males curved laterally and not strongly enlarged, medial edge only slightly concave, with several small teeth. Mandibles of females irregularly triangular. Eyes very strongly protruding in males, moderately protruding in females. Setae on underside of 1st–4th protarsomeres moderately long, all about same length.

Redescription

Head. (Fig. 355, 356) wider than long, widest across eyes. **Dorsal surface** very glossy; frons deeply concave in males, flattened or slightly concave in females, with slightly raised small mound on midline near level of posterior margin of eyes; anterior margin of head smooth or rimmed, vertex smooth, flattened to slightly convex; **punctures** well de-

fined, deep, small, dense, those near eyes and on anterior margin of head with long or moderately long, erect, very narrow, pale scales, remainder with either much shorter, decumbent scales or with microsetae; preocular margin obtusely rounded or truncate; supra-antennal brow strongly arched and ridged in males, low and rounded in females, outer surface descending almost vertically to eye; postocular margin straight or convex, extremely short in males, moderately long in females. **Labrum** short, broad, about $1.5\text{--}2.0\times$ wider than long, horizontal on proximal 1/2, sloping forward distally, very setose; labral suture distinct. Intermandibular process relatively long in males, very short in females, oblique, not concealed by anterior margin of head. Mandibles not lobed externally at base; **mandibles of males** deep dorsoventrally with strong apical tooth directed anteromedially, large subapical dorsal tooth that is almost horizontal and directed medially, and 2–5 very small teeth along ventral medial margin; **mandibles of females** slightly concave on dorsal surface, obtusely rounded externally near base, with large apical tooth, small subapical dorsal tooth, left mandible with small subapical ventral tooth. **Antennae** (Fig. 357, 358) with strongly arched and moderately broad scape; funicle long, rather broad, 1st segment about $1.7\times$ longer than wide in males, about $1.5\times$ in females, 5th segment strongly asymmetrical, 2nd–4th segments approximately symmetrical in males and most females, but 3rd and 4th segments in females sometimes asymmetrical; club about $6\times$ wider than long in males, about $1.3\times$ wider than long in females, setae dense, much longer than diameters of individual segments in males, shorter than diameters in females. **Eyes** very strongly protruding in males, moderately protruding in females, width together about equal to interocular distance in males, about $0.6\times$ interocular distance in females. **Mentum** with very large tubercle in centre of exposed surface in males, with smaller tubercle in females; 4th segment of maxillary palp about $5.6\times$ longer than wide (males) or $4.2\text{--}4.6\times$ (females); 3rd segment of labial palp about $4.2\times$ longer than wide (males) or $3.4\text{--}3.6\times$ (females).

Thorax. Pronotum (Fig. 359, 360) very glossy, $1.6\text{--}1.7\times$ wider than long, about $1.5\times$ wider than head in males, $1.3\text{--}1.5\times$ wider than long and about $1.8\times$ wider than head in females; punctures well defined, mostly dense and rather shallow, small on disc, increasing in size to moderately large on brim; vestiture consisting mainly of inconspicuous, narrow, pale yellow, appressed and decumbent scales about $5\times$ longer than wide, and microsetae; disc flattened in males, slightly convex in females, surface with narrow, raised, glossy, sparsely punctate or entirely smooth longitudinal median strip on posterior 1/2 of disc and 2 or 3 paired, small, similarly raised areas on anterior 2/3rds of disc, these raised areas larger and less elevated in females;

brim sloping gradually from disc, reflexed and extremely broad in males, horizontal and narrow in females; sides obtusely rounded near middle; front angles close to eyes, obtusely rounded in males, right-angled in females; lateral margins serrated; hind angles obtuse. **Elytra** about $1.1\times$ wider than pronotum, about $1.7\times$ longer than wide (males) or $1.5\times$ (females); punctures (Fig. 361) small, dense, rather shallow, many containing microsetae, scales when present like those on pronotum, very inconspicuous apart from a few that are slightly wider, semi-erect, and in small groups or short rows mainly near sides of elytra; humeral angle very low; sutural margin slightly raised on declivity, flattened elsewhere; each elytron with up to 4 variably developed longitudinal grooves on disc; elytral declivity sloping gently; sides sloping almost vertically; brim absent except near humeral angle where it is very narrow; outer rim horizontal with single row of punctures containing semi-erect, narrow scales. **Wing** about $2\times$ longer than elytron. **Front tibia** (Fig. 362, 363) slightly widened beyond mid dorsal tooth, with 11–14 denticles between mid dorsal and apical teeth (males) or 6–10 (females) and 11–20 denticles between mid dorsal tooth and base (males) or 11–17 (females); ventral margin distinctly concave; ventral and lateral setae on protarsomeres 2 and 3 (Fig. 364) all about same length, moderately long, directed anteroventrally, visible in dorsal aspect as dense fringe on posterior (outer) margin of segments and as a sparser fringe on anterior (inner) margin, fringe absent on about proximal $1/6$ th– $1/3$ rd of each segment. **Middle tibia** with inconspicuous mid dorsal tooth and few smaller teeth proximally on dorsal surface. **Hind tibia** (Fig. 365) straight; dorsal surface lacking mid dorsal tooth but with numerous small teeth, small inconspicuous cluster of these near apex in females. **Prosternum** strongly keeled. Mesosternum weakly tuberculate in front of mesocoxae. Metasternum totally fused to mesosternum, suture if present very rudimentary; midline area very slightly depressed, scales appressed to semi-erect, very narrow.

Abdomen. Ventrites (Fig. 366, 367) glossy; punctures small, dense; scales decumbent to erect, very narrow; apex of 5th ventrite truncate or slightly concave in males, strongly convex in females.

Male genitalia (Fig. 631–633) symmetrical. **9th abdominal segment** (Fig. 631) rather broad. **Penis** (Fig. 632, 633) very narrow, arched, compressed laterally; dorsal surface smooth and convex; sides smooth; ventral surface concave, keeled on midline, terminating distally in a short, blunt, subapical hook; base of penis distant from proximal end of basal piece; ostium terminal; internal sac very narrow, with some armature. **Parameres** immovable on basal piece, marked off from it on lateral margin by short, shallow suture extending across entire dorsal surface as

weakly impressed line, but not continuing to ventral surface; medial surface of parameres concave, with large, broad dorsal, flange on proximal $1/2$; apical $1/3$ rd of parameres deep dorsoventrally, compressed laterally, with subapical row of 7–13 small, dark-tipped, apparently movable, peg-like structures on dorsal margin; apex of parameres slightly expanded, weakly sclerotised. **Basal piece** about $1/2$ length of parameres.

Female genitalia (Fig. 703). **Hemisternites** slender, strongly convex on medial edge, notched on outer edge; styli straight, moderately long, 1.5 – $2.0\times$ longer than wide. **Bursa copulatrix** with very short, narrow, smaller lobe and saccate larger lobe; bursal duct long, very narrow, sharply demarcated from bursa copulatrix. **Spermathecal duct** long, narrow, slightly widened at juncture with bursa copulatrix; spermatheca narrow proximally, spherical apically; spermathecal gland much longer than its duct, combined length of gland and duct about $1.25\times$ length of spermathecal duct.

Type data. The lectotype male from the Chatham Islands (approximately $43^{\circ} 57'S$, $176^{\circ} 20'W$) was collected in February 1907 by W. B. Benham and is in the BMNH. The original description is based on two males but since my 1961 revision I have still not been able to locate the second specimen. Therefore I am designating the only known specimen as lectotype in order to fix this taxonomic concept of *reflexus* Broun. A card-mounted female of *reflexus* in NZAC, from the Broun Duplicate Collection, is labelled “11–female” in Broun’s handwriting but lacks any other original label data and was never mentioned in any of Broun’s publications.

Material examined. Lectotype male of *Mitophyllus reflexus* and 58 non-type specimens (40 males, 18 females) (AMNZ, BMNH, CMNZ, LUNZ, MONZ, NZAC).

Distribution (Map 16). Chatham Islands archipelago (Chatham, Mangere, Pitt, Rangatira), (approximately $43^{\circ} 57'S$), from sea level to about 100 m.

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Biology. Adults in the material examined were collected in August and from November to February in association with rotting wood of *Myrsine chathamica* (mapou) and *Plagianthus betulinus* (manatu), and on vegetation at night. Emberson (1998) found that adults were widespread in dead trees, logs, and branches, and on tree trunks at night, on Chatham, Pitt, and Rangatira (South East) Islands in January, March, July, and November. Larvae present in rotting wood collected in February 1967 and kept in the laboratory at Entomology Division in Nelson emerged as adults in July 1968.

Remarks. *Mitophyllus reflexus* has a dark brown rather flattened body with dense, small punctures covering the

entire dorsal surface. The scales are short, very narrow, mainly appressed, and inconspicuous. Males have huge eyes, an extremely large antennal club, and relatively small mandibles. Typically, females lack extreme morphological features externally but their depressed frons, and rather spiny hind tibiae are somewhat unusual for the genus. Unique genitalic features in males are the row of peg-like structures near the apex of the parameres, and the very narrow penis with a blunt, ventral, subapical hook. The slender bursal duct and short, narrow smaller lobe of the bursa copulatrix are distinctive features of females.

Mitophyllus solox new species

Fig. 122, 123, 368–381, 634–636, 704. Map 17.

Diagnosis. Length: males (including mandibles) 13.4–14.6 mm, (excluding mandibles) 12.2–13.6 mm; females (including mandibles) 13.3–14.4 mm, (excluding mandibles) 12.6–13.9 mm. Width: males 5.8–6.2 mm; females 6.1–6.4 mm. Sexual dimorphism conspicuous on head. Body (Fig. 122, 123) stout, convex dorsally; integument dark reddish- or blackish-brown. Punctures on dorsal surface mostly small, their raised floor visible at $\times 45$ with a stereomicroscope. Pronotum and elytra extensively clothed with large, elongate-oval, yellowish-brown, mainly appressed scales broken up into a somewhat chequered pattern by small, irregularly shaped, dark, non-squamose areas; elytra with irregular tufts of standing scales producing a shaggy appearance. Mandibles triangular, with uniformly convex external margin and a very broad-based subapical dorsal tooth in males, slightly angulated externally at the base and conspicuously attenuated apically in females. Eyes moderately protruding. Setae on ventral surface and lateral margins of 1st–4th protarsomeres very long, all about same length.

Description

Head. (Fig. 368, 369) wider than long, widest across eyes in males, across or behind the eyes in females. **Dorsal surface** glossy; frons flattened or slightly convex, surface smooth in females, with very slightly raised, large triangular, median area in males; prominent crescentic ridge behind intermandibular projection in females; anterior margin not rimmed, concave in males, protruding in females; vertex smooth, flattened or slightly convex in males, slightly concave in females; **punctures** well defined, deep, small, dense, those near medial edge of eyes and some on sides of vertex and anteriorly on frons with long, yellowish-brown, appressed to erect scales, remainder devoid of scales but with microsetae that are difficult to see with a stereomicroscope; preocular margin obtusely rounded or truncate; supra-antennal brow low, outer surface sloping gradually to eye; postocular margin straight or slightly

convex, rather short. **Labrum** short, about $2\times$ wider than long, almost horizontal, very setose distally; labral suture distinct. Intermandibular projection not discernible. Mandibles triangular, not deep dorsoventrally; **mandibles of males** (Fig. 368, 370, 371) with strong apical tooth directed anteromedially, very large, broad-based, erect, subapical dorsal tooth directed medially, small subapical ventral tooth directed medially, and large, obtusely rounded, almost horizontal, external, basal lobe; **mandibles of females** (Fig. 369) very concave on dorsal surface, slightly angulate externally at base, conspicuously attenuated apically, with large apical tooth, small subapical dorsal tooth, 1 or 2 very small teeth on ventral medial edge and in left mandible a small subapical ventral tooth. **Antennae** (Fig. 372, 373) with slightly arched moderately broad scape; funicle short, broad, 1st segment, about $1.3\times$ longer than wide, 2nd and 3rd segments approximately symmetrical (fused in some males), 4th and 5th segments moderately asymmetrical; club about $1.9\times$ wider than long in males, about $1.3\times$ wider in females, setae dense, shorter than diameters of individual club segments. **Eyes** moderately protruding in females, more strongly protruding in males, width together about $0.6\times$ interocular distance (males) or $0.5\times$ (females). **Mentum** slightly concave; 4th segment of maxillary palp $7.5\text{--}8.0\times$ longer than wide (males) or $6.2\text{--}6.4\times$ (females); 3rd segment of labial palp about $6.4\times$ longer than wide (males) or $4.4\times$ (females).

Thorax. Pronotum (Fig. 374) moderately glossy, $1.6\text{--}1.7\times$ wider than long and $1.5\text{--}1.7\times$ wider than head in males, $1.5\text{--}1.6\times$ wider than long and about $2.0\times$ wider than head in females; punctures well defined, deep, uniformly dense except sparse on glossy median band, small on disc, moderately large on brim, all punctures with conspicuously raised floor; vestiture consisting of large, elongate-oval, yellowish-brown, appressed scales $3\text{--}6\times$ longer than wide, and microsetae mostly not visible with a stereomicroscope; disc slightly convex, surface slightly uneven, with dark, fragmented, non-squamose band on midline and several small, inconspicuous, somewhat bilaterally symmetrical, non-squamose patches towards sides; brim horizontal, very broad; sides sloping gradually from disc; lateral margins weakly serrated, rounded or obtusely angulate near middle, sometimes appearing more angulate than they actually are because of a marginal tuft of scales; hind angles obtuse. **Elytra** about $1.2\times$ wider than pronotum and $1.4\text{--}1.6\times$ longer than wide; punctures small, dense, with conspicuously raised floor; scales like those on pronotum, mainly appressed, but each elytron also with about 12 tufts of erect or suberect paler scales distributed irregularly in about 3 longitudinal rows, giving vestiture a shaggy, unkempt appearance; non-squamose areas very small, somewhat circular; humeral angle low; sutural mar-

gin slightly raised, appearing very “lumpy” on posterior 1/2; elytral declivity sloping gently; sides almost vertical, brim absent except near humeral angle where it is extremely narrow; outer rim almost vertical, with single row of punctures containing very small, curved scales. **Wing** about $2.1\times$ longer than elytron. **Front tibia** (Fig. 375) slightly widened beyond mid dorsal tooth, with 8–12 denticles between mid dorsal and apical teeth and 17–24 denticles between mid dorsal tooth and base; ventral margin almost straight; ventral and lateral setae of protarsomeres 2 and 3 (Fig. 376, 377) directed anteroventrally, absent on about proximal 1/4 of each segment, all about same length, very long. **Middle tibia** with conspicuous mid dorsal tooth but scarcely any denticles dorsally. **Hind tibia** (Fig. 378) slightly curved distally, lacking mid dorsal tooth, denticles if present few in number, extremely small and not clustered near apex. **Prosternum** moderately convex on midline. Mesosternum moderately tuberculate in front of coxae. Metasternum marked off from mesosternum by conspicuous suture; midline area flat; vestiture (Fig. 379) composed of dense, appressed, broad, mostly large scales.

Abdomen. **Ventrites** (Fig. 380, 381) glossy; punctures small dense; scales appressed, extremely narrow near midline of each ventrite, broad on sides; apex of 5th ventrite notched in males, truncate or slightly indented in females.

Male genitalia (Fig. 634–636) symmetrical. **9th abdominal segment** (Fig. 634) slender. **Penis** (Fig. 635, 636) cylindrical, broad; dorsal surface slightly concave; ventral surface slightly convex; base close to proximal end of basal piece; sides with numerous, conspicuous, rather long, oblique grooves near middle; ostium terminal; internal sac broad, with some armature. Tegmen longer than penis. **Parameres** immovable on basal piece but marked off from it dorsally and ventrally by a suture; medial edge of parameres concave, with very narrow flange; long, oblique ridge on dorsal surface near middle of each paramere; tips moderately slender, tapering, slightly curved, directed ventrally. **Basal piece** about 1/3rd length of parameres.

Female genitalia (Fig. 704). **Hemisternites** triangular, moderately broad, with sinuous medial edge; styli slender, slightly curved, about $3\times$ longer than wide. **Bursa copulatrix** broad throughout its length; smaller lobe relatively long; bursal duct long, narrow for only short part of its length (towards median oviduct) then widening so that its juncture with bursa copulatrix is not sharply demarcated. **Spermathecal duct** extremely short, moderately broad, not widened where it joins bursa copulatrix; spermatheca narrow except for spherical apex; spermathecal gland long, duct short, combined length of gland and duct about $6\times$ the length of spermathecal duct.

Type data. Holotype male, length including mandibles 14.6

mm, width 5.9 mm, Rereaia Swamp, BP ($37^{\circ} 36'S$, $178^{\circ} 05'E$), 17 September 1992, G. M. Barker (NZAC). Paratypes See Appendix 2, p. 129.

Material examined Holotype male and 11 paratypes (7 males, 4 females) (LUNZ, NZAC).

Distribution (Map 17). Northernmost record: Lottin Point, Otanga, BP (latitude $37^{\circ} 32'S$); southernmost records: Orete Forest, Te Puia Hut, BP and Kakanui, GB, (both latitude $37^{\circ} 39'S$), from near sea level to about 300 m.

BP, GB / —

Biology. Adults have been collected in February, March, April, September, and October in rotten logs and in a pit-fall trap. The pupa from which an adult emerged in March 1993 was collected in February 1993.

Remarks. *Mitophyllus solox* is known from only a few specimens collected at several East Cape localities. It is very similar in size and colour to *M. falcatus* and *M. parrianus*. Distinctive features in both males and females are the long, similar-sized setae on the 2nd and 3rd protarsomeres, the greatly reduced non-squamose areas on the pronotum, including the fragmented non-squamose band on the midline, the shaggy, untidy-looking vestiture and very small non-squamose patches on the elytra, and the broad scales on the metasternum. The mandibles of *solox* males have some resemblance to those of *parrianus* but the male genitalia are more like those in *falcatus*, mainly because of the narrow flange on the medial edge of the parameres and the strong, oblique ridges on the sides of the penis. Genitalic similarities in the female genitalia of *solox* and *falcatus* are apparent in the shape of the hemisternites. Compared with those of *falcatus* and *parrianus* the mandibles of *solox* females are attenuated apically but this difference may not be appreciated in the absence of comparative material.

Etymology. The specific epithet is a latin word meaning unkempt and draws attention to the shaggy appearance of the elytral vestiture.

Subfamily LAMPRIMINAE MacLeay, 1819: 97

The key to the subfamily is on **page 26**.

RECOGNITION CHARACTERS OF LAMPRIMINAE IN NEW ZEALAND Large, rather convex; integument chocolate-brown or shades of green and bronze; length including mandibles 17–32 mm. Antennae partially geniculate or not geniculate; scape smooth, not with longitudinal dorsal groove, but a posterodorsal groove may be present; club composed of 3 stout, pilose segments. Eyes not divided by canthus. Maxillae with lacinia terminating in a sclerotised hook or pointed blade. Mentum not covering base of 1st segment of labial palp. Paired elements of prementum strongly sclerotised, ring-like, located on apex of mentum, and visible in ventral aspect. Mandibles of females with basal ventral tooth. Legs robust; front tibia broad, expanding conspicuously from base to apex. Elytra ribbed or smooth, their vestiture consisting of sparse, inconspicuous, narrow scales with an associated pore close to base (visible only with SEM). Wings fully developed. Male genitalia with pair of short struts articulating on base of penis; basal piece cylindrical, enclosing much of penis; internal sac eversible, flagellate; parameres short. Female genitalia with hemisternites and elements of 9th segment strongly sclerotised; styli present, narrow or broad, with strong apical setae; spermatheca not very curved, not annulate; bursal duct absent.

For information on the worldwide composition and distribution of the subfamily **see page 17**.

Of the two lamprimine genera recorded from New Zealand, *Dendroblax* is endemic and monotypic, and *Lamprima*, an Australian genus, is very doubtfully established, being known at present from a single specimen of *L. aurata*. A key to these genera is **on page 27**.

Genus *Dendroblax* White

White, 1846: 9. Broun 1880: 250. Holloway 1961: 11. Type species *Dendroblax earlii* White, by monotypy.

Diagnosis. Large, convex, scarabaeid-like lamprimines (length including mandibles 17–28 mm) with dark brown or reddish-brown integument. Sexual dimorphism slight; no appreciable allometry. Head small. Mandibles very similar in males and females, not ornate. Legs robust, fossorial. Punctures (pits) on dorsal surface dense, large, deeply concave, containing a minute, colourless seta; punctures on ventral surface mostly small, very dense, containing long, silky, fulvous hairs.

Redescription

Head. **Anterior margin** shallowly indented or straight. Preocular margin short, not laminate. **Mandibles** about the same in males and females, short, coarsely punctate,

deep dorsoventrally, consisting of a broad, somewhat triangular dorsal tooth, excavated above and lacking cusps, and a small inwardly directed basal ventral tooth. Maxillae with very short galea; lacinia with a few small spines below sclerotised, curved apical blade. **Mentum** small, approximately semicircular, very setose. Ligula small, not very setose. Intermandibular projection short, broad, directed ventrally or anteroventrally, not concave. Labral suture present; labrum long, narrow, almost vertical, with rounded apex. **Antennae** very similar in males and females; the 3 club segments stout, opposable, with short fine hairs and a few long setae. Supra-antennal brow prominent. **Eyes** large, protruding, evenly convex in dorsal aspect. Postocular margin extremely short, not lobed.

Thorax. **Pronotum** wider than long; front angles obtuse, not prominent; disc not tuberculate; sides serrated, with or without upturned rim; brim present anteriorly; hind angles acute to obtuse. Scutellum triangular, wider than long. **Elytra** parallel-sided; outer margin with low, sparsely punctate rim and very few setae; integument adjacent to rim not forming brim; striae not discernible on dorsal surface (but visible on ventral surface of elytron); each elytron with 3 or 4 prominent, sparsely punctate, broad, longitudinal ribs alternating with densely punctate, broad, depressed areas; elytral punctures (pits) large, containing a minute standing seta with a pore close to its base (visible only with SEM). **Wings** fully developed. **Prosternal process** narrow, concealed by procoxae. Mesosternal process narrow. **Legs** stout and fossorial; procoxal process moderately large; femora with mostly dense punctures containing long, suberect, yellow or orange hairs; front femur robust, about 1.7× longer than wide, setiferous patch well defined, large, punctate over entire surface and reaching beyond the middle of segment; tibial hairs long, yellow or orange, mostly aligned in rows, not in grooves; front tibia broad, variably arched, with very few teeth, spur conical; middle and hind tibiae conspicuously expanded distally, with several large, spine-like teeth dorsally and lacking setiferous patches; ventral surface of 1st–4th tarsomeres with an apical row of long setae; **arolium** with cluster of 3–12 setae on either side of apex.

Abdomen. Lateral margins of ventrites not flanged; distal margin of **5th ventrite** dimorphic distinctly convex in females, truncate or slightly convex in males.

Male genitalia. **9th abdominal segment** symmetrical, rather slender; sternite broad, its distal margin entire and setose. **Tegmen** (basal piece plus parameres) symmetrical; parameres continuous with basal piece ventrally but separated from it dorsally by rigid membrane. **Basal piece** long, narrow, cylindrical; ventral surface undivided and almost uniformly sclerotised; dorsal surface divided on

midline, proximal 1/2 membranous. **Parameres** much shorter than basal piece, somewhat conical; marginal microtrichia and setae inconspicuous; medial surface not flanged; parameres connected to base of penis by pair of sclerotised plates. **Penis** symmetrical, moderately long, straight, cylindrical, strongly sclerotised, with proximal crossbars dorsally and ventrally, its apex not reaching as far as tips of parameres; ostium terminal; internal sac very long, with spinules and scales on part of its length, becoming narrow and flagellate distally, terminating in a minute hook. Struts deep dorsoventrally, articulating on proximal end of penis.

Female genitalia. **Hemisternites** elongate; styli slender with long apical setae. **Accessory gland** small, elongate. **Bursa copulatrix** and spermathecal duct not separately recognisable, instead combined in strongly sclerotised, broad tube. **Spermatheca** very large, slightly crescentic, broad basally, tapering to a point distally. Spermathecal gland very small, conspicuously demarcated from its duct, combined length of gland and duct much less than length of spermatheca.

Range. New Zealand.

Remarks. *Dendrobax* is related to *Lamprima* Latreille from Australia, Tasmania, Lord Howe I, Norfolk I, and New Guinea, and *Streptocerus* Fairmaire from Chile. It stands out from these by its strong superficial resemblance to a burrowing scarabaeid beetle. For descriptions and illustrations of the male and female genitalia and some external features of *Dendrobax* and *Lamprima*, in addition to those provided in this revision, and of *Streptocerus* see Holloway (1960). It is especially interesting to compare the different development of the accessory gland and bursa copulatrix in the female genitalia of these three genera, both structures being large in *Streptocerus*, smaller in *Lamprima*, and very small (the bursa copulatrix is actually indistinguishable) in *Dendrobax* (Holloway 1960, fig. 18, 28, 37). For a summary of these and some other character states among the three genera see Appendix 3A, p. 130.

Dendrobax has a single species that is widely distributed in New Zealand.

***Dendrobax earlii* White Earl's stag beetle**

Fig. 12, 14, 20, 21, 31, 52, 61, 63, 79, 124, 125, 382–390, 637–639, 705. Map 18

earlii White, 1846: 9, pl 2, fig. 9, 10 (as *Dendrobax Earlii*, *Dendrobax Earlianus*, and *Dendrobax Earlianus*). Westwood 1855: 213 (*Dendrobax Earlianus*). Broun 1880: 251 (*Dendrobax earlii*). (Roon, 1910: 6 (*Dendrobax Earlei*). Hudson 1934 162 (*Dendrobax earlianus*). Arrow 1935: 122 (*Dendrobax earlei*). Benesh 1960: 44 (*Dendrobax earlei*). Holloway 1960: 329, fig. 19–28 (*Dendrobax earlii*); 1961: 12, frontispiece 1, fig.

3, 8, 11, 16, 20, 21, 97–103 (*Dendrobax earlii*); 1963b: 104, fig. 15, 24 (*Dendrobax earlii*); 1997: 51, fig. 1, 33, 34 (*Dendrobax earli*).

acutangulus Arrow, 1935: 122. Holloway 1961: 13 (synonym of *D. earlii*). Bacchus 1978: 108 (lectotype designation).

See Benesh (1960) for additional references.

Diagnosis. Length: males (including mandibles) 17.6–25.6 mm, (excluding mandibles) 16.5–24.2 mm; females (including mandibles) 19.2–27.4 mm, (excluding mandibles) 18.1–26.2 mm. Width: males 9.0–12.6 mm; females 9.6–13.8 mm. Large, convex, dark brown, scarabaeid-like lamprimitives with fossorial legs (Fig. 79, 124, 125).

Redescription (in addition to features given in the generic redescription)

Head (Fig. 382, 383) wider than long, widest across eyes. **Dorsal surface** glossy; frons and vertex irregularly convex to deeply concave; preocular margin varying from obtusely rounded to acutely and sharply angulate; supra-antennal brow slightly to prominently arched, sometimes tuberculate. **Mandibles** with dorsal tooth deeply concave dorsally, outer edge gently rounded in males, more prominently convex in females, medial edge weakly toothed near base; basal ventral tooth in males (Fig. 384) short, not extending forward as far as the apex of dorsal tooth, and only slightly incurved, in females (Fig. 385) long, extending forwards at least to apex of dorsal tooth, and strongly incurved. **Antennae** rather similar in males and females; funicle segments showing considerable variation in size, especially in length of 2nd segment, and extent of asymmetry in 4th and 5th segments (Fig. 20, 386, 387); club 1.0–1.2× longer than wide. **Eyes** strongly protruding in males, less protruding in females, width together about 0.6× interocular distance (males) or 0.5× (females). Maxilla (Fig. 14) with 4th segment of palp not conspicuously dilated. Labium (Fig. 12) with 3rd segment of palp slightly dilated in males, strongly dilated in females.

Thorax. Pronotum 1.5–1.7× wider than long and 2.1–2.3× wider than head; sides prominently and obtusely angulate near middle, fringed with long fulvous hairs; hind angles blunt to spiniform; posterior margin with conspicuous fringe of long fulvous hairs overhanging bases of elytra and scutellum. **Elytra** 1.2–1.3× wider than pronotum, 1.2–1.3× longer than wide; punctures (pits), vestiture, and pores as in Fig. 21 and 31. **Wing** about 1.6× longer than elytron (Holloway 1963b, fig. 15). Prosternal process (Fig. 52) narrow; procoxal process moderately large; procoxal fringe and profemoral setiferous patch as in Fig 61. Femora with mostly dense punctures containing long, suberect, yellow or orange hairs. Tibial hairs long, yellow or orange, aligned in rows but not in grooves; **front tibia** (Fig. 63, 388) broad, variably arched, its spur conical; **middle** and **hind tibiae**

as in Fig. 389 and 390. Ventral surface of protasomeres 1–4 with apical row of long setae; arolium (Fig. 63) with cluster of 3–12 setae on either side of apex.

Abdomen

Male genitalia as in Fig. 637–639. For additional illustrations see Holloway (1960 fig. 22–26).

Female genitalia as in Fig. 705.

Type data. White described *Dendroblox earlii* from two specimens collected “on the Hutt River, Port Nicholson [WN (41° 14’S, 174° 54’E)] by Mr Earl.” The lectotype, sex undetermined, is in the BMNH. The whereabouts of the second specimen are unknown.

The description of *Dendroblox acutangulus* Arrow was based on five specimens collected in Greymouth BR (42° 27’S, 171° 12’E) by Mr Helms. They were sent to Dr David Sharp who identified them as *D. earlei* [sic] and it was in Sharp’s collection that Arrow found them. The lectotype was designated by Bacchus (1978) and is in the BMNH.

Material examined. Lectotype (sex undetermined) of *D. earlii*, lectotype male and 3 female paralectotypes of *D. acutangulus*, and 70 non-type specimens (28 males, 42 females). (AMNZ, BMNH, LUNZ, MONZ, NZAC).

Distribution (Map 18). Northernmost record: Mokohinau I., ND (latitude 35° 50’S); southernmost record: Ben Lomond, OL (latitude 45° 01’S), from near sea level to about 600 m.

ND (including Mokohinau I), CL, AK, WO, BP, GB, TO, TK, RI, WI, WA, WN / NN, BR, OL

Biology. Adults have been collected in forests, paddocks, and gardens from September to May. They fly freely at dusk (Hudson 1934) and in the evening. Westwood (1855) stated that females are apterous but those I have studied have normal wings, and the material examined includes two females that flew to mercury vapour lamps set up to attract moths, and two others caught in a Malaise trap. In my earlier revision (Holloway 1961) I suggested that the larvae probably live in soil and perhaps feed on grass roots. That they are in fact soil inhabiting has now been confirmed by the rearing of an adult female from a fully grown larva found in a pupation chamber in soil in a paddock at Te Awamutu (WA). The larva was collected on 20 September 1983 and the adult emerged on 2 March 1984. The rearing was carried out at the Lynfield Research Centre, Auckland and the adult and its immature remains are in NZAC. Whether the larvae feed on grass roots or soil is still unknown. Hosking (1971) found larvae of what he assumed were those of *D. earlii*, because of their association with fragments of an adult, in buried sections of decaying hardwood telephone poles at Te Pohue (HB). He attempted to rear the specimens but on examining the wood

after it had been in the laboratory for nine months found that they all had died. The fact that one larva had extended its tunnel for a distance of 10 cm through sound wood and that there was earlier evidence of larvae having fed on similar sound wood suggests that they may have belonged to another lucanid, perhaps *Syndesus cornutus*. Nothing is currently known about the feeding behaviour of *D. earlii* adults. I could not find any identifiable material in the hindgut of specimens that I dissected.

Remarks. Adults of this species show an exceptional amount of individual variation in the form of the antennae, elevation of the frons, shape of the pronotum and, in males, the width of the front tibiae. As well, several specimens in the material examined have the antennae and maxillary palps severely malformed.

Genus *Lamprima* Latreille

Latreille, 1807: 132. Type species *Lethrus aeneus* Fabricius, 1792, by monotypy.

See Moore & Cassis (1992) for additional information.

The diagnosis and redescription given below are based on *L. adolphinae* (Gestro, 1875), *L. aurata* Latreille, 1817, and *L. latreillei* MacLeay, 1819.

Diagnosis. Large lamprimines (length including mandibles 19–32 mm) with glossy or dull integument ranging in colour from bronze to shades of green, red, or blue. Sexual dimorphism conspicuous, allometry inconspicuous. Head small. Mandibles very long and almost straight in males, short and approximately triangular in females. Front legs slender or fossorial, with a fan-shaped apical spur in males; middle and hind legs rather slender. Punctures (pits) on dorsal surface mostly sparse, small to moderately large, denser and larger on head and pronotum, each containing a minute, simple seta; punctures on ventral surface mostly dense, moderately large, containing long, cream, decumbent hairs.

Redescription

Head. Anterior margin truncate or indented. Preocular margin short, slightly angulate, not laminate. **Mandibles** of males long, barely curved, parallel-sided, with upturned apex and a few dorsal cusps, medial surface variably toothed, with very dense yellow hairs; mandibles of females short, deep, somewhat triangular with conspicuous, inwardly-directed basal ventral tooth, a few dorsal cusps, and inconspicuous setae on medial surface. Maxilla with moderately long galea; apex of lacinia strongly sclerotised, straight in males, hooked in females; galea and lacinia with hooklets on medial edge in females, without hooklets in males. Mentum small, somewhat hemispherical, setose. Ligula large, bilobed, very setose. Intermandibular projection long, broad, concave proximally, convex distally, almost vertical. Labral

suture present; labrum long, narrow, almost vertical, apex rounded. **Antennae** rather similar in males and females, not geniculate; the 3 club segments stout, opposable, with pubescence and a few long setae. Supra-antennal brow prominent. **Eyes** moderately large, slightly protruding, unevenly convex in dorsal aspect. Postocular margins short, lobed.

Thorax. Pronotum wider than long; front angles obtuse, not prominent; disc not tuberculate; sides in males with narrow, almost horizontal, weakly punctate, smooth or weakly serrated rim and adjacent narrow brim; sides in females serrated at least anteriorly, without brim. Scutellum triangular, slightly wider than long. **Elytra** smooth, sides slightly convergent posteriorly; outer margin with smooth, narrow rim and very few setae; integument adjacent to rim forming very narrow brim; striae not discernible on dorsal surface (but visible on underside of elytron); elytral punctures (pits) rather small, sparse, shallow, uniformly distributed, containing a minute decumbent seta with a pore close to its base (visible only with SEM). **Wings** fully developed. **Prosternal** process narrow, concealed by procoxae. Mesosternal process broad. **Legs** rather elongate, slender or stout; procoxal process large; femoral punctures mostly sparse with appressed to erect simple setae; front femur robust, 2–3× longer than wide, its setiferous patch well defined, large, punctate over entire surface, reaching slightly beyond middle of segment; tibial vestiture moderately long, aligned in well defined rows, sometimes in grooves; front tibia slender or fossorial, variably arched, its spur large and fan-shaped in males, small and conical in females; middle and hind tibiae smooth or spiny, not fossorial, lacking setiferous sex patches; ventral surface of protarsomeres 1–4 with apical or subapical row of long setae; **arolium** with tuft of about 7 setae on either side of apex.

Abdomen. Sides of ventrites not flanged; distal margin of **5th ventrite** slightly concave in males, slightly convex in females.

Male genitalia. 9th abdominal segment symmetrical, rather slender; sternite broad, its distal margin entire and not setose. **Tegmen** symmetrical; parameres separated from basal piece dorsally and ventrally by rigid membrane. **Basal piece** long, narrow, cylindrical, uniformly sclerotised dorsally and ventrally throughout its length. **Parameres** much shorter than basal piece, somewhat laminate, connected to base of penis by pair of sclerotised plates; outer surface with microtrichia and setae; medial surface with an obliquely longitudinal, strongly sclerotised, ribbed flange. **Penis** symmetrical, very long, straight, cylindrical, strongly sclerotised, with proximal crossbars dorsally and ventrally, its apex not reaching as far as tips of parameres; ostium terminal; internal sac long, coiled, clothed with very

fine spinules, terminating in long flagellum. Struts deep dorsoventrally, articulating laterally on proximal end of penis.

Female genitalia. Hemisternites moderately long; styli short, their apex broad, with short setae. **Accessory gland** relatively large, saccate. **Bursa copulatrix** narrow, rigid, tapering towards spermathecal duct which is very long, narrow, coiled, and rigid. **Spermatheca** small, rigid, narrow, almost straight. Spermathecal gland very small, conspicuously demarcated from its duct; combined length of duct and gland much less than length of spermatheca.

Range. The natural range of *Lamprima* is Australia (including Tasmania), Norfolk I, Lord Howe I, and New Guinea.

Remarks. Five of the 8 recognised species of *Lamprima* are from Australia and Tasmania. Because of infraspecific variation in size and colour most of the species have several synonyms (Moore & Cassis 1992). See Holloway (1960) for illustrations and descriptions of the genitalia and mouthparts of *L. latreillei*. A summary of some character states among *Lamprima*, *Dendroblox*, and *Streptocerus* is given in Appendix 3A, p. 130. *Lamprima* is known in New Zealand from a single male of *L. aurata*, a common species in eastern Australia and Tasmania.

Lamprima aurata Latreille

Fig. 22, 32, 80, 126, 127, 391–396. Map 19

aurata Latreille, 1817: 278. Holloway 1997: 51 (New Zealand record).

For synonymy and additional references see Benesh (1960) and Moore & Cassis (1992).

Diagnosis (in the context of the New Zealand lucanid fauna, not necessarily in relation to the other *Lamprima* species). Length: males (including mandibles) 19.8–31.7 mm, (excluding mandibles) 17.3–25.6 mm; females (including mandibles) 19.5–25.6 mm (excluding mandibles) 18.1–24.2 mm. Width: males 7.8–12.3 mm; females 8.3–11.7 mm. Body (Fig. 80, 126, 127) large, broad, green, bronze or blue with rather smooth elytra and robust front legs. Males with dense yellow setae on medial surface of mandibles.

Redescription. This summary of morphological features is additional to the generic redescription.

Head (Fig. 80, 391). Frons and vertex of females more densely and coarsely punctate than in males. **Mandibles of males** with 2 or 3 erect apical teeth and 1–3 irregularly shaped, inwardly directed subapical ventral cusps. **Mandibles of females** with inwardly directed apical dorsal tooth, erect, blunt, basal dorsal tooth, and sharply pointed, inwardly directed basal ventral tooth (Fig. 392). **Antennae** (Fig. 393, 394); funicle segments in females shorter

and more robust than in males and more conspicuously asymmetrical; club about 1.1× wider than long. Maxillary palp and labium similar to those in *L. latreillei* (Holloway 1960, fig. 12–14).

Thorax. Lateral margin of pronotum smooth in males, serrated over most of its length in females. **Front tibia** fossorial; narrow proximally, very broad distally, with large triangular spur in males (Fig. 395), broad proximally, gradually widening distally, with short conical spur in females (Fig. 396); dorsal margin with 5–9 teeth. **Middle and hind tibiae** with 4–8 spines dorsally, larger and more numerous in females. Elytral punctures and vestiture as in Fig. 22 and 32.

Abdomen.

Male genitalia similar to those in *L. latreillei* (Holloway 1960, fig. 15–17).

Female genitalia similar to those in *L. latreillei* (Holloway 1960, fig. 18).

Type data. Holotype not examined. I am indebted to Dr B. P. Moore for confirming the identity of the New Zealand specimen, and to Dr G. F. Bournemissza for sending identified males and females of *L. aurata*. Moore & Cassis (1992) give the type locality of the species as Australia (as Nouvelle-Hollande) with no other details.

Material examined. 1 male from New Zealand and 38 specimens (25 males, 13 females) from Tasmania and eastern Australia (NZAC).

Distribution (New Zealand record Map 19). Near Puha, GB (38° 27'S, 177° 50'E), approximately 28 km NW of Gisborne. Near sea level.

GB? / —

Remarks. The New Zealand specimen was found alive on a farm track in daytime on 11 January 1990 by Dr Stuart Davis, Field Research Scientist for Watties Frozen Foods, Gisborne. Whether *L. aurata* is established in New Zealand is unknown but if so, it will be easily recognised in the field by its large size and brilliant colour. Dr Bournemissza has kindly provided the following information about this species in Australia and Tasmania: “They breed in logs or at the base of dead trunks of gums, she-oaks, and even exotic dead trees, etc. Strangely they also turn up in heaps of sawdust around sawmills. In all situations, however, a certain type of decomposition is present, recognisable with a fungal smell and discoloration of the timber/sawdust concerned. Adults, especially females, do nibble on gumtips but the “damage” is hardly worth registering.”

Subfamily SYNDESINAE MacLeay, 1819: 103

The key to the subfamily is on page 26.

RECOGNITION CHARACTERS OF SYNDESINAE IN NEW ZEALAND Small to medium-sized, reddish-brown to almost black, glossy, convex, parallel-sided; length including mandibles 9–14 mm. Antennae non-geniculate; scape lacking dorsal or posterodorsal longitudinal groove with associated row or group of setae; club 7-segmented. Eyes entire, not divided by a canthus. Maxillae lacking hooks and hooklets. Mentum not covering base of 1st segment of labial palp. Paired elements of prementum strongly sclerotised, ring-like, located on apex of mentum and visible in ventral aspect. Mandibles elongate, not laterally curved, not with basal ventral tooth. Legs slender, not fossorial. Elytra with alternating rows of grooves and ribs, grooves containing row of large, evenly spaced punctures with minute, elongate, thread-like, horizontal setae in their anterior wall, ribs dotted with small, unevenly distributed punctures containing a centrally placed, minute, short, broad, erect seta. Wings fully developed. Male genitalia with pair of moderately long struts articulating somewhat dorsally on base of penis; internal sac eversible, not flagellate; parameres long. Female genitalia with hemisternites and 9th abdominal segments moderately sclerotised; styli narrow with long apical setae; spermatheca strongly curved, partly annulate; bursal duct indistinguishable.

The subfamily has 25 species placed in 3 genera: *Syndesus* Macleay, 1819 in Australia, New Guinea, Brazil, and Ecuador, and *Ceruchus* MacLeay, 1819 and *Sinodendron* Hellwig, 1792, both in the Holarctic region (Lawrence & Newton 1995; Bartolozzi *et al.* 1998). It is represented in New Zealand by the accidentally introduced Australian species, *Syndesus cornutus*. For illustrations and descriptions of the main morphological features of *Ceruchus* see Holloway (1960) and of *Syndesus* and *Sinodendron* see Holloway (1968).

Genus *Syndesus* MacLeay

MacLeay, 1819: 104. Type species *Sinodendron cornutus*

Fabricius, 1801, by monotypy.

See Benesh (1960) for additional references and synonymy.

Diagnosis based on *Syndesus cornutus* and in addition to characters given for subfamily. Small reddish-brown parallel-sided syndesines (Fig. 81, 128, 129) showing conspicuous sexual dimorphism; allometry insignificant. Punctures circular, sharply defined, deep. Elytral vestiture inconspicuous, consisting of minute fine setae with divided tips, some with barbed sides (Fig. 23, 33). Head very short. Pronotum with a median tubercle on or close to anterior margin.

Redescription

See Appendix 4 (p. 132) for previously published illustrations including the mouthparts and male and female genitalia.

Head. **Anterior margin** deeply indented; sides not laminate; postocular margin short, straight. Labrum not distinct. Intermandibular projection long, narrow, directed anteroventrally. Mentum small, inconspicuous, wider than long; ligula narrow, undivided, with few setae. **Mandibles** elongate, not curved, straight sided on medial edge, angulate dorsolaterally, not conspicuously setose. **Antennae** rather similar in both sexes; the 7 club segments slender, loose, pubescent. **Eyes** very large, protruding, evenly convex in dorsal aspect.

Thorax. **Pronotum** quadrangular, somewhat flattened, wider than long, uniformly covered with dense, small, circular punctures containing minute erect setae, many punctures containing mounds of exudate; front angles obtuse, not prominent; hind angles obtuse; sides with narrow, almost horizontal, punctate, irregularly serrated rim; integument adjacent to rim horizontal; disc depressed on midline with conical, horizontal, tubercle rounded or truncate apically present near anterior margin and overhanging base of head. Scutellum about as wide as long. **Elytra** moderately convex; outer margin with horizontal, punctate rim, punctures containing minute, curved, simple setae; integument adjacent to rim not forming brim. **Prosternal and mesosternal processes** narrow. **Legs** rather short and stout; procoxal process moderately large; femora with dense punctures containing appressed simple setae; front femur about 2× longer than wide, setiferous patch well defined, large, punctate over most of surface and reaching well beyond middle of segment; tibial vestiture aligned in poorly defined rows, not associated with grooves; front tibia dentate along entire dorsal margin; middle and hind tibiae spiny, lacking setiferous patches, ventral surface of protarsomeres 1–4 with very long setae, mainly on distal 1/2 of segments; arolium with 1 seta on either side of apex.

Abdomen. Sides of ventrites not flanged; distal margin of **5th ventrite** truncate in males, slightly rounded in females.

Male genitalia symmetrical. **9th abdominal segment** robust; distal margin of sternite entire, setose. **Basal piece** of tegmen strongly sclerotised, short, broad, surrounding struts and proximal 1/2 of penis. **Parameres** large, somewhat leaf-like, lacking marginal hairs and microsetae, connected to basal piece by rigid membrane. **Penis** elongate, bulbous; base curved slightly towards dorsal surface and lacking crossbars; distal dorsal edge with large recurved hook; eversible internal sac clothed with fine spinules; ostium large and terminal.

Female genitalia. **Hemisternites** long, slender; styli elongate. **Accessory gland** large, bulbous. **Bursa**

copulatrix lacking duct, extremely long, uniformly narrow, with close, fine transverse grooves throughout its length. **Spermatheca** large, colourless but rigid, sessile near end of bursa copulatrix; spermathecal gland somewhat oval, with well defined duct entering apex of spermatheca.

Remarks. *Syndesus* stands out in the New Zealand lucanid fauna as the only genus with a 7-segmented antennal club and deep, punctate grooves on the elytra. These two features also set it apart from the other syndesine genera, *Ceruchus* and *Sinodendron*, which have a 3-segmented club and smooth elytra.

Syndesus cornutus (Fabricius)

Fig. 23, 33, 81, 128, 129, 397–400. Appendix 4. Map 20 Fabricius, 1801: 377 (*Sinodendron*). MacLeay 1819: 104 (*Syndesus*).

Diagnosis. See generic diagnosis. Length: males (including mandibles) 9.6–14.1 mm, (excluding mandibles) 8.5–12.2 mm; females (including mandibles) 10.1–11.2 mm, (excluding mandibles) 9.5–10.7 mm. Width: males 3.7–5.3 mm; females 3.8–4.5 mm.

Head (Fig. 81, 128, 129, 397, 398). Supra-antennal brow with conical protuberance, low and blunt in males, large and sharply pointed in females. **Mandibles** of males and females simple, with a long, erect apical tooth; males additionally with large, erect, laterodorsal subapical tooth, females with very small, dorsolateral projection towards base. **Antennae** (Fig. 399) similar in males and females except the club is 1.1–1.2× longer than wide in males and 1.3–1.5× longer than wide in females. Maxilla and labium, see Appendix 4.

Thorax. Median protuberance on anterior margin of pronotum long in males, shorter in females. **Front tibia** (Fig. 400) approximately the same in males and females, dorsal edge with 14–17 teeth. **Middle** and **hind tibiae** with numerous variably-sized spines on dorsal surface. Elytral punctures and vestiture as in Fig. 23 and 33; all setae with multi-incised apices, those in groove punctures with barbed sides. **Wings** fully developed.

Abdomen

Male genitalia, see Appendix 4, p. 132.

Female genitalia, see Appendix 4, p. 132.

Type data. Moore & Cassis (1992) record the type locality as Tasmania and the status and whereabouts of the type as unknown.

Material examined. 41 non-type specimens from New Zealand (30 males, 11 females) and 2 specimens from Australia (NZAC).

Distribution (Map 20). Northernmost record: Whangarei, ND (latitude 38° 41'S); southernmost record in the North Island: Gisborne, GB (latitude 38° 40'S), near sea level.

ND, CL (Mayor I), AK, WO, BP, GB / — / CH?

The Chatham I. record is based on a single specimen found at Waitangi (43°57'S, 176° 33'W) (Emberson 1998) in a hardwood pole. It seems likely that it was taken to the Chathams accidentally on this timber and has not become established there (Emberson personal communication).

Biology. Adults have been collected in New Zealand from January to May. They were collected in or on pine, eucalyptus and macrocarpa logs and branches, in rotting floorboards, and in an oak post. Adults fly at dusk and during the evening and are attracted to lights. A pair was taken *in copula* on 30 April 1982. Larvae found in a rotting post in late October 1990 emerged as adults during February 1991.

Remarks. *Syndesus cornutus* is easily recognised by its 7-segmented antennal club, glossy, usually reddish-brown integument, long, straight, simple mandibles and its conspicuously ridged and grooved elytra. The minute hair inside each of the groove punctures is set in the anterior wall of the puncture and lies almost horizontally across it but setae and minute hairs elsewhere on the integument are erect and arise near the middle of the floor of their punctures.

Syndesus cornutus was first collected in New Zealand in 1961 at two widely separated localities, Gisborne and the Auckland suburb of Mt Albert (May 1963). The species is relatively common on the entire eastern coast of Australia where larvae and adults have been taken together in structural timber that had been attacked by a brown rot fungus (Lawrence 1981b). As the earliest known New Zealand specimens were collected near ports the species almost certainly arrived here in timber shipments, either as immatures and adults inside logs or as stowaway adults attracted to lights on ships in Australian ports.

Larvae have been described and illustrated by Alderson (1975), and by Lawrence (1981a) who points out that in Alderson's paper the stridulatory organs of the larva are shown in Fig. 25, not in Fig. 26 as labelled on the plate.

Subfamily LUCANINAE Latreille, 1804a: 149

The key to the subfamily is on page 26.

RECOGNITION CHARACTERS OF NEW ZEALAND LUCANINAE Small to very large black or brown lucanids, some species exhibiting conspicuous sexual dimorphism and allometry; length including mandibles 9.0–55.0 mm. Antennae geniculate; scape without dorsal or posterodorsal longitudinal groove and associated row or group of setae; club moderately deep, with 3 or 6 non-opposable segments. Eyes partially or completely divided by canthus. Maxillae with or without lacinial hook. Mentum covering base of 1st segment of labial palp. Paired elements of

prementum weakly sclerotised, located near middle or base of mentum, not visible in ventral aspect. Legs rather stout, sometimes fossorial. Elytra ridged, indented, or smooth; vestiture squamose or setose, sometimes distinctively patterned. Wings vestigial in endemic species, fully developed in foreign species. Male genitalia with penis articulating on distal margin of basal piece, not surrounded by it; pair of struts articulating on base of penis; internal sac permanently everted, strap-shaped over much of length, either expanding or narrowing distally, not flagellate; parameres lamellate or thickened, rounded or truncate apically. Female genitalia strongly sclerotised; styli present and spermatheca crescentic in endemic species, styli absent and spermatheca bulbous or multilobed in foreign species.

Nineteen species of Lucaninae have been found in New Zealand. Seventeen of these are in the endemic genera *Geodorcus* Holloway and *Paralissotes* Holloway, one species, accidentally introduced from Australia and established here belongs in *Ryssonotus* Kirby, and the remaining species, probably brought in deliberately and unlikely to be established, is *Serrognathus sika* (Kriesche) from Taiwan. A key for separating the genera is on page 27.

For information on the relationships of the endemic genera see page 17.

Genus *Geodorcus* Holloway

Holloway, 1996: 61. Type species *Lucanus novaezealandiae* Hope, 1845, by original designation.

Diagnosis. Small to very large, vestigial winged lucanines (length including mandibles 11.5–45.0 mm) showing conspicuous sexual dimorphism, and allometric growth in males. Integument dark brown or black, dull to glossy, variably punctured; punctures (pits) shallow, saucer-shaped, with well defined margins and polygonally sculptured walls and floor; integument adjacent to pits also polygonally sculptured. Vestiture on dorsal surface consisting of short to long, yellow or brown, erect to decumbent, short-stalked, dendritic setae with numerous tapering, pointed, smooth-sided branches of varying lengths. Front margin of head straight or slightly protruding; middle 1/3rd not indented. Eyes partially divided anteriorly by canthus. Antennal club 3-segmented. Lacinia of maxilla with sclerotised apical hook in females but not in males. Elytra with distinct or fragmentary longitudinal ribs. Front tibia expanding slightly or strongly from base to apex. Male genitalia not flagellate, instead with broad, smooth-surfaced, permanently everted internal sac terminating in wide, cup- or spoon-shaped structure. Female genitalia with styli, large accessory gland, and a very large saccate bursa copulatrix that has a short, tapered lateral lobe continuous with spermathecal duct.

Redescription

Head. **Anterior margin** straight or undulating, not deeply indented, not rimmed, not tuberculate; preocular margin long, often laminate. **Mandibles** in males large, straight-sided or laterally curved, often ornately toothed, usually small and simple in females; surface finely to coarsely punctate with few or no setae. Maxillae with well developed galea and lacinia; apex of lacinia sclerotised, straight in males, hooked in females. Mentum much wider than long; punctures sparse and fine in large males, dense and coarse in females and small males. Ligula well developed, deeply divided on midline. Intermandibular projection very short or absent. Labral suture present; labrum short, broad, directed anteroventrally, with few setae, its apex straight or rounded or trilobed. Frons concave to slightly convex, not tuberculate. **Antennae** very similar in males and females; club with 3 stout, opposable, extensively pubescent segments. Supra-antennal brow short, not strongly arched. **Eyes** small, barely or not protruding, less conspicuous in males, slightly to almost completely divided by anterior canthus, sometimes with short posterior canthus. Postocular margin long, tuberculate or lobed in males, straight or lobed in females.

Thorax. **Pronotum** wider than long; front angles acute to obtuse, not prominent; disc smooth, not tuberculate, sides descending gradually; lateral margin upturned, rimmed, punctate, setose, not serrated; integument adjacent to rim depressed, forming shallow channel; hind angles obtuse, blunt or sharp. Scutellum wider than long, triangular or semicircular. **Elytra** with sides parallel or rounded; outer margin with upturned, punctate rim, at least some punctures with erect, branched setae; integument adjacent to rim stretched laterally and depressed to form brim containing enlarged, distorted punctures and transverse folds, especially anteriorly; striae punctures indistinct on dorsal surface but discernible on underside of elytron; each elytron with up to 7 variably developed, low, longitudinal ribs or traces of these, separated by flattened integumental bands often with punctures and setae different from those on ribs. **Wings** vestigial. **Prosternal** and **mesosternal processes** broad. **Legs** varying from long and slender to short and stout, usually relatively longer in large males; procoxal process absent; femora with moderately dense, coarse or fine punctures, some containing appressed or standing, simple or branched setae; front femur robust, about 2× longer than wide, setiferous patch well defined, large, reaching approximately to middle of segment and punctate over most of surface; tibiae with about 7 longitudinal rows, sometimes excavated as grooves, containing either simple or dendritic setae or both; front tibia somewhat fossorial in females, slender and sometimes arched in males, teeth increasing in size from base to apex of segment, often poorly

defined, usually with widely separated apices; middle tibia short, usually with small simple or compound mid dorsal spine, sometimes with setiferous patch near apex; hind tibia usually similar to middle tibia but longer, with smaller mid dorsal spine; ventral surface of tarsomeres 1–4 with single transverse row (sometimes broken on midline) of long setae near distal margin; **arolium** with 1–4 setae on either side of apex.

Abdomen. Sides of ventrites 1–4 with dorsally directed flange; distal margin of **ventrite 5** not conspicuously sexually dimorphic.

Male genitalia symmetrical. **9th abdominal segment** very robust; distal margin of sternite setose, convex, notched on midline. **Basal piece** strongly sclerotised ventrally and laterally, mostly membranous dorsally, enclosing pair of long, slender struts articulating on proximal end of penis. **Parameres** large, leaf-like, broad apically, with marginal fringe of minute hairs at least distally; connected to basal piece by very flexible membrane. **Penis** elongate, not enclosed by basal piece; ventral surface strongly sclerotised except for deep membranous incisions on midline proximally and distally; sides sclerotised; dorsal surface mostly membranous; base with pair of ventrolateral bridges fused to sides of dorsolateral crossbar; dorsolateral processes of crossbar short, with rounded apices. **Permanently everted internal sac** about same length as **tegmen** (basal piece + parameres), broad throughout its length, weakly sclerotised, colourless or pale brown, lacking papillae, partly clothed with dense, short spinules, expanded distally into spoon- or cup-shaped structure on which gonopore, sometimes with associated sclerites, is located.

Female genitalia. **Hemisternites** strongly sclerotised, deeply pigmented, with small, setose, apical stylus. **Accessory gland** large, elongate or saccate. **Bursal duct** distinct. **Bursa copulatrix** saccate, weakly sclerotised, colourless, longitudinally folded. Spermathecal duct very short, weakly sclerotised, continuous with tapered lateral lobe of bursa copulatrix. **Spermatheca** elongate, curved, moderately sclerotised, not annulate. Spermathecal gland bulbous or slightly elongate, weakly sclerotised, its duct arising near base of spermatheca.

Range. New Zealand.

Remarks. The six species I previously assigned to *Dorcus* MacLeay (Holloway 1961) together with four new species belong in *Geodorcus*. *Dorcus* and *Geodorcus* both have divided eyes, a 3-segmented antennal club and, in females, a hooked lacinia but they are not closely related. The many differences between *Geodorcus* and *Dorcus*, as exemplified by the type species *D. parallelipipedus* (Linnaeus, 1758), have been listed, with references to illustrations, in Holloway (1996).

In summary the main differences are:

- elytral setae dendritic and with numerous tapering branches in *Geodorcus*, cylindrical and unbranched with a few shallow apical incisions in *Dorcus*;
- wings vestigial in *Geodorcus*, fully developed in *Dorcus*;
- sides of pronotum and elytra with a brim in *Geodorcus*, without a brim in *Dorcus*;
- hemisternites with an apical stylus in *Geodorcus*, without a stylus in *Dorcus*;
- bursa copulatrix large and saccate in *Geodorcus*, small and tapering in *Dorcus*;
- spermatheca small, narrow, and curved in *Geodorcus*, large, bulbous, and straight in *Dorcus*;
- sternite of segment 9 in males notched apically in *Geodorcus*, without a notch in *Dorcus*;
- base of penis with a pair of lateral bridges and small rounded dorsolateral processes in *Geodorcus*, without lateral bridges and with large pointed dorsolateral processes in *Dorcus*;
- sides of penis sclerotised in *Geodorcus*, with membranous lobes in *Dorcus*;
- permanently everted internal sac broad throughout its length, expanded apically into a spoon- or cup-shaped process in *Geodorcus*, tapering and becoming tripartite apically in *Dorcus*.

Apterodorcus Arrow, 1943 from Chile is the morphologically closest genus to *Geodorcus* that I have seen. Similarities and differences between the two genera are listed in Holloway (1996). Shared characters include dendritic elytral vestiture, general head structure, vestigial wings, styli and crescentic spermathecae in females, and in males ventrolateral bridges, and penis with sclerotised sides. *Aegus* MacLeay, 1819 is the only other genus I know that has dendritic elytral setae but its other morphological features are unlike those in both *Geodorcus* and *Dorcus*.

Geodorcus ranges from the Mokohinau Islands (latitude 35° 50'S) to Big South Cape Island (latitude 47° 15'S). Only *G. helmsi* is widespread having been collected in parts of the west and south of the South Island and in the Stewart Island area. Several of the nine other species are known only from offshore islands or isolated mountains. These large, flightless, slow-moving, mainly nocturnal beetles are vulnerable to rodent predation, and are also at risk of exploitation in the lucrative beetle trade. In some parts of the world, especially Asia, large lucanids are highly prized by collectors who want specimens not for research purposes but for reasons such as their rarity or spectacular appearance, and for sale or exchange.

The importance of *Geodorcus* in the New Zealand fauna is equal to that of birds such as kiwi, takahe, and kakapo but at present only two species are legally protected. Theoretically all lucanids in National Parks are safe from illegal collecting, although policing may be difficult if not impossible, but in areas outside the Parks which may be just as important there are no legal restrictions to stop collectors from taking every stag beetle they can find, other than the two protected species. Small populations on islands and mountains are most at risk. New Zealand has been slow to develop a policy prohibiting the unauthorised collecting of its endemic insects, especially those that are flightless. In South Africa and Hawaii, stag beetles in the genera *Colophon* and *Apterocyclus* respectively, comparable to those in *Geodorcus* because they are large, flightless, and mostly have restricted distributions, are totally protected from collecting and trade by CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora).

Very little is known about longevity, life histories, and actual abundance of most of the *Geodorcus* species, and until that information becomes available and can be taken into consideration for conservation purposes a “look and leave” policy in the field would be desirable. *Geodorcus* surveys need to be carried out along the lines of bird surveys where specimens are recorded but not collected. All the known *Geodorcus* species are identifiable in the field with the aid of a hand lens. Insect pit trapping in places where *Geodorcus* is known to occur needs to be limited to avoid the unnecessary killing of adults.

KEY TO SPECIES OF *Geodorcus* MALES

The male of *G. montivagus* Holloway is unknown.

- 01 Head with deep, saucer-shaped depression between eyes; anterior canthus at least 1/2 length of eye; anterior margin of pronotum strongly convex and overhanging vertex (Fig. 464) (p. 93)... *novaezealandiae*
- Head flattened or shallowly and irregularly depressed or convex between eyes; anterior canthus less than 1/2 length of eye; anterior margin of pronotum straight or very slightly convex, not overhanging vertex (e.g., Fig. 401, 436) 02
- 02(01) Apical 1/2 of mandibles erect and recurved (Fig. 490, 492) (p. 99)... *sororum*
- Apical 1/2 of mandibles neither erect nor recurved.. 03
- 03(02) Front tibiae strongly curved (Fig. 474, 484) 04
- Front tibiae straight (e.g., Fig. 452) or very slightly curved (e.g., Fig. 444) 05

- 04(03) Front tibiae with long, curved, apical ventral spine visible in dorsal aspect (Fig. 474); median lobe on distal margin of labrum rounded apically, shorter than lateral lobes (Fig. 471); mid dorsal spine on middle tibia small, single-tipped (Fig. 476) (p. 95)... *philpotti*
- Front tibiae with short, straight, apical ventral spine not visible in dorsal aspect (Fig. 484); median lobe on distal margin of labrum angulate apically, much longer than lateral lobes (Fig. 478); mid dorsal spine on middle tibia large, multi-tipped (Fig. 486) (p. 97)... *servandus*
- 05(03) Mandibles with obliquely erect mid dorsal tooth that is either single-tipped (Fig. 447) or bifurcate at tip (Fig. 405, 416) 06
- Mandibles without obliquely erect mid dorsal tooth, at most with low lamina or carina in this position (Fig. 428, 436) 08
- 06(05) Mid dorsal tooth of mandibles single-tipped (Fig. 447) (p. 88)... *ithaginis*
- Mid dorsal tooth of mandibles bifurcate apically (Fig. 401, 405, 416) 07
- 07(06) Postocular margin in dorsal aspect divided into small, convex, anterior lobe adjacent to eye and large almost straight-sided posterior lobe (Fig. 401), the lobes not arched in lateral aspect (Fig. 403); subapical ventral tooth moderately long, close to apex of mandible (Fig. 404) (p. 79)... *alsobius*
- Postocular margin in dorsal aspect with single large, almost right-angled lobe (Fig. 416), conspicuously arched in lateral aspect (Fig. 418); subapical ventral tooth very short, distant from apex of mandible (Fig. 419) (p. 81)... *auriculatus*
- 08(05) Elytral ribs very conspicuous, with extremely dense, small punctures containing erect, moderately long, branched setae; integumental bands between ribs with sparser, larger punctures and much shorter setae (in abraded specimens differences in density and size of punctures are still apparent); funicle segments of antennae asymmetrical (Fig. 442); preocular margin straight or angulate, not projecting beyond eyes (Fig. 436); outer margin of eyes straight in dorsal aspect; middle and hind tibiae with numerous branched setae (p. 85)... *helmsi*
- Elytral ribs moderately conspicuous but with very small and sparse punctures like those on intervening integumental bands and setae rather short like those elsewhere on elytra; funicle segments of antennae symmetrical (Fig. 431); preocular margin convex, projecting beyond eyes (Fig. 428); outer margin of eyes convex in dorsal aspect; middle and hind tibiae with only simple, unbranched setae (p. 83)... *capito*

KEY TO SPECIES OF *Geodorcus* FEMALES

- 01 Head smooth and deeply depressed on frons and vertex; anterior canthus more than 1/2 length of eye (Fig. 465) (p. 93)... *novaezealandiae*
- Head irregularly convex or very shallowly concave on frons and vertex, never deeply depressed; anterior canthus less than 1/2 length of eye (e.g., Fig 437, 491) 02
- 02(01) Dorsomedial edge of mandibles with long, obliquely erect, conical tooth near middle (Fig. 448) (p. 88)... *ithaginis*
- Dorsomedial edge of mandibles without long, obliquely erect, tooth near middle but sometimes with lamina or very small horizontal tooth in this position (e.g., Fig. 456, 491) 03
- 03(02) Front tibiae conspicuously constricted basally, very broad apically (Fig. 475) (p. 95)... *philpotti*
- Front tibiae expanding gradually from base to apex (e.g., Fig. 425, 445) 04
- 04(03) Antennae with strongly arched pedicel and conspicuously broad, robust funicle segments (Fig. 457); middle and hind tibiae with apical, ventral patch of dense setae (Fig. 462, 463)... (p. 91)... *montivagus*
- Antennae with straight or slightly curved pedicel and relatively slender funicle segments (e.g., Fig. 422, male); middle and hind tibiae lacking apical, ventral patch of dense setae (e.g., Fig. 414, 415, of male) 05
- 05(04) Dorsal spine of middle and hind tibiae large, curved, obliquely transverse, conspicuously multi-tipped, integument beneath spine concave (e.g., Fig. 487, 489) (p. 97)... *servandus*
- Dorsal spine (when present) of middle and hind tibiae, rather small, straight, longitudinal, single-tipped or inconspicuously multi-tipped, integument beneath spine flattened, not concave (e.g., Fig. 414, 446, of male) 06
- 06(05) Head widest across eyes; postocular margin not lobed (e.g., Fig. 429, 437) 07
- Head widest behind eyes; postocular margin lobed (e.g., Fig. 402, 417, 491) 08
- 07 (06) Dorsal surface of mandibles with horizontal lamina near middle; outer edge of mandibles angulate near base, distinctly arched; apex of mandibles with 3 broad, rather blunt teeth (Fig. 429) (p. 83)... *capito*
- Dorsal surface of mandibles not with horizontal lamina near middle; outer edge of mandibles gently curved, not angulate; apex of mandibles with 3 slender, tapering teeth (Fig. 437) (p. 85)... *helmsi*

- 08(06) Postocular margin of head with large, obtuse-angled or slightly rounded lobe at least as long as eye (Fig. 417) (p. 81)... *auriculatus*
- Postocular margin of head with small, rounded or acute-angled lobe much shorter than eye (e.g., Fig. 402, 491) 09
- 09(08) Postocular margin rounded; outer edge of mandibles almost uniformly convex; dorsomedial edge of mandibles without lamina; apex of mandibles bidentate (Fig. 402) (p. 79)... *alsobius*
- Postocular margin angulate; outer edge of mandibles obtusely rounded or angulate near base then curving very slightly to apex; dorsomedial edge of mandibles with obliquely vertical lamina; apex of mandibles tridentate (Fig. 491) (p. 99)... *sorum*

Geodorcus alsobius new species

Fig. 130, 131, 401–415, 640, 641, 706. Map 21

Diagnosis. Length: males (including mandibles) 21.0–27.0 mm, (excluding mandibles) 18.1–23.0 mm; females (including mandibles) 21.0–23.7 mm, (excluding mandibles) 19.0–22.1 mm. Width: males 8.5–10.7 mm, females 9.3–10.4 mm. Medium-sized to large with dull or glossy, mostly densely punctate, black integument (Fig. 130, 131). Elytra almost uniformly coarsely punctate, with fragments of about 7 narrow ribs; vestiture when visible consisting of minute, erect, weakly dendritic setae with branches often glued together. Mandibles of males arched laterally, tridentate apically, with very broad, almost horizontal, bifid-tipped mid dorsal tooth. Mandibles of females bidentate apically, with uniformly convex outer edge. Postocular margin short and rounded in females, long, with conspicuously projecting, truncate, laminate horizontal lobe in males. Front tibia not arched, very slender in males, moderately slender in females. Middle and hind tibiae expanded very gradually; mid dorsal spine small or absent; ventral setiferous patch absent.

Description

Head (Fig. 401, 402) widest behind eyes. **Dorsal surface** moderately glossy; frons smooth and distinctly depressed in males, uneven and shallowly depressed in females; **punctures** deep, sharply defined; moderately dense and mostly small or minute in large males, dense and moderately large in females and small males; setae minute, erect, barely visible; preocular integument somewhat laminate, sloping outwards in males, slightly depressed in females, margin concave or straight; postocular margin in males with minute, obtusely angulate horizontal lobe immediately adjacent to eye and posteriorly a very large, obtusely rounded or angulate lamina that is flattened dorsally, slightly concave

ventrally (Fig. 403); postocular margin in females short, with rounded conical lobe. **Labrum** rectangular; 2.0–2.4× wider than long with slightly uneven surface, sparse to dense small punctures and truncate or weakly trilobed distal margin in males, 2.3–2.4× wider than long with dense, moderately large punctures and slightly indented or weakly trilobed distal margin in females (Fig. 406); all punctures with short erect setae; labral suture well defined. **Mandibles of males** curved laterally, not deep dorsoventrally; punctures poorly defined, minute and sparse in large males, small and dense in small males; setae minute or apparently absent; both mandibles with short, single-tipped apical ventral, subapical dorsal, subapical ventral teeth and broad, inwardly directed, almost horizontal mid dorsal tooth with bilobed apex, this tooth long and evenly bilobed in large males (Fig. 405), short and unevenly bilobed in small males (Fig. 401, 404); large males with large, basal, ventral tooth, small males with single-tipped or weakly bilobed mid ventral tooth (Fig. 404). **Mandibles of females** (Fig. 402, 406) curved, somewhat parallel-sided, slightly expanded externally at base, carinate on dorsomedial and dorsolateral margins; punctures rather weakly defined, mostly small, dense, containing minute setae; both mandibles with variably developed single-tipped, apical dorsal and subapical ventral teeth. **Antennae** (Fig. 407) with similar basic form in males and females; pedicel slender, slightly curved, about 1.8–2.0× longer than wide in males, about 1.6× in females; funicle segments 1–3 virtually symmetrical, 4 and 5 slightly asymmetrical, approximate length/width values for segments 1–5 respectively 1.4, 1.4, 1.1, 1.0, 0.7 in males, 1.3, 1.2, 0.8, 0.7, 0.6 in females; club about 2.0× longer than wide. **Eyes** not protruding beyond canthi; anterior canthus about 0.3× length of eye; posterior canthus about 0.1× length of eye in males, about 0.3× in females. **Mentum** rectangular, about 2.0× wider than long; lateral margins rounded; distal margin slightly indented; 4th segment of maxillary palp (Fig. 408) flattened ventrally, about 3.0× longer than wide in males, about 2.6× in females; 3rd segment of labial palp (Fig. 409), about 2.8× longer than wide in males, about 2.0× in females, ventral surface slightly convex.

Thorax. Pronotum dull or moderately glossy, 1.6–1.9× wider than long in males, 1.5–1.6× in females, about 1.1× wider than head in males, 1.5–1.6× in females; **punctures** sharply defined and deep; minute to small, sparse to moderately dense on anterior 1/2 of disc, moderately large and dense to moderately dense towards sides and posteriorly and large or moderately large and dense to coalescent in brim in large males; small to moderately large and dense to moderately dense on disc, and large and very dense or coalescent in brim in females and small males; setae minute to short and barely visible in smallest punctures, short to

moderately long in largest; disc flattened or slightly convex; brim broad; anterior margin very slightly convex on median 0.3; front angles distant from eyes; sides parallel or slightly divergent over anterior 0.7 then strongly convergent in males, slightly divergent over anterior 0.6 then convergent in females. **Elytra** dull or glossy, mostly densely and coarsely punctate, about 0.9× as wide as pronotum in males, about same width as pronotum in females; striae and interstriae clearly visible in ventral aspect (Fig. 410) but indistinct dorsally; each elytron with about 7 moderately raised, shiny, fragmentary or coalescent, narrow, longitudinal ribs with large, sparse, punctures; intervening spaces with smaller, denser punctures; setae minute on disc, larger on lateral and posterior declivities; brim well defined, concave; rim with single row of small dense punctures containing short to moderately long setae. **Wing** (Fig. 411) about 1/2 length of elytron, with vestiges of radial recurrent, cubitus, and 2 anal veins. **Front tibia** slender, straight, gradually expanded from base in males (Fig. 412); broad, slightly curved, gradually expanded in females (Fig. 413); dorsal edge with large apical tooth, moderately large subapical tooth and rudiments of 2–4 others; ventral apical spine minute. **Middle tibia** (Fig. 414) expanded gradually from base; longitudinal setiferous rows containing only simple setae; mid dorsal spine small, obliquely longitudinal, tip undivided or bifid; integument underlying spine flattened, not concave; ventral margin straight, without apical setiferous patch; spurs subcylindrical proximally, becoming flattened dorsally towards apex, shiny, not striated; anteroventral spur curved in males, straight in females; posteroventral spur about 1.2× as long as anteroventral spur and about same length as adjacent tarsomere 1 in males, about 1.8× length of anteroventral spur, and about 1.3× length of tarsomere 1 in females. **Hind tibia** (Fig. 415) similar in shape and vestiture to middle tibia except longer with dorsal spine smaller or absent; spurs cylindrical basally, flattened dorsally towards apex, shiny, not striated; posteroventral spur about 5.0× longer than wide, about 1.5× length of anteroventral spur, and about 1.2× longer than adjacent tarsomere 1 in males, about 5.6× longer than wide, about 1.8× as long as anteroventral spur and about 1.5× longer than tarsomere 1 in females. **Arolia** of all legs with 1 seta on either side of apex.

Abdomen. Ventrites moderately glossy; sides of ventrite 1 with broad low rim lacking adjacent groove; sides of ventrites 2–4 and free margin of ventrite 5 with very low rim on anterior 0.2, lacking groove; punctures small, sharply defined, deep, dense on median 0.5 and moderately dense towards sides on ventrites 1–4, uniformly dense on ventrite 5; setae long on apex of ventrite 5, short elsewhere.

Male genitalia. 9th abdominal segment (Fig. 640);

apices of tergite and ventrite indented. **Permanently everted internal sac** (Fig. 641) terminating in large, bilaterally symmetrical funnel with somewhat triangular aperture and deeply excavated dorsal margin; **gonopore** elongate, submarginal internally on excavated dorsal edge of funnel, enclosed by pair of large, weakly sclerotised lips. **Parameres** with very narrow translucent, cuticular area along ventral margin.

Female genitalia (Fig. 706). **Accessory gland** large, saccate; bursal duct short broad; **bursa copulatrix** strongly folded, with very short, narrow lobe on which broad, tapering, relatively long spermathecal duct inserts; **spermatheca** large; spermathecal gland small with short distinct duct.

Type data. Holotype male [25.6 mm (including mandibles) × 10.3 mm, with abdomen, macerated genitalia, left maxilla, and left wing in accompanying minivial]: New Zealand, CL, Mt Moehau (36° 32'S, 175° 24'E), under log in last patch of bush before summit of Little Moehau, November 1980, J. J. Goulstone (NZAC). Paratypes: see Appendix 2, p. 129.

Material examined Holotype male and 11 paratypes (8 males, 3 females) (LUNZ, NZAC).

Distribution (Map 21). Mt Moehau (latitude 36° 32'S), between 460 and 875 m.

CL / —

Biology. Live adults have been seen in January, February, and November. The specimens I examined were found under logs and rocks. Colin Johnson, participating in a native frog survey on Mt Moehau in 1982, saw 7 adults of *alsobius*, which he identified as *Dorcus auriculatus*. He recorded their sex, measurements, and habitats in a detailed handwritten report (Johnson c. 1983). Four of the males and one female were in wet soil under large rotted logs in the open at altitudes between 760 m and 840 m, and two other males were located in wet humic soil under a large stone and in a rock pile in a deep forested gully. All the specimens were found during the day and were inactive when disturbed except for two males that began fighting when grouped with a female for a photograph. Additional information about adult habitats, including the names of associated plant species is given in Sherley *et al.* (1994) and McGuinness (2001). The paper by Sherley *et al.* (1994) includes a January record of specimens having been seen in copulation, and references to larvae which were thought to be those of this species but as no specimens were collected the identification could not be confirmed.

Remarks. Characters for identifying *G. alsobius* are given in the keys and diagnosis. *Geodorcus auriculatus*, found further south on the Coromandel Peninsula, is the morphologically most similar species. Its males, like those of

alsobius, have mandibles with a bifid tipped mid-dorsal tooth but the apices of their mandibles are bidentate, the postocular margin of their head is long, angulate, and arched dorsally, their eyes are very small, the elytral ridges are broad and inconspicuous, and the subapical ventral tooth of the mandible is distant from the apex. Females of *G. auriculatus* can be recognised by their obtusely angulate rather than rounded, non laminate postocular margin, small eyes, and weakly curved mandibles.

Cattle, goats, and pigs have roamed over the slopes of Mt Moehau for many years, and ship rats (*Rattus rattus*) and Norwegian rats (*R. norvegicus*) also are present (Taylor 1978). *Geodorcus alsobius* has managed to coexist with these intruders and through the efforts being made by the Department of Conservation should continue to do so well into the future. The Department has undertaken possum and goat control on Te Moehau since the mid 1980s and monitoring of rats was commenced in 1999 (McGuinness 2001). An intensive survey elsewhere on the Moehau Range and in other parts of the Coromandel Forest Park by Department of Conservation staff failed to extend the range of *alsobius* beyond Mt Moehau thus highlighting the importance of protecting the type locality and its environs. There is an urgent need to give this species legal protection from unscrupulous collectors.

Conservation status. The species, as *Geodorcus* sp. 'Moehau', is listed as 'Range Restricted' by Hitchmough (2000).

Etymology. The summit of Te Moehau where *G. alsobius* has been found and a small forested area below it are in a Maori Reserve belonging to Ngati Maru (McEwen 1966) and lying outside the Coromandel Forest Park. Tama Te Kapua who commanded Te Arawa Canoe settled in the vicinity of Te Moehau and was buried close to its summit (Foster 1966). Accordingly, *alsobius*, derived from the Greek words "alsos", meaning a small sacred forest and "bios", meaning life, has been chosen as the specific epithet for this stag beetle.

***Geodorcus auriculatus* (Broun)**

Fig. 82, 83, 132, 133, 416–427, 642, 643, 707. Map 22
auriculatus Broun, 1903: 615 (*Lissotes*). Holloway, 1961: 35, fig. 41–43, 118 (*Dorcus*); 1963b: 102, fig. 3, 19 (*Dorcus*); 1992: 62 (*Geodorcus*).

Diagnosis. Length: males (including mandibles) 21.1–29.0 mm, (excluding mandibles) 17.5–25.0 mm; females (including mandibles) 19.0–20.1 mm, (excluding mandibles) 17.5–18.4 mm. Width: males 9.5–13.3 mm; females 9.0–9.2 mm. Medium-sized to large (Fig. 82, 83, 132, 133) with dull to glossy, very uniformly, densely punctate, black or brownish-black integument. Elytra almost uniformly covered with

dense, rather coarse punctures with minute, erect, weakly dendritic setae, but traces of about 4 low, broad, inconspicuous ribs are discernible. Mandibles of males bidentate apically, with moderately broad, obliquely erect, bifid-tipped mid dorsal tooth. Mandibles of females bidentate apically; outer edge irregularly and weakly convex. Postocular margin short and angulate in females; long with conspicuously projecting, dorsally arched, angulate lobe in males. Front tibia not arched, very slender in males, moderately slender in females. Middle and hind tibiae very gradually expanded; with small, simple mid dorsal spine; ventral setiferous patch absent.

Redescription

Head (Fig. 416, 417) widest behind eyes. **Dorsal surface** moderately glossy; frons smooth and distinctly depressed in males, irregularly and shallowly depressed in females; vertex slightly convex, smooth in males, uneven in females; **punctures** deep, dense, sharply defined, minute in large males, small to moderately large in females and small males; setae erect, minute, barely visible in smallest punctures; preocular integument slightly convex, somewhat laminate and sloping downwards in males, distinctly laminate and slightly concave in females; postocular margin short and conical in females, long, obtusely angulate, laminate, arched dorsally, concave ventrally in males (Fig. 418). **Labrum** rectangular and smooth; 2.4–3.0× wider than long, truncate or slightly convex distally and with small punctures in males, 2.4–2.7× wider than long, slightly indented or weakly trilobed distally, and with large, weakly demarcated and irregularly distributed punctures in females (Fig. 421); all punctures with minute erect setae; labral suture well defined. **Mandibles of males** curved laterally, not deep dorsoventrally; punctures sharply defined, small, moderately dense and containing a minute seta on basal 1/2 of mandible, minute, sparse to moderately dense, and apparently lacking setae on apical 1/2; both mandibles with dorsolateral ridge near base, large, moderately broad somewhat obliquely erect, inwardly directed mid dorsal tooth with bifid apex (this tooth moderately long and narrow (Fig. 416, 419) in large males, short and broad (Fig. 420) in small males), and variably developed, single-tipped, apical ventral, subapical dorsal, subapical ventral (considerably distant from apex), basal dorsal and basal ventral teeth. **Mandibles of females** (Fig. 417, 421) not very curved, vaguely triangular, not lobed externally at base, dorsomedial and dorsolateral margins somewhat carinate, punctures sharply defined, mostly small, dense, and containing minute setae; both mandibles with variably developed, single-tipped, apical dorsal and subapical ventral teeth; right mandible with vestigial subapical dorsal tooth. **Antennae** (Fig. 422) approximately the same in males and females; pedicel slender, almost straight, 2.0–2.1× longer than wide; funicle

segments virtually symmetrical, approximate length/width values for segments 1–5 respectively 1.2, 1.2, 0.9, 0.8, 0.8 in males, 1.1, 0.9, 1.0, 0.9, 0.8 in females; club about 2.0× longer than wide. **Eyes** not protruding beyond canthi; anterior canthus about 0.3× length of eye in males, almost 0.5× in females; posterior canthus about 0.2× length of eye. **Mentum** rectangular, 2.1–3.0× wider than long in males, 2.1–2.4× in females; lateral margins convex; distal margin truncate or shallowly indented; 4th segment of maxillary palp flattened ventrally, about 3.0× longer than wide in males (Fig. 423), about 2.6× longer in females; 3rd segment of labial palp about 2.9× longer than wide in males, about 2.1× in females.

Thorax. Pronotum moderately glossy, 1.7–2.4× wider than long in males, 1.6–1.7× in females, and 0.9–1.1× as wide as head in males, 1.4–1.5× in females; **punctures** deep, sharply defined; in large males minute to small and mostly moderately dense on anterior 1/2 of disc, dense and moderately large on posterior 1/2 of disc, in females and small males small to moderately large and dense; setae barely visible in smallest punctures, short in larger ones, moderately long in brim; disc flattened or slightly convex; brim broad; anterior margin slightly convex on median 0.3 in males, straight in females; front angles distant from eyes; sides slightly convex in females, parallel over anterior 0.7 then convergent in males. **Elytra** very densely and uniformly punctate, dull or glossy, 0.7–0.8× as wide as pronotum in males, about 0.9× in females; punctures mostly small except large on sides and in brim; each elytron with 3 or 4 low, rounded, rather broad, longitudinal ribs, most obvious anteriorly, their punctures like those elsewhere on elytra; setae erect, present in all punctures, minute near suture, increasing in length across elytron to become short in brim and on posterior declivity; brim well defined, concave; rim punctures very dense, mostly coalescent, small, shallow, poorly defined, irregularly aligned in up to 3 rows anteriorly, in a single row posteriorly, their setae moderately long. **Wing** (Holloway 1963b, fig. 3) about 0.5× length of elytron; cubitus, medial recurrent, and radial recurrent veins absent. **Front tibia** in males slender, straight and almost parallel-sided except for basal constriction (Fig. 424), broad, slightly curved, gradually expanded from base to apex in females (Fig. 425); dorsal edge with large apical tooth, moderately large subapical tooth, and 2 or 3 very small teeth near middle; ventral apical spine small in males, minute in females. **Middle tibia** (Fig. 426) expanded very gradually from base; longitudinal setiferous rows containing mostly simple setae except for branched setae proximally; mid dorsal spine small, longitudinal, laminate, single-tipped; integument under spine flattened, not concave; ventral margin straight; ventral setiferous patch absent; spurs shiny, not striated, subcylindrical proximally, flat-

tened dorsally towards apex; anteroventral spur straight-tipped; posteroventral spur about 4× longer than wide, about 1.5× length of anteroventral spur, about 1.3× length of adjacent 1st tarsomere. **Hind tibia** (Fig. 427) similar to middle tibia but longer; spurs subcylindrical basally, flattened dorsally towards apex, shiny, not striated; posteroventral spur about 4.7× longer than wide, about 1.6× length of anteroventral spur, about 1.4× length of adjacent 1st tarsomere. **Arolia** of all legs with 1 seta or rarely 2 on either side of apex.

Abdomen. Ventrites moderately glossy; sides of ventrites 1–5 with broad rim separated from remainder of surface by groove; punctures small, sharply defined, deep, those on ventrite 1 dense anteriorly and sparse posteriorly in males, uniformly dense in females, on ventrites 2–4 mostly sparse in males, moderately dense in females, on ventrite 5 dense in males and females; setae long near apex of ventrite 5, minute or short elsewhere.

Male genitalia. 9th abdominal segment (Fig. 642); apex of tergite rounded; apex of ventrite deeply notched. **Permanently everted internal sac** (Fig. 643) terminating in a large cup-like structure with bilaterally symmetrical dorsal and ventral lobes; **gonopore** short, oval, on midline inside dorsal lobe, distant from margin, near rectangular submarginal sclerite, and partly covered by pair of minute, elongate, membranous flaps. **Parameres** with ventral margin normally sclerotised (not translucent).

Female genitalia. (Fig. 707). **Accessory gland** short, narrow, somewhat tubular; **bursa copulatrix** slightly folded longitudinally, with short, broad invaginated lobe into which the narrow, tapering spermathecal duct opens; **spermatheca** and **spermathecal gland** large.

Type data. Broun described *Lissotes auriculatus* from two males collected at Thames, CL (37° 09'S, 175° 33'E), and sent to him by Mr R. Curtis. One of the specimens is in BMNH. It measures 25.0 x 11.8 mm, including mandibles, and is accompanied by the following labels: (1) SYNTYPE [BMNH blue circle label]; (2) 2811. Male [in Broun's handwriting]; (3) [on upperside of label] *Lissotes auriculatus* male, [on underside of label] Thames [in Broun's handwriting]; (4) New Zeal, Broun Coll., Briti. Mus., 1922–482. In my earlier revision (Holloway 1961) I noted that the second specimen was not in BMNH and incorrectly referred loosely to the BMNH syntype as the "Type". During the more than 40 years since then I have been unable to locate the second specimen so in order to fix a single name bearer for the species I am now giving the BMNH specimen lectotype status.

Material examined. Lectotype male, 12 non-type examples (8 males, 4 females), and fragments of 2 males (BMNH, NZAC).

Distribution (Map 22). From Manaia (latitude 36° 51'S) to Mt Te Aroha (37° 32'S), near sea level to about 950 m.

CL, BP / —

Map 22 includes records from Owen (1991) and McGuinness (2001), but excludes the generalised locality “Waikato” of a female in BMNH.

Biology. Live adults have been seen from January to March and in November. Colin Johnson, mentioned earlier in *G. alsobius* Remarks, saw five live males of *auriculatus* at Te Puru, just North of Thames (Johnson c. 1983) (seven specimens from Mt Moehau that he identified as *auriculatus* were *alsobius*). They were under logs and a stone in damp soil at altitudes between 700 and 720 m. Reports on surveys undertaken by Department of Conservation staff in the 1990s include precise information on localities and habitats for this species (Owen 1991; McGuinness 2001). In general the substrates and associated vegetational types are like those favoured by *alsobius*.

Remarks. Males of *auriculatus* are easily recognised by the angulate, dorsally arched postocular margin of the head, and very small eyes. Females can be identified by their conical postocular margin and weakly arched mandibles. See *G. alsobius* Remarks for other differences as well as similarities between these two species.

When I prepared my 1961 revision the only *auriculatus* specimens available for study were the male from Thames and a female from Waikato. The intense surveys carried out on the Coromandel Peninsula and in the Kaimai Mamaku State Forest Park by staff of the Department of Conservation have greatly extended the known range of this species (Owen 1991; Sherley *et al.* 1994; McGuinness 2001). The impetus for the surveys came from *G. auriculatus* having been given legal protection from collectors and accorded the conservation status of “endangered” (Owen 1991). As a result of these outstandingly dedicated surveys it is now apparent that *auriculatus* is not currently at risk of extinction and Sherley *et al.* (1994) have in fact suggested that it may be reasonable to reduce its conservation status from “endangered” to “rare”. In the New Zealand Threat Classification System (Hichmough 2002) it is listed as ‘sparse’.

Rats, possums, and pigs are the major threats to this species and its habitat (McGuinness 2001). Specimens on some parts of Mt Te Aroha, the best-studied locality for *auriculatus*, are also at risk from two unalterable causes. Firstly, during heavy rain they may be washed down water channels that have developed below the summit and either drown or die later from exposure on open ground and secondly, during their wanderings at night in the summit area they may become trapped against the concrete walls of the TV Tower and Repeater Station where they either die from exposure or are eaten by moreporks and frogs.

Credit must be given here to Colin Johnson who not only was the first person to record details of the habitats and biology of *auriculatus* and *alsobius*, but also included in his report accurate figures and a description of the male genitalia of *auriculatus* which had not previously been examined.

***Geodorcus capito* Deyrolle**

Fig. 3, 4, 6, 7, 13, 18, 73, 134, 135, 428–435, 644, 645, 708. Map 23

capito Deyrolle, 1873: 339, pl. 5, fig. 4 (*Lissotes*). Broun 1909: 146 (*Lissotes*). Holloway 1961: 37, fig. 46, 47, 108, 113, 119, 126 (*Dorcus*); 1963b: 102, fig. 5 (*Dorcus*); 1996: 62 (*Geodorcus*). Fukinuki 2000: 33, includes photos of males, females, larvae, and pupa (*Lissotes*). *dispar* Broun, 1910b: 307 (*Lissotes*). Brookes 1925: 290 (*Lissotes*). Holloway 1961: 37 (as synonym of *Dorcus capito*).

Diagnosis. Length: males (including mandibles) 17.0–27.0 mm, (excluding mandibles) 14.8–22.0 mm; females (including mandibles) 15.0–19.5 mm, (excluding mandibles) 14.2–18.2 mm. Width: males 7.2–12.0 mm, females 7.0–9.4 mm. Small to large, rather slender, with variably glossy black or brownish black integument (Fig. 134, 135). Punctures on head and pronotum minute and mostly sparse in males, small and mostly dense in females, apparently lacking vestiture. Elytra in males conspicuously ribbed and with moderately long, erect, dendritic setae on entire surface; in females vaguely ribbed and with barely visible setae. Male mandibles slender, strongly arched laterally, with very long apical tooth widely separated from 3 teeth towards base. Female mandibles tridentate apically; outer margin of external basal lobe of mandible oblique but not erect. Postocular margin of head protruding slightly beyond eye in males, not protruding beyond eye in females. Front tibia not arched, moderately slender. Middle and hind tibiae gradually expanded; their mid dorsal spine moderately large, simple conical; ventral setiferous patch absent.

Redescription

Head (Fig. 3, 4, 6, 428, 429) widest in front of eyes in smallest males, behind eyes in larger males, across eyes in females. **Dorsal surface** very glossy; frons barely depressed, smooth in males, uneven in females; vertex slightly convex, smooth in males, uneven in females; punctures sharply defined; very shallow and minute in males, dense in smallest males, moderately dense in largest males, moderately deep, small, dense to very dense in females; most **punctures** without visible setae in males, with minute, barely visible erect setae in females; preocular margin moderately to strongly convex in males, slightly concave to slightly convex in females, weakly rimmed, integument immediately in front of eye strongly depressed and lami-

nate; postocular margin in males diverging from eye then forming an obtusely or acutely angulate or rounded, slightly arched, laminate lobe; postocular margin in females convergent posteriorly except for very small conical protuberance adjacent to eye. **Labrum** rectangular, 2.0–2.4× wider than long in males, 2.4–2.5× in females; surface slightly uneven; punctures minute and sparse in males, small and dense in females; larger punctures containing minute setae; distal margin strongly trilobed in males, weakly trilobed in females; 3 or 4 long setae on either side of middle lobe; labral suture poorly defined especially in females. **Mandibles of males** strongly curved laterally, not deep dorsoventrally; punctures shallow, minute, mostly dense, apparently lacking setae; both mandibles with very long apical dorsal tooth, moderately long, weakly bifurcate ventral tooth towards base, short blunt ventral basal tooth, and variably developed, obliquely erect, dorsal lamina or tooth towards base. **Mandibles of females** approximately parallel-sided but with small triangular projection at base; entire dorsolateral margin carinate; punctures moderately deep, small, dense, apparently lacking setae; both mandibles tridentate apically and with elongate horizontal carina or slightly erect lamina on dorsomedial edge. **Antennae** (Fig. 18, 431) approximately the same in males and females; pedicel slender, almost straight, about 2× longer than wide; funicle segments 1–4 approximately symmetrical, segment 5 slightly asymmetrical; approximate length/width values for funicle segment 1–5 respectively 1.3, 1.2, 1.2, 1.1, 1.0 in males, 1.0, 0.8, 0.8, 0.7, 0.6 in females; club 1.3–1.8× longer than wide in males, 1.5–1.6× longer than wide in females. **Eyes** distinctly convex laterally, protruding beyond preocular and postocular margins in females but not in males; anterior canthus about 0.3× length of eye in males, about 0.2× in females; posterior canthus absent. **Mentum** (Fig. 7) somewhat rectangular but narrower apically, 2.5–2.7× wider than long in males, 2.2–2.3× in females; distal margin indented; ventral surface flattened; 4th segment of maxillary palp (Fig. 13, 430) flattened ventrally, 3.1–3.5× longer than wide in males, about 3.2× in females; 3rd segment of labial palp 3.2–4.0× longer than wide in males, about 3.0× in females.

Thorax. Pronotum very glossy, 1.6–1.9× wider than long in males, about 1.5× in females, 1.0–1.4× as wide as head in males, widest in largest specimens, about 1.4× in females; **punctures** sharply defined, mostly minute, shallow and sparse in large males, mostly small, moderately deep and moderately dense in small males, small, deep, and dense or moderately dense in females; setae minute or absent on disc, short near sides; disc slightly convex in females, flattened on the midline and with shallow depression on either side of this in males; brim absent or very narrow; anterior margin slightly concave; front angles dis-

tant from eyes; sides slightly convex in females, slightly convergent posteriorly in small males, strongly convergent and with obtuse angulation at posterior 0.6 in large males.

Elytra moderately glossy, rather parallel-sided, 1.1–1.3× longer than their combined width, approximately 0.9× width of pronotum in males, 1.1× in females; each elytron with about 4 shallowly etched, longitudinal lines and about 7 slightly raised longitudinal, rather narrow ribs separated by flattened or shallowly depressed broader integumental bands, the ribs and alternating bands conspicuous in males, rather indistinct in females; punctures sharply defined, minute to small and sparse in large males, mostly small and moderately dense in females and small males; setae in males erect, mostly moderately long, slightly longer, denser, more conspicuous on elevated ribs and in larger punctures, inconspicuous or absent in minute punctures, in females barely visible except for short erect setae on outer 0.2 of elytron; brim narrow, sloping; rim punctures minute, dense or very dense, deep, irregularly aligned in 3 or 4 rows anteriorly, 2 or 3 rows near middle, in a single row posteriorly, containing mainly long setae in males, short setae in females. **Wing** (Holloway 1963b, fig.5) 0.3–0.4× length of elytron; cubitus, medial recurrent, and radial recurrent veins absent. **Front tibia** straight and gradually expanded from base to apex in males (Fig. 432), slightly curved and more prominently expanded in females (Fig. 433); dorsal edge with large apical tooth, small subapical tooth and 3–7 small teeth decreasing in size towards base of tibia; ventral apical spine small. **Middle tibia** (Fig. 434) gradually expanded from base; longitudinal setiferous rows containing both branched and simple setae, branched setae rather sparse especially in females; mid dorsal spine moderately large, single-tipped, conical or very slightly laminate, integument under spine flattened, not concave; ventral margin straight; ventral setiferous patch absent; spurs shiny, not striated, subcylindrical proximally, flattened towards apex; anteroventral spur slightly bent at tip; posteroventral spur 1.3–1.6× as long as anteroventral spur and about 1.4× length of adjacent 1st tarsomere. **Hind tibia** (Fig. 435) similar to middle tibia but longer, more slender especially apically, and with smaller mid dorsal spine; spurs cylindrical basally then flattened, shiny, not striated; posteroventral spur about 5× longer than wide, 1.8–2.0× as long as anteroventral spur, 1.6–1.8× as long as 1st tarsomere. **Arolia** of all legs with 1 seta on either side of apex.

Abdomen. Ventrites moderately to very glossy; sides of ventrites 2–4 and anterior 0.6 of sides of ventrite 5 with moderately broad rim separated from remainder of ventrite by narrow groove; punctures sharply defined, uniformly dense, minute and deep in large males, small and shallow in females and small males; setae moderately long in males, short in females.

Male genitalia. 9th abdominal segment (Fig. 644); apex of tergite slightly indented; apex of ventrite shallowly notched. **Permanently everted internal sac** (Fig. 645) terminating in large, elongate-oval, boat-shaped expansion; **gonopore** oval, on midline between pair of lips on concave surface of expansion, rather distant from a submarginal semicircular sclerite. **Parameres** with ventral margin sclerotised normally, not translucent.

Female genitalia (Fig. 73, 708). **Accessory gland** extremely long, tubular; bursal duct short, broad; **bursa copulatrix** strongly folded with very long tapering lobe that is continuous with short tapering spermathecal duct; **spermatheca** relatively small; spermathecal gland long with poorly differentiated duct.

Type data. The holotype male of *Lissotes capito* Deyrolle is in MNHN. It measures 27.0 x 11.6 mm including mandibles and has the following labels: (1) Type [on red label]; (2) capito HD [as monogram] type, I. Chatam [43° 52'S, 176° 30'W]; (3) Ex-Musaeo Mniszech; (4) Lissotes capito H. Deyr. Holotype male, J. P. Lacroix det. 1975.

The holotype of *Lissotes dispar* Broun is in BMNH. It is a small male collected at "TeWhakuru" Chatham Islands by Miss S. D. Shand (Holloway 1961). I have not found this locality on the maps available to me but assume it is on the main island.

Material examined. Primary types of *capito* and *dispar* and 40 non-type specimens (26 males, 14 females) (AMNZ, BMNH, CMNZ, LUNZ, MNHN, MONZ, NZAC).

Distribution (Map 23). Chatham Islands archipelago: Chatham I (Rekohu/Wharekauri), Pitt I (Rangiauria), Star Keys (Motuhope), Mangere I (Mangere), South East I (Rangatira), and Little Mangere I (Tapuaenuku) (this record from Emberson (1998)), from near sea level to about 200 m. Northernmost record: Chatham I (latitude approximately 43° 52'S); southernmost record: Star Keys (latitude 44° 21'S).

— / — / CH

Biology. Adults in the material examined were collected from November to February. Some were found at night on the ground and on trees. Emberson (1998) reported finding specimens during the day under rotten snags and accumulations of debris on trunks of *Dracophyllum arboreum*. In early December 1999 Fukinuki (2000) found all stages, including eggs, in moss covered cavities of fallen and standing trees on Chatham Island. On smaller islands adults have been collected under rocks in coastal forest (Emberson 1998).

Remarks. In my earlier revision (Holloway 1961) I included specimens from The Sisters Islands approximately 20 km NW of Chatham Island in this species because of

their identical genitalia. Having had the opportunity to examine additional material from various localities in the Chatham archipelago I am now separating The Sisters specimens as a distinct species. To distinguish *capito* from The Sisters species see Remarks in *G. sororum*. In my 1961 paper I synonymised *Lissotes desmaresti* Deyrolle, 1881 with *capito* on the basis of the original description, its type not being available at the time. Subsequently Dr B. P. Moore of CSIRO located the holotype male and advised me that it was quite different from *capito*. Through the efforts of J. S. Dugdale (then of DSIR) and Dr J. P. Dechambre (MNHN) I was able to examine the holotypes of *capito* and *desmaresti* and realised that *desmaresti* was not part of the New Zealand fauna; it is now recognised as a Tasmanian species (Moore & Cassis 1992).

Geodorcus helmsi (Sharp) Helms's stag beetle

Figures 2, 24, 36, 49, 53–58, 136, 137, 436–446, 646–648, 709. Map 24

helmsi Sharp, 1881: 49 (*Lissotes*). Hudson 1934: 160 (*Lissotes*). Holloway 1961: 26, frontispiece 2–4, fig. 1, 7, 12, 13, 17, 24–31, 105, 110, 116, 122, 123 (*Dorcus*); 1963b: 102, fig. 6, 20 (*Dorcus*); 1996: 62 (*Geodorcus*). Sharell 1971: 96, includes photo of male and female (*Dorcus*). Forster & Forster 1974: 76, includes photos of male (*Dorcus*). Patrick *et al.* 1987: 36, includes photo of male (*Dorcus*). Fukinuki 2000: 36, photo of larva (*Lissotes*); 2001: 15, includes photos of male and females (*Lissotes*).

aemulus Broun, 1893: 1109 (*Lissotes*). Holloway 1961: 26 (synonym of *Dorcus helmsi*).

acmenus Lewis, 1902: (*Lissotes*). Tillyard 1926: 227, pl. 18 fig. 28 (*Lissotes*). Hudson 1934: 161 (*Lissotes*). Arrow 1935: 122 (synonym of *Lissotes helmsi*).

Diagnosis. Length: males (including mandibles) 17.5–44.0 mm, (excluding mandibles) 15.5–34.3 mm; females (including mandibles) 16.5–27.5 mm, (excluding mandibles) 15.2–24.2 mm. Width: males 8.0–21.5 mm, females 8.1–14.0 mm. Small to very large, robust, with dull or glossy, black or brownish black integument (Fig. 136, 137). Punctures on head and pronotum small and dense in females and small males, minute and sparse to moderately dense in largest males; setae minute, erect, visible in some large punctures, not discernible in minute punctures. Elytra each with 5 longitudinal, raised, densely punctate, setose narrow ribs alternating with broad integumental bands that have more widely spaced, larger, setose punctures; all setae branched, erect, brown, usually longer and more conspicuous on ribs, usually most conspicuous in large males, often abraded on dorsum. Male mandibles arched laterally, with horizontal dorsal apical tooth, downwardly directed ventral subapical tooth and near base a short erect or horizontal laminate lobe arising dorsally or ventrally. Female

mandibles arched laterally, almost parallel-sided, tridentate apically, carinate on dorsolateral margin with rudimentary tooth on dorsomedial edge near base. Postocular margin in males with small conical projection protruding at most only slightly beyond eye, postocular margin in females lacking projections and not protruding beyond eye. Front tibia moderately slender in males, moderately broad in females, straight or slightly curved, not arched, expanded gradually. Middle and hind tibiae straight, expanding gradually; mid dorsal spine if present small and single-tipped; ventral setiferous patch absent.

Redescription

Head (Fig. 436, 437) widest behind eyes in largest males, across eyes in females and small males. **Dorsal surface** dull to glossy; frons weakly depressed, slightly uneven; vertex slightly convex, uneven; **punctures** sharply defined, deep, small, dense in smallest males, shallow, minute and moderately dense in largest males, deep, mostly moderately large and dense to very dense in females; most punctures with minute or short, erect, sometimes barely visible setae; preocular margin straight, rounded, or obtusely angulate, usually rimmed in females, usually lacking rim in males; integument immediately in front of eye strongly depressed and markedly laminate; postocular margin in males straight or slightly indented immediately behind eye, then produced laterally into a short, horizontal cone, minute in smallest specimens; postocular margin in females straight, rounded, or slightly indented, neither lobed nor laminate. **Labrum** somewhat rectangular, 1.4–1.7× wider than long in males, 2.0–2.3× in females; surface in males smooth with a few punctures in smallest specimens, without punctures in largest; surface in females slightly uneven, with small, dense punctures containing minute setae; distal margin rounded, weakly and uniformly trilobed, or rounded and with minute median projection; labral suture well defined. **Mandibles of males** (Fig. 436, 438–441) deep at base, small, short, stout and slightly curved laterally in small specimens, long, slender and strongly arched in large specimens; punctures mostly minute, moderately dense in largest specimens, dense in smallest specimens, apparently lacking setae; both mandibles with strong horizontal, dorsal apical tooth that has a weak subapical ventral flange (barely distinguishable in some very small specimens), strong, undivided or variably bilobed, downwardly directed ventral tooth that arises near middle of mandible in smallest specimens, closer to base in largest specimens, and short, blunt, laminate lobe, either horizontal or obliquely erect, arising either dorsally or ventrally near mandible base; some specimens additionally with 1 or 2 rudimentary conical protuberances and/or a vestigial longitudinal ridge dorsally on basal 1/2 of 1 or both mandibles. **Mandibles of females** (Fig. 2, 437) short, curved, almost paral-

lel-sided; dorsolateral edge carinate; punctures, small, mostly dense, some confluent, containing minute setae; both mandibles with apical dorsal, subapical ventral, and subapical dorsal teeth, (the latter rudimentary in left mandible) and minute tooth on dorsomedial edge near base. **Antennae** (Fig. 442) approximately the same in males and females; pedicel stout, curved, about 1.6× longer than wide in males, about 1.1× in females; funicle segments slightly asymmetrical; approximate length/width values for funicle segments 1–5 respectively 1.2, 1.1, 1.2, 0.9, 0.7 in males, 0.9, 0.7, 0.8, 0.6, 0.4 in females; club 1.5–1.8× longer than wide. **Eyes** protruding beyond pre- and post-ocular margins in females and small males, not protruding in large males; anterior canthus 0.2–0.4× length of eye; posterior canthus absent. **Mentum** (Fig. 2) trapezial with very convex lateral margins, 2.2–2.9× wider than long in males, 2.0–2.2× in females; ventral surface flattened or slightly concave; 4th segment of maxillary palp flattened ventrally in females, strongly concave ventrally in males (Fig. 443), 2.4–3.0× longer than wide in males, 3.0–4.0× in females; 3rd segment of labial palp 2.9–3.0× longer than wide in males, 3.0–4.0× in females.

Thorax. Pronotum moderately to very glossy, 1.7–2.2× wider than long in males, 1.4–1.6× in females, 1.0–1.3× as wide as head in males, 1.4–1.6× in females; **punctures** sharply defined, moderately deep, small and dense in females and small males, shallow, minute and sparse to moderately dense in large males; setae short in females and small males, mainly minute in large males; disc flattened in males, slightly convex in females; brim absent or narrow anteriorly and broad posteriorly in males, narrow throughout its length in females; anterior margin slightly convex on middle 1/3rd; front angles distant from eyes in larger males, almost reaching posterior margin of eyes in females and smallest males; sides straight and parallel in smallest males, slightly convex but markedly convergent posteriorly in large males, convex near middle in females. **Elytra** glossy, rather parallel-sided, tapering towards apex in males, not in females, 1.1–1.3× longer than their combined width, 1.1–1.4× as wide as pronotum in males, 0.9–1.1× in females; each elytron with 5 variably raised, evenly spaced, narrow, longitudinal ribs that have small, deep, dense to very dense punctures containing conspicuous short to moderately long, erect brown, prominently dendritic setae (Fig. 24, 36); intervening tracts very broad, flattened, with small to moderately large, deep, mostly moderately dense punctures containing short, erect, relatively inconspicuous setae; elytral setae easily abraded, especially on dorsum; brim broad, deeply concave; rim punctures small, very dense, rather shallow, mostly poorly defined, irregularly aligned in about 6 rows anteriorly and posteriorly but fewer rows near middle, their setae long. **Wing** (Fig. 49)

0.2–0.4× elytral length; cubitus vestigial, medial recurrent and radial recurrent indistinguishable. **Front tibia** in males (Fig. 444) almost straight, slightly constricted at base then expanding gradually towards apex, in females (Fig. 445) straight or slightly curved, gradually expanded from base; dorsal edge with large apical tooth, moderately large sub-apical tooth and 4–7 small teeth decreasing in size towards tibial base; ventral apical spine absent or very small in females and small males, moderately long in largest males but not visible in anterodorsal aspect; details of coxal fringe and femoral setiferous patch shown in Fig. 53, 55–58. **Middle tibia** gradually expanded from base; longitudinal setiferous rows containing both simple and dendritic setae; mid dorsal spine moderately large, longitudinal, laminate, usually single-tipped, integument under spine flattened, not concave; ventral margin straight; ventral setiferous patch absent; spurs shiny, not striated, subcylindrical proximally, flattened towards apex; anteroventral spur slightly curved at tip; posteroventral spur 1.2–1.4× as long as anteroventral spur, about 1.4× as long as adjacent 1st tarsomere. **Hind tibia** (Fig. 446) similar to middle tibia but longer and with mid dorsal spine very small or absent; spurs cylindrical near base then conspicuously laminate, shiny, not striated; posteroventral spur 3.9–4.7× longer than wide in males, 3.2–5.2× in females, 1.6–1.7× as long as anteroventral spur in males, 1.4–1.6× in females, and 1.5–1.7× as long as adjacent 1st tarsomere in males, 1.7–2.0× in females. **Arolia** of all legs usually with 2 setae or rarely with 1 or 3 on either side of apex.

Abdomen. Ventrites (Fig. 2) glossy; sides of ventrites 2–4 and anterior 0.2–0.6 of free margin of ventrite 5 with broad rim separated from remainder of ventrite by at most a shallowly impressed line; punctures sharply defined in females and small males, weakly defined in large males, rather shallow, minute or small, and moderately dense on ventrites 1–4, small and mostly dense on ventrite 5; setae long near apex of ventrite 5, short elsewhere.

Male genitalia. 9th abdominal segment (Fig. 646); apex of tergite straight or slightly indented; apex of ventrite shallowly notched. **Permanently everted internal sac** (Fig. 647) terminating in elongate boat-shaped expansion; **gonopore** oval, submarginal on midline in a circular depression between pair of broad sclerites positioned distally on convex surface of internal sac. **Parameres** with ventral margin sclerotised normally, not translucent; structure and arrangement of microsetae on concave surface and margin of paramere shown in Fig. 648.

Female genitalia (Fig. 709). **Accessory gland** moderately long, tubular; bursal duct short, narrow; **bursa copulatrix** very large, longitudinally folded, with very short, tapering lobe continuous with short, narrow spermathecal duct; **spermatheca** relatively small; spermathecal gland

short, oval, with very narrow duct.

Type data. The holotype of *Lissotes helmsi* Sharp is in BMNH. It is a male, 22.5 mm in length (including mandibles) and labelled as follows: (1) *Lissotes Helmsi*. Type D. S., Greymouth New Zealand, 1880; (2) TYPE; (3) Greymouth [BR, 42° 27'S, 171° 12'E], New Zealand. Helms; (4) Sharp Coll. 1905–313.

Syntypes of *Lissotes acmenus* Lewis: This species was described by Lewis from “a good series of males” sent to him by Mr G. Howes (presumably the collector) of Invercargill, SL (46° 25'S, 168° 22'E, presumably the type locality). The whereabouts of these specimens are unknown. In the original description Lewis mentioned that Sharp considered *acmenus* to be identical with *helmsi* but 30 years elapsed before it was formally synonymised with this species by Gilbert Arrow (1935).

Holotype of *Lissotes aemulus* Broun: The specimen is in BMNH. It is a female measuring 20.8 x 9.9 mm (including mandibles) and has the following labels: (1) SYNTYPE [BMNH label]; (2) Type [BMNH label, reversed on pin]; (3) Boatmans Westland [BR, 42° 00'S, 171° 53'E]; (4) *Lissotes aemulus* [Broun's handwriting]; (5) New Zealand, Broun Coll., Brit. Mus., 1922 – 482; (6) HOLOTYPE *Lissotes aemulus* Broun, 1893, female, Det. B. A. Holloway 1991. In the original description Broun noted that the specimen was “found by Mr A. T. Cavell at a landslip, Fox's Creek, October 1889.” *L. aemulus* was synonymised with *helmsi* Sharp by Holloway (1961).

Material examined. Primary types of *helmsi* and *aemulus* and 537 non-type specimens (304 males, 233 females) (AMNZ, BMNH, MONZ, NZAC).

Distribution (Map 24). Northernmost record: Kohaihai River mouth, NN (latitude 41° 07'S); southernmost record: Murderer's Cove, Big South Cape I, SI (latitude 47° 15'S), from near sea level to about 1400 m.

— / NN, WD, FD, DN, SL, SI (including Codfish, Big Stage, Long, Big South Cape, Owen, and Solander Islands)

Map 24 includes records from Emberson (1975), Patrick *et al.* (1986, 1987), Patrick (1988), and Trewick (2000). In his book entitled “Insects of Australia” Goode (1980) included an illustration taken from Tillyard (1926) of this species (as *Lissotes acmenus*). In the absence of explanatory text it could be erroneously assumed that *G. helmsi* is part of the Australian fauna.

Biology. Adults have been collected throughout the year. They are most active at night when they have sometimes been seen feeding on sap exuding from trunks of broad-leaved trees (Holloway 1961, 1963) but they may also move about in daytime especially in wet weather. Usually during the day they shelter on the ground under logs and among leaf litter and moss, in moss covered cavities in

standing trees, in soil at the bases of tree trunks, and in other similarly moist situations. On Stewart Island Fukinuki (2001) found males and females in tunnels below ground level; one female was moving along a tree root at a depth of 15 cm. At the same locality he also discovered eggs at a depth of 5 cm and a larval chamber some 10 cm below the ground surface. Gut contents of larvae that I have examined consist of soil with scarcely any recognisable plant material. The duration of the larval stage and the life span of adults are unknown. Males and females can be found at all times of the year suggesting that they may be quite long lived. If erosion of the front tibial teeth, through burrowing, is an indication of longevity in *G. helmsi* as it is in some South African Tenebrionidae (Endrödy-Younga 1988) then a few of the females I examined must have been several years old when collected. Four males and 3 females, all in NZAC, have deformed legs, or antennae, or an asymmetrical head.

Remarks. Males of *G. helmsi* are most easily distinguished by their straight, not arched, front tibiae, gradually expanded middle and hind tibiae, the small conical projection on the postocular margin, and the 5 conspicuously setose ridges on each elytron. Females are characterised by their straight, gradually expanded front tibiae, protruding eyes, and the setose ridges on the elytra.

G. helmsi is the most widespread species of the genus having been found at various localities in the west, south, and east of the South Island, and from the Stewart Island area. On the eastern side of the South Island it has been found as far north as Tapanui (SL). In my earlier revision (Holloway 1961) I considered the species to show clinal variation in body size, because in the material studied all the specimens from the northernmost part of the range were small and those from the Stewart Island area all were large. Now that I have been able to examine a great many more specimens it has become apparent that while only small specimens are known from the northern extremity of the range, both large and small specimens occur elsewhere. A long series from Bauza Island (FD) includes the smallest and some of the largest specimens examined. The quality and abundance of soil available to larvae during their development must greatly influence the size of the beetles into which they transform and may explain why some very large adults have been found on sea bird inhabited islands that have deep, moist, guano-enriched soil. *G. helmsi* occurs over a wide altitudinal range encompassing a variety of vegetational types, all with high rainfall, from the sparsely clad coastal strip near Bluff (SD) to the alpine tussock of Red Hill (WD). A survey carried out along a north-south transect across the marine terraces, west of Te Waewae Bay (FD), recorded adults of *helmsi* in all zones from near sea level to 460 m (Patrick 1988).

Over a large part of its range *G. helmsi* is surviving in the presence of two species of rats and in some places with three. The ship rat (*Rattus rattus*) is widespread in both the South Island and Stewart Island; Norway rats (*R. norvegicus*) are present on Stewart Island and have a patchy distribution in the South Island, including parts of Fiordland; and kiore (*R. exulans*) are known from Stewart Island and parts of Fiordland (Taylor 1978). Such coexistence does not happen on small islands. Bremner *et al.* (1984) studied the density of indigenous invertebrates in relation to the presence of introduced mammals on Resolution Island (20860 ha), Gilbert No. 6 Island (20 ha), and Breaksea Island (170 ha), three islands with similar soils, climate, and vegetation in Breaksea Sound (FD). Using standard sampling techniques they found that the mean number of *G. helmsi* per 100 square metres on Resolution Island, apparently rat free at the time but with *R. norvegicus* prior to 1902, was 11 specimens, and on Gilbert No. 6 Island, apparently always rat free, was 8 specimens. On Breaksea Island where *R. norvegicus* had been established for many years, neither adults nor larvae of *helmsi* were found but the discovery of fragments of adult mandibles and elytra in the leaf litter “where they may persist for years, show that this species was once present.” The largest adults in the material examined were from Bauza Island in Fiordland and Big Island (also known as Stage Island) off the west coast of Stewart Island, both rat free islands. Emberson (1975) found remains of about 30 specimens of *G. helmsi* on the summit of Mt Gog (SI), down one side of a small granite rock. Because the site resembled an “anvil stone” he concluded that the beetles had been caught by a song thrush (*Turdus musicus*), but it is more likely that the site was a rat feeding station. Philpott (1919) reported seeing large stag beetles, undoubtedly *G. helmsi*, being eaten by the “black” weka (*Gallirallus australe*) in southwest Otago.

***Geodorcus ithaginis* (Broun) Mokohinau stag beetle**

Fig. 84, 138, 139, 447–455, 649, 650, 710. Map 25
ithaginis Broun, 1893: 1108 (*Lissotes*). Holloway 1961: 32, frontispiece 8, 9, fig. 37–40, 107, 111, 117 (*Dorcus*); 1963b: 102, fig. 4, 20 (*Dorcus*); 1996: 62 (*Geodorcus*).

Diagnosis. Length: males (including mandibles) 25.5–32.8 mm, (excluding mandibles) 20.5–24.8 mm; females (including mandibles) 20.0–22.5 mm, (excluding mandibles) 18.0–20.5 mm. Width: males 10.4–12.6 mm, females 9.4–11.4 mm. Medium-sized to large, robust, with dull or moderately glossy black integument (Fig. 84, 138, 139). Punctures on head minute, moderately dense to sparse and barely discernible in males, small and dense in females; setae erect and minute or short in small punctures, indiscernible in

minute punctures. Elytra not ribbed, entirely covered with small dense punctures containing short setae. Male mandibles very slightly curved laterally, tridentate apically, with conspicuous, erect mid dorsal tooth. Female mandibles laterally arched, deep dorsoventrally, somewhat wedge-shaped, carinate on proximal dorsolateral margin, bidentate apically, with erect mid dorsal tooth. Postocular margin projecting beyond eye, with 2 small lobes in males, truncate, rounded, or slightly sinuous in females. Front tibiae long, straight, very slender, and almost parallel-sided in males, slightly curved, moderately broad, gradually expanded from base in females. Middle and hind tibiae straight, slender, gradually expanded; mid dorsal spine small and single-tipped; ventral setiferous patch absent.

Redescription

Head (Fig. 447, 448) widest behind eyes. **Dorsal surface** moderately glossy; frons smooth and barely depressed in males, uneven and slightly depressed in females; vertex slightly convex, smooth in males, uneven in females; **punctures** rather shallow with obscure margins, mostly minute and sparse to moderately dense in males, small and dense in females, most containing minute erect setae (barely visible at $\times 45$). Preocular margin slightly convex or sinuous; integument immediately in front of each eye barely depressed in males, distinctly depressed and laminate in females; postocular margin with 2 small, obtusely angulate, laminate, horizontal lobes in males (Fig. 449), with truncate, rounded, or slightly sinuous, laminate, horizontal lobe in females. **Labrum** rectangular, 2.3–2.4 \times wider than long in males, about 2.0 \times in females; surface slightly uneven, with broad band of small dense punctures distally containing short or moderately long setae; distal margin trilobed, weakly in males, more strongly in females; labral suture well defined. **Mandibles of males** slender, slightly curved, not deep dorsoventrally; punctures dense to moderately dense, on basal 1/2 minute or small and containing a minute seta, on apical 1/2 minute and apparently lacking setae; both mandibles with dorsolateral ridge near base and long apical ventral, long apical dorsal, moderately long subapical ventral, and long inwardly directed, obliquely vertical mid dorsal teeth, all single-tipped. **Mandibles of females** somewhat wedge-shaped, with upturned external basal lobe; punctures weakly defined, mostly small, dense and with minute setae; both mandibles with long apical, short subapical, and moderately long, obliquely vertical mid dorsal teeth; right mandible additionally with rudimentary subapical dorsal tooth. **Antennae** (Fig. 450) approximately the same in males and females; pedicel slender, about 1.7 \times longer than wide in males, about 1.4 \times in females; funicle segments 1 and 2 approximately symmetrical, segments 3–5 asymmetrical; approximate length/width values for funicle segments 1–5 respectively 1.4,

1.6, 1.3, 1.0, 0.9 in males, 1.1, 0.9, 0.8, 0.6, 0.5 in females; club about 1.9 \times longer than wide in males, about 1.5 \times in females. **Eyes** not protruding; anterior canthus about 0.5 \times length of eye in males, about 0.2 \times in females; posterior canthus about 0.2 \times length of eye in males, about 0.4 \times in females. **Mentum** trapezoidal, 2.6–3.0 \times wider than long in males, about 2.5 \times in females; lateral margins straight in males, convex in females; distal margin with shallow median indentation; 4th segment of maxillary palp (Fig. 451) flattened ventrally, about 3.8 \times longer than wide in males, about 2.7 \times in females; 3rd segment of labial palp 3.3–3.4 \times longer than wide.

Thorax. Pronotum moderately glossy, about 2.0 \times wider than long in males, about 1.6 \times in females, about 1.1 \times wider than head in males, about 1.4 \times in females; **punctures** rather shallow with somewhat obscure margins, in males minute to small, dense to moderately dense, largest and most dense posteriorly and in brim, in females more or less uniformly small and dense; setae minute in smallest punctures, short in largest; disc flattened; brim narrow; anterior margin slightly convex on median 1/3rd; front angles distant from eyes; sides in males parallel over anterior 0.6 then convergent, in females slightly divergent posterad over anterior 0.6 then convergent. **Elytra** rather dull, parallel-sided, rounded posteriorly, 0.9–1.0 \times width of pronotum, length about equal to their combined width; ribs absent; entire surface almost uniformly covered with small, sharply defined, deeply impressed, dense punctures containing short, distinctly dendritic setae; brim absent posteriorly, well defined and slightly sloping anteriorly but not concave, with small to moderately large, discrete or coalescent punctures containing moderately long setae; rim punctures very small, shallow, poorly defined, mostly coalescent, irregularly aligned in about 4 rows near humeral angle, in 2 or 3 rows on remaining anterior 1/2 of rim and in single uneven row posteriorly; their punctures containing moderately long setae. **Wing** (Holloway 1963b, fig. 4) 0.41–0.54 \times length of elytron; cubitus and medial recurrent vein absent, radial recurrent vein vestigial. **Front tibia** straight and almost parallel-sided in males (Fig. 452), slightly curved and uniformly expanded in females (Fig. 453); dorsal edge with large apical tooth, moderately large subapical tooth and 3 or 4 very small, evenly spaced teeth; ventral apical spine minute or absent. **Middle tibia** (Fig. 454) expanded gradually from base; longitudinal setiferous rows with simple and branched setae; mid dorsal spine small, longitudinal, somewhat laminate, single-tipped; integument under spine, flattened not concave; ventral margin not excavated; ventral setiferous patch absent; spurs subcylindrical proximally, flattened towards apex, shiny, with weak, obliquely longitudinal striations (visible at $\times 70$); anteroventral spur almost straight-tipped; posteroventral spur about 1.3 \times

longer than anteroventral spur and about as long as adjacent 1st tarsomere. **Hind tibia** (Fig. 455) longer than middle tibia but with similar shape and vestiture; spurs cylindrical basally, flattened dorsally towards apex, shiny, weakly striated; posteroventral spur about 5× longer than wide, about 1.8× longer than anteroventral spur and about 1.7× longer than adjacent 1st tarsomere. Arolia of all legs with 1 seta or rarely 2 on either side of apex.

Abdomen. Ventrites moderately glossy; sides of ventrites 2–5 with broad shiny rim separated by groove from remainder of ventrite; punctures small, sharply defined, moderately deep, sparse (males) or moderately dense (females) on sides of ventrites 1–4, dense elsewhere; setae near apex of ventrite 5 moderately long, short elsewhere.

Male genitalia. 9th abdominal segment (Fig. 649); apex of tergite truncate; apex of ventrite shallowly notched. **Permanently everted internal sac** (Fig. 650) terminating in large saucer-shaped structure with bilaterally symmetrical dorsal and ventral lobes; **gonopore** pear-shaped, located on midline inside dorsal lobe, near sclerotised, semicircular, marginal rim. **Parameres** without translucent cuticular area on ventral margin.

Female genitalia (Fig. 710). **Accessory gland** moderately long, saccate; bursal duct moderately long, broad; **bursa copulatrix** large, longitudinally folded, with short, broad, tapering lobe continuous with short, very narrow spermathecal duct; **spermatheca** long, narrow, strongly curved; spermathecal gland short, narrow, not strongly demarcated from its narrow duct.

Type data. *Geodorcus ithaginis* was described from a complete female and fragments of a male collected on Halodroma Islet, in the Mokohinau Islands, ND (35° 55'S, 175° 10'E) by Mr P. Sandager. The female, measuring 21.0 x 10.2 mm (including mandibles) is in the Broun Collection (BMNH) and is accompanied by the following labels: (1) SYNTYPE [BMNH label]; (2) Type [BMNH label, reversed on pin]; (3) New Zealand, Broun Coll., Brit. Mus., 1922–482; (4) Halodroma Islet (Moko.); (5) Lissotes ithaginis [Broun's handwriting]; (6) 1966. Female [Broun's handwriting]; (7) LECTOTYPE Lissotes ithaginis Broun, 1893, female Det. B. A. Holloway 1991. The fragments of the male paralectotype have not been located and even if they had been there would be no justification for giving them lectotype status.

The name "Halodroma Islet" does not appear on any published maps that I have seen, but some years ago Mr E. G. Turbott, formerly of the Auckland Institute and Museum, told me that this probably was the local name for the small, flat area now called Lizard Island lying 40 m SE of Burgess Island. *Halodroma* is the former name of the diving petrel, *Pelecanoides urinatrix*, which at the time of the discovery of *G. ithaginis* was breeding in the Mokohinau

Group "on three of the smaller comparatively low islands, where it forms its burrows in the peat-like substance consisting of light soil and decayed *Mesambryanthemum* with which they are covered" (Sandager 1890). In the original description Broun mentions that the adults of *ithaginis* also burrow through the peat-like layer, 8–10 inches in thickness, formed by *M. australe* (now known as *Disphyma australe*).

Material examined. Lectotype female, 10 non-type specimens (4 male, 6 females), and fragments of a male and a female (BMNH, MONZ, NZAC).

Distribution (Map 25). Mokohinau Islands (latitude 35° 55'S, 175° 07'E), close to sea level.

ND / —

Hudson (1934) gives the highly unlikely Remarkable Mountains in Central Otago as an additional locality for *G. ithaginis*.

Biology. Live adults have been collected in January and May.

Remarks. Males and females of *Geodorcus ithaginis* can be distinguished from those of *G. alsobius*, the morphologically most similar species, and all the other known species of the genus by the single-tipped, obliquely erect, dorsal tooth near the middle of the mandible. The species is apparently confined to the Mokohinau Islands, and is poorly represented in collections. Until January 1984, when a live male and fragments of a female were found on "Stack H", SW of Burgess Island (see Wright 1980, fig. 1 for place names in the Mokohinau Group), the most recently collected specimens were those taken in May 1902 by the entomologist J. H. Lewis. The difficulty of getting to Burgess Island (where, since 1883 there had been a lighthouse), then to outlying islands had discouraged entomologists from trying to visit the Group. Consequently our knowledge of past and present insect faunas of the islands and stacks is limited although it should be noted that F. Sandager, the Assistant Lighthouse Keeper on Burgess Island in the 1880s, collected 130 species of Coleoptera of which "one-third proved to be new" (Sandager 1890). I am aware of only two specifically entomological field trips to the area prior to 1991, each of fewer than five days' duration, since Lewis's visit: R. A. Harrison in August 1955 and G. Kuschel in late February and early March 1978. Harrison, who visited Burgess, Fanal, and Lizard islands, was mainly interested in collecting Diptera, but Kuschel actively searched for *G. ithaginis* without success on Burgess, Fanal, Lizard, Maori Bay, and Trig islands. The live male found on "Stack H" (about 1.2 ha) was collected by members of the Auckland University Field Club, whose main interest was to record reptile species of the Mokohinau Islands and look for evidence of kiore (*Rattus exulans*) on the islands (McCallum 1980; Wright 1980).

From 1991 to 1994 a group Department of Conservation staff spent four weeks searching specifically for *ithaginis* on the main islands and stacks in the Mokohinau Group. They found (and left) three live females among dried pohutukawa leaves in litter on “Stack H” where they also collected fragments of several males, none showing signs of rat predation. There was no evidence of *ithaginis*, even as fragments, at any of the other places visited during the surveys (Sherley *et al.* 1994; McGuinness 2001). While it is premature to say that *ithaginis* is not present on the larger islands of the Mokohinau Group, prospects for its survival on these do not look good because of the loss of habitat and also possible rodent predation. During much of the 19th and 20th centuries the vegetation of the islands was grossly modified (Esler 1978). It was “burnt by muttonbirders and fishermen, browsed by goats and more recently by the lighthousekeeper’s livestock” (McCallum 1980). Of a total of seven islands and stacks visited in 1979 by the Auckland University Field Club only “Stack H” was found to be free of kiore (McCallum 1980; Wright 1980). Kiore are known to eat a variety of invertebrates ranging in size from small ants to large solitary insects such as tree weta (*Hemideina* spp.) (Campbell *et al.* 1984). Until 1977 Lizard Island, the type locality of *G. ithaginis*, had remained virtually unmodified by man and his associates. However, early in that year kiore were found to have reached this small island (0.8 ha). In May 1978, rat poison was laid, and in May 1979 when the Field Club visited the island, there was very little evidence of rats (McCallum 1980). If *ithaginis* had been present on Lizard Island up to 1977 it could be expected that, following the kiore invasion, there would have been a dramatic decline in the number of its adults, through predation, but the species may have survived through its larval and pupal stages which are subterranean and therefore somewhat protected. The duration of the immature stages is unknown but in total is likely to be at least a year and perhaps several years. No rats or fresh rat sign were seen on Lizard Island in a survey carried out in December 1983 to January 1984 so the poisoning programme apparently was successful (McCallum 1986) but to date no *ithaginis* specimens have been found there either.

Conservation status. *Geodorcus ithaginis* has been given legal protection from collectors but that alone will not ensure its survival. The Department of Conservation has already embarked on a programme to find out the habitat requirements of the species and obtain information on its life history. It sees habitat maintenance and rodent monitoring on “Stack H” as the main management needs for *G. ithaginis* (McGuinness 2001). *G. ithaginis* is listed by Hitchmough (2002) as ‘Nationally Critical’.

Geodorcus montivagus new species

Fig. 140, 456–463, 711. Map 26

Diagnosis. The holotype female is the only known specimen. Length: (including mandibles) 21.1 mm, (excluding mandibles) 20.0 mm. Width: 10.9 mm. Large, robust, with black, somewhat glossy integument (Fig. 140). Head, pronotum, and elytra covered with small to moderately large, dense or moderately dense, sharply defined, deep punctures; setae minute, erect, barely visible except on outer elytral margin where they are moderately large and distinctly dendritic. Inner half of elytron with 3 broad, strongly raised, longitudinal ribs, including sutural rib, with small, moderately dense punctures; ribs alternating with flattened, slightly broader bands that have larger, denser punctures; outer 1/2 of elytron with small, moderately dense punctures and fragments of longitudinal ribs. Mandibles arched, very short, almost parallel-sided, tridentate apically, carinate on dorsolateral margin and with rudimentary tooth on dorsomedial edge towards base. Eye very slightly convex, barely protruding. Postocular margin almost straight, slightly convergent, not projecting beyond outer margin of eye. Antennae very robust; pedicel and funicle segments strongly asymmetrical. Front tibia slightly curved, somewhat parallel-sided on proximal 1/3rd then expanding gradually. Middle and hind tibiae conspicuously flared at apex, with single-tipped mid dorsal spine and ventral, apical setiferous patch.

Description

Head (Fig. 456) widest at anterior canthus. **Dorsal surface** moderately glossy; frons uneven, weakly depressed; vertex flattened, punctures sharply defined, deep, small to moderately large, moderately dense to dense, most containing minute or short setae, largest **punctures** and longest setae on sides of head; preocular margin convex, rimmed; integument immediately in front of each eye moderately depressed, distinctly laminate; postocular margin almost straight, convergent, not lobed, not laminate. **Labrum** pentagonal, 1.9× wider than long; surface smooth; apical 1/2 with a few punctures containing minute setae; centre of apical margin prominently angulate; labral suture well defined. **Mandibles** short, slightly arched, almost parallel-sided, weakly carinate on dorsolateral margin, with rudimentary triangular lobe externally at base; punctures minute, barely discernible, shallow, mostly dense, apparently lacking setae; both mandibles with large apical ventral, small subapical dorsal and small subapical ventral teeth, and very short laminate, inwardly directed lobe on dorsomedial edge towards base. **Antennae** (Fig. 457) robust; pedicel strongly asymmetrical, conspicuously arched, 1.1× longer than wide; funicle segments strongly asymmetrical; approximate length/width values for funicle segments 1–5 respectively 1.0, 1.0, 0.6, 0.5, 0.3; club 1.3×

longer than wide. **Eyes** not protruding but with very slightly convex outer margin; anterior canthus about $0.2\times$ length of eye; posterior canthus absent. **Mentum** trapezoidal with convex lateral margins, $2.3\times$ wider than long; ventral surface slightly concave; 4th segment of maxillary palp (Fig. 458) about $3.6\times$ longer than wide, flattened ventrally; 3rd segment of labial palp (Fig. 459) flattened ventrally, $2.5\times$ longer than wide.

Thorax. **Pronotum** moderately glossy, $1.6\times$ wider than long, about $1.4\times$ wider than head; **punctures** sharply defined, moderately deep, dense, mostly small on disc, mostly moderately large near brim; setae minute on disc, short on brim; disc slightly convex; brim narrow; anterior margin slightly convex on middle 1/3rd; front angles reaching almost to posterior margin of eye; sides slightly convex. **Elytra** somewhat dull, slightly convex laterally, rounded posteriorly, $1.2\times$ longer than their combined width, about equal in width to pronotum; each elytron with 3 strongly raised, evenly spaced, moderately wide, longitudinal ribs and fragments of several others, the ribs with mostly small, deep, dense punctures; intervening integumental tracts flattened, broader than ribs, with moderately large, very deep, dense punctures; all punctures sharply defined and containing inconspicuous, short setae; brim broad, concave, with coalescent punctures; rim punctures somewhat hexagonal, minute or small, very dense, rather shallow, well defined, irregularly aligned in about 4 rows anteriorly, 5 rows near middle, 3 rows posteriorly and containing moderately long setae (many abraded). **Wing** (Fig. 460) $0.4\times$ length of elytron; cubitus and radial recurrent vein vestigial, medial recurrent vein absent. **Front tibia** (Fig. 461) slightly curved, relatively broad and almost parallel-sided on proximal 1/3rd then expanding gradually to apex; dorsal edge with rather short apical and subapical teeth and 4 smaller teeth decreasing in size towards tibial base; ventral apical spine absent. **Middle tibia** (Fig. 462) gradually expanded from base to flared apex, except for constriction beyond dorsal spine; dorsal longitudinal setiferous rows with branched and simple setae; mid dorsal spine large, laminate, oblique, single-tipped; integument underlying mid dorsal spine flattened, not excavated; ventral setiferous patch present on distal 0.2, its setae only moderately dense; spurs cylindrical on basal 1/3rd then flattened, their surface shiny, not striated; anteroventral spur with straight tip; posteroventral spur $1.8\times$ length of anteroventral spur and $1.5\times$ length of adjacent 1st tarsomere. **Hind tibia** (Fig. 463) similar in shape and vestiture to middle tibia except longer with mid dorsal spine transverse and smaller, ventral setiferous patch smaller, and without constriction at mid dorsal spine; spurs cylindrical proximally, flattened distally; posteroventral spurs damaged in this specimen. Arolia with 2 setae on either side of apex.

Abdomen. **Ventrites** moderately glossy; sides lacking rim and groove; punctures small, sharply defined, rather shallow and mostly sparse on ventrites 1–4, deeper and dense to very dense on ventrite 5; setae moderately long on apex of ventrite 5, elsewhere minute or short.

Female genitalia (Fig. 711). **Accessory gland** long, oval; **bursal duct** long, widening towards bursa copulatrix which is broad, longitudinally folded and has a conspicuously long, tapered lobe that is continuous with the extremely short spermathecal duct; **spermatheca** long, narrow, curved; spermathecal gland short, oval, its duct very long and narrow.

Type data. Holotype female (21.1 x 10.9 mm, including mandibles), with left wing and macerated genitalia in accompanying minival: New Zealand, BR, Victoria Range (approximately $42^{\circ} 06'S$, $172^{\circ} 07'E$), 4000 feet (1220 m), in tussock, 30 January 1973, R. K. Jordan. The specimen lacks 2 tarsal segments on the right front leg and left hind leg, 3 on the left middle leg, and 4 on the right hind leg. The posteroventral spur is broken on the left hind leg and missing on the right hind leg. There are 2 Victoria Ranges in New Zealand, the northernmost in BR runs north–south from east of Reefton, and the other, a much shorter range in WD runs west–east from east of Fox Glacier. The type specimen was labelled “Victoria Range” without any other reference point. I have tentatively selected the Victoria Range in BR as the type locality because its long history of tracks and huts makes it a more likely place to be visited by trampers than does its namesake in WD which appears from maps to lack those facilities and is very difficult to access.

Material examined. Holotype only (NZAC).

Distribution (Map 26). The Victoria Range (approximate latitude $42^{\circ} 06'S$ at 1200 m) is over 30 km long from north to south and includes more than 10 peaks between 1100 and 1640 metres in height.

— / BR

Remarks. Characters for identifying females of *G. montivagus* are given in the key to species and the diagnosis. This is the only known species of *Geodorcus* that has setiferous patches on the middle and hind tibiae of females. Similarly located but more extensive patches are present in males of *G. servandus* and *G. philpotti*, and will almost certainly be a feature of *montivagus* males. It can also be expected that the antennae of males will resemble those of females in having extremely asymmetrical funicle segments and a strongly arched pedicel. The morphologically closest species, based on females, are *G. philpotti* and *G. servandus*. The distribution of major character states in females of the three species is given in Appendix 3B, p. 131.

Etymology. The specific epithet, *montivagus*, is a Latin word meaning “mountain wanderer”.

***Geodorcus novaezealandiae* (Hope)**

Fig. 25, 35, 48, 54, 59, 64–66, 69, 141, 142, 464–470, 651–653, 712. Map 27

novaezealandiae Hope, 1845: 25 (as *Lucanus Novae Zeelandiae*). Gemminger & Harold 1868: 963 (*Lissotes*). Parry 1873: 340 (*Lissotes*). Sharp 1884: 221 (*Lissotes*). Hudson 1934: 160 (*Lissotes*). Holloway 1961: 22, frontispiece 5, 6, fig. 22, 23, 104, 109, 114, 120, 121 (*Dorcus*); 1963b: 102, fig. 2, 19 (*Dorcus*); 1996: 62, fig. 1, 2, 4 (*Geodorcus*).

abditus Broun, 1881b: 673 (*Dorcus*). Sharp 1884: 221 (*Lissotes*). Holloway 1961: 22 (synonym of *Dorcus novaezealandiae*).

caviceps Westwood, 1855: 212, pl. 12, fig. 6, 7 (*Sclerostomus*). Gemminger & Harold 1868: 963 (synonym of *Lissotes novaezealandiae*).

punctulatus White, 1846: 9 (*Dorcus*). Gemminger & Harold 1868: 963 (synonym of *Lissotes novaezealandiae*). Parry 1873: 340 (*Lissotes*). Broun 1880: 251 (*Dorcus*). Sharp 1884: 221 (*Lissotes*).

Diagnosis. Length: males (including mandibles) 12.0–21.5 mm, (excluding mandibles) 11.0–18.7 mm; females (including mandibles) 11.0–17.4 mm, (excluding mandibles) 10.0–16.3 mm. Width: males 4.8–8.6 mm, females 4.8–7.7 mm. Small to medium-sized, slender, with dull or moderately glossy, black integument (Fig. 141, 142). Entire dorsal surface mostly densely punctate. Setae erect, minute in most punctures, most apparent on sides of pronotum and elytra and on elytral declivity. Frons and vertex deeply depressed. Each elytron with 4 or 5 very low, narrow, shiny ribs. Male mandibles deep, barely arched laterally and including conspicuous broad, erect, slightly recurved, apical tooth. Female mandibles very short, slightly arched, somewhat parallel-sided, both with apical and subapical teeth, right mandible with additional rudimentary subapical tooth or ridge. Postocular margin with conical lobe in males, not lobed in females. Front tibia moderately slender in males, broad in females, straight or slightly curved, not arched. Middle and hind tibiae gradually expanded; mid dorsal spine when present small, longitudinal, single tipped; ventral setiferous patch absent.

Redescription

Head (Fig. 464, 465) widest behind eyes in large males, near middle of eyes in females and small males. **Dorsal surface** dull to moderately glossy; frons and vertex smooth, deeply concave; **punctures** small, mostly deep and sharply defined, dense to very dense in females and small males, sparse to dense in large males, most containing minute erect setae. Preocular margin slightly convex; integument immediately in front of each eye strongly depressed and laminate; postocular margin with large conical lobe in males, straight or very slightly convex in females. **Labrum** somewhat rectangular, 2.1–2.3× wider than long in males, 1.0–

2.0× in females; surface uneven with irregular, submarginal row of small, very dense or coalescent punctures containing moderately long setae; distal margin variably trilobed; labral suture well defined. **Mandibles of males** broad, deep dorsoventrally, barely arcuate; punctures on basal 1/2 small, dense and containing short setae, on apical 1/2 minute, dense to very dense and containing minute setae; both mandibles with short, weakly defined dorsolateral ridge near base and teeth as follows: short, tapering apical ventral; short, tapering (in right mandible) or broad, almost truncate (in left mandible) subapical ventral; short, tapering prebasal ventral; short, tapering (in small specimens) or long, broad, slightly bilobed and laminate (in large specimens) obliquely vertical, apical dorsal and short, tapering prebasal dorsal. **Mandibles of females** short, arched, not lobed externally; with an apical tooth and a subapical ventral tooth; right mandible with indistinct subapical dorsal tooth or ridge. **Antennae** (Fig. 466) approximately the same in males and females; pedicel slender, symmetrical, about 2× longer than wide in males, 1.4× in females; funicle segments almost symmetrical, approximate length/width values for segments 1–5 respectively 1.1, 0.9, 0.9, 0.9, 0.8 in males, 0.9, 0.8, 0.7, 0.6, 0.5 in females; club about 1.8× longer than wide in males, about 1.5× in females. **Eyes** very narrow and elongate in dorsal aspect, not protruding; anterior canthus 0.7–0.9× length of eye in males, about 0.5× in females; posterior canthus absent. **Mentum** rectangular, 2.3–2.6× wider than long in males, 2.2–2.3× in females; lateral margins convex, distal margin with shallow median indentation; 4th segment of maxillary palp flattened ventrally, about 3× longer than wide in males, about 2.5× in females; 3rd segment of labial palp 2.5–2.8× longer than wide in males, about 2.1× in females.

Thorax. **Pronotum** moderately glossy, 1.3–1.5× wider than long; 1.1–1.3× wider than head in males, 1.6–1.7× in females; **punctures** deep, sharply defined, uniformly small and dense except for minute, moderately dense punctures anteriorly in large males; setae minute in smallest punctures, short in largest; disc slightly depressed on midline; brim narrow; anterior margin convex on median 1/3rd, projecting forward very strongly in large males, weakly in females and small males; front angles distant from eyes in males, reaching at least to posterior margin of eyes in females; sides approximately parallel over anterior 0.7 then convergent in males, slightly divergent over anterior 0.7 then convergent in females. **Elytra** moderately glossy, parallel-sided, rounded apically, about 1.3× longer than their combined width, 0.9–1.1× as wide as pronotum; each elytron with 4 or 5 shiny, narrow ribs about 1/2 width of intervening tracts; punctures sharply defined, deeply impressed, small to moderately large, dense to very dense, sometimes coalescent, smallest and least dense on ribs;

setae (Fig. 25, 35) minute to short, longest on posterior declivity and towards sides; brim well defined, concave, many of its punctures coalescent; rim punctures small, shallow, well defined, mainly dense, some coalescent, aligned in a single row except for double row near humeral angle, containing minute setae. **Wing** (Fig. 48) 0.50–0.6× length of elytra; cubitus and vestiges of medial and radial recurrent veins recognisable. **Front tibia** (Fig. 467, 468) gradually expanded from base to apex; dorsal edge with large apical and subapical teeth and 4–11 smaller teeth decreasing in size towards base; ventral edge straight in large males, slightly concave in females and small males; ventral apical spine well developed. Details of femoral setiferous patch and coxal fringe shown in Fig. 54, 59. **Middle tibia** (Fig. 469) gradually expanded from base to apex; dorsal longitudinal setiferous rows containing only simple setae; mid dorsal spine small, longitudinal, laminate, single-tipped; integument under spine flattened not concave; ventral margin straight; ventral setiferous patch absent; spurs subcylindrical except for flattened tip, shiny, striated; tip of anteroventral spur curved in males, straight in females; posteroventral spur about 1.5× longer than anteroventral spur in males, about 2× in females, about same length as adjacent tarsomere in males, about 1.5× its length in females. **Hind tibia** (Fig. 470) resembling middle tibia except mid dorsal spine very small or absent; spurs cylindrical, shiny, striated, with slightly flattened tip; posteroventral spur about 5.6× longer than wide, about 1.9× length of anteroventral spur, about 1.2× length of adjacent tarsomere in males, about 1.7× its length in females. Arolia of all legs with 1 seta on either side of apex.

Abdomen. Ventrites glossy; sides of ventrites 2–5 with broad, shiny rim separated from remainder of ventrite by groove; punctures sharply defined, small, deep, mostly uniformly dense; side of ventrites 2–4 with areas of very dense, extremely fine, pustulate and spiculate projections (visible at ×45) in males but not in females; setae near apex of ventrite 5 long, short elsewhere.

Male genitalia. 9th abdominal segment (Fig. 64, 651); apex of tergite shallowly indented; apex of ventrite deeply notched. **Permanently everted internal sac** (Fig. 65, 652) flattened dorsoventrally, terminating in large saucer-shaped structure with small, elongate-oval **gonopore** located apically and submarginally on its inner surface. **Parameres** with extensive, translucent, cuticular lobe on ventral margin; sclerotised ventral surface of penis divided deeply into 4 finger-like lobes. Dorsal aspect of base of aedeagus shown in Fig. 66, 653.

Female genitalia (Fig. 69, 712). **Accessory gland** moderately long, narrow; **bursal duct** very short, broad; bursa copulatrix with weak longitudinal folds; spermathecal duct arising near rounded apex of small lobe on bursa

copulatrix; **spermatheca** long, broad, strongly curved; spermathecal gland long, narrow, not distinctly demarcated from its duct.

Type data. The nominal species and those synonymised under it were all based on more than one specimen. In order to fix the taxonomic concept of *Novae Zealandiae* Hope, *abditus* Broun, *caviceps* Westwood, and *punctulatus* White I have selected and here designate the following 4 lectotypes.

1. Lectotype of *Lucanus Novae Zealandiae* Hope: The two females on which the species was based are in the Hope Department Collection, Oxford University. The specimen selected as lectotype measures 13.8 × 6.1 mm, including mandibles, and is accompanied by the following labels: (1) N. Zealand; (2) TYPE, HOPE, Cat. Lucan. 1845, P. 25, Coll. Hope Oxon.; (3) TYPE COL: 323 2/2 *Lucanus novae-zealandiae* Hope (Westw.) HOPE DEPT. OXFORD; (4) LECTOTYPE *Lucanus Novae Zealandiae* Hope, 1845, female, Det. B. A. Holloway 1991.

2. Lectotype of *Dorcus abditus* Broun: The species was described from 2 males collected under wood in Wellington, WN (41° 17'S, 174° 46'E) by Mr P. Stewart. They are in the BMNH. Both lack the abdomen. The specimen selected as lectotype measures 14.5 × 5.8 mm, including mandibles, and has the following labels: (1) Syntype [BMNH label]; (2) Type [BMNH label, reversed on pin]; (3) New Zealand, Broun Coll. Brit. Mus., 1922–482; (4) 1175 [Broun's handwriting]; (5) *Lissotes abditus* [Broun's handwriting]; (6) LECTOTYPE *Dorcus abditus* Broun, 1881, male, Det. B. A. Holloway 1991.

3. Lectotype of *Sclerostomus caviceps* Westwood: The male and female syntypes are in the Hope Department Collection, Oxford University. I have selected the male as lectotype. It measures 17.0 × 6.9 mm, including mandibles; the maxillae and labium, dissected some time previously, are glued to a card on the pin. The labels accompanying the specimen are: (1) N. Zealand; (2) W; (3) *Sclerostomus caviceps* Westw. Tr. Ent. Soc. n s 3, pl XII f 7 & 6; (4) TYPE, WESTWOOD, Trans. Ent. Soc. 1855 P. 212, T. 12. fig. 6 & 7, Coll. Hope Oxon.; (5) TYPE COL; 322 1/2 *Sclerostomus caviceps* Westw. HOPE DEPT. OXFORD; (6) LECTOTYPE *Sclerostomus caviceps* Westwood, 1855, male, Det. B. A. Holloway 1991.

4. Lectotype of *Dorcus punctulatus* White: The original description must have been based on more than a single specimen because the length is given as "6 to 7 lines". The only syntype known to me is a male in the collection of BMNH which I have labelled as lectotype. It measures 15.2 × 6.1 mm, including mandibles, and is accompanied by the following labels: (1) SYNTYPE [BMNH label]; (2) Type [BMNH label, reversed on pin]; (3) N. Zealand; (4) *Dorcus punctulatus*, Zool. Erebus & Terror; (5) 85/28; (6)

LECTOTYPE *Dorcus punctulatus* White, 1846, Det. B. A. Holloway 1991.

Material examined. Primary types of *novaezealandiae* Hope, *abditus* Broun, *caviceps* Westwood, and *punctulatus* White, and 116 non-type specimens (64 males, 52 females) (AMNZ, MONZ, NZAC).

Distribution (Map 27). From near sea level to about 365 m. Northernmost record: Akatarawa, WN (latitude 41° 00'S); southernmost record: Siberia [Trig], Aorangi Ra, WA (latitude 41° 22'S).

WA, WN / —

Biology. Adults in the material examined were collected from July to April inclusive, but Moeed & Meads (1985) pit trapped specimens throughout the year in the Orongorongo Valley (WN).

During the day specimens have been found at and below ground level under scaly bark of *Dacrydium cupressinum* (rimu) and under bark of live beech trees (*Nothofagus* species) (Hudson 1934). They sometimes occur in considerable numbers among fibrous roots at the bases of beech trees as well as in old beech stumps (Holloway 1961). Moeed & Meads (1983) caught a few specimens in upward and downward traps set 1.5 m above ground level on trunks of *Meliclytus ramiflorus* (mahoe) and *Elaeocarpus dentatus* (hinau) in the Orongorongo Valley. Several males and females collected at Owhiro Bay (WN) by R. M. Bull were seen to be feeding at the base of the main stem of *Aciphylla* sp. (karamea), and adults kept in captivity fed at the cut surfaces of apples (Holloway 1961). The material examined includes a pair taken *in copula* in mid October. Fitzgerald *et al.* (1986) found remains of *novaezealandiae* in pellets ejected by nestlings of kingfishers (*Halcyon sancta*) in the Orongorongo Valley (WN).

Remarks. *Geodorcus novaezealandiae* is relatively common over a limited latitudinal range in the extreme south of the North Island. It is the smallest species of the genus and is unique in having the frons and vertex depressed in both males and females. Its wings are the least reduced of the 10 species in *Geodorcus*. Mandibles of the males are unusual for the genus in being deep, barely arched laterally, and slightly recurved apically. Males of *G. capito* from The Sisters islands have somewhat similar mandibles but differ markedly from *novaezealandiae* in other morphological features.

Geodorcus philpotti (Broun)

Fig. 143, 144, 471–477, 654, 655, 713. Map 28
philpotti Broun, 1914: 103 (*Lissotes*). Holloway 1961: 30, frontispiece 7, fig. 32–36, 106, 112, 115, 124, 125 (*Dorcus*); 1963b: 102, fig. 7, 19 (*Dorcus*); 1996: 62 (*Geodorcus*).

Diagnosis. Length: males (including mandibles) 20.5–29.0 mm, (excluding mandibles) 17.5–24.2 mm; females (including mandibles) 17.0–23.6 mm, (excluding mandibles) 16.0–21.6 mm. Width: males 9.0–12.9 mm, females 8.0–11.9 mm. Small to large, robust, with dull or moderately glossy, black integument (Fig. 143, 144). Punctures on head in males shallow, minute, dense in small specimens, sparse in largest, deep, mostly small and very dense in females; most punctures with minute, erect setae. Elytra with dense to very dense punctures, most containing an erect yellowish seta; each elytron with 4 or 5 strongly raised, broad ribs; elytral rim in non-abraded specimens with conspicuous fringe of erect seta. Male mandibles arched laterally, with very long apical dorsal tooth, variably bifurcate mid ventral tooth and blunt mid dorsal tooth. Mandibles of females moderately long, arched, not deep, with apical dorsal and subapical ventral teeth; right mandible with subapical dorsal tooth. Postocular margin with sharply pointed triangular lobe projecting beyond eye in males, margin approximately straight and not projecting beyond eye in females. Front tibia in males conspicuously arched, slender except for widened apex, with large, curved, apical ventral spine; in females slightly curved, broad, stalked proximally, conspicuously widened and paddle-shaped distally. Middle and hind tibiae densely setose, straight or slightly curved, prominently flared distally in largest males less flared in females and small males; ventral setiferous patch present in males, not in females.

Redescription

Head (Fig. 471, 472) widest behind eyes in males, in front or near middle of eyes in females. **Dorsal surface** glossy; frons smooth and barely depressed in males, uneven and moderately depressed on either side of midline in females; vertex smooth and slightly convex; **punctures** sharply defined, shallow, minute, dense (smallest specimens) to sparse (largest specimens) in males, deep, small and very dense in females, most punctures containing minute erect setae. Preocular margin slightly angulate in males, convex in females; integument immediately in front of eyes laminate, strongly depressed in males, slightly depressed in females. Postocular margin in males deeply indented almost immediately behind eye then extending outwards into an acute-angled, slightly recurved, laminate lobe with short, branched, brown setae on its anterior face; in females almost straight, not laminate. **Labrum** rectangular, about 2× wider than long; surface slightly uneven, lacking punctures in males, with dense minute punctures containing minute setae in females; distal margin with short median lobe and 2 long lateral lobes in males, weakly and evenly trilobed in females, with 2 or 3 short bristles on either side of median lobe in males and females; labral suture well defined. **Mandibles of males** laterally curved, not very deep dorsoven-

trally; punctures minute, dense, apparently lacking setae; both mandibles with long apical dorsal tooth, long, obliquely vertical mid ventral tooth with weakly bifurcate tip and short, horizontal (rarely obliquely erect) mid dorsal tooth with rounded tip. **Mandibles of females** arched, somewhat parallel-sided, not lobed externally at base, weakly carinate on dorsomedial and dorsolateral margins; punctures minute, very dense, lacking setae; left mandible with apical dorsal and subapical ventral teeth; right mandible with apical ventral, subapical ventral and rudimentary subapical dorsal teeth. **Antennae** (Fig. 473) approximately the same in males and females; pedicel slender, about 1.8× longer than wide in males, about 1.3× in females; funicle segments slightly asymmetrical; approximate length/width values for funicle segments 1–5 respectively 1.1, 0.9, 0.8, 0.8, 0.7 in males, 1.0, 0.7, 0.6, 0.5, 0.4 in females; club 1.6–1.9× longer than wide in males, 1.6–1.8× in females. **Eyes** barely protruding; anterior canthus about 0.2× length of eye; posterior canthus absent. **Mentum** rectangular, about 2.8× wider than long in males, about 2.3× in females; lateral margins convex; distal margin straight; 4th segment of maxillary palp flattened or slightly concave on ventral surface, about 2.6× longer than wide in males, about 3× in females; 3rd segment of labial palp about 2.5× longer than wide in males, about 2.3× in females.

Thorax. Pronotum glossy, 1.6–2.1× wider than long in males, widest in largest specimens, about 1.5× in females, about 1.1× as wide as head in males, about 1.5× in females; **punctures** moderately deep, sharply defined, minute to small, dense to very dense, largest posteriorly and towards brim, smaller, shallower and less dense in males; setae short in brim, minute elsewhere; disc flattened; brim narrow in females, wider in males; anterior margin slightly convex on median 1/3rd; front angles distant from eyes in males, almost reaching posterior margin of eyes in females; sides in males almost parallel over anterior 0.6 then convergent, slightly divergent over anterior 0.5 then convergent in females; rim with conspicuous fringe of erect, moderately long, branched setae in non-abraded specimens. **Elytra** moderately glossy, distinctly widest near middle, rounded posteriorly, 1.1–1.2× longer than their combined width, about 0.9× as wide as pronotum in males, 0.9–1.1× in females; entire dorsal surface with sharply defined, deeply impressed punctures; each elytron with 4 or 5 broad, rounded, conspicuously raised ribs that have dense, minute punctures containing short dendritic setae, intervening tracts flattened or slightly concave, their punctures very dense, small (about 2× size of rib punctures) and with minute or very short setae (about 1/2 length of rib setae); brim very broad, concave, its punctures extremely stretched, some coalesced, some barely discernible; rim punctures very dense, moderately deep, most poorly de-

finer, irregularly aligned in up to 4 rows anteriorly, in 1 or 2 rows posteriorly, their setae short, erect, forming conspicuous fringe when not abraded; all elytral setae shorter in females. **Wing** (Holloway 1963b, fig. 7) about 0.3× length of elytron; cubitus vestigial, medial recurrent and radial recurrent veins absent. **Front tibia** in males (Fig. 474) very strongly curved, almost parallel-sided on basal 0.5 then gradually expanded, in females (Fig. 475) slightly curved, gradually expanded on basal 0.3 than conspicuously widened to apex; dorsal edge with large apical tooth, small subapical tooth, and up to about 5 very small teeth, mainly on apical 1/2, all teeth rather vague in females; ventral surface with large curved apical spine in males, very small straight spine in females (and also in a male from Lake Fraser, FD). **Middle tibia** (Fig. 476) straight, gradually expanded from base; ventral surface conspicuously excavated beyond middle in males, flattened and not excavated in females, flared conspicuously towards apex in large males, less so in females and small males; apex with large dorsal spine; dorsal longitudinal setiferous rows with numerous branched setae, especially on proximal 1/2; mid dorsal spine laminate, single-tipped, longitudinal, moderately large in females, smaller in males; integument underlying spine flattened; ventral setiferous patch absent in females, elongate and occupying entire, excavated, distal surface beyond mid dorsal spine in males; spurs subcylindrical proximally, flattened apically, shiny, not striated; tip of anteroventral spur curved in males, straight in females; posteroventral spur about 2.2× length of anteroventral spur and about 1.4× length of adjacent tarsomere. **Hind tibia** (Fig. 477) resembling middle tibia but much longer and in males the mid dorsal spine is very small or absent, distal 0.3 of tibia is bent inwards conspicuously and ventral setiferous patch is larger; spurs cylindrical basally, flattened dorsally towards apex, shiny, not striated; posteroventral spur 5.1–5.5× longer than wide in males, 5.7–6.3× in females, 1.9–2.1× length of anteroventral spur, 1.6–1.8× length of adjacent tarsomere in males, 1.9–2.2× in females. **Arolia** of all legs with 2 setae, or rarely 1, on either side of apex.

Abdomen. Ventrites very glossy; sides of ventrites 1–4 and proximal 0.6 of ventrite 5 with a broad rim separated from remainder of ventrite by groove; punctures sharply defined, deep, minute and dense on ventrites 1–4, small and mostly dense on ventrite 5; setae short near apex of ventrite 5, minute elsewhere.

Male genitalia. 9th abdominal segment (Fig. 654); apices of tergite and sternite shallowly indented. **Permanently everted internal sac** (Fig. 655) terminating in elongate scoop-shaped structure with pair of large triangular lobes proximally; **gonopore** narrow, elongate-oval, marginal on dorsal midline in circular membranous

depression with incomplete sclerotised border that terminates apically in a pair of short, dark, spines. **Parameres** with neither translucent strip nor lobe on ventral margin.

Female genitalia (Fig. 713). **Accessory gland** short, broad; **bursal duct** long, narrow; bursa copulatrix large, saccate; spermathecal duct wide, entering long, broad lobe of bursa copulatrix subapically; **spermatheca** relatively short, slightly curved; spermathecal gland short, broad, somewhat oval, clearly demarcated from its very short duct.

Type data. The holotype of *Lissotes philpotti* Broun is in BMNH. It is a male measuring 26.5 mm (including mandibles) and has the following labels: (1) SYNTYPE [BMNH label]; (2) Type [BMNH label, reversed on pin]; (3) New Zealand, Broun Coll., Brit. Mus., 1922–482; Hump Ridge [FD, 46° 07'S, 167° 20'E], Feby. 1912 [Broun's handwriting]; (5) *Lissotes philpotti* male [Broun's handwriting]; (6) 3416. male.; (7) HOLOTYPE *Lissotes philpotti* Broun, 1914, male, Det. B. A. Holloway 1991. According to the original description the specimen was collected by Mr A. Philpott in February 1911 at an altitude of 3,500 feet.

Material examined. Holotype male and 98 non-type examples (73 males, 25 females). (AMNZ, MONZ, NZAC).

Distribution (Map 28). From near sea level to about 1370 m. Northernmost record: Grebe River (latitude 45° 35'S); southernmost record: Waitutu River (latitude 46° 15'S).

— / FD

Biology. Adults in the material examined were collected from November to February but Patrick (1988) found live specimens in May 1985 on the Waitutu marine terraces. Very little biological information is available. One specimen was found under an *Astelia* plant and a few were collected on vegetation at night.

Remarks. *Geodorcus philpotti* is known only from the southwest corner of the South Island where its altitudinal range extends from sea level to almost 1400 m. On the Hump Ridge and at Puysegur Point, Waitutu River, Te WaeWae Bay, and Lake Hauroko it is sympatric with *G. helmsi*, from which it is easily distinguished by the strongly curved front tibiae of its males and paddle-shaped front tibiae of its females. A comparison of some female character states in *G. philpotti*, *G. montivagus*, and *G. servandus* is given in Appendix 3B, p. 131.

Geodorcus servandus new species

Fig. 145, 146, 478–489, 656, 657, 714. Map 29

Diagnosis. Length: males (including mandibles) 24.0–35.0 mm, (excluding mandibles) 21.3–31.0 mm; females (including mandibles) 23.4–26.5 mm, (excluding mandibles) 22.0–

25.0 mm. Width: males 11.2–16.6 mm, females 11.5–13.4 mm. Large to very large, robust, with dull or glossy, black integument (Fig. 145, 146). Entire dorsal surface conspicuously punctate, punctures rather shallow in males, deep in females, mostly small and dense in small males, minute and sparse to large and dense in large males, mostly small and very dense in small females, large and dense in large females; erect branched setae clearly visible on pronotal rim, elytral rim and sides of elytra, barely discernible elsewhere. Elytra indistinctly ribbed, each elytron with 2 or 3 weak longitudinal ribs visible mainly on anterior 0.3 of elytron and recognisable by their small punctures. Male mandibles relatively short, very strongly arched laterally, deep, dorsoventrally, with apical dorsal, apical ventral and basal ventral teeth and elongate, oblique, prebasal, dorsal ridge. Mandibles of females somewhat triangular with apical ventral, subapical ventral, subapical dorsal and rudimentary prebasal dorsal teeth. Median lobe of labrum large, triangular, and extending forward prominently in the middle beyond the flattened lateral lobes. Postocular margin in males with small conical lobe projecting beyond eye, in females slightly convex then directed inwards and not projecting beyond eye. Front tibia of males strongly arched, slender, parallel-sided on proximal 0.5 then gradually expanded; ventral apical spine small, straight. Front tibia of females slightly curved, rather broad, somewhat parallel-sided on proximal 0.25 then expanding gradually, not paddle-shaped. Middle tibiae of males and females densely setose, conspicuously flared, with multi-tipped mid dorsal tooth; males with ventral setiferous patch. Hind tibia densely setose, flared moderately in males, barely in females; ventral setiferous patch present in males, not in females.

Description

Head (Fig. 478, 479) widest behind eyes in males, near middle of eyes in females. **Dorsal surface** glossy or dull; frons unevenly depressed; vertex irregularly concave to slightly convex; **punctures** with distinct margins; shallow, small and dense in small males, minute to small and moderately dense to dense in large males, deep, small and dense to very dense in small females, small to moderately large and dense to very dense in large females, smallest and sparsest on frons and vertex in males and females, most with minute or short erect setae. Preocular margin straight, slightly rounded, or weakly indented, rimmed; integument immediately in front of each eye distinctly laminate; postocular margin in males with obtusely angulate conical projection, in females slightly convex then directed inwards. **Labrum** 1.6–1.8× wider than long, rectangular on proximal 0.5 then triangular, apex of triangle protruding very prominently in males, less prominently in females; surface smooth, even; a few small punctures on either side of apical triangle base with long setae; labral suture distinct but

very weakly impressed in some specimens. **Mandibles of males** short, strongly arched laterally, deep dorsoventrally; punctures poorly defined, shallow, sparse, minute or small, most with minute setae (barely visible at $\times 70$); both mandibles with conspicuous, oblique, elongate, dorsal prebasal ridge and 3 single-tipped teeth as follows: long apical dorsal (tip worn down in some specimens), long apical ventral, short basal ventral. **Mandibles of females** somewhat triangular but not lobed at base; dorsolateral margin weakly carinate; punctures as in males; both mandibles with single-tipped teeth as follows: long apical ventral, short subapical dorsal, short subapical ventral, rudimentary prebasal dorsal. **Antennae** (Fig. 480) approximately the same in males and females; pedicel slender, distinctly stalked, about $1.8\times$ longer than wide in males, about $1.6\times$ in females; all funicle segment markedly asymmetrical, almost as deep as club segments; approximate length/width values for funicle segments 1–5 respectively 1.2, 0.9, 0.9, 0.8, 0.7 in males, 1.1, 0.8, 0.7, 0.6, 0.5 in females; club about $1.8\times$ longer than wide in males, about $1.4\times$ in females. **Eyes** slightly protruding in males, strongly protruding in females; anterior canthus about $0.3\times$ length of eye; posterior canthus absent. **Mentum** somewhat rectangular, about $2.1\times$ wider than long; sides convex; distal margin sinuous; 4th segment of maxillary palp (Fig. 481) and 3rd segment of labial palp (Fig. 482) slender, flattened ventrally and about $4\times$ longer than wide.

Thorax. Pronotum moderately glossy, about $1.9\times$ wider than long in males, 1.5 – $1.7\times$ in females, about $1.1\times$ as wide as head in males, about $1.4\times$ in females; **punctures** sharply defined and dense, small and deep in females and small males, shallow and minute or small in large males; setae minute to short, shortest in large males and on centre of disc in females and small males; disc flattened or slightly convex; brim broad; anterior margin slightly convex on median 1/3rd; front angles distant from eyes in males, approaching posterior margin of eyes in females; sides almost parallel in males, strongly convex in females. **Elytra** in males parallel-sided on basal 1/2 then strongly convergent and narrowly rounded posteriorly, slightly convex laterally and broadly rounded posteriorly in females; about $1.2\times$ longer than their combined width, 0.8 – $0.9\times$ as wide as pronotum; entire dorsal surface with sharply defined, deeply impressed, mostly small, dense punctures except for some moderately large, sparser punctures in brim, all punctures larger and denser in females; each elytron with 2 or 3 weak, barely elevated ribs, best developed near base of elytron, about 1/2 width of intervening tracts, and recognisable by their smaller, denser punctures; about 5 evenly spaced, fine, wavy, weakly impressed lines extending from base to near apex of each elytron; setae increasing in length across elytron from minute near suture to long at sides;

brim well defined, concave, with extremely stretched, distorted punctures; rim punctures very dense, minute or small, moderately deep, irregularly arranged in about 4 rows and with long brown setae. **Wing** (Fig. 483) 0.41 – $0.46\times$ as long as elytra; vestige of radial recurrent discernible. **Front tibia** in males (Fig. 484) curved, parallel-sided on proximal 1/2 then gradually widening to apex, parallel-sided on proximal 0.25 then expanding markedly to apex but not becoming paddle-shaped in females (Fig. 485); dorsal edge with rather broad apical and subapical teeth and about 8 variably sized, short, blunt teeth, mainly on apical 0.6; ventral apical spine very short and conical in males, absent in females. **Middle tibia** (Fig. 486, 487) conspicuously flared distally; dorsal longitudinal setiferous rows with branched and simple setae; mid dorsal spine large, obliquely transverse, multi-tipped, laminate, hollowed out on underside; integument underlying mid dorsal spine concave; ventral surface of tibia not excavated; ventral setiferous patch containing dense branched setae present on distal 0.6 in males, absent in females; spurs subcylindrical on proximal 0.3, flattened dorsally towards apex, shiny, not striated; anteroventral spur with curved tip; posteroventral spur about $1.6\times$ length of anteroventral spur and about $1.7\times$ longer than adjacent 1st tarsomere. **Hind tibia** (Fig. 488, 489) less flared than middle tibia, with smaller mid dorsal spine and, in males, with much longer setiferous patch; spurs subcylindrical on proximal 0.1, then concave dorsally and convex ventrally, shiny, not striated; posteroventral spur 3.8 – $4.0\times$ longer than wide, 1.7 – $1.8\times$ length of anteroventral spur and about $1.8\times$ longer than adjacent 1st tarsomere. **Arolia** of all legs with 2 or 3 setae on either side of apex.

Abdomen. Ventrites moderately glossy; sides of ventrites 1–4 and free margin of ventrite 5 lacking rim and groove; punctures small, sharply defined, deep, uniformly dense on ventrite 5, moderately dense and mostly confined to anterior margin and middle 1/3rd of ventrites 1–4; setae minute or short except for long setae on apex of ventrite 5.

Male genitalia. 9th abdominal segment (Fig. 656); apex of tergite deeply notched; apex of ventrite shallowly notched. **Permanently everted internal sac** (Fig. 657) terminating in large, asymmetrically ovate, rather flattened expansion with irregular margin and slightly recurved apex; **gonopore** circular, submarginal in elongate depression between pair of triangular sclerites on dorsal midline of recurved apex. **Parameres** without translucent strip or lobe on ventral margin.

Female genitalia (Fig. 714). **Accessory gland** short, narrow; **bursal duct** constricted at base then extending to main lobe of bursa copulatrix as short, very broad tube; bursa copulatrix large, saccate, its lateral lobe very long, uniformly broad, with short, spermathecal duct arising on

it subapically; **spermatheca** elongate, slightly curved, moderately large; spermathecal gland elongate, cylindrical, clearly demarcated from its long duct.

Type data. Holotype male, (31.0 x 14.5 mm, including mandibles) with wings and macerated genitalia in accompanying minivial: New Zealand, WD, Mt Tuhua summit (42° 49'S 171° 11'E), 1122 m, under *Celmisia*, 4 December 1960, P. R. Kettle (NZAC). Paratypes: 4 males, 3 females, same data as holotype (NZAC).

Material examined. Type series only (NZAC).

Distribution (Map 29). Mt Tuhua (latitude 42° 49'S) at 1122 m.

— / WD

The type series was collected in December.

Remarks. This spectacular stag beetle was discovered in December 1960 by Dr P. R. Kettle while he was looking for land snails among clumps of the New Zealand mountain daisy *Celmisia* sp. (tikumu) on the summit of Mt Tuhua. It seems not to have been collected since that time. When I briefly visited the type locality in November 1984 *Celmisia* plants were present on a small rocky area around the summit but nowhere else in the immediate vicinity. There was evidence of fire having swept over this part of the mountain some years earlier. Because the actual area of *Celmisia* was so small and fragile I did not pull out or dig around any of the plants but merely lifted up the leaves and searched in the accumulated dead plant material between them. In doing so I found a female of *Geodorcus helmsi* but no specimens or remains of *servandus*. Hopefully, the presence of the *helmsi* female was an indication that *servandus* might also have been there.

I am reluctant to be giving details of the type locality because I am aware that the Mt Tuhua population and its habitat could so easily be destroyed by overzealous New Zealand entomologists and foreign collectors. I hope that the description and illustrations I have included will be sufficient for serious researchers to know whether they need to see actual specimens. If they do they would be able to examine the type series at NZAC or ask to have specimens sent on loan.

If a search for *servandus* on Mt Tuhua is ever undertaken great care will be required to limit damage to both the beetles and the vegetation. The species is sufficiently distinctive to be easily recognised in the field so there would be no need to collect specimens. Photographs taken with the cameras now available would suffice. The least harmful way of capturing specimens would probably be by setting dry overnight pit traps, containing crumpled paper for beetles to shelter in, among the vegetation and releasing trapped specimens early next morning before the day warms up.

Etymology. The epithet, *servandus*, is a latin word meaning "preserve, conserve, look after". As a gerundive, it implies that an action *should* be done.

Geodorcus sororum new species

Fig. 85, 147, 148, 490–498. Map 30

Diagnosis. Length: males (including mandibles) 18.5–28.5 mm, (excluding mandibles) 16.1–24.5 mm; females (including mandibles) 19.4–24.0 mm, (excluding mandibles) 18.0–23.0 mm. Width: males 9.0–13.6 mm, females 9.8–13.3 mm. Medium-sized to large, broad-bodied, with very glossy, black or reddish black integument (Fig. 85, 147, 148). Punctures on head and pronotum minute to small and mostly sparse in males, small and dense in females, mostly without vestiture. Elytra not distinctly ribbed, devoid of vestiture except for short to moderately long, erect, branched setae on posterior declivity and lower slopes of sides; each elytron with several rather finely etched, longitudinal lines running full length of dorsum. Male mandibles barely arched laterally, their apical 1/2 bulky, deep, erect, and recurved. Female mandibles tridentate apically and with somewhat erect outer margin on external lobe at base. Postocular margin protruding very strongly beyond eye margin in males, protruding less strongly in females. Front tibia straight, slender, and somewhat stalked in males, slightly curved, broad, and rather paddle-shaped in females. Middle and hind tibiae gradually expanded but apex of middle tibia very broad; mid dorsal spine large, laminate, often multi-tipped; ventral setiferous patch absent.

Description

Head (Fig. 490, 491) widest behind eyes. **Dorsal surface** very glossy; frons barely depressed, smooth in males, slightly uneven in females; vertex very slightly convex, smooth in males, slightly uneven in females; **punctures** sharply defined, extremely minute, sparse and barely visible in large males, minute and dense in small males, small to moderately large and dense in females, mostly with no visible setae in males, with minute, barely visible, erect setae in females; preocular margin moderately to strongly convex in males, slightly concave to slightly convex in females, weakly rimmed; integument immediately in front of eye strongly depressed and markedly laminate; postocular margin in males strongly laminate, protruding conspicuously as acutely angulate or rounded, arched lobe, in females somewhat laminate, protruding less conspicuously as acutely or obtusely angulate, arched lobe. **Labrum** approximately rectangular, 2.6–3.2× wider than long in males, 3.1–3.2× wider than long in females; surface in males slightly uneven, with a few minute punctures lacking setae, surface in females with small, dense punctures containing minute

setae; distal margin strongly trilobed in males, weakly trilobed in females, with 3 or 4 setae on either side of median lobe; labral suture well defined in females, distinct or poorly defined in males. **Mandibles of males** weakly curved laterally, strongly erect and recurved on distal 1/2 (Fig. 492), deep, dorsoventrally especially at apex, the erect face broad, somewhat triangular and blade-like; punctures shallow, minute, mostly moderately dense; setae visible only near outer basal angle; both mandibles with short apical dorsal, moderately long subapical dorsal, short apical ventral and short basal ventral teeth and a short, dorsal, obliquely vertical ridge near outer edge at base of mandible. **Mandibles of females** approximately parallel-sided but with triangular lobe externally at base, carinate on entire dorsolateral margin; punctures moderately deep, small, very dense, apparently lacking setae; both mandibles tridentate apically and with elongate, obliquely vertical lamina on dorsomedial edge. **Antennae** (Fig. 493) approximately the same in males and females; pedicel rather broad, almost straight, about 1.5× longer than wide; funicle segments 1–4 virtually symmetrical, segment 5 slightly asymmetrical; approximate length/width values for funicle segments 1–5 respectively 1.1, 1.1, 1.1, 1.0, 0.8 in males, 1.0, 1.0, 0.9, 0.8, 0.6 in females; club 1.6–1.7× longer than wide in males, about 1.5× in females. **Eyes** not protruding beyond canthi; anterior canthus 0.2–0.3× as long as eye; posterior canthus if present at most 0.1× as long as eye. **Mentum** trapezial, 2.2–2.4× wider than long in males, 2.0–2.4× in females; lateral margins rounded, distal margin indented; ventral surface slightly concave; 4th segment of maxillary palp (Fig. 494) flattened ventrally, 3.7–5.0× longer than wide in males, 3.0–3.2× in females; 3rd segment of labial palp 3.8–4.5× longer than wide in males, 3.3–3.6× in females.

Thorax. **Pronotum** very glossy, 1.8–2.0× wider than long in males, 1.6–1.7× in females, 1.0–1.1× as wide as head in males, about 1.5× in females; **punctures** like those on head; setae absent near middle, short near sides; lateral and posterior margins with conspicuous long setae in large males, with short setae in females and small males; disc with variably developed circular depression on either side of flattened midline; brim very narrow or absent; anterior margin slightly indented; front angles distant from eyes, sides slightly convex in females, convergent posterad and obtusely angulate at 0.6 in males. **Elytra** very glossy, about 1.1× longer than combined width and 0.9–1.1× as wide as pronotum; sides somewhat parallel in small specimens, distinctly convex in large specimens; integument not ribbed but each elytron with about 7 finely etched, evenly spaced, longitudinal lines running full length of elytron; integument between lines slightly raised and appearing somewhat ribbed; lines and intervening spaces distinct in females and small males, weakly defined in large males; punctures sharply defined and shallow, small and sparse in large males,

small and moderately dense in females and small males, becoming larger and denser near sides and on posterior declivity in males and females; setae short or moderately long on outer 0.2 of elytron, barely visible or absent elsewhere; brim narrow, sloping; rim punctures small, dense, deep, irregularly aligned in 3 or 4 rows anteriorly, 1 or 2 rows near middle, and single row posteriorly, with setae long in males, short in females. **Wing** 0.3–0.4× length of elytron; cubitus, medial recurrent and radial recurrent veins absent. **Front tibia** straight and gradually expanded from base in males (Fig. 495), slightly curved and prominently expanded towards apex in females (Fig. 496); dorsal edge with large apical tooth, small subapical tooth (often showing wear in females), and 3–7 small teeth decreasing in size towards tibial base; ventral apical spine small. **Middle tibia** (Fig. 497) gradually expanded from base; longitudinal setiferous rows with branched and simple setae, branched setae sparse in some specimens especially females; mid dorsal spine somewhat laminate, large, longitudinal, usually multi-tipped; integument underlying spine flattened, not concave; ventral margin straight; ventral setiferous patch absent; spurs shiny, not striated, subcylindrical proximally, flattened towards apex; anteroventral spur slightly bent at tip; posteroventral spur 1.6–2.0× as long as anteroventral spur in males, 1.4–1.7× in females, 1.2–1.7× as long as adjacent 1st tarsomere in males, about 1.5× in females. **Hind tibia** (Fig. 498) similar to middle tibia except longer and more slender especially apically; spurs cylindrical basally then flattened, shiny, not striated; posteroventral spur about 5.0× longer than wide, 1.4–1.5× as long as anteroventral spur in males, about 1.8× in females, and 1.5–1.6× as long as adjacent 1st tarsomere. **Arolia** of all legs with 1 seta on either side of apex.

Abdomen. **Ventrites** moderately to very glossy; sides of ventrites 2–4 and anterior 0.6 of free margin of ventrite 5 with moderately broad rim separated from remainder of ventrite by narrow groove; punctures sharply defined, small, mostly moderately dense, deep in males, shallow in females; setae minute to short on ventrites 1–4, long or moderately long on ventrite 5.

Male genitalia exactly as in *G. capito* (Fig. 644, 645).

Female genitalia exactly as in *G. capito* (Fig. 73, 708).

Type data. Holotype male, length including mandibles 27.9 mm, width 13.5 mm. NEW ZEALAND, CHATHAM ISLANDS, Middle Sister Island (43° 33'S, 176° 48'W), dead on rock landing, 14 November 1973, A. Wright. The Sisters Expedition, Chatham Is. (NZAC). Paratypes: see Appendix 2, p. 129.

Material examined. Holotype male and 21 paratypes (14 males, 7 females) (LUNZ, NZAC). Other material, recorded as *Dorcus capito* in Holloway (1961): 11 males and 1 female (CMNZ).

Distribution (Map 30). Chatham Islands: Middle Sister I (latitude 43° 33' S) from near sea level to about 40 m.

— / — / CH

Biology. Adults have been collected in January, February, October, and November on and under the coastal iceplant, *Disphyma australe* (horokaka), on *Festuca coxii* tussock, under ferns and rocks, in a petrel burrow in soft soil, and on open ground. A female collected on 21 Feb 1974 was found when dissected to contain 7 mature eggs, each measuring approximately 3.5 mm × 2.0 mm. One was partially extruded between the hemisternites indicating that it was being laid when the specimen was captured.

Remarks. *Geodorcus sororum* is easily recognised by its very robust form, highly distinctive male mandibles, and the shape of the postocular margin in both males and females. *G. novaezealandiae* is the only other species with erect, recurved male mandibles but in that species the mandibular apex is slender and excavated posteriorly not developed as a broad, triangular, flattened blade.

As mentioned in Remarks for *G. capito* the *Geodorcus* specimens (as *Dorcus*) from The Sisters were previously treated as a “form” of that species (Holloway 1961) because of their identical genitalia. Differences in their mandibles and other external features were regarded as size-related because in the material available at that time all The Sisters specimens were considerably larger than those of typical *capito*. As the Sisters and Chathams material that has since been collected includes both large and small specimens size can no longer be regarded as significant and I am now treating the Sisters *Geodorcus* as a distinct species even though mitochondrial sequence data do not support that decision. Trewick (2000) has found that *G. capito*, based on specimens from Taiko Camp on Chatham I and from Little Mangere I, is paraphyletic with respect to The Sisters *Geodorcus*. In terms of sequence variation of the gene tested it appears that individuals of *sorum* are as close to individuals of *capito* as they are to one another. Because of their identical genitalia it is tantalising to wonder whether the two species could reproduce if they were put together, but until that has been shown to happen, it makes sense to have a concise scientific name for the Sisters *Geodorcus*, the most unusual-looking species in the genus. Nothing is known about courtship and copulation in *Geodorcus* species, in particular whether the mandibles of males have a distinct sexual role either for grasping females or as sites for the production and release of species specific pheromones. Some wonderful opportunities exist for researchers interested in the behaviour and physiology of these fantastic stag beetles.

The following are the main external differences between *G. capito* and *G. sororum*.

Mandibles of males: slender, laterally curved, neither erect nor recurved apically in *capito*; robust, almost straight-sided laterally, erect and recurved apically, the erect face broad, deep, blade-like in *sorum*.

Postocular margin of head in males: not laminate immediately behind eye but more posteriorly with a small laminate, slightly protruding lobe in *capito*; laminate throughout its length and with a large, strongly protruding posterior lobe in *sorum*.

Postocular margin of head in females: almost straight, not extending laterally beyond outer margin of eye in *capito*; strongly convex, extending laterally well beyond outer margin of eye in *sorum*.

Pedice and first 2 funicle segments of antennae: elongate and slender in *capito*; short and broad in *sorum*.

Fourth segment of maxillary palp: about 3.3× longer than wide in *capito*; about 5× longer than wide in *sorum*.

Sides of elytra: parallel in *capito*; convex in *sorum*.

Elytral disc of males: strongly ribbed and with numerous moderately large punctures containing conspicuous short, branched setae in *capito*; lacking ribs and with sparse, minute punctures containing minute unbranched setae in *sorum*.

The Sisters (Rangitatahi) comprise three small rodent free islands ranging in height from 20 m (East Island) to 40 m (Middle Sister) to 80 m (West Sister) and lying about 19 km NW of Chatham Island. Middle Sister, the only known locality for *G. sororum*, is the breeding place for some large mollymawks and albatrosses and is sometimes visited by birds. During these visits there is a risk of rodents being taken ashore accidentally in boxes of provisions and equipment. Their establishment on such a small island would be a disaster for *G. sororum*. Considering the unique status and apparent limited distribution of this stag beetle measures need to be put in place to ensure its long term survival, perhaps by having regularly monitored poison bait stations on the island and if feasible by relocating some of the population to a rodent free island with very limited public access. McGuiness (2001) includes this species in Part H of Appendix 11 as an invertebrate of potential interest to conservation. This species, as *Geodorcus* sp. “Sisters” is listed as ‘Nationally Critical’ by Hitchmough (2002). Further collecting of *G. sororum* for either public or private collections should be discouraged, if not prohibited, until more is known about its abundance and biology. Entomologists wishing to examine specimens can do so at the institutions listed above.

Etymology. The name *sorum* is a latin word meaning “belonging to the sisters”.

Genus *Paralissotes* Holloway

Holloway, 1996: 62. Type species *Lucanus reticulatus* Westwood, 1844, by original designation.

Diagnosis. Small to medium-sized, vestigial winged lucanines (length including mandibles 10.0–20.0 mm) showing only slight sexual dimorphism and allometry. Front margin of head deeply indented on median 1/3rd. Antennal club 3-segmented. Eyes partially divided anteriorly by canthus. Integument dark brown or black, dull to glossy, variably punctured, punctures (pits) shallow, saucer-shaped, with well defined margins and polygonally sculptured walls and floor; integument adjacent to pits polygonally sculptured. Vestiture on dorsal surface consisting of a few simple setae but mainly of minute to moderately long, appressed to erect, yellow or brown, elongate, stalked, somewhat fan-shaped, longitudinally ribbed scales either uniformly and densely distributed or arranged in bilaterally symmetrical patches separated by conspicuous non-squamose areas. Front tibia either constricted basally or expanded gradually from base to apex.

Redescription

Head. **Anterior margin** strongly concave on median 1/3rd, extending forward conspicuously near base of mandibles, not rimmed, not tuberculate; preocular margin long, laminate. **Mandibles** small to moderately large, triangular or laterally arcuate, with few or no setae, relatively similar in males and females. Maxillae similar in males and females, with well developed galea and lacinia; apex of lacinia strongly sclerotised and hooked. Mentum approximately rectangular, much wider than long, with convex sides and indented distal margin; ventral surface slightly concave, with large, dense punctures. Ligula well developed, deeply divided on midline. Intermandibular projection absent. Labral suture present; labrum short, broad, directed anteroventrally, distal margin straight, rounded, or weakly bilobed, usually with median, marginal or submarginal tubercle that has long yellow hairs behind or on either side of it. **Antennae** very similar in males and females; club with 3 stout, opposable, extensively pubescent segments. Supra-antennal brow short, not strongly arched. **Eyes** small to moderately large, not strongly protruding, similar in males and females; anterior canthus 0.3–0.5× length of eye; posterior canthus absent. Postocular margin straight, slightly convex, or sinuate, not with tubercles or lobes.

Thorax. **Pronotum** wider than long; front angles acute to obtuse, not prominent; disc either smooth or with a tubercle anteriorly on midline; sides descending gradually; lateral margin smooth, rounded, rimmed, upturned, punctate and squamose; integument adjacent to rim depressed, forming narrow channel; hind angles obtuse. Scutellum wider than long; shape varying intraspecifically. **Elytra** parallel-

sided; outer margin with upturned punctate rim, at least some of punctures with appressed or erect scales; integument adjacent to rim depressed slightly forming inconspicuous brim; striae punctures not discernible on dorsal surface but visible on underside of elytra; elytral surface uniformly smooth or with weak longitudinal ridges or with variably developed reticulate patterns. **Wings** vestigial. **Prosternal** and **mesosternal processes** broad. **Legs** short, stout, similar in males and females; procoxal process absent; femora with moderately dense, small punctures, some containing appressed to erect scales or setae; front femur robust, about 2× longer than wide; setiferous patch well defined, large, punctate over most of its surface, reaching to about middle of segment; tibiae with 7–9 longitudinal rows or shallow grooves containing scales or setae; front tibia moderately broad, sometimes constricted proximally, sometimes arched in males, teeth increasing in size from base to apex of segment; middle tibia short, with small, simple or compound mid dorsal spine; hind tibia somewhat similar to middle tibia but longer, with mid dorsal spine smaller or absent and with distinct row or patch of setae on posterior surface in some males; ventral surface of tarsomeres 1–4 with a transverse row (sometimes broken on the midline) of long setae near distal margin; **arolium** with 1 seta on either side of apex.

Abdomen. Sides of ventrites 2–5 with a dorsally directed flange that interlocks with the marginal ridge of epipleural fold; **ventrite 5** not conspicuously sexually dimorphic.

Male genitalia symmetrical. **9th abdominal segment** robust; distal margin of sternite setose, slightly convex, neither notched nor pointed on midline; distal margin of tergite indented. **Basal piece** sclerotised ventrally and laterally, mostly membranous dorsally, enclosing a pair of long, slender struts that articulate on base of penis. **Parameres** large, leaf-like, connected to basal piece by very flexible membrane; apex convex with marginal fringe of minute hairs. **Penis** short and broad; ventral surface with a deeply pigmented, long, median sclerite and pair of somewhat hemispherical, inflated, sclerotised, lateral lobes that have very pale, stiffened marginal bands; median sclerite bifurcate distally, divided proximally into pair of arms that extend across base of penis then curve laterally to become lateral bridges which are fused to the dorsal crossbar (see Fig. 668–671); dorsolateral processes of dorsal crossbar very short, with rounded apex. **Permanently everted internal sac** broad, at least 2× length of tegmen, proximal 1/2 parallel-sided, pale, smooth, not spinulose, with pair of internal sclerites on either side of ejaculatory duct, and distally either a median, ventral papilla or pair of lateral papillate flaps; distal 1/2 greatly expanded, usually tapering and longitudinally folded towards apex, with colourless or brown spinulues on part of surface, a pair of elongate,

arched sclerites present on either side of ventral midline and pair of shorter, broader sclerites on either side of dorsal midline; gonopore broad, terminal.

Female genitalia. **Hemisternites** strongly sclerotised, deeply pigmented; stylus small, setose. **Accessory gland** elongate or saccate, large. Bursal duct not distinct. **Bursa copulatrix** saccate, much larger than accessory gland; part of ventral wall strongly sclerotised, pigmented, longitudinally folded or convoluted, with pale, partly divided internal sclerite or pair of sclerites. Spermathecal duct relatively long, weakly sclerotised, entering bursa copulatrix between the pair of sclerites or between arms of partly divided sclerite. **Spermatheca** very small, somewhat bulbous, curved, weakly sclerotised, pale, not annulated. Spermathecal gland bulbous or elongate, weakly sclerotised, its duct entering spermatheca near its base.

Range. New Zealand.

Remarks. *Paralissotes* has 7 species known species. They are distinguishable externally from *Geodorcus* species by their generally smaller size, inconspicuous sexual dimorphism, deeply indented anterior margin of the head and fan-shaped elytral scales. Distinctive features of the male genitalia of *Paralissotes* are the papillae, apical folds, 2 pairs of external sclerites, and broad gonopore on the permanently everted internal sac, cushion-like ventral lobes with stiffened margins on the penis, and notched margin of the tergite and convex margin of the sternite on the ninth abdominal segment. The most distinctive features of the female genitalia are the conspicuously folded or corrugated sclerotised patch and pair of free or conjoined sclerites on the ventral surface of the bursa copulatrix. Some morphological characters of *Paralissotes* shared with *Lissotes* Westwood, 1855 from Australia and the South American genera *Pycnosiphorus* Solier, 1851 and *Sclerostomus* Burmeister, 1847, and perhaps indicating a close relationship among these genera are: partially divided eyes, rounded (not truncate) and at least partially pubescent terminal antennal club segment, lacinial hook present in males and females, indistinct strial punctures on elytra, male genitalia with a permanently everted internal sac (not a flagellum), penis with membranous sides and a basal ventral plate fused to the lateral bridges which are joined to the outer edge of the dorsal crossbar. The distribution of some other character states among the 4 genera is given in Appendix 3C, p. 131.

The genus ranges from the Three Kings Islands (latitude 34° 10'S) to Waimate (SC) (latitude 44° 44'S) at altitudes mainly below 1000 m. *P. reticulatus* has been collected from Mt Te Aroha (BP) (latitude 37° 32'S) in the North Island to Waimate in the South Island (Emberson 1982) and *P. stewarti* is widespread in the North Island but the 5

other species have quite limited distributions. *Paralissotes* is absent from the Chatham Islands and from the southwestern side of the South Island.

Adults have been found during the day under logs, stones, and loose bark and sometimes, together with their larvae, inside rotting wood on the ground. At night they move about on tree trunks and on the ground. They have not been seen feeding but unidentifiable pale, solid material resembling cells of blue-green algae was present in the hindgut of some of the dissected specimens.

KEY TO THE SPECIES OF *Paralissotes*

- 01 Integument immediately in front of eye conspicuously depressed; pronotum with a small tubercle on midline near anterior margin; elytra with a reticulate pattern of yellowish appressed scales separated by non-squamose areas02
- Integument immediately in front of eye flattened, but not concave; pronotum not tuberculate; elytra not with a reticulate scale pattern, instead most of their surface clothed with standing brownish or yellowish scales .
.....03
- 02(01) Dorsal surface of head at base of both mandibles with a small but conspicuous patch of coarse punctures containing long scales (Fig. 534), the scales sometimes abraded but punctures always present; band of scales behind anterior margin of pronotum broken in the middle by a naked strip considerably narrower than 1/3rd the pronotal width (Fig. 537); scales on basal 1/2 of elytron about 2× longer than wide (p. 110)... **rufipes**
- Dorsal surface of head at base of mandibles lacking a patch of coarse punctures and scales, with at most in this position only 2 or 3 coarse punctures containing scales (Fig. 524); band of scales behind anterior margin of pronotum broken in the middle by a naked strip at least 1/3rd the pronotal width (Fig. 527); scales on basal 1/2 of elytron at least 4× longer than wide
..... (p. 109)... **reticulatus**
- 03(01) Front tibia prominently constricted on proximal 1/3rd (Fig. 519); elytra with several elongate, shiny, sparsely punctate patches lacking scales (Fig. 518)..
..... (p. 107)... **planus**
- Front tibia gradually expanded from base to apex (Fig. 502, 546); elytra uniformly punctate, most of the punctures containing a minute or small scale04
- 04(03) Front tibia relatively slender, distinctly arched and with a relatively narrow apex (Fig. 502, 503); lateral margin of basal 1/2 of elytron rounded, smooth and without scales (p. 104)... **mangonuiensis**

- Front tibia relatively broad, straight or barely curved, with a wide apex (Fig. 510, 546); lateral margin of basal 1/2 of elytron flattened, uneven, with coarse punctures and a fringe of standing scales05
- 05(04) Eyes in dorsal aspect very narrow, about 3× longer than wide (Fig. 550); basal 1/2 of mandibles with satiny smooth surface and minute punctures barely visible at ×45(p. 114)... *triregius*
- Eyes in dorsal aspect moderately broad, about 2× longer than wide (Fig. 507, 544); basal 1/2 of mandibles with shiny uneven surface and moderately large punctures conspicuous at ×4506
- 06(05) Preocular margins strongly convex, markedly convergent anteriorly (Fig. 507, 508); mandibles distinctly angulate externally at the base; male mandibles broadly triangular, apical tooth of left mandible curved inwards almost at a right-angle; external edge of left mandible in females unevenly convex, somewhat sinuous(p. 105)... *oconnori*
- Preocular margins very slightly convex, not markedly convergent anteriorly (Fig. 543, 544); mandibles rounded or barely angulate externally at the base; male mandibles elongate triangular, apical tooth of left mandible scarcely curved inwards; external edge of left mandible in females uniformly convex, not sinuous ..
.....(p. 112)... *stewarti*

Paralissotes mangonuiensis (Brookes)

Fig. 149, 150, 499–506, 658–660, 715. Map 31

mangonuiensis Brookes, 1927: 564, fig. 1 (*Lissotes*).

Holloway 1961: 58, fig. 60–62, 132, 137, 144 (*Lissotes*);

1963b: 104, fig. 12, 22 (*Lissotes*); 1996: 65 (*Paralissotes*).

Diagnosis. Length: males (including mandibles) 11.6–14.7 mm, (excluding mandibles) 10.6–13.4 mm; females (including mandibles) 10.6–11.5 mm, (excluding mandibles) 9.6–10.8 mm. Width: males 4.8–6.2 mm; females 4.5–4.6 mm. Small with dull or moderately glossy, dark brownish-black integument (Fig. 149, 150). Elytral punctures small, dense, with barely discernible, minute, erect, scales or thick setae. Reflexed outer margin of elytra rounded with scarcely any punctures and lacking scales. Frons and vertex concave. Eyes in dorsal aspect relatively short and broad, slightly protruding. Mandibles of males short, curved; right mandible slender, left mandible triangular with long, recurved tooth near middle. Mandibles of females short with uniformly convex outer margin. Front tibia slender, conspicuously curved, only slightly expanded apically. Hind tibia with a long, narrow setiferous patch on posterior surface in males.

Redescription

Head (Fig. 499) widest across or in front of eyes. **Dorsal surface** rather dull; frons and vertex smooth and slightly depressed; **punctures** in males small and dense immediately in front of eye, elsewhere minute to small, dense to moderately dense, sharply defined except on anterior 1/2 of head, moderately large and very dense on medial edge of eye, small and mostly moderately dense on remaining upper part of head; punctures in females small and dense immediately in front of eye, elsewhere sharply defined, uniformly dense, small except near medial edge of eye where they are moderately large; most punctures containing minute, erect, thickened setae. Preocular margin rounded or slightly indented; integument immediately in front of eye sloping outwards, flattened but not laminate; postocular margin straight, slightly convergent posteriorly. **Labrum** about 1.5× wider than long; proximal 1/2 with small group of setae at base of a conspicuous median tubercle; distal margin truncate. **Mandibles of males** short, moderately curved laterally, not very triangular, moderately deep dorsoventrally, obtusely angulate externally at base, outer edge of mandible very slightly sinuate; dorsal surface of proximal 1/2 glossy, slightly concave, uneven; punctures mostly minute, sparse proximally, dense distally, most with minute, erect, thickened setae; left mandible somewhat triangular, with single-tipped apical dorsal, subapical ventral and basal ventral teeth and a large recurved tooth near middle of ventromedial edge; right mandible arcuate, very concave on medial edge, with bifurcate apical ventral, single-tipped subapical dorsal and single-tipped or weakly bilobed basal ventral teeth; both mandibles with a short ridge dorsally running inwards from angulate basal projection. **Mandibles of females** (Fig. 500) short, somewhat triangular, only slightly curved laterally, not deep dorsoventrally, obtusely rounded externally at base, outer edge uniformly convex; dorsal surface of proximal 1/2 glossy slightly concave, very uneven; punctures minute or small, dense, some with minute setae; left mandible with single-tipped apical dorsal, subapical ventral and basal ventral teeth; right mandible with single-tipped apical ventral and subapical dorsal teeth and a short bilobed basal ventral tooth. **Antennal club** (Fig. 501) about 1.6× longer than wide in males, about 1.5× in females; process of segment 1 and almost entire surface of segments 2 and 3 with short, very dense pubescence on apices, longer, sparser pubescence elsewhere. **Eyes** slightly protruding, in dorsal aspect relatively short, about 2× longer than wide; anterior canthus about 0.3× length of eye in males, about 0.1× in females. Galea of maxilla with 3 or 4 hooklets.

Thorax. **Pronotum** moderately glossy, about 1.4× wider than long, about 1.5× wider than head in males, about 1.6× in females; **punctures** mostly dense, mostly minute in

males except for broad band of small punctures on lateral and posterior margins, small in females but with the largest in the size range located laterally and posteriorly; a few punctures in posterolateral corners with short, decumbent, brownish scales, remainder with minute, erect, thickened setae; posterior 0.3 of oblique lateral edge with 2 rows of short, standing scales, remainder of edge devoid of vestiture; disc flattened or weakly depressed, not grooved on midline, not tuberculate; anterior margin slightly convex on median 1/3rd; front angles reaching to posterior margin of eye; sides slightly rounded near middle. **Elytra** about as wide as pronotum, uniformly covered with small, dense punctures, most containing thickened, minute setae (barely visible at $\times 70$) but those on declivity and near anterior and lateral margins with short, erect scales; scales on proximal 1/2 of elytron about $3\times$ longer than wide; discal part of each elytron with 3 or 4 weakly impressed longitudinal striae; lateral margin of elytron reflexed, integument on outer side of its proximal 1/2 rounded, smooth, with sparse, minute, shallow punctures lacking vestiture, medial side of margin with fringe of short, standing scales; brim very narrow, present only on proximal 0.3 of elytron. **Wing** (Holloway 1963b: fig. 12) about $0.3\times$ length of elytron; radial recurrent and base of cubitus absent. **Front tibia** (Fig. 502, 503) slender, uniformly expanded from base, relatively narrow apically, conspicuously arcuate especially in males, ventral edge markedly concave; dorsal edge with large apical tooth and 3–5 broad-based teeth, small at proximal end, increasing in size distally; ventral apical spine large. **Middle tibia** (Fig. 504) gradually expanded from base, flared at apex; a few scales present in some longitudinal setiferous rows; spurs subcylindrical on proximal 0.25 then flattened on dorsal surface, tip slightly curved on anteroventral spur, straight on posteroventral spur. **Hind tibia** (Fig. 505, 506) gradually expanded from base, very slightly flared, a few scales present in some setiferous rows; posterior surface flattened in males, with an elongate patch of about 20 widely spaced, thickened setae between the dorsal and ventral longitudinal rows; posterior surface in females grooved, without a setiferous patch; spurs subcylindrical on proximal 0.3 then flattened on dorsal surface, posteroventral spur straight, narrow, not markedly laminate, weakly keeled on dorsal midline; tips of spurs straight or very slightly curved.

Abdomen. Ventrites rather dull; punctures small and mostly dense on ventrites 1 and 5, submarginal on ventrite 4, absent on ventrites 2 and 3.

Male genitalia. 9th abdominal segment (Fig. 658); apex of tergite slightly emarginate. **Permanently everted internal sac** (Fig. 659) about $2.5\times$ length of tegmen, distal 0.2 with numerous longitudinal folds, not conspicuously spinulose; papilla small; paired ventral sclerites short,

slender, widely separated from base of papilla. **Marginal bands** on ventral lobes of penis wide (Fig. 660).

Female genitalia (Fig. 715). **Ventral surface of bursa copulatrix** with a pair of long, broad sclerites that connect with a broad, crumpled, strongly sclerotised, pigmented band on distal 2/5ths of bursa. **Spermathecal duct** moderately long, entering bursa between the bases of the sclerites.

Type data. The holotype male was collected at Oruru ($35^{\circ} 03'S$, $173^{\circ} 30'E$) (ND) on 6 September 1918 by A. E. Brookes and is deposited in NZAC. The specimen measures 11.6 mm (including mandibles) \times 4.8 mm.

Material examined. Holotype male, paratype female, and 5 non-type specimens (4 males, 1 female) (NZAC).

Distribution (Map 31). Northland (including Poor Knights Is) from Oruru (latitude $35^{\circ} 03'S$) to Waipoua S. F. (latitude $35^{\circ} 39'S$), from near sea level to about 100 m. Map 31 includes records provided by Dr K. J. Fox (now deceased) of specimens he collected at Russell, Opuia, and Waipoua Forest in January 1978, 1980, 1981. The 2 specimens from the Poor Knights Islands were collected in 1980 by Dr J. C. Watt who provisionally identified them as belonging to a new species (Watt 1982).

ND / —

Biology. Adults have been collected in January, August, September, and November under stones, in leaf litter, and in a fallen trunk of *Kunzea ericoides* (kanuka). One specimen was obtained by pit trapping.

Remarks. *Paralissotes mangonuiensis* is superficially similar to *P. connori*, *P. stewarti*, and *P. triregius* but is easily recognised by its slender, curved front tibiae and relatively short, broad eyes. Males have a distinctive recurved tooth on the medial edge of the left mandible and their right mandible is slender and arcuate (resembling that of *P. planus*).

Conservation status. *P. mangonuiensis* is listed as 'Sparse' by Hitchmough (2002).

Paralissotes oconnori (Holloway)

Fig. 28, 151, 152, 507–513, 661–663, 716. Map 32
oconnori Holloway, 1961: 60, fig. 63, 64, 133, 138 (*Lissotes*); 1963a: 77, fig. 4, 8 (*Lissotes*); 1963b: 104, fig. 11, 21 (*Lissotes*); 1996: 65 (*Paralissotes*).

Diagnosis. Length: males (including mandibles) 11.4–13.8 mm, (excluding mandibles) 10.5–12.6 mm; females (including mandibles) 10.4–12.7 mm, (excluding mandibles) 9.6–12.0 mm. Width: males 4.8–5.7 mm; females 4.2–5.1 mm. Small with dull or moderately glossy, dark brownish-black integument (Fig. 151, 152). Elytral punctures small, uniformly dense, with erect, short or minute, brown scales

except near anterior margin, near outer 1/5th of elytron, and on the posterior declivity where they are longer and yellowish. Reflexed outer margin of elytron obliquely flattened anteriorly, with coarse punctures and a fringe of scales. Frons weakly concave. Eyes relatively long and broad, slightly protruding. Mandibles of males short, triangular, angulate externally at base; left mandible with a short, horizontal recurved tooth on medial edge, towards base. Mandibles of females short, angulate at the base, slightly sinuous on outer margin. Front tibia broad, almost straight, strongly expanded apically. Hind tibia of male without a setiferous patch on posterior surface.

Redescription

Head (Fig. 507, 508) widest across or in front of eyes.

Dorsal surface glossy; frons smooth, slightly concave; vertex smooth, flattened or slightly convex; **punctures** dense, small to moderately large and with minute erect setae immediately in front of eye, large and with short, erect, brown scales in a triangular patch adjacent to eye, small to moderately large with a minute, erect, thickened setae elsewhere. Preocular margin rounded or slightly indented, integument immediately in front of eye sloping outwards and slightly laminate; postocular margin straight, slightly convergent posteriorly. **Labrum** 1.1–1.3× wider than long; proximal 1/2 with a pair of setal tufts or a short transverse row of setae near base of low median tubercle; distal margin rounded or truncate. **Mandibles** somewhat triangular, short, not very curved laterally, moderately deep dorsoventrally in males, not very deep in females, conspicuously angulate externally at base, remainder of outer margin sinuate; dorsal surface of proximal 1/2 glossy, smooth, slightly concave in males, horizontal in females; punctures dense, minute and sharply defined in males, small with irregular margins in females, most with minute, erect, thickened setae; mandibles in males with single-tipped apical ventral, subapical dorsal, subapical ventral teeth and a bilobed basal ventral tooth; left mandible in females with single-tipped apical dorsal, subapical ventral, and basal ventral teeth, right mandible with single-tipped apical ventral and subapical dorsal teeth and a bilobed basal ventral tooth, dorsomedial edge sharp in both mandibles. **Antennal club** (Fig. 509) 1.6–1.8× longer than wide; process of segment 1 and most of segments 2 and 3, pubescent. **Eyes** slightly protruding, in dorsal aspect relatively long and broad, about 2× longer than wide; anterior canthus about 0.4× length of eye in males, about 0.3× in females. Galea of maxilla with 3 hooklets.

Thorax. Pronotum glossy, 1.3–1.4× wider than long, 1.3–1.4× wider than head; **punctures** uniformly dense and small, larger ones in the range near lateral and posterior margins and containing moderately long, yellowish, decumbent scales, remaining punctures with minute, erect

scales; oblique lateral edge of pronotum with about 2 rows of moderately long, yellowish, standing scales; disc flattened or slightly depressed, with shallow groove on midline, not tuberculate; anterior margin very slightly convex on median 1/3rd; front angles reaching to posterior margin of eye; sides slightly divergent on anterior 0.6 then convergent. **Elytra** about as wide as pronotum, covered with small, dense punctures, those on posterior declivity, near anterior margin, and on outer 1/5th of elytron with short or moderately long, standing, yellowish scales, remainder with short or minute, erect, brown scales (Fig. 28), largest scales about 3× longer than wide and on proximal 1/2 of elytron; discal part of each elytron with traces of 2 or 3 low ridges; outer margin of elytron reflexed, integument on proximal 1/2 of rim oblique, flattened, uneven, with fringe of standing scales arising from 2 or 3 rows of coarse punctures; anterior 0.4 of elytron with narrow, submarginal groove. **Wing** (Holloway 1963b fig. 11) about 0.3× elytral length; cubitus, radial recurrent, and medial recurrent veins absent. **Front tibia** (Fig. 510) broad, more or less uniformly expanded from base, wide apically; anteroventral edge slightly indented except for a small, obtusely rounded projection near base; dorsal edge with large apical tooth and 3 or 4 broad-based teeth that are minute near proximal end and increase in size distally; posteroventral apical spine moderately large. **Middle tibia** (Fig. 511) gradually expanded from base, flared at apex; scales present in some longitudinal setiferous rows; spurs subcylindrical on proximal 0.2 then flattened on dorsal surface, tip of anteroventral spur slightly curved, of posteroventral spur curved in males, almost straight in females. **Hind tibia** (Fig. 512, 513) gradually expanded from base, with flared apex; scales present in some setiferous rows; posterior surface flattened and lacking setiferous patch in males and females; spurs subcylindrical on proximal 0.2 then flattened on dorsal surface, posteroventral spur straight, narrow, not markedly laminate, not keeled on midline, its tip not curved; tip of anteroventral spur curved.

Abdomen. Ventrites glossy; entire surface of ventrites 1, 4, and 5 and median 1/3rd of ventrites 2 and 3 with small, dense punctures.

Male genitalia. 9th abdominal segment (Fig. 661); apex of tergite deeply emarginate. **Permanently everted internal sac** (Fig. 662) about 2× length of tegmen, distal 0.4 tapering markedly towards apex, not strongly folded, much of its surface with rows of conspicuous spinules; papilla absent, but pair of lateral, triangular lobes in its “expected” position; paired ventral sclerites short, very slender, widely separated from triangular lobes. **Marginal bands** on ventral lobes of penis moderately wide (Fig. 663).

Female genitalia.(Fig. 716). **Ventral surface of bursa**

copulatrix with obliquely longitudinal, sclerotised, pigmented folds and somewhat pear-shaped, partly bilobed sclerite. **Spermathecal duct** short, entering the bursa between the lobes.

Type data. The holotype male was collected on the Pandora Track (34° 27'S, 172° 47'E), Spirits Bay, (ND) on 30 November 1960 by B. A. Holloway and is in MONZ. It measures 11.4 mm (including mandibles) × 4.8 mm.

Material examined. Holotype male, paratype female, and 5 non-type specimens (2 males, 3 females) (MONZ, NZAC).

Distribution (Map 32). Northland from Unuwahao (latitude 34° 26'S) to Mangamuka Saddle (latitude 35° 12'S) from near sea level to about 300 m.

ND / —

The Mangamuka record is based on a single specimen supposedly collected at this locality on a field trip that included Spirits Bay. It is a possibility that the locality ascribed to the specimen is incorrect and that the species may be confined to the extreme north of the North Island. *Paralissotes oconnori* is listed as 'Sparse' by Hitchmough (2002).

Biology. Adults have been collected under sound and rotting fallen logs from October to January.

Remarks. *Paralissotes oconnori* has highly distinctive genitalia but lacks easily appreciated external features to separate it from *P. mangoniensis* and *P. triregius*. Combined characters to distinguish it from these 2 species are its short, broadly triangular mandibles that are angulate externally at the base and have a shiny surface with small but distinct punctures, eyes that are relatively broad, elytra with dense, well defined punctures containing clearly discernible, erect scales, and a fringe of standing scales anteriorly along the oblique, flattened, outer margin of the elytra. The front tibiae are uniformly expanded from the base and not curved, but the anteroventral margin is slightly indented.

Paralissotes planus (Broun)

Fig. 47, 153, 154, 514–523, 664–666, F71731. Map 33
planus Broun, 1880: 252 (*Dorcus*). Roon 1910: 48 (*Lissotes*).
Holloway 1961: 53, frontispiece 14, fig. 53–56, 130, 136, 142, 157 (*Lissotes*); 1963b: 104, fig. 13, 21 (*Lissotes*); 1996: 65 (*Paralissotes*).

Diagnosis. Length: males (including mandibles) 14.6–19.7 mm, (excluding mandibles) 13.6–17.7 mm; females (including mandibles) 13.0–17.3 mm, (excluding mandibles) 12.2–16.1 mm. Width: males 6.0–8.2 mm; females 5.8–7.2 mm. Small to medium-sized with dull to glossy, dark brownish-or reddish-black integument (Fig. 153, 154). Elytral punctures

absent or very small and with a few minute setae on several variably sized, bilaterally symmetrically paired, raised, shiny patches, large, dense and with decumbent to erect, yellowish-orange scales on remaining integument. Reflexed outer margin of elytra rounded dorsally, with minute and small punctures, most lacking vestiture, medial surface with some standing scales. Frons and vertex irregularly depressed. Eyes rather broad, slightly protruding. Mandibles of males relatively long, laterally curved, rather parallel-sided, with a large gap between apical and basal teeth. Mandibles of females short, broad, triangular, with almost uniformly convex outer margin. Front tibia broad, but conspicuously constricted on proximal 1/3rd. Hind tibia of male lacking a setiferous patch on posterior surface but with a few thickened setae in this position.

Redescription

Head (Fig. 514, 515) widest across eyes. **Dorsal surface** glossy; frons irregularly raised on anterior margin then slightly depressed; **punctures** sharply defined, mostly small, dense, with minute, erect setae, but posterior 1/2 of head with 2 paired, rather inconspicuous, somewhat triangular groups of moderately large, dense to very dense punctures containing moderately long, decumbent to erect, easily abraded, yellowish scales, these groups located on medial edge of eye and in frontal depression; a pair of very small squamose patches present at base of mandibles. Preocular margin indented, integument immediately in front of eye flattened, not concave; postocular margin straight, convergent posteriorly in males, divergent in females. **Labrum** about 1.5× wider than long, its proximal 1/2 with pair of setal tufts on either side of a conspicuous median tubercle; distal margin truncate or slightly indented. **Mandibles of males** moderately long and slender, curved laterally, parallel-sided, moderately deep dorsoventrally; outer edge uniformly convex, sometimes very slightly angulate near base; dorsal surface of proximal 1/2 glossy, convex, smooth; punctures small, dense, largest on basal 1/2, most with minute, erect setae; both mandibles with single-tipped apical dorsal and apical ventral teeth, bilobed basal ventral tooth and sharp dorsomedial edge, right mandible additionally with subapical dorsal tooth. **Mandibles of females** short, not deep dorsoventrally, broadly triangular; outer edge convex or very slightly angulate near base, dorsal surface of proximal 1/2 glossy, irregularly concave; punctures small, dense, largest near base, most with minute, erect setae; both mandibles with bilobed basal ventral tooth and keel on dorsomedial edge; left mandible with apical dorsal tooth, right mandible with apical ventral and subapical dorsal teeth. **Antennal club** (Fig. 516) about 1.6× longer than wide; pubescence present on most of process of segment 1 and on almost entire surface of segments 2 and 3. **Eyes** protruding, more prominent in females than

males, relatively short in dorsal aspect, about 2.3× longer than wide in males, about 1.7× in females; anterior canthus about 0.3× length of eye in males, about 0.2× in females; posterior canthus about 0.3× length of eye. Galea of maxilla with 5 or 6 hooklets.

Thorax. Pronotum (Fig. 517) glossy, 1.4–1.5× wider than long, about 1.4× width of head in males, about 1.6× in females; **punctures** and vestiture as on head, the small, dense punctures with minute, erect setae most numerous, the larger, very dense punctures with standing or decumbent scales arranged in 2 paired, circular groups on the disc, in a broad band on posterior and lateral margins, and on all but the median 0.3–0.5 of anterior margin, the discal groups varying in their development, well defined and in integumental depressions in some specimens, especially males, almost indistinguishable or absent in others, especially females and abraded specimens; posterior 0.6 of lateral oblique edge of pronotum with about 2 rows of long, standing scales. **Elytra** (Fig. 518) 1.0–1.1× width of pronotum, mostly covered with small, dense punctures containing short, yellowish-orange scales but with several small, flattened or raised, glossy areas that lack scales and have a few small or minute punctures, some aligned in fragmented striae and containing minute, erect setae, these areas varying greatly in size and shape; scales on basal 1/2 of elytron about 4× longer than wide; elytral scales near suture often abraded; outer margin of elytron reflexed, the basal half rounded, smooth, with more or less single row of small punctures dorsally, mostly devoid of scales; medial edge with fringe of standing scales; broad brim present anteriorly. **Wing** (Fig. 47) 0.3–0.4× length of elytron; radial recurrent and medial recurrent veins absent, base of cubitus distinguishable. **Front tibia** (Fig. 519) constricted on proximal 0.3 by indentation on ventral edge, then gradually expanded; dorsal edge with large apical tooth and 3 or 4 small blunt teeth; ventral apical spine moderately large. **Middle tibia** (Fig. 520) constricted on proximal 0.3 as on front tibia, then gradually expanded, apex not flared; longitudinal setiferous rows with scales as well as setae; dorsal edge spiny; spurs subcylindrical on proximal 0.25 then flattened dorsally, tip curved strongly on anteroventral spur, slightly on posteroventral spur. **Hind tibia** (Fig. 521, 522) constricted on proximal 0.2 then very slightly expanded, apex not flared; numerous scales as well as setae in longitudinal setiferous rows; posterior surface in males grooved, lacking distinct setiferous patch but sometimes with up to 3 thickened setae in the expected position between the dorsal and ventral rows; posterior surface in females flattened, without a setiferous patch; spurs subcylindrical on proximal 0.1 then flattened dorsally, the posteroventral spur not markedly laminate (Fig. 523), tip of anteroventral spur slightly curved, of posteroventral spur almost straight.

Abdomen. Ventrites glossy; punctures dense, small on ventrite 5 and sides of ventrites 1–4, mostly minute elsewhere.

Male genitalia. 9th abdominal segment (Fig. 664); apex of tergite slightly emarginate. **Permanently everted internal sac** (Fig. 665) about 3.5× length of tegmen; distal 0.2 with numerous longitudinal folds, surface not conspicuously spinulose; papilla large; paired ventral sclerites robust, long but not reaching to base of papilla. **Marginal bands** on ventral lobes of penis moderately wide (Fig. 666), with very conspicuous ducts along their inner border.

Female genitalia (Fig. 717). **Ventral surface of bursa copulatrix** with pair of very broad, rather short sclerites that connect with a broad band of sclerotised, pigmented, crumpled folds on distal 1/2 of bursa. **Spermathecal duct** moderately long, entering bursa copulatrix between bases of paired sclerites.

Type data. Broun described this species from four specimens he collected at Whangarei Heads (ND). Only one of these, a male labelled “Type Parua [Bay] (35° 46’S, 174° 27’E), Whangarei Heads” in Broun’s handwriting is in his collection at the BMNH. In my earlier revision I incorrectly regarded this specimen as the holotype. As 40 years have passed and it is still the specimen of the four that can be located I am here designating it as the lectotype in order to fix this taxonomic concept of *planus* Broun.

Material examined. Lectotype male and 73 non-type specimens (39 males, 34 females) (AMNZ, BMNH, MONZ, NZAC).

Distribution (Map 33). Northernmost record: Mangonui, ND (34° 59’S); southernmost record: Okauia, WO/BP (37° 47’S), from near sea level to about 500 m.

ND, AK, CL (including Little Barrier Island), WO/BP / —

Biology. Adults have been collected throughout the year under stones, in and under logs, under loose bark of dead trees, and in tunnels in the trunk of a dead *Leptospermum scoparium* (manuka) tree. One specimen in the material examined was collected in a pit trap. Brenda May (now deceased) reared a female from a larva she found on 2 November 1979 in a cell under a stone on Mt Moehau (CL). The specimen emerged on 5 January 1980. Fragments of *P. planus* were present in the gizzard of a North Island Kiwi (*Apteryx australis mantelli*) found “near Kaitaia” (ND) in March 1971 (Watt 1971).

Remarks. *Paralissotes planus* is easily recognised by the basally constricted front tibiae of males and females and by both mandibles being laterally arcuate in males. The standing scales on the elytra are like those in *P. mangonuiensis*, *P. stewarti*, and *P. triregius* but the sculp-

tured patterns on the pronotum and elytra, although somewhat rudimentary, are similar to those in *P. reticulatus* and *P. rufipes*. The female genitalia are almost identical with those in *P. mangonuiensis* whose males interestingly have one of their mandibles laterally arcuate.

Paralissotes reticulatus (Westwood) Reticulate stag beetle

Fig. 27, 37, 50, 86, 155, 156, 524–533, 667–671, 718.
Map 34

reticulatus Westwood, 1844: 106 (*Lucanus*); 1847: 275, pl. 20, fig. 4 (*Lucanus*); 1855: 218, pl. 12, fig. 8a, 8b (*Lissotes*). Benesh 1960: 41 (*Lissotes*). Holloway 1961: 47, fig. 14, 18, 49, 50, 127, 128, 134, 140, 145–153 (*Lissotes*); 1963b: 104, fig. 9; 1996: 65, fig. 6, 7, 14 (*Paralissotes*).

squamidorsis White, 1846: 9, pl. 2, fig. 2 (*Dorcus*). Fairmaire 1849: 414 (synonym of *Lucanus reticulatus*).

zelandicus Blanchard, 1847 pl. 9, fig. 13 (*Lucanus*). Fairmaire 1849: 414 (synonym of *Lucanus reticulatus*).

cicatricosis Burmeister, 1847: 403 (*Aegus*). Parry 1863: 451 (synonym of *Lissotes reticulatus*).

For additional references see Benesh (1960).

Diagnosis. Length: males (including mandibles) 12.7–21.8 mm, (excluding mandibles) 11.6–20.3 mm; females (including mandibles) 13.8–21.3 mm, (excluding mandibles) 12.8–20.0 mm. Width: males 5.3–9.3 mm; females 5.8–9.0 mm. Small to medium-sized with glossy, blackish integument; dorsal surface with conspicuous areas of large, appressed, dull, yellowish-brown scales, those on the elytra forming a reticulate pattern (Fig. 86, 155, 156); punctures moderately large and dense on squamose areas, small, sparse or absent on non-squamose areas. Outer margin of elytron barely reflexed. Frons and vertex depressed. Eyes relatively short, broad, slightly protruding. Mandibles very similar in males and females, triangular, moderately long; outer margin barely convex; medial edge with closely spaced teeth. Front margin of head without squamose patches near base of mandibles. Pronotum lacking squamose band on middle 1/3–1/2 of front margin. Front tibiae broad, slightly curved. Male with a large setiferous patch on posterior surface of hind tibia.

Redescription

Head (Fig. 524) widest across or immediately in front of eyes. **Dorsal surface** glossy; frons and vertex deeply depressed; **punctures** sharply defined, most minute, moderately dense, and with minute, barely visible, erect setae, but posterior 1/2 of head with 4 conspicuous somewhat triangular groups of larger, very dense, sometimes confluent punctures containing moderately long, appressed, relatively narrow, brownish scales, not overlapping one another, and not obscuring the punctures, these groups on

medial edge of each eye and in frontal depression. Preocular margin deeply indented; integument immediately in front of eye deeply depressed, laminate, with a few minute punctures; postocular margin slightly convex, convergent posteriorly. **Labrum** about 1.8× wider than long; proximal 1/2 with pair of setal tufts on either side of low median tubercle; distal margin truncate or slightly indented. **Mandibles** triangular, deep dorsoventrally, very slightly curved laterally; outer margin somewhat sinuate, obtusely angulate at base; dorsal surface of proximal 1/2 glossy, slightly concave, uneven; punctures minute or small, dense, most with minute, erect, thickened setae; both mandibles with single-tipped apical ventral, subapical ventral, and subapical dorsal teeth, a bilobed basal ventral tooth, and a low ridge or lamina proximally on dorsomedial edge; teeth on medial edge arranged fairly uniformly; apices of subapical and basal ventral teeth finely striated; left mandible of males (Fig. 525) additionally with small ventral cusp on anterior face of the more proximal member of the bilobed basal ventral tooth and sometimes also a with minute cusp on subapical ventral tooth. **Antennal club** (Fig. 526) 1.6–1.8× longer than wide; apical 1/2 of processes on segments 1 and 2, and about 2/3rds of entire surface of segment 3 pubescent. **Eyes** slightly protruding, in dorsal aspect about 2× longer than wide; anterior canthus about 0.3× length of eye, posterior canthus about 0.2×. Maxilla (Holloway 1961, fig. 14); galea with 2 or 3 hooklets.

Thorax Pronotum (Fig. 527) glossy, 1.3–1.4× wider than long, 1.4–1.6× wider than head; **punctures** as on head, most minute, moderately dense, with barely visible setae but large punctures containing moderately long, appressed, yellow scales present in 4 irregularly circular, variably sized depressions on disc, in a wide continuous band along the posterior and lateral margins, and on all but the median 1/3rd or 1/2 of anterior margin; disc with small median tubercle near anterior margin and a shallow groove on part of midline; anterior margin very slightly convex on median 1/3rd; front angles reaching posterior margin of eye; sides slightly divergent over anterior 0.6 then convergent; posterior 0.6 of lateral oblique edge with about 2 rows of moderately long, standing scales. **Elytra** (Fig. 528, 529) about same width as pronotum, with extensive, elongate, variably sized, ragged-edged, depressed, squamose areas separated from one another by non-squamose integument, producing a reticulate pattern (Fig. 86, 155, 156), the depressed areas with large, dense punctures and appressed, moderately long, yellowish scales (Fig. 37); scales on proximal 1/2 of elytron at least 4× longer than wide; non-squamose areas glossy, mainly smooth, with a few small punctures, some aligned in striae, containing minute erect setae; outer margin of elytron very slightly reflexed; brim absent. **Wing** (Holloway 1963b, fig. 9) 0.5–0.7× length of elytron; cubi-

tus present, radial recurrent and medial recurrent veins absent. The broad prosternal process of this species, typical for the genus, is shown in Fig. 50. **Front tibia** (Fig. 530) broad, gradually expanded from base; ventral edge slightly concave; dorsal edge with large apical tooth and 5–10 rather broad-based teeth, minute at proximal end of tibia, increasing in size distally; ventral apical spine moderately large. **Middle tibia** (Fig. 531) gradually expanded from base, slightly flared at apex; longitudinal setiferous rows containing only setae; spurs subcylindrical on basal 0.25 then flattened, tips slightly curved. **Hind tibia** (Fig. 532, 533) very slightly expanded from base, not conspicuously flared at apex; scales absent from longitudinal setiferous rows; posterior surface in males with a shallow longitudinal groove enclosing a large, elongate setiferous patch; posterior surface in females with a deeper longitudinal groove, without a setiferous patch; spurs subcylindrical on proximal 0.5 then flattened on dorsal surface, posterior spur not markedly laminate; tip curved on anteroventral spur, straight on posteroventral spur.

Abdomen. Ventrites glossy, with small mostly dense punctures on entire surface.

Male genitalia. 9th abdominal segment (Fig. 667); apex of tergite slightly emarginate. **Permanently everted internal sac** (Fig. 668) about 3× length of tegmen; not conspicuously spinulose; distal 0.3 with numerous longitudinal folds; papilla large; paired ventral sclerites robust, long, reaching to base of papilla. **Marginal bands** on ventral lobes of penis wide (Fig. 669–671).

Female genitalia (Fig. 718). **Ventral surface of bursa copulatrix** with a pair of weakly sclerotised, partly joined sclerites that connect with a large, crumpled, shiny, sclerotised patch on distal end of bursa. **Spermathecal duct** long, entering bursa through the narrow gap between the pair of sclerites.

Type data. I have not been able to track down the types of *Lucanus reticulatus* Westwood, *Lucanus zelandicus* Blanchard, and *Aegus cicatricosus* Burmeister but the illustrations provided by these authors leave no doubt as to their identity. No type locality other than New Zealand was given in the original descriptions but considering the historical period in which the specimens were collected it can be reasonably assumed that they were from Wellington city (41° 17'S, 174° 46'E). Westwood's original description lacked definitive characters for identifying *reticulatus* but he rectified this several years later (Westwood 1847) by publishing a more detailed description as well as an illustration. The type material of *Dorcus squamidorsis* White was collected at Port Nicholson [Wellington Harbour]. Apparently White had more than 1 specimen because he gave a range of measurements for length for the species. Only one of his specimens is in the BMNH. It is

labelled "Type" but it designated here as the lectotype in order to fix the taxonomic concept of *squamidorsis* White.

Material examined. Lectotype of *Dorcus squamidorsis* (sex not determined) and 265 non-type specimens (140 males, 125 females) (AMNZ, BMNH, CMNZ, NMNZ, NZAC).

Distribution (Map 34). Northernmost record: Mt Te Aroha, BP (latitude 37° 32'S); southernmost record: Waimate, SC (latitude 44° 44'S), from near sea level to about 950 m. The SC records are from Emberson (1982).

BP, GB, TO, TK, RI, WI, WN / NN, SD (including Stephens I), MB, KA, BR, NC, MC, SC

Biology. Adults are active throughout the year. During the day they have been collected in and under well-decayed logs and fallen branches of native trees, under loose bark of standing native trees, and under stones. Several specimens in the material examined were from pit traps. The adults move about at night and sometimes also in daytime. Moeed & Meads (1983) collected them throughout the year in up and down traps placed 1.5 m above ground on tree trunks in native forest in the Orongorongo Valley (WN). Also at this locality Fitzgerald *et al.* (1986) identified fragments of adults in ejected pellets of nestling kingfishers (*Halcyon sancta*) and in regurgitated crop contents of an adult kingfisher. The larvae live in and under rotting wood and have been described and illustrated by Hudson (1934) who included descriptions and illustrations of the pupa and adult. Pupae have been found in January (Holloway 1961). The material examined includes a pair of adults taken *in copula* on 28 October 1962. Sharell (1961) has colour photographs of a live adult and larva.

Remarks. This is the commonest and most widespread species of *Paralissotes*. It is most similar externally to *P. rufipes* (Sharp) but can be distinguished from that species by the absence of scales at the base of the mandibles and on the median 1/3rd or 1/2 of the front margin of the pronotum, and by the patches of scales on the elytra being more elongate and having irregular margins. The setiferous patch on the posterior surface of the hind tibia of males is the largest and most conspicuous in the genus.

Paralissotes rufipes (Sharp)

Fig. 46, 157, 158, 534–542, 672–674, 719. Map 35
rufipes Sharp, 1886: 398 (*Lissotes*). Holloway 1961: 51, frontispiece 11, fig. 51, 52, 129, 135, 141, 154–156 (*Lissotes*); 1963b: 102, 104, fig. 8, 21 (*Lissotes*); 1996: 65 (*Paralissotes*).

elegans Broun, 1893: 1110 (*Lissotes*). Holloway 1961: 51 (synonym of *L. rufipes*).

Diagnosis. Length: males (including mandibles) 14.2–17.4 mm, (excluding mandibles) 13.0–15.7 mm; females (includ-

ing mandibles) 15.0–18.6 mm, (excluding mandibles) 13.8–16.9 mm. Width: males 5.6–6.7 mm; females 5.8–7.3 mm. Small to medium-sized with glossy blackish or reddish integument; dorsal surface with conspicuous patches of large, appressed, dull yellowish-brown scales; elytra with a reticulate pattern (Fig. 157, 158); punctures moderately large and dense in squamose areas, minute and sparse in non-squamose areas. Outer margin of elytron not reflexed. Frons and vertex deeply depressed. Eyes relatively short, broad, barely protruding. Mandibles relatively similar in males and females, somewhat triangular, moderately long; outer margin distinctly convex; medial edge with approximately evenly spaced teeth; basal ventral tooth bilobed in males, single-tipped in females. Head with small patch of yellowish appressed scales near base of mandibles. Pronotum lacking squamose band on at most middle 1/5th of front margin. Front tibiae slender, slightly curved. Setiferous patch absent from posterior surface of hind tibia of males but represented by several thickened setae in this position.

Redescription

Head (Fig. 534) widest in front of eyes or behind them.

Dorsal surface glossy; frons and vertex smooth, deeply depressed; **punctures** sharply defined, mostly minute, dense and containing minute, erect seta, but larger, denser, sometimes confluent punctures with moderately long, appressed, yellowish scales present in 3 paired, somewhat triangular groups near base of mandibles, on medial edge of eyes, and in frontal depression, these scales relatively broad, mostly overlapping, usually obscuring punctures. Preocular margin indented; integument immediately in front of eye moderately depressed, laminate, with sparse, minute punctures; postocular margin moderately convex, convergent posterad. **Labrum** about 1.7× wider than long; proximal 1/2 with pair of setal tufts or transverse row of setae near base of low median tubercle; distal margin truncate or slightly indented. **Mandibles** triangular, deep dorsoventrally, moderately curved laterally, outer edge uniformly convex, base not angulate; dorsal surface glossy on proximal 1/2, slightly convex, smooth; punctures minute to small, dense, most with minute, thickened setae; both mandibles with single-tipped apical, subapical dorsal (better developed in males), and subapical ventral (widely separated from apex in females) teeth, rudimentary tooth, ridge, or lamina (better developed in females) on dorsomedial edge and a basal ventral tooth, bilobed in males (Fig. 534), single-tipped in females (Fig. 535); apices of subapical ventral and basal ventral teeth finely striated. **Antennal club** (Fig. 536) 1.4–1.5× longer than wide; pubescent on about 1/3rd of process of segment 1, on about 1/2 of process of segment 2 and about 3/4 of entire surface of segment 3. **Eyes** not protruding, in dorsal aspect about 2× longer than wide; anterior canthus about 0.4× length of eye; posterior

canthus about 0.2× length of eye. Galea of maxilla with 2–6 hooklets.

Thorax. Pronotum (Fig. 157, 158, 537) glossy, 1.3–1.4× wider than long, 1.3–1.4× wider than head; **punctures** of 2 types as on head, larger ones with moderately long, appressed, overlapping, yellowish scales arranged in 2 pairs of depressed, circular, oval, or somewhat triangular groups on either side of midline (anterior and posterior groups sometimes partly conjoined), in a wide band along posterior and lateral margins and on all except median 1/5th or less of anterior margin; posterior 0.8 of lateral oblique edge of pronotum with about 2 rows of moderately long, appressed scales; anterior margin moderately convex on median 1/3rd; midline of disc with rudimentary groove on posterior 1/2 and small median tubercle near anterior margin; front angles distant from posterior margin of eyes; sides almost parallel over anterior 0.6 then convergent.

Elytra (Fig. 538) 1.0–1.1× width of pronotum, with extensive, variably developed, depressed areas that have moderately large, dense **punctures** and scales like those on the head and pronotum; scales on proximal 1/2 of elytron about 2× longer than wide; non-squamose areas forming a reticulate pattern, glossy, mainly smooth, with a few minute punctures, not aligned, containing minute, erect setae; outer margin of elytron not reflexed; brim absent. **Wing** (Fig. 46; Holloway 1963b, fig. 8) about 0.8× length of elytron; cubitus, radial recurrent, and medial recurrent veins present.

Front tibia (Fig. 539) relatively slender, approximately uniformly expanded from base; ventral edge slightly concave; dorsal edge with a large apical tooth and 6–8 narrow-based teeth that are minute at proximal end of segment, increasing in size towards distal end; ventral apical spine minute. **Middle tibia** (Fig. 540) gradually expanded from base; apex flared; longitudinal setiferous rows with scales as well as setae; spurs subcylindrical on basal 0.25 then flattened on dorsal surface, tips slightly curved. **Hind tibia** (Fig. 541, 542) very slightly expanded from base; apex moderately flared in males, less so in females; longitudinal setiferous rows containing mainly scales; posterior surface flattened, not grooved; setiferous patch absent but represented by 1–4 thickened setae in males; spurs subcylindrical on proximal 0.5 then flattened but not laminate on dorsal surface; tip of anteroventral spur curved, tip of posteroventral spur straight.

Abdomen. Ventrites glossy; punctures on ventrite 5 and anterior margins of ventrites 1–4 mostly small and dense, elsewhere mostly sparse and minute.

Male genitalia. 9th abdominal segment (Fig. 672); apex of tergite conspicuously emarginate. **Permanently everted internal sac** (Fig. 673) about 2.5× length of tegmen, not conspicuously spinulose, distal 0.2 with numerous longitudinal folds; papilla large; paired ventral sclerites long, reaching base of papilla. **Marginal bands** on ventral lobes of penis narrow (Fig. 674).

Female genitalia (Fig. 719). **Bursa copulatrix** with pair of short, broad, partly joined ventral sclerites connected to a large, crumpled, strongly sclerotised, trilobed patch extending over about 1/2 of the ventral surface of bursa copulatrix. **Spermathecal duct** moderately long, entering bursa copulatrix between apices of the paired sclerites.

Type data. Sharp described *Lissotes rufipes* from 2 specimens collected in Picton, SD (41° 18'S, 174° 00'E) by Helms. Only 1 specimen (sex undetermined), in BMNH and labelled "Type" in Sharp's handwriting but more correctly regarded as the lectotype, has been located and I am here designating this specimen as the lectotype in order to fix this taxonomic concept of *rufipes* Sharp.

Lissotes elegans was described by Broun from 3 specimens collected on Mt Arthur, NN (41° 12'S, 172° 42'E) and forwarded to him by G. V. Hudson. I have been able to trace only 1 of these, a specimen (sex undetermined) in the BMNH. I am here designating this specimen as the lectotype in order to fix this taxonomic concept of *elegans* Broun.

Material examined. Lectotypes of *Lissotes rufipes* Sharp and *Lissotes elegans* Broun and 85 non-type specimens (46 males, 39 females) (AMNZ, BMNH, MONZ, NZAC).

Distribution (Map 35). Northernmost record: Canoe Bay, French Pass, SD (latitude 40° 10'S); southernmost record: Lake Rotoiti, BR (latitude 41° 50'S), from near sea level to about 950 m based on label data of specimens examined, but according to Hudson (1934) this species occurs in the forest on the slopes of Mt Arthur up to an altitude of 4000 feet (1200m).

— / NN, SD, MB, BR

Biology. Adults have been collected throughout the year. During the day they may be found in and under rotten logs. At night they move about on the ground and on tree trunks. The material examined includes a specimen found sheltering during the day in a knot-hole on the trunk of *Kunzea ericoides* (kanuka) and a pair taken *in copula* on 30 January 1945.

Remarks. This species is known only from the northern part of the South Island, north of latitude 42°S. Over most of its range it is sympatric with the rather similar-looking *P. reticulatus* from which it can easily be distinguished by its narrower, more parallel-sided form, the well defined patch of yellowish scales at the bases of the mandibles, and the very narrow non-squamose gap in the middle of the anterior margin of the pronotum. *P. rufipes* is the only species in the genus whose wings, although vestigial, have clearly recognisable radial recurrent, medial recurrent, cubitus, and anal veins, all relatively strongly sclerotised and pigmented and almost certainly indicating that the immediate ancestor of *Paralissotes* was fully winged (Holloway 1963b).

Paralissotes stewarti (Broun)

Fig. 87, 159, 160, 543–549, 675–677, 720. Map 36
stewarti Broun, 1881b: 673 (*Dorcus*). Roon 1910: (*Lissotes*).
Holloway 1961: 56, frontispiece 12, 13, fig. 57–59, 131, 139, 143, 158, 159 (*Lissotes*); 1963b: 104, fig. 10, 23 (*Lissotes*); 1996: 65 (*Paralissotes*).

Diagnosis. Length: males (including mandibles) 10.2–14.0 mm, (excluding mandibles) 9.0–12.3 mm; females (including mandibles) 9.1–13.7 mm, (excluding mandibles) 8.4–12.5 mm. Width: males 4.2–5.4 mm; females 3.9–5.8 mm. Small with glossy, blackish integument (Fig. 87, 159, 160). Elytral punctures small to moderately large, uniformly dense, with erect, mostly minute, yellowish or brownish scales. Elytra lacking a brim, outer margin not reflexed; marginal rim flattened and with coarse punctures containing standing scales. Frons concave; vertex flattened or convex. Eyes long, relatively broad, barely protruding. Mandibles relatively long, especially in males, triangular, the outer margin weakly convex, not conspicuously angulate externally at base. Front tibia broad, almost straight, strongly expanded apically. Setiferous patch absent from hind tibia but sometimes represented by a few thickened setae.

Redescription

Head (Fig. 543, 544) widest across or in front of eyes. **Dorsal surface** glossy; frons smooth, slightly concave, vertex smooth flattened or slightly convex; **punctures** sharply defined, dense, small to moderately large immediately in front of eye, moderately large in 1 or 2 rows along medial edge of eye, small elsewhere, those along medial edge of eye with short, erect, yellowish scales, remainder with minute, erect, brownish scales. Preocular margin uniformly rounded or obtusely angulate, sometimes slightly indented, integument immediately in front of eye slightly laminate and sloping downwards; postocular margin straight or slightly convex. **Labrum** 1.4–1.6× wider than long, its proximal 1/2 with pair of setal tufts at base of low median tubercle; distal margin truncate. **Mandibles** relatively long, especially in males, moderately deep dorsoventrally in males, not very deep in females; outer edge weakly convex or barely sinuate, sometimes weakly angulate basally; dorsal surface of proximal 1/2 glossy, slightly uneven, almost horizontal; punctures small, dense, with somewhat irregular margins, most with minute, erect, thickened setae. **Left mandible of males** with single-tipped apical dorsal, subapical ventral and basal ventral teeth and large blunt-tipped or occasionally weakly bilobed tooth near middle of ventral edge; right mandible of males with single-tipped apical dorsal, subapical dorsal, and subapical ventral teeth and bilobed ventral tooth; some teeth often rudimentary; distance between bilobed basal and subapical ventral teeth sometimes much greater than in specimen shown in Fig.

543. **Left mandible of females** with single-tipped apical dorsal, subapical ventral and basal ventral teeth; right mandible of females with single-tipped apical ventral and subapical dorsal teeth and bilobed basal ventral tooth (single-tipped in 1 of the specimens examined). Dorsomedial edge of both mandibles sharp in males and females. **Antennal club** (Fig. 545) 1.3–1.4× longer than wide; pubescent on process of segment 1 and on most of segments 2 and 3.

Eyes slightly protruding, in dorsal aspect about 2× longer than wide; anterior canthus 0.3–0.4× length of eye in males, 0.2–0.3× in females. Galea of maxilla with 4–6 hooklets.

Thorax. Pronotum glossy, 1.3–1.4× wider than long, 1.3× wider than head in males, 1.4× in females; **punctures** uniformly dense, small to moderately large, the larger ones near lateral and posterior margins and with short or moderately long, erect, yellowish scales, remaining punctures small with minute, erect, brown scales; disc slightly depressed, with a shallow groove on most of midline, not tuberculate; anterior margin very slightly convex on median 1/3rd; front angles reaching posterior margin of eyes; sides almost parallel on anterior 0.6 then convergent their margin oblique with 2 or 3 irregular rows of short, standing, yellowish scales. **Elytra** about same width as pronotum, parallel-sided, uniformly covered with small to moderately large, dense punctures, those on posterior declivity, near anterior margin and on outer 1/2 of each elytron with short, standing, yellowish scales, remainder with minute or short, erect, brownish scales, the largest of these about 2× longer than wide and on proximal 1/2 of elytron; both elytra in some specimens with traces of 3 or 4 slightly raised, longitudinal ridges on disc and a small, sparsely punctate, oval patch on posterior declivity; outer margin of elytron lacking brim and groove, not reflexed; integument on proximal 1/2 of rim oblique, flattened, uneven, with fringe of standing scales in row of coarse punctures. **Wing** (Holloway 1963b fig. 10) 0.4–0.5× length of elytron; radial and medial recurrent veins absent, base of cubitus present. **Front tibia** (Fig. 654) robust, approximately uniformly expanded, broad; ventral edge slightly concave; dorsal edge with large apical tooth and 3–5 broad-based teeth, minute at proximal end of tibia, increasing in size towards distal end; ventral apical spine moderately large. **Middle tibia** (Fig. 547) gradually expanded from base, slightly flared at apex; scales as well as setae in some of the longitudinal setiferous rows; spurs subcylindrical on proximal 0.2 then flattened on dorsal surface; tip of posteroventral spur slightly curved, of anteroventral spur curved strongly in males, slightly in females. **Hind tibia** (Fig. 548, 549) gradually expanded from base, moderately flared at apex in males, weakly flared in females; scales as well as setae in some of the longitudinal setiferous rows; posterior surface flattened, lacking a setiferous patch but with up to 5 thickened setae in this

position in males, and 1 such seta in some females; spurs subcylindrical on proximal 0.2 then flattened dorsally; posteroventral spur straight, narrow, not markedly laminate, not keeled on midline; tip of anteroventral spur curved, of posteroventral spur straight.

Abdomen Ventrites glossy; punctures small to moderately large, sparse on sides of ventrites 1–3, dense elsewhere.

Male genitalia. 9th abdominal segment (Fig. 675); apex of tergite slightly emarginate. **Permanently everted internal sac** (Fig. 676) about 3× length of tegmen, not conspicuously spinulose; distal 0.2 with numerous longitudinal folds; papilla large; paired ventral sclerites robust, long, almost reaching base of papilla. **Marginal bands** on ventral lobes of penis narrow (Fig. 677).

Female genitalia (Fig. 720). Ventral surface of **bursa copulatrix** with a very broad, sclerotised, pigmented, longitudinally folded subapical band incorporating a pair of partly fused sclerites. **Spermathecal duct** entering bursa between sclerites; apex of the bursa copulatrix membranous and lacking folds; spermathecal duct very long.

Type data. Broun described this species from 3 mutilated specimens, 1 from Wellington, WN (41° 17'S, 174° 46'E) collected by Mr P. Stewart, and the other 2, collected by Broun, from Stoke Point, Waitemata Harbour, AK (36° 50'S, 174° 41'E). All 3 are in the Broun Collection at BMNH. The Wellington specimen, a male, is in the best condition and is the only one bearing a type label. I am here designating this specimen as the lectotype in order to fix this taxonomic concept of *stewarti* Broun.

Material examined. Lectotype male, 2 paralectotypes, and 56 non-type specimens (28 males, 28 females) (AMNZ, BMNH, CMNZ, NZAC).

Distribution (Map 36). Northernmost record: Herekino, ND (latitude 36° 15'S); southernmost record: Turanganui River, WA (latitude 41° 26'S), from near sea level to about 460 m.

ND, AK, CL, TK, RI, WI, WA, WN / —

In my earlier revision (Holloway 1961) I mentioned that one of the specimens examined was labelled as being from Christchurch but was probably from Auckland. It now seems certain that the specimen was probably collected on Waiheke Island in Auckland so I am disregarding this supposed South Island record.

Biology. Adults in the material examined were collected throughout the year under logs and stones, under loose bark, and in leaf litter, and several were caught in pit traps. Reid *et al.* (1982) found fragments of adults in gizzard contents of the North Island Brown Kiwi (*Apteryx australis mantelli*).

Remarks. Males of *P. stewarti* are distinctive in having elongate, narrow, triangular mandibles in contrast to the shorter, broader, triangular mandibles in males of *P. mangonuiensis*, *P. oconnori*, and *P. triregius*. The mandibles of *P. stewarti* females also are relatively elongate and somewhat narrow but these features are less certain for identification purposes. Males and females can both be distinguished from *P. mangonuiensis* by their broad, straight front tibiae (compared with narrow, curved front tibiae in *mangonuiensis*), from *P. oconnori* by the base of their mandibles being narrow and not angulate (compared with the broad, angulate-based mandibles of *oconnori*), and from *P. triregius* by their broad eyes (compared with very narrow eyes of *triregius*).

Paralissotes triregius (Holloway)

Fig. 38, 161, 162, 550–558, 678–680, 721. Map 37
triregius Holloway, 1963a: 78, fig. 1–3, 5–7 (*Lissotes*); 1963b: 104, fig. 14, 23 (*Lissotes*); 1996: 65 (*Paralissotes*).

Diagnosis. Length: males (including mandibles) 10.8–13.1 mm, (excluding mandibles) 9.8–11.7 mm; females (including mandibles) 11.5–13.0 mm, (excluding mandibles) 10.8–12.0 mm. Width: males 5.0–5.8 mm; females 5.1–5.7 mm. Small, with dull to glossy black integument (Fig. 161, 162). Elytral punctures small to moderately large, dense, containing minute, barely discernible, erect scales. Reflexed outer margin of elytra obliquely flattened, coarsely punctate and with a fringe of standing scales. Frons depressed, vertex convex. Eyes long, very narrow, very slightly protruding. Mandibles triangular, short, broad, with uniformly convex outer edge. Front tibia broad, strongly expanded apically. Hind tibia of male without a setiferous patch on posterior surface.

Redescription

Head (Fig. 550) widest across preocular margin. **Dorsal surface** dullish; frons slightly depressed, vertex slightly convex; both with smooth surface; **punctures** sharply defined, mostly small and moderately dense on vertex and anterior 1/2 of frons, mostly moderately large and dense on medial edge of eye, punctures with erect, thickened setae that are minute in smallest punctures, short in larger punctures. Preocular margin rounded or slightly indented; integument immediately in front of eye horizontal or sloping, not markedly laminate, with 2 or 3 small punctures; postocular margin straight, very slightly convergent posteriorly in males, very slightly divergent in females. **Labrum** about 1.5× wider than long, proximal 1/2 with an almost contiguous pair of setal tufts at base of conspicuous median tubercle; distal margin truncate or slightly indented. **Mandibles** somewhat triangular, not deep dorsally, only slightly arched laterally; outer edge uniformly convex, obtusely rounded externally at base; dorsal

surface of proximal 1/2 satiny, horizontal, smooth; punctures minute and dense in males, small and mostly dense in females, some with minute, erect, thickened setae. Left mandible in males with single-tipped apical dorsal and subapical ventral teeth and bilobed basal ventral tooth; right mandible in males with single-tipped apical ventral, subapical ventral and subapical dorsal teeth and bilobed basal ventral tooth; dorsomedial edge of both mandibles rounded. Left mandible of females (Fig. 551) with single-tipped apical dorsal and subapical ventral teeth and blunt-tipped or barely bilobed basal ventral tooth; right mandible with single-tipped apical ventral and subapical dorsal teeth and bilobed basal ventral tooth; dorsomedial edge of both mandibles slightly keeled. **Antennal club** (Fig. 552) about 1.7× longer than wide in males, about 1.5× in females; pubescent on process of segment 1 and on most of segments 2 and 3. **Eyes** very slightly protruding, in dorsal aspect long and very narrow and about 3× longer than wide; anterior canthus about 0.5× length of eye in males, about 0.4× in females. Galea of maxilla with 1 or 2 hooklets.

Thorax. Pronotum glossy, 1.3–1.4× wider than long, 1.3–1.4× wider than head in males, 1.4–1.5× wider than head in females; **punctures** dense or moderately dense, small to moderately large, smallest ones mostly on centre of disc and with minute, erect, thickened setae, largest most numerous in posterolateral corners and with short, erect scales; posterior 0.7 of lateral oblique edge with 2 or 3 rows of short to moderately long, standing scales, remainder of edge with minute scales arranged more or less in single row; disc flattened or feebly depressed, not grooved on midline, not tuberculate; anterior margin slightly convex on median 1/3rd; front angles not reaching posterior margin of eyes in males, reaching to at least posterior margin in females; sides slightly divergent on anterior 0.6 then convergent. **Elytra** about same width as pronotum, covered uniformly with small to moderately large, dense punctures and short, erect scales (Fig. 38); scales on proximal 1/2 of elytron about 4× longer than wide; discal part of elytron with traces of 2 very weak longitudinal ridges; outer margin reflexed, the integument on proximal 1/2 oblique, flattened, uneven, coarsely punctate and with fringe of standing scales; proximal 1/2 of elytron with narrow brim. **Wing** (Holloway 1963b, fig. 14) 0.2–0.3× length of elytron; radial recurrent and medial recurrent veins absent, base of cubitus present. **Front tibia** (Fig. 553) approximately uniformly expanded from base, broad apically; ventral edge slightly concave; dorsal edge with large apical tooth and 4–6 broad-based teeth that are minute on proximal end of tibia, increasing in size towards distal end; ventral apical spine moderately large. **Middle tibia** (Fig. 554) gradually expanded from base, flared apically; no scales in longitudinal setiferous rows; spurs subcylindrical on proximal 0.25 then flattened on dorsal surface, tip of anteroventral spur strongly curved, weakly curved on posteroventral spur. **Hind tibia** (Fig.

555, 556) gradually expanded from base to apex; no scales in longitudinal setiferous rows; posterior surface in males flattened, lacking setiferous patch and "additional" setae between dorsal and ventral setiferous rows; posterior surface in females grooved, lacking setiferous patch; spurs subcylindrical on about proximal 0.25 then broad, laminate, curved, and with a variably developed keel on midline (Fig. 557, 558); tip curved on anteroventral spur, straight on posteroventral spur.

Abdomen. **Ventrites** glossy; punctures small, dense, present on most of ventrites 1–4, on entire surface of ventrite 5.

Male genitalia. **9th abdominal segment** (Fig. 678); apex of tergite slightly emarginate. **Permanently everted internal sac** (Fig. 679) about 2.6× length of tegmen; not conspicuously spinulose; distal 0.1 tapering markedly towards apex, with a few longitudinal folds; papilla large; paired ventral sclerites extremely long, robust; reaching to base of papilla. **Marginal bands** on ventral lobes of penis very narrow (Fig. 680).

Female genitalia (Fig. 721). Ventral surface of **bursa copulatrix** with a deep, broad, crumpled, sclerotised and pigmented band occupying at least 1/2 of its distal end and connecting proximally with a weakly sclerotised, vaguely rectangular sclerite that has a pair of slender, curved arms extending into the crumpled, sclerotised part of bursa; **spermathecal duct** moderately long, entering bursa copulatrix near centre of rectangular sclerite.

Type data. The holotype male, collected on the northeastern slopes above Hapuka Point, Great Island, Three Kings Islands (34° 10'S, 172° 07'E) on 8 May 1946 by E. G. Turbott, is in AMNZ. It measures 12.0 mm × 5.4 mm (including mandibles).

Material examined. Holotype male, 3 paratypes (2 males, 1 female), and 22 non-type specimens (11 males, 11 females) (AMNZ, MONZ, NZAC).

Distribution (Map 37). Three Kings Is (Great Island) (latitude 34° 10'S), approximately 53 km NW of the North Island of New Zealand. Taken from near sea level to about 270 m.

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Biology. The specimens examined were collected in January, May, and November. They were found during the day under stones, in decaying wood, and under bark of dead *Kunzea ericoides* (kanuka), and at night moving over the ground.

Remarks. This is the only lucanid known from the Three Kings Is. It has some features of *P. mangoniensis*, *P. oconnori*, and *P. stewarti* but is easily recognised by its long, narrow eyes.

Genus *Ryssonotus* MacLeay, 1819

MacLeay, 1819: 98. Type species *Lucanus nebulosus* Kirby, 1818, by monotypy. For additional references see Benesh (1960).

The diagnosis and redescription are based on *Ryssonotus nebulosus* (Kirby, 1818) but some of the features apply also to *R. politus* Carter, 1921 (see Holloway 1961: 339, fig. 63–69).

Diagnosis. Medium-sized to large; sexual dimorphism apparent mainly in size and shape of the mandibles. Integument reddish brown or almost black. Head broad, rectangular, with 1 or more tubercles on midline. Pronotum broad, rectangular, deep dorsoventrally. Mandibles of males and females long, straight, multi-cusped and densely setose on the medial surface. Antennal club narrow, 5- or 6-segmented, not conspicuously demarcated from funicle segments. Eyes completely divided by anterior and posterior canthi. Front tibiae not fossorial.

Redescription

Head short, broad, somewhat rectangular; **anterior margin** truncate or sinuous, not rimmed; lateral margins straight, round edged, not laminate. **Mandibles** deep dorsoventrally, long, not laterally curved, medial surface concave, with marginal cusps and numerous brownish or orange setae. Maxillae with well developed galea and lacinia; apex of lacinia weakly sclerotised, not hooked. Mentum relatively small, wider than long; sides convex; distal margin deeply notched, ventral surface smooth, without setae. Ligula elongate, very narrow, not divided on midline. Intermandibular process short, concave, receding beneath anterior margin of head. Labrum inconspicuous, narrow, elongate, its surface smooth. **Antennae** very similar in males and females; club with 5 or 6 stout, non-opposable segments inconspicuously demarcated in width from funicle segments, and mostly with only small amounts of pubescence. Supra-antennal brow short, sharply arched. **Eyes** about the same in males and females, completely divided by canthi into a relatively large, dorsal section and a much larger ventral section. Postocular margin short, concave, usually concealed by large front angles of pronotum.

Thorax. **Pronotum** much wider than long; front angles conspicuous, acute to obtuse; disc not tuberculate, surface uneven; sides descending almost vertically to lateral margins which are narrowly rimmed, almost horizontal, sparsely punctate and smooth edged; integument adjacent to rim slightly depressed forming narrow channel; hind angles obtuse. Scutellum wider than long. **Elytra** parallel-sided; outer margin with very narrow, horizontal rim that has a few minute setose punctures; integument adjacent to rim not forming a brim; striae punctures not visible on dorsal surface. **Wings** fully developed. **Prosternal** process narrow; mesosternal process broad. **Legs** long, moderately

stout, similar in males and females; procoxal process broad, short; femora with moderately dense punctures containing simple setae, front femur robust and about 2× longer than wide, its setiferous patch well defined, relatively small, punctate over most of its surface, not reaching middle of segment; front tibia not fossorial; middle and hind tibiae with very few spines, lacking setiferous patches; ventral surface of tarsomere 1 lacking setae, of tarsomeres 2–4 with a few scattered setae; arolium with a tuft of 3 easily abraded setae on either side of apex.

Abdomen. Sides of ventrites not flanged; **ventrite 5** not conspicuously dimorphic.

Male genitalia. **9th abdominal segment** robust. Basal piece not totally sclerotised. **Parameres** large, not laminate instead rather cushiony, lacking marginal fringe of setae but entire surface covered with minute setae that are dense near apex, sparse elsewhere; parameres connected to basal piece by a very flexible membrane. **Penis** elongate, almost parallel-sided, membranous except for pair of rather long, narrow, sclerotised lateral bands; ventral cross bar absent; dorsal cross bar narrow; connected by pair of very short lateral bridges to bases of sclerotised lateral bands. **Permanently everted internal sac** about same length as tegmen, smooth walled, strap-like, terminating in a short flagellum.

Female genitalia. **Hemisternites** moderately strongly sclerotised, deeply pigmented; apices pointed, setose, lacking styli. **Accessory gland** long and narrow. **Bursal duct** not distinct. Bursa copulatrix short. Spermathecal duct short. **Spermatheca** either spherical or divided into lobes.

Range. Australia; accidentally established in New Zealand.

Remarks. *Ryssonotus* has 7 known species, distributed mainly in an eastern zone from Queensland to Victoria (Benesh 1960; Cassis & Moore 1992). On the basis of its completely divided eye, unarmed galea and lacinia, flagellate male genitalia, and female genitalia lacking the typical lucanine crescentic spermatheca and styli, the genus appears to be closely allied to *Aegus* MacLeay, 1819, as exemplified by *A. chelifera* MacLeay, 1819, *A. gestroi* Boileau, 1902, and *A. malaccus* Thomson, 1856, the only species of *Aegus* that I have been able to examine in detail. The tufted, incised, barbed setae of *R. nebulosus*, the type species of the genus, are very distinctive. Tufted, incised setae are also present in *Aegus* but I have not examined the surface structure of these with SEM to see whether they are also barbed. The absence of a cross bar or plate ventrally at the base of the penis is an unusual feature that I have not seen in any other lucanine genus.

I have retained MacLeay's original spelling of the genus but the emended form *Rhyssonotus* is commonly used nowadays.

Ryssonotus is the only lucanine genus in New Zealand that has a 6-segmented antennal club, but as the amount of pubescence on the first club segment is small and not very visible the club appears superficially to be 5-segmented. The genus is represented in New Zealand by *R. nebulosus*, the type species.

Ryssonotus nebulosus (Kirby)

Fig. 5, 26, 34, 88, 163, 164, 559–564, 681, 682, 722.

Map 38

nebulosus Kirby, 1818: 411, pl. 21, fig.12 (*Lucanus*). MacLeay 1819: 99 (*Ryssonotus*). Parry, 1870: 70 (*Rhyssonotus*; has *Lucanus foveolatus* Thunberg, 1806 as a doubtful synonym). Roon 1910: 6 (*Rhyssonotus*). Benesh 1960: 148 (*Rhyssonotus*; has *Lucanus foveolatus* Thunberg, 1806 as synonym). Moore & Cassis 1992: 16 (*Rhyssonotus*; has *L. foveolatus* Thunberg as synonym but the authors note that the status of this name is not resolved).

See Benesh (1960) for additional references.

Diagnosis. Length: males (including mandibles) 19.0–28.2 mm, (excluding mandibles) 15.9–21.9; females (including mandibles) 20.3–27.7 mm, (excluding mandibles) 17.9–23.8 mm. Width: males 8.0–11.5 mm; females 9.3–12.2 mm. Large bodied (Fig. 88, 163, 164). Integument reddish brown, very finely and polygonally sculptured; head and pronotum somewhat glossy; elytra dull, velvety, with mottled light and dark brownish pattern. Punctures (pits) polygonally sculptured on walls and floor, large, deep, and dense on head and pronotum, minute, shallow, and sparse on elytra. Vestiture on dorsal surface consisting of minute, standing, deeply incised, barbed setae and a few minute simple setae. Mandibles very long; outer edge with an angulate projection near the middle; medial surface in males with dense orange setae that obscure the marginal cusps; medial surface in females with sparser brownish setae and exposed cusps. Head with a tubercle near middle of anterior margin and one midway between eyes. Fully winged.

Redescription

Head (Fig. 5, 559, 560). Median conical tubercles near anterior margin of head and between eyes much larger in males than in females. **Labrum** narrow, elongate, inconspicuous; labral suture present. **Mandibles of males** with apex slightly recurved, oblique, incorporating a short, blunt apical tooth and a small subapical dorsal tooth; middle of mandible conspicuously angulate on outer margin and with inwardly curved, erect tooth on dorsomedial edge; ventromedial edge with several irregularly shaped, short teeth concealed in dorsal aspect by a broad band of long, dense orange setae. **Mandibles of females** resembling those of males but smaller, with shorter, sparser, brownish setae on medial surface and several additional teeth dorsally near middle. **Antennae** (Fig. 561) similar in males and females

except that club is 2.9–3.3× longer than wide in males, 2.6–2.7× in females; club not sharply differentiated in width from funicle segments but composed of 6 segments that can be recognised as belonging to the club by their pubescence which covers the entire surface of segment 6, the processes of segments 2–4 and a minute patch on the process of segment 1. **Eyes** transverse in dorsal aspect, totally divided into upper and lower sections but with suture visible between anterior and posterior canthi. Maxillary palp as in Fig. 562. Mentum not “normally” chitinised, instead somewhat translucent; labium as in Fig. 563.

Thorax. Pronotal surface mottled, very uneven, with 4 deep, circular depressions on either side of a broad, median groove, the surface more uneven and coarsely punctate in females than in males. **Elytral surface** polygonally sculptured, but under high magnification appearing somewhat granulate, especially on paler areas, because of extensive, uneven, exudations from the walls of the polygons (Fig. 34). Vestiture (Fig. 26) inconspicuous to naked eye, but at high magnifications seen to consist of minute, tufted, deeply incised setae with broad, scale-like barbs on their walls, especially apically, and looking like bunches of asparagus! **Front tibiae** (Fig. 564) relatively broad but not fossorial; posterior surface grooved in males, smooth in females; dorsal margin with 5–8 slender, widely separated teeth, small at proximal end of tibia, increasing in size towards apex. **Middle and hind tibiae** (Fig. 88) with 1–3 slender spines dorsally and lacking setiferous patches.

Abdomen

Male genitalia slightly asymmetrical. **9th abdominal segment** (Fig. 681); apex of tergite conspicuously angulate; apex of sternite shallowly indented; pleurites joined on dorsal midline with no visible suture, their stalks slightly asymmetrical. **Aedeagus** (Fig. 682); parameres truncate apically; **basal piece** slightly asymmetrical, strongly sclerotised except for distal membranous patch; lateral sclerotised bands on **ventral surface of penis** asymmetrical, left band much longer than right, both bands extending on to dorsal surface where they project vertically as a pair of narrow, sclerotised “wings”.

Female genitalia (Fig. 722). **Hemisternites** with sharply pointed apices. Accessory gland long, narrow. **Bursa copulatrix** short, broad, with transverse folds. **Spermathecal duct** very short and broad; **spermatheca** large; composed of 6 elongate lobes, outermost on each side single, remaining 4 arranged in 2 conjoined pairs; spermathecal gland duct entering spermatheca between bases of 1 pair of lobes.

Type data According to Moore & Cassis (1992) the probable holotype of *Lucanus nebulosus* Kirby is in BMNH, and the status of *Lucanus foveolatus* Thunberg is unknown. They give Australia as the type locality of *L. nebulosus*

and “? Australia” for *L. foveolatus*.

Material examined. 29 non-type specimens from New Zealand (15 males, 14 females) (NZAC).

Distribution (New Zealand, Map 38). In Auckland city, AK (latitude 36° 53'S) and in the vicinity of Gisborne city GB (latitude 38° 40'S), near sea level.

AK, GB / —

In Australia *R. nebulosus* occurs in coastal Queensland and New South Wales (Moore & Cassis 1992).

Biology. Adults in New Zealand have been collected from December to February. They fly in the evening and are attracted to lights. Gourlay (1954) first recorded the species in New Zealand from 2 specimens, 1 found in a house in Gisborne, the other, also from Gisborne, where it had been discovered along with several others in dying bluegum trees (*Eucalyptus*). In 1964, 7 males and 10 females were found in a dead *Acacia* stump in Gisborne. The first known Auckland specimen was collected in 1967 and a second was found in 1984. It was not until Thorpe (2000; 2001) discovered larvae and adults in old stumps of privet (*Ligustrum lucidum*) in the Mt Eden/Epsom area that it was known for certain the species had become established in urban Auckland. Thorpe's 2 papers contain observations on the behaviour of adults and larvae. The record of a specimen reared in 1960 by the Forest Research Institute, Rotorua from a *Eucalyptus* post imported into Gisborne from Australia 4 months previously gives a good indication of how *R. nebulosus* probably arrived in New Zealand. Moore & Cassis (1992) give “fallen timber” as the larval substrate for this species in Australia.

Remarks. *Ryssonotus nebulosus* is easily recognised by its transverse, rectangular head, long, porrect mandibles, completely divided eyes, velvety, brown patterned elytra, and 6-segmented, narrow antennal club. The velvety appearance of the elytra and sometimes also of the pronotum is caused by accumulated exudations from the walls of the tiny polygonal cells on the integumental surface. A few of these cells showing varying amounts of exudations on the walls can be seen on the left of the micrograph featured as Fig. 34. The density of the cells and their exudations on a larger area of the elytron, and at a lower magnification, is strikingly apparent in a micrograph published earlier (Holloway 1997, fig. 49). Interestingly, similar exudations are present on the elytra of the Chilean lucanine, *Pycnosiphorus caelatus* (Holloway 1997, fig. 47, 48) which also has barbed incised setae but which in other respects is totally different from *R. nebulosus*. In some specimens of *nebulosus* the pronotum and elytra lack distinct mottling, the integument instead being dark brown and glossy. Although I have not examined any of those specimens under SEM it seems likely that these differences in the appearance of the pronota and elytra result from the lack of a build up exudations.

Genus *Serrognathus* Motschulsky, 1861

Serrognathus Motschulsky, 1861: 12. Roon, 1910: 33 (as synonym of *Eurytrachelus* Thomson, 1862). Benesh 1960: 80 (genus reinstated; catalogue and synonyms). Type species: *Serrognathus castanicolor* Motschulsky, 1861 (= *Lucanus titanus* Boisduval, 1835) by monotypy (as cited in Moore & Cassis 1992: 17).

The following Diagnosis and Redescription are based on males and females of *S. okinawanus* (Kreische, 1922) from Japan, *S. platymelus* (Saunders, 1854) from China, *S. sika* (Kriesche, 1921) from Taiwan, and *S. titanus* (Boisduval, 1835) from Sulawesi, all identified and sent to me for study by Dr Luca Bartolozzi of Florence.

Diagnosis. Large to very large lucanines, length including mandibles about 30–70 mm in males, about 20–40 mm in females, showing marked sexual dimorphism, and allometry in features of the head and pronotum of males. Mandibles of males long, straight, rather narrow, with a large, incurved apical tooth; other teeth, when present, horizontal, and confined to the medial edge of the mandible. Integument entirely black, dull or moderately glossy, with concave, polygonally sculptured punctures (pits) that have a centrally placed, often minute, inconspicuous, linear scale; in large males some punctures filled with exudate make the surface appear pustulate. Antennal club 3-segmented; medial (anterior) edge of antenna with 1 or a pair of long setae on funicle segment 3, 2 to about 10 long setae on triangular process of funicle segment 5 and lacking setae on the medial edge of funicle segments 1, 2, and 4. Labrum porrect, notched on midline. Ventral apical 1/2 of mentum in males with a broad band of dense erect, brown scales. Eyes completely or incompletely divided by canthi. Front tibiae not fossorial.

Redescription

Head. **Dorsal surface** of head and mandibles dull and almost entirely densely pustulate in large males, glossy and punctate in females and small males. **Anterior margin** slightly sinuous, neither rimmed nor tuberculate. Preocular margin somewhat laminate. **Mandibles of males** much longer than head, not arched; apex conspicuously incurved, undivided or bifurcate; medial edge with a short but conspicuous incurved tooth at base, edge between this tooth and apex variably sinuous, serrated, or dentate. **Mandibles of females** narrow, relatively long but shorter than head, with apical and subapical ventral teeth and oblique, inwardly directed dorsal flange or tooth towards the base. Maxillae with well developed lacinia and galea; apex of lacinia hooked in females, not hooked in males. **Mentum** approximately rectangular, much wider than long; ventral surface rather finely and densely pustulate in large males, mostly punctate in small males, the distal 1/2 in males a with broad, transverse band of dense, long, wide, laminate,

sometimes furred, erect, brown scales (sometimes partly abraded); ventral surface in females with coarse, mostly confluent punctures containing erect, brown setae or scales of varying sizes. Ligula deeply divided. Intermandibular projection very short, sloping obliquely. Labral suture present. **Labrum** short, wide, almost horizontal; surface convex in females, concave in the middle in males; distal margin variably notched on midline, convex on either side of notch in females, sinuous or bifid on either side of notch and with a sharp lateral angle in males; surface rather dull and often densely pustulate in large males, moderately glossy, mostly punctate, with a few pustules in small males, glossy and entirely punctate in females. **Antennae** conspicuously sexually dimorphic; club 3-segmented, terminal segment totally pubescent, other 2 segments partially pubescent; pedicel and funicle segments approximately symmetrical, 3rd funicle segment with 1 seta or a pair of setae on the medial (anterior) margin, 5th with medial edge produced distally into a conspicuous angulate process that has 2 apical setae in females, about 10 apical setae in males. Supra-antennal brow very short, sharply arched. **Eyes** narrow, not protruding, small in males, larger in females; anterior canthus narrow and reaching well beyond middle of eye in males, broad, laminate and extending almost or totally to postocular margin but not fusing with it in females. Postocular margin long and straight or slightly convex in males, very short, divergent, and mostly concealed by front angles of pronotum in females. Interocular surface smooth in males, uneven and with pair of obscure tubercles in females.

Thorax. **Pronotum** much wider than long; front angles acute, conspicuous in females, inconspicuous in males; disc flattened, smooth; sides sloping gradually; lateral margins narrowly rimmed, slightly serrated, convex in females, almost parallel but often with 1 or 2 sharp projections in males; brim if present narrow; hind angles obtuse. Scutellum wider than long. **Elytra** straight-sided or slightly convex; outer margin with oblique, narrow, vaguely serrated rim and a few minute setae; integument adjacent to rim forming narrow, shallow brim; striae sparse, weak and punctate in females, represented mostly by finely etched lines in males, entire surface otherwise uniformly punctate and squamose; punctures polygonally sculptured and concave, minute in males, usually larger in females; scales narrow, erect, usually minute in males, usually slightly longer in females. **Wings** fully developed. **Pro- and meso-sternal processes** broad. **Legs** long, moderately slender; procoxal process absent. Femora with mostly moderately dense punctures containing minute, narrow scales; front femur slender and about 3× longer than wide in males, robust and about 2.5× longer than wide in females; setiferous patch punctate over most of its surface and reaching to at least the middle of the

segment. Tibiae with 5 longitudinal rows of long scales or thickened setae, and fine, short setae between rows; front tibia moderately slender and with similar-sized teeth along posterior (outer) margin in males, broader and with alternating large and small teeth on posterior margin in females; middle and hind tibiae with mid dorsal spine and no other spines apart from those at apex, distinct setiferous patches absent but some long, thickened setae ventrally near apex. Ventral surface of tarsomeres 1–4 in males with pair of conspicuous setose subapical patches, often joined at midline, and less conspicuous setae in approximately V-shaped patch near middle of segment; ventral surface of tarsomeres 1–4 in females with patches like those in males but smaller and with shorter setae; ventral surface of tarsomere 5 with very short, row or cluster of curved setae distally on midline; arolium with about 10 long setae in cluster on either side of apex.

Abdomen. Apex of **ventrite 5** uniformly convex, not angulate, with submarginal, apical band (not circular setiferous patch) of scales in males.

Male genitalia. Symmetrical except for slight asymmetry in penis. **9th abdominal segment** robust, broad; distal margin of tergite convex or slightly indented; distal margin of ventrite convex, setose, rather cushiony.

Basal piece sclerotised ventrally and laterally, membranous dorsally, enclosing a pair of long struts. **Parameres** large; apical and dorsal margins laminate; ventral margin with 2 conspicuous, inwardly directed teeth. **Base of penis** lacking lateral bridge between ventral and dorsal crossbars; ventral crossbar with pair of large lateral plates, each plate with rather stiff but cushiony, pale distal lobe, left lobe always shorter than right lobe; dorsal crossbar with pair of long, pointed, strongly sclerotised, deeply pigmented prongs on outer edge. **Permanently everted internal sac** much longer than tegmen, strap-like, relatively narrow, with pair of very short, pointed, digitate processes about midway along its length; apex terminating in balloon-like structure with pointed projection on which gonopore is located; much of outer surface of permanently everted sac clothed with dense, very short, brown microsetae.

Female genitalia. **Hemisternites** mostly membranous but strongly sclerotised on apical 0.3–0.5 and on a narrow stalk that extends down the middle of each hemisternite and expands into a somewhat triangular or oval “foot” proximally. **Styli** absent. **Accessory gland** narrow. Bursal duct not distinct. **Bursa copulatrix** long, tubular, longitudinally folded. Spermathecal duct short, stiff, very broad basally, joining bursa copulatrix laterally (not terminally) near apex. **Spermatheca** bulbous or elongate-oval, with a long stalk. Spermathecal gland short, bulbous or oval, vaguely or markedly differentiated from its duct.

Range. Oriental and Palaearctic Regions, Papua New Guinea, Solomon Islands, and Australia (Moore & Cassis 1992). Not known to be established in New Zealand.

Remarks. The greater Asian region is home to an assemblage of large, black lucanines that are all rather similar-looking externally except for the usually spectacular development of mandibles and some other morphological features found only in largest males of the various species. On the basis of these characters genera, subgenera, and species have been described without consideration being given to the identification of females and small males. The resulting frustration has forced some authors to ignore most of the generic names and to group all the species of the “complex” in one or a few very loosely defined genera. In his volume on the Lucanidae of India Arrow (1950) placed most of the species he examined in *Dorcus* MacLeay, 1819 under which he listed 27 synonyms comprising replacement names, subgenera, and genera including *Serrognathus* Motschulsky, 1861 and *Eurytrachellelus* Didier, 1931. Mitzuma & Nagai (1994) followed Arrow’s usage of *Dorcus* but others have limited that genus to a relatively small number of species and placed the remainder either in *Eurytrachellelus* (Didier & Seguy 1953; Maes 1982) or *Serrognathus* (Benesh 1960; Bartolozzi *et al.* 1998).

The recent discovery of 3 moribund males of *Serrognathus sika* (Kriesche) in an outer suburb of Auckland provided the opportunity not only to confirm the genus but also to make a detailed study of external and internal structures in a range of species placed in *Serrognathus*. Didier (1937) and Maes (1982) had illustrated parts of the male genitalia of several species of the complex but no comparable study had been made of the genitalia of females. Using identified material sent by Dr Luca Bartolozzi I was able to compare the male and female genitalia and external features of *S. sika* with those of *S. titanus* (Boisduval, 1835), the type species of the genus. From previous work on lucanids I had found the configurations of the male and female genitalia to be the best indicators of genera so these were the first structures I examined in the two species. Not surprisingly they proved to be similarly useful in *Serrognathus*. While there were specific differences in the shape and size of some of the components, the configurations were the same for both species (see Fig. 683–686, 723, 724), and furthermore, similar configurations, with specific differences, were recognisable in *S. platymelus* (Saunders, 1854) and *S. okinawanus* (Kriesche, 1922), the two other species sent to me by Dr Bartolozzi. Having established that the four species were congeneric it was easy to determine which external features were generically important. By using the same method I found that six other species placed in *Serrognathus* by Benesh (1960) do not belong in that genus, instead they

represent four different genera: *Lucanus saiga* Olivier, 1789 and *Serrognathus arfakianus* Lansberge, 1880 are congeneric; *Eurytrachelus prosti* Boileau, 1901 and *Eurytrachelus cervulus* Boileau, 1901 are congeneric; and *Lucanus gypaetus* Castelnau, 1840 and *Lucanus lineopunctatus* Hope, 1831 (synonym of *Dorcus tityus* Hope, 1842) both belong in separate genera. Almost certainly, generic names are available for all these species, none of which belongs in *Dorcus* as exemplified by *D. parallelipipedus* (Linnaeus, 1835), but someone with better access to type specimens and old literature will have to sort those out.

Serrognathus species are most easily recognised externally by the number and arrangement of setae on the medial (anterior) edge of the 3rd and 5th funicle segments in males and females (Fig. 569, 570). The band of scales on the distal half of the mentum (Fig. 571) is an easily seen unique character of males; females have a pair of obsolete tubercles between the eyes but this feature is not unique to *Serrognathus*.

The three males of *S. sika* are the only known New Zealand specimens of *Serrognathus* and it is extremely unlikely that the genus is established here.

***Serrognathus sika* (Kriesche)**

Fig. 89, 165, 166, 565–579, 683, 684, 723. Map 39.

sika Kriesche, 1921: 118 (*Eurytrachelus titanus* (Boisduval) subspecies *sika*). Didier & Séguéy 1952, pl C11, fig. 1 & 2 (*Eurytrachellelus titanus* var. *sika*); 1953: 142; (*Eurytrachellelus titanus* var. *sika*). Benesh 1960: 87 (synonym of *Serrognathus titanus*). Maes 1982: 7, fig. 6, 17, (*Eurytrachellelus sika*). Mitzunuma & Nagai 1994: 269, pl. 102, fig. 403 (39–43) (*Dorcus titanus sika*). Bartolozzi *et al.* 1998: 35 (*Serrognathus sika*).

Diagnosis (based on males from New Zealand and Taiwan, and females from Taiwan). Length: males (including mandibles) 30–50 mm, (excluding mandibles) 25–40 mm; females (including mandibles) 26–34 mm, (excluding mandibles) 25–31 mm. Width: males 10–19 mm; females 10–13 mm. Body large to very large (Fig. 89, 165, 166). Dorsal integument in large males (length including mandibles at least 40 mm) dull and pustulate on head and pronotum, shiny elsewhere; entirely smooth and shiny in small males (less than 40 mm) and females. Head of females with a pair of low tubercles between eyes. Elytral vestiture inconspicuous or barely discernible, consisting of minute or short, erect, narrow scales. Labrum notched on midline; anterolateral corners rounded in females, with rather blunt, single tipped projection in males. Preocular margins of head obtusely angulate anteriorly then parallel-sided in males, convex and slightly divergent in females. Postocular margins bulging slightly in males, almost entirely concealed by front

angles of pronotum in females. Sides of pronotum uniformly convex in females, slightly convex and with 2 pairs of small angulations in males. Front tibiae of females deeply forked at apex, the 2 prongs separated by at most a right angle.

Redescription

Head (Fig. 565–568) widest in front of eyes. **Dorsal surface** smooth in males, uneven and with pair of small interocular tubercles in females; **punctures** mostly small, very dense, pustulate, and almost all filled with exudate in large males, mostly large, moderately dense, lacking both pustules and exudate in females and small males, punctures on anterior 1/2 of head pustulate and filled with exudate in some medium-sized males; small punctures mostly without visible vestiture, larger punctures with centrally placed minute scales. Preocular margin laminate in females, not laminate in males, divergent from mandible base to supra-antennal brow then parallel in males, convex or sinuous in females. Postocular margin obscure in females, with a small, convex projection in males. **Labrum** 3.2–3.7× wider than long in males, about 3.0× in females; dorsal surface finely punctate and concave in males, coarsely punctate and convex in females; distal margin notched on midline, convex on either side of notch in females, with pair of anterolateral projections in males. **Mandibles of males** with incurved apical tooth, very small subapical dorsal tooth (large males only, Fig. 567), inwardly directed tooth towards base, large in largest males, small in medium-sized males (Fig. 565), inconspicuous in smallest males (Fig. 566); medial edge with row of distinct teeth (large males) or feeble serrations (small and medium-sized males). **Mandibles of females** (Fig. 568) narrowly triangular, with large apical tooth, obliquely erect lamina or short tooth ventrally near base, and short horizontal tooth ventrally near middle of medial edge. Mandibular punctures fine, dense and with exudate in large males, coarse, rather sparse and without exudate in females and smallest males. **Antennal club** (Fig. 569, 570) 1.2–1.3× longer than wide; process of club segment 1 and all of club segments 2 and 3 pubescent; pedicel and funicle segments 1–4 approximately symmetrical; funicle segment 5 strongly asymmetrical on dorsal (medial) edge; funicle segment 3 with long, subapical dorsal seta; apex of asymmetrical projection on funicle segment 5 with tuft of at least 6 long, curved setae in males, 2 long setae in females. **Eyes** elongate, not protruding, in dorsal aspect about 1.8–2.2× longer than wide in males, about 1.7× in females; canthus in males extremely narrow, not extending along entire outer edge of eye, in females broad, about 0.3× width of eye, extending along entire outer edge of eye. **Mentum** in males (Fig. 571) with broad ventral, apical band of dense, long, brown, funnel-shaped, erect scales; ventral surface in females with large, dense,

sometimes coalescent punctures containing fine, mostly short, brown setae.

Thorax Pronotum (Fig. 572, 573) moderately glossy, about 1.8× wider than long in males, about 1.5× in females, about 1.2× wider than head in males, about 1.4× in females; punctures in males all with minute or short setae, fine, sparse and without exudate on centre of disc, small, very dense and with exudate on sides of disc, large, moderately dense, some with exudate, on pronotal margins; punctures in females all without exudate, fine and sparse on centre of pronotum, larger and denser elsewhere; setae not visible in smallest punctures, short in others; disc flattened in males, slightly convex in females; anterior margin excavated on either side of midline; front angles conspicuous, very distant from eyes in males, reaching almost to eyes in females; sides in males approximately parallel but with angulate projection at anterior 0.3 and slight swelling (small and medium-sized males) or angulate projection (largest specimens) at hind angle where serrated lateral margin meets smooth, forwardly directed part of posterior margin; sides in females serrated, uniformly convex, meeting smooth, entirely transverse posterior margin in obtusely rounded hind angle. **Elytra** shiny, about same width as pronotum; punctures dense and minute in males, dense and minute on discal part of elytra, and increasing in size towards sides and posterior declivity in females; all punctures with minute erect scales; outer margins slightly reflexed, smooth, oblique, almost devoid of punctures and vestiture; brim barely discernible; traces of about 5 striae on each elytron, very vague in males, more obvious in females. **Front tibia** (Fig. 574, 575) straight, only slightly expanded at apex; dorsal edge extending forward prominently at forked apex, remainder of edge with about 6 moderately large teeth alternating with very small, irregularly shaped teeth in males, with close, irregularly shaped teeth increasing in size from base to apex of segment in females; **middle and hind tibiae** very similar, narrow at base, otherwise almost parallel-sided (Fig. 576, 577), the 5 longitudinal rows of scales or thickened setae conspicuous, a tuft of longer setae ventrally at apex; mid dorsal spine small in males, large in females; spurs subcylindrical on proximal 1/2 then slightly flattened, short in males, longer in females; posteroventral spur straight, narrow; tips of spurs straight or very slightly curved.

Abdomen. Apex of **ventrite 5** narrowly convex in males (Fig. 578), broadly convex in females (Fig. 579).

Male genitalia. **9th abdominal** segment (Fig. 683); apex of sternite slightly indented. **Parameres** with outer edge straight, not produced laterally at base (Fig. 684); ventromedial margin with large, recurved tooth near middle and much smaller subapical tooth. Dorsolateral prongs at base of **penis** slender, short, barely or not reaching apex of

proximal tooth of paramere. Terminal funnel of **permanently everted internal sac** elongate, gradually expanded. Apex of larger (right) papilla of penis pointed, of smaller (left) papilla rounded.

Female genitalia (Fig. 723). **Hemisternites** moderately sclerotised with rounded (not truncate) apex and relatively broad, parallel-sided stalk that is only slightly widened at base. Paired sclerites of sternite 9 near bases of hemisternites very narrow. Spermathecal duct slightly widened where it joins **bursa copulatrix**. **Spermatheca** spherical. Spermathecal gland much wider than its duct.

Type data. Kriesche described *sika* as a subspecies of *Eurytrachelus platymelus* Saunders from a series of 245 males and 125 females collected at 6 localities in Formosa (now Taiwan). I have not seen any of those specimens. My identification of the specimens found in Auckland was made provisionally from the original description, and from excellent photographs in Mitzunuma & Nagai (as *Dorcus titanus sika* new combination) and Taroni (1998) (as *Serrognathus sika*), and from the description and figures of part of the male genitalia provided by Maes (1982) (as *Eurytrachellelus sika*). The identification was confirmed by comparison with identified *Serrognathus sika* material sent by Dr Bartolozzi in Florence. The size range of males (28–62 mm) in the type series is much greater than in the small number of specimens I have examined.

Material examined. 18 non-type specimens (10 males, 5 females from the Bartolozzi collection in Florence and 3 males in the MAF collection at Tamaki, Auckland). The Bartolozzi material is from “Taiwan”, no other data; the 3 males in the MAF collection were found moribund or recently dead at 2 properties in the same street of the Auckland suburb of Pakuranga (36° 55’S, 174° 54’E) between December 2000 and April 2001. See Map 39.

Remarks. The *Serrognathus* species that I have examined, *okinawanus*, *platymelus*, *sika* and *titanus*, all have striking specific differences in the male and female genitalia (compare Fig. 683 and Fig. 684 with Fig. 685 and Fig. 686, and Fig. 723 with Fig. 724), but relatively few external differences. Males of *sika* are distinguishable from those of *titanus* by labral features, the anterolateral corners of the labrum having a single angulate projection in *sika*, but 2 projections in *titanus*, and females by their elytral vestiture, absent apart from a few scales near the posterolateral margin in *sika*, consisting of erect, short, cream scales, dense except in the immediate vicinity of the suture in *titanus*. The slightly bulging postocular margin of the head and 2 angulate projections on the sides of the pronotum distinguish *sika* males from those of *okinawanus* in which the postocular margin and sides of the pronotum are straight. In females of *sika* the apex of the front tibiae is deeply forked and the 2 prongs of the fork are separated by at

most a right-angle while in *okinawanus* the tibial apex is shallowly forked with a widely obtuse angle separating the 2 prongs. Males of *sika* can be distinguished from those of *platymelus* by pronotal characters, the sides of the pronotum in *sika* being divergent to the anterior angulation, then convergent or convex to the posterior angle which is sharp and conspicuous whereas in *platymelus* they are parallel both in front of and behind the anterior angulation and the posterior angle of the pronotum is rounded. Features of the head can be used to distinguish females of the 2 species, *sika* having slightly divergent preocular margins and a narrow anterior canthus about 0.3× the width of the eye in dorsal aspect, and *platymelus* having strongly divergent preocular margins and a broad anterior canthus about 0.6× the eye width.

As there have been no further sightings of *S. sika* in the Auckland area it seems unlikely that this species is established in New Zealand. The most probable explanation for the presence of the 3 males in Pakuranga is that they were purchased as pets in Taiwan, brought into New Zealand illegally, and later escaped or were deliberately released outdoors.

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Appendix 1 Geographical distribution. Summary of the distribution of New Zealand's Lucanidae. Area code letters (Crosby *et al.* 1998) inside parentheses indicate either northern and southern limits of distribution or a single area of occurrence, based on the material examined; *, vestigial winged species; **, foreign species. Each species is confined to the "major area" under which it is listed.

KERMADEC, NORTH, SOUTH, AND STEWART ISLANDS (includes some offshore islands): *Mitophyllus irroratus* (KE, ND-SI).

THREE KINGS ISLANDS: **Paralissotes tshiregus*.

NORTH ISLAND (includes some offshore islands): **Geodorcus alsobius* (CL); **G. auriculatus* (CL-BP); **G. ithaginis* (ND, on Mokohinau group only); **G. novaezealandiae* (WA-WN); *Holloceratognathus passaliformis* (WN); ***Lamprima aurata* (BP); *Mitophyllus arcuatus* (ND-BP); *M. gibbosus* (ND-WN); *M. macrocerus* (ND-AK); *M. solox* (BP-GB); **Paralissotes mangonuiensis* (ND); **P. oconnori* (ND); **P. planus* (ND-WA/BP); **P. stewarti* (ND-WN); ***Ryssonotus nebulosus* (AK, BP); ***Serrognathus sika* (AK).

NORTH AND SOUTH ISLANDS (includes some offshore islands): *Dendroblax earlii* (ND-OL); *Holloceratognathus cylindricus* (AK-MK); *Mitophyllus alboguttatus* (AK-OL); *M. angusticeps* (WN-OL); *M. dispar* (TO-SL); *M. falcatus* (ND-NN); **Paralissotes reticulatus* (BP-SC).

NORTH AND CHATHAM ISLANDS: ***Syndesus cornutus* (ND-GB, CH).

NORTH, SOUTH, AND CHATHAM ISLANDS: *Holloceratognathus helotoides* (GB-SL, CH).

NORTH, SOUTH, AND STEWART ISLAND (includes some offshore islands but not Solander): *Mitophyllus parrianus* (ND-SI).

SOUTH ISLAND: **Geodorcus montivagus* (BR); **G. philpotti* (FD); **G. servandus* (WD); *Mitophyllus foveolatus* (NN-FD); **M. fusculus* (DN); *M. insignis* (NN-OL); **Paralissotes rufipes* (NN-BR).

SOUTH AND STEWART ISLAND (includes Solander and some other offshore islands): **Geodorcus helmsi* (NN-SI).

CHATHAM ISLANDS (includes offshore islands): *Geodorcus capito*; *G. sororum*; *Mitophyllus reflexus*.

Appendix 2 Paratypes specimen information for new species.

Mitophyllus arcuatus Holloway

f, female(s); m, male(s)

MONZ: CL 1m, Great Barrier I., Motairehe, Katherine Bay, 20 April 1966, S. Leask. 1m, Great Barrier I., Motairehe, Katherine Bay, April 1966, S. Leask. NZAC: ND 3m, Paihia, 14 Mar 1974, at light, R.A. Cumber. 1m, Aupori Peninsula, near Paparore, 26 Dec. 1985, reared, *Ulex europaeus*, em. 27 Feb 1986, C.J. Green. 1m, Paihia, 30 Mar 1975, attracted to light, R.A. Cumber. 2m, Hokianga Sth, Whirinaki Valley, Jan 1957, Miss W. Davidson. 1f, Omahuta S.F. Kauri Sanctuary, 4 Feb 1975, ex rotten wood 75/21, G. Kuschel. 2m, 1f, Paparore, in privately owned regenerating bush, 26 Oct 1985, cut out of dead *Ulex* (gorse) stem, C.J. Green. 1f, Whangarei, 5 Apr 1926, E. Fairburn, A.E. Brookes Collection. AK 1m, Mt Albert, 22 Mar 1985, light trap at MARC, D. Allen. 1m, 1f, Muriwai, 4 Mar 1996, E.H. Kuschel. 1m, Muriwai, 7 Mar 1997, E.H. Kuschel. 1m, 3f, Lynfield, 25 Mar 1995, in dead branch of *Ficus macrophylla*, G. Kuschel. 1m, Lynfield, 9 Mar 1997, B.A. Holloway. 1m, Auckland, 7 Jan 1941, [in] power pole, K. Harrow. 1f, Purewa Bush, 21 Mar 1942, D.W. McKenzie. 1m, Laingholm, 3 Mar 1980, in light trap, R. Kleinpaste. 1m, Huia, 24 Sep 1976, old dead stump *Leptospermum*, reared W76/17, em. 18 Mar 1977, B.M. May. 2f, Huia, 24 Sep 1976, old dead stump *Leptospermum*, reared W76/17, em. 1 Feb 1977, B.M. May. 1m, Titirangi, 19 Apr 1976, G.W. Ramsay. 1m, Mt Albert, MARC, 28 Feb 1980, in light trap, N.A. Martin. 1m, Mt Albert, 2 Apr 1980, light trap, N.A. Martin. 1m, North Shore, AK, Chelsea Sugar Refinery 7 Nov 1979, larva in well rotted branch on standing oak, em. Jan 1980, associated larva and pupa in alcohol, J.F. Longworth. 1m, East Tamaki, Jan-Feb 1980, H.M. Rauden. 1m, Laingholm, 19 Mar 1980, R.H. Kleinpaste. 1m, Te Atatu, 11 Mar 1978, B. Eykel. 1m, Lynfield W[attle] B[ay], 5 Jan 1979, G. Kuschel. 1m, Glen Eden, 2 Jan 1992, on flowers *Kunzea ericoides* in garden near bush, R.C. Henderson. 1m, Lynfield, Tropicana Drive, 6 Jan 1977, G. Kuschel. 1m, Noises Is, Motuhoropapa I., 19-20 Feb 1978, malaise trap 1, J.S. Dugdale. 1m, Noises Is, Motuhoropapa I., SW slope, 11-17 Jan 1978, malaise trap near pit trap 23, L.L. Deitz. 1m, Titirangi, 5 Mar 1978, photogr. MARC 6 Mar 78, G.W. Ramsay. 1m, Riverhead Forest, Jan 1955, to light trap, J.S. Edwards. 1m, Pakiri Beach, N. Auckland, 1 Apr 1961, under *Spinifex*, J.C. Watt. 1m, Rangitoto I., 10 Mar 1957, ex rotten branch, J.C. Watt. 1m, Waiheke I., 23 Dec 1942, G. Chamberlain. 3m, Auckland, 23 Feb 1940, E.S. Gourlay. 2m, 2f, Auckland, 7 Jan 1941, [in] power pole, K. Harrow. 1m, Auckland, Owairaka, 13 May 1939, off coat, Mr Cornford. 1m, 1f, Takapuna, Jan 1940, K. Harrow. 2m, Purewa Bush, 20 Feb 1943, D. McKenzie. 4 m, Titirangi Apr 1953, C.R. Thomas. 1m, Waiheke I., Jan 1944, G. Chamberlain. 1m, Mt Roskill, Auckland, 28, Mar 1947, A.E. Brookes, A.E. Brookes Collection. 1m, Mt Albert, Auckland, Mar 1915, "445 male", A. E. Brookes Collection. 1m, Titirangi, 30 Jan 1953, ex light trap, C.R. Thomas. 1m, 1f, Mt Albert, Mar 1946, T. Atkinson. 1m, 2f, Orua Bay, 5 Apr 1942, J. M. Kelsey. 1m, Mangere,

26 Mar 1951, K.P.Lamb. 1m, Titirangi, 1953, ex light trap, C.R. Thomas. 1m, Titirangi, 25 Feb. 1953, C.R. Thomas. 1m, Grafton Gully, Auck., 20 Jan 1951, D. Spiller. 2m, 3f, Mill Bay, near Cornwallis, 13 Mar 1960, in tunnels, *Eucalyptus* log, K.A.J. Wise. 1m, Titirangi, 14 Nov ex light trap, J.S. Edwards, J.C. Watt Collection. 1m, Lynfield, Tropicana Drive, 3 Apr 1976, G. Kuschel. 1m, Mt Albert, 27 Mar 1982, P. Herbert. 1m, Lynfield, 28 Feb 1980, reared *Weinmannia*, G. Kuschel. 1m, Lynfield, 3 Apr 1980, malaise trap, G. Kuschel. 1m, Lynfield, 2 Feb 1980, *Corynocarpus laevigatus*, G. Kuschel. 1f, Waitakere Ra., Cascades, Kauri Park, 14 Oct 1976, reared rotten wet branch (unidentified), W76/18, em. 18 Feb 1977, J.C. Watt. 1f, Mangatangi, Hunua Ra., 9 Mar–5 Apr 1977, ARA kauri seed trap 12, I. Barton. 1f, Mangatangi, Hunua Ra., 9 Apr 1976, ARA, ex kauri seed trap 3, no collector's name. 1f, Papatotetoe, 27 Jun 1954, J.C. Watt, J.C. Watt Collection. 1f, Remuera, 25 Mar 1957, attracted to light, J. Robb, J.C. Watt Collection. 1m, 1f, Titirangi, 2 Apr 1991, at light, P.A. Maddison. 1f, Noises Is, Motuoropapa I., 17 Jan–16 Feb 1978, pit trap 16, L.L. Deitz and J.S. Dugdale. 1f, Lynfield, 22 Mar 1981, malaise trap 4, G. Kuschel. 1f, Owairaka, Auck., 10 Mar 1943, D. McKenzie. 1f, Mt Albert, MARC, 24 Mar 1980, in light trap, N.A. Martin. 1f, Lynfield, 4 Feb 1978, G. Kuschel. 1f, Lynfield, 4 May 1980, malaise trap, G. Kuschel. 1f, Lynfield, Tropicana Dr., 25 Jan 1975, G. Kuschel. 1m, Noises Is, Motuoropapa I., 17 Feb 1978, malaise trap 2, J.S. Dugdale. 1m, Mt Albert, 20 Feb 1989, inside MARC, P.A. Maddison. 1f, Laingholm, 11 Mar 1980, R.H. Kleinpaste. 1f, Titirangi, 10 Apr 1942, bred ex timber, em. Mar 1943, M.W. Carter. 2f, Auckland, Feb 1924, "iron bark" no collector's name. 1f, Laingholm, 19 Mar 1980, R.H. Kleinpaste. 1f, Titirangi, 13 Mar 1979, to light, P.A. Maddison. 1f, Lynfield, 28 Jan 1980, G. Kuschel. 1f, Waitakere Ra., Kauri Knoll, 23 Jan 1979, J.S. Dugdale. 2m, 3f, Wattle Bay, Lynfield, 20 Mar 1999, in rotten wood of *Meliclytus ramiflorus*, G. Kuschel. 1m, Lynfield, 30 Mar 1999, in porch, B.A. Holloway. **CL** 1m, Little Barrier I., Te Maraeroa, 7–10 Mar 1974, at light, J.C. Watt. 1m, Thames, 8 Apr 1954, J.S. Armstrong, J.S. Armstrong Collection. 2f, Great Barrier, Arid I. [=Mahuki I. in Broken Is Group], 17 Jan 1944, Major Buddle. **WO** 1m, 1f, Hapua Kohe Ra., 3km SW of Kaihere, 29 Jan 1984, ex rotten ?*Knightia* log, J.C. Watt. 2m, Waipuna Reserve, Waitomo, 28 Oct. 1977, ex damp rotten wood on ground, reared W77/21, em. 9 Dec 77, B.M. May. 1m, Waipuna Reserve, Waitomo, 28 Oct 1977, ex damp rotten wood on ground, reared W77/21, em. 16 Dec 77, B.M. May. 1f, Waipuna Reserve, Waitomo, 28 Oct 1977, ex damp rotten wood on ground, reared W77/21, em. 6 Jan 78. 1m, Karamu, Te Awamutu, 20 Apr. 1957, in tent, B.M. May. 1f, Matamata, Kaimai Ra., Jan 1932, A.E. Brookes, A.E. Brookes Collection. **WO/BP** 1m, Okauia, 19 Dec 1920, "445", no collector's name, A.E. Brookes Collection. 1f, Okauia, 13 Feb 1920, no collector's name, A.E. Brookes Collection. 1f, Okauia, 5 Mar 1921, no collector's name, A.E. Brookes Collection. **BP** 1m, Otaramarae, L. Rotoiti, 26 Dec 1977–3 Jan 78, in house, J.S. Dugdale. 1m, Otaramarae, L. Rotoiti, 29 Dec 1977, ex dead logs in secondary growth bush, J.S. Dugdale. 1m, 1f, Otaramarae, L. Rotoiti, 29 Dec 1977, in dead cherry trunk, J.S. Dugdale.

Mitophyllus falcatus Holloway

f, female(s); m, male(s)

NZAC: **ND** 1f, Spirits Bay, Nov 1967, J.I. Townsend. 1m, Mt Manaia, Whangarei, 14 Mar 1970, in dead wood, B.M. May. **AK** 1f, Tropicana Drive, Lynfield, 23 Nov 1974, G. Kuschel. 1m, Lynfield, 13 Apr 1975, litter 75/74, G. Kuschel. 2m, Lynfield, 4 May 1975, litter 75/103, G. Kuschel. 1m, Lynfield, 21 Jun 1975, G. Kuschel. 1m, Lynfield, 10 Aug 1980, malaise trap 4, G. Kuschel. 1f, Lynfield, 3 Aug 1980, malaise trap site 5, G. Kuschel. 1f, Lynfield, 9 Nov 1980, malaise trap 5, G. Kuschel. 1f, Wattle Bay [Lynfield], 20 Sep 1981, ex rotten wood, C.F. Butcher. 1m, Huia, 24 Sep 1976, old dead stump of *Leptospermum*, reared W76/17, em. 21 Jul 1977, B.M. May. 1f, Orua Bay, 10 Apr 1944, D. Spiller. **NN** 1f, Nelson [city], 19 Aug 1966, J.C. Watt.

Mitophyllus solox Holloway

f, female(s); m, male(s)

LUNZ: **BP** 1m, Rereauria, NZMS 260 Y14584906, 20 Oct 92, in rotten log on ridge of *Nothofagus truncata* forest, ECIS 1992/3, J.W.M. Marris. 5m, 1f, Otanga Bush, NZMS Y14662823, 12 Mar 1993, ex rotten log, East Cape Insect Survey 1992/3, J.W.M. Marris. **GB**: 1f, Kakanui, 300 m, NZMS 260 Z14876806, 1 Feb 1993, pitfall trap *Nothofagus* forest, ECIS 1992/3, R.M. Emberson. 1f, Kakanui, 300 m, NZMS 260 Z14876806, 16 Mar 1993, *Nothofagus* forest, reared from pupa ex kanuka (*Kunzia ericoides*), ECIS 1992/3, J.W.M. Marris. NZAC: **BP**: 1m, Lottin Pt, Otanga, 27 Apr 1993, ex rotten *Litsea* on ground, J.S. Dugdale. 1f, Orete Foest, Te Puia Hut, 26 Apr 1993, in rotten wood, G. Hall.

Geodorcus alsobius Holloway

f, female(s); m, male(s)

LUNZ: **CL** 1m, Mt Moehau, summit ridge, 875 m, Coromandel Forest P[ar]k, 12 Feb 1978, R. M. Emberson, found dead [incomplete, consists of fragments glued to card]. 1m, track to Mt Moehau, Coromandel Forest P[ar]k, 500–600 m, 12 Feb 1978, C. A. Muir, found dead [badly crushed, apparently had been trodden on; fragments glued to card]. NZAC: **CL** 1m, Mt Moehau, 610 m, 19 Mar 1980, G. Kuschel, found dead under log [incomplete, consists of fragments glued to card]. 1m, Mt Moehau, 24 Feb 1990, T. J. Herman, moribund on bare ground near trig station. 1m [complete], 1m [head fragments only, glued to card], 1f, Mt Moehau bush edge, S10: 254/159, 6 Jan 1992, R. Thorpe. 1m [incomplete, fragments glued to card], Little Moehau, S10: 260/148, 7 Jan 1992, K. Owen, found dead. 1m, 1f, Little Moehau, Mt Moehau, S10: 260/148, 7 Jan 1992, G. Sherley, in overgrown rock jumble. 1f [some appendages missing], Mt Moehau, S10: 248/157, 7 Jan 1992, R. Thorpe.

Geodorcus sororum Holloway

f, female(s); m, male(s)

LUNZ: **CH** 3m, Middle Sister I., 12 Jan 1980, R. Chappell. NZAC **CH** 1m, Middle Sister I., 29 Oct 1973, A. Wright, Bulls Cave Slope, on iceplant, The Sisters Expedition, Chatham Is. 1f, Middle Sister I., 29 Oct 1973, A. Wright,

under rock, campsite, The Sisters Expedition, Chatham Is [has forked spermatheca]. 1m, Middle Sister I., 4 Nov 1973, A. Wright, tussock rock pile, The Sisters Expedition, Chatham Is. 1f, Middle Sister I., 5 Nov 1973, A. Wright, on *Festuca coxii* tussock, NW Ledge, The Sisters Expedition, Chatham Is. 1m, Middle Sister I., 17 Nov 1973, A. Wright, in tussock, landing, The Sisters Expedition, Chatham Is. 1m, 6 Feb 1974, A. Wright, Runway, no. 61, The Sisters Expedition, Chatham Is. 1m, 1f, Middle Sister I., 12 Feb 1974, A. Wright, under iceplant, rock pile, no. 67, The Sisters Expedition, Chatham Is [male drawn by D. Helmore 26. 9. 90]. 1f, Middle Sister I., 12 Feb 1974, A. Wright, under rocks, The Sisters Expedition, Chatham Is [7 eggs from abdomen in genitalia vial]. 1f, Middle Sister I., 12 Feb 1974, under fern, no. 68, The Sisters Expedition, Chatham Is. 4m, Middle Sister I., 19 Nov 1994, in iceplant, David Bell. 1m, Middle Sister I., 19 Nov 1994, in petrel burrow in soft soil, rock pile locality, David Bell. 1m, Middle Sister I., 20 Nov. 1994, on open ground near rocks, Upper Buller Cave, C. I. Robertson. 1f, Middle Sister I., 27 Nov 1994, in iceplant, David Bell.

Appendix 3 Distribution of some character states among lucanid species.

A. Dendroblax earlii White, *Lamprima* Latreille based on *L. aurata* Latreille and *L. latreillei* MacLeay, and *Streptocerus speciosus* Fairmaire.

Body

- 1.1 Dorsal integument metallic, in shades of green, blue, or bronze: *Lamprima*
- 1.2 Dorsal integument not metallic, instead uniformly brown (*Dendroblax*) or black (*Streptocerus*)

Head

- 2.1 Eyes very large, strongly protruding: *Dendroblax*
- 2.2 Eyes small or only moderately large, slightly protruding: *Lamprima*, *Streptocerus*
- 3.1 Seventh antennal segment greatly enlarged, superficially resembling a club segment but not pilose: *Streptocerus*
- 3.2 Seventh antennal segment "normal": *Dendroblax*, *Lamprima*
- 4.1 Mandibles of males very similar to those of females, and with a basal ventral tooth: *Dendroblax*
- 4.2 Mandibles of males very different from those of females, and without a basal ventral tooth: *Lamprima*, *Streptocerus*
- 5.1 Ligula small, not bilobed, not very setose: *Dendroblax*
- 5.2 Ligula large, bilobed, very setose: *Lamprima*, *Streptocerus*

- 6.1 Lacinia terminating in a slightly curved, pointed blade in both sexes: *Dendroblax*
- 6.2 Lacinia terminating in a pointed blade in males and in a large hook in females: *Lamprima*, *Streptocerus*
- 7.1 Galea very small, not very setose: *Dendroblax*
- 7.2 Galea large, very setose: *Lamprima*, *Streptocerus*

Thorax

- 8.1 Fore tibial spur of males enlarged, fan-shaped: *Lamprima*
- 8.2 Fore tibial spur of males "normal", conical: *Dendroblax*, *Streptocerus*
- 9.1 Middle and hind tibiae fossorial, very broad apically: *Dendroblax*
- 9.2 Middle and hind legs not fossorial, "normal" apically: *Lamprima*, *Streptocerus*
- 10.2 Sides of the pronotum serrated in males and females: *Dendroblax*
- 10.2 Sides of the pronotum serrated in females, smooth in males: *Lamprima*, *Streptocerus*

Abdomen

Male Genitalia

- 11.1 Parameres separated from the basal piece dorsally, continuous with it ventrally: *Dendroblax*
- 11.2 Parameres separated from the basal piece dorsally and ventrally: *Lamprima*, *Streptocerus*
- 12.1 Parameres somewhat conical, not laminate: *Dendroblax*
- 12.2 Parameres laminate: *Lamprima*, *Streptocerus*
- 13.1 Sternite of the ninth abdominal segment "normal", not expanding distally: *Lamprima*
- 13.2 Sternite of the ninth abdominal segment very broad, conspicuously expanded distally: *Dendroblax*, *Streptocerus*
- 14.1 Eversible internal sac and flagellum relatively short: *Streptocerus*
- 14.2 Eversible internal sac and flagellum extremely long: *Dendroblax*, *Lamprima*

Female Genitalia

- 15.1 Styli long and narrow: *Dendroblax*
- 15.2 Styli short and broad: *Lamprima*, *Streptocerus*
- 16.1 Accessory gland very small: *Dendroblax*
- 16.2 Accessory gland very large: *Lamprima*, *Streptocerus*
- 17.1 Bursa copulatrix indistinguishable from the spermathecal duct: *Dendroblax*
- 17.2 Bursa copulatrix distinguishable from the spermathecal duct, very small (*Lamprima*) or relatively large (*Streptocerus*)
- 18.1 Spermathecal duct extremely long: *Lamprima*
- 18.2 Spermathecal duct short (*Streptocerus*) or indistinctly demarcated *Dendroblax*
- 19.1 Spermatheca conspicuously demarcated from the spermathecal duct: *Lamprima*
- 19.2 Spermatheca not clearly demarcated from the spermathecal duct: *Dendroblax*, *Streptocerus*

B. *Geodorcus montivagus* new species, *G. philpotti* (Broun), and *G. servandus* new species.

Head

- 1.1 Eyes protruding: *servandus*
- 1.2 Eyes not protruding: *montivagus, philpotti*
- 2.1 Eyes broad in dorsal aspect: *montivagus, servandus*
- 2.2 Eyes narrow in dorsal aspect: *philpotti*
- 3.1 Antennal pedicel slightly asymmetrical distally and with a straight or barely arched stalk: *philpotti, servandus*
- 3.2 Antennal pedicel conspicuously asymmetrical distally and with a strongly arched stalk: *montivagus*
- 4.1 Antennal funicle segments 3–5 slightly asymmetrical: *philpotti*
- 4.2 Antennal funicle segments 3–5 markedly asymmetrical: *montivagus, servandus*
- 5.1 Subapical ventral tooth of mandibles close to apex: *philpotti*
- 5.2 Subapical ventral tooth of mandibles distant from apex: *montivagus, servandus*
- 6.1 Right mandible with a small dorsomedial lamina or projection: *montivagus, servandus*
- 6.2 Right mandible lacking a dorsomedial lamina or projection: *philpotti*
- 7.1 Labrum shiny, not punctate, its anterior margin with a large median lobe: *montivagus, servandus*
- 7.2 Labrum dull, punctate at least anteriorly, its anterior margin with 3 small, approximately equal-sized lobes: *philpotti*

Thorax

- 8.1 Elytral ribs moderately or very high, their punctures much smaller than those in the intervening tracts: *montivagus, philpotti*
- 8.2 Elytral ribs low, barely discernible, their punctures about the same size as those in the intervening tracts: *servandus*
- 9.1 Front tibia with a narrow stalk proximally then expanding conspicuously to apex: *philpotti*
- 9.2 Front tibia with a moderately broad stalk proximally then expanding gradually to apex: *montivagus, servandus*
- 10.1 Middle tibia with a large apical dorsal spine: *philpotti*
- 10.2 Middle tibia lacking an apical dorsal spine: *montivagus, servandus*
- 11.1 Middle and hind tibiae with an apical ventral setiferous patch: *montivagus*
- 11.2 Middle and hind tibiae lacking setiferous patches: *philpotti, servandus*
- 12.1 Middle and hind tibiae with a simple mid dorsal spine: *montivagus, philpotti*
- 12.2 Middle and hind tibiae with a multidentate mid dorsal spine: *servandus*
- 13.1 Hind tibia moderately or strongly flared distally: *montivagus, servandus*
- 13.2 Hind tibia weakly flared distally: *philpotti*

C. *Paralissotes* Holloway, 1996, *Lissotes* Westwood, 1855 based on *L. menalcas* Westwood, 1855 and *L. rudis* Lea, 1910, *Pycnosiphorus* Solier, 1851 based on *Pycnosiphorus caelatus* (Blanchard, 1842) and *Pycnosiphorus femoralis* (Guerin, 1839), and *Sclerostomus* Burmeister, 1847 based on *S. cucullatus* (Blanchard, 1842).

Head

- 1.1 Postocular margin in males straight or very slightly convex: *Paralissotes, Sclerostomus*
- 1.2 Postocular margin in males strongly convex: *Lissotes, Pycnosiphorus*

Thorax

- 2.1 Elytral vestiture consisting of fan-shaped scales: *Paralissotes*
- 2.2 Elytral vestiture consisting of branched setae with truncate tips: *Lissotes, Pycnosiphorus, Sclerostomus*
- 3.1 Wings vestigial: *Paralissotes, Lissotes, Pycnosiphorus*
- 3.2 Wings fully developed: *Sclerostomus*

Abdomen

Male genitalia

- 4.1 Penis short and broad: *Paralissotes*
- 4.2 Penis long and narrow: *Lissotes, Pycnosiphorus, Sclerostomus*
- 5.1 Permanently everted internal sac with either a median papilla or a pair of lateral papillae about halfway along its length: *Paralissotes*
- 5.2 Permanently everted internal sac not papillate: *Lissotes, Pycnosiphorus, Sclerostomus*
- 6.1 Permanently everted internal sac with 2 pairs of external sclerites: *Paralissotes*
- 6.2 Permanently everted internal sac without paired, external sclerites: *Lissotes, Pycnosiphorus, Sclerostomus*
- 7.1 Gonopore large, broad, terminal, not on a process: *Paralissotes, Lissotes, Pycnosiphorus*
- 7.2 Gonopore minute, on a short, narrow, curved process: *Sclerostomus*
- 8.1 Ventral surface of basal piece strongly and uniformly sclerotised and pigmented: *Paralissotes, Pycnosiphorus, Sclerostomus*
- 8.2 Ventral surface of basal piece sclerotised and colourless on distal half: *Lissotes*
- 9.1 Tergite of ninth abdominal segment rounded at apex: *Paralissotes, Lissotes, Sclerostomus*
- 9.3 Tergite of ninth abdominal segment angulate at apex: *Pycnosiphorus*

Female genitalia

- 10.1 Bursa copulatrix much larger than accessory gland: *Paralissotes*
- 10.2 Bursa copulatrix smaller than accessory gland: *Lissotes, Pycnosiphorus, Sclerostomus*
- 11.1 Bursa copulatrix with sclerites on either side of spermathecal duct insertion: *Paralissotes*
- 11.2 Bursa copulatrix lacking sclerites: *Lissotes, Pycnosiphorus, Sclerostomus*

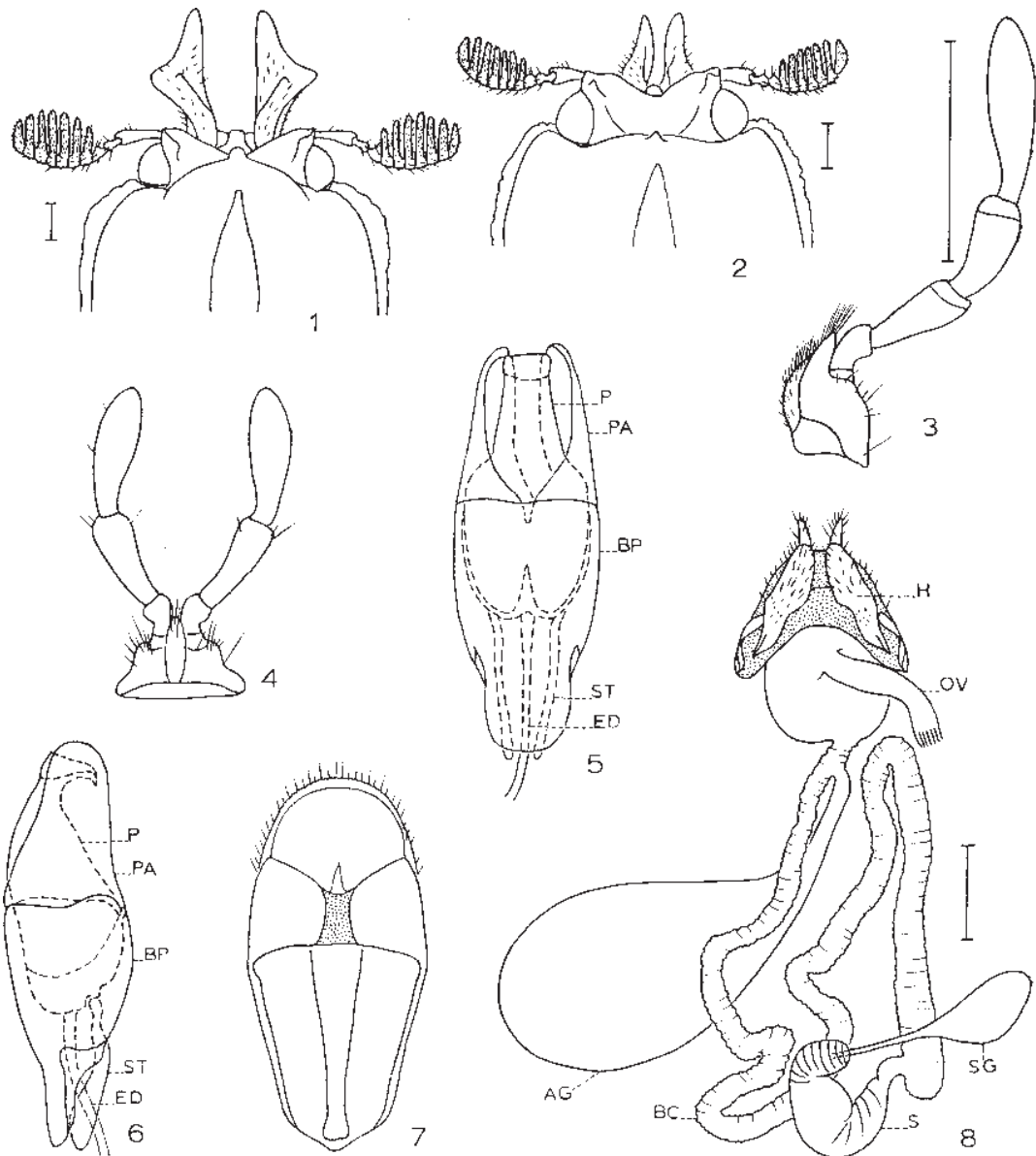
Appendix 4. *Syndesus cornutum* (Fabricius), illustrations of morphological features.

Fig. 1–8 *Syndesus cornutum* (Fabricius). (1) head of male; (2) head of female; (3) left maxilla of female; (4) labium (inner aspect) of female; (5) sclerotised parts of male genitalia (ventral); (6) sclerotised parts of male genitalia (lateral); (7) 9th abdominal segment of male (dorsal); (8) sclerotised parts of female genitalia (ventral). All scales equal 0.5 mm; figures 3 and 4 drawn to same scale; figures 5–8 same scale. (From Holloway (1968), *New Zealand Journal of Science* 11(2): 265).

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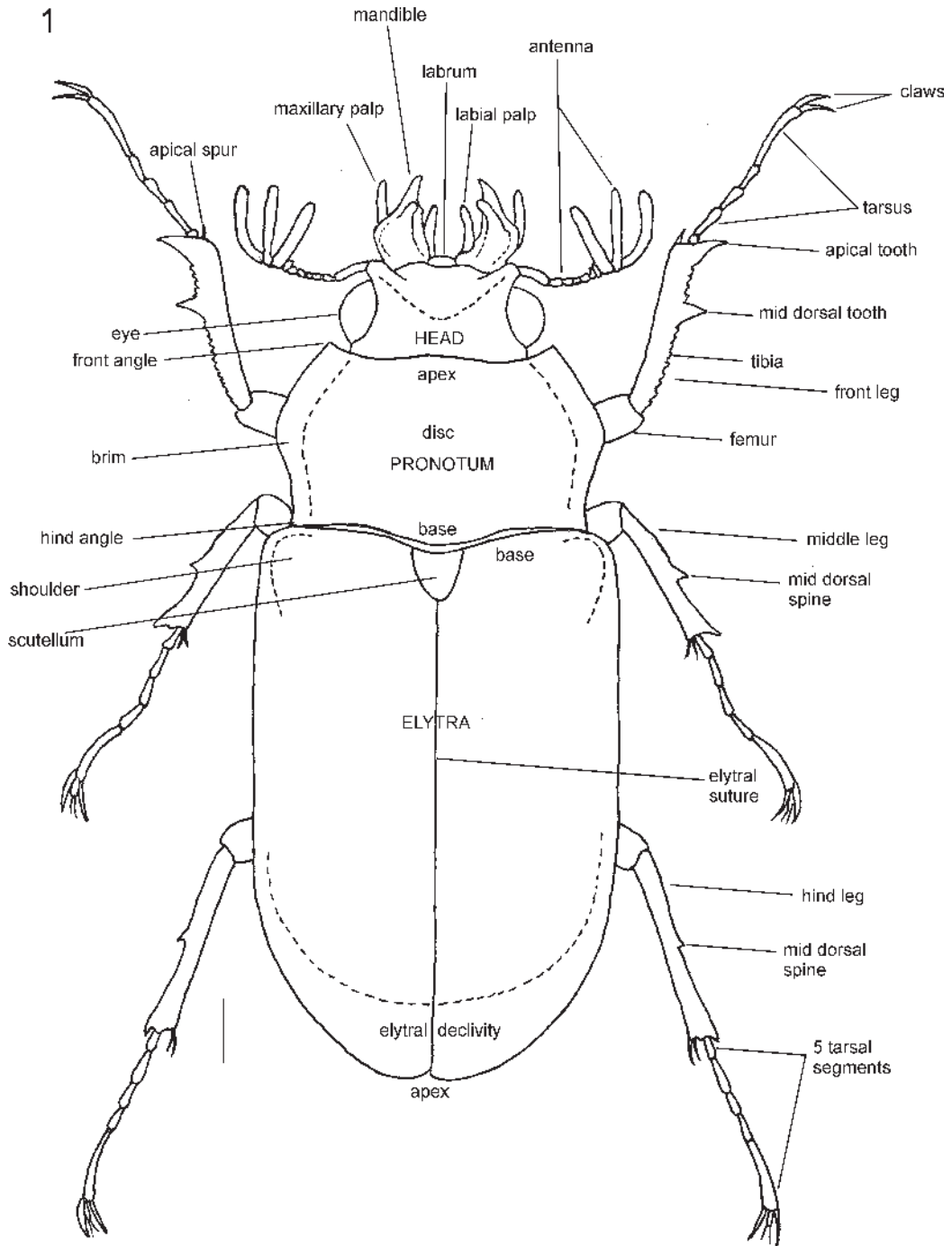


Fig. 1 Features of body visible in dorsal aspect: *Mitophyllus parrianus*, male.

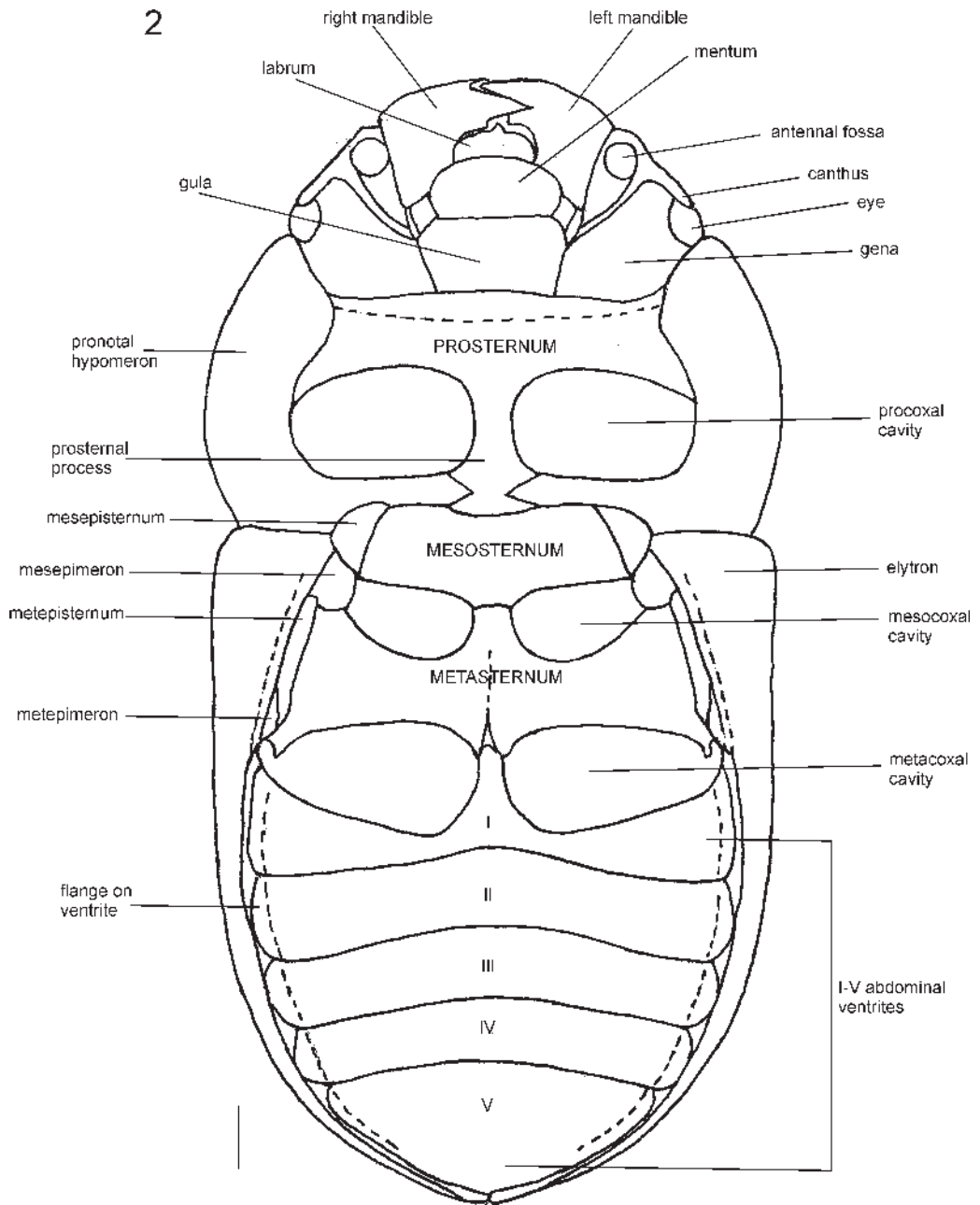


Fig. 2 Features of body visible in ventral aspect (appendages omitted): *Geodorcus helmsi*, female.

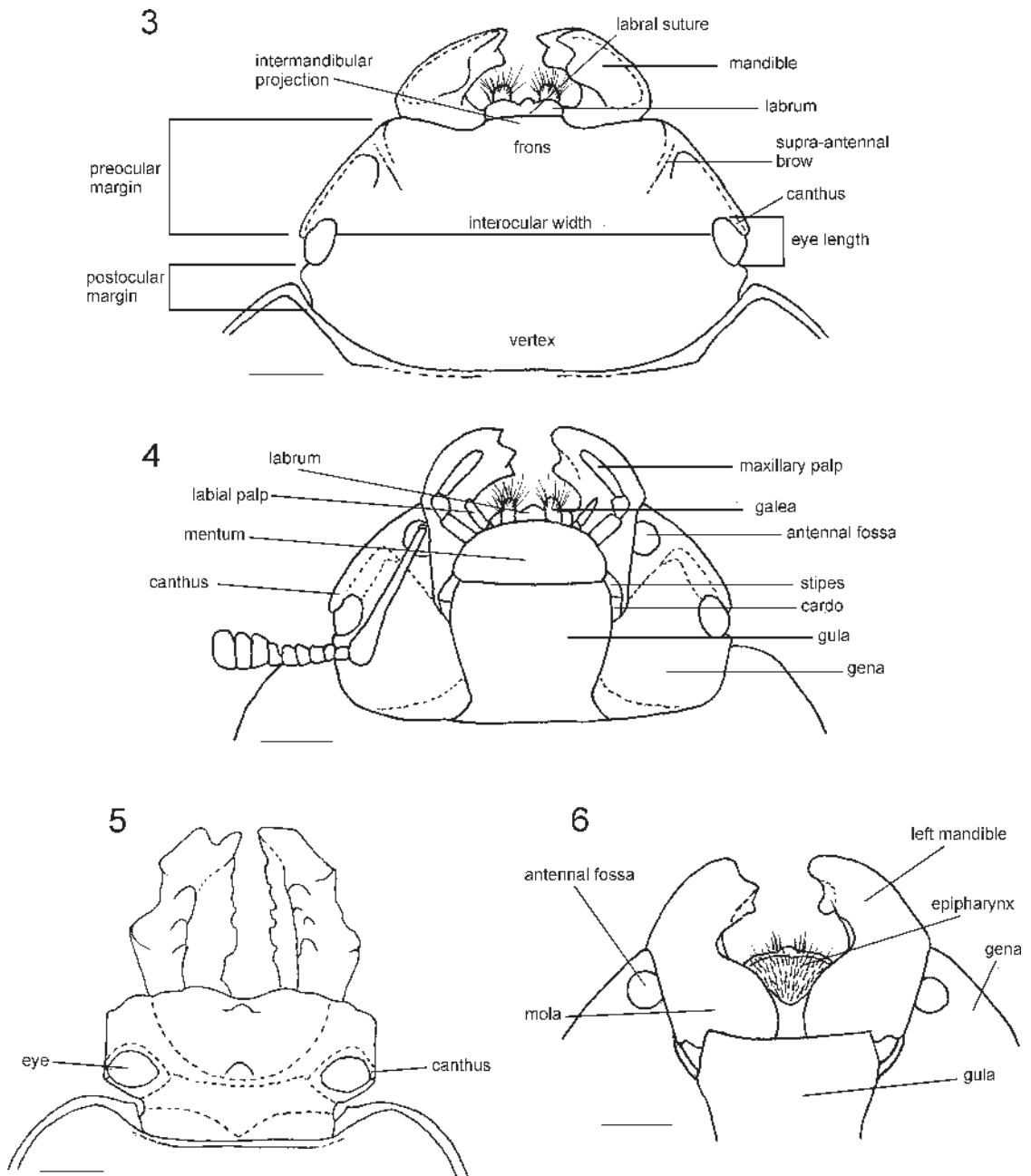


Fig. 3–6 Features of head (antennae omitted) visible in dorsal aspect (3, 5) and ventral aspect (4, 6): 3, 4, *Geodorcus capito*, female; 5, *Ryssonotus nebulosus*, female; 6, *G. capito*, female, with mentum removed to show epipharynx on internal surface of labrum and mola on base of mandible.

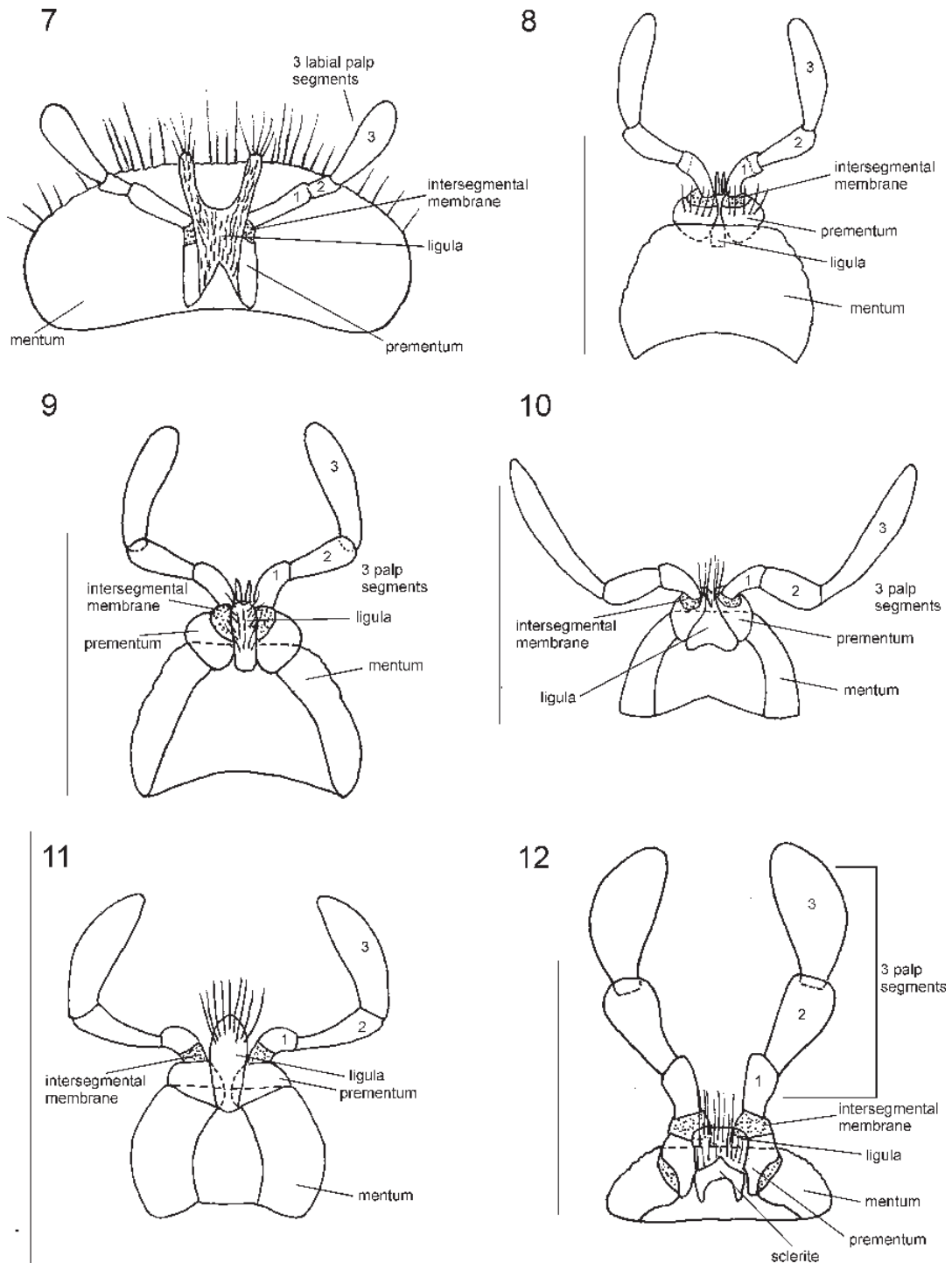


Fig. 7–12 Features of labia visible in dorsal (internal) aspect (7, 9–12) and in ventral (external) aspect (8): 7, *Geodorcus capito*, female; 8, 9, *Mitophyllus parrianus*, female; 10, *M. alboguttatus*, male; 11, *Holloceratognathus cylindricus*, female; 12, *Dendroblox earlii*, male. Setae shown only on ligula. Stipple represents membranous areas.

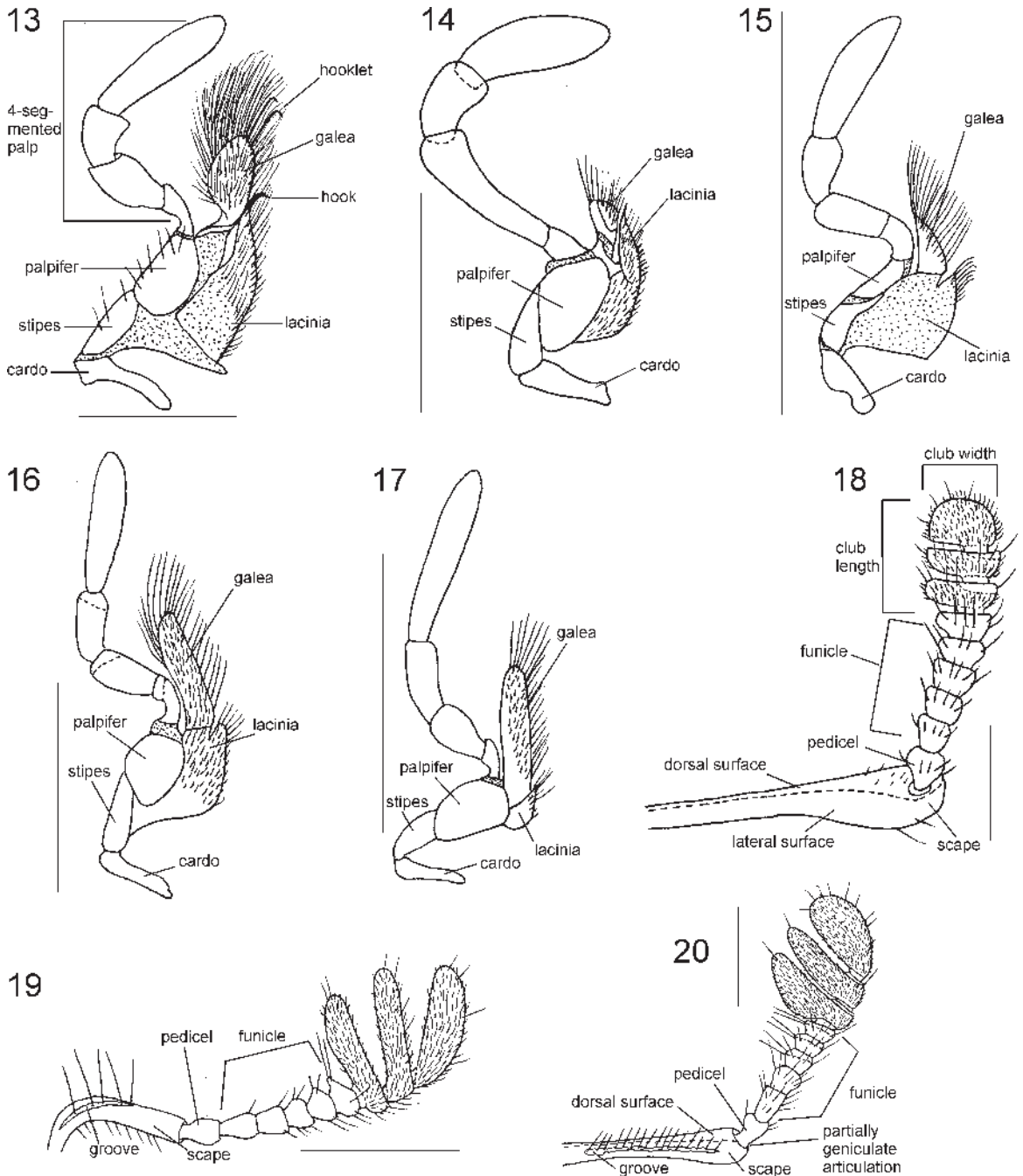


Fig. 13–20 Features of the left maxillae (13–17) and the right antennae (18–20): 13, 18, *Geodorcus capito*, female; 14, 20, *Dendroblax earlii*, male; 15, *Holloceratognathus cylindricus*, female; 16, 19, *Mitophyllus parrianus*, female; 17, *M. alboguttatus*, male. Setae omitted from palp segments. Stipple represents membranous areas.

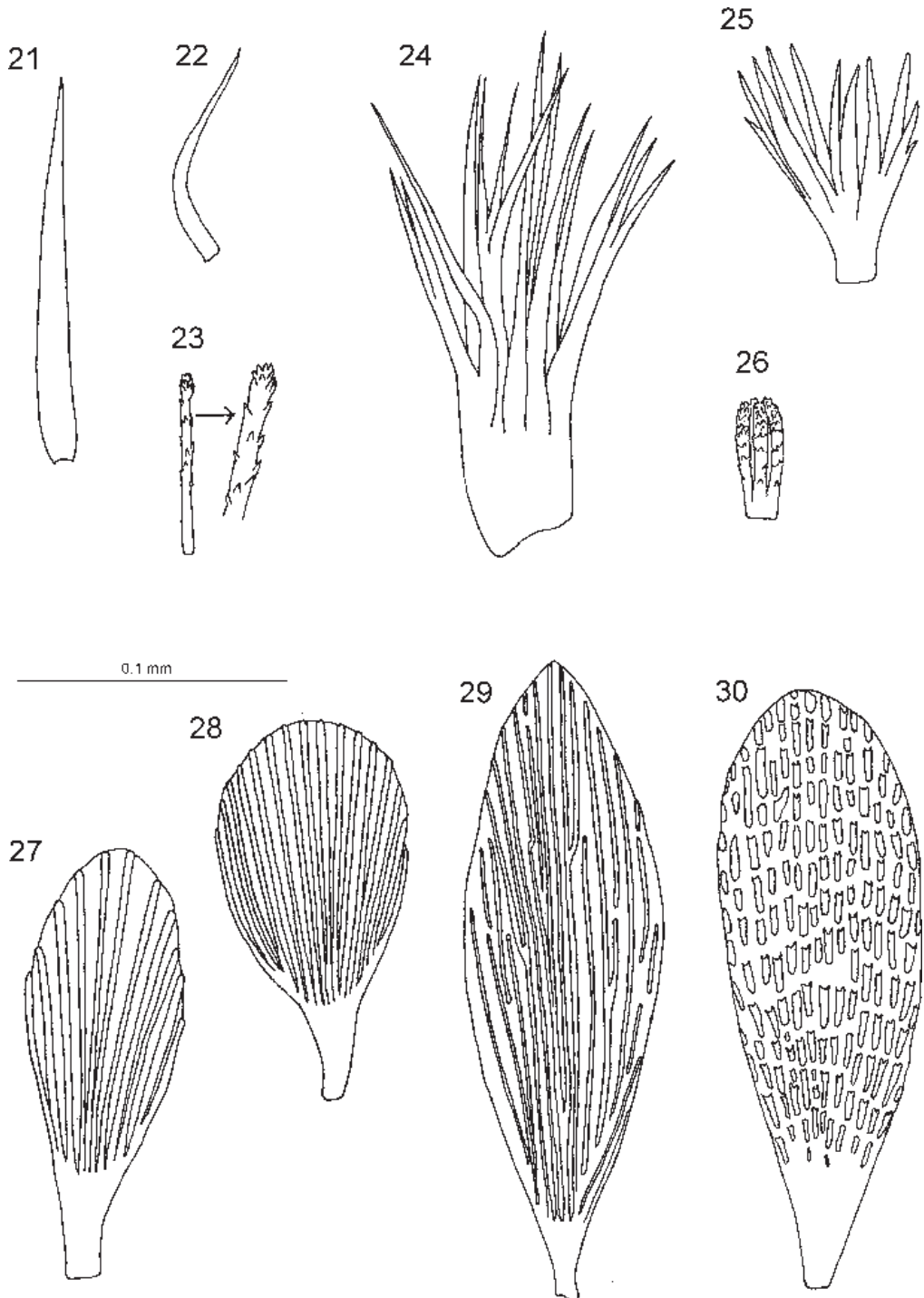


Fig. 21–30 Elytral vestiture as seen with a compound microscope: 21, *Dendroblax earlii*, smooth seta; 22, *Lamprima* sp., smooth seta; 23, *Syndesus cornutus*, barbed seta; 24, *Geodorcus helmsi*, dendritic seta; 25, *G. novaezealandiae*, dendritic seta; 26, *Ryssonotus nebulosus*, incised, barbed seta; 27, *Paralissotes reticulatus*, scale with undivided ribs; 28, *P. oconnori*, scale with undivided ribs; 29, *Holloceratognathus helotoides*, scale with divided ribs; 30, *Mitophyllus parrianus*, scale with anastomosing ribs. After Holloway 1997.

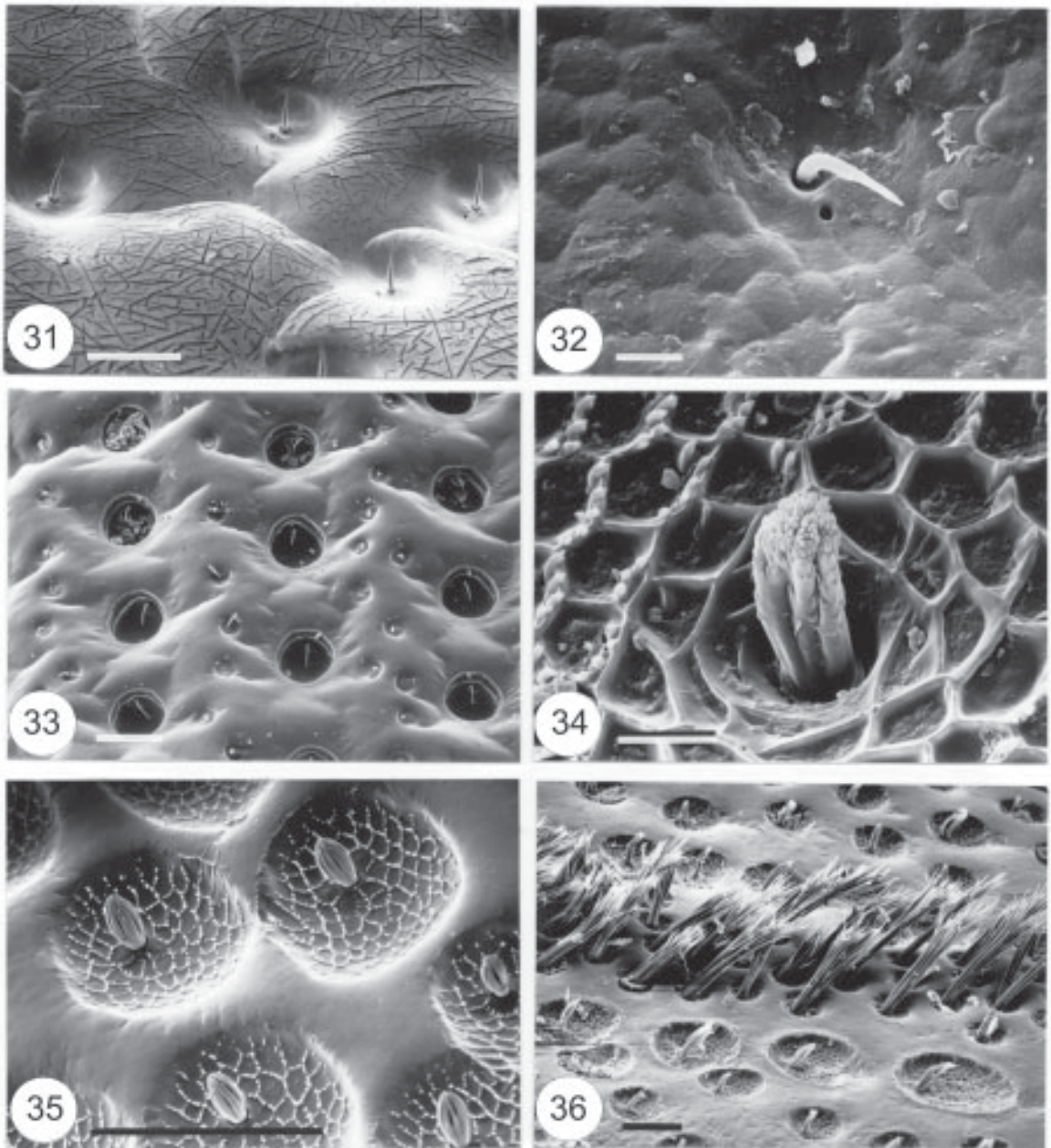


Fig. 31–36 Micrographs of elytral surface structures in Lampriminae (31, 32), Syndesinae (33), and Lucaninae (34–36): 31, *Dendrobax earlii*, 4 setae and associated pores; 32, *Lamprima* sp., seta and associated pore; 33, *Syndesus cornutus*, alternating rows of large pits containing long, horizontal setae and small pits containing short, erect setae; 34, *Ryssonotus nebulosus*, incised, barbed seta in pit with smooth-topped polygonal sculpturing that contrasts with peaked sculpturing on adjacent integument; 35, *Geodorcus novaezealandiae*, several dendritic setae in polygonally sculptured pits; 36, *G. helmsi*, alternating tracts of short and long setae in polygonally sculptured pits. Bars in 31, 33, 35, 36 equal 0.1 mm; in 32, 34 equal 10 μ m. After Holloway 1997.

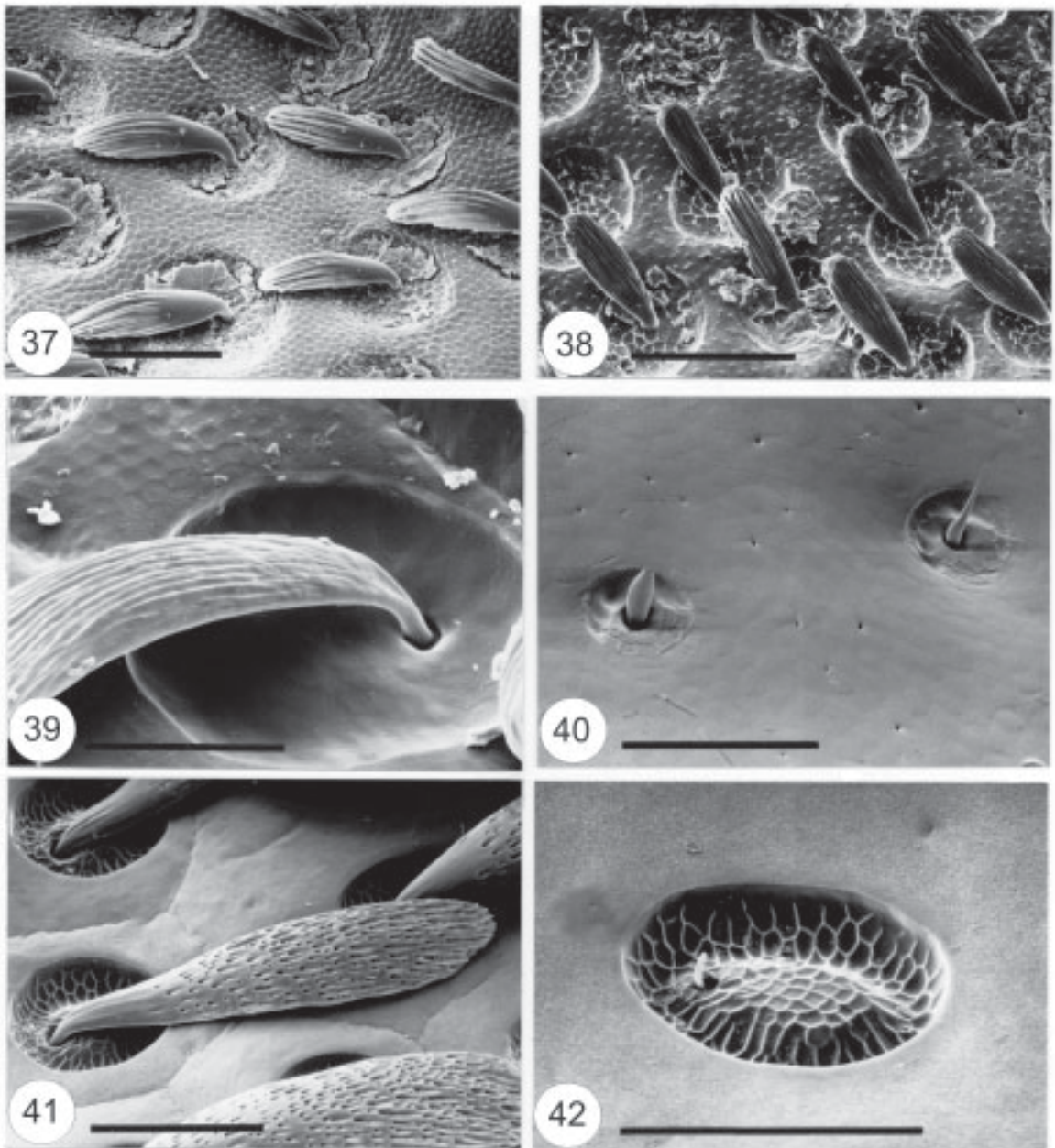


Fig. 37–42 Micrographs of elytral surface structures in Lucaninae (37, 38) and Aesalinae (39–42): 37, *Paralissotes reticulatus*, appressed, ribbed scales in polygonally sculptured pits on section of elytron heavily coated with exudate; 38, *P. triregius*, standing, ribbed scales in polygonally sculptured pits, with sculpture on adjacent integument partly obscured by exudate; 39, *Holloceratognathus helotoides*, part of ribbed scale in polygonally sculptured pit, and showing polygonally sculptured adjacent integument; 40, *H. passaliformis*, narrow scale and broader scale in polygonally sculptured pits, and showing faint polygonal sculpturing on adjacent integument; 41, *Mitophyllus parrianus*, large scales with cross-connected ribs in polygonally sculptured pits with raised floors; 42, *M. parrianus*, microseta in sculptured pit with raised floor, and showing very finely granulose surface of adjacent integument. Bars in 37, 38, 41, 42, equal 0.1 mm; in 39, 40, equal 0.05 mm. After Holloway 1997.

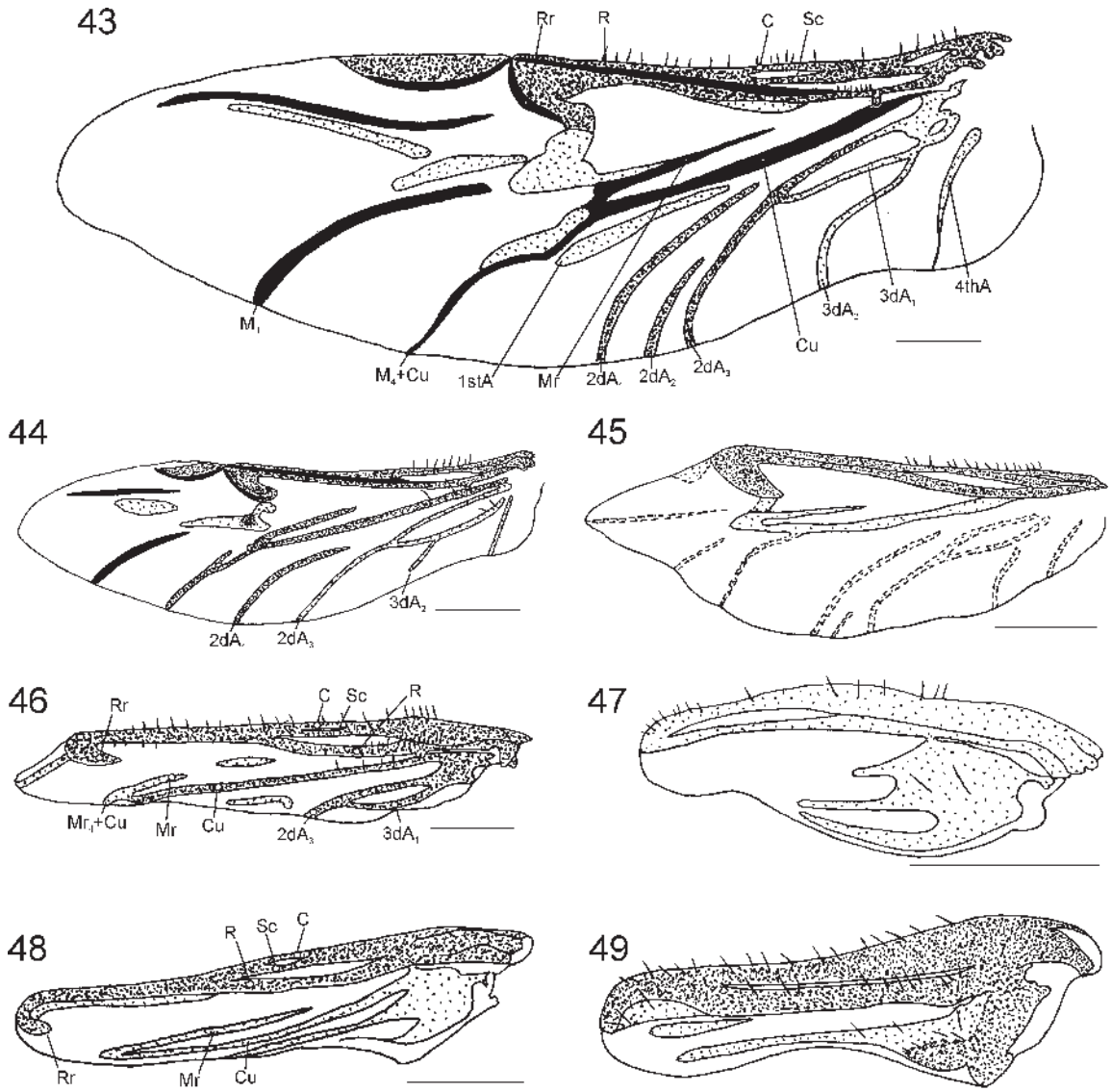


Fig. 43–49 Features of the left wing of: 43, *Mitophyllus gibbosus*, male, “normal” wing; 44, *Holloceratognathus passaliformis*, male, wing slightly reduced mainly in anal vein region; 45, *M. fuscus*, female, significantly reduced wing with weak but recognisable veins; 46, *Paralissotes rufipes*, female, reduced wing with many recognisable veins; 47, *P. planus*, male, highly vestigial wing; 48, *Geodorcus novaezealandiae*, male, reduced wing with several recognisable veins; 49, *G. helmsi*, male, highly vestigial wing. Wing length/elytron length ratios in Fig 43–49: 43, 1.9; 44, 1.5; 45, 1.0; 46, 0.8; 47, 0.3; 48, 0.6; 49, 0.3. Abbreviations: 1stA, 4thA, 1st and 4th anal veins; 2dA1, 2dA2, 2dA3, branches of 2nd anal vein; 3dA1, 3dA2, branches of 3rd anal vein; C, costa; Cu, cubitus; M1, M4, branches of media; Mr, medial recurrent; R, radius; Rr, radial recurrent; Sc, subcosta. Axillary sclerites not shown. Black indicates deep pigmentation; dense stipple, moderate pigmentation; sparse stipple, pale pigmentation. Broken lines enclose extremely pale veins. Partly after Holloway 1963b.

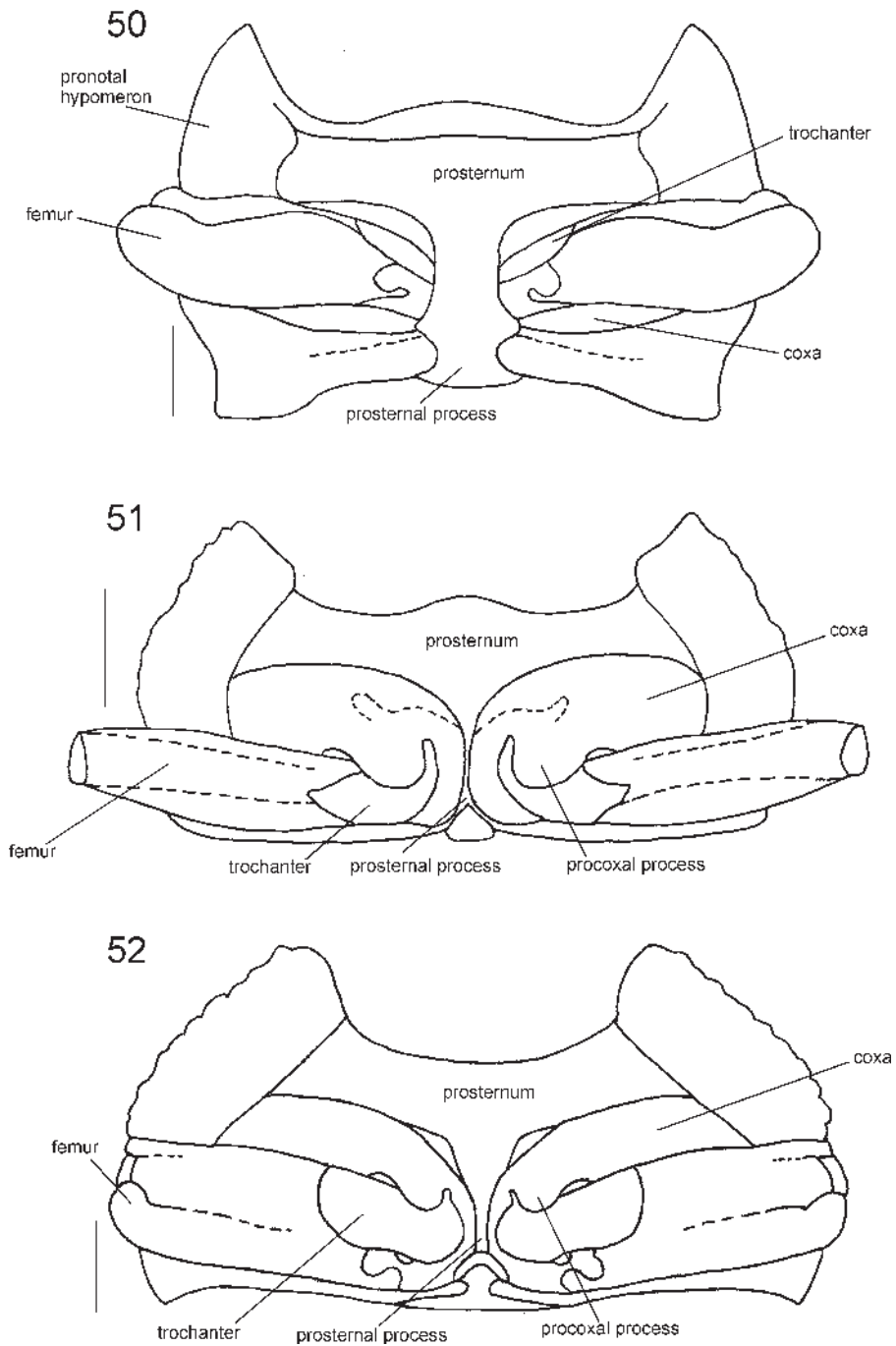


Fig. 50–52 Ventral aspect of prothorax in Lucaninae (50), Aesalinae (51), and Lampriminae (52): 50, *Paralissotes reticulatus*, broad prosternal process and no procoxal processes; 51, *Mitophyllus parrianus*, male, narrow prosternal process and large procoxal processes; 52, *Dendroblax earlii*, male, narrow prosternal process and small procoxal processes.

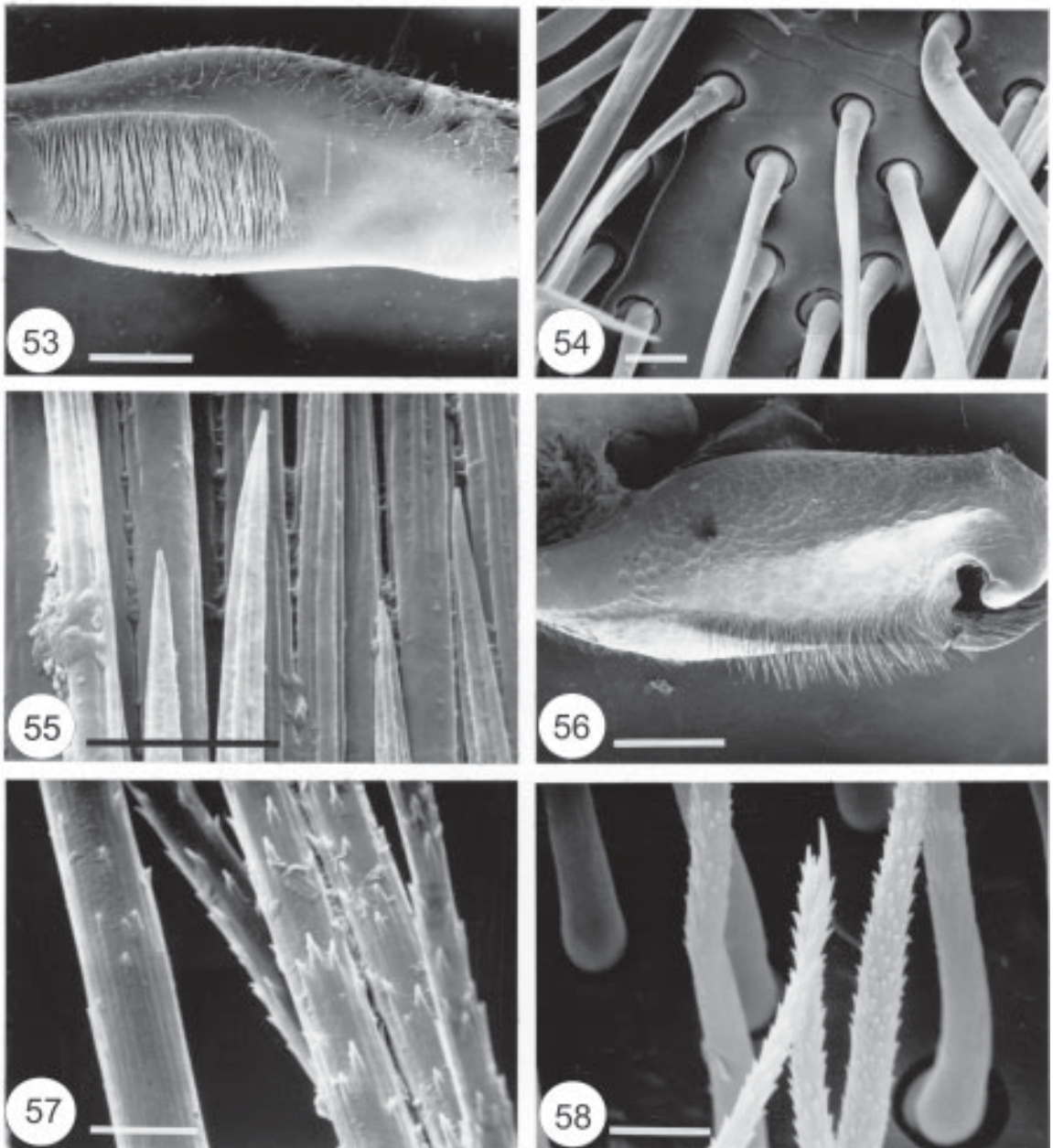


Fig. 53–58 Micrographs of setae on profemora and procoxae in *Geodorcus helmsi* (53, 55–58) and *G. novaezealandiae* (54): 53, setiferous patch on anterior surface of left femur; 54, bases of setae in femoral setiferous patch; 55, apices of grooved setae in femoral setiferous patch; 56, broad fringe of setae extending over ventral margin on posterior surface of left coxa; 57, middle region of coxal fringe setae showing grooves and barbs; 58, parts of coxal fringe setae showing sparsely barbed bases and densely barbed apices. Bars in 53, 56, equal 1.0 mm; in 54, 55, 57, 58, equal 10 μ m.

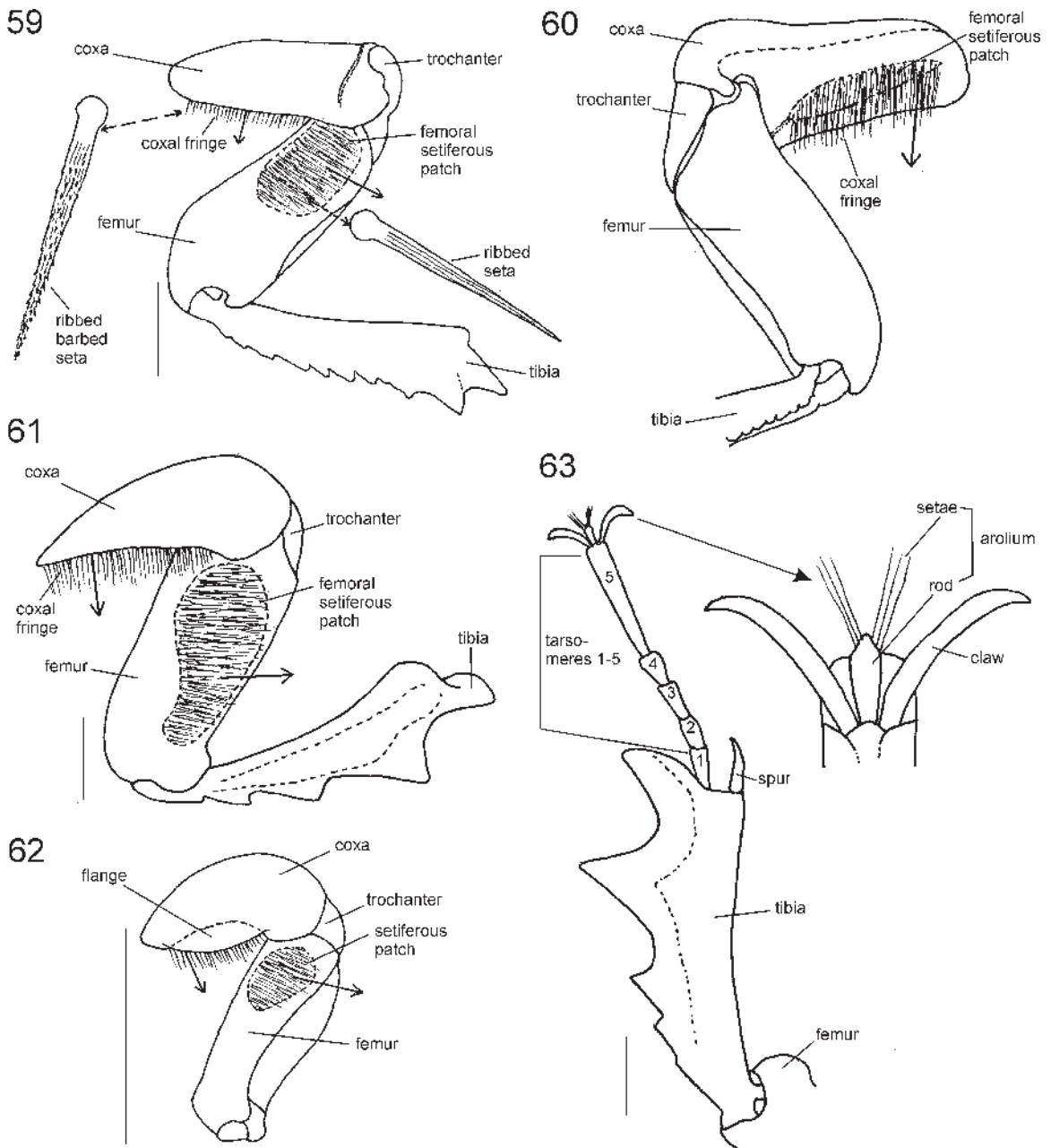


Fig. 59–63 Features of fore legs: 59, *Geodorcus novaezealandiae*, male, anterior aspect of part of right leg showing coxal fringe, femoral setiferous patch, and enlargements of setae; 60, *Mitophyllus parrianus*, female, posterior aspect of part of right leg showing coxal fringe patch; 61, *Dendroblax earlii*, male, anterior aspect of part of right leg showing coxal fringe and elongate femoral setiferous patch; 62, *Holloceratognathus passaliformis*, male, anterior aspect of part of right leg showing very small femoral setiferous patch and crescentic flange extending over coxal fringe patch; 63, *D. earlii*, male, anterodorsal aspect of part of left leg with enlargement of apex of 5th tarsomere. Short arrows indicate setal direction in the figured positions of the coxae and femora.

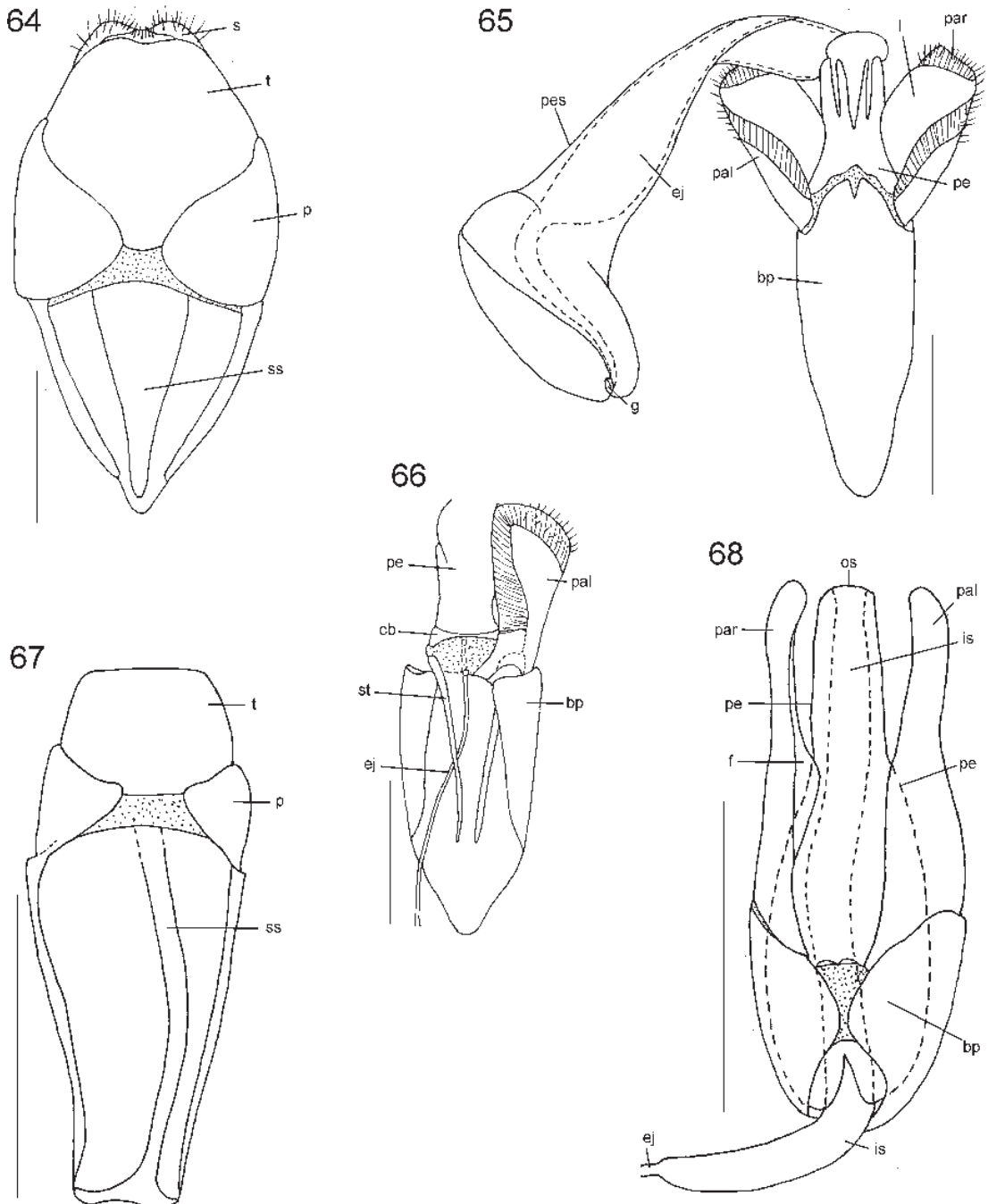


Fig. 64–68 Male genitalia of *Geodorcus novaezealandiae* (64–66) and *Mitophyllus alboguttatus* (67,68): 64, ninth abdominal segment, dorsal; 65, aedeagus, ventral; 66, aedeagus, dorsal, with right paramere removed and most of permanently everted internal sac excluded, showing penis resting on distal end of basal piece; 67, asymmetrical ninth abdominal segment, dorsal; 68, asymmetrical aedeagus with penis enclosed in basal piece, dorsal. Abbreviations: bp, basal piece; cb, crossbar at base of penis; ej, ejaculatory duct; f, flange; g, gonopore; is, internal sac; l, lobe; os, ostium; p, pleurite; pal, left paramere; par, right paramere; pe, penis; pes, permanently everted internal sac; s, sternite; ss, stalk of sternite; st, strut; t, tergite.

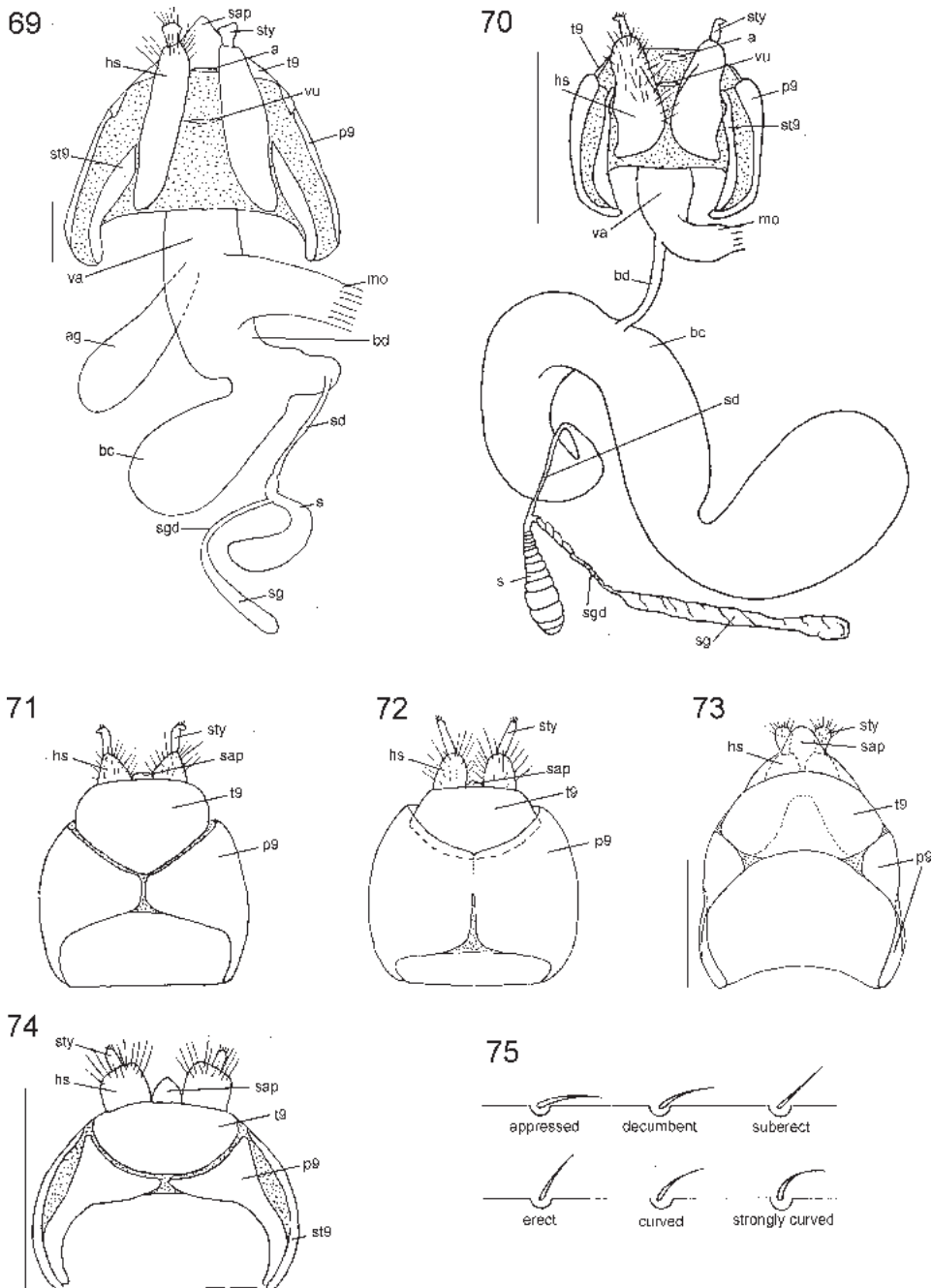
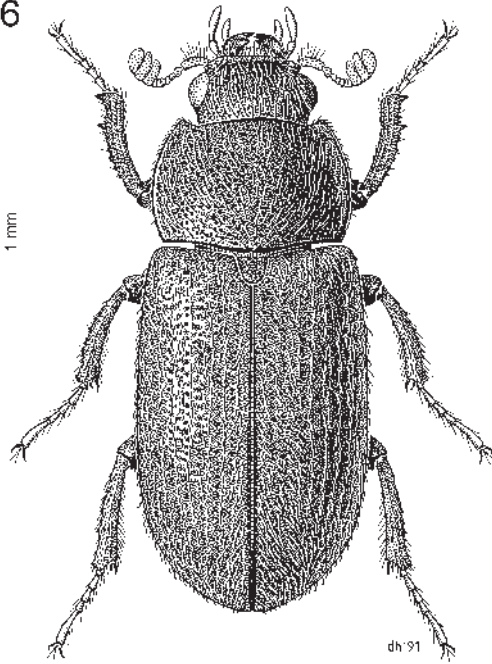
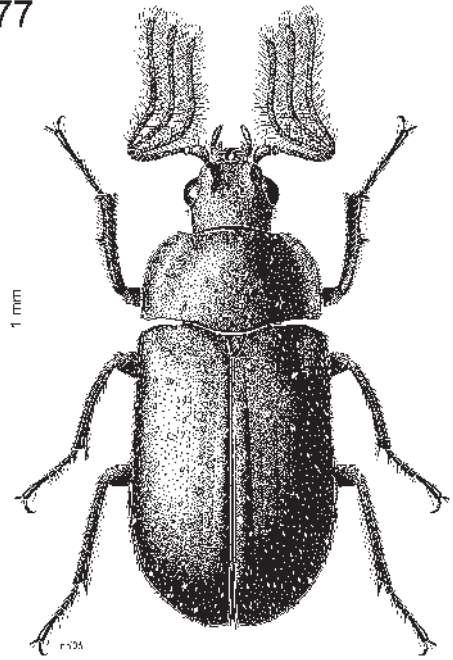


Fig. 69–75 Features of female genitalia (69–74) and terminology of vestiture (75): 69, 70, entire genitalia, ventral aspect, in *Geodorcus novaezealandiae* (69) and *Mitophyllus alboguttatus* (70); 71–74, ninth abdominal segment and hemisternites, dorsal aspect, in *M. foveolatus* (71), *M. parrius* (72), *G. capito* (73), and *Holloceratognathus helotoides* (74); 75, curvature and angle of inclination of body vestiture. Stipple indicates clear, colourless areas. Abbreviations: a, anus; ag, accessory gland; bc, bursa copulatrix; bd, bursal duct; hs, hemisternite; mo, median oviduct; p9, pleurite 9; s, spermatheca; sap, supra anal projection; sd, spermathecal duct; sg, spermathecal gland; sgd, spermathecal gland duct; st9, sternite 9; sty, stylus; t9, tergite 9; va, vagina; vu, vulva.

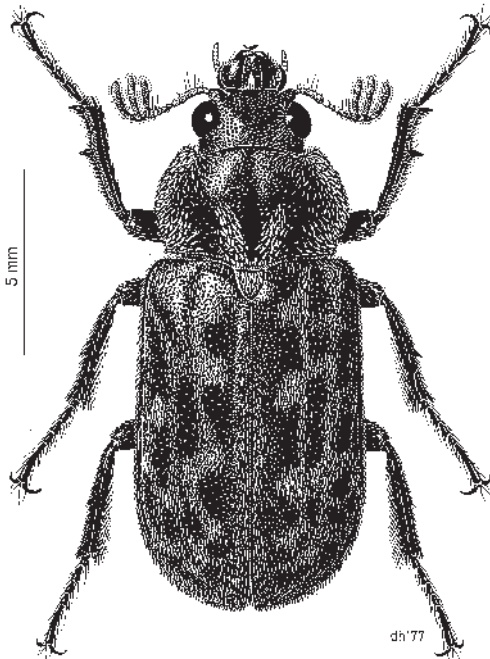
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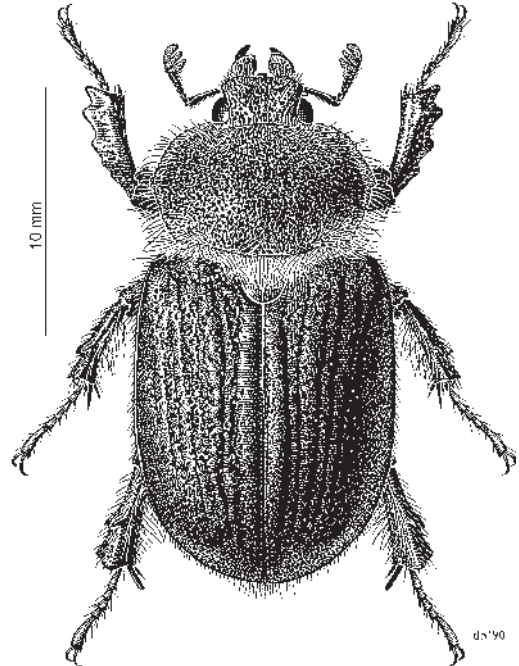
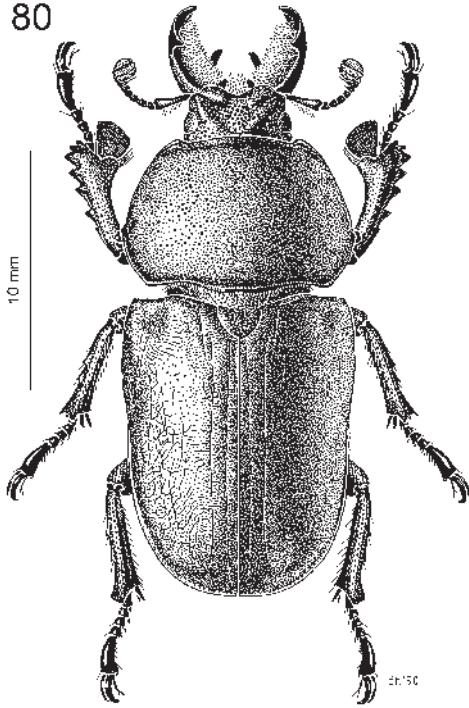
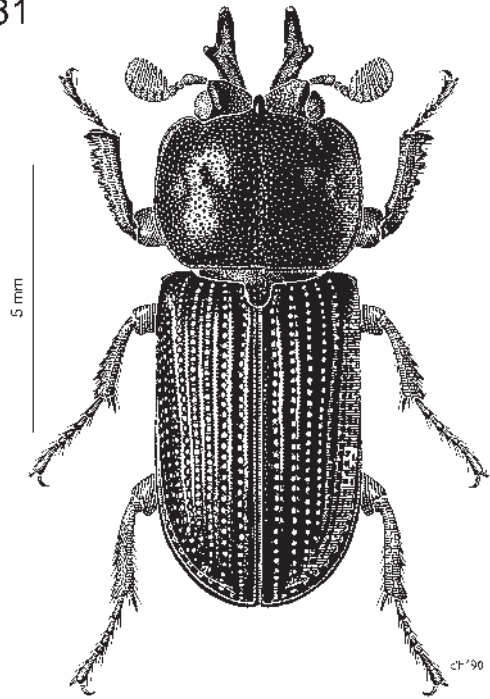


Fig. 76–89 Habitus illustrations: 76, *Holloceratognathus cylindricus* (male); 77, *Mitophyllus macrocerus* (male); 78, *Mitophyllus parrianus* (male); 79, *Dendroblax earlii* (male).

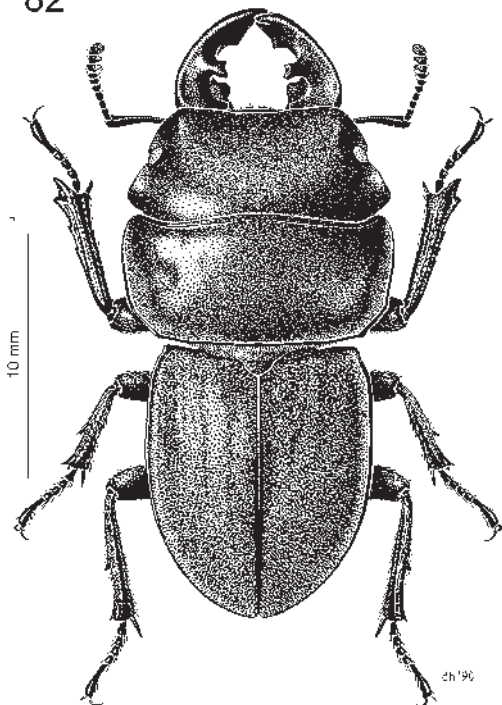
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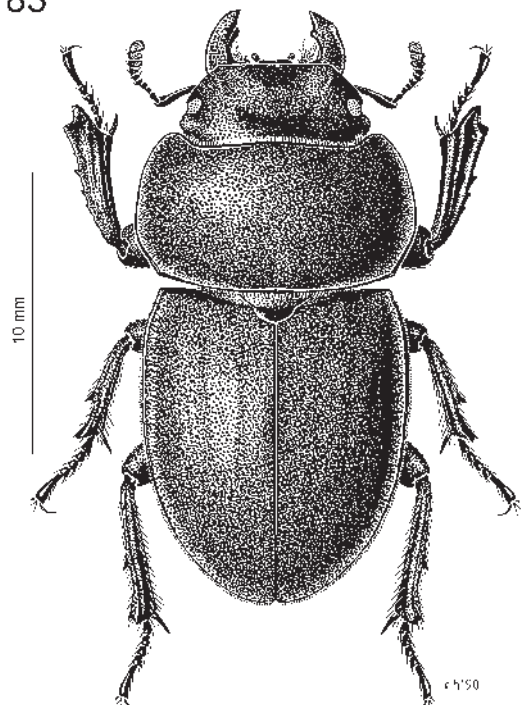
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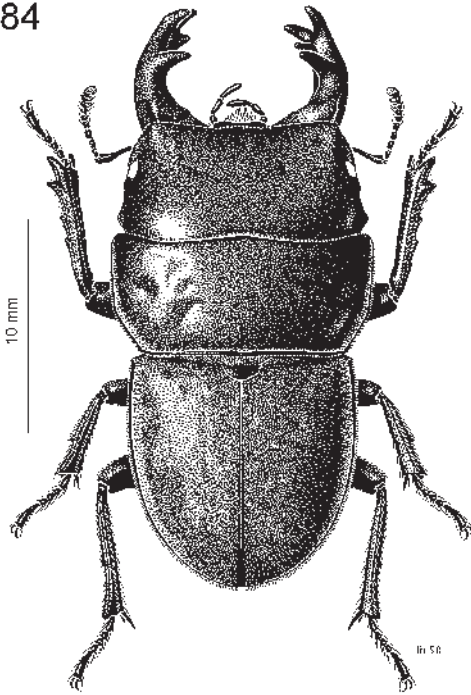


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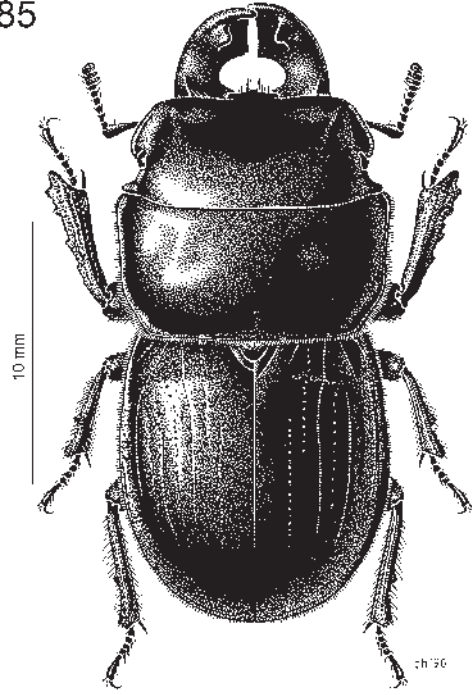


80, *Lamprima aurata* (male); 81, *Syndesus cornutus* (male); 82, *Geodorcus auriculatus* (male); 83, *Geodorcus auriculatus* (female).

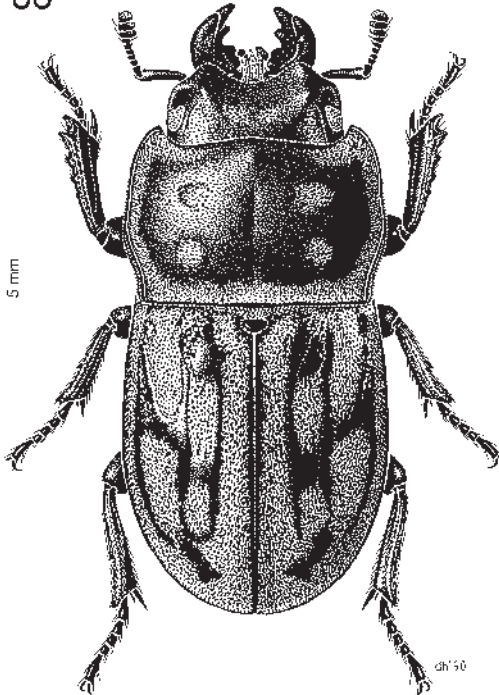
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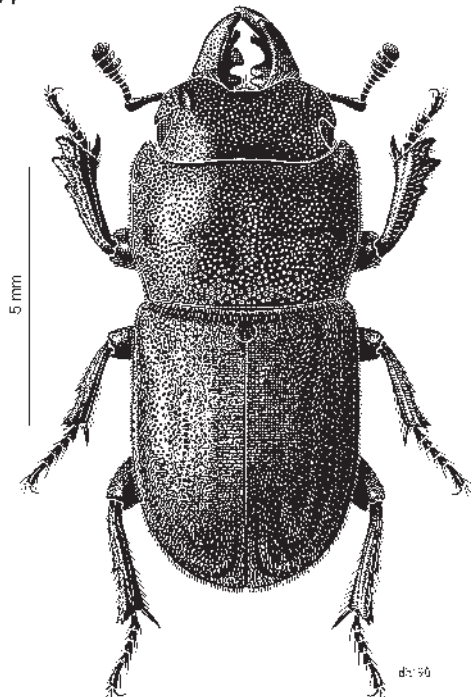
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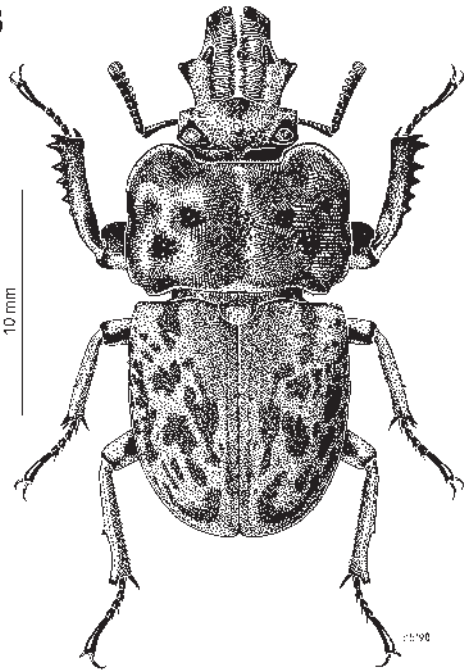


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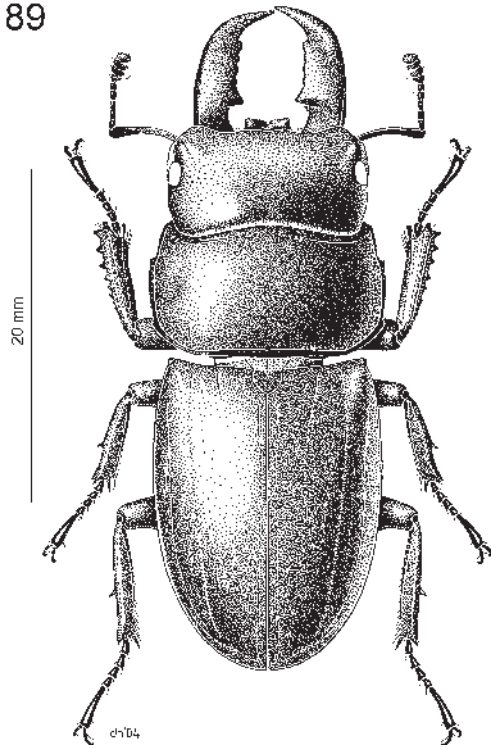


84, *Geodorcus ithaginis* (male); 85, *Geodorcus sororum* (male); 86, *Paralissotes reticulatus* (male); 87, *Paralissotes stewarti* (male).

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88, *Ryssonotus nebulosus* (male); 89, *Serrognathus sika* (male, Pakuranga (NZ) specimen).

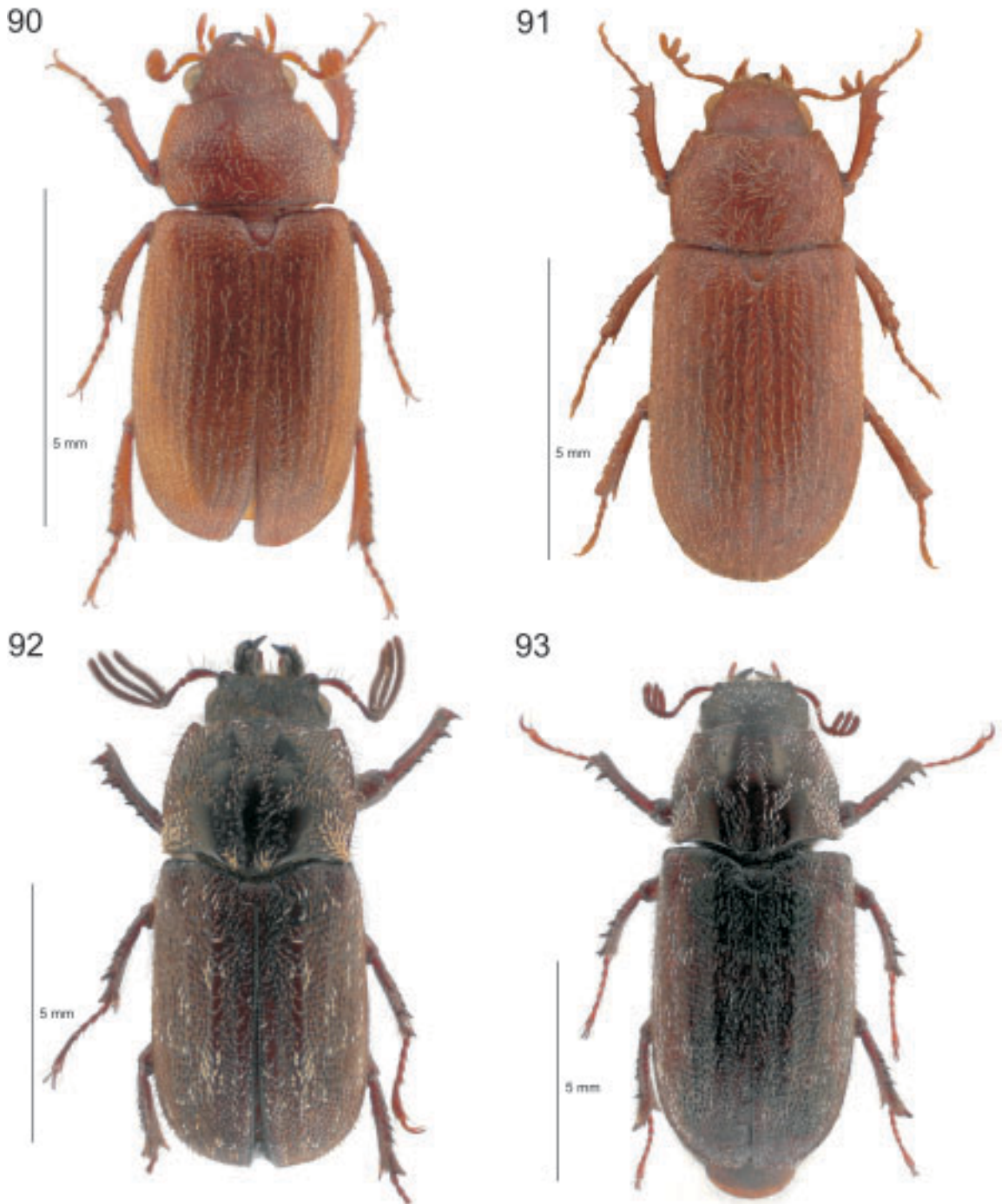
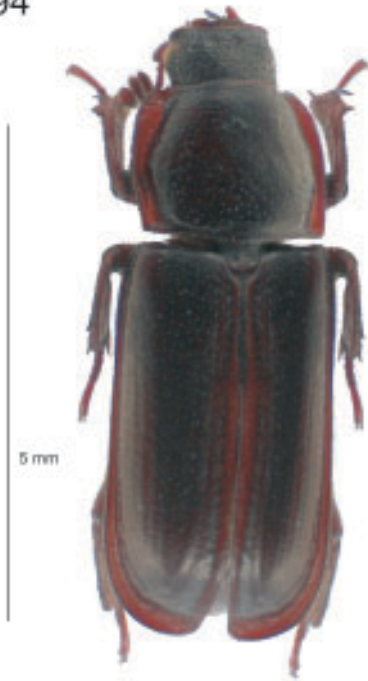


Fig. 90–166 Automontaged habitus photographs, dorsal view: **Fig. 90–123** Aesalinae. (90, 91) *Holloceratognathus cylindricus*, 90 male, 91 female; (92, 93) *Holloceratognathus helotoides*, 92 male, 93 female.

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(94, 95) *Holloceratognathus passaliformis*, 94 male, 95 female; (96, 97) *Mitophyllus alboguttatus*, 96 male, 97 female.

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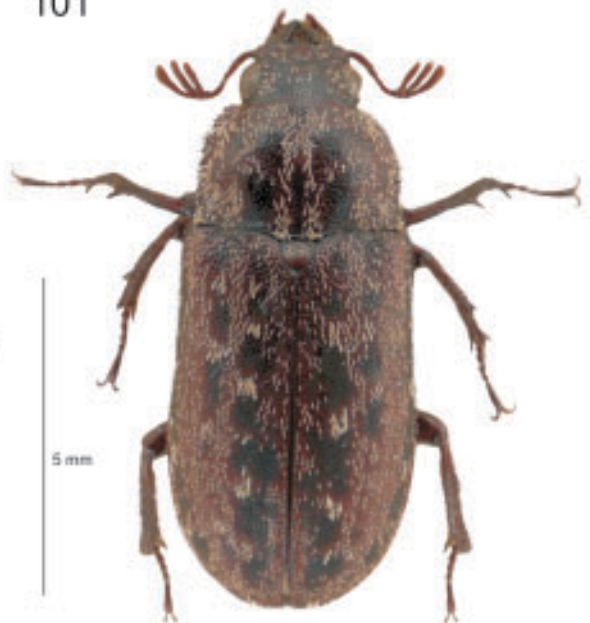
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(98, 99) *Mitophyllus angusticeps*, 98 male, 99 female; (100, 101) *Mitophyllus arcuatus*, 100 male, 101 female.

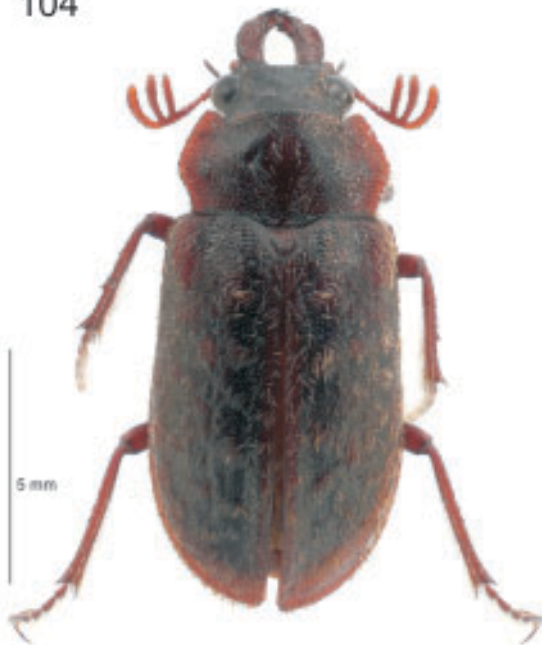
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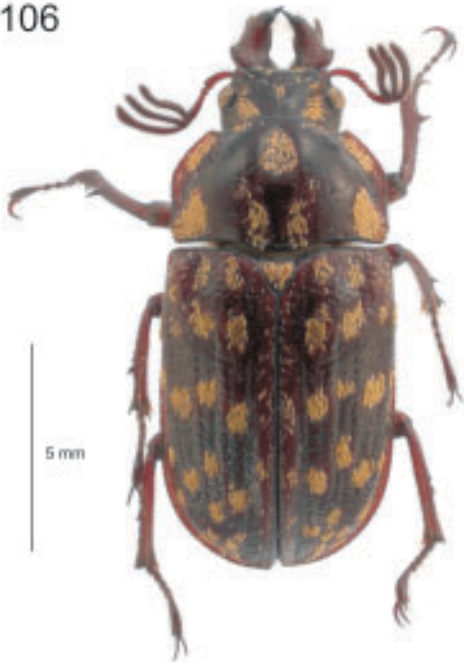


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(102, 103) *Mitophyllus dispar*, 102 male, 103 female; (104, 105) *Mitophyllus falcatus*, 104 male, 105 female.

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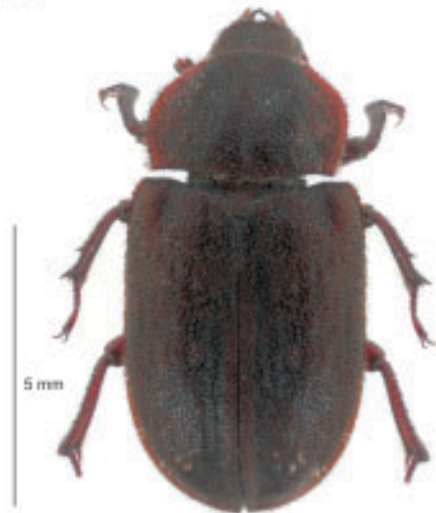
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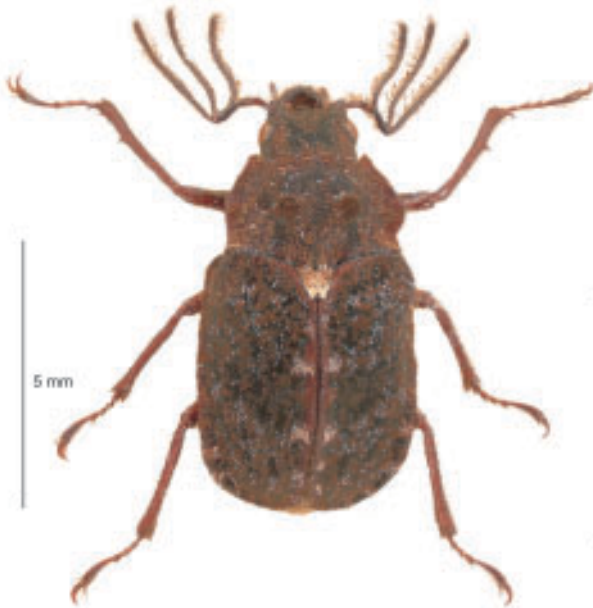


109



(106, 107) *Mitophyllus foveolatus*, 106 male, 107 female; (108, 109) *Mitophyllus fuscus*, 108 male, 109 female.

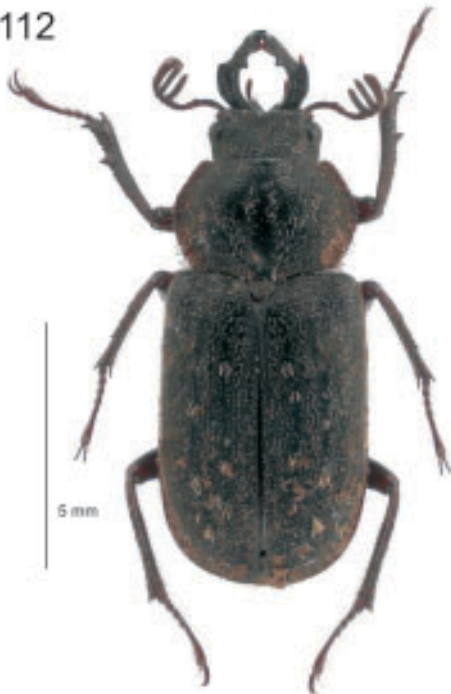
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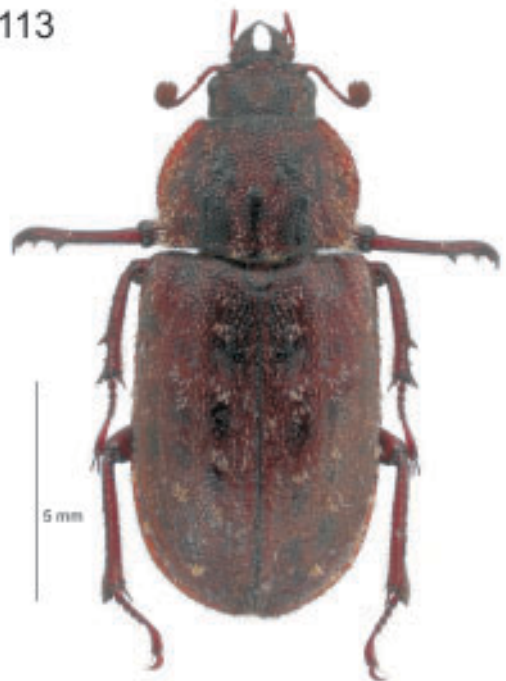
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(110, 111) *Mitophyllus gibbosus*, 110 male, 111, female; (112, 113) *Mitophyllus insignis*, 112 male, 113 female.

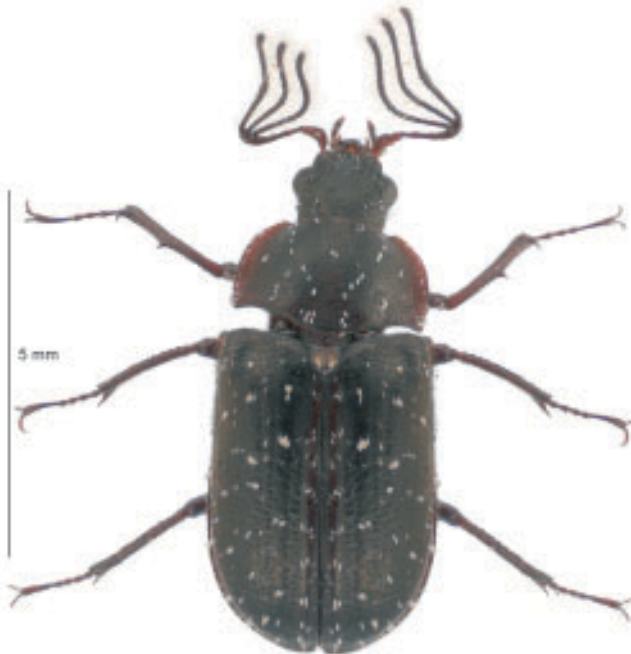
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(114, 115) *Mitophyllus irroratus*, 114 male, 115 female; (116, 117) *Mitophyllus macrocerus*, 116 male, 117 female.

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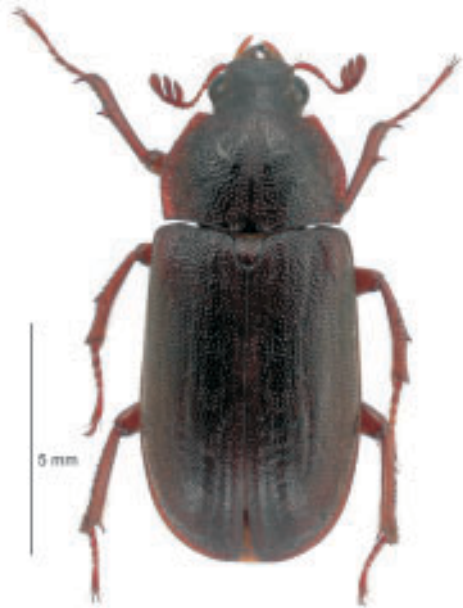
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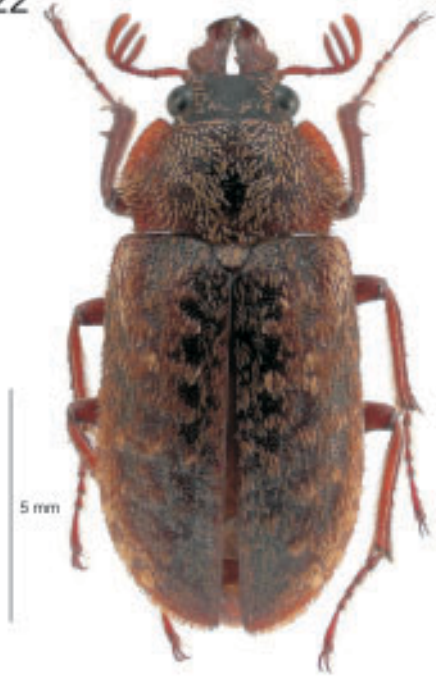


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(118, 119) *Mitophyllus parrianus*, 118 male, 119 female; (120, 121) *Mitophyllus reflexus*, 120 male, 121 female.

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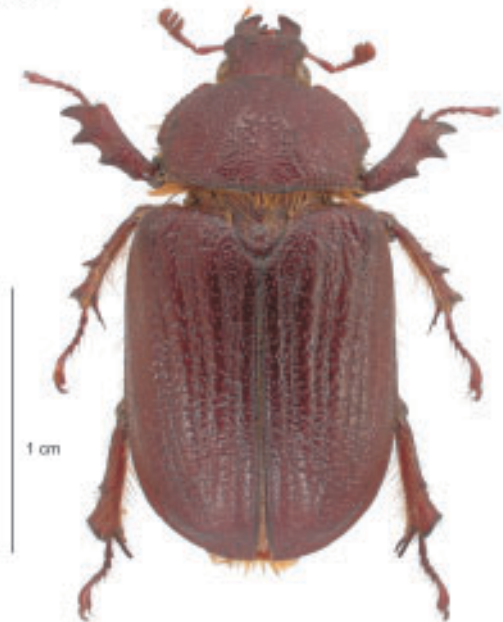


(122, 123) *Mitophyllus solox*, 122 male, 123 female.

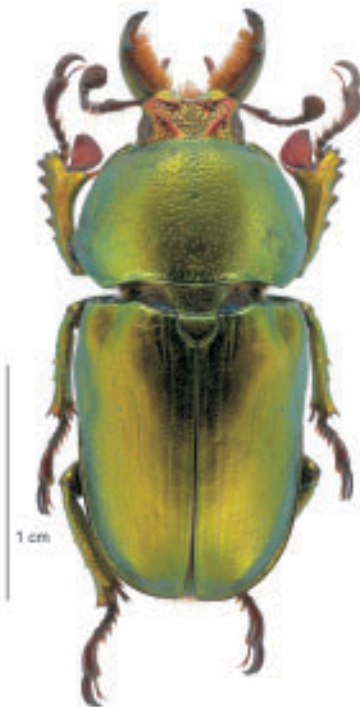
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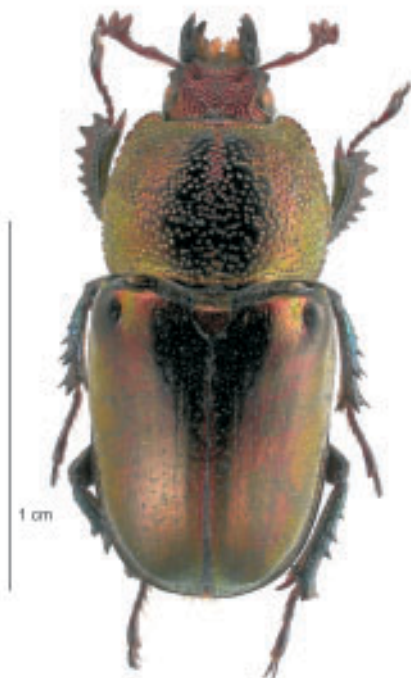
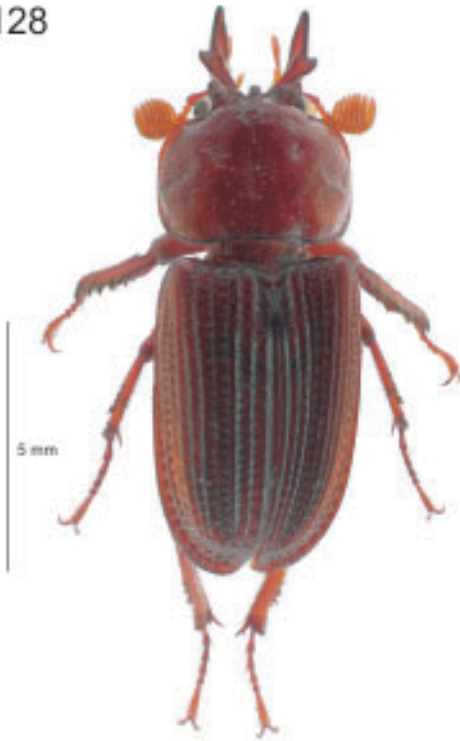


Fig. 124–127 Lampriminae; (124, 125), *Dendroblax earlii*, 124 male, 125 female; (126, 127), *Lamprima aurata*, 126 male, 127 female.

128

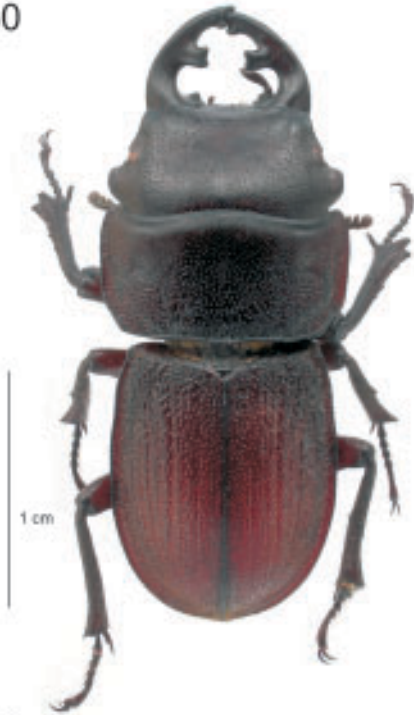


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Fig. 128, 129 Syndesinae, *Syndesus cornutus*, 128 male, 129 female.

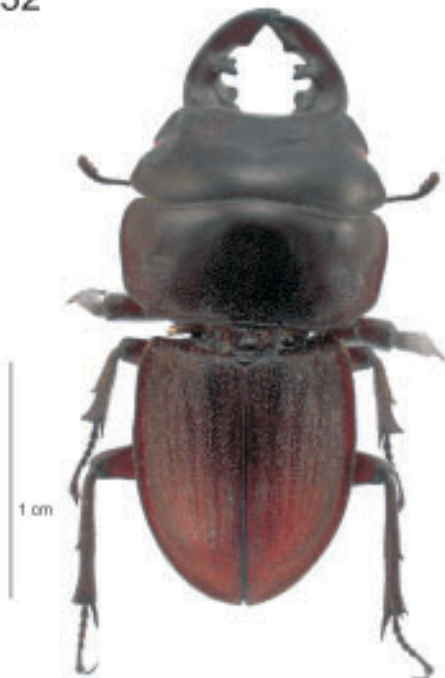
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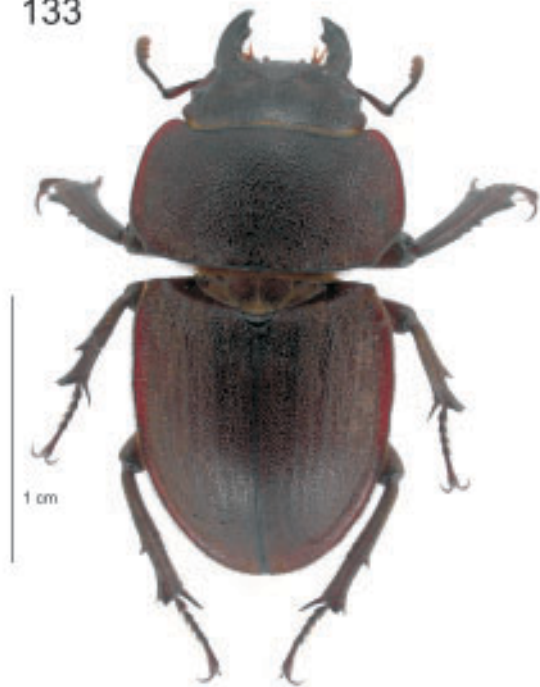
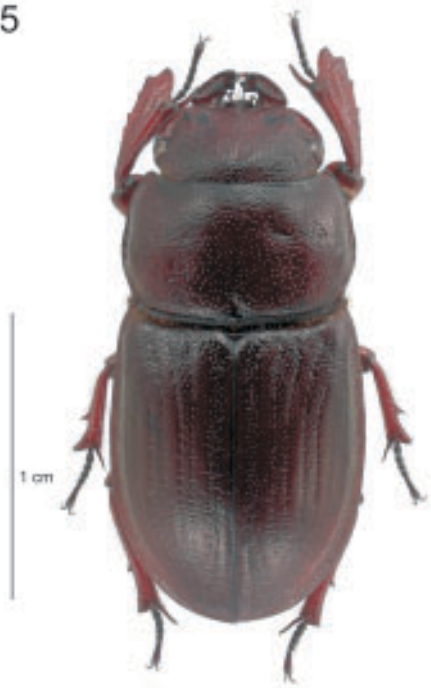


Fig. 130–166 Lucaninae; (131, 132) *Geodorcus alsobius*, 130 male, 131 female; (132, 133) *Geodorcus auriculatus*, 132 male, 133 female.

134



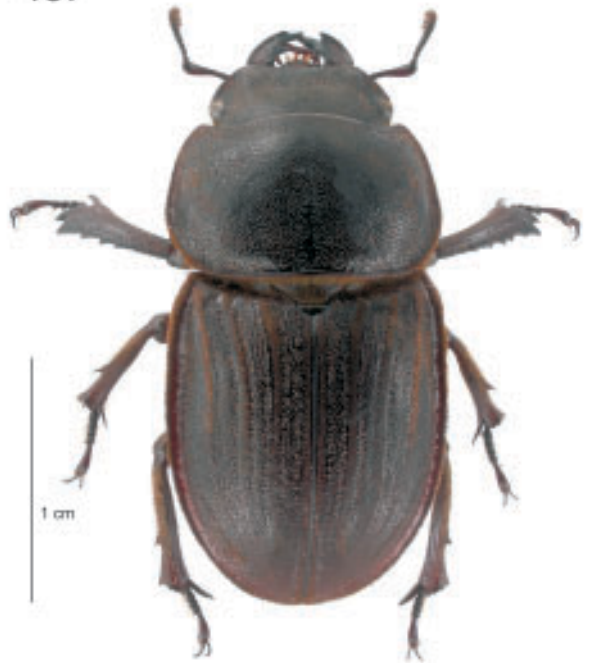
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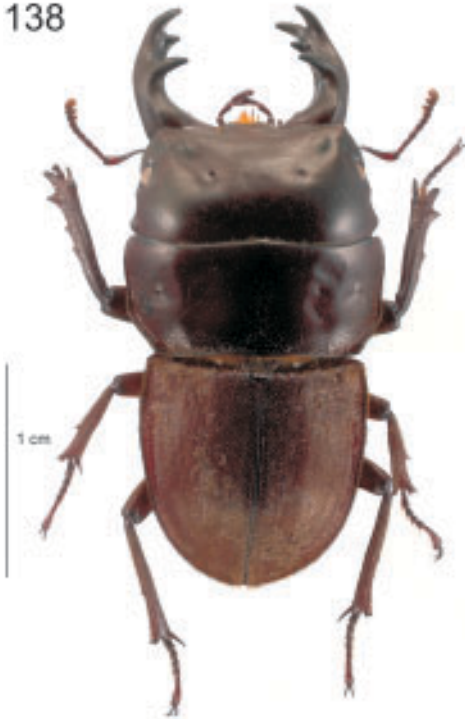


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(134, 135) *Geodorcus capito*, 134 male; 135 female; (136, 137) *Geodorcus helmsi*, 136 male, 137 female.

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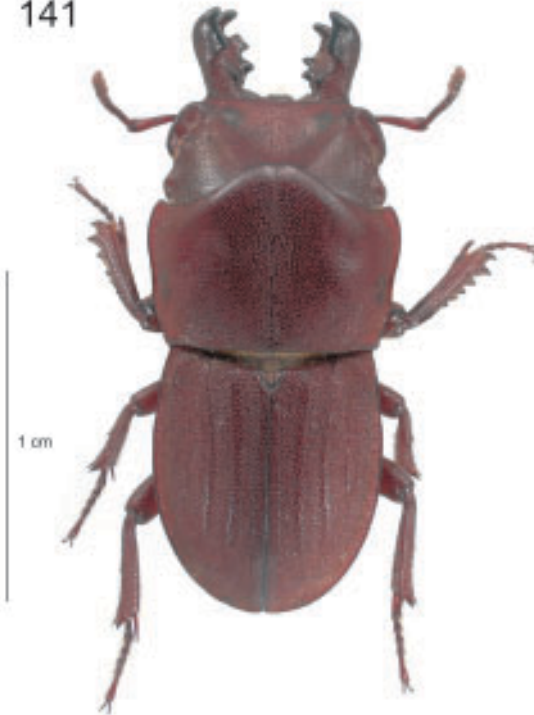


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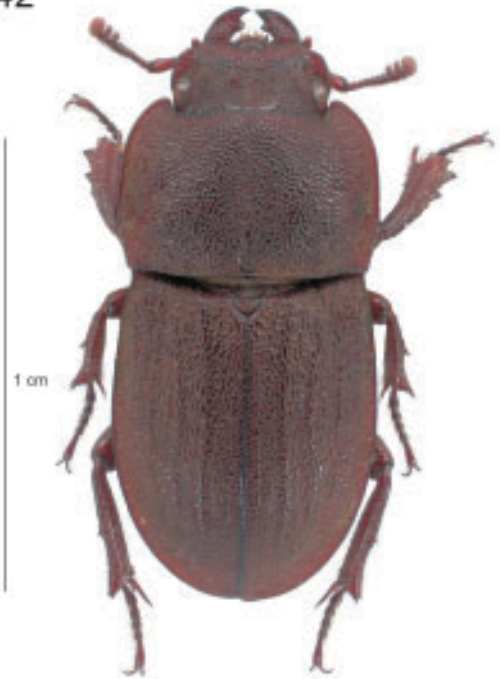


(138, 139) *Geodorcus ithaginis*, 138 male, 139 female; 140, *Geodorcus montivagus*, female.

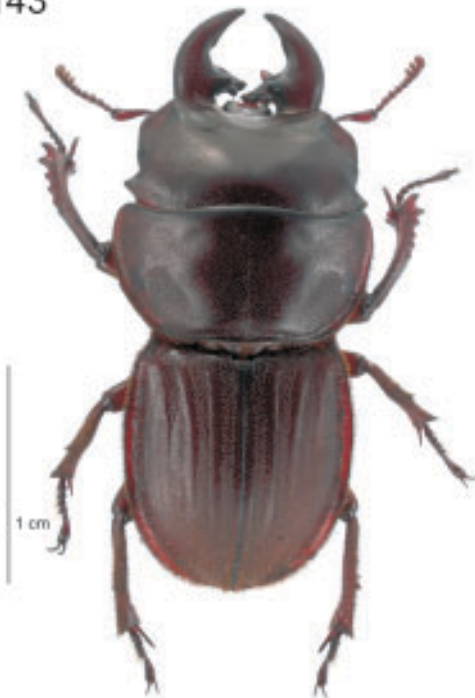
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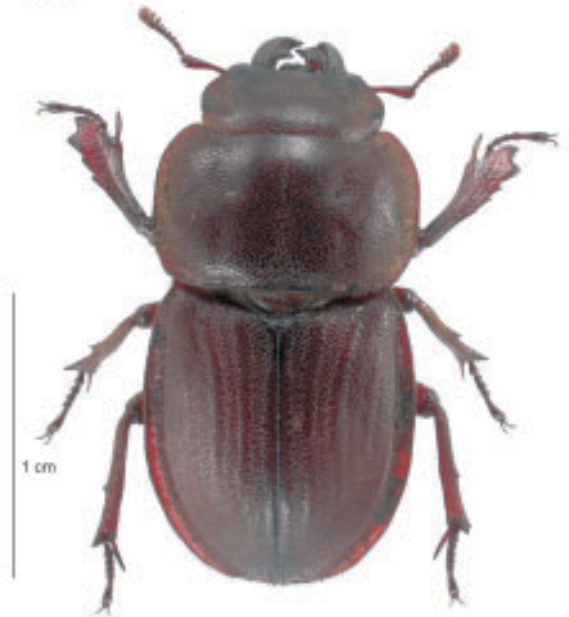
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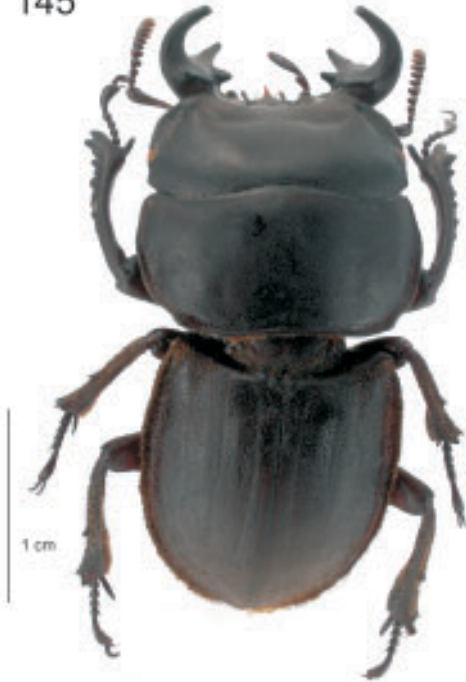


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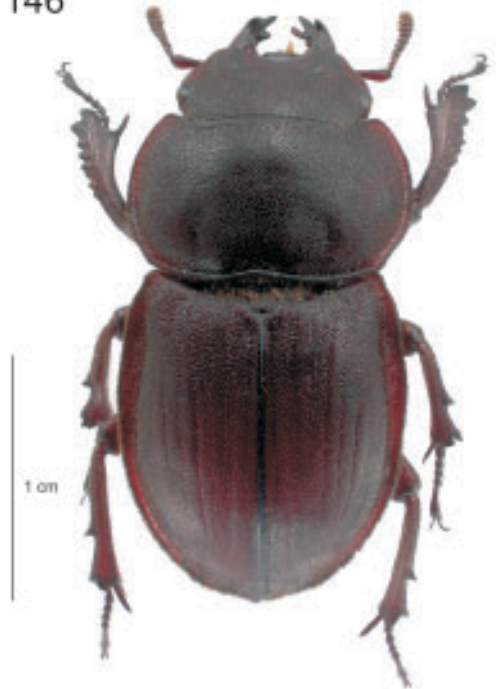


(141, 142) *Geodorcus novaezealandiae*, 141 male, 142 female; (143, 144) *Geodorcus philpotti*, 143 male, 144 female.

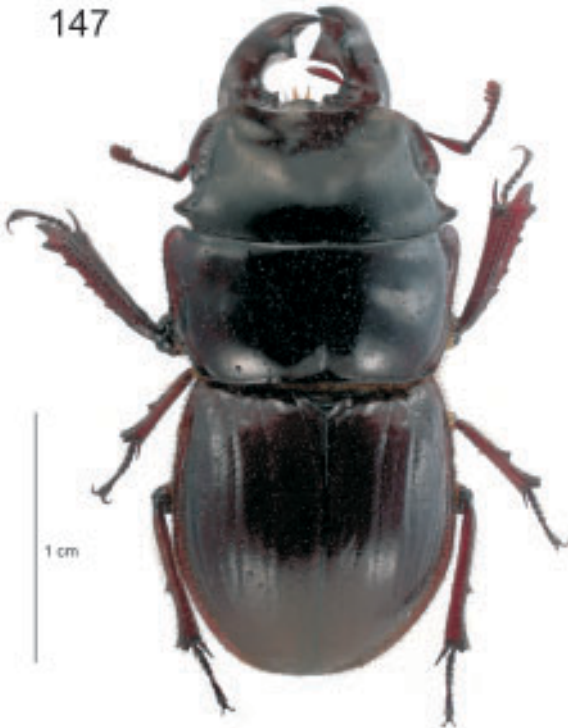
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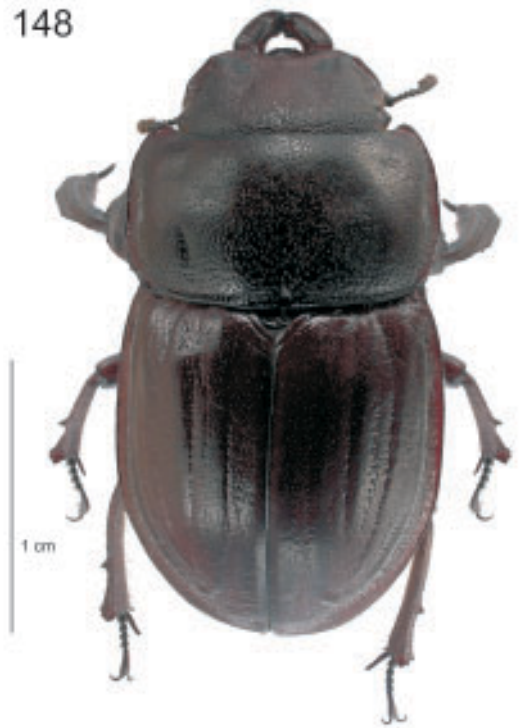
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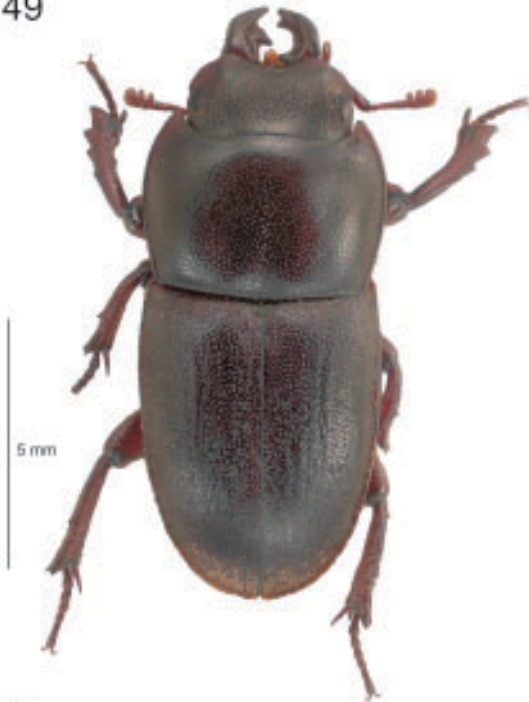


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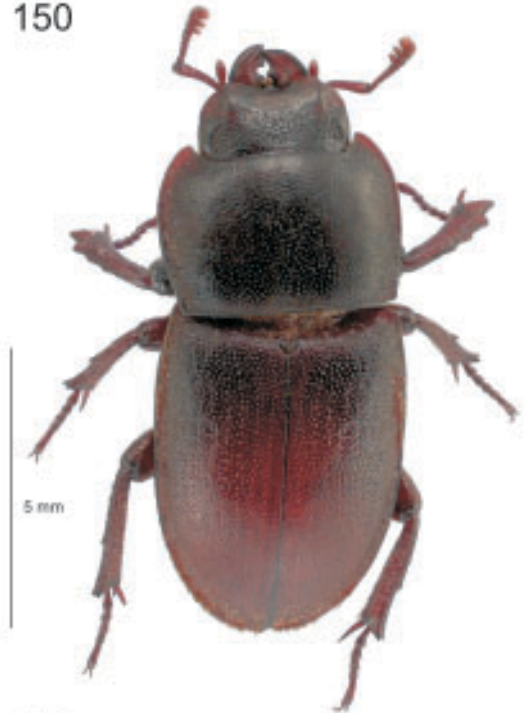


(145, 146) *Geodorcus servandus*, 145 male, 146 female; (147, 148) *Geodorcus sororum*, 147 male, 148 female.

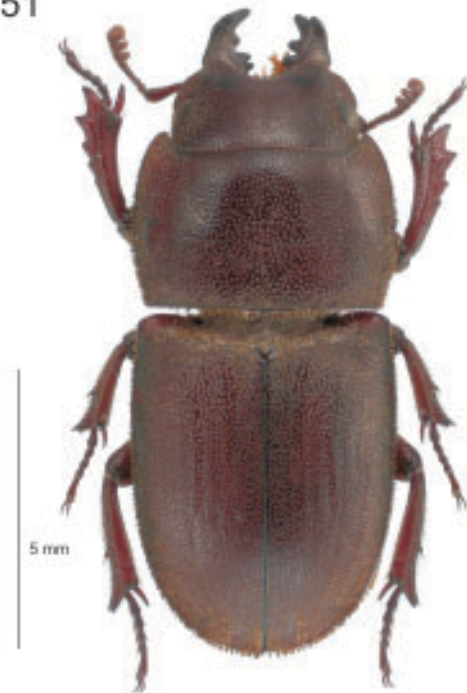
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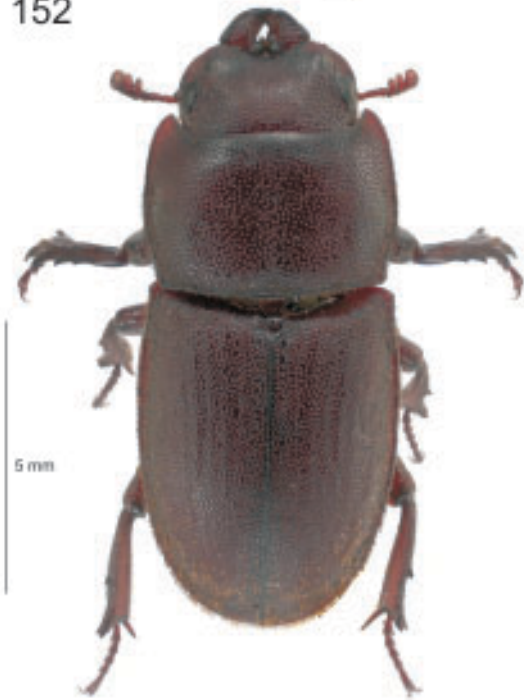
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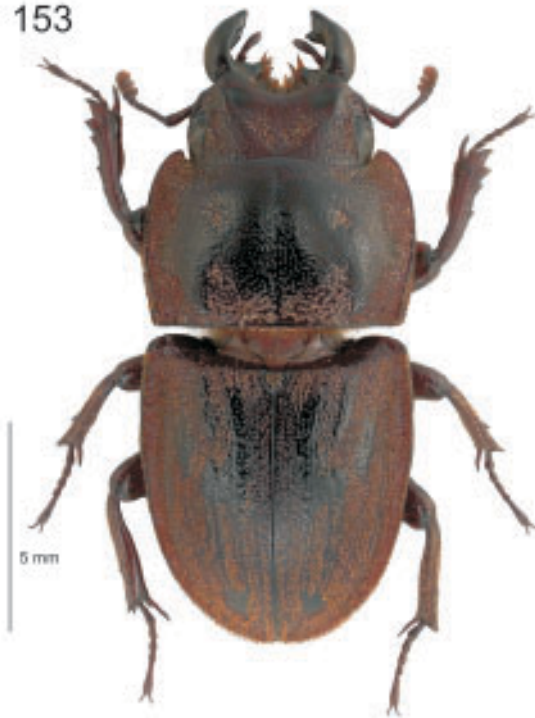


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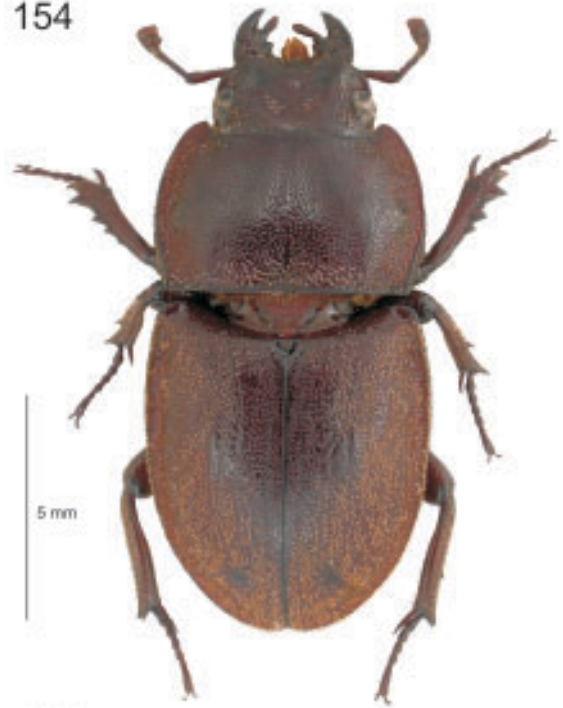


(149, 150) *Paralissotes mangonuiensis*, 149 male, 150 female; (151, 152) *Paralissotes oconnori*, 151 male, 152 female.

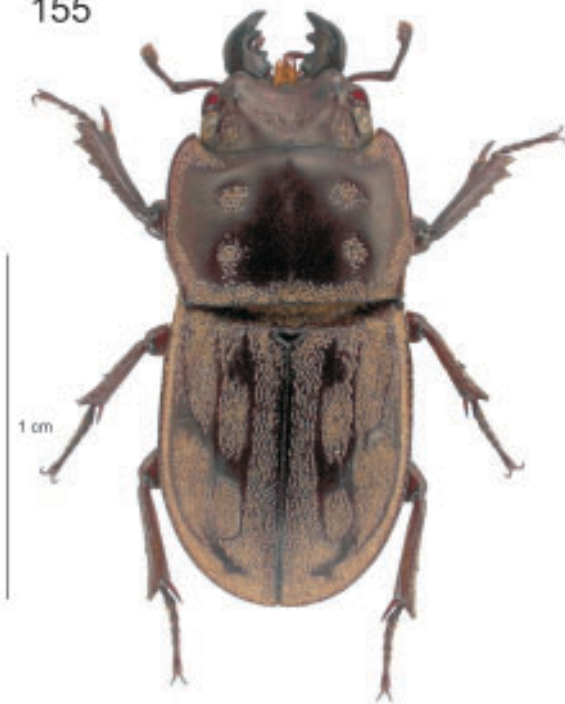
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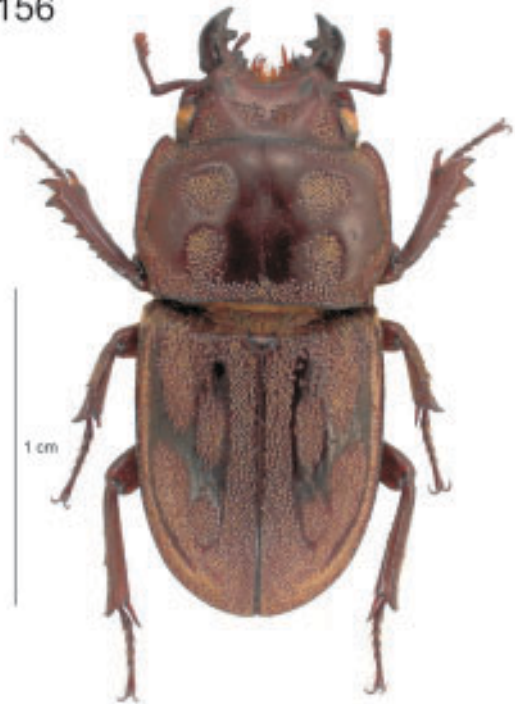
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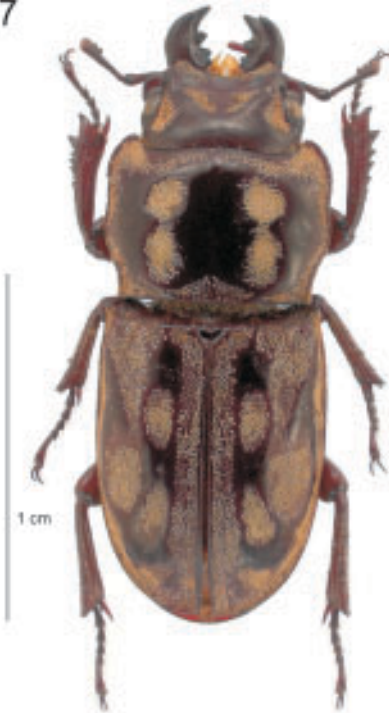


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(153, 154) *Paralissotes planus*, 153 male, 154 female; (155, 156) *Paralissotes reticulatus*, 155 male, 156 female.

157



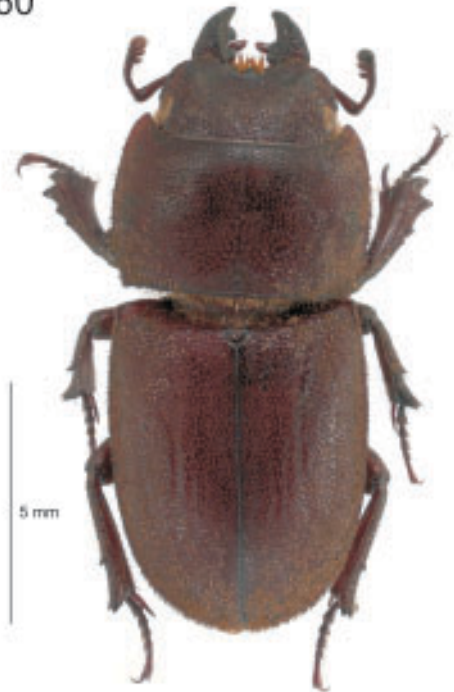
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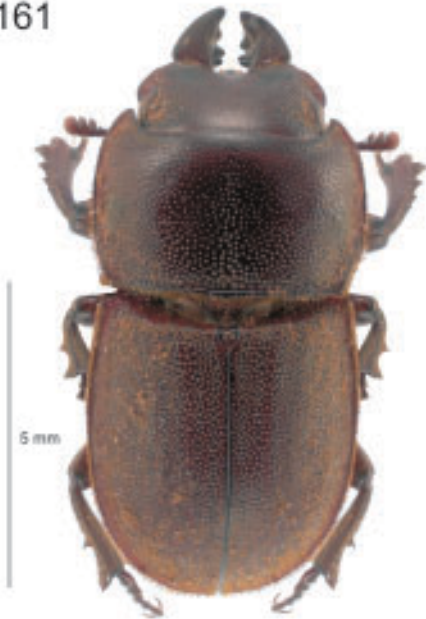


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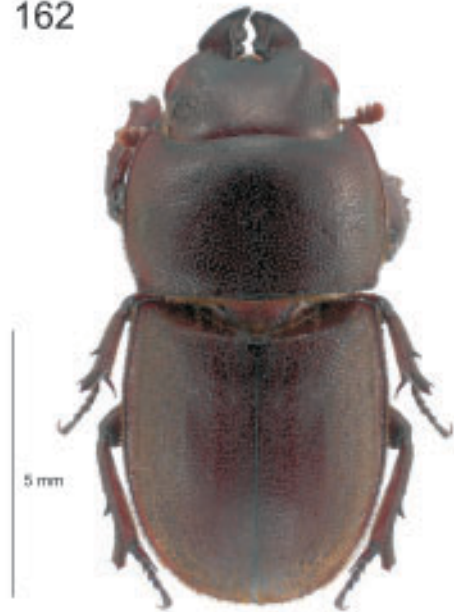


(157, 158) *Paralissotes rufipes*, 157 male, 158 female; (159, 160) *Paralissotes stewarti*, 159 male, 160 female.

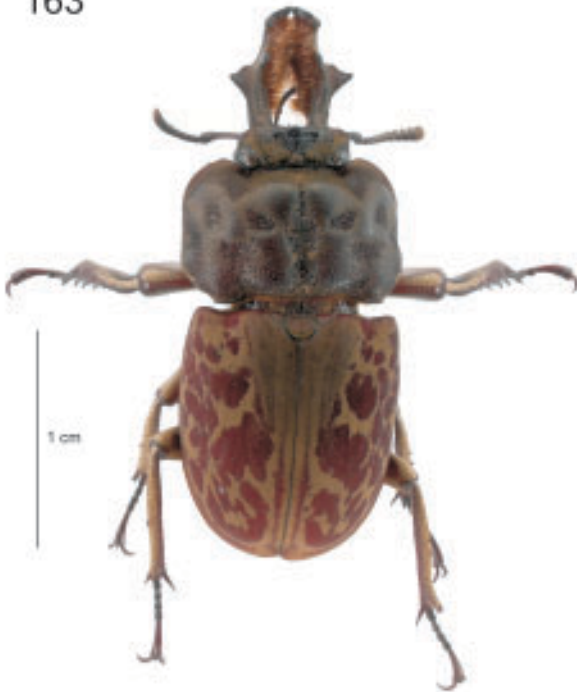
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(161, 162) *Paralissotes triregius*, 161 male, 162 female; (163, 164) *Ryssonotus nebulosus*, 163 male, 164 female.

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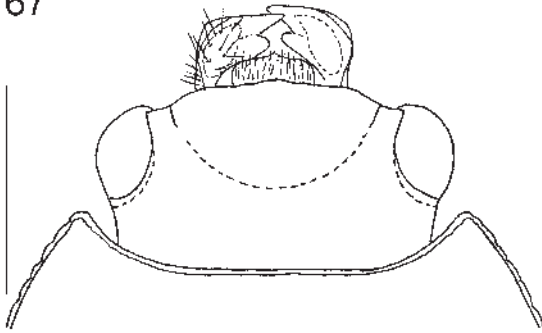


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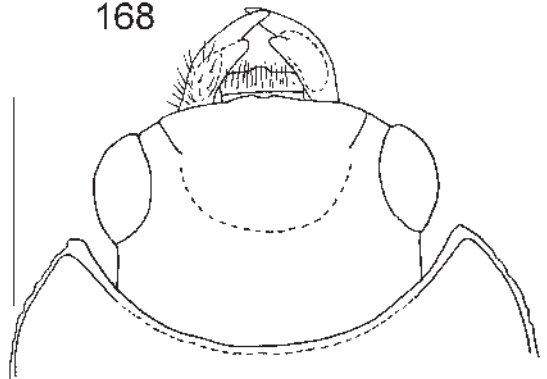


(165, 166) *Serrognathus sika*, 165 male, 166 female.

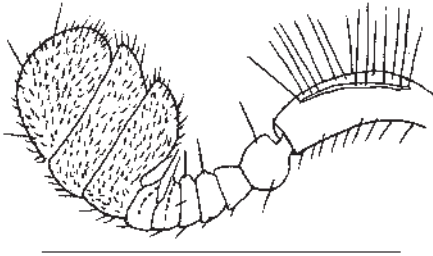
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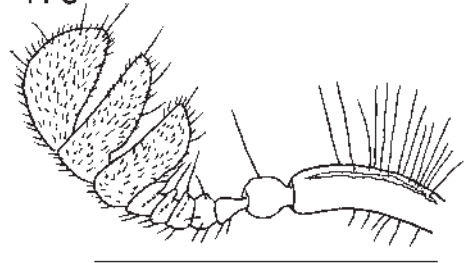
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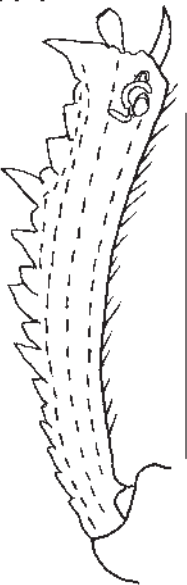
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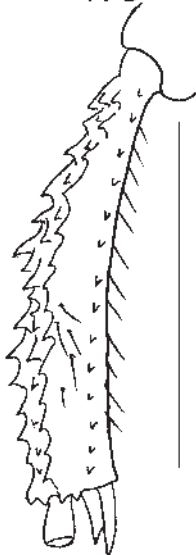
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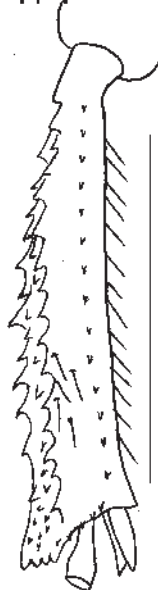
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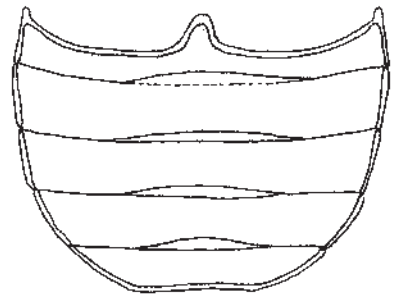
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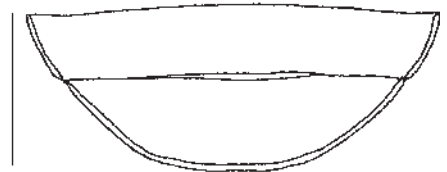


Fig. 167–176 *Holloceratognathus cylindricus*: 167, head (male); 168, head (female); 169, left antenna (male); 170, left antenna (female); 171, left front tibia (female); 172, underside of left protarsomeres 2 and 3 (female); 173, left middle tibia (female); 174, left hind tibia (female); 175, ventrites 1–5 (male); 176, ventrites 4 and 5 (female).

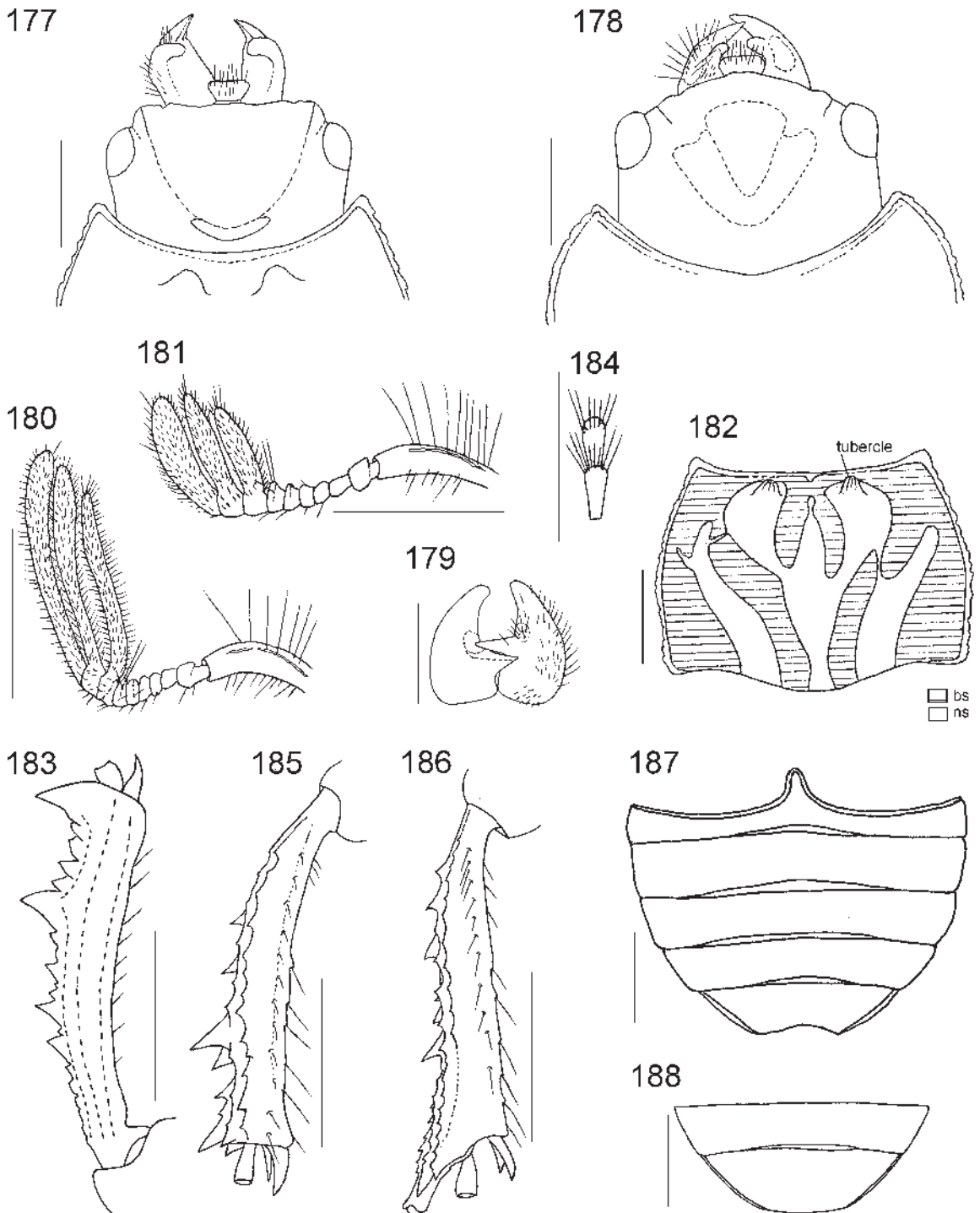


Fig. 177–188 *Holloceratognathus helotoides*: 177, head (male); 178, head (female); 179, front view of closed mandibles (male); 180, left antenna (male); 181, left antenna (female); 182, pronotum (male); 183, left front tibia (female); 184, underside of left protarsomeres 2 and 3 (female); 185, left middle tibia (female); 186, left hind tibia (female); 187, ventrites 1–5 (male); 188, ventrites 4 and 5 (female). Abbreviations: bs, brown scales; ns, no scales.

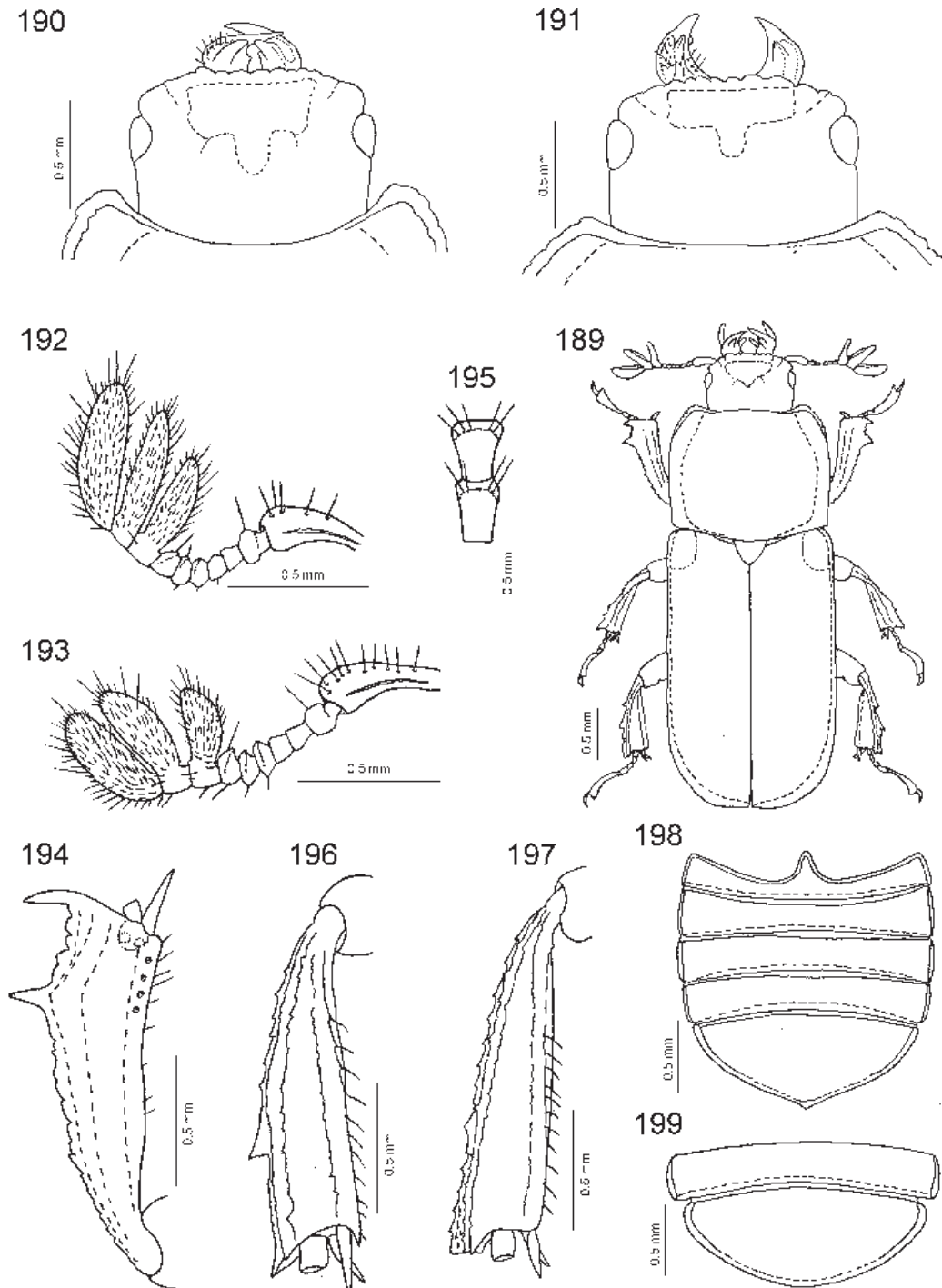


Fig. 189–199 *Holloceratognathus passaliformis*: 189, outline of body (male) (after Holloway 1962); 190, head (male); 191, head (female); 192, left antenna (male); 193, left antenna (female); 194, left front tibia (female); 195, underside of left protarsomeres 2 and 3 (female); 196, left middle tibia (female); 197, left hind tibia (female); 198, ventrites 1–5 (male); 199, ventrites 4 and 5 (female).

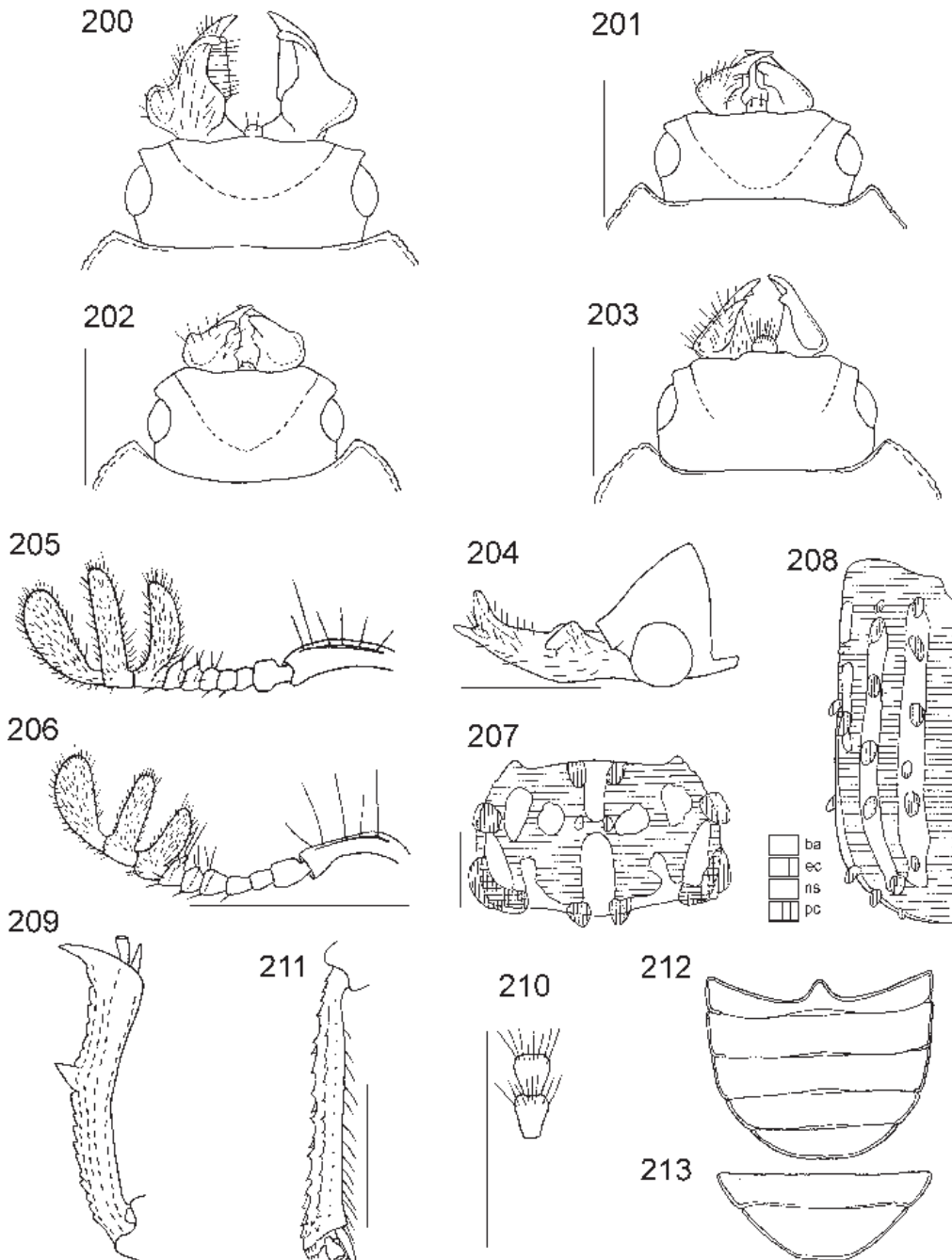


Fig. 200–213 *Mitophyllus alboguttatus*: 200, head (male, Saddle Hill, NN); 201, head (male, Auckland, AK, specimen compared with the type of *Ceratognathus alboguttatus* Bates by Parry); 202, head (male, Lake Rotoroa, BR, old denuded specimen with vestiture only on antennal club); 203, head (female); 204, left mandible of male in Fig. 200; 205, left antenna (male); 206, left antenna (female); 207, pronotum, indicating scale pattern (male); 208, discal surface of left elytron, indicating scale pattern (female); 209, left front tibia (female); 210, underside of left protarsomeres 2 and 3 (male); 211, left hind tibia (female); 212, ventrites 1–5 (male); 213, ventrites 4 and 5 (female). Abbreviations: ba, brown, appressed to suberect scales; bd, brown, mainly decumbent scales; ec, erect cream or yellow scales in a compact tuft; ns, no scales; pc, patch of appressed to erect cream scales.

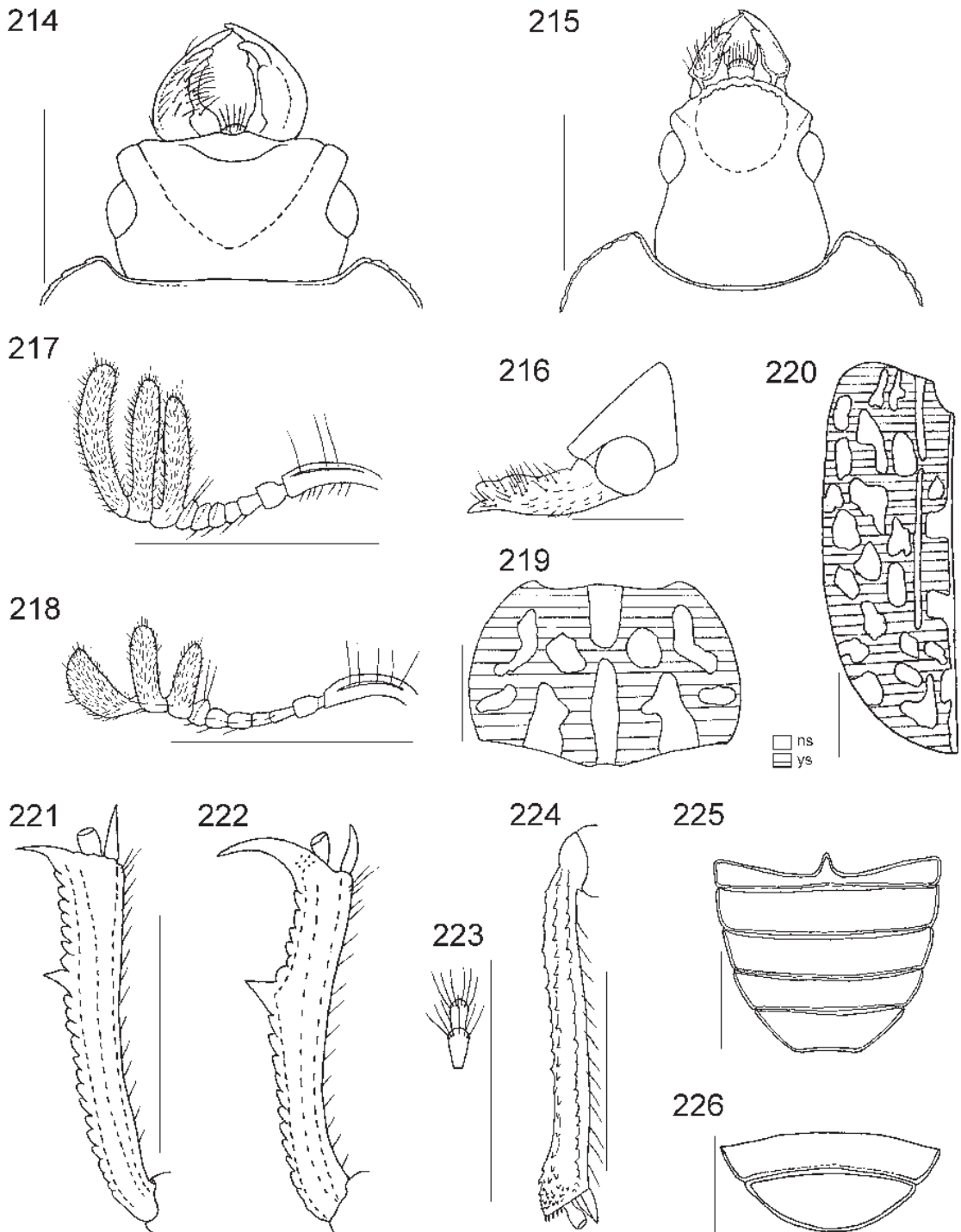


Fig. 214–226 *Mitophyllus angusticeps*: 214, head (male); 215, head (female); 216, left mandible and head, lateral view (male); 217, left antenna (male); 218, left antenna (female); 219, pronotum, indicating generalised scale pattern (female); 220, left elytron, indicating generalised scale pattern (female); 221, left front tibia (male); 222, left front tibia (female); 223, underside of left protarsomeres 2 and 3 (female); 224, left hind tibia (female); 225, ventrites 1–5 (male); 226, ventrites 4 and 5 (female). Abbreviations: ns, no scales; ys, yellowish scales.

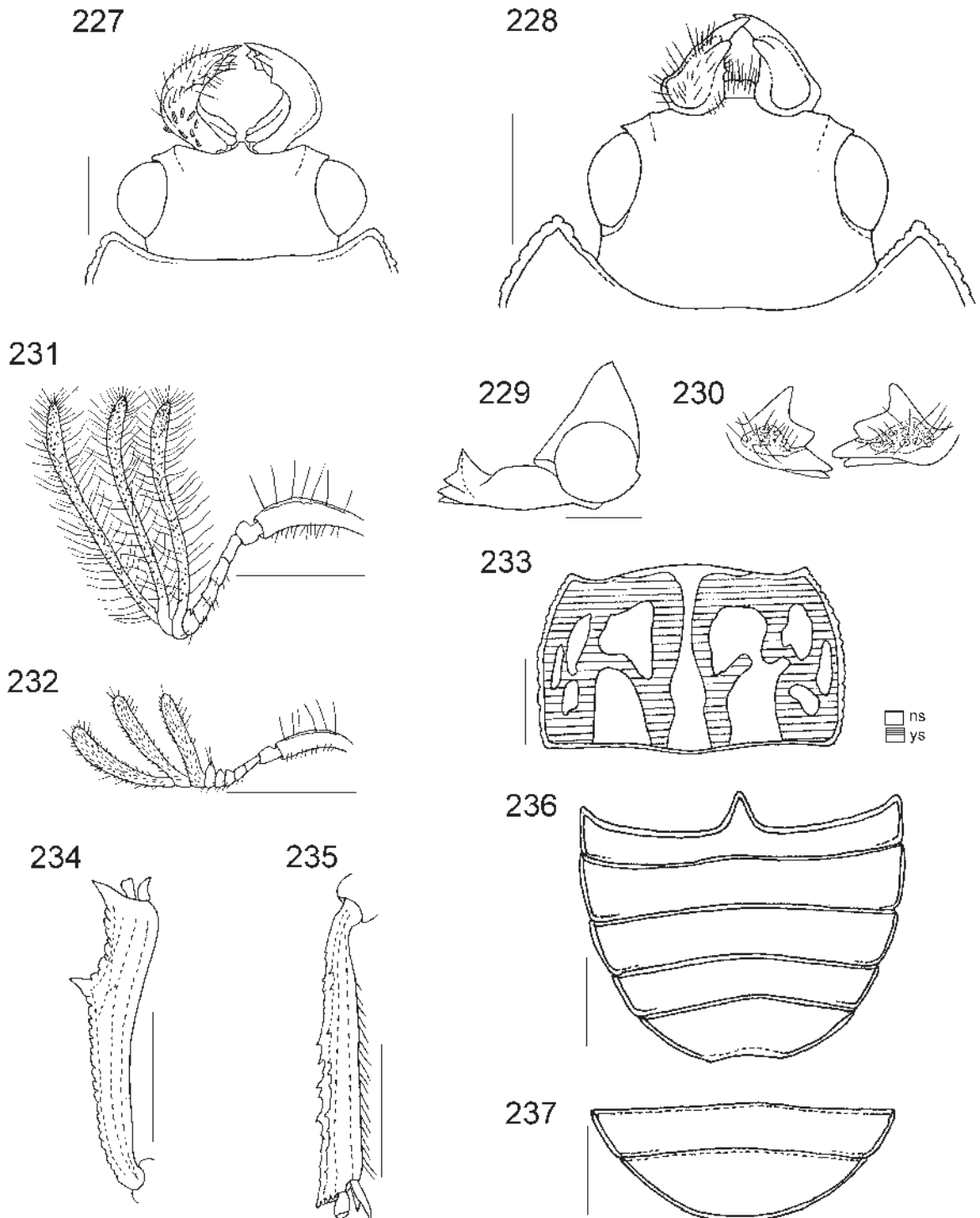


Fig. 227–237 *Mitophyllus arcuatus*: 227, head (male); 228, head (female); 229, left mandible and head, lateral aspect (male); 230, front view of mandibles (male); 231, left antenna (male); 232, left antenna (female); 233, pronotum showing scale pattern; 234, left front tibia (male); 235, left hind tibia (male); 236, ventrites 1–5 (male); 237, ventrites 4 and 5 (female). Abbreviations: ns, no scales; ys, yellow and brown scales.

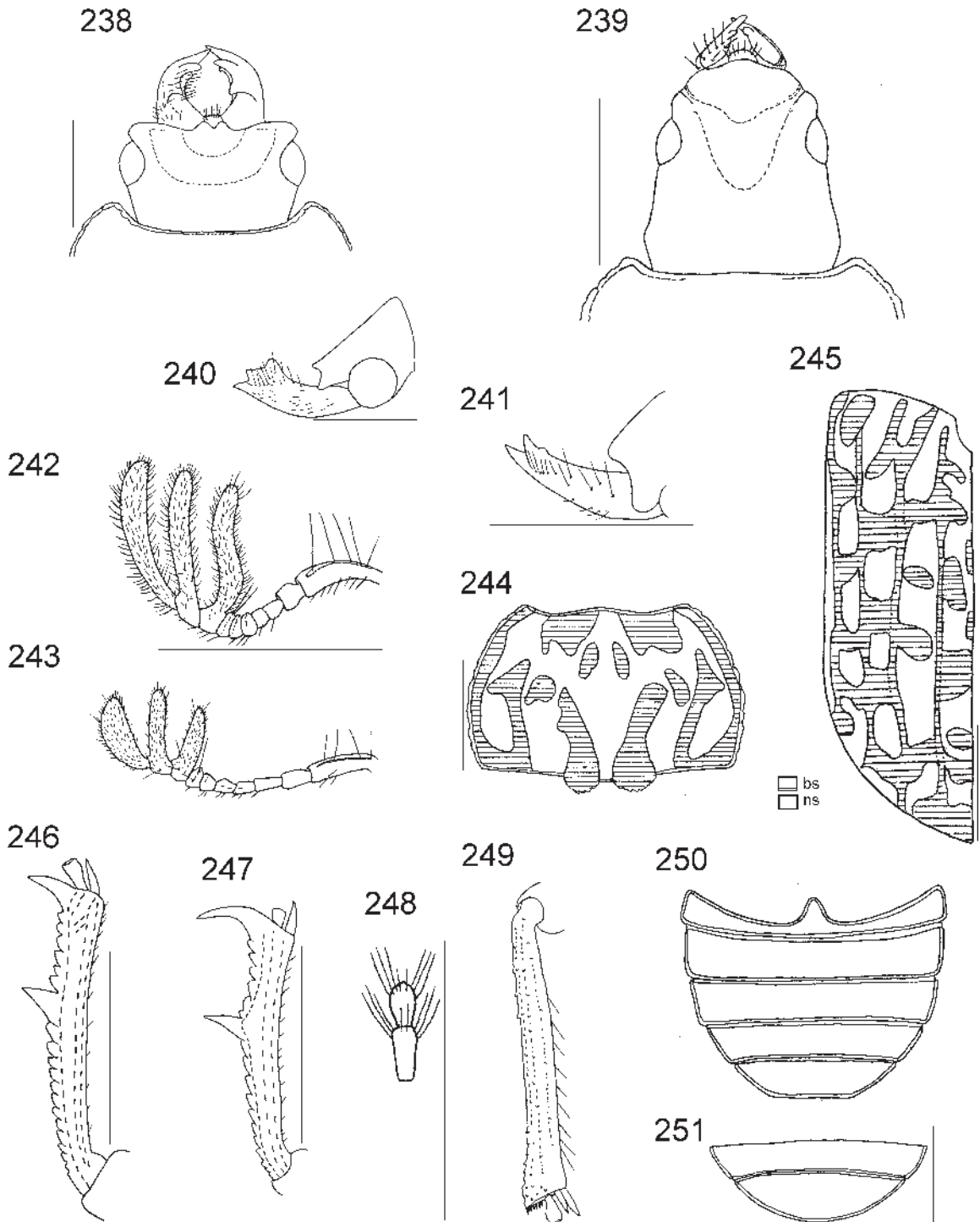


Fig. 238–251 *Mitophyllus dispar*. 238, head (male); 239, head (female); 240, left mandible and head, lateral aspect (large male); 241, left mandible and head, lateral aspect (small male); 242, left antenna (male); 243, left antenna (female); 244, pronotum indicating generalised scale pattern (male); 245, left elytron indicating generalised scale pattern (male); 246, left front tibia (male); 247, left front tibia (female); 248, underside of left protarsomeres 2 and 3 (female); 249, left hind tibia (female); 250, ventrites 1–5 (male); 251, ventrites 4 and 5 (female). Abbreviations: ns, no scales; sc, brown and clay-coloured scales.

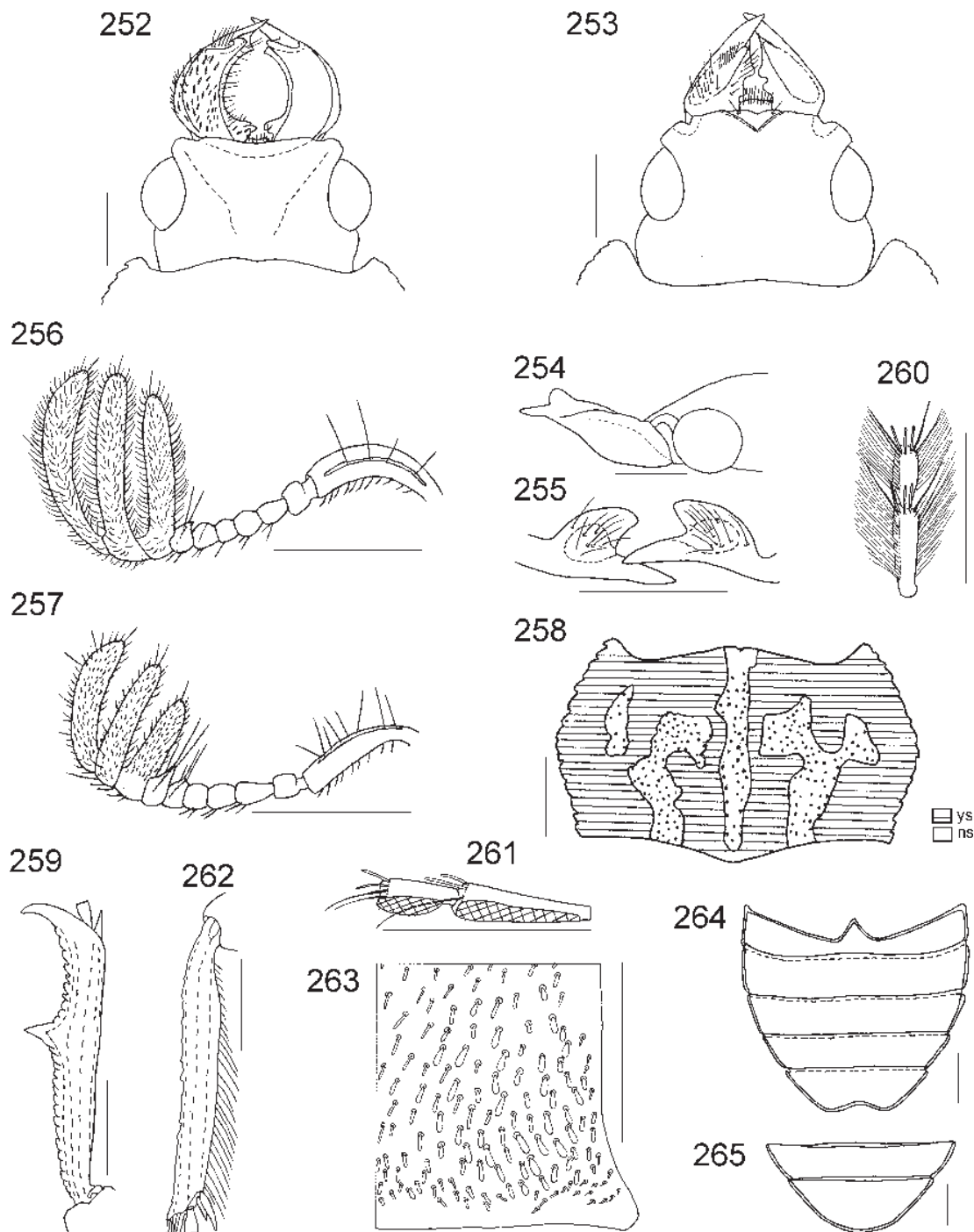


Fig. 252–265 *Mitophyllus falcatus*: 252, head (male); 253, head (female); 254, left mandible and head, lateral aspect (male); 255, front view of mandibles (male); 256, left antenna (male); 257, left antenna (female); 258, pronotum showing scale pattern, dots indicate actual punctures on scale-free areas (male); 259, left front tibia (female); 260, underside of protarsomeres 2 and 3 (female); 261, lateral aspect protarsomeres 2 and 3 with cross-hatched areas indicating where setae arise (female); 262, left hind tibia (female); 263, left half of metasternum showing vestiture (female); 264, ventrites 1–5 (male); 265, ventrites 4 and 5 (female). Abbreviations: ns, no scales; ys, yellowish-brown scales.

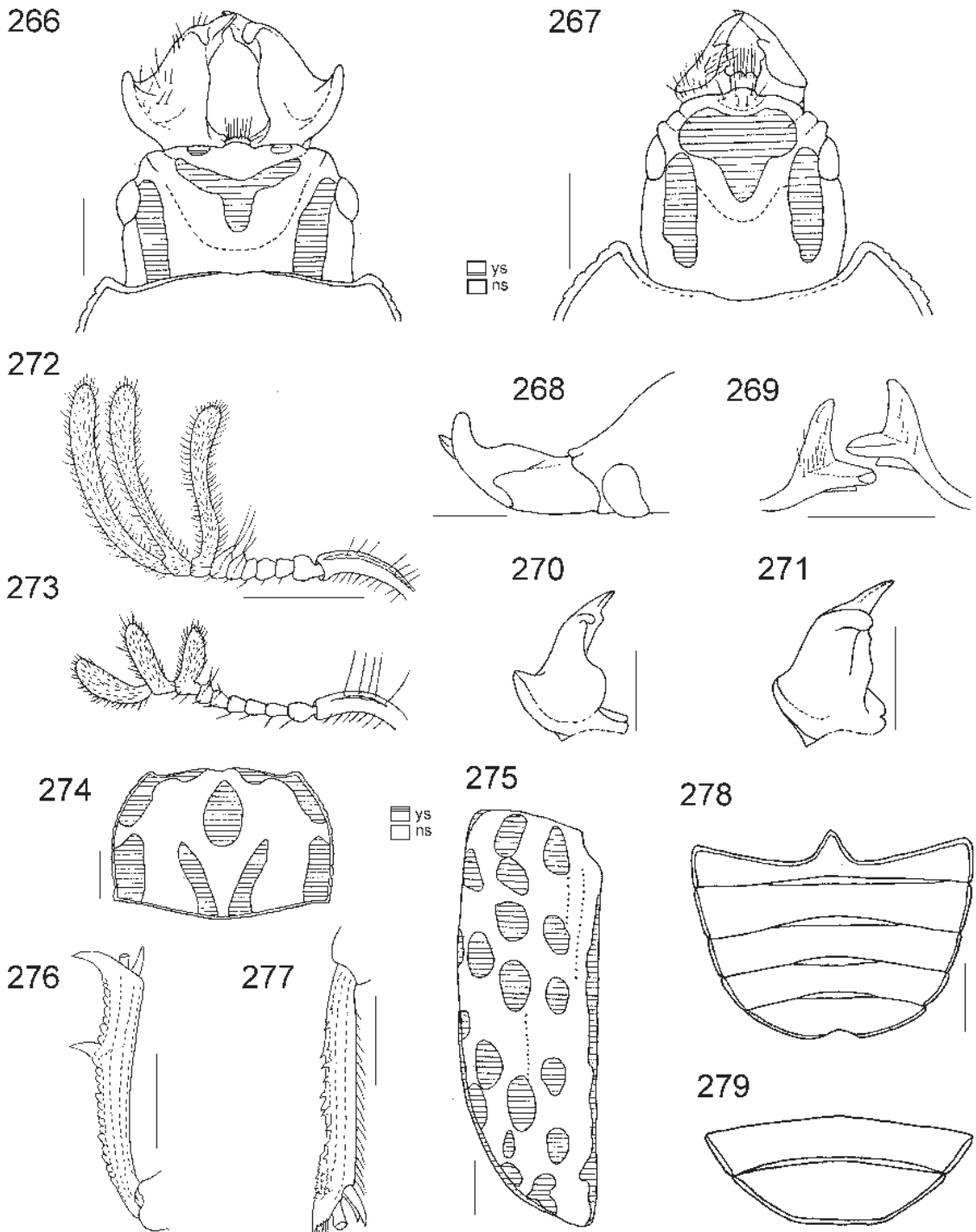


Fig. 266–279 *Mitophyllus foveolatus*: 266, head (male, Gordons Knob, NN); 267, head (female); 268, left mandible and head, lateral aspect (male in Fig. 100); 269, front view of mandibles (male in Fig. 266); 270, left mandible (male, Upper Maitai, NN); 271, left mandible (male, Fletchers Creek, BR); 272, left antenna (male); 273, left antenna (female); 274, pronotum showing scale pattern (male); 275, elytron showing scale pattern (male); 276, left front tibia (female); 277, left hind tibia (female); 278, ventrites 1–5 (male); 279, ventrites 4 and 5 (female). Abbreviations: ns, no scales; ys, yellow scales.

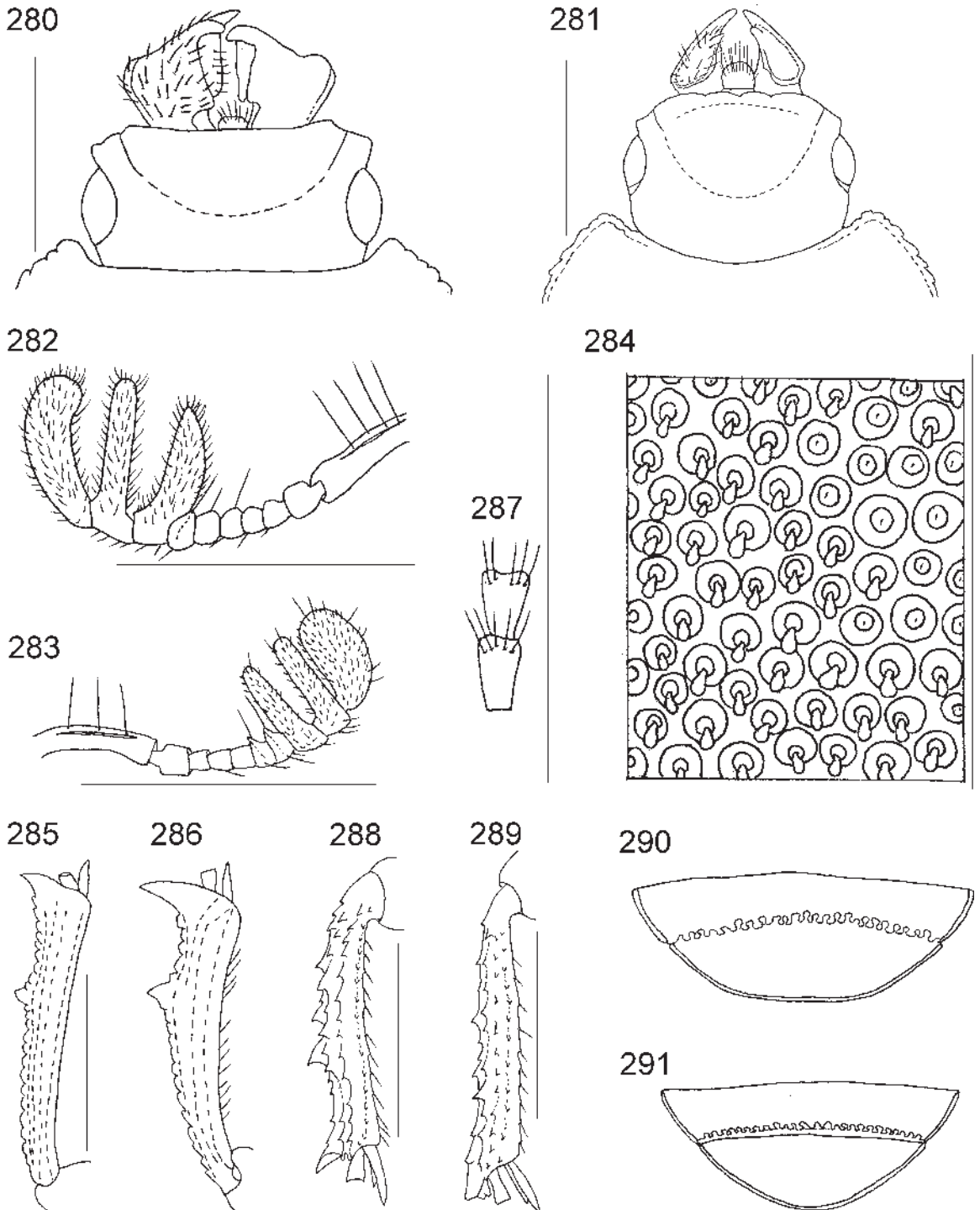


Fig. 280–291 *Mitophyllus fuscus* : 280, head (male); 281, head (female); 282, left antenna (male); 283, right antenna (female); 284, elytral vestiture and scales (female); 285, left front tibia (male); 286, left front tibia (female); 287, underside of left protarsomeres 2 and 3 (female); 288, left middle tibia (female); 289, left hind tibia (female); 290, ventrites 4 and 5 (male); 291, ventrites 4 and 5 (female).

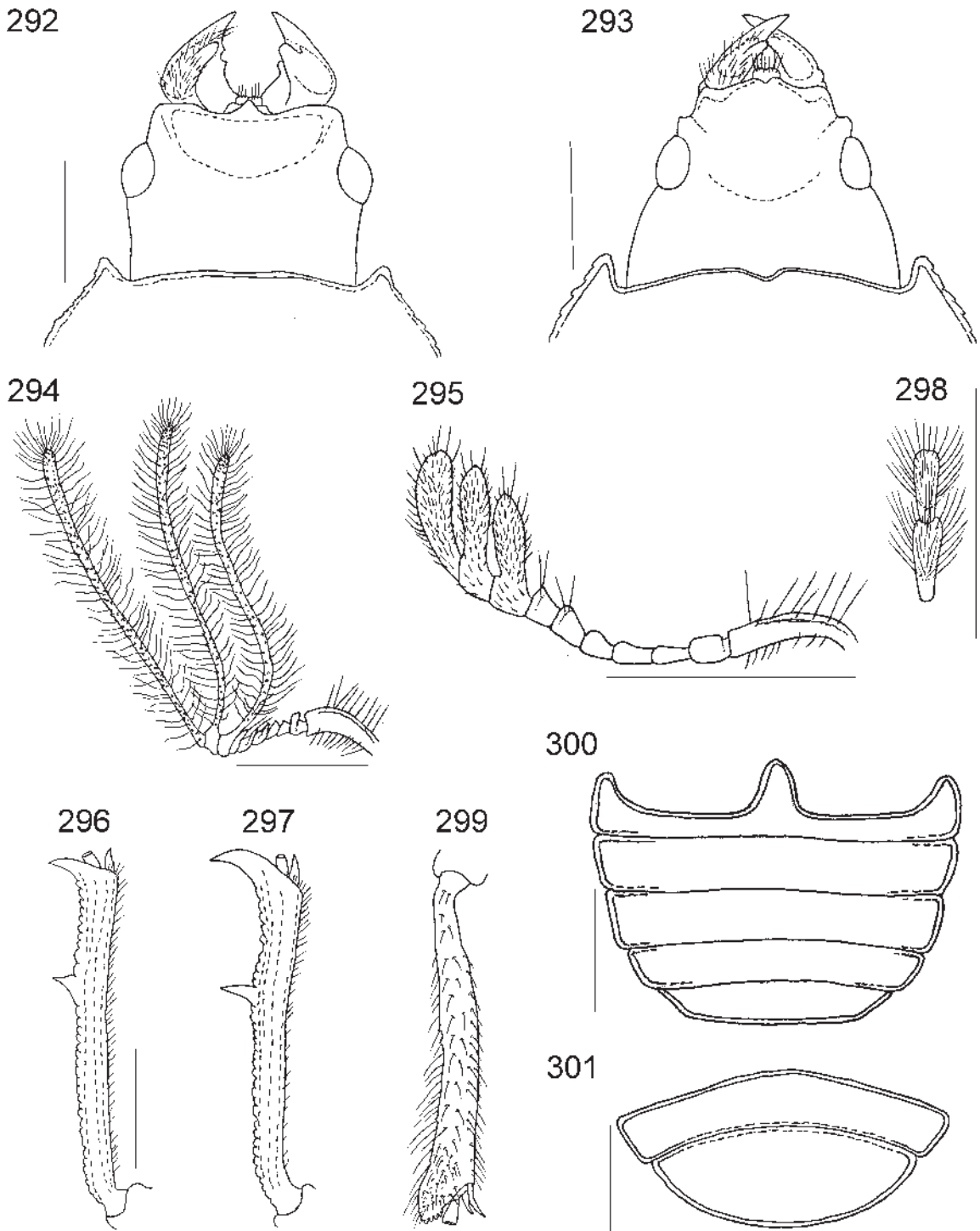


Fig. 292–301 *Mitophyllus gibbosus*: 292, head (male); 293, head (female); 294, left antenna (male); 295, left antenna (female); 296, left front tibia (male); 297, left front tibia (female); 298, underside of left protarsomeres 2 and 3 (male); 299, left hind tibia (female); 300, ventrites 1–5 (male); 301, ventrites 4 and 5 (female).

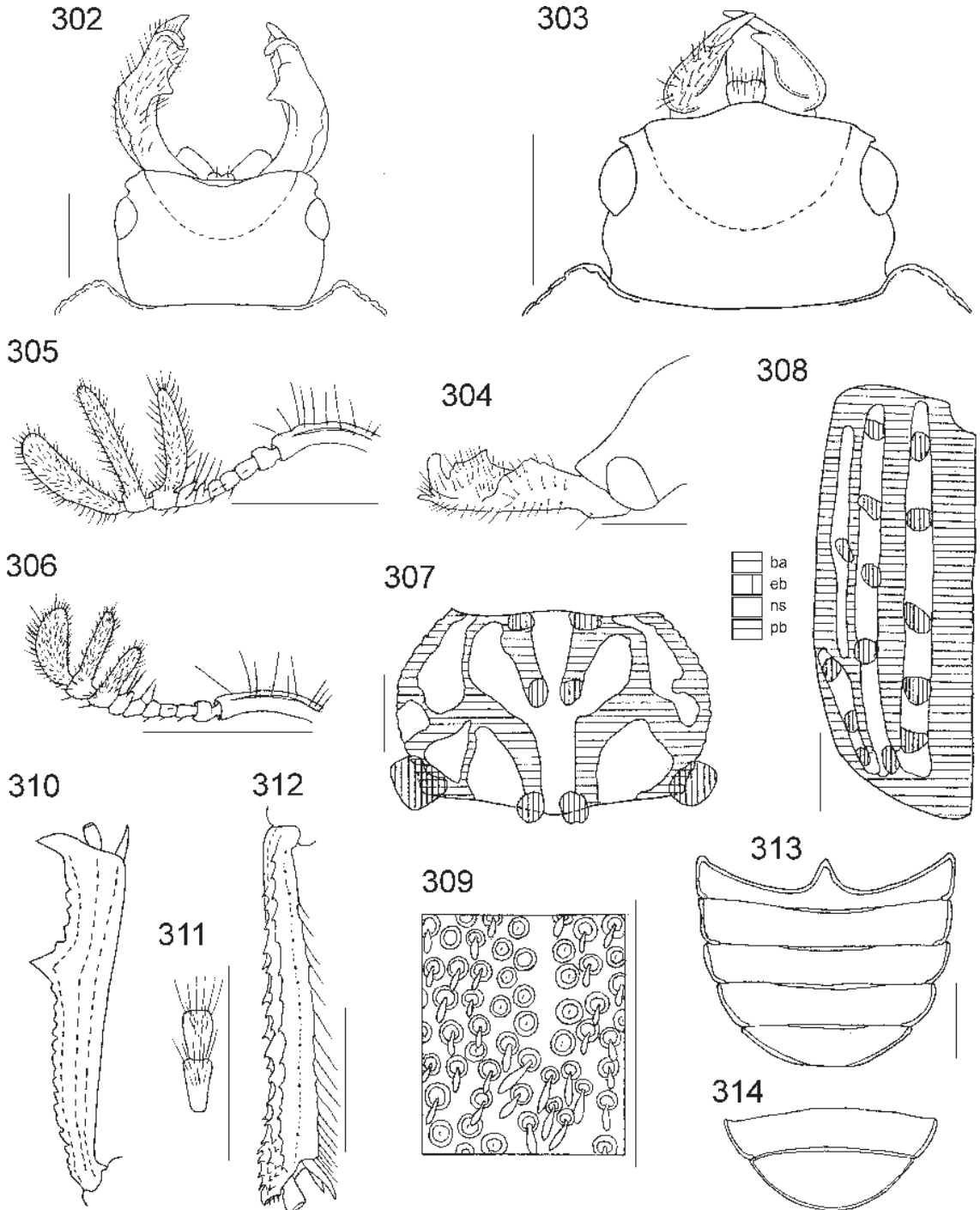
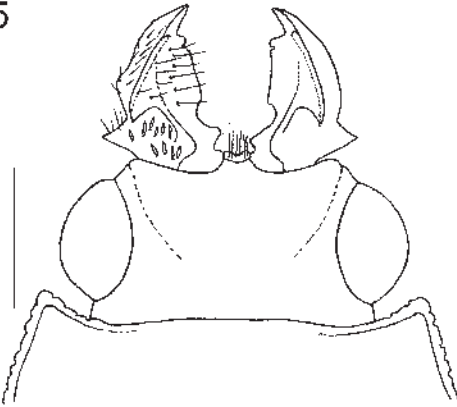
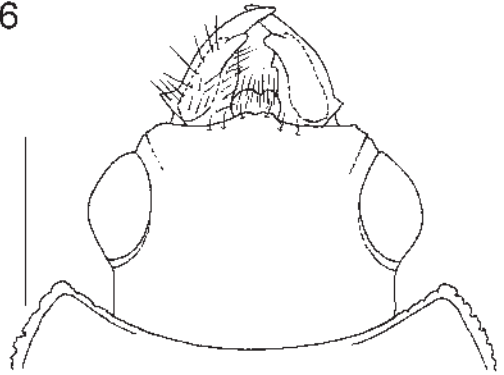


Fig. 302–314 *Mitophyllus insignis*: 302, head (male); 303, head (female); 304, left mandible and head, lateral aspect (male); 305, left antenna (male); 306, left antenna (female); 307, pronotum showing scale pattern (male); 308, left elytron showing scale pattern (female); 309, details of elytral surface (female); 310, left front tibia (female), 311, underside of left protarsomeres 2 and 3 (female); 312, left hind tibia (female); 313, ventrites 1–5 (male); 314, ventrites 4 and 5 (female). Abbreviations: ba, brown appressed scales; eb, loose tuft of erect yellowish brown scales; ns, no scales; pb, patch of yellowish brown appressed to erect scales.

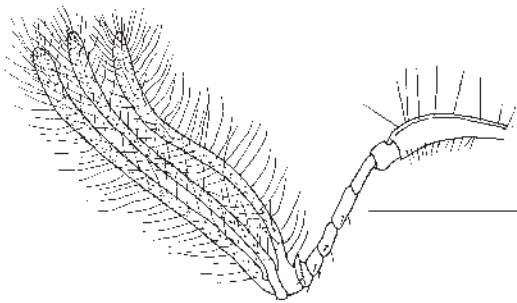
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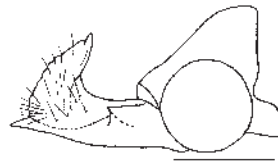
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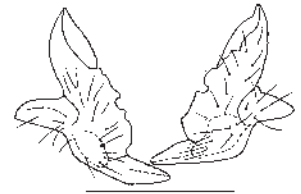
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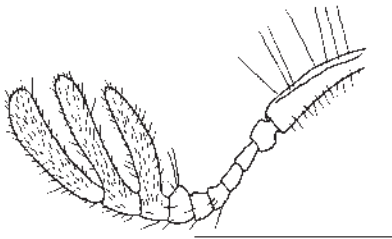
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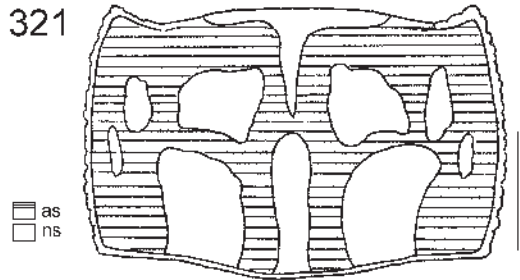
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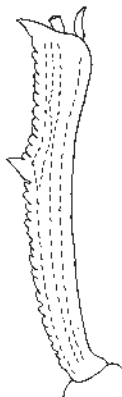
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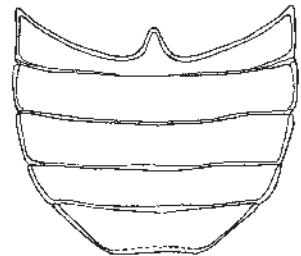
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Fig. 315–325 *Mitophyllus irroratus*: 315, head (male); 316, head (female); 317, left mandible and head, lateral (male); 318, front view of partially closed mandibles (male); 319, left antenna (male); 320, left antenna (female); 321, pronotum showing scale pattern (male); 322, left front tibia (male); 323, left hind tibia (male); 324, ventrites 1–5 (male); 325, ventrites 4 and 5 (female). Abbreviations: as, appressed yellowish brown scales; ns, no scales.

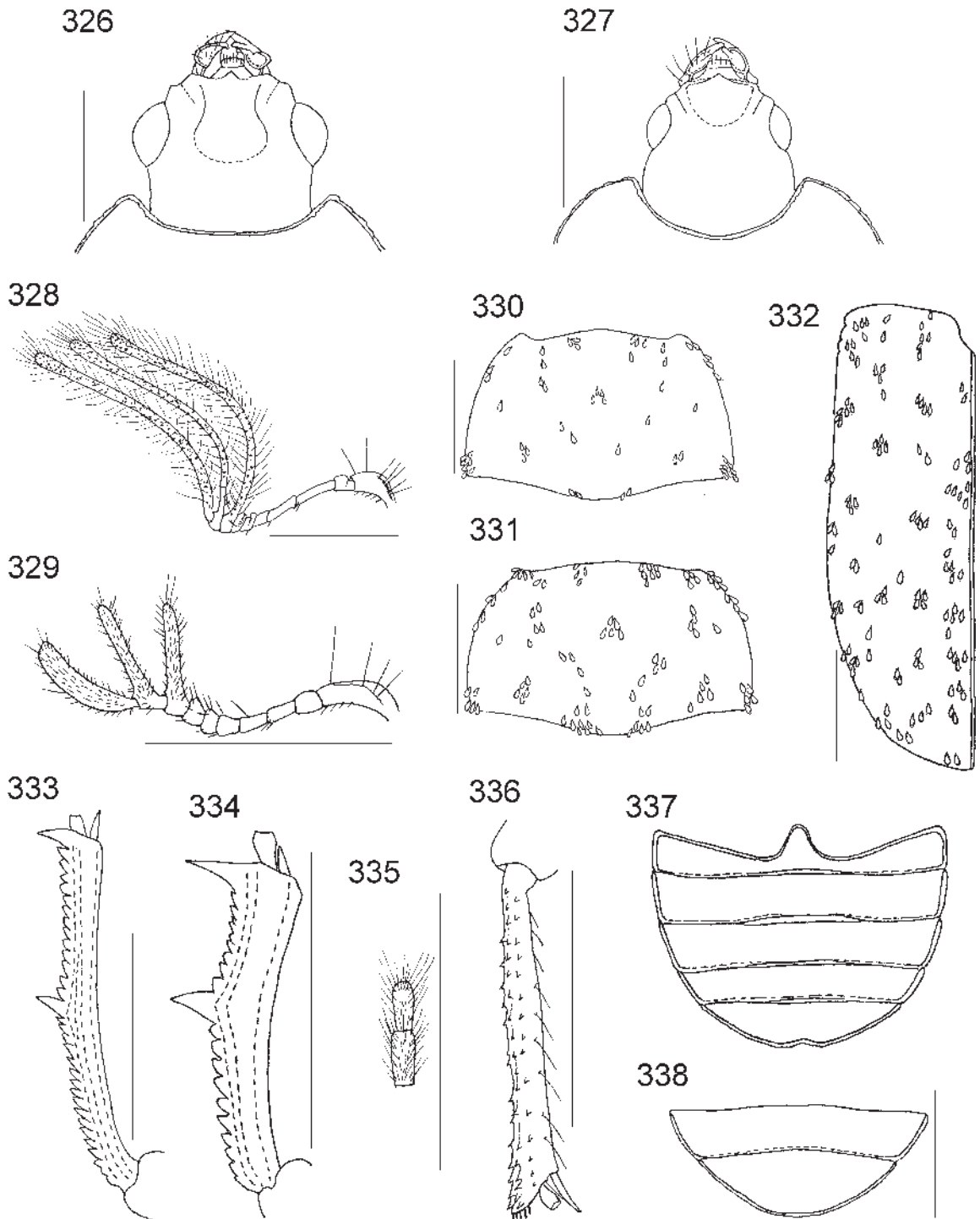


Fig. 326–338 *Mitophyllus macrocerus*: 326, head (male); 327, head (female); 328, left antenna (male); 329, left antenna (female); 330, pronotum showing scale pattern (male); 331, pronotum showing scale pattern (female); 332, left elytron showing scale pattern (male); 333, left front tibia (male); 334, left front tibia (female); 335, underside of left protarsomeres 2 and 3 (male); 336, left hind tibia (female); 337, ventrites 1–5 (male); 338, ventrites 4 and 5 (female).

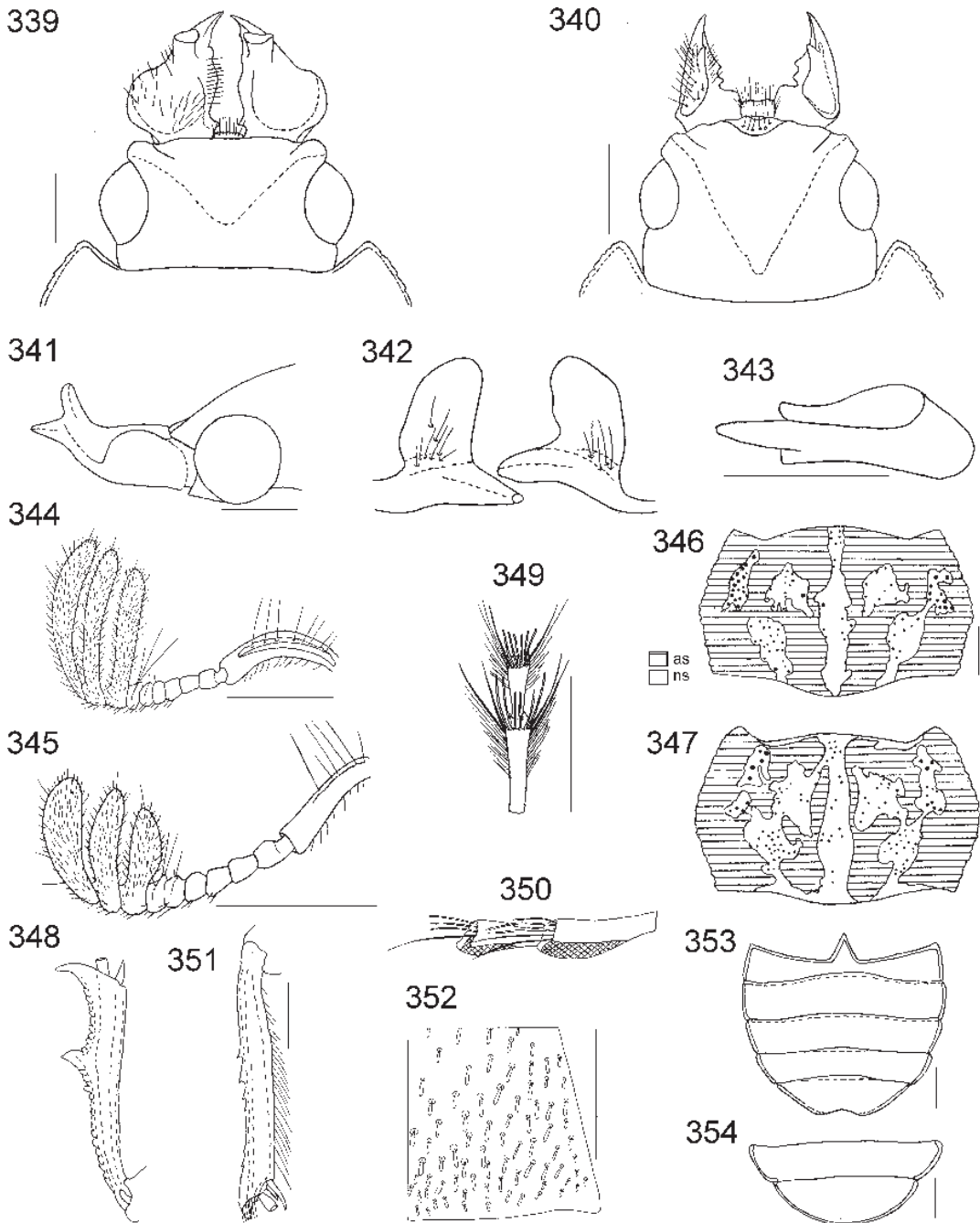


Fig. 339–354 *Mitophyllus parrianus*: 339, head (male); 340, head (female); 341, left mandible and head, lateral (male); 342, front view of closed mandibles (male); 343, left mandible, lateral, showing apical, subapical dorsal, and subapical ventral teeth (female); 344, left antenna (male); 345, left antenna (female); 346 and 347, pronota showing variation in scale patterns; dots on non-squamosose areas indicate actual punctures (males; 346, from Ungohi Stream, CL; 347, from Waiheke I., AK); 348, left front tibia (female); 349, dorsal aspect of left protarsomeres 2 and 3 (female); 350, lateral aspect of left protarsomeres 2 and 3, areas where setae arise indicated by cross-hatching (female); 351, left hind tibia (female); 352, left half of metasternum showing vestiture (female); 353, ventrites 1–5 (male); 354, ventrites 4 and 5 (female). Abbreviations: as, appressed scales; ns, no scales.

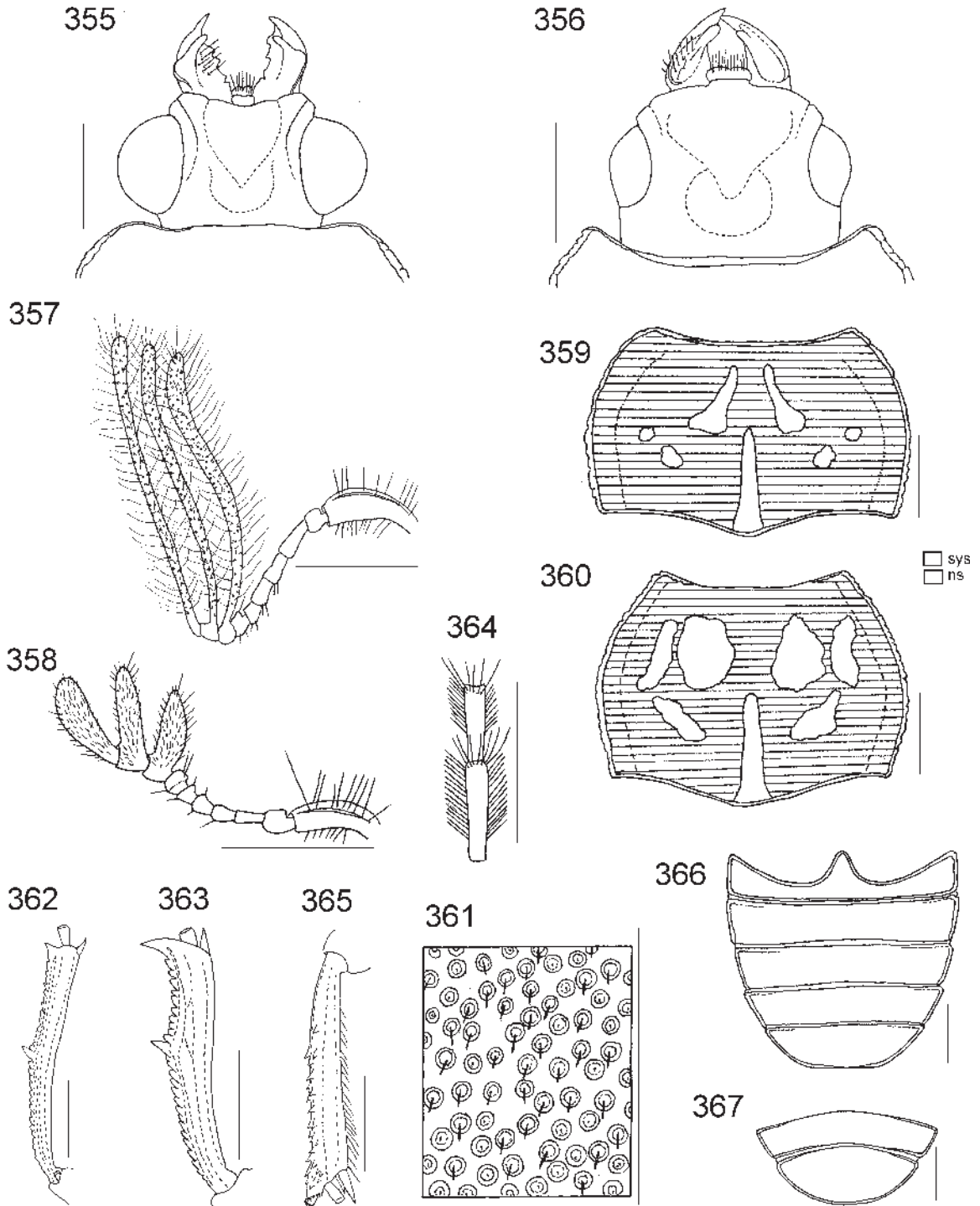


Fig. 355–367 *Mitophyllus reflexus*: 355, head (male); 356, head (female); 357, left antenna (male); 358, left antenna (female); 359, pronotum showing raised areas on disc (male); 360, pronotum showing raised areas on disc (female); 361, elytral punctures and scales (female) 362, left front tibia (male); 363, left front tibia (female); 364, dorsal aspect of left protarsomeres 2 and 3 (male); 365, left hind tibia (female); 366, ventrites 1–5 (male); 367, ventrites 4 and 5 (female). Abbreviations: ns, no scales; sys, microsetae and yellow scales.

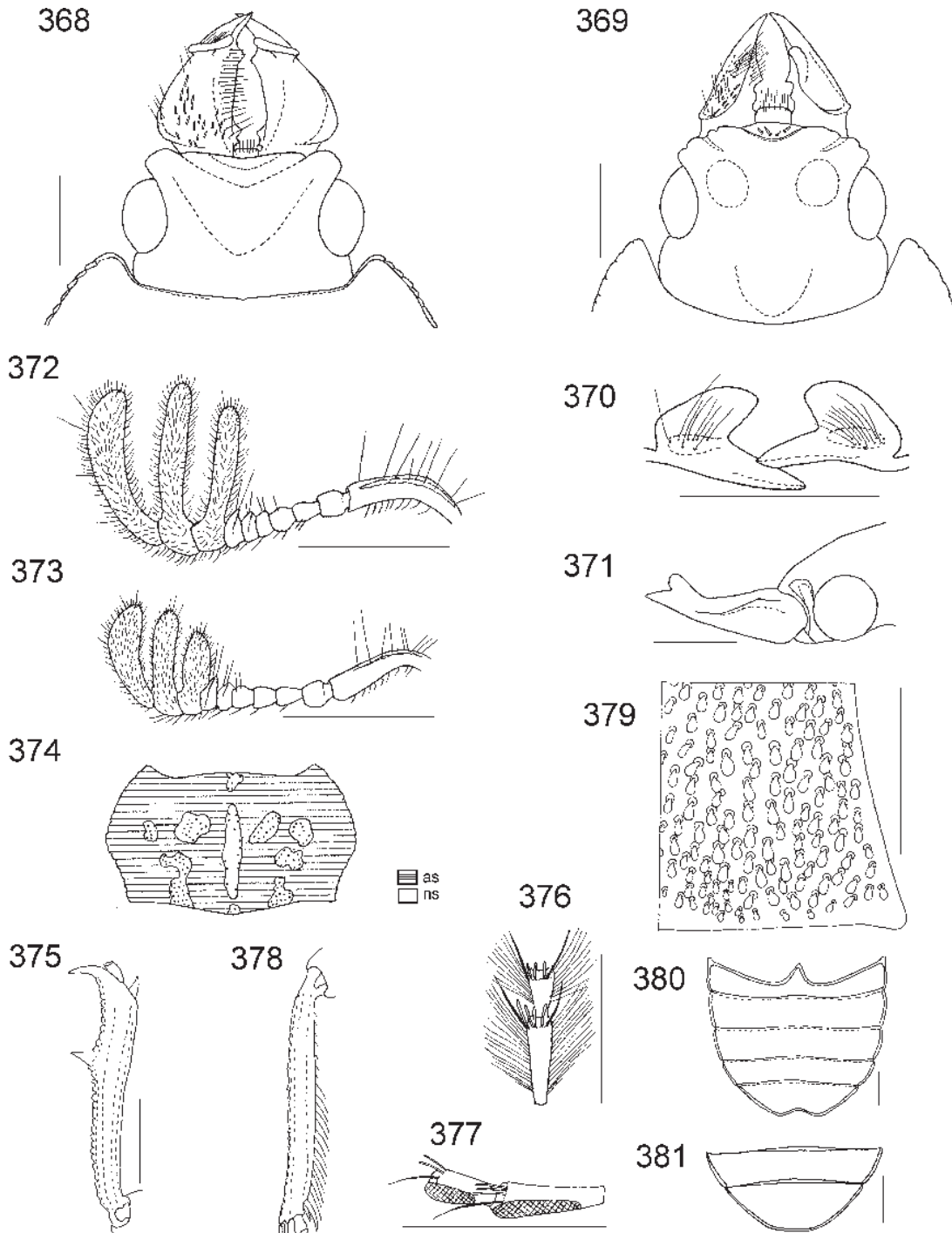


Fig. 368–381 *Mitophyllus solox*: 368, head (male); 369, head (female); 370, front view of closed mandibles (male); 371, left mandible and head (male); 372, left antenna (male); 373, left antenna (female); 374, pronotum showing scale pattern, dots represent punctures on non-squamose areas (male); 375, left front tibia (female); 376, dorsal aspect of left protarsomeres 2 and 3 (female); 377, lateral aspect of left protarsomeres 2 and 3 with cross-hatched areas showing where setae arise (female); 378, left hind tibia (female); 379, part of left side of metasternum showing scales (female); 380, ventrites 1–5, (male); 381, ventrites 4 and 5 (female). Abbreviations: as, appressed scales; ns, no scales.

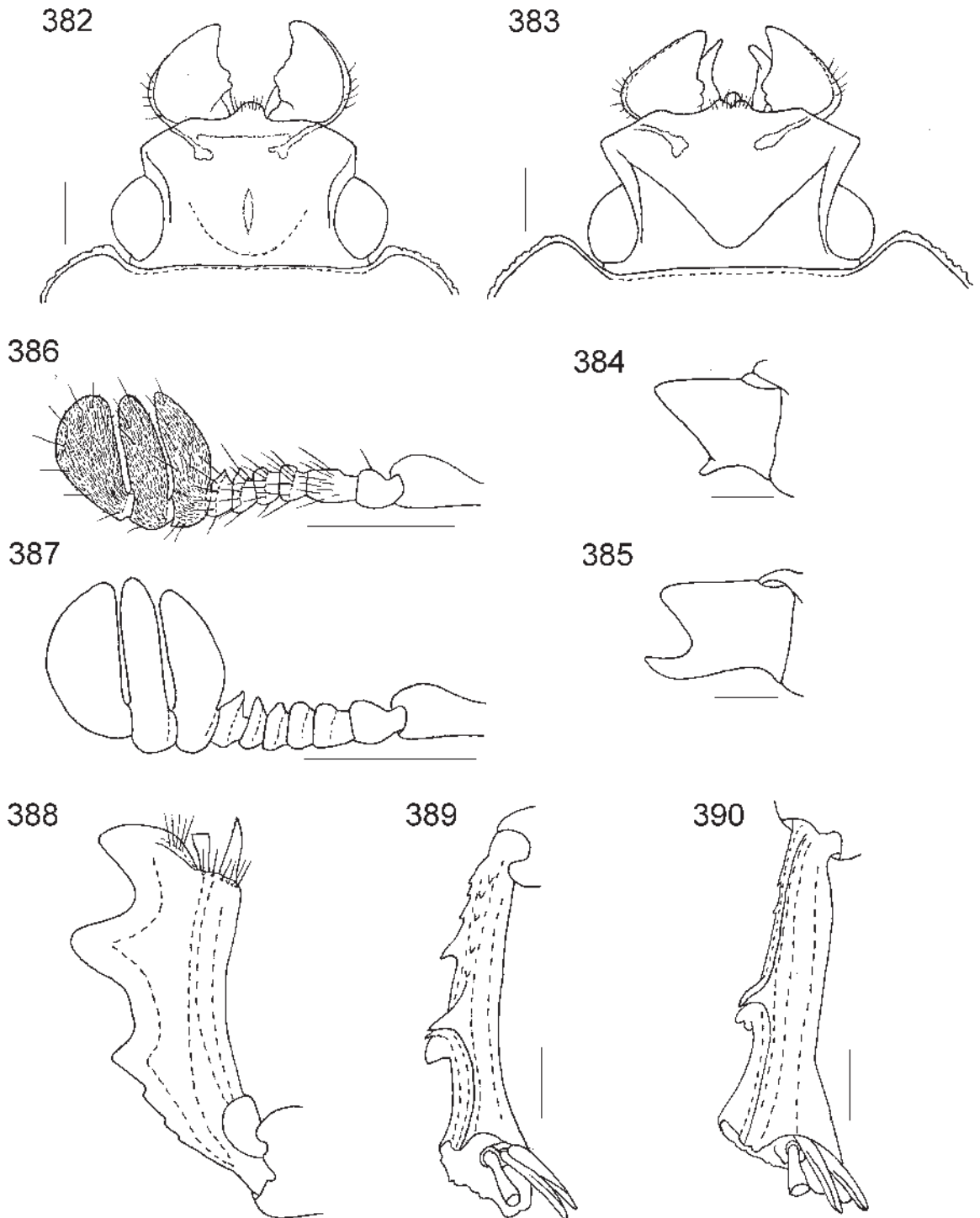


Fig. 382–390 *Dendroblax earlii*: 382, head (male); 383, head (female); 384, left mandible, lateral aspect (male); 385, left mandible, lateral aspect (female); 386, left antenna (male from Te Mata, WO); 387, left antenna (male from Keketahi, TO, vestiture omitted); 388, left front tibia (female); 389, left middle tibia (female); 390, left hind tibia (female).

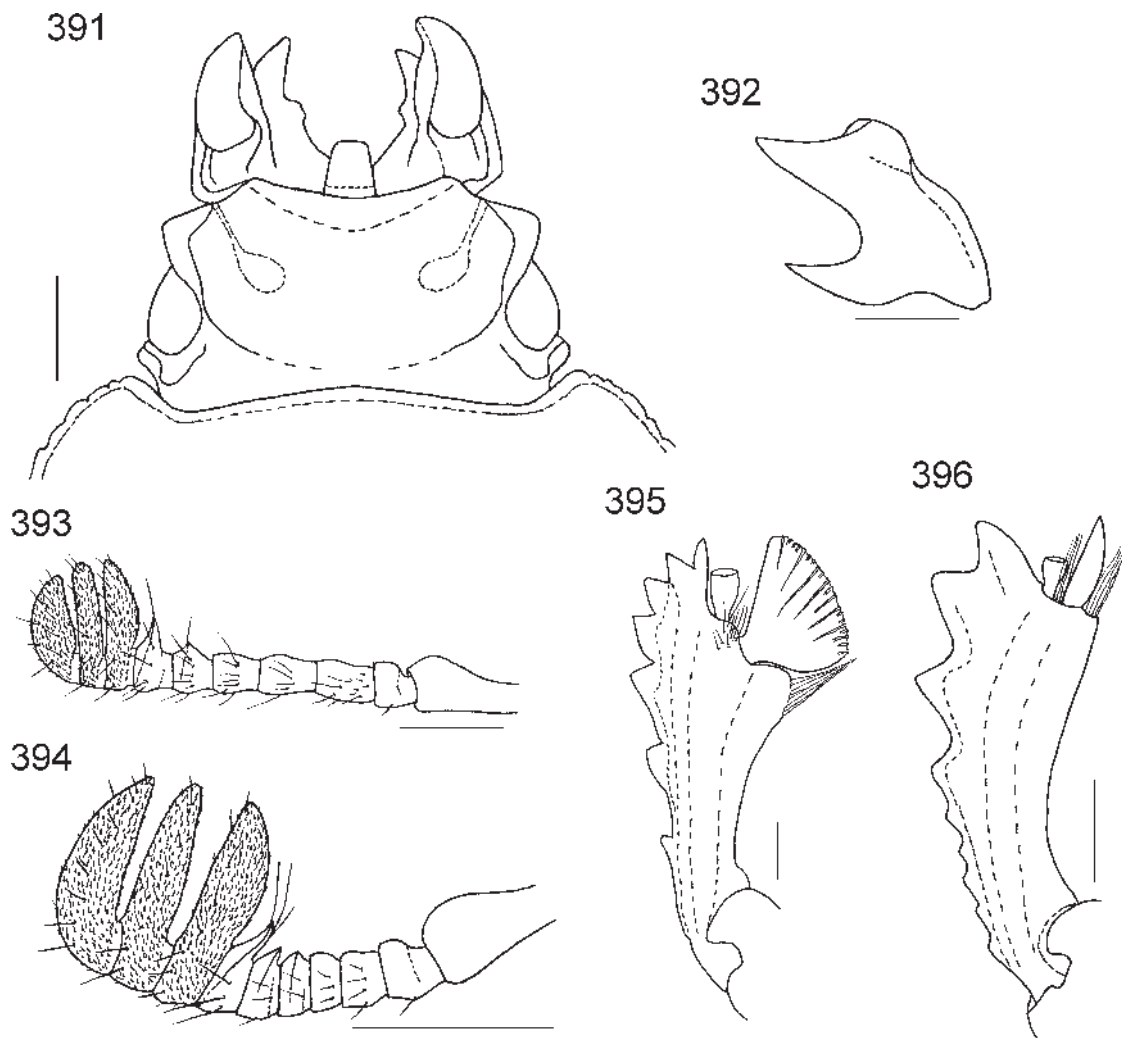


Fig. 391–396 *Lamprima aurata*: 391, head (female, vestiture omitted); 392, left mandible, lateral aspect (female); 393, left antenna (male); 394, left antenna (female); 395, left front tibia (male); 396, left front tibia (female).

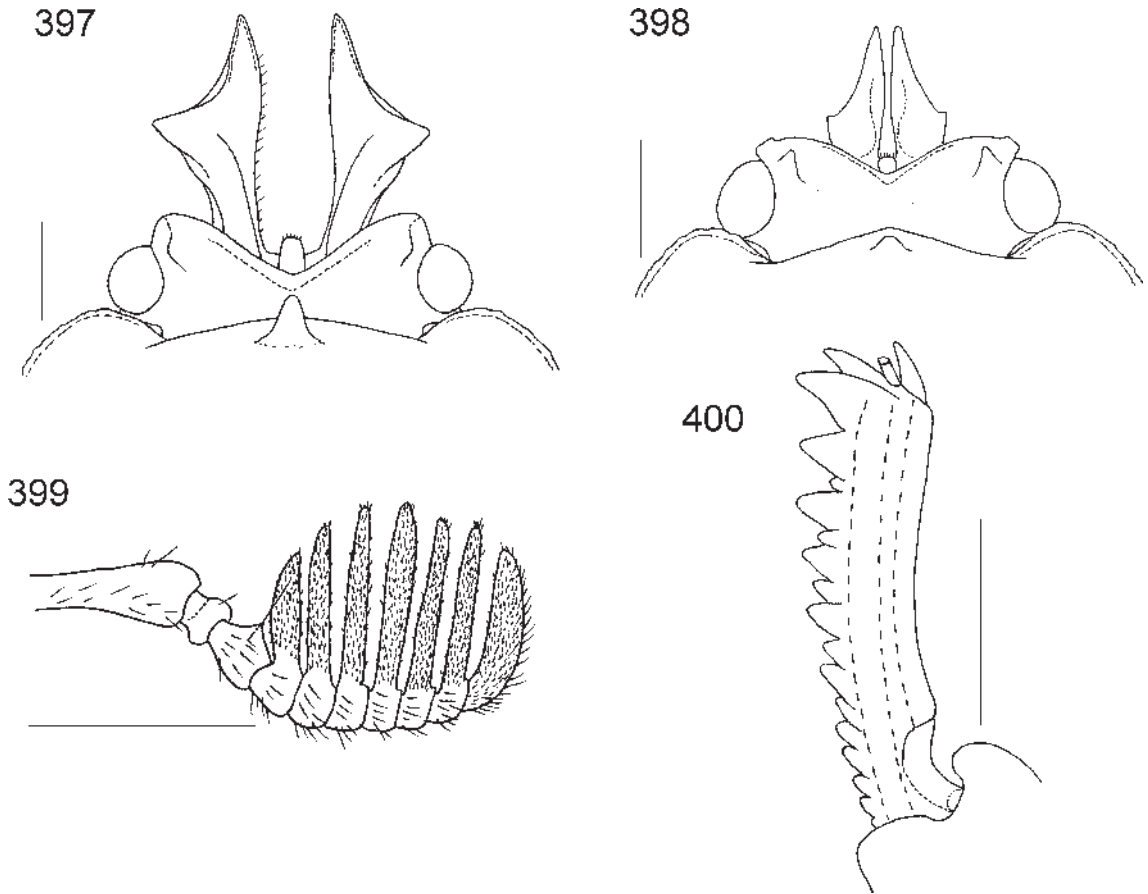


Fig. 397–400 *Syndesus cornutus*: 397, head (male); 398, head (female); 399, right antenna (male); 400, left front tibia (male).

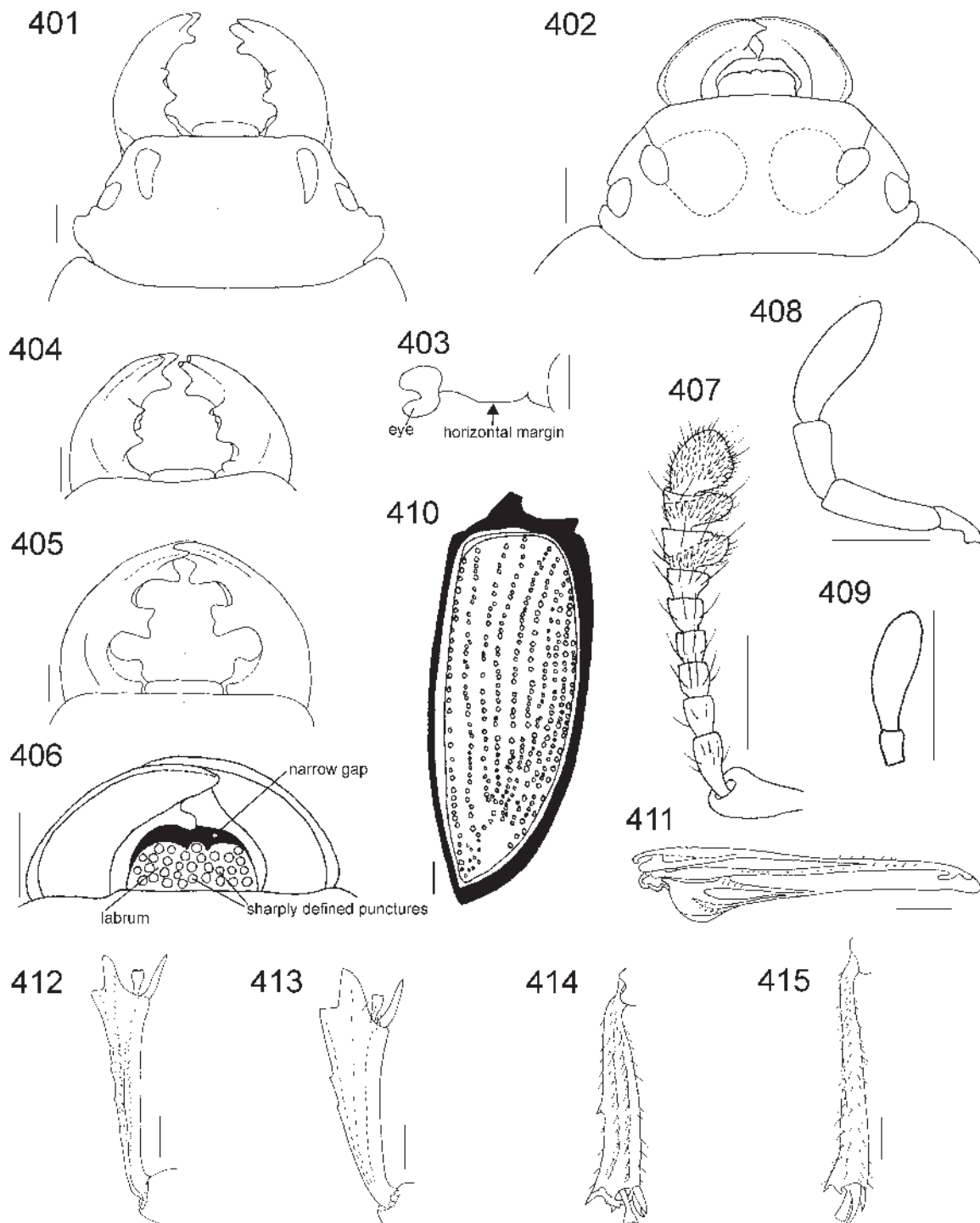


Fig. 401–415 *Geodorcus alsobius*: 401, head (male); 402, head (female); 403, lateral aspect of left eye and horizontal postocular margin (male); 404, mandibles of small male; 405, mandibles of large male; 406, closed mandibles of female showing narrow gap in front of strongly and uniformly punctate labrum (female); 407, left antenna (male); 408, left maxillary palp (male); 409, 2nd and 3rd segments of left labial palp (male); 410, ventral aspect of left elytron showing striae (male); 411, vestigial right wing (male); 412, left front tibia (male); 413, left front tibia (female); 414, left middle tibia (male); 415, left hind tibia (male).

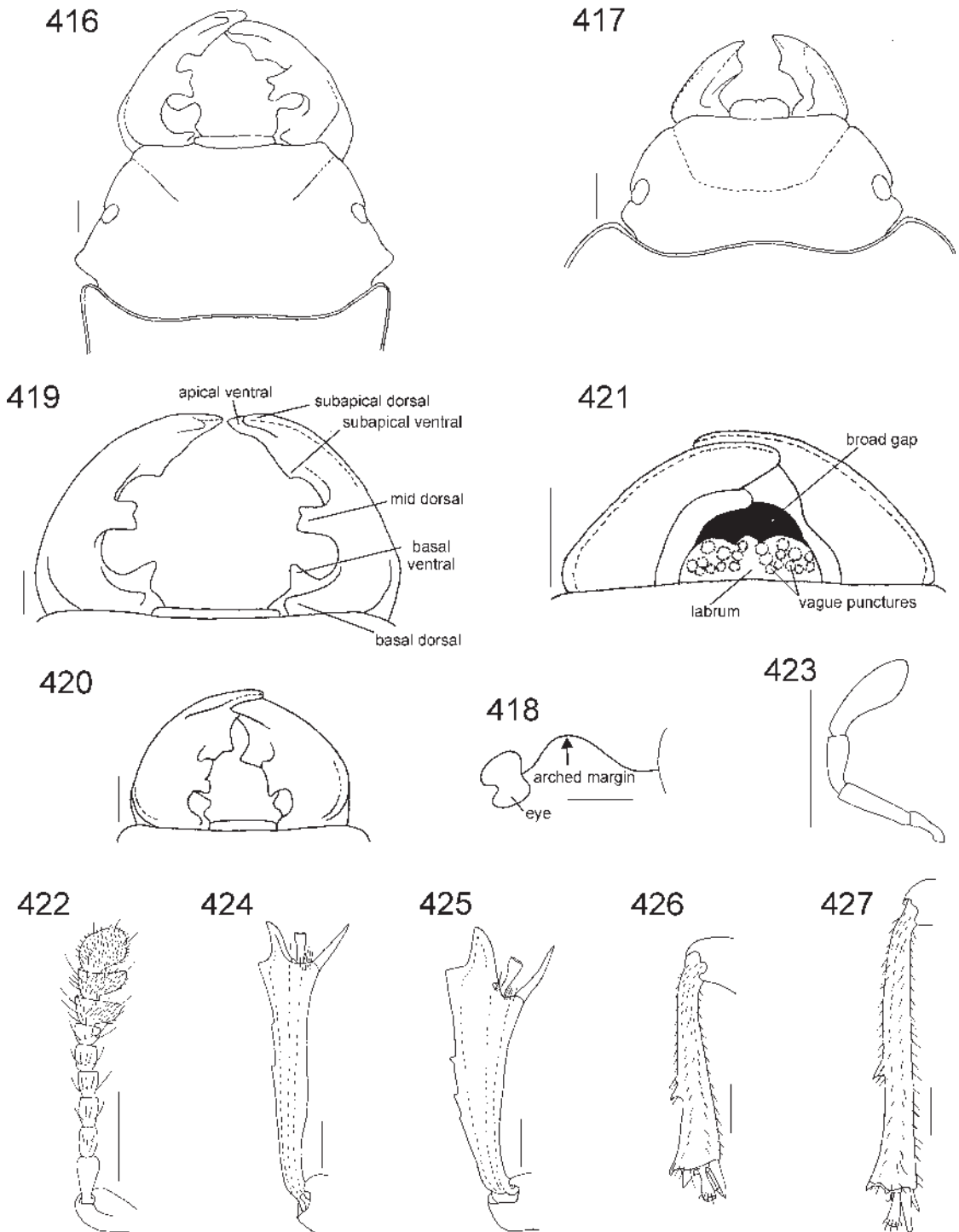


Fig. 416–427 *Geodorcus auriculatus*: 416, head (male); 417, head (female); 418, lateral aspect of left eye and arched postocular margin (male); 419, mandibles of large male; 420, mandibles of small male; 421, closed mandibles of female showing large gap in front of weakly and irregularly punctate labrum; 422, left antenna (male); 423, left maxillary palp (male); 424, left front tibia (male); 425, left front tibia (female); 426, left middle tibia (male); 427, left hind tibia (male).

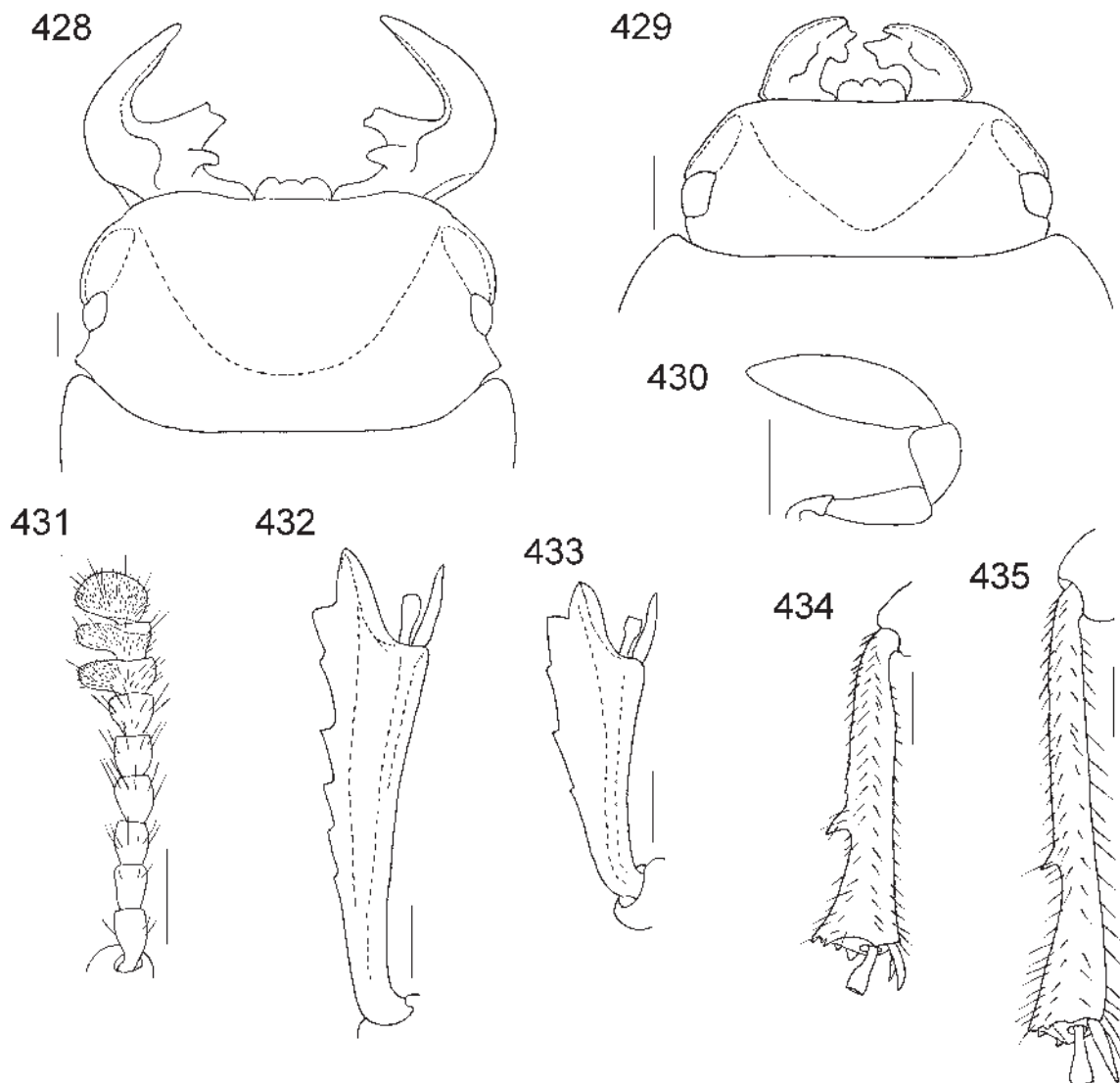


Fig. 428–435 *Geodorcus capito*: 428, head (male); 429, head (female); 430, right maxillary palp (male); 431, right antenna (male); 432, left front tibia (male); 433, left front tibia (female); 434, left middle tibia (male); 435, left hind tibia (male).

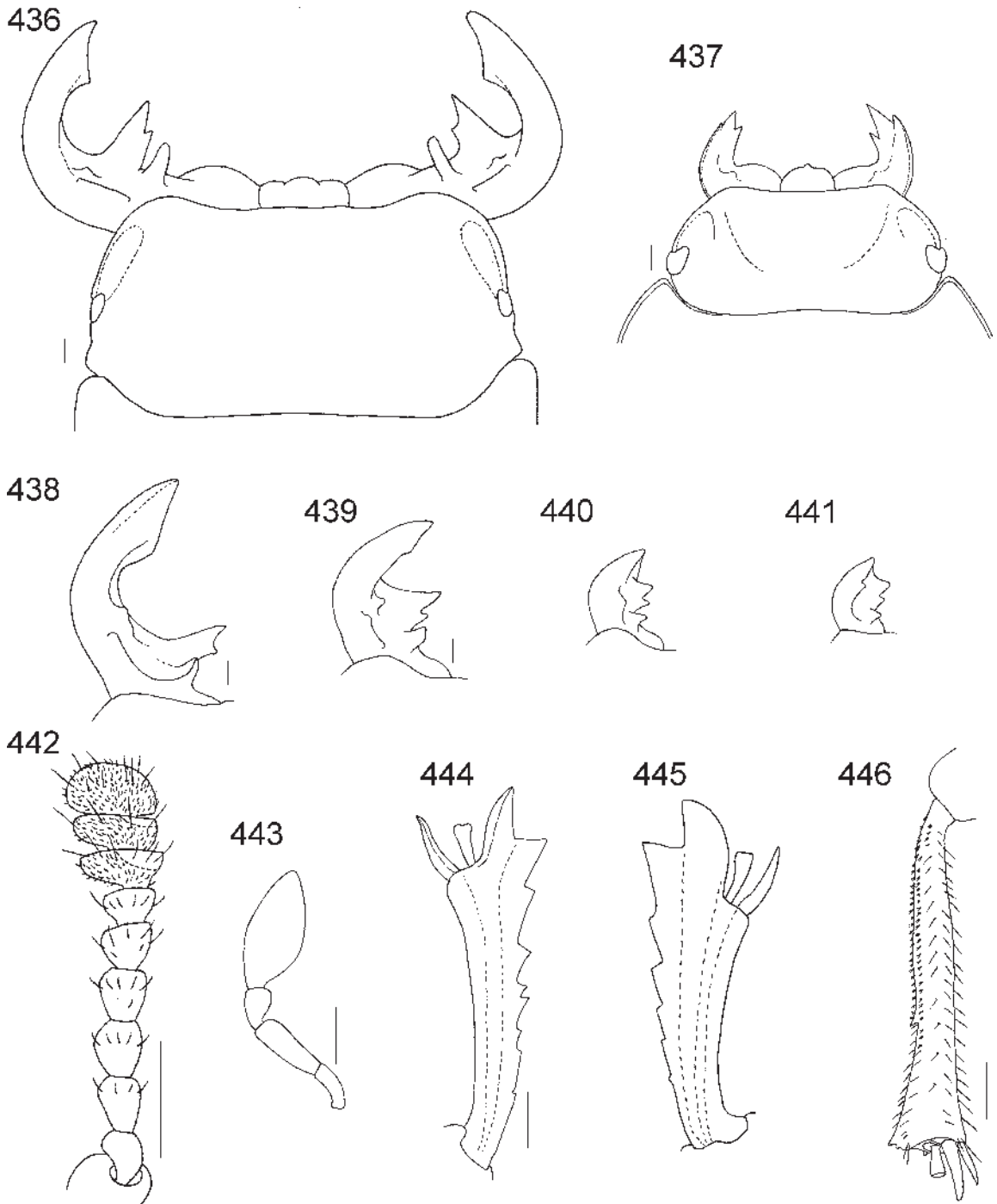


Fig. 436–446 *Geodorcus helmsi*: 436, head (male); 437, head (female); 438–441, left mandibles of large and small males from 3 localities: 438, Big Stage I. (SI), 439, Mt Greenland (WD), 440, 441, Karama (NN); 442, right antenna (male); 443, left maxillary palp (male); 444, right front tibia (male); 445, left front tibia (female); 446, left hind tibia (male).

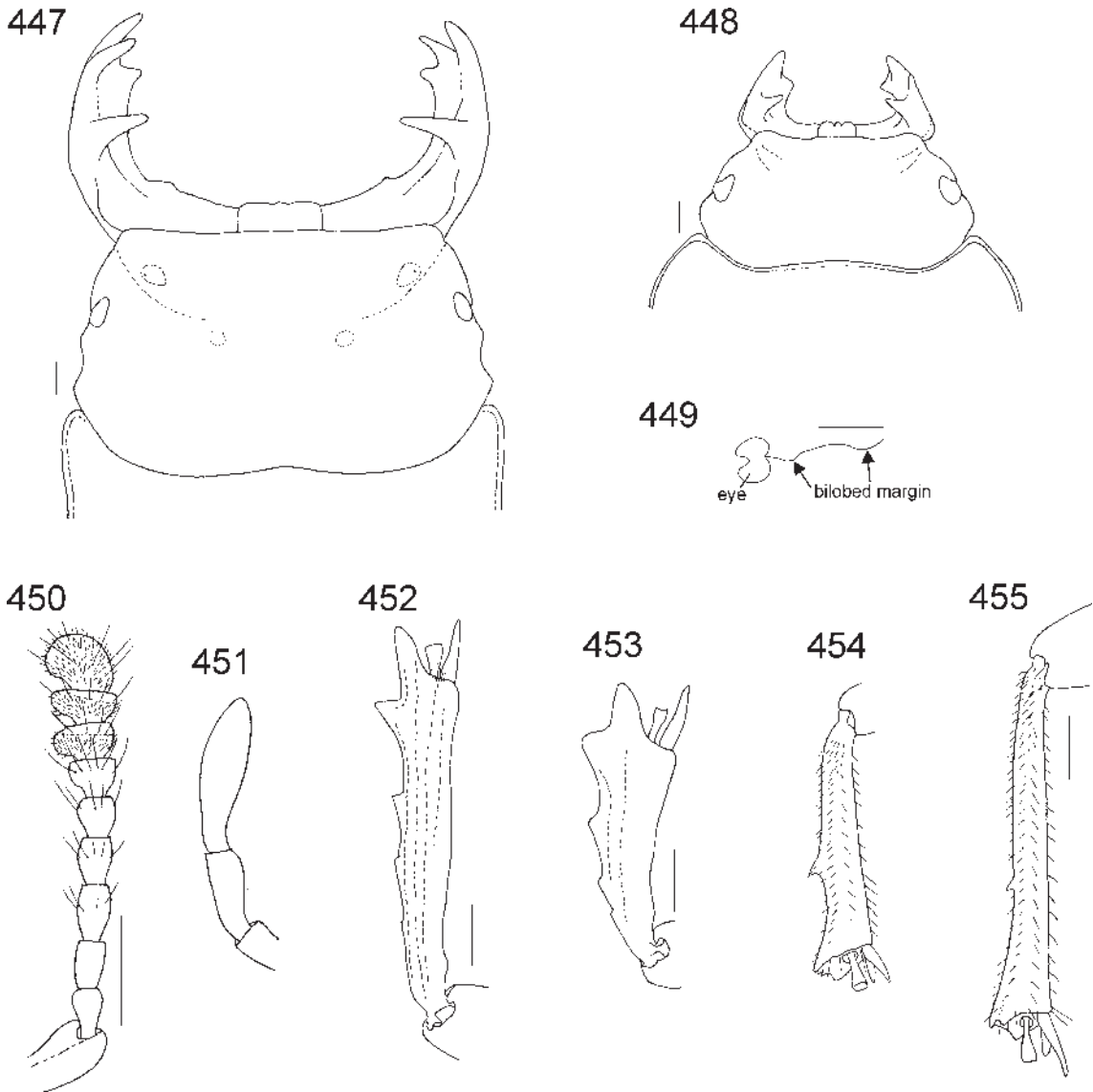


Fig. 447–455 *Geodorcus ithaginis*: 447, head (male); 448, head (female); 449, lateral aspect of left eye and postocular margin showing 2 small horizontal lobes (male); 450, right antenna (male); 451, left maxillary palp (male); 452, left front tibia (male); 453, left front tibia (female); 454, left middle tibia (male); 455, left hind tibia (male).

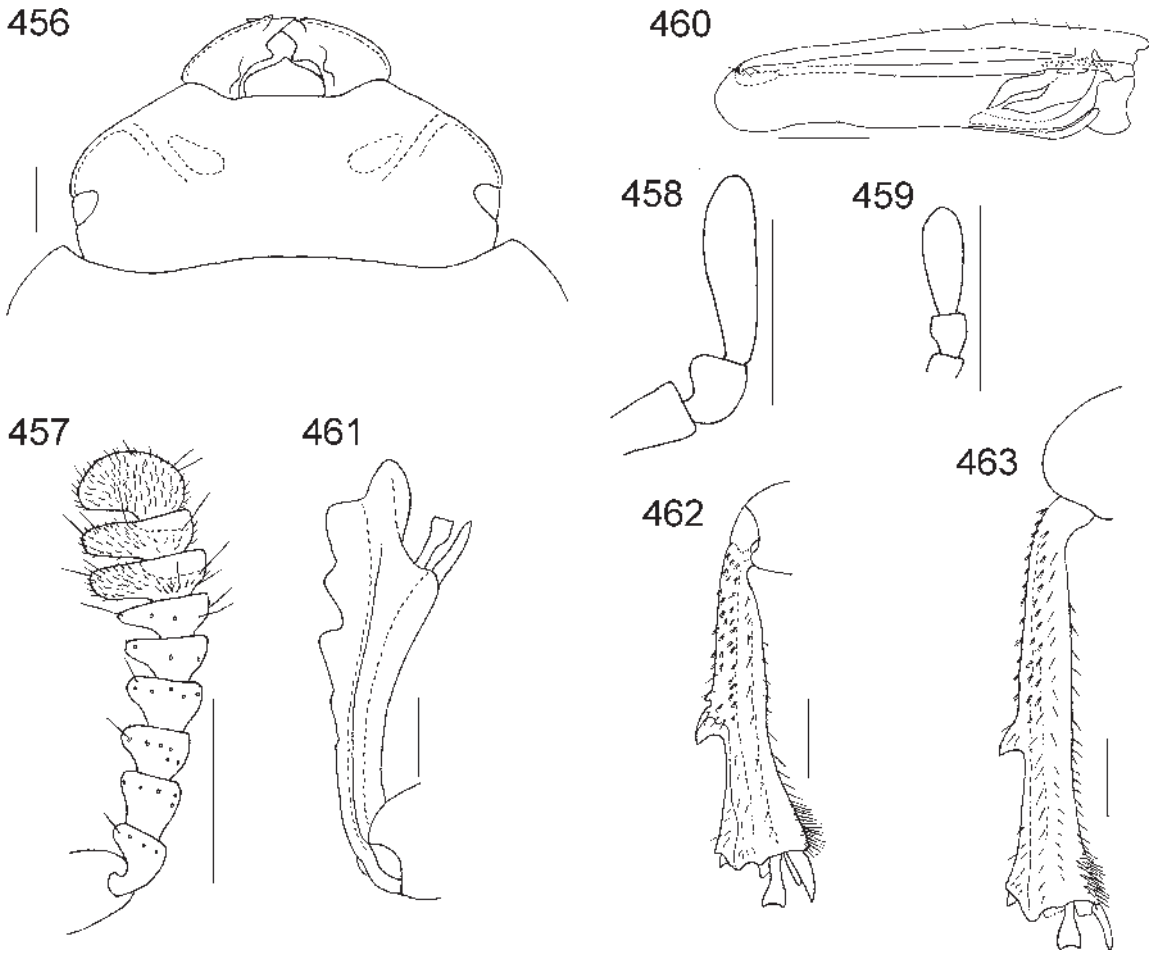


Fig. 456–463 *Geodorcus montivagus*: All figures are of the holotype female. 456, head; 457, right antenna; 458, left maxillary palp; 459, left labial palp; 460, left wing; 461, left front tibia; 462, left middle tibia; 463, left hind tibia.

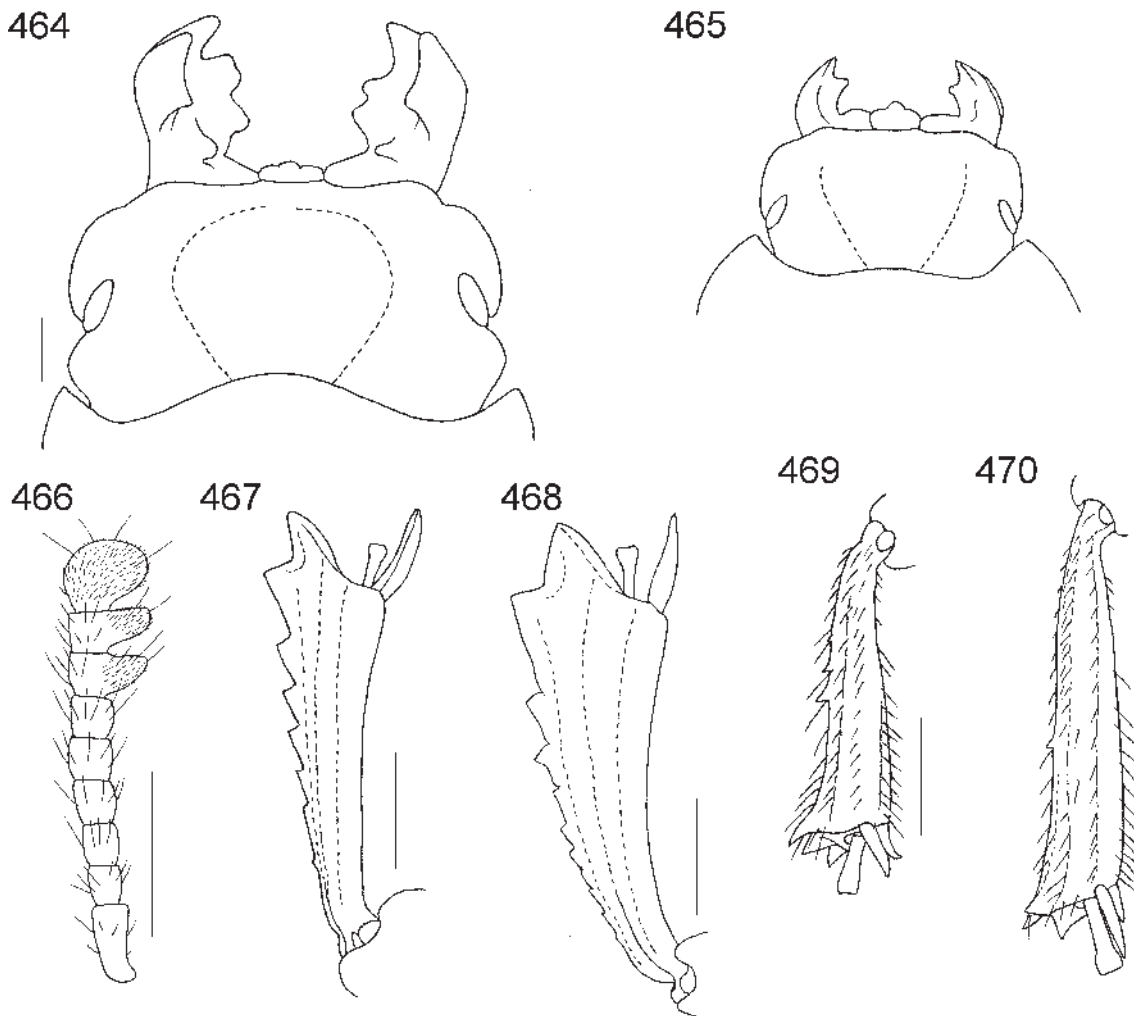
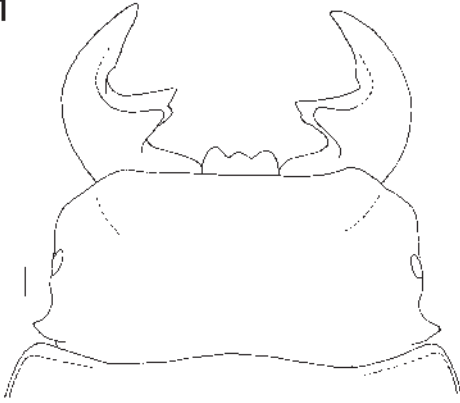
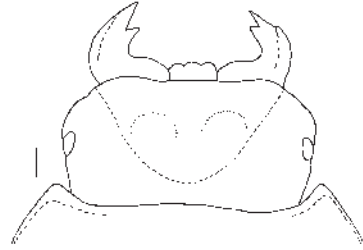


Fig. 464–470 *Geodorcus novaezealandiae*: 464, head (male); 465, head (female); 466, left antenna, scape omitted (male); 467, left front tibia (male); 468, left front tibia (female); 469, left middle tibia (male); 470, left hind tibia (male).

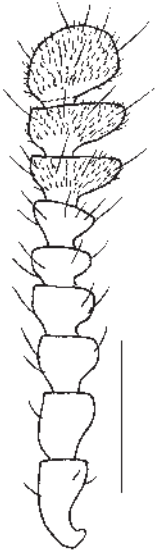
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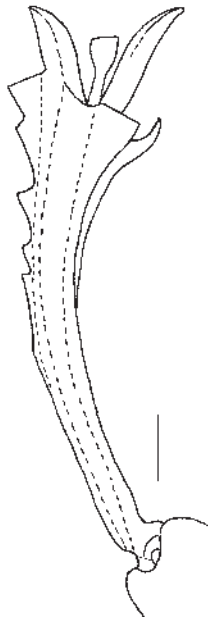
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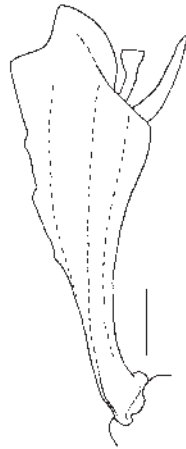
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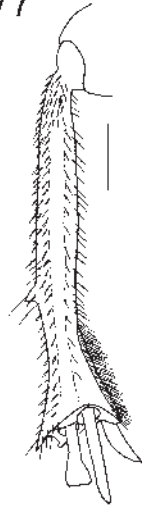


Fig. 471–477 *Geodorcus philpotti*: 471, head (male); 472, head (female); 473, left antenna, scape omitted (male); 474, left front tibia (male); 475, left front tibia (female); 476, left middle tibia (male), 477, left hind tibia (male).

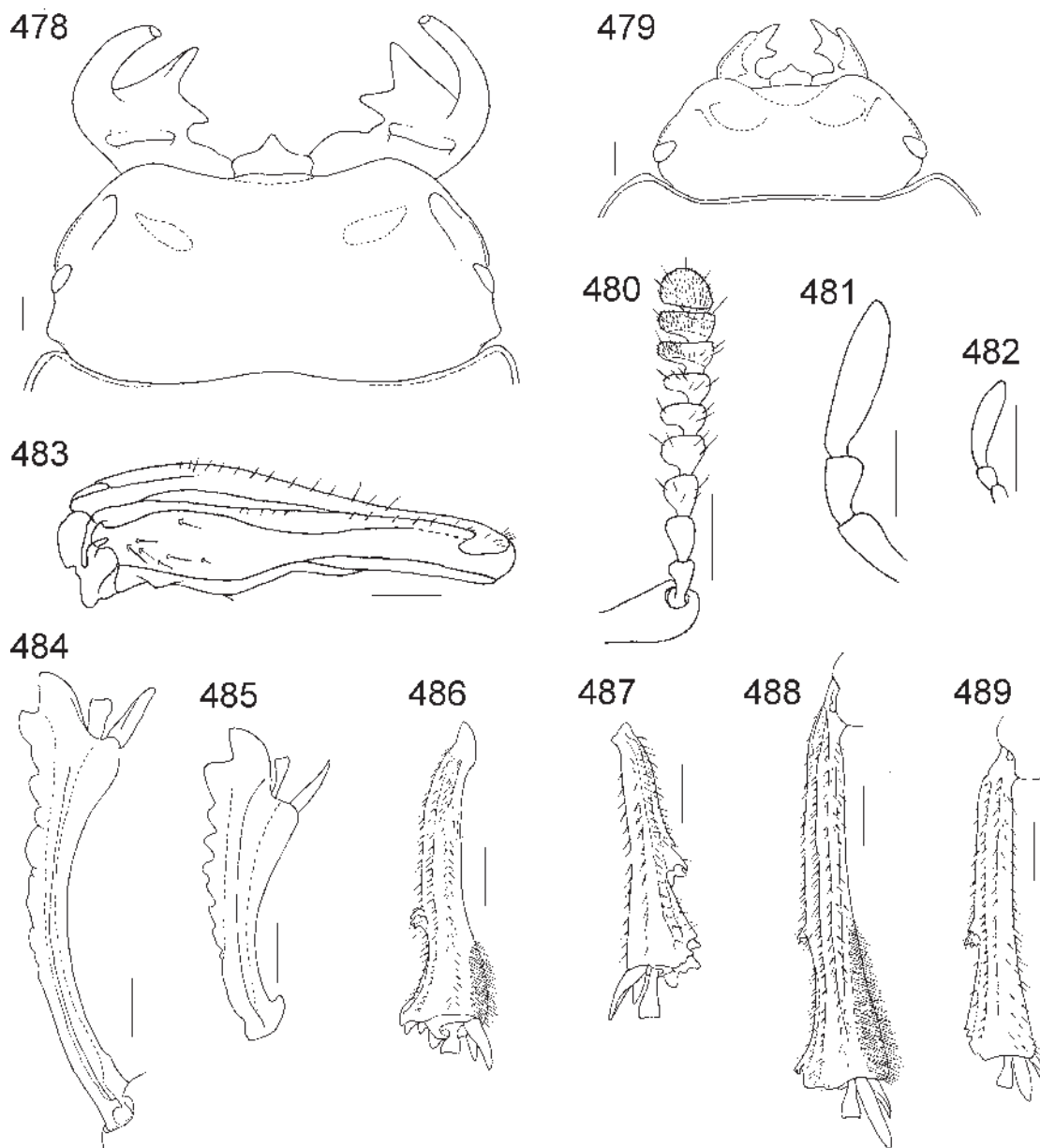


Fig. 478–489 *Geodorcus servandus*: 478, head (male); 479, head (female); 480, right antenna (male); 481, left maxillary palp (male); 482, left labial palp (male); 483, right wing (male); 484, left front tibia (male); 485, left front tibia (female); 486, left middle tibia (male); 487, right middle tibia (female); 488, left hind tibia (male); 489, left hind tibia (female).

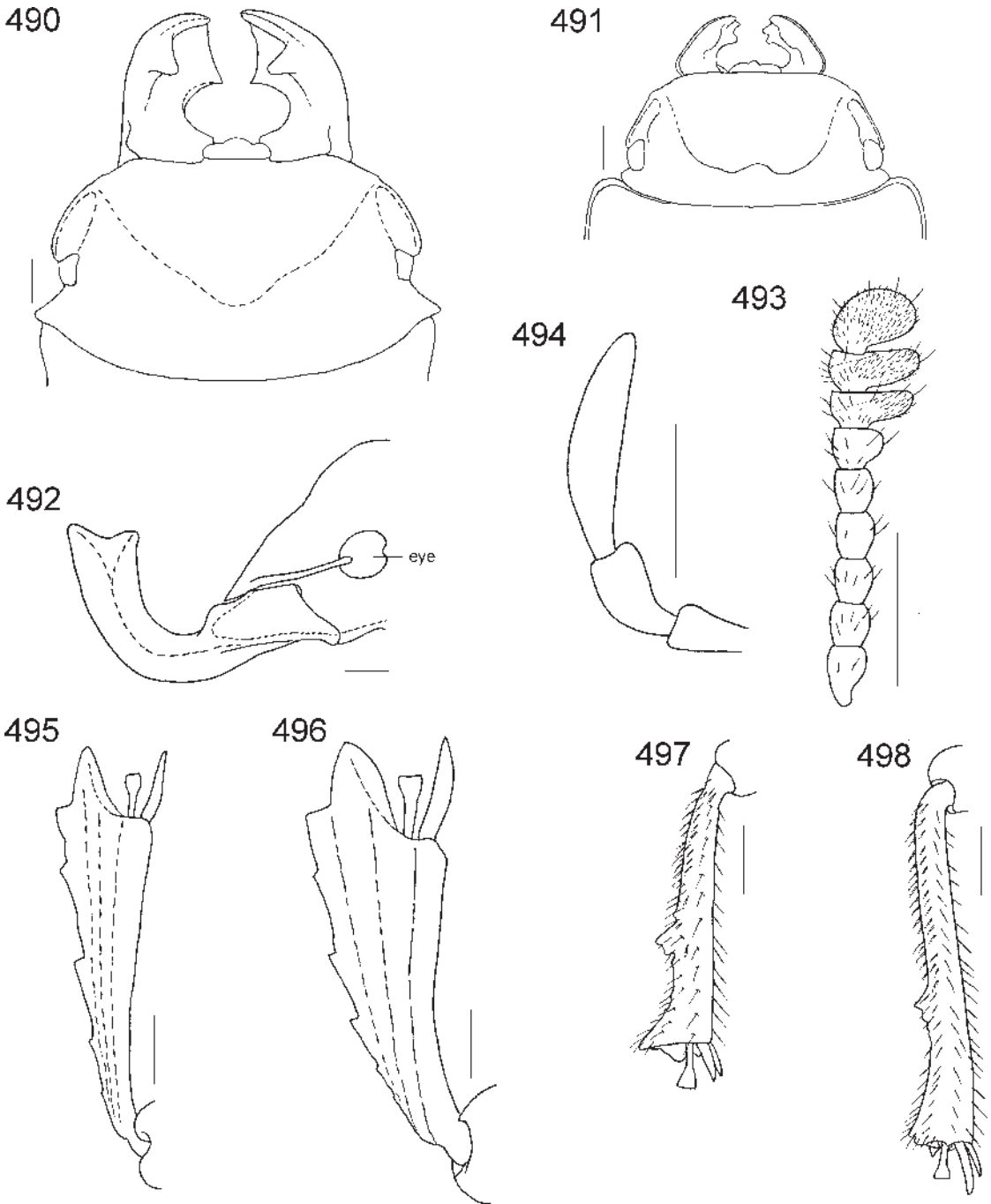


Fig. 490–498 *Geodorcus sororum*: 490, head (male); 491, head (female); 492, lateral aspect of left mandible and head (male); 493, left antenna, scape omitted (male); 494, left maxillary palp (male); 495, left front tibia (male); 496, left front tibia (female); 497, left middle tibia (male); 498, left hind tibia (male).

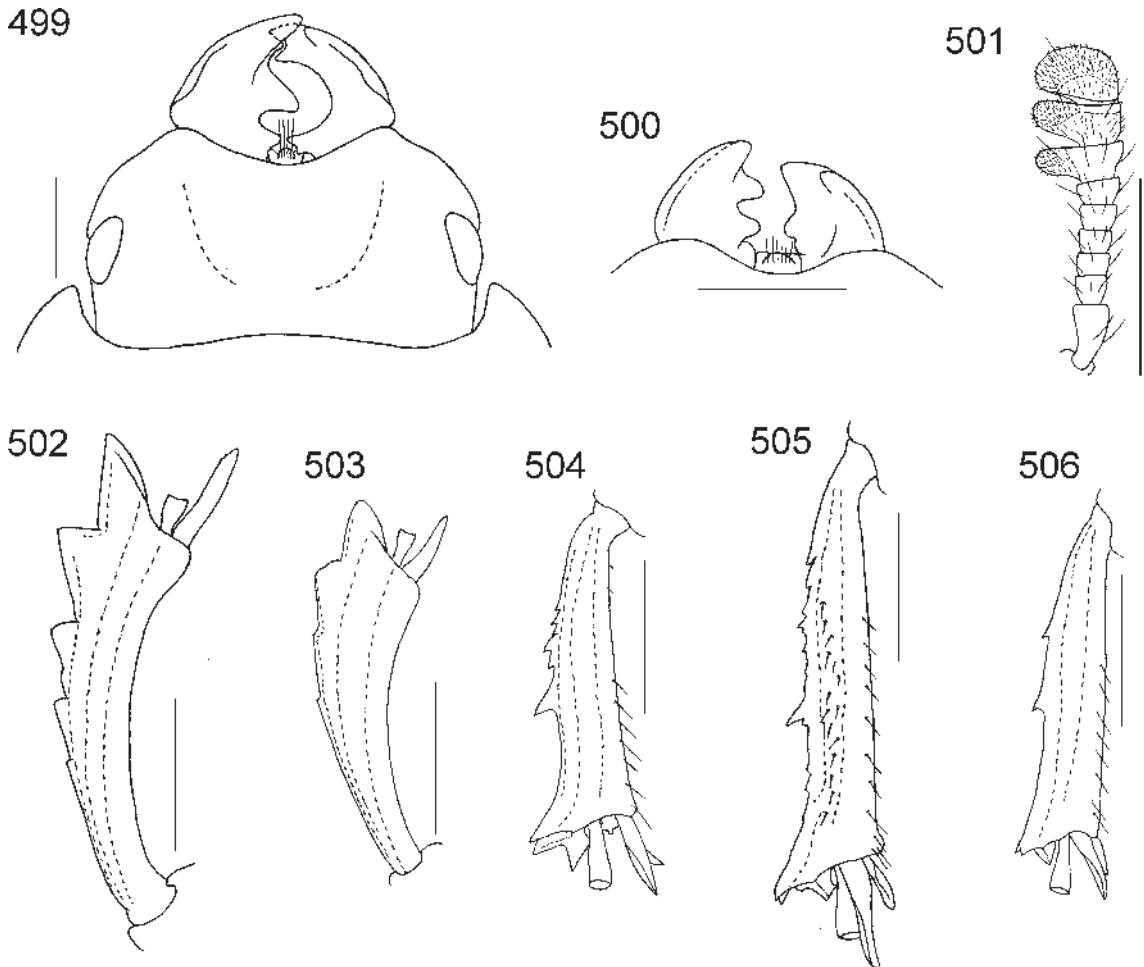
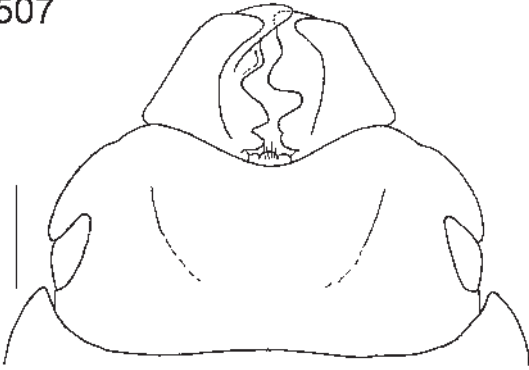
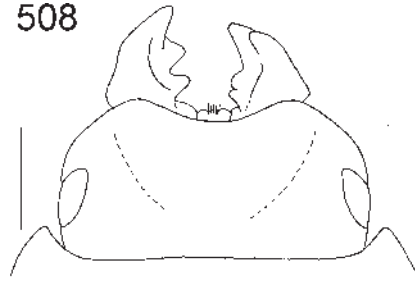


Fig. 499–506 *Paralissotes mangonuiensis*: 499, head (male); 500, mandibles and front of head (female); 501, right antenna, scape omitted (male); 502, left front tibia (male); 503, left front tibia (female); 504, left middle tibia (male); 505, left hind tibia (male); 506, left hind tibia (female).

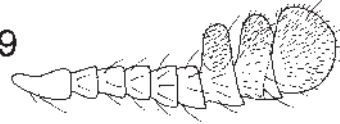
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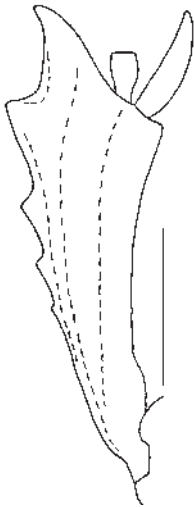
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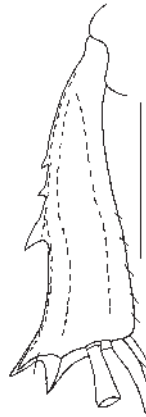
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Fig. 507–513 *Paralissotes oconnori*: 507, head (male); 508, head (female); 509, right antenna, scape omitted (male); 510, left front tibia (male); 511, left middle tibia (male); 512, left hind tibia (male); 513, left hind tibia (female).

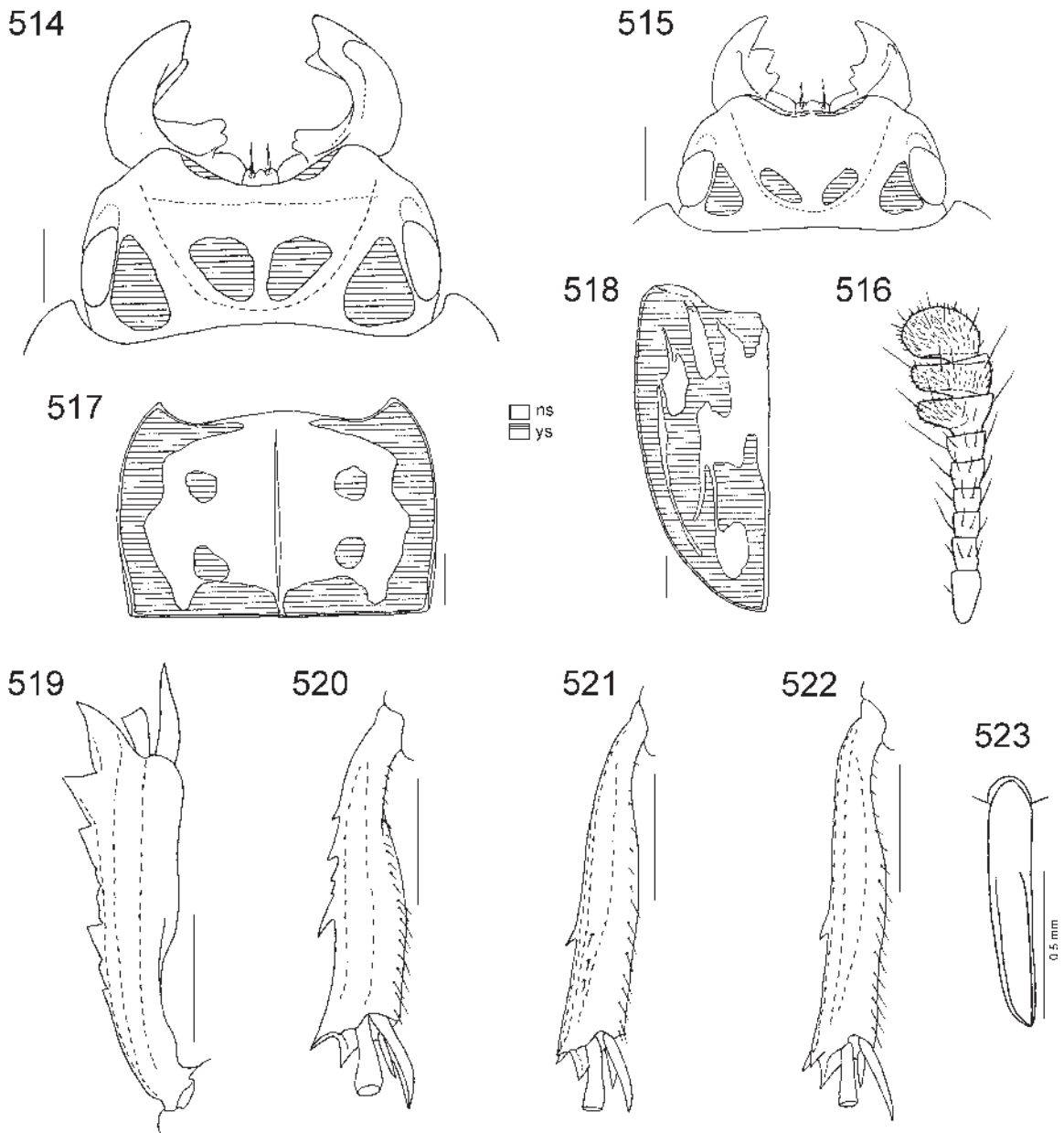


Fig. 514–523 *Paralissotes planus*: 514, head (male); 515, head (female); 516, right antenna, scape omitted (male); 517, pronotum (male); 518, left elytron (male); 519, left front tibia (male); 520, left middle tibia (male); 521, left hind tibia (male); 522, left hind tibia (female); 523, anterior aspect of posteroventral spur on hind leg (male). Abbreviations: ns, no scales; ys, yellowish scales.

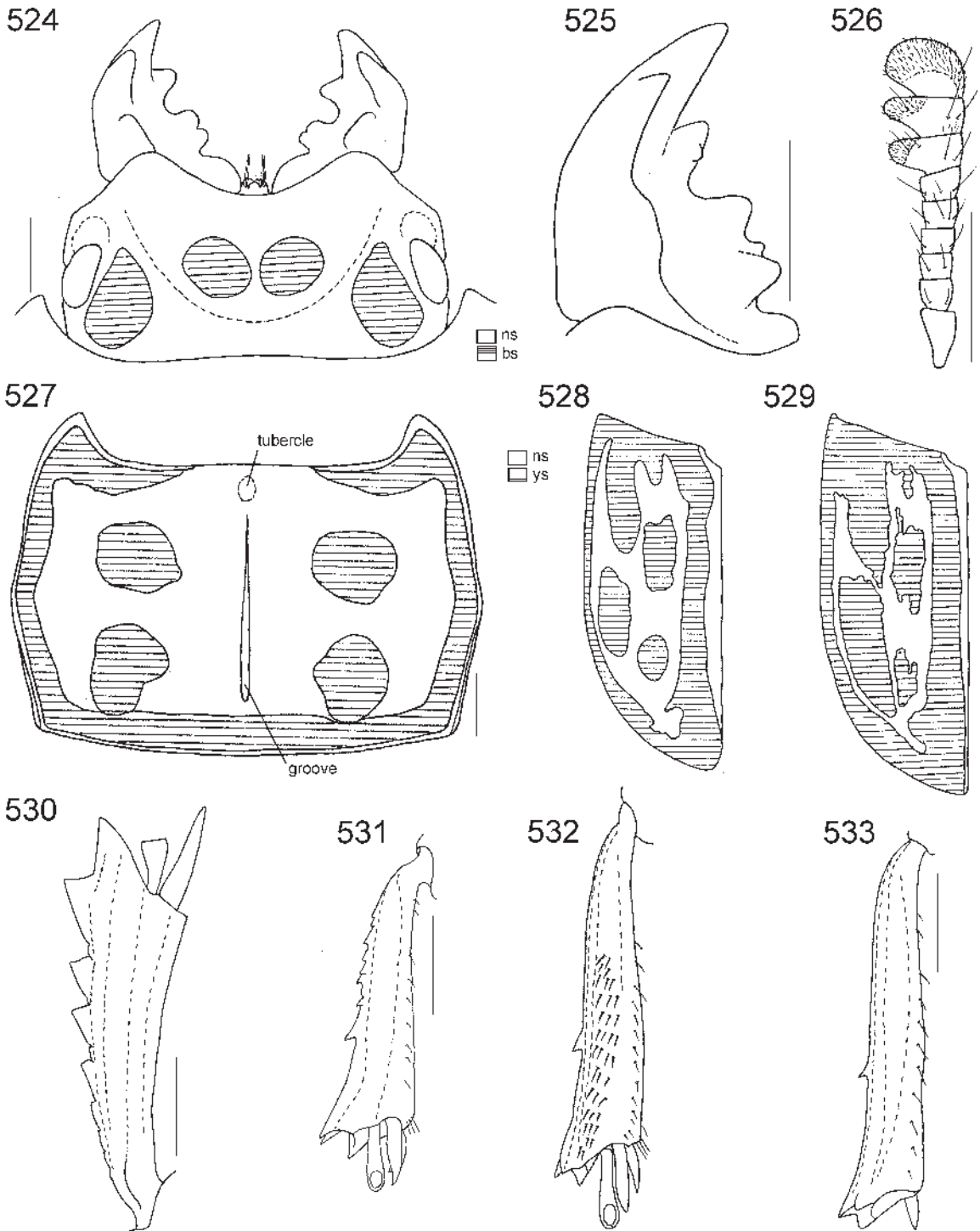
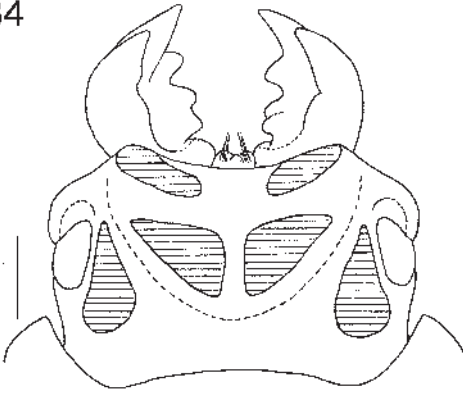
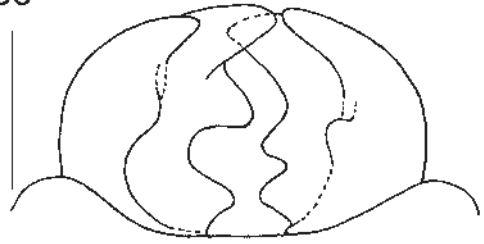


Fig. 524–533 *Paralissotes reticulatus*: 524, head (female); 525, left mandible (male); 526, right antenna, scape omitted (female); 527, pronotum (female); 528, left elytron (male) and 529, left elytron (female) showing variation in squamose areas; 530, left front tibia (male); 531, left middle tibia (male); 532, left hind tibia (male); 533, left hind tibia (female). Abbreviations: bs, brownish scales; ns, no scales; ys, yellowish scales.

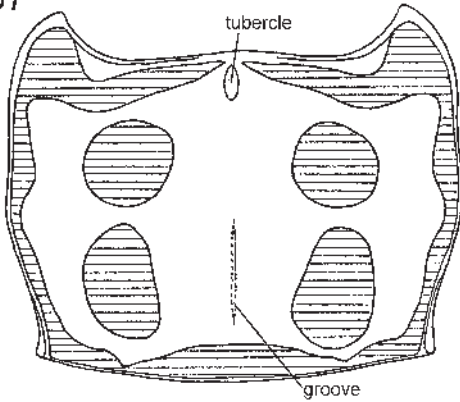
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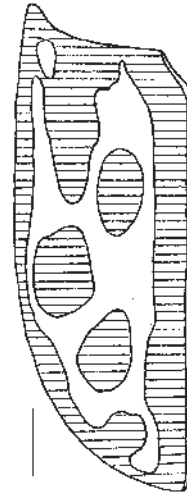


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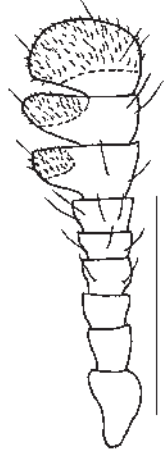


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□ ns
▨ ys



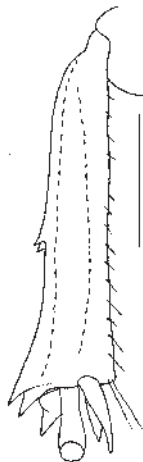
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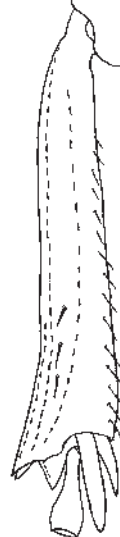
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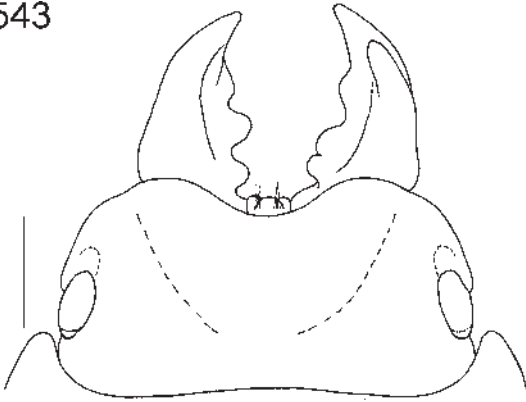


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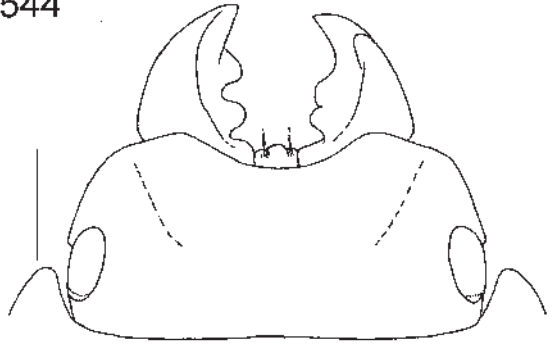


Fig. 534–542 *Paralissotes rufipes*: 534, head (male); 535, mandibles (female); 536, right antenna, scape omitted (male); 537, pronotum (male); 538, left elytron (male); 539, left front tibia (male); 540, left middle tibia (male); 541, left hind tibia (male); 542, left hind tibia (female). Abbreviations: ns, no scales; ys, yellowish scales.

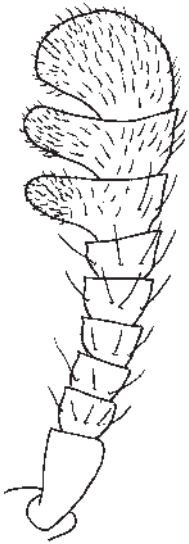
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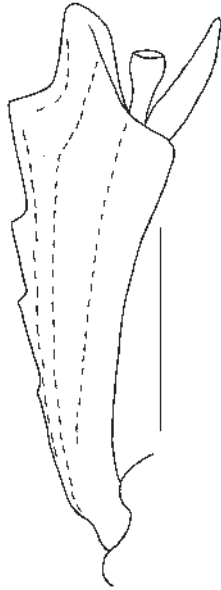
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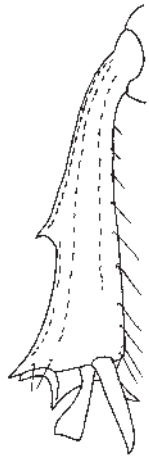
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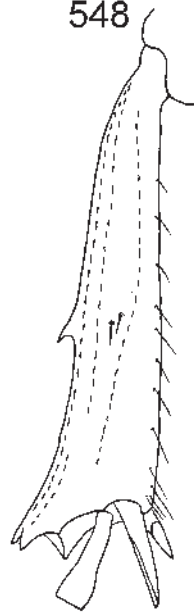
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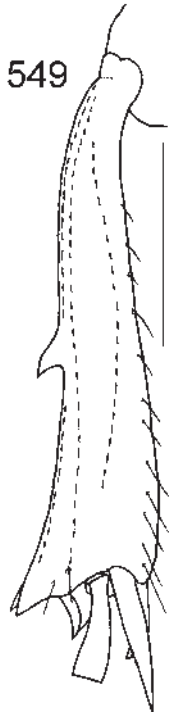


Fig. 543–549 *Paralissotes stewarti*: 543, head (male); 544, head (female); 545, right antenna (male); 546, left front tibia (male); 547, left middle tibia (male); 548, left hind tibia (male); 549, left hind tibia (female).

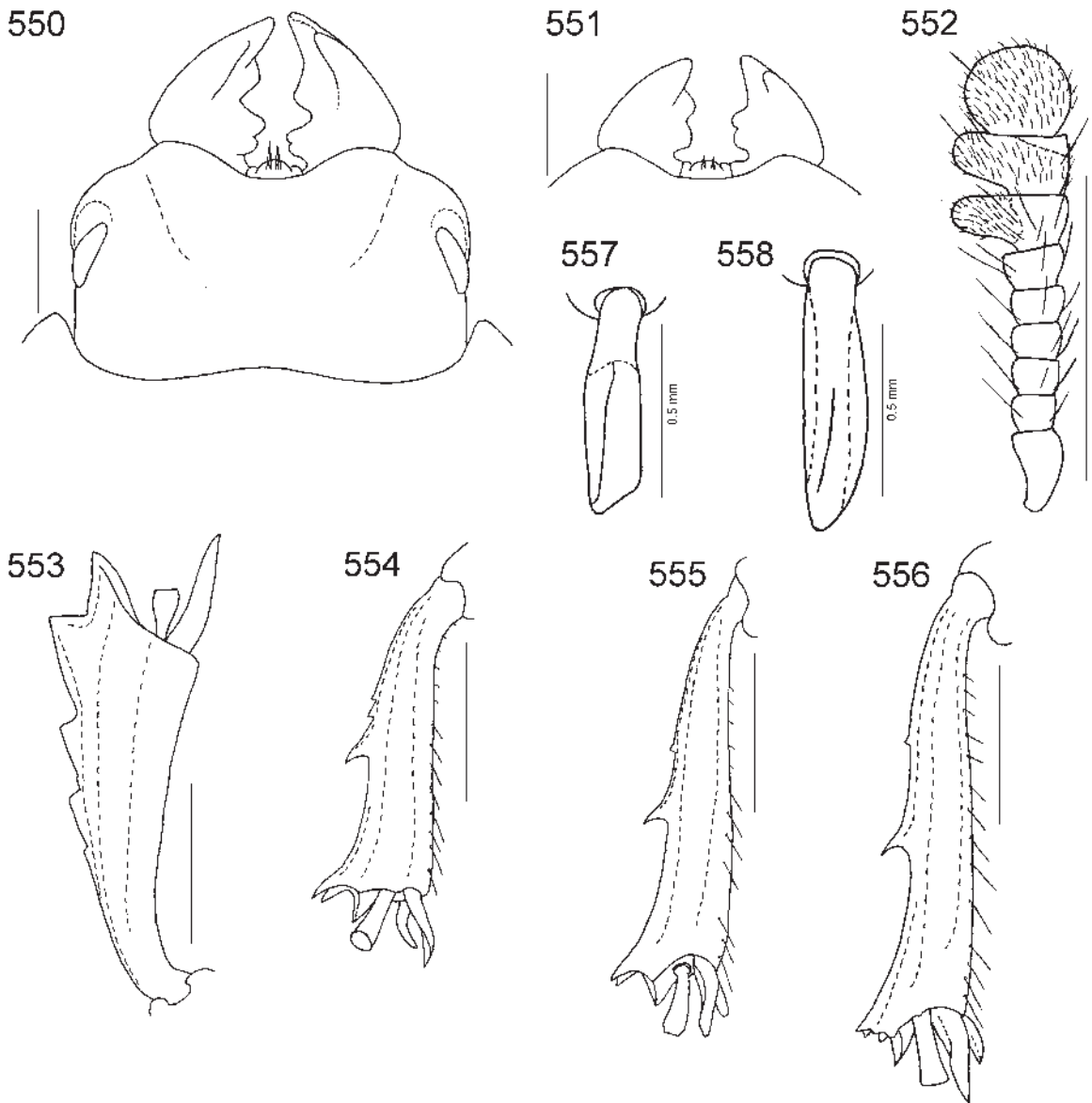


Fig. 550–558 *Paralissotes triregius*: 550, head (male); 551, mandibles (female); 552, right antenna, scape omitted (male); 553, left front tibia (male); 554, left middle tibia ((male); 555, left hind tibia (male); 556, left hind tibia (female); 557, anterior aspect of posteroventral spur on hind leg (male); 558, anterior aspect of posteroventral spur on hind leg (female).

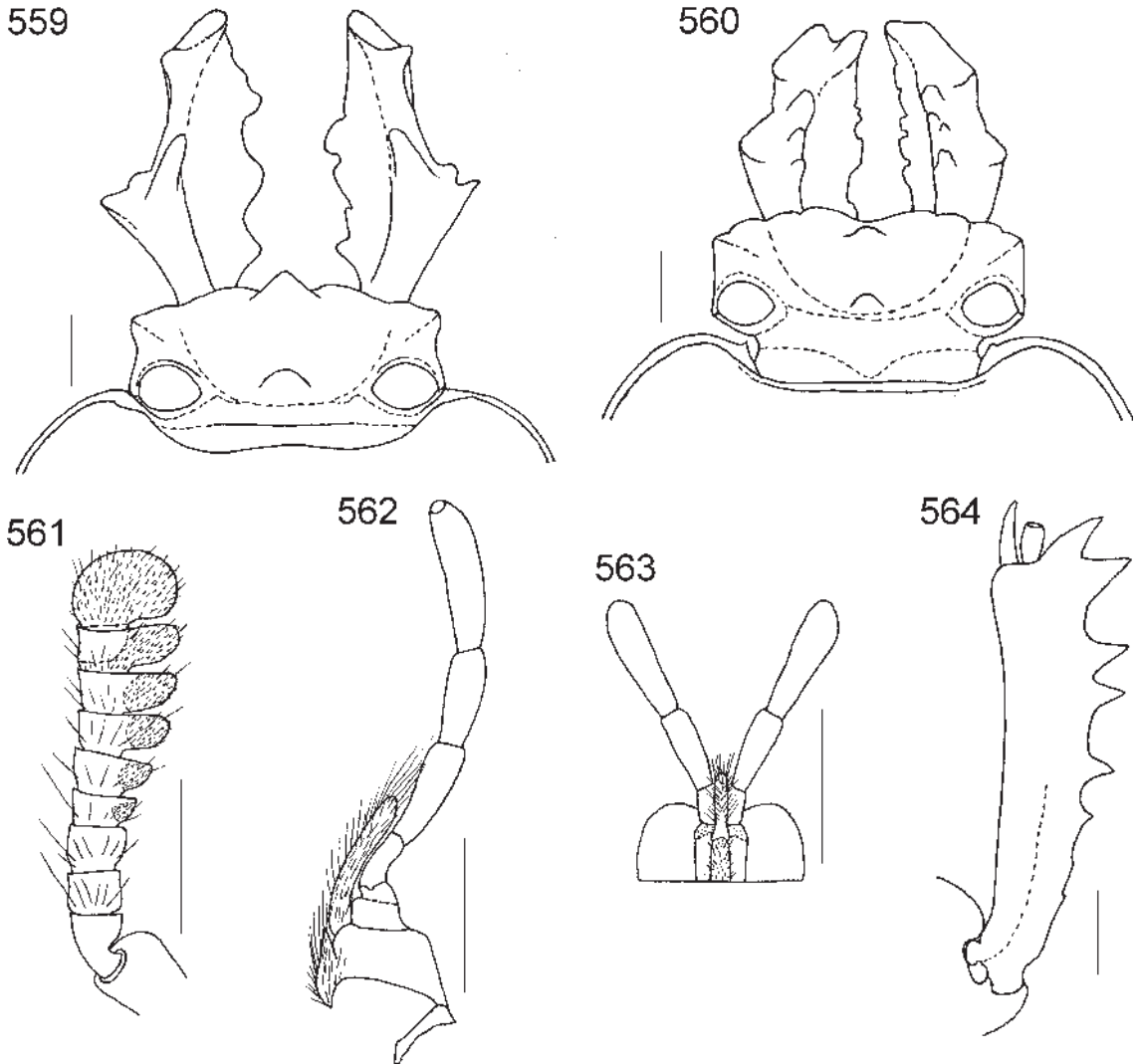


Fig. 559–564 *Ryssonotus nebulosus*: 559, head (male, dense setae on mandibles omitted); 560, head (female, dense setae on mandibles omitted); 561, left antenna (female); 562, ventral aspect of right maxilla (female); 563, labium (female); 564, right front tibia (male).

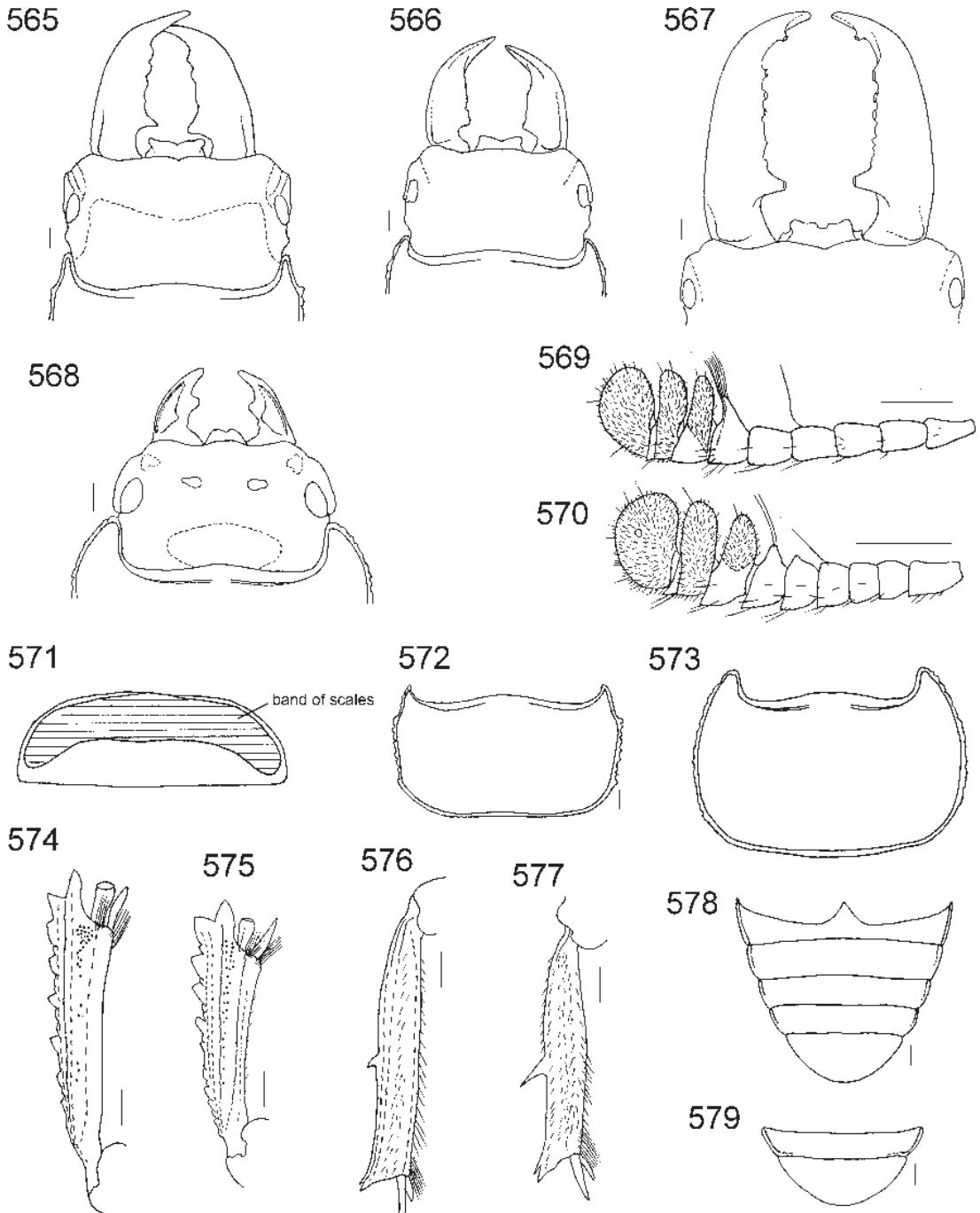


Fig. 565–579 *Serrognathus sika*: 565, head (male, Pakuranga, N.Z.); 566, head (small male, Taiwan); 567, part of head (large male, Taiwan); 568, head (female, Taiwan); 569, left antenna, scape omitted (male, Pakuranga); 570, left antenna, scape omitted (female, Taiwan); 571, ventral surface of mentum with cross hatching indicating distal band of long, funnel-shaped, erect scales, (male, Pakuranga); 572, pronotum (male, Pakuranga); 573, pronotum (female, Taiwan); 574, left front tibia (male, Pakuranga); 575, left front tibia (female, Taiwan); 576, left hind tibia (male, Pakuranga); 577, left hind tibia (female, Taiwan); 578, abdominal ventrites 1–5 (male, Pakuranga); 579, abdominal ventrites 4 and 5 (female, Taiwan).

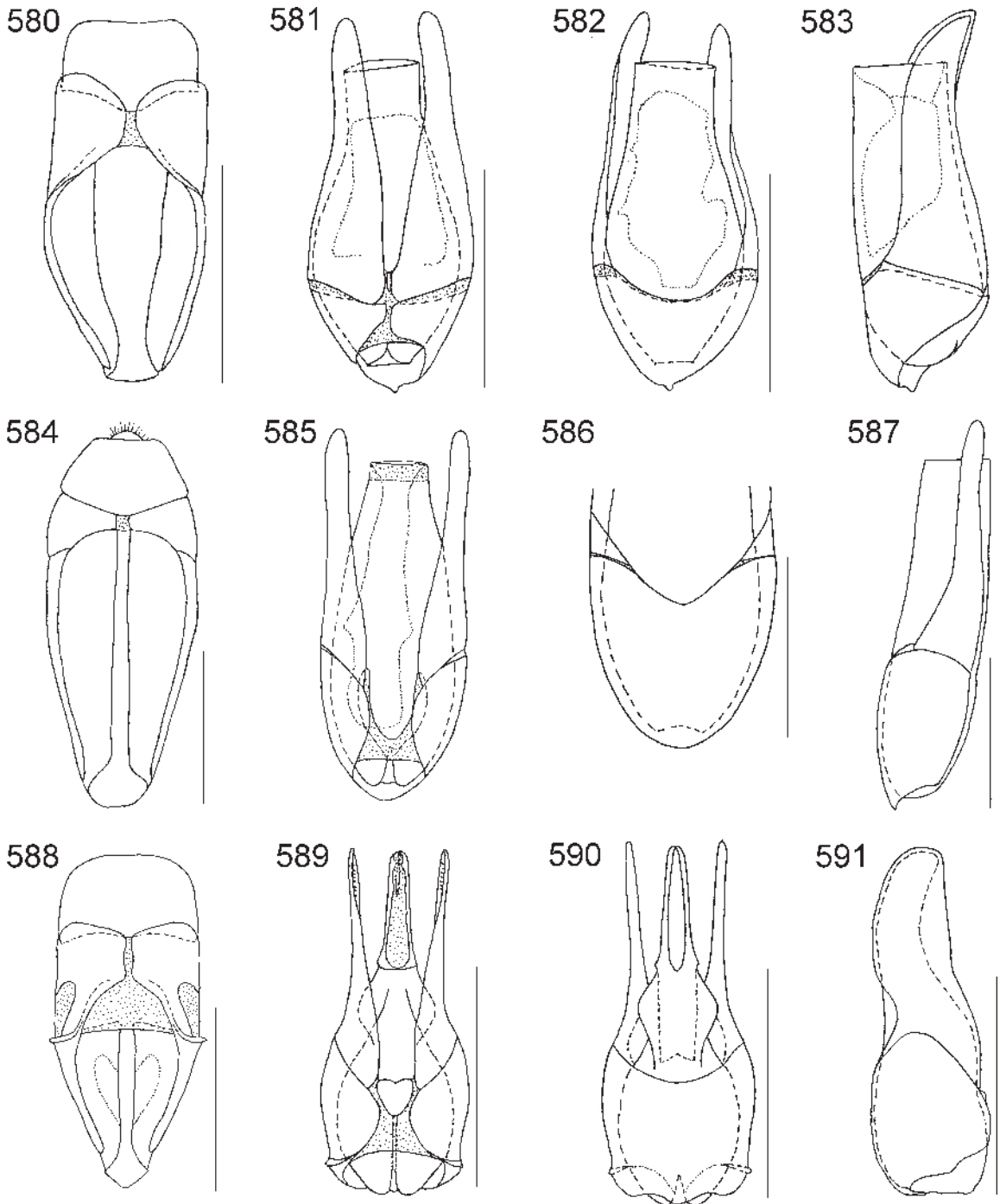


Fig. 580–591 Male genitalia: 580–583: *Holloceratognathus cylindricus*: 580, ninth abdominal segment (dorsal); 581, aedeagus (dorsal); 582, aedeagus (ventral); 583, aedeagus (lateral). 584–587: *Holloceratognathus helotoides*: 584, ninth abdominal segment (dorsal); 585, aedeagus (dorsal); 586, basal piece and bases of parameres (ventral); 587, aedeagus (lateral). 588–591: *Holloceratognathus passaliformis*: 588, ninth abdominal segment (dorsal); 589, aedeagus (dorsal); 590, aedeagus (ventral); 591, aedeagus (lateral).

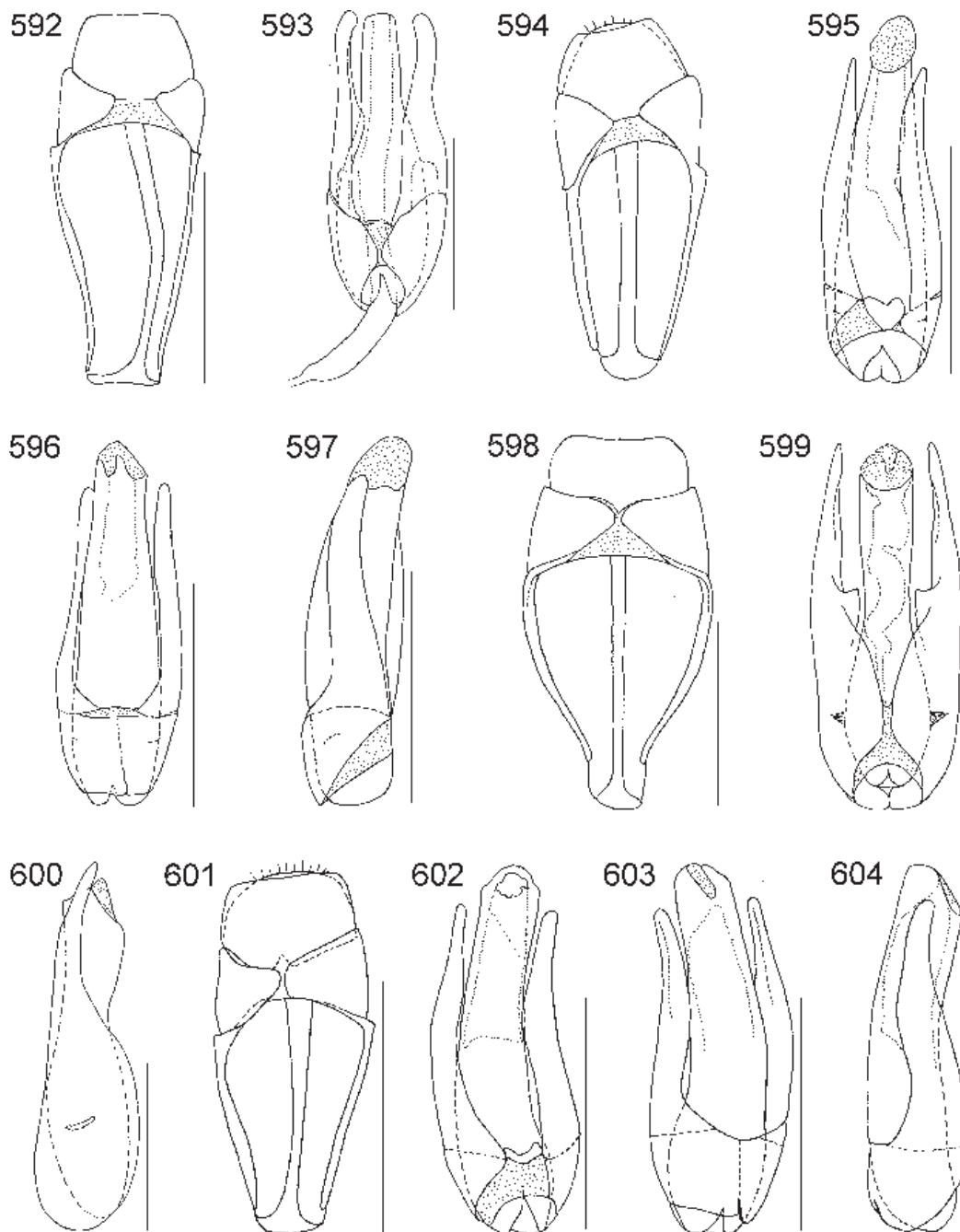


Fig. 592–604 Male genitalia: 592, 593: *Mitophyllus alboguttatus*: 592, ninth abdominal segment (dorsal); 593, aedeagus (dorsal). 594–597: *Mitophyllus angusticeps*: 594, ninth abdominal segment (dorsal); 595, aedeagus (dorsal); 596, aedeagus (ventral, note the faint, obliquely longitudinal “midline” suture on the basal piece); 597, aedeagus (lateral). 598–600: *Mitophyllus arcuatus*: 598, ninth abdominal segment (dorsal); 599, aedeagus (dorsal); 600, aedeagus (lateral). 601–604: *Mitophyllus dispar*: 601, ninth abdominal segment (dorsal); 602, aedeagus (dorsal); 603, aedeagus (ventral, note faint, obliquely longitudinal “midline” suture on basal piece); 604, aedeagus (lateral).

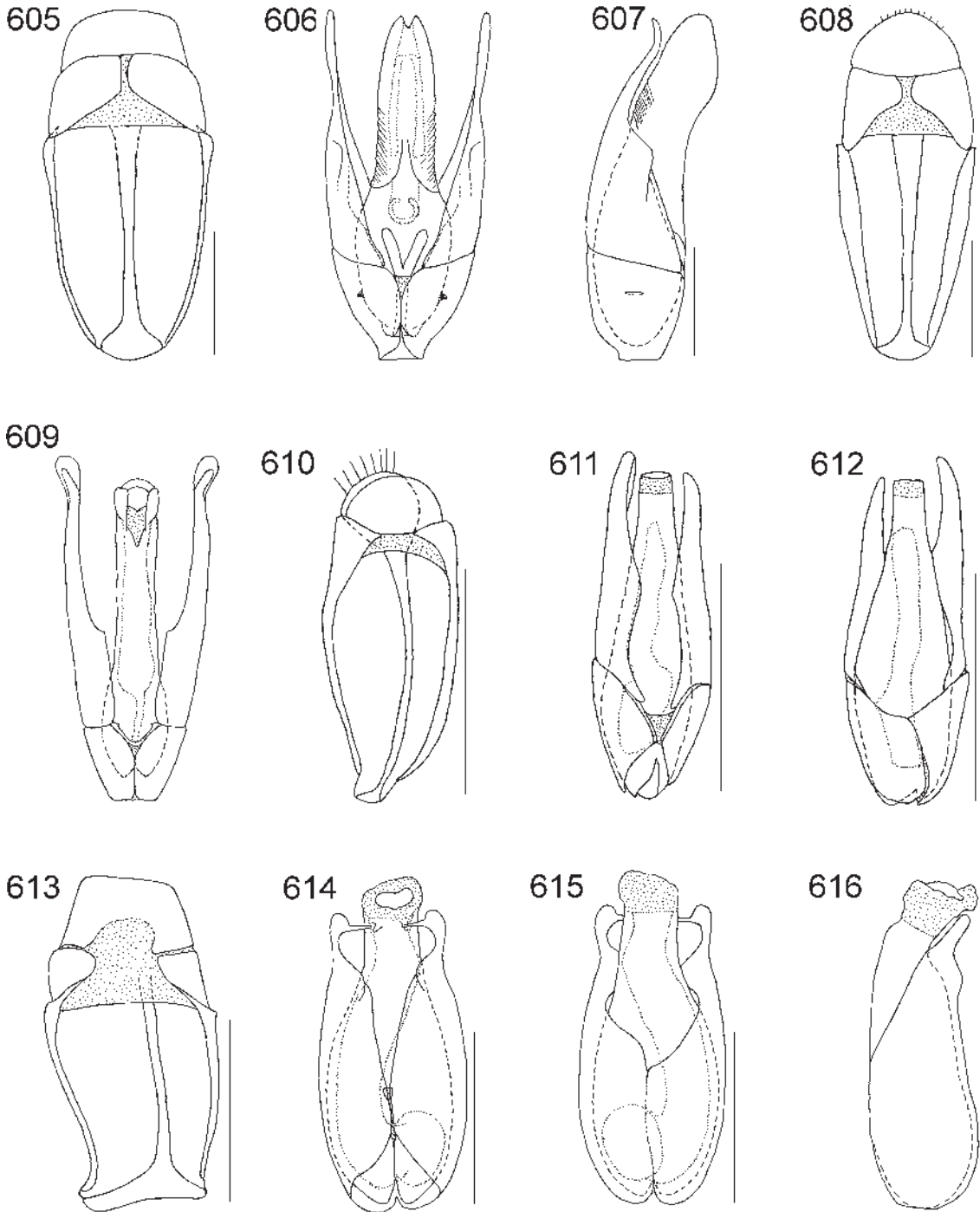


Fig. 605–616 Male genitalia: 605–607: *Mitophyllus falcatus*: 605, ninth abdominal segment (dorsal); 606, aedeagus (dorsal); 607, aedeagus (lateral). 608, 609: *Mitophyllus foveolatus*: 608, ninth abdominal segment (dorsal); 609, aedeagus (dorsal). 610–612: *Mitophyllus fuscus*: 610, ninth abdominal segment (dorsal); 611, aedeagus (dorsal); 612, aedeagus (ventral). 613–616: *Mitophyllus gibbosus*: 613, ninth abdominal segment (dorsal); 614, aedeagus (dorsal); 615, aedeagus (ventral); 616, aedeagus (lateral).

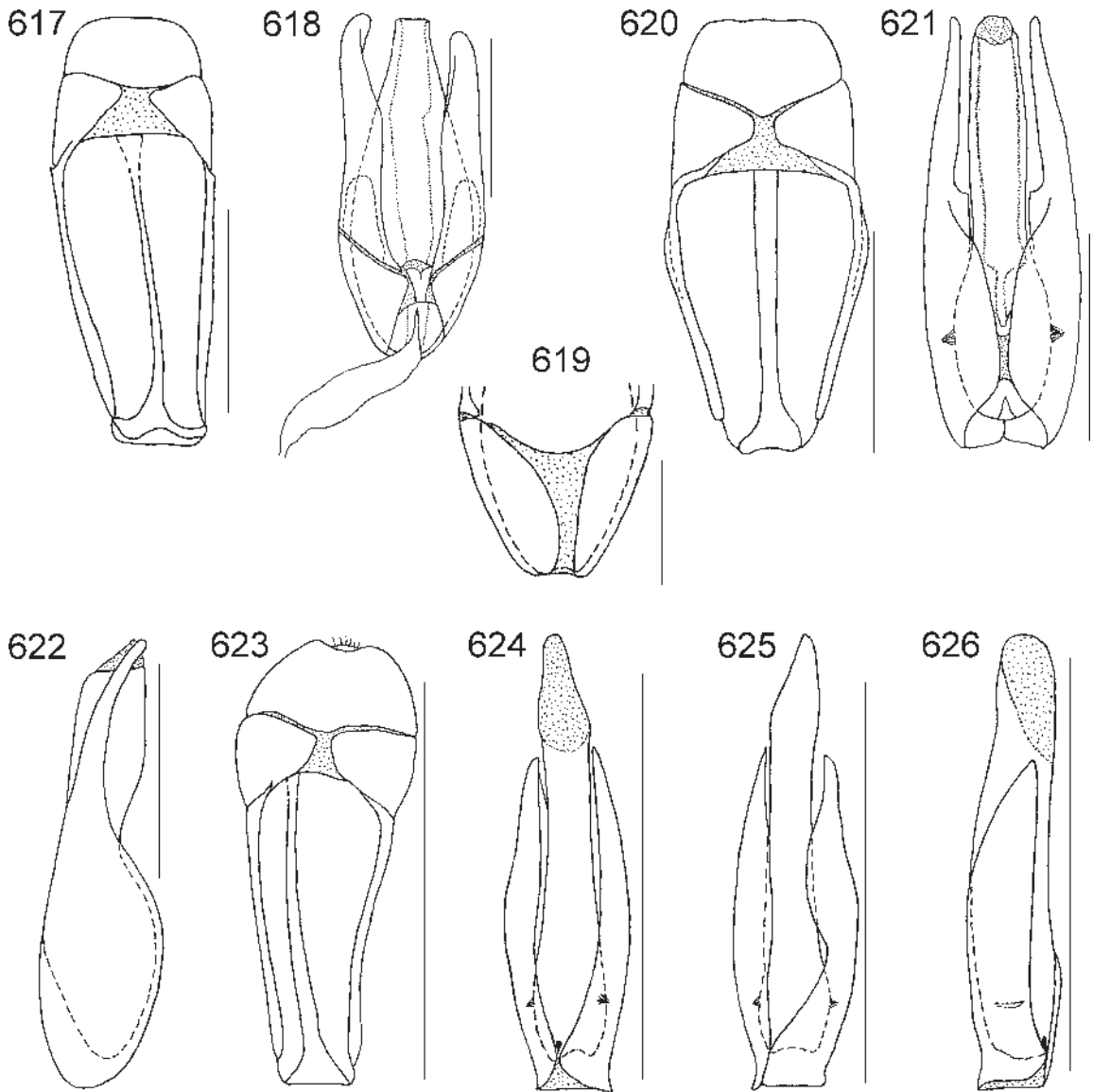


Fig. 617–626 Male genitalia: 617–619: *Mitophyllus insignis*: 617, ninth abdominal segment (dorsal); 618, aedeagus (dorsal); 619, base of tegmen (ventral, note asymmetry of basal piece). 620–622: *Mitophyllus irroratus*: 620, ninth abdominal segment (dorsal); 621, aedeagus (dorsal); 622, aedeagus (lateral). 623–626: *Mitophyllus macrocerus*: 623, ninth abdominal segment; 624, aedeagus (dorsal); 625, aedeagus (ventral); 626, aedeagus (lateral). (In Fig. 622 and Fig. 623 note oblique suture in basal piece “region”.)

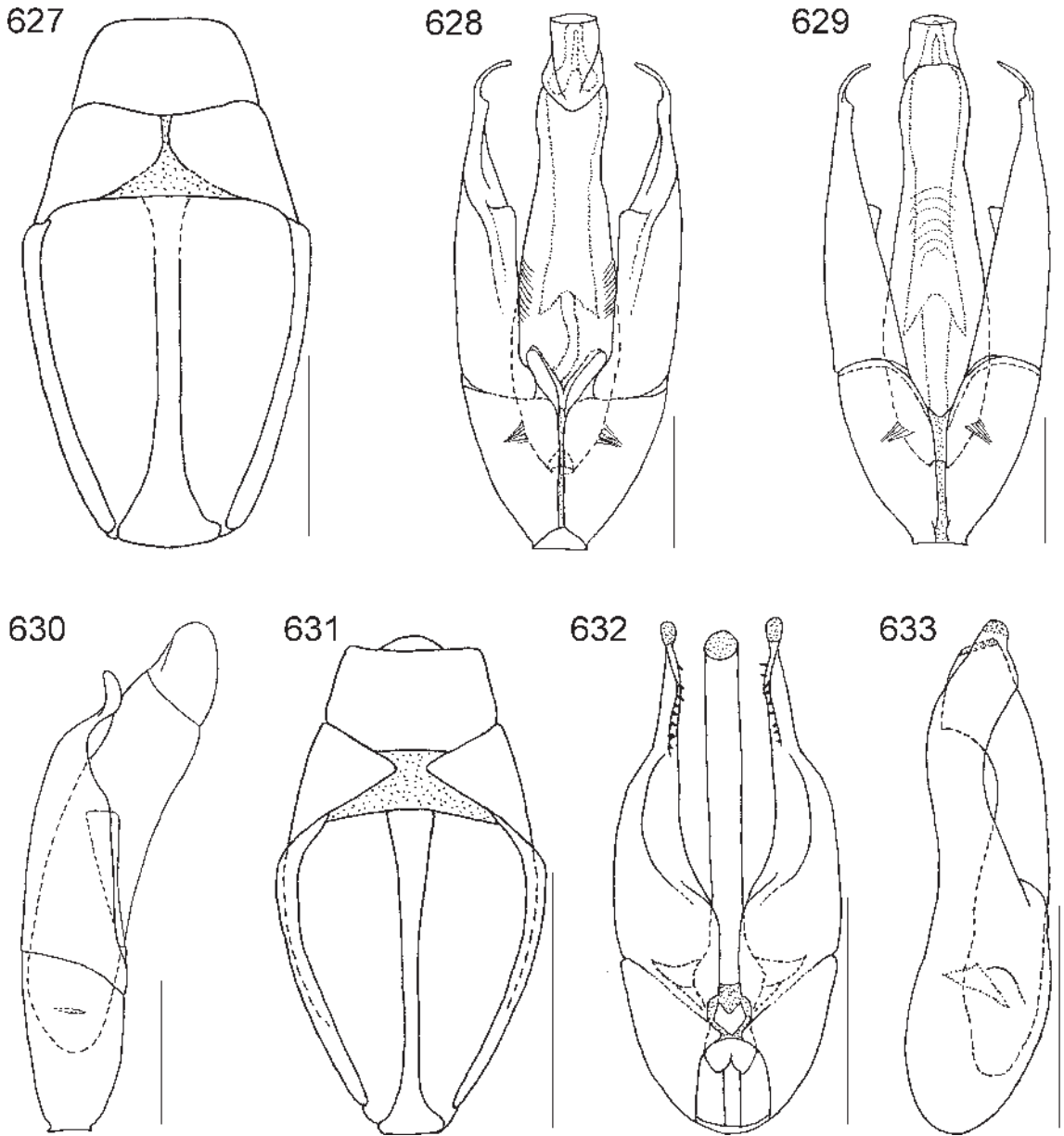


Fig. 627–633 Male genitalia: 627–630: *Mitophyllus parrianus*: 627, ninth abdominal segment; 628, aedeagus (dorsal); 629, aedeagus (ventral); 630, aedeagus (lateral). 631–633: *Mitophyllus reflexus*: 631, ninth abdominal segment (dorsal); 632, aedeagus (dorsal); 633, aedeagus (lateral).

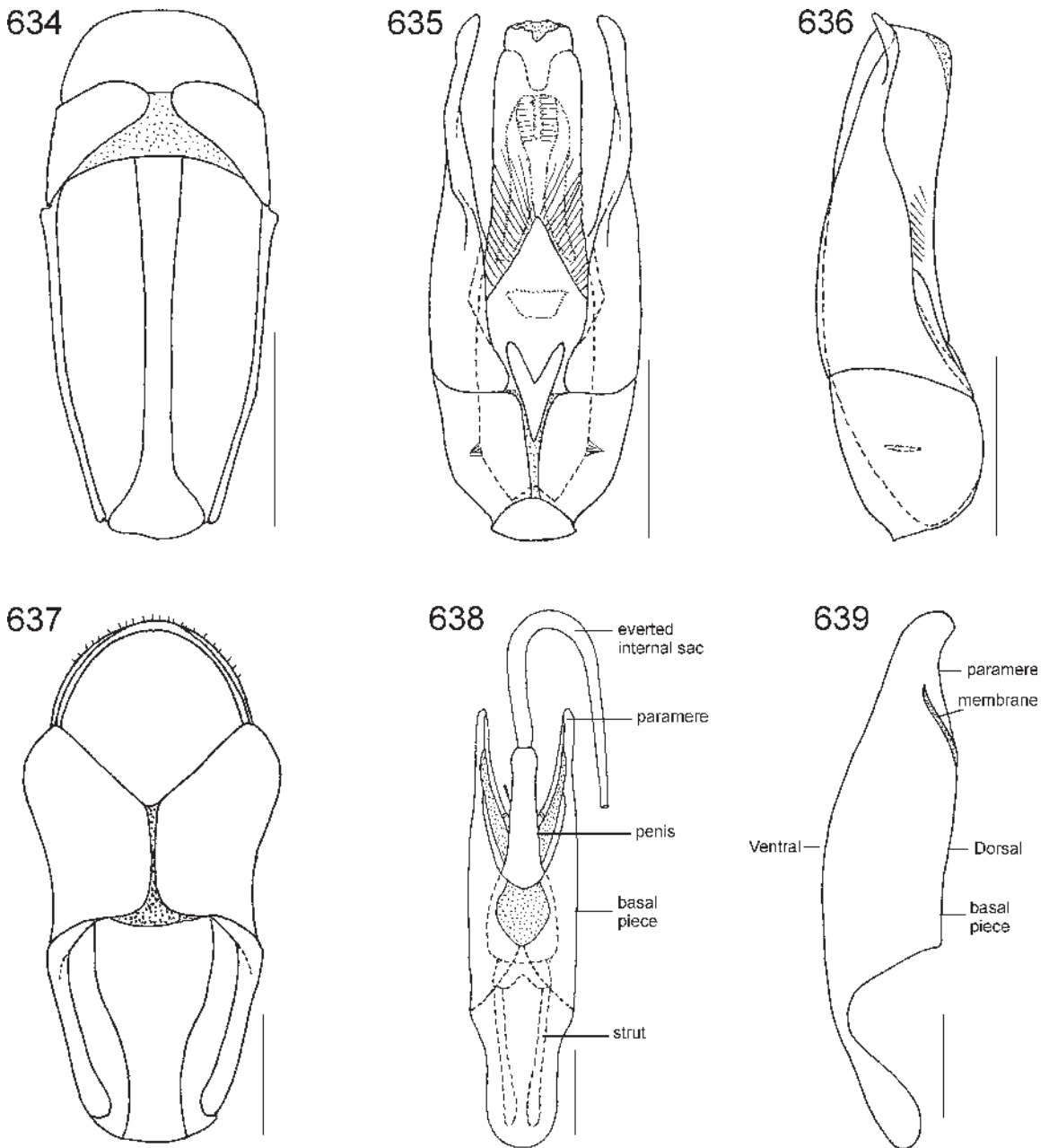
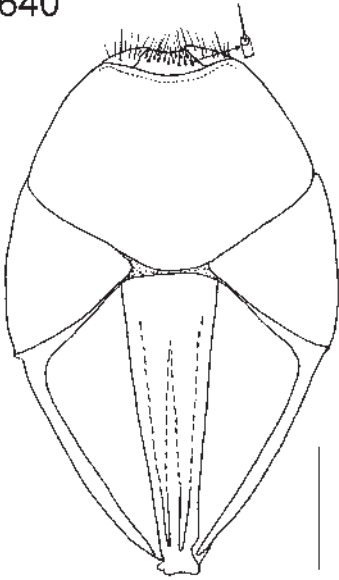
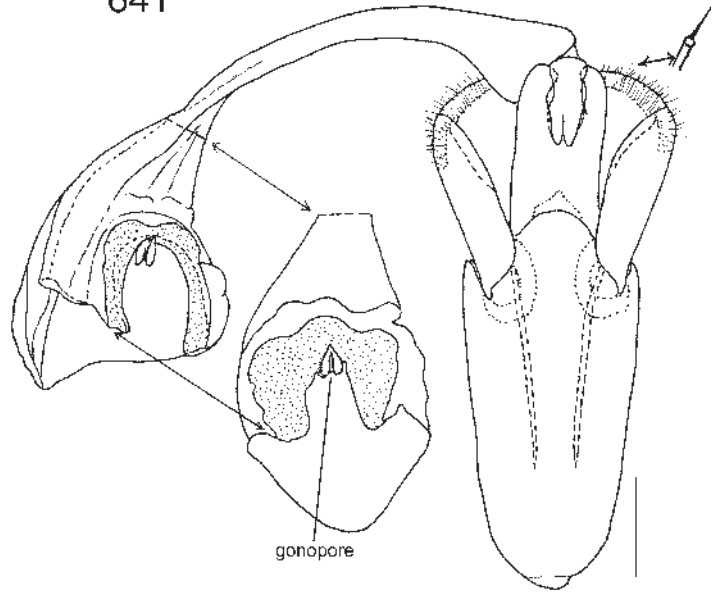


Fig. 634–639 Male genitalia: 634–636: *Mitophyllus solox*: 634, ninth abdominal segment (dorsal); 635, aedeagus (dorsal); 636, aedeagus (lateral). 637–639: *Dendroblox earlii*: 637, ninth abdominal segment (dorsal); 638, aedeagus with internal sac partly everted (ventral); 639, left side of tegmen (lateral).

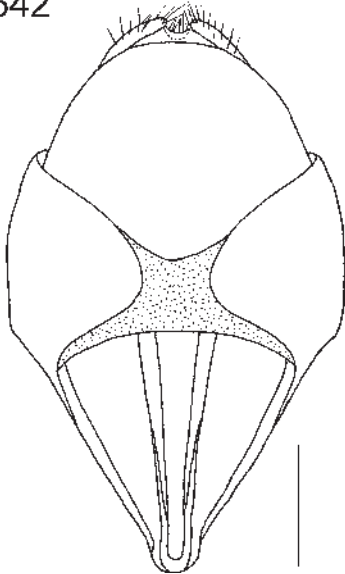
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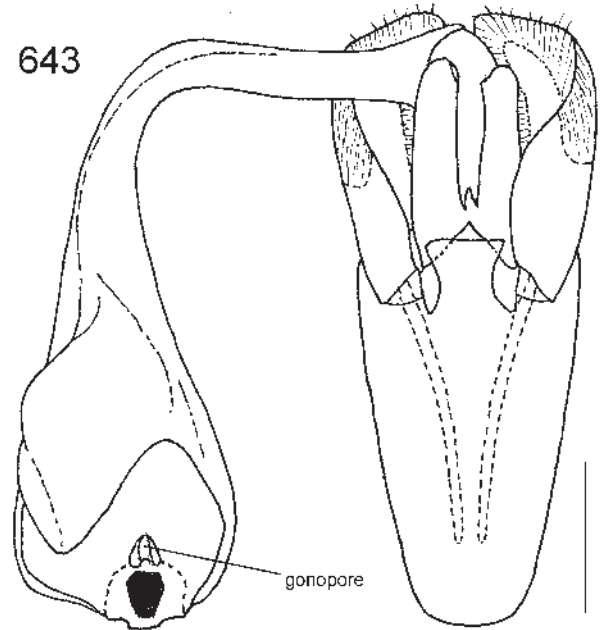


Fig. 640–643 Male genitalia: 640, 641: *Geodorcus alsobius*: 640, ninth abdominal segment (dorsal); 641, aedeagus (ventral). 642, 643: *Geodorcus auriculatus*: 642, ninth abdominal segment (dorsal); 643, aedeagus (ventral).

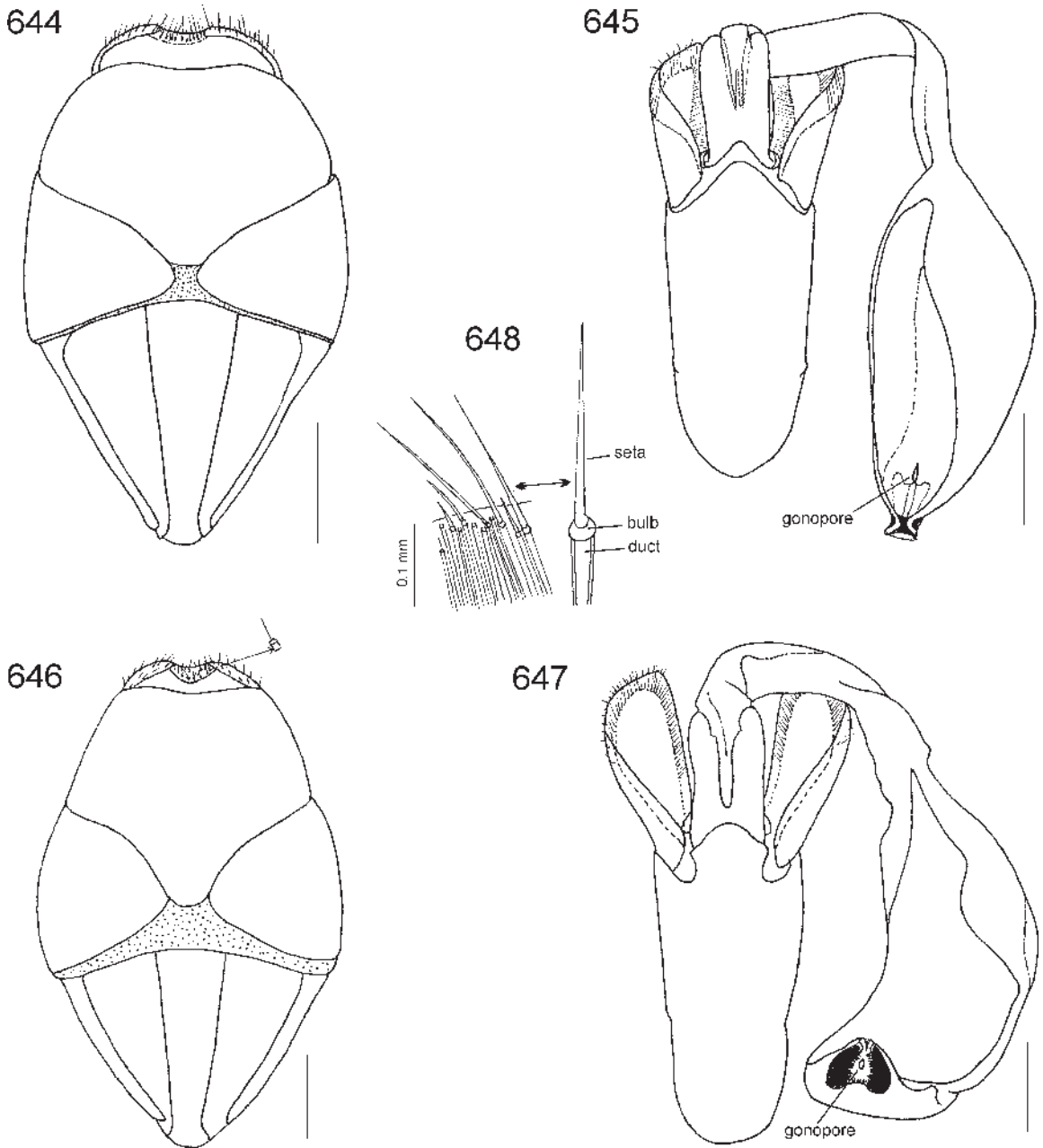


Fig. 644–648 Male genitalia: 644, 645: *Geodorcus capito* (also apply to *G. sororum*): 644, ninth abdominal segment (dorsal); 645, aedeagus (ventral). 646–648: *Geodorcus helmsi*: 646, ninth abdominal segment (dorsal), note “peg base” setae at apex of tergite; 647, aedeagus (ventral); 648, part of fringe of microsetae on concave surface of paramere with sketch of a microseta showing transparent bulb at base and part of a duct.

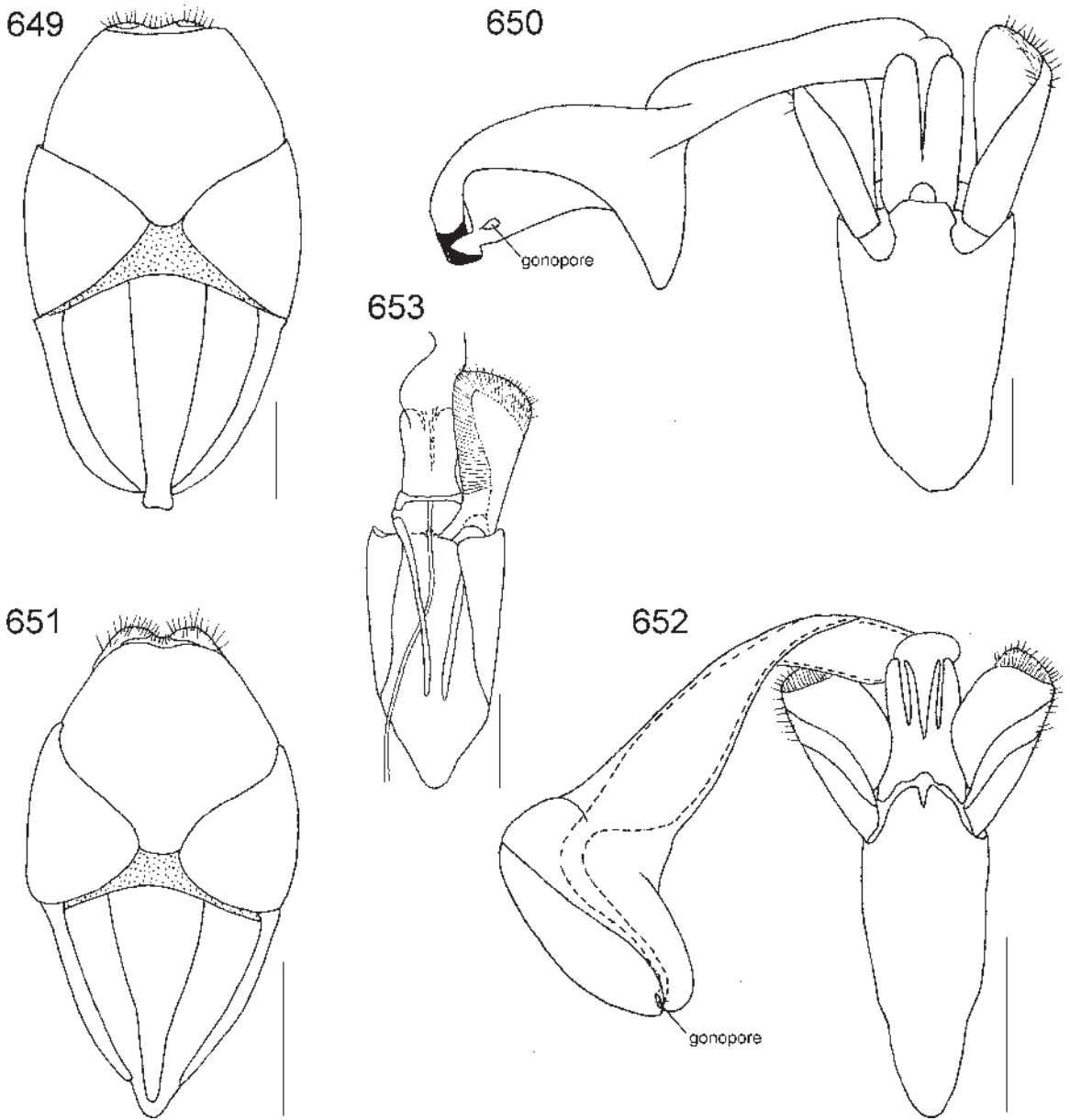
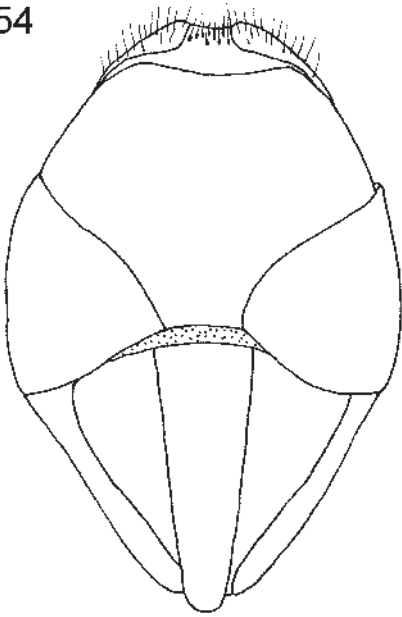
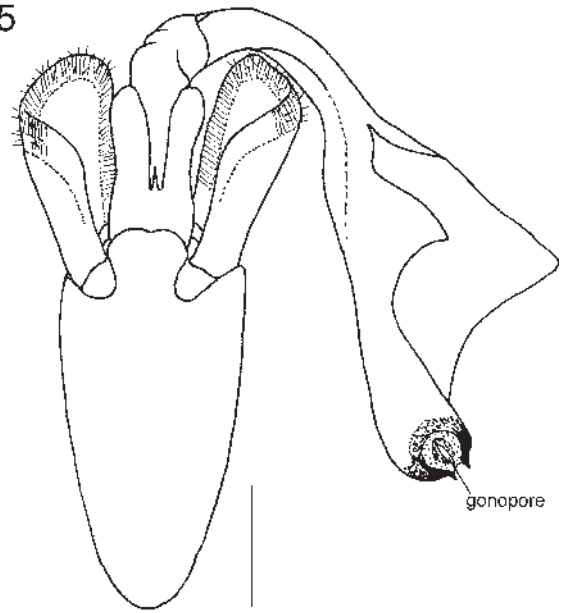


Fig. 649–653 Male genitalia: 649, 650: *Geodorcus ithaginis*: 649, ninth abdominal segment (dorsal); 650, aedeagus (ventral). 651–653: *Geodorcus novaezealandiae*: 651, ninth abdominal segment (dorsal); 652, aedeagus (ventral); 653, aedeagus slightly compressed and left paramere removed (dorsal).

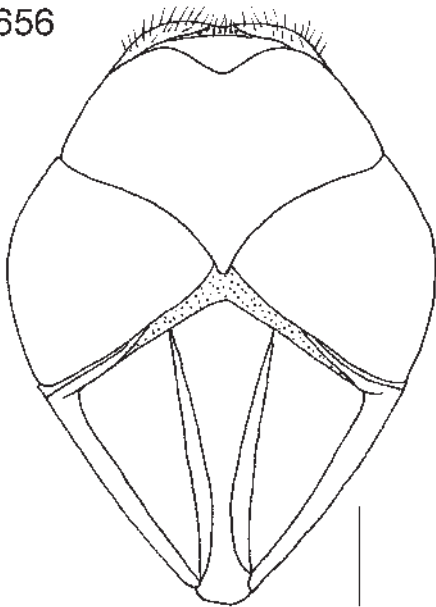
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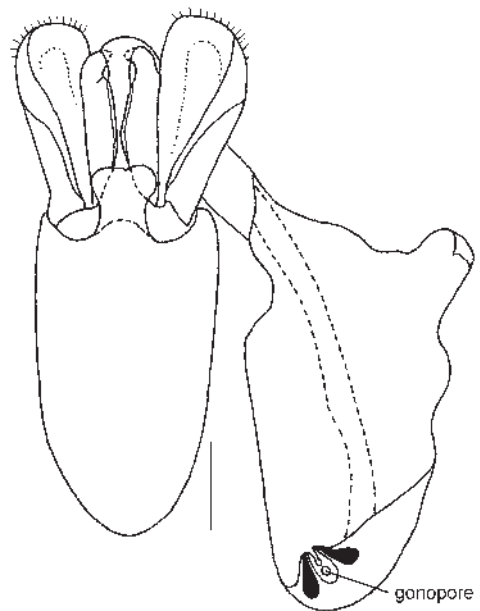


Fig. 654–657 Male genitalia: 654, 655: *Geodorcus philpotti*: 654, ninth abdominal segment (dorsal); 655, aedeagus (ventral). 656, 657: *Geodorcus servandus*: 656, ninth abdominal segment (dorsal); 657, aedeagus (ventral).

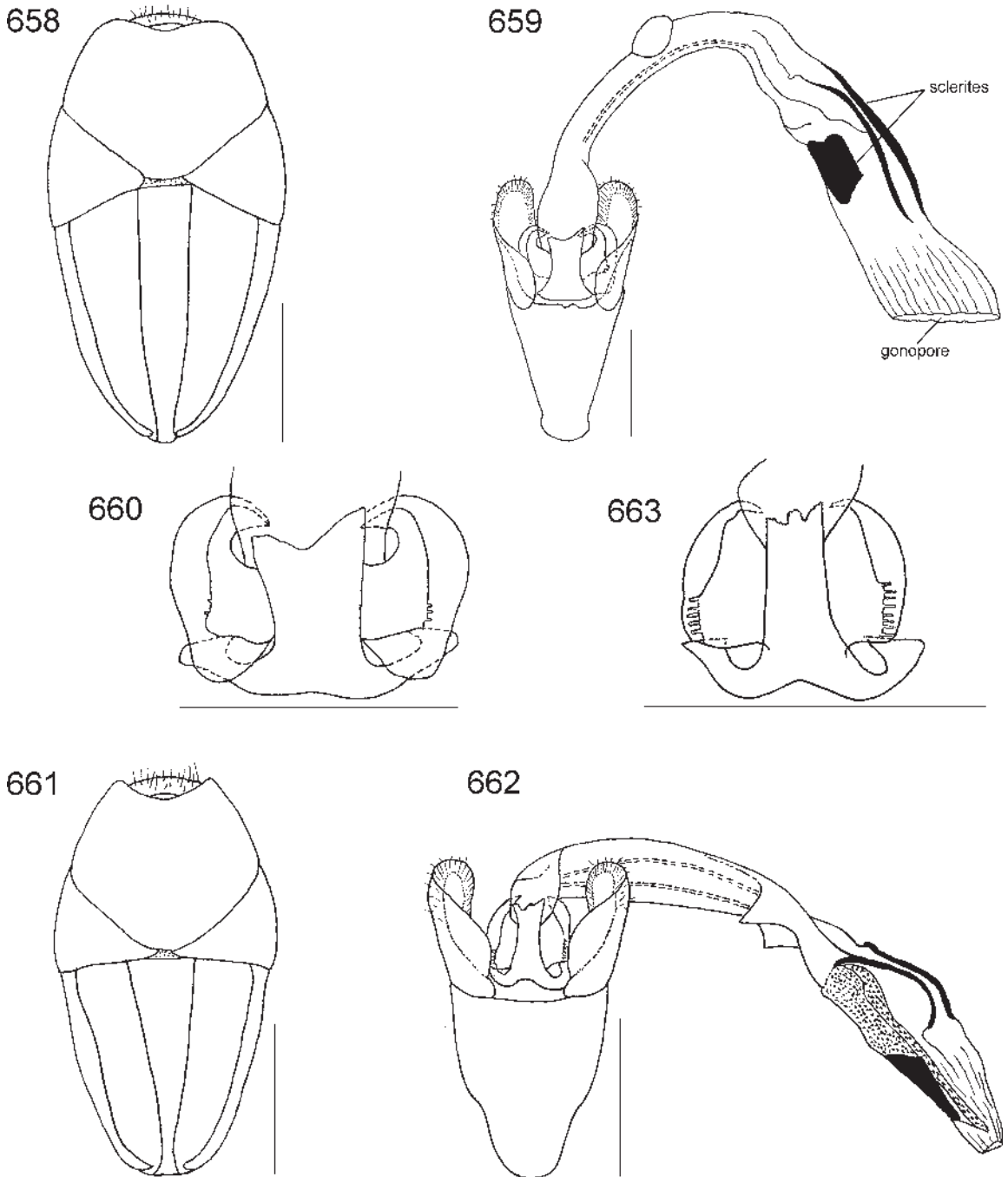


Fig. 658–663 Male genitalia: 658–660: *Paralissotes mangonuiensis*: 658, ninth abdominal segment (dorsal); 659, aedeagus (ventral); 660, details of penis (ventral). 661–663: *Paralissotes oconnori*: 661, ninth abdominal segment (dorsal); 662, aedeagus (ventral); 663, details of penis (ventral).

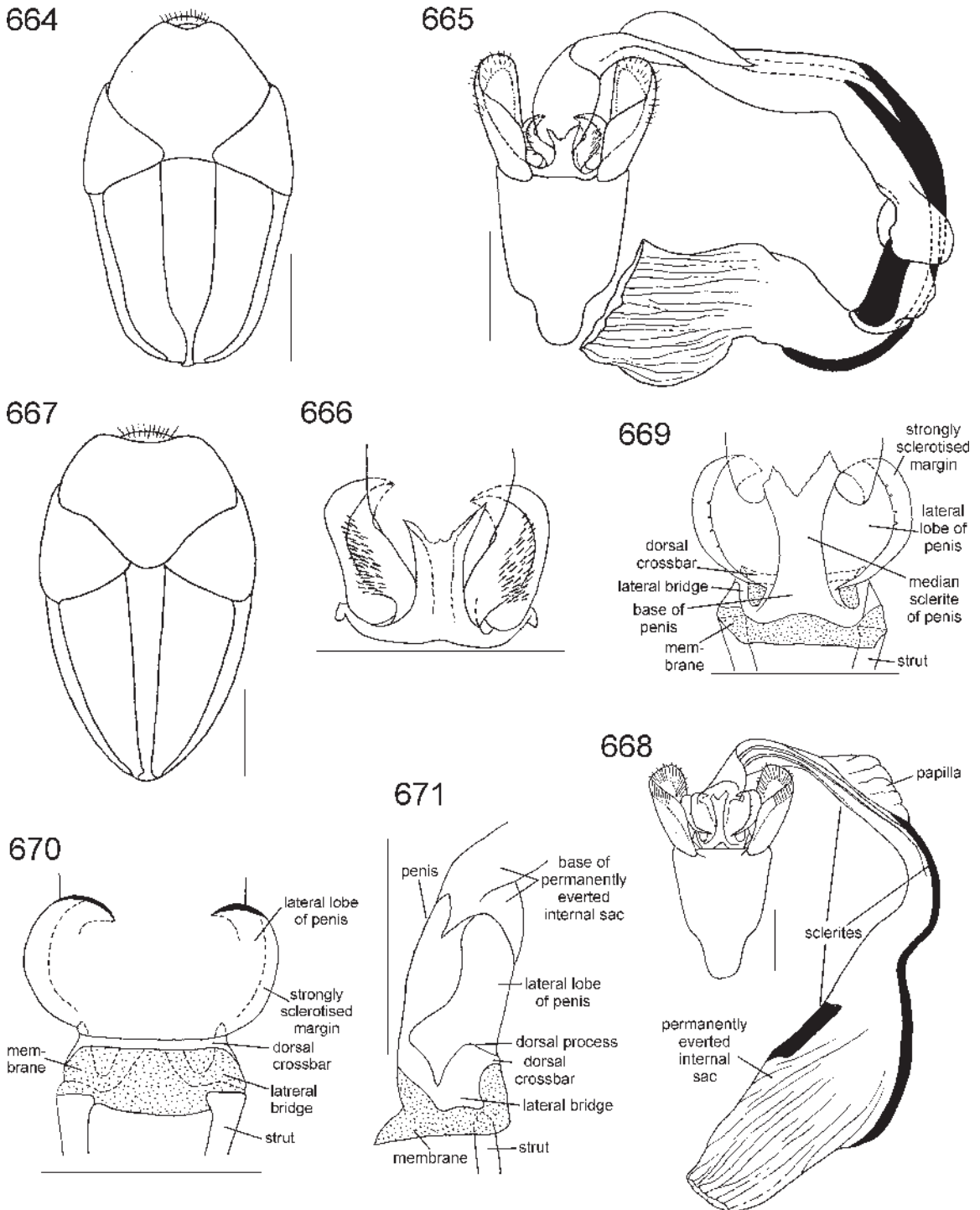


Fig. 664–671 Male genitalia: 664–666: *Paralisstotes planus*: 664, ninth abdominal segment (dorsal); 665, aedeagus (ventral); 666, details of penis (ventral). 667–671: *Paralisstotes reticulatus*: 667, ninth abdominal segment (dorsal); 668, aedeagus (ventral); 669–671, details of penis, ventral (669), dorsal (670), lateral (671).

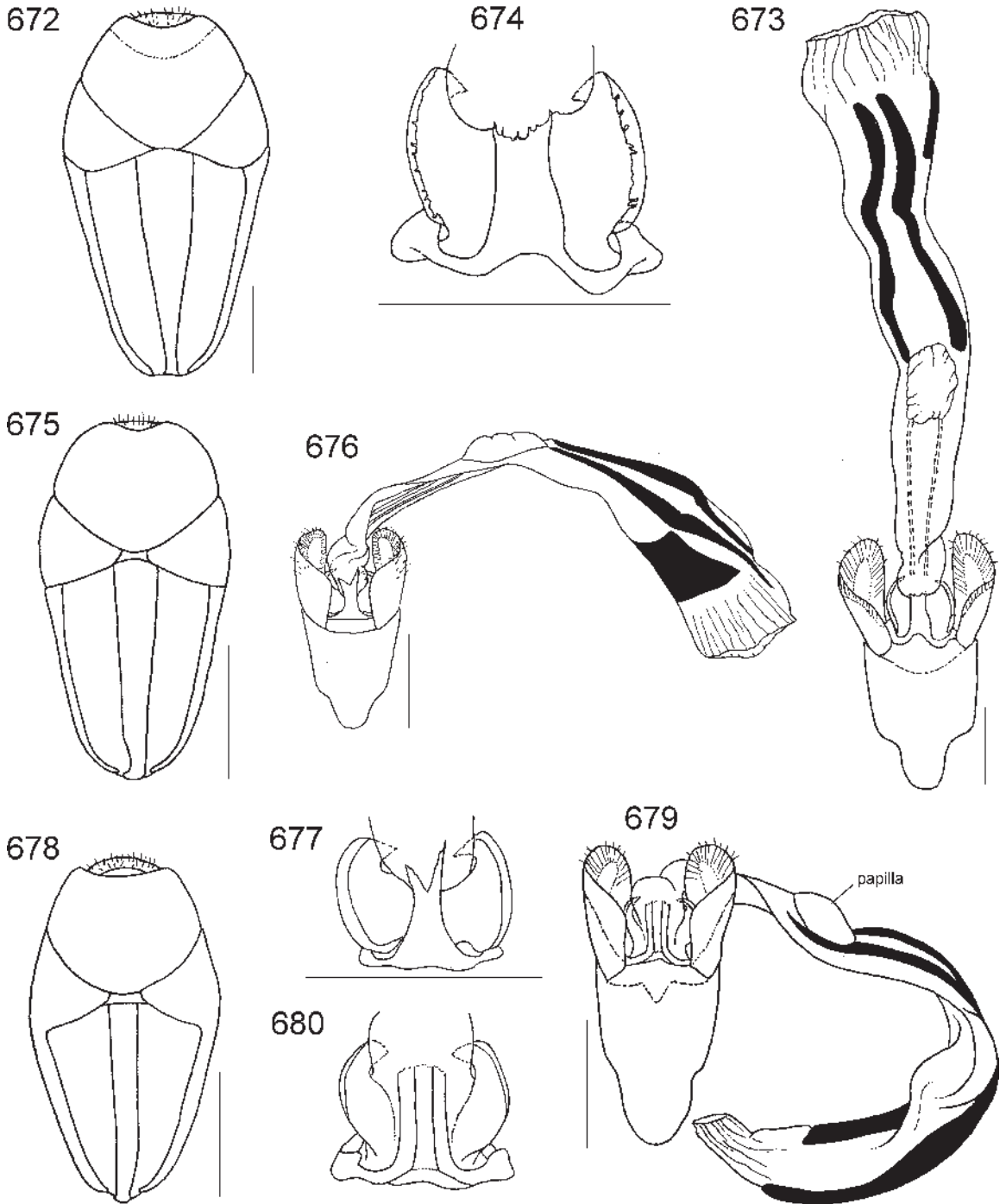


Fig. 672–680 Male genitalia: 672–674: *Paralissotes rufipes*: 672, ninth abdominal segment (dorsal); 673, aedeagus (ventral); 674, details of penis (ventral). 675–677: *Paralissotes stewarti*: 675, ninth abdominal segment (dorsal); 676, aedeagus (ventral); 677, details of penis (ventral). 678–680: *Paralissotes triregius*: 678, ninth abdominal segment (dorsal); 679, aedeagus (ventral); 680, details of penis (ventral).

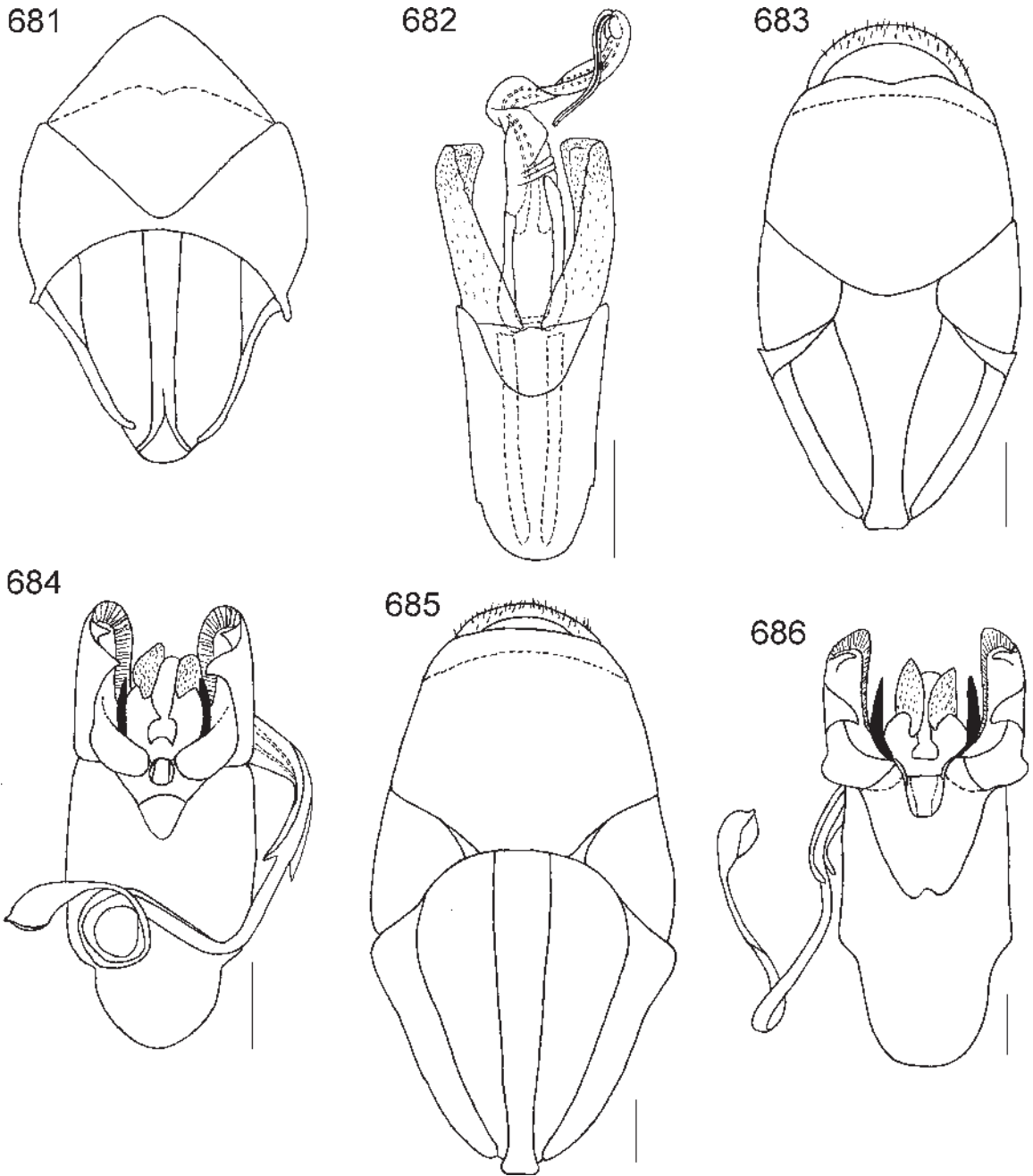


Fig. 681–686 Male genitalia: 681, 682: *Ryssonotus nebulosus*: 681, ninth abdominal segment (dorsal); 682, aedeagus (ventral). 683, 684: *Serrognathus sika* (Pakuranga, NZ specimen): 683, ninth abdominal segment (dorsal); 684, aedeagus (ventral). 685, 686: *Serrognathus titanus* (type species of *Serrognathus*) (Sulawesi specimen): 685, ninth abdominal segment (dorsal); 686, aedeagus (ventral).

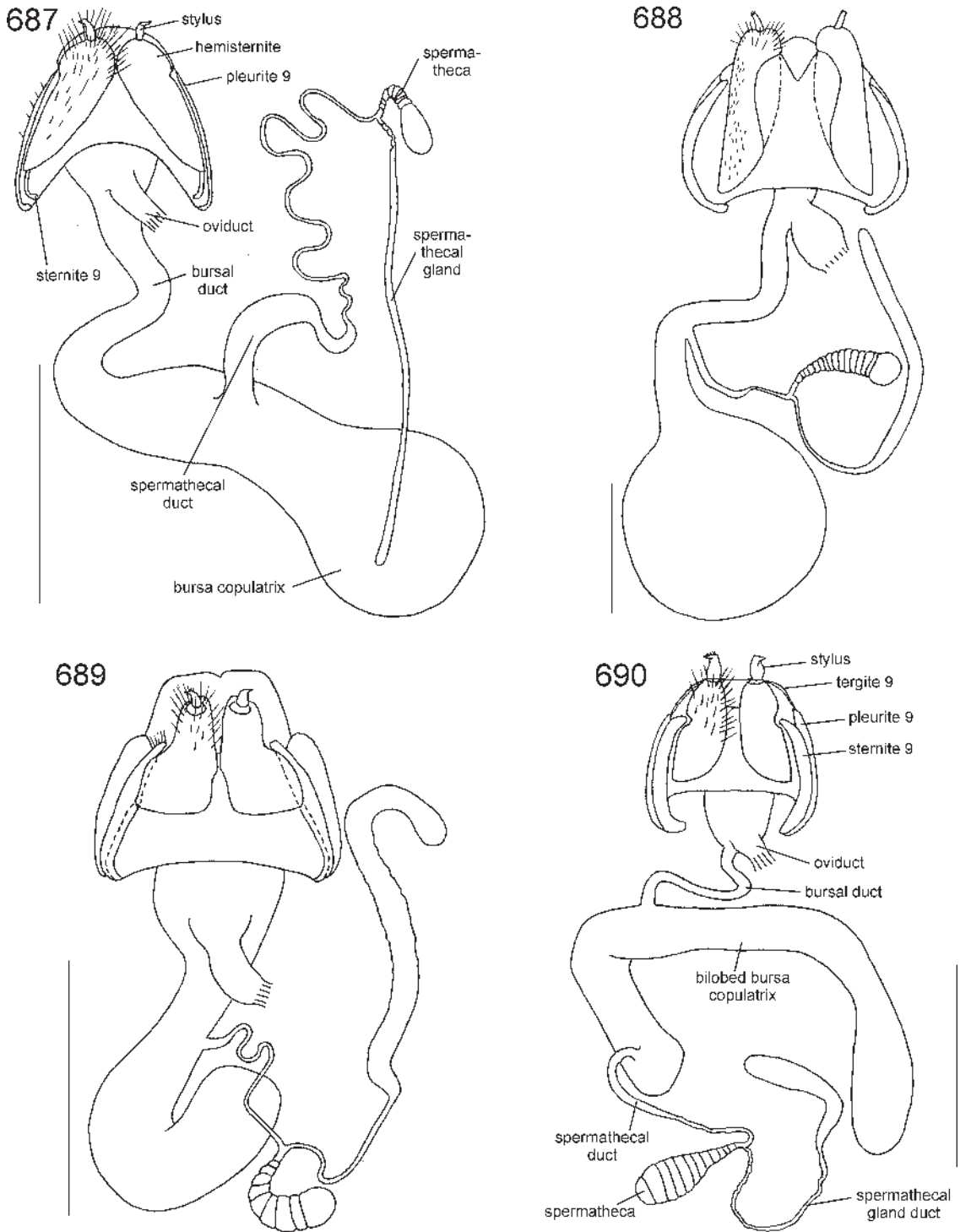


Fig. 687–690 Female genitalia (ventral): 687, *Holloceratognathus cylindricus*; 688, *Holloceratognathus helotoides*; 689, *Holloceratognathus passaliformis*; 690, *Mitophyllus alboguttatus*.

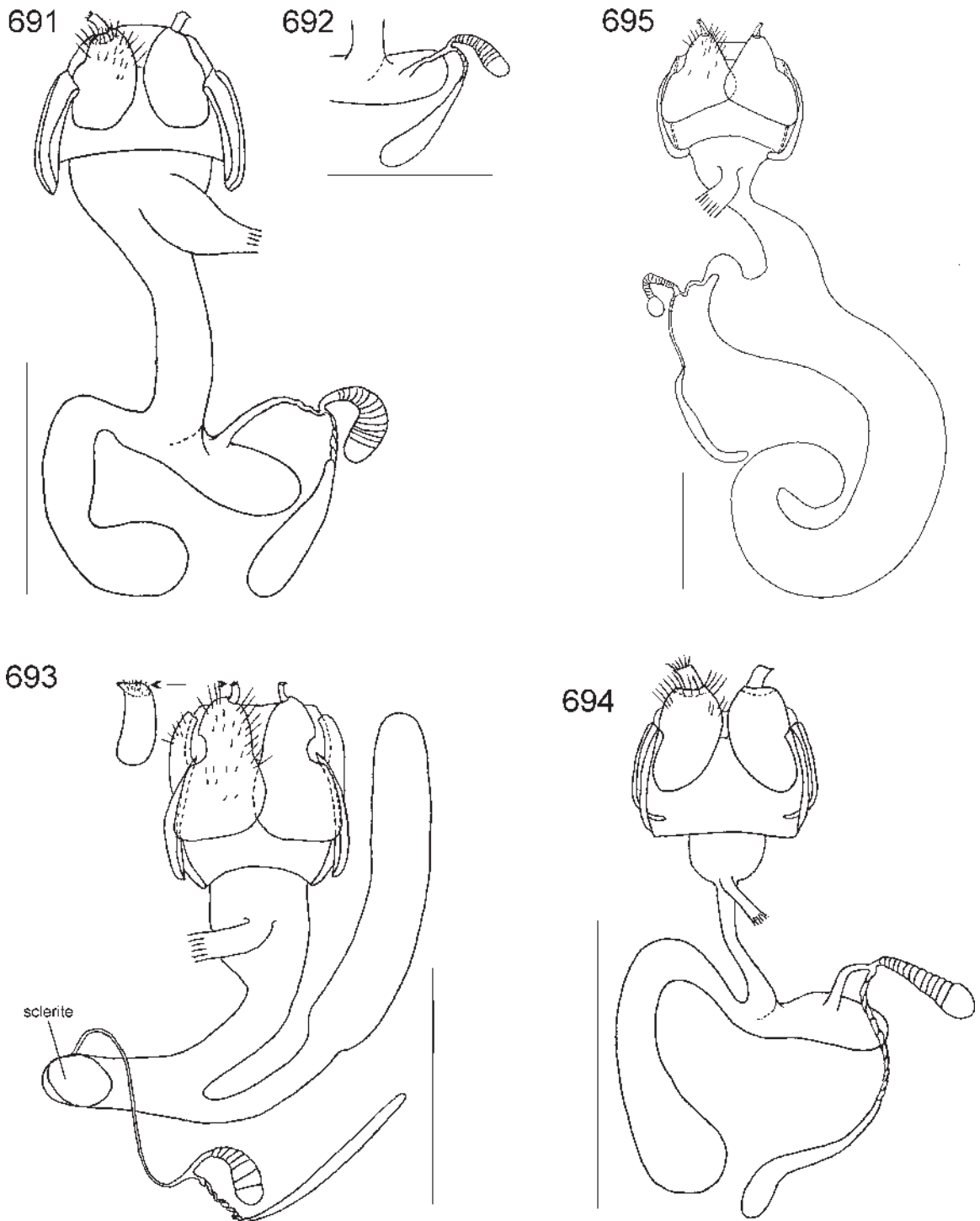
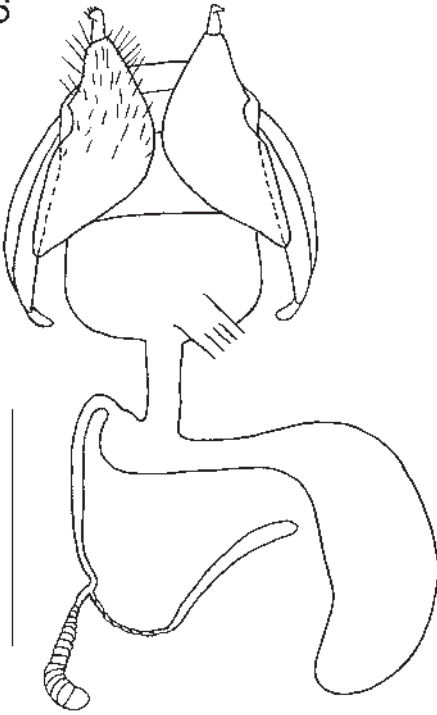
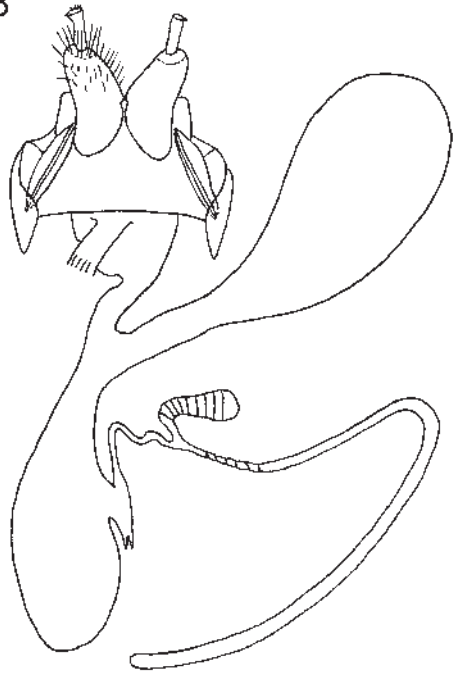


Fig. 691–695 Female genitalia (ventral): 691, *Mitophyllus angusticeps*, specimen from L. Rotoiti, NN; 692, *M. angusticeps*, bursa copulatrix and associated structures of another specimen from L. Rotoiti, NN showing different insertion point of spermathecal duct; 693, *Mitophyllus arcuatus*; 694, *Mitophyllus dispar*; 695, *Mitophyllus falcatus*.

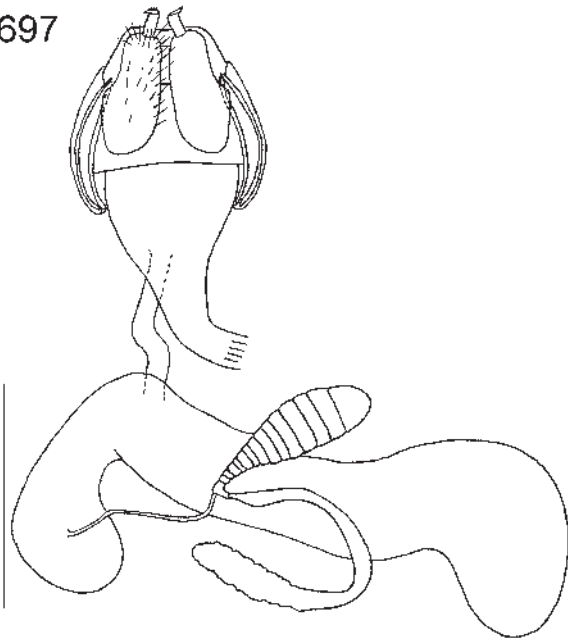
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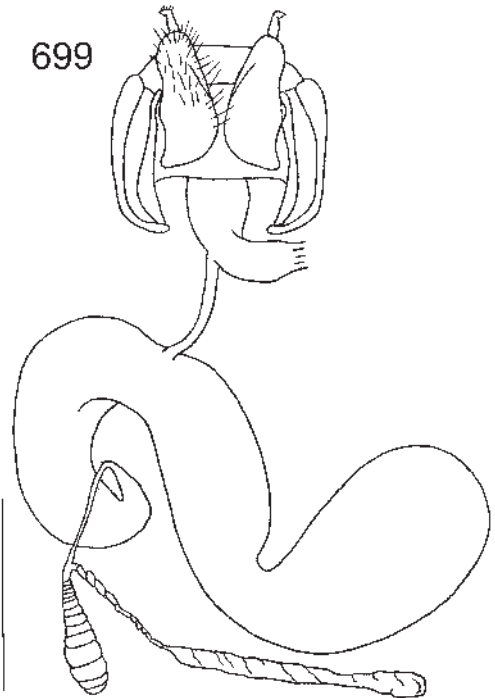
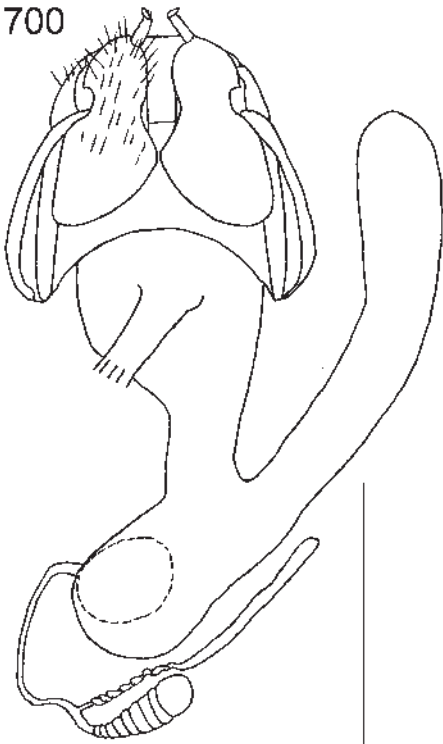
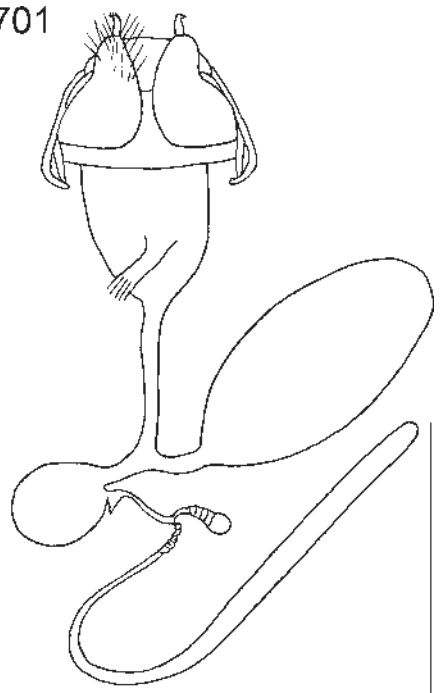


Fig. 696–699 Female genitalia (ventral): 696, *Mitophyllus foveolatus*; 697, *Mitophyllus fuscus*; 698, *Mitophyllus gibbosus*; 699, *Mitophyllus insignis*.

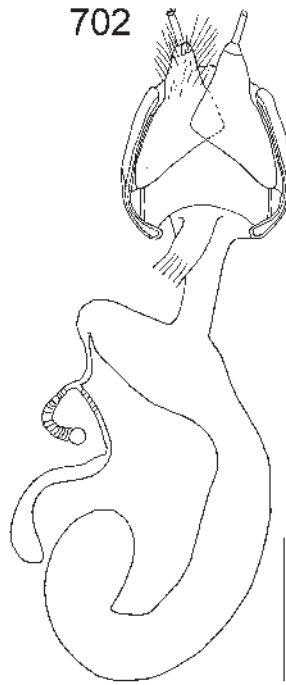
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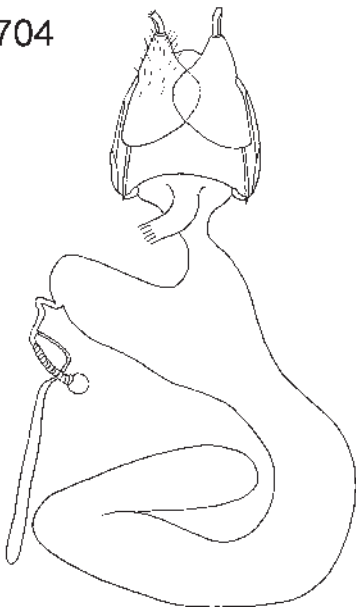
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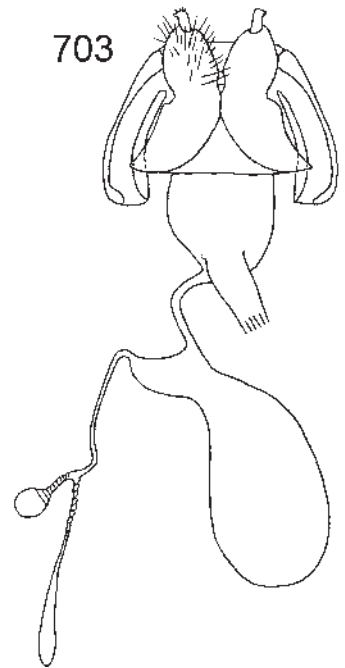


Fig. 700–704 Female genitalia (ventral): 700, *Mitophyllus irroratus*; 701, *Mitophyllus macrocerus*; 702, *Mitophyllus parrianus*; 703, *Mitophyllus reflexus*; 704, *Mitophyllus solox*.

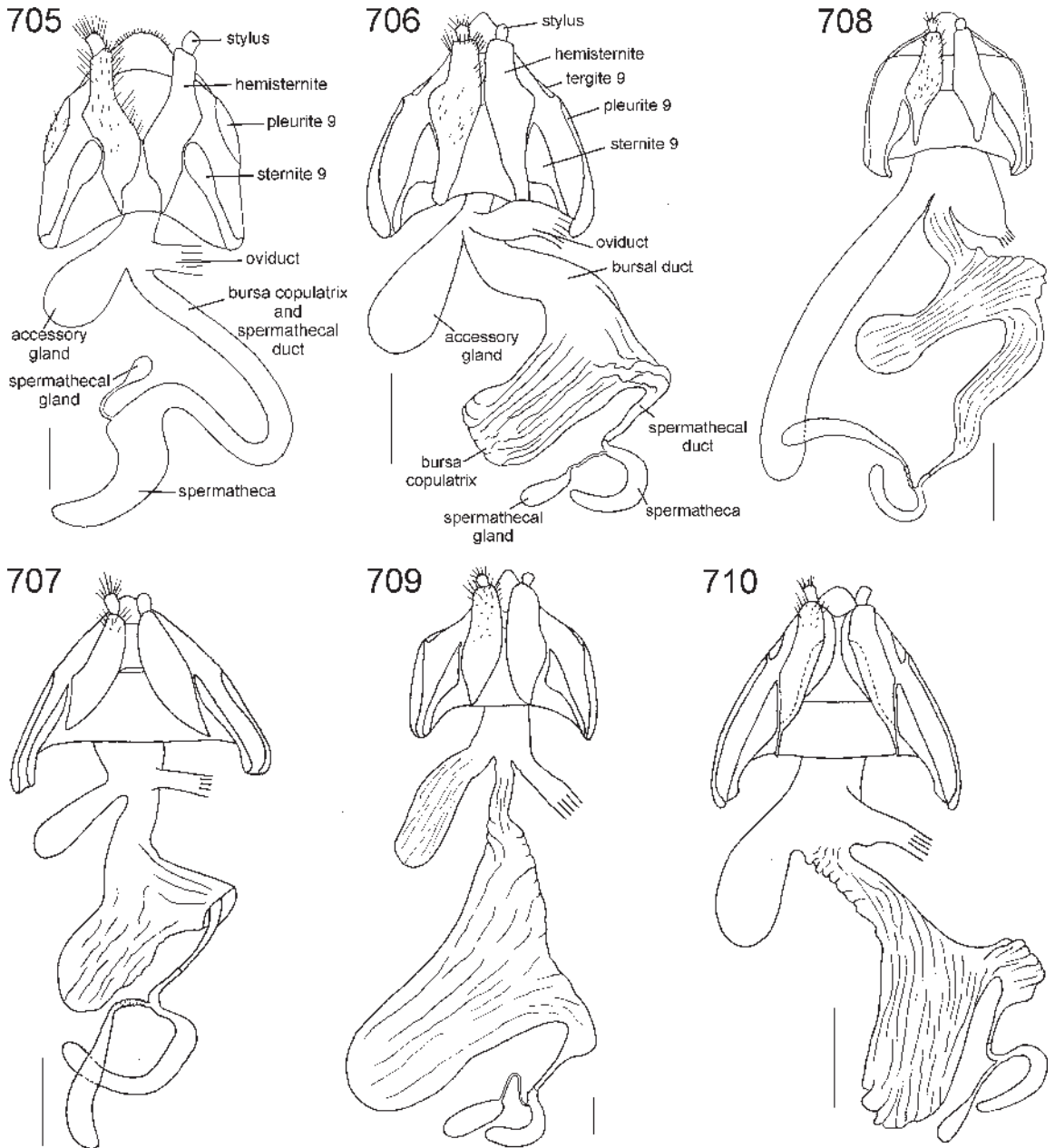


Fig. 705–710 Female genitalia (ventral): 705, *Dendroblax earlii*; 706, *Geodorcus alsobius*; 707, *Geodorcus auriculatus*; 708, *Geodorcus capito* (also applies to *G. sororum*); 709, *Geodorcus helmsi*; 710, *Geodorcus ithaginis*.

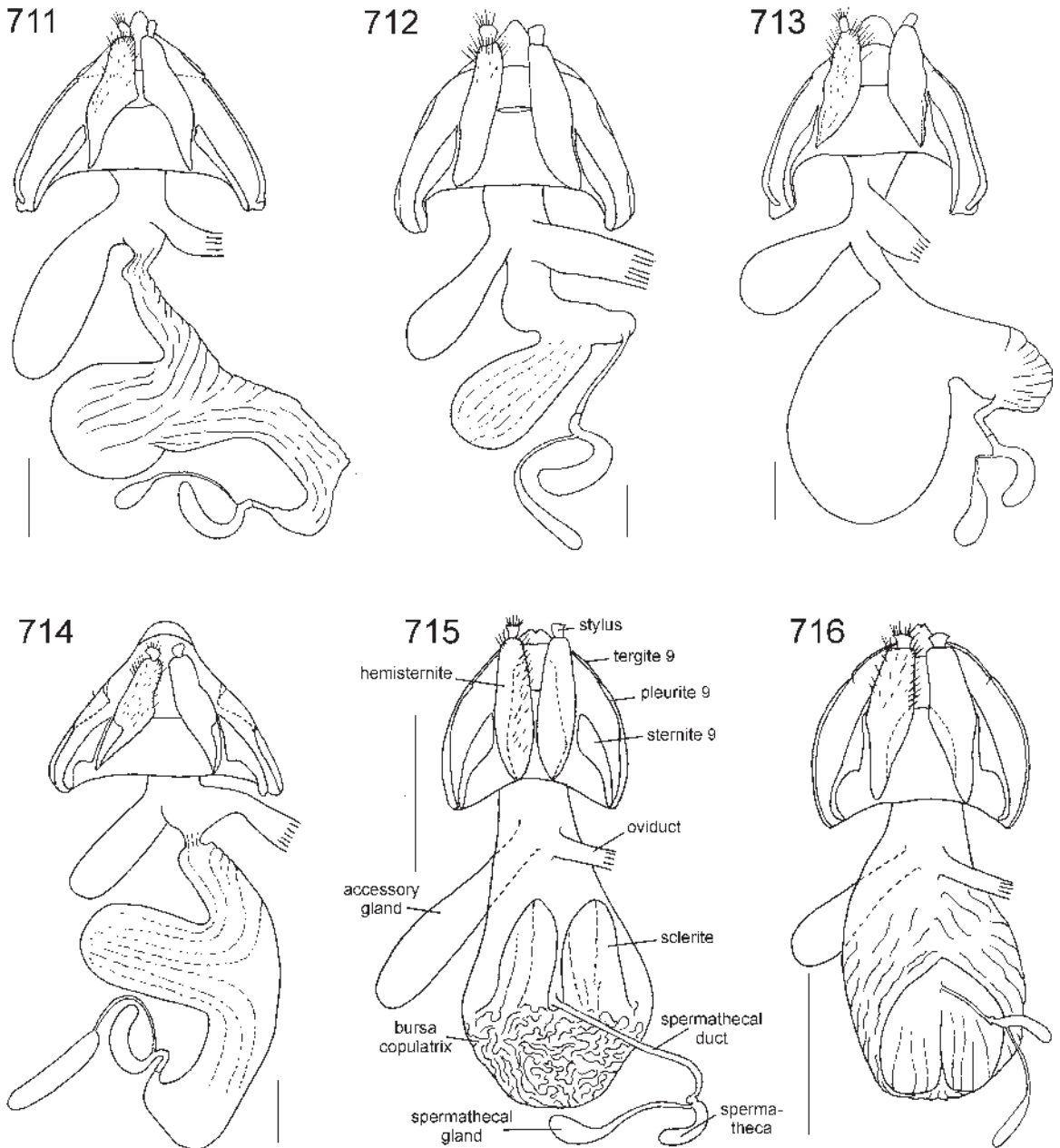


Fig. 711–716 Female genitalia (ventral): 711, *Geodorcus montivagus*; 712, *Geodorcus novaezealandiae*; 713, *Geodorcus philpotti*; 714, *Geodorcus servandus*; 715, *Paralissotes mangonuiensis*; 716, *Paralissotes oconnori*.

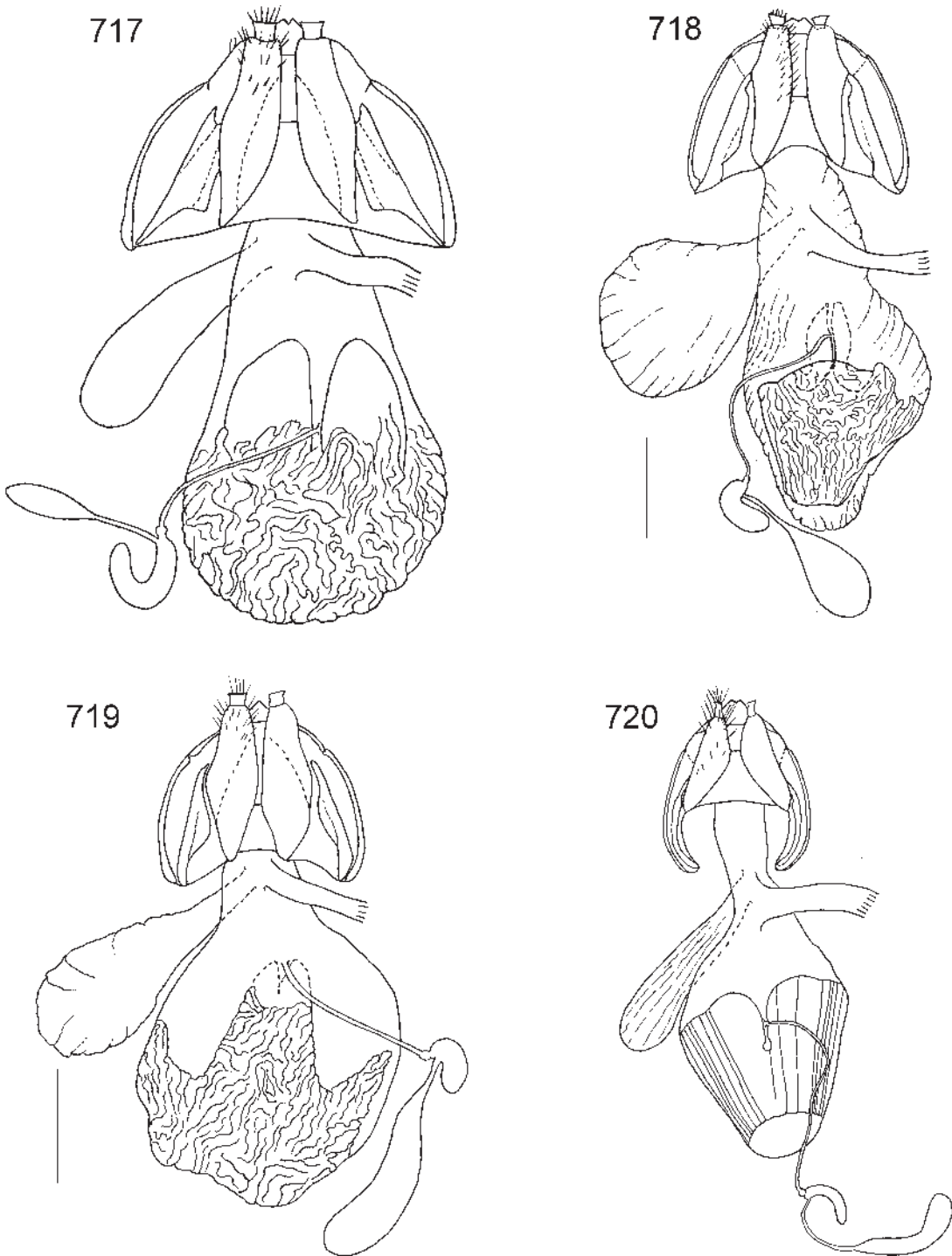


Fig. 717–720 Female genitalia (ventral): 717, *Paralissotes planus*; 718, *Paralissotes reticulatus*; 719, *Paralissotes rufipes*; 720, *Paralissotes stewarti*.

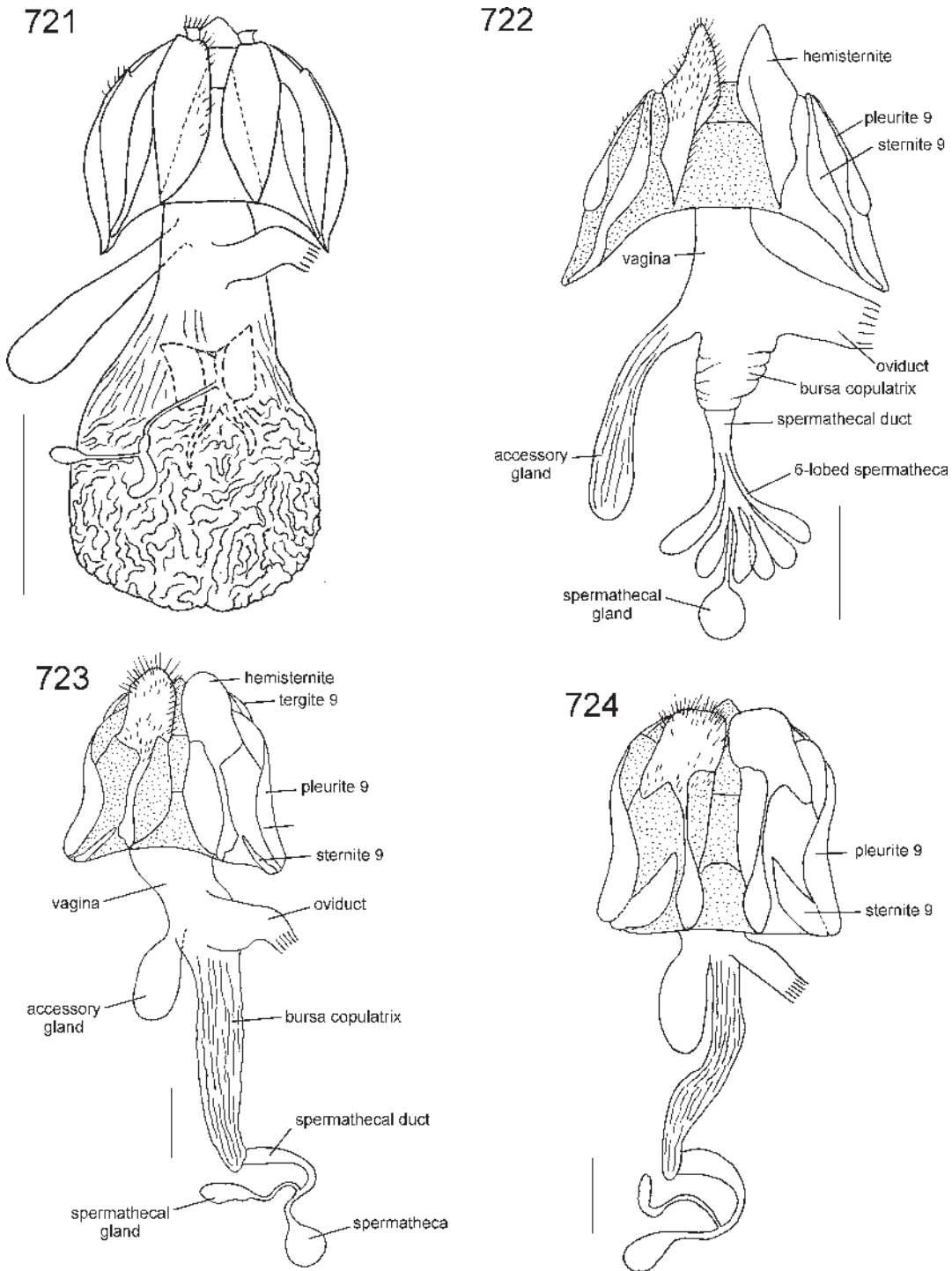
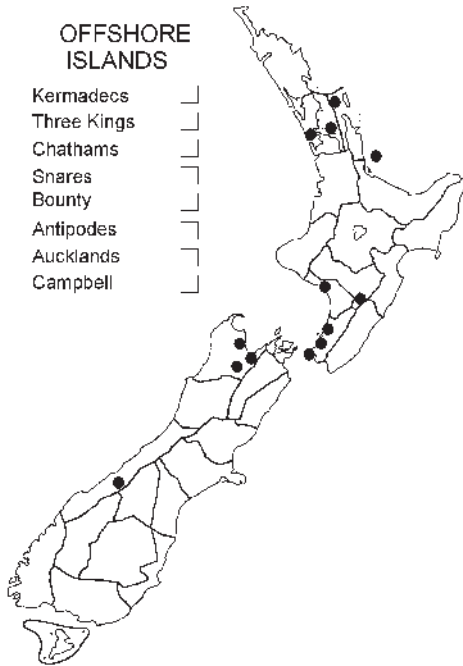
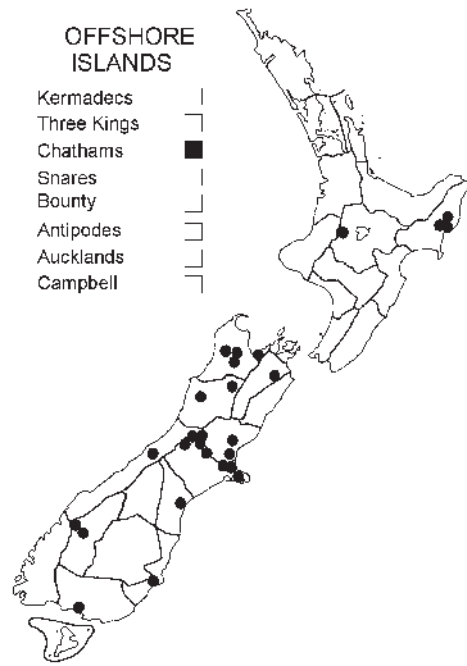


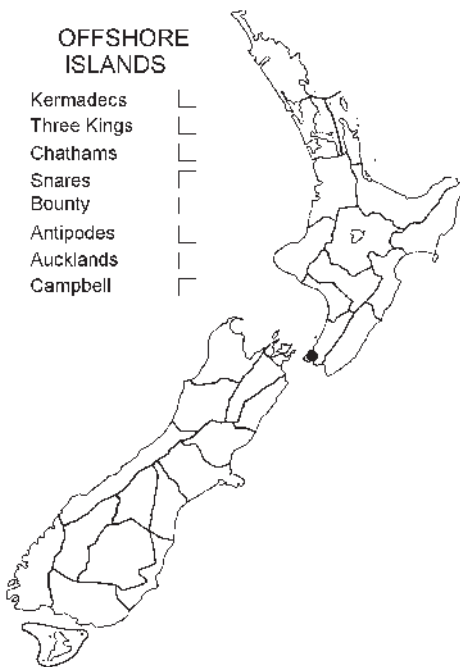
Fig. 721–724 Female genitalia (ventral): 721, *Paralissotes triregius*; 722, *Ryssonotus nebulosus*; 723, *Serrognathus sika* Taiwanese specimen; 724, *Serrognathus titanus* (type species of *Serrognathus*) Celebes specimen.



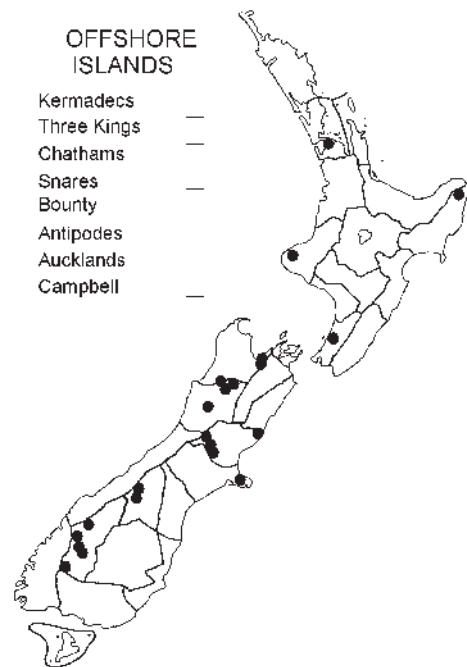
Map 1 Collection localities, *Holloceratognathus cylindricus*



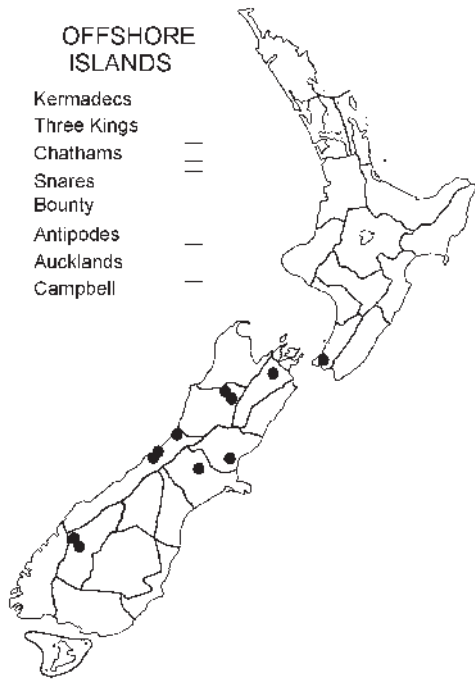
Map 2 Collection localities, *Holloceratognathus helotoides*



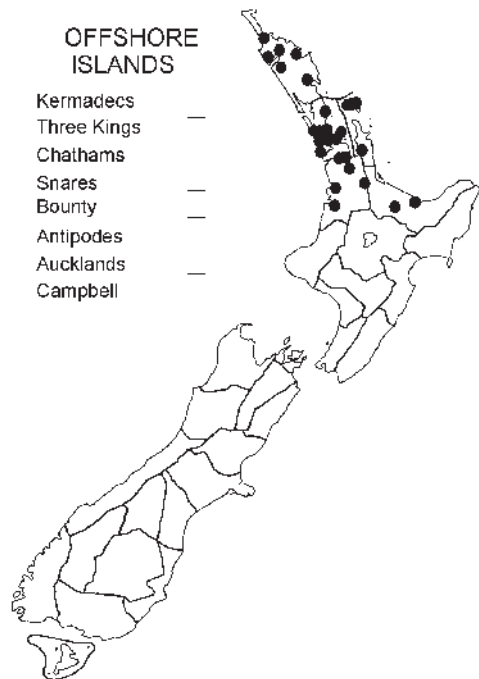
Map 3 Collection localities, *Holloceratognathus passaliformis*



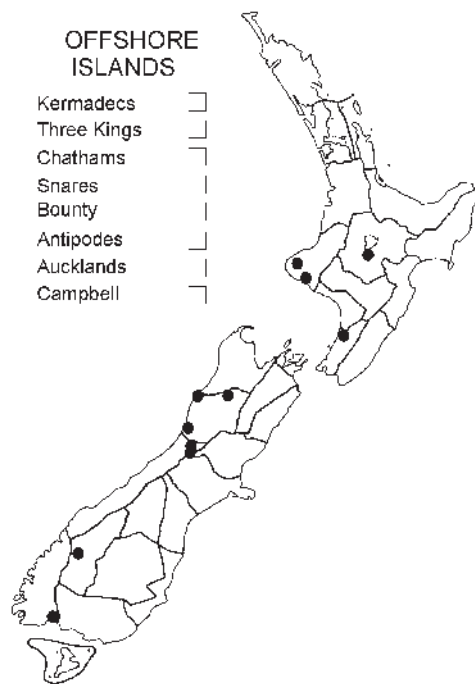
Map 4 Collection localities, *Mitophyllus alboguttatus*



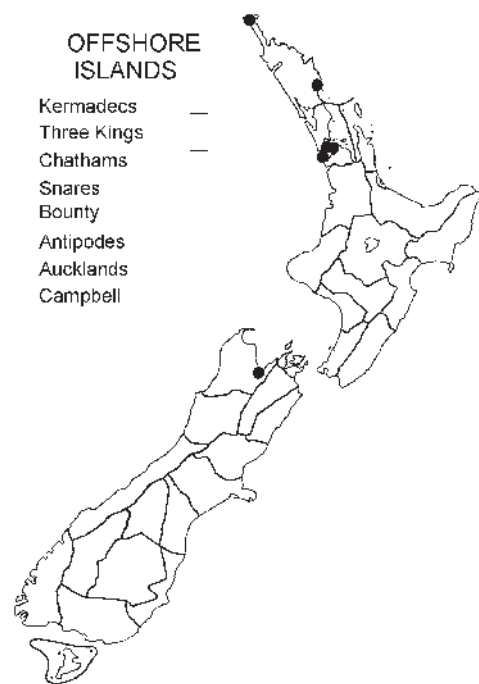
Map 5 Collection localities, *Mitophyllus angusticeps*



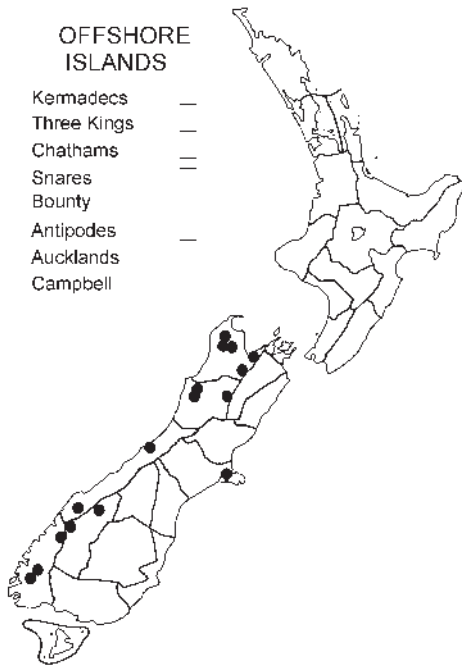
Map 6 Collection localities, *Mitophyllus arcuatus*



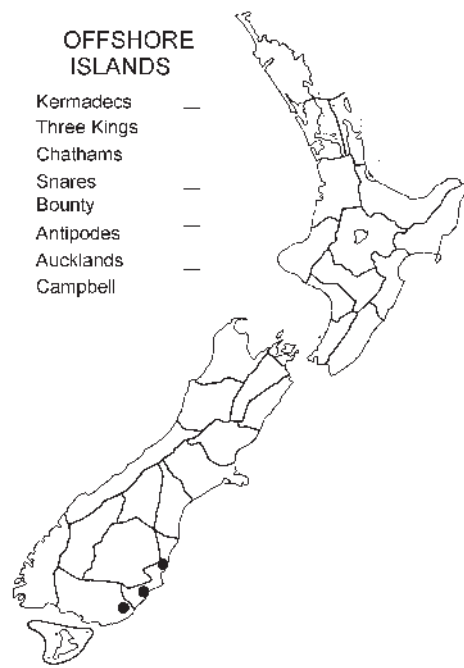
Map 7 Collection localities, *Mitophyllus dispar*



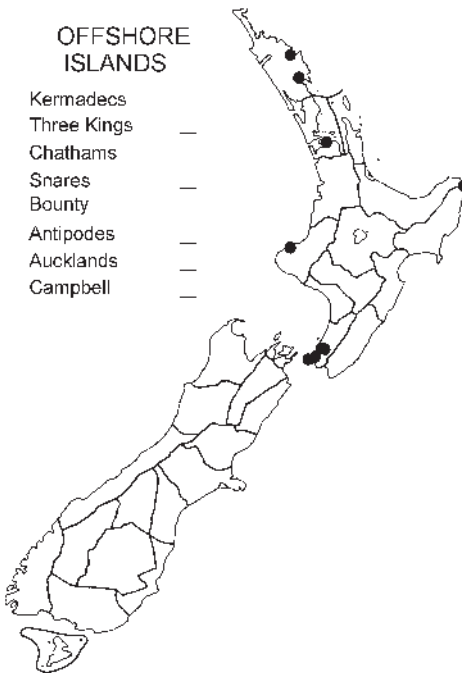
Map 8 Collection localities, *Mitophyllus falcatus*



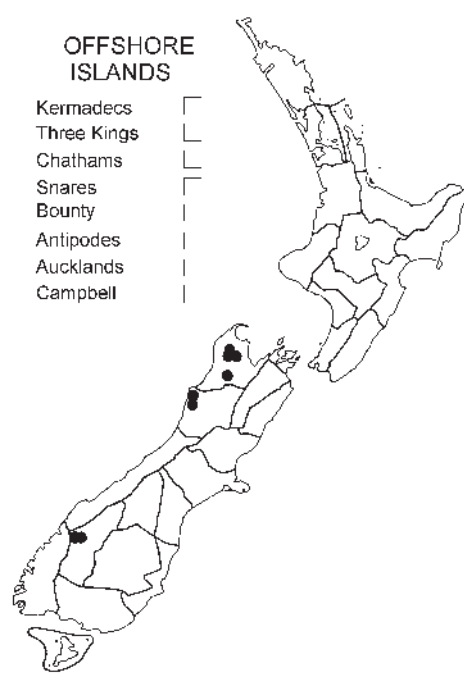
Map 9 Collection localities, *Mitophyllus foveolatus*



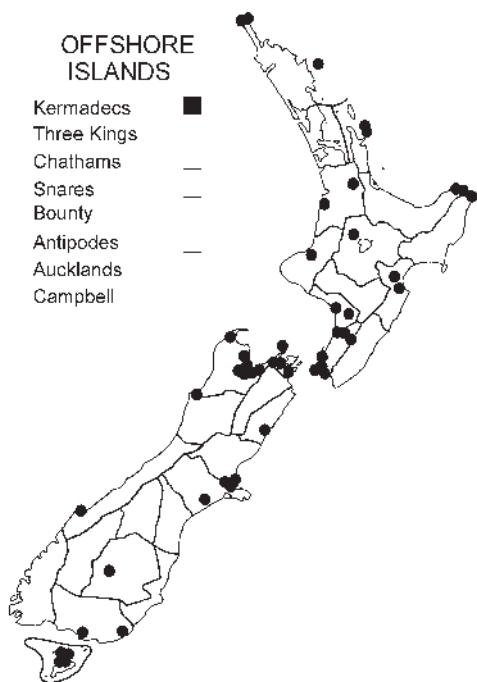
Map 10 Collection localities, *Mitophyllus fuscus*



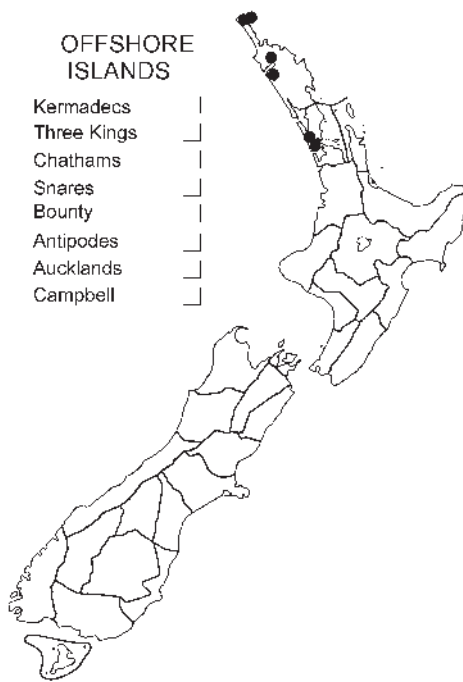
Map 11 Collection localities, *Mitophyllus gibbosus*



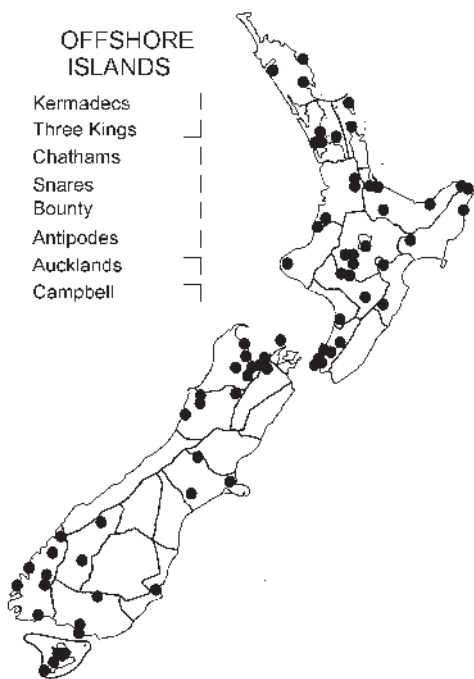
Map 12 Collection localities, *Mitophyllus insignis*



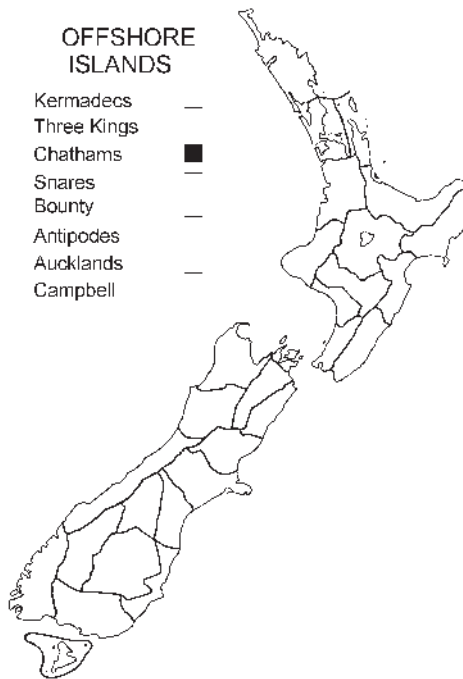
Map 13 Collection localities, *Mitophyllus irroratus*



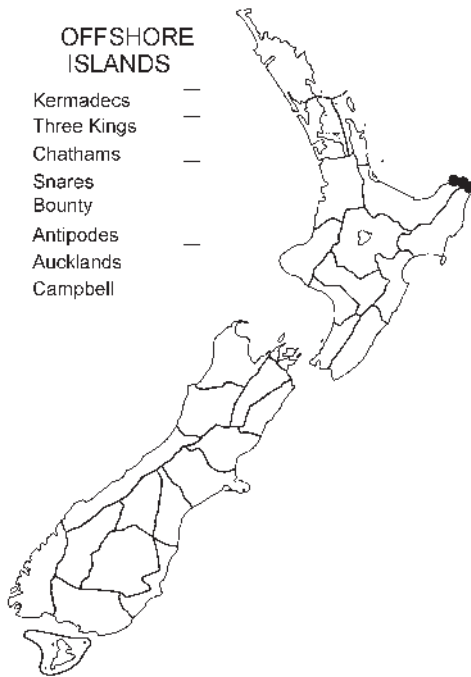
Map 14 Collection localities, *Mitophyllus macrocerus*



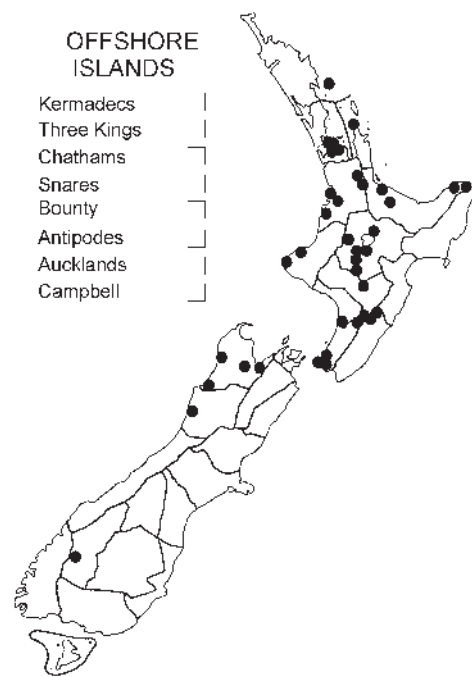
Map 15 Collection localities, *Mitophyllus parianus*



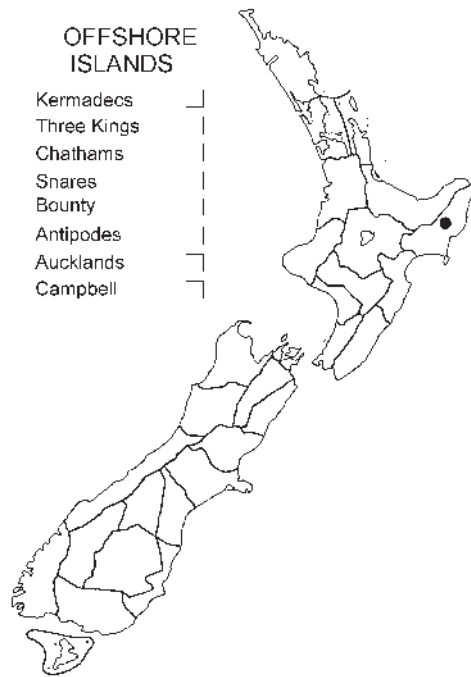
Map 16 Collection localities, *Mitophyllus reflexus*



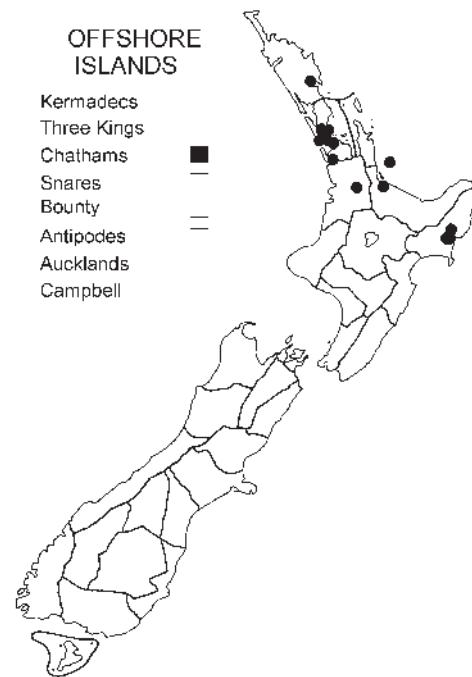
Map 17 Collection localities, *Mitophyllus solox*



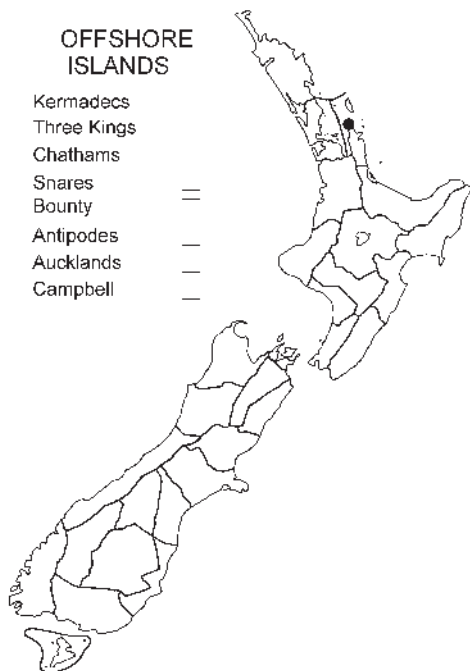
Map 18 Collection localities, *Dendroblox earlii*



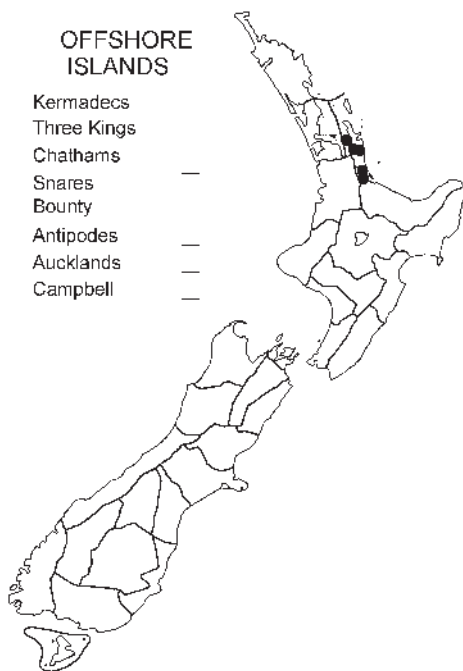
Map 19 Collection localities, *Lamprima aurata*



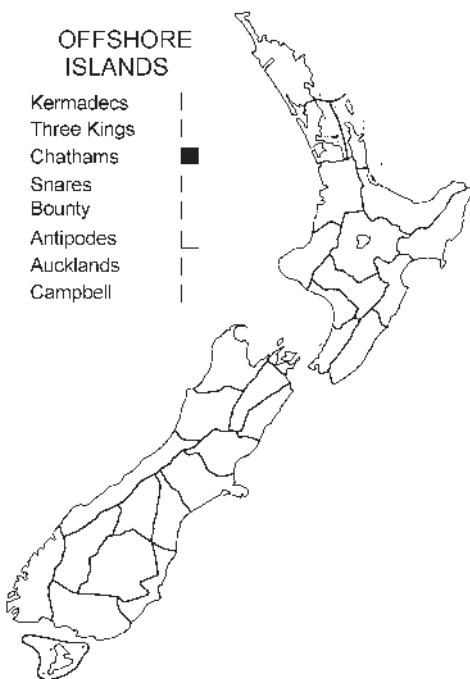
Map 20 Collection localities, *Syndesus comutus*



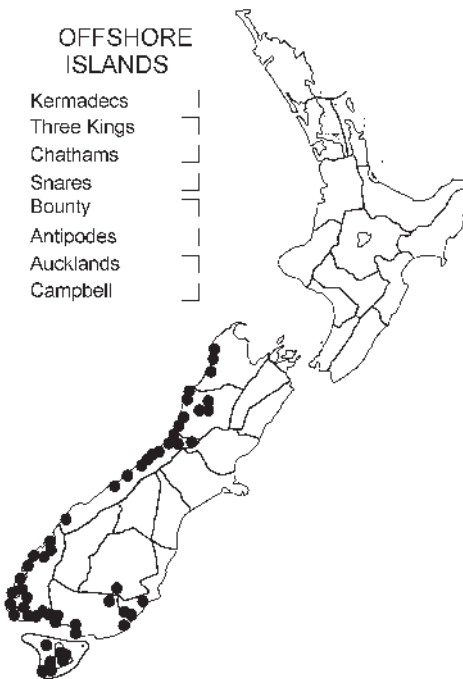
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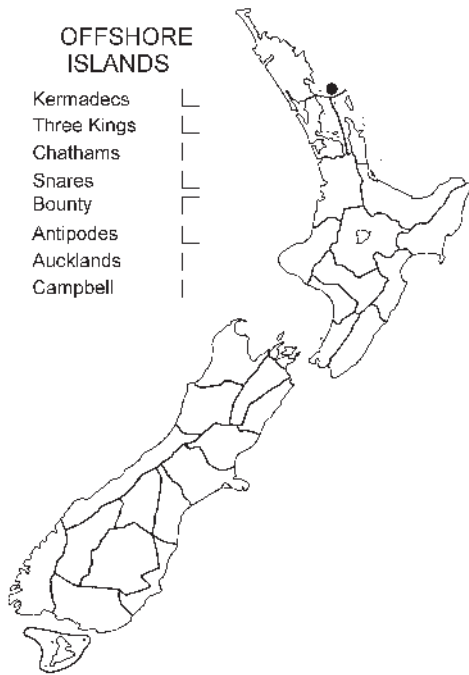
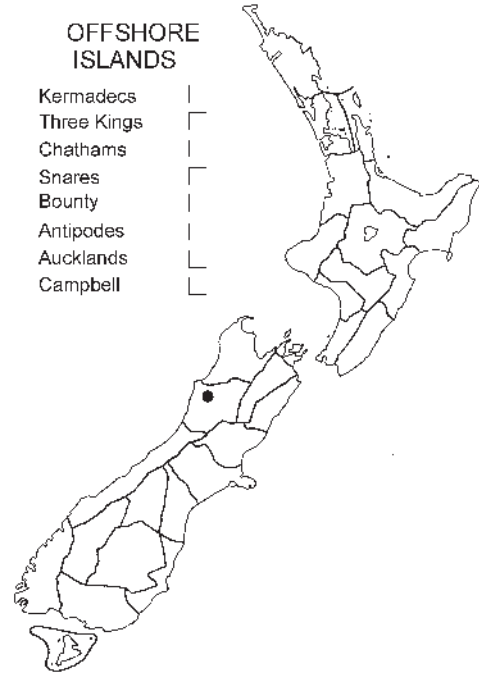
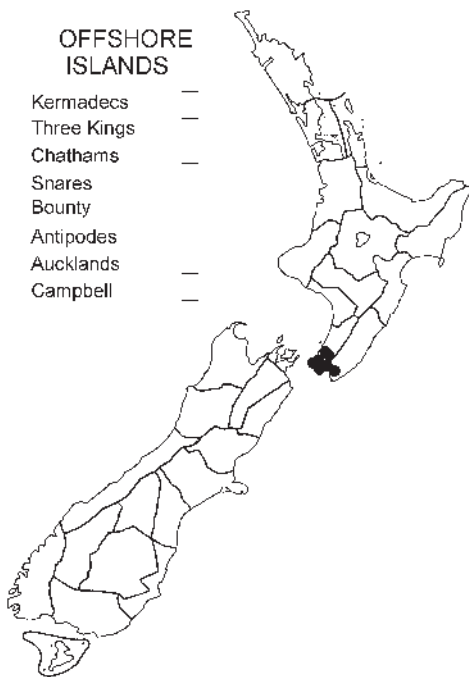
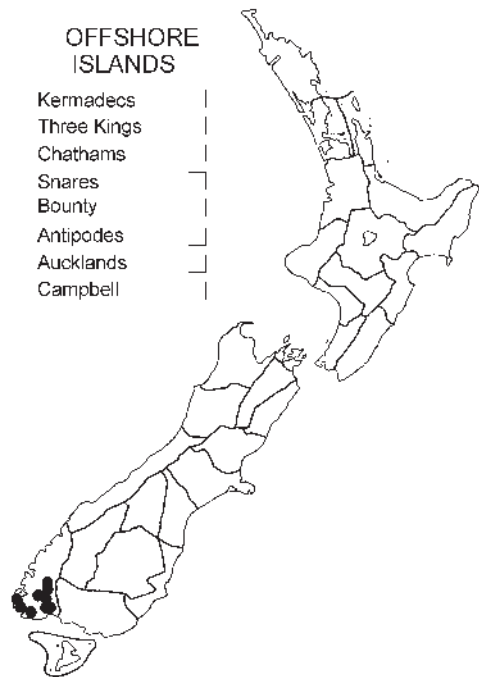
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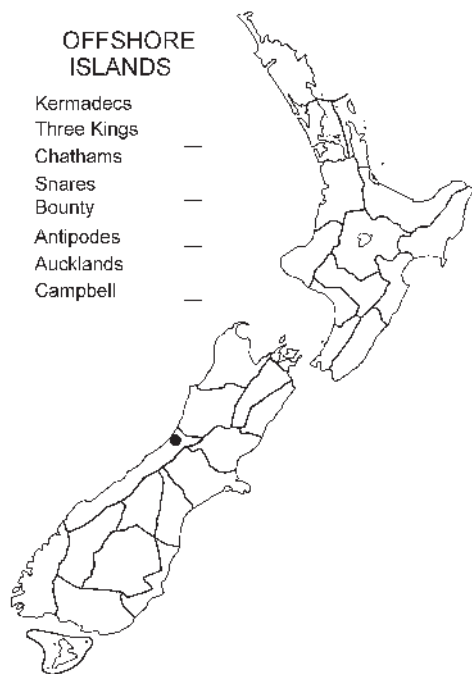


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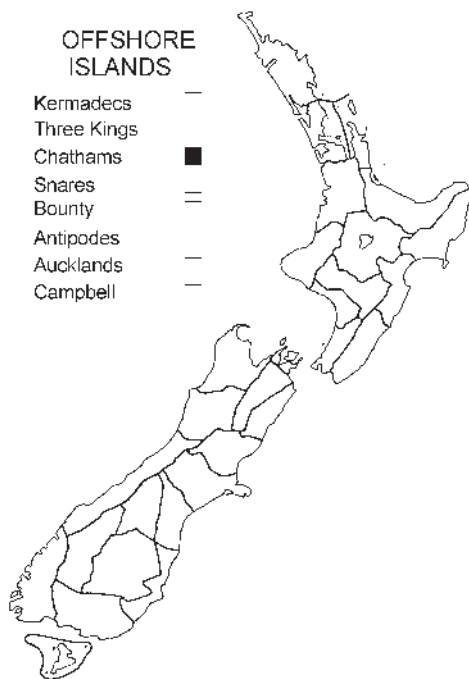


Map 24 Collection localities, *Geodorcus helmsi*

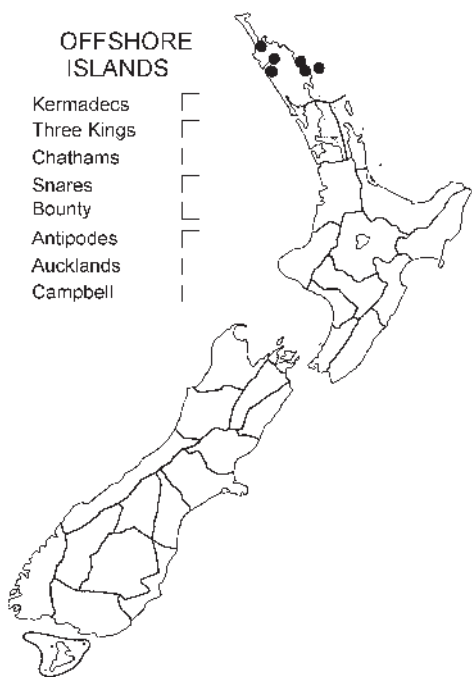
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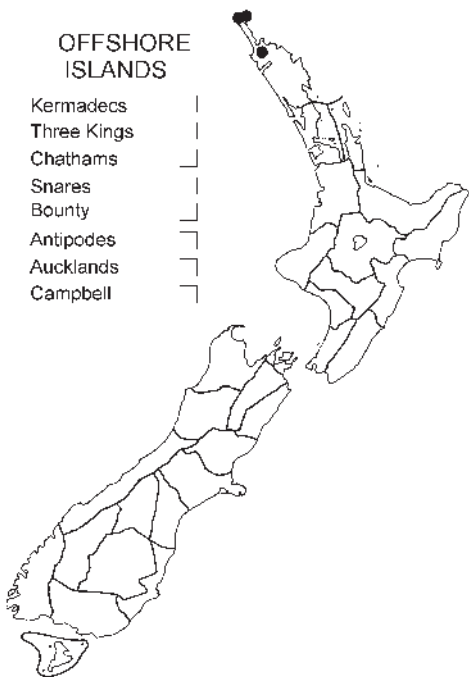
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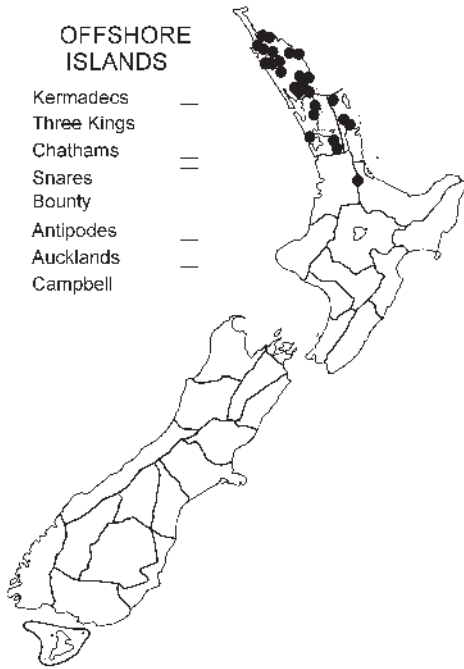
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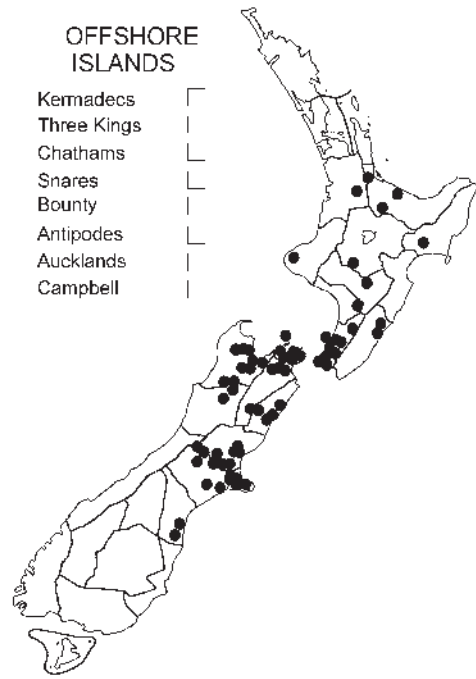
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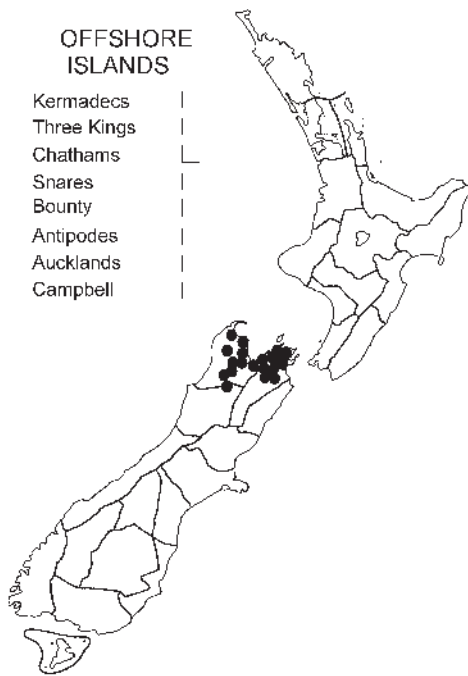
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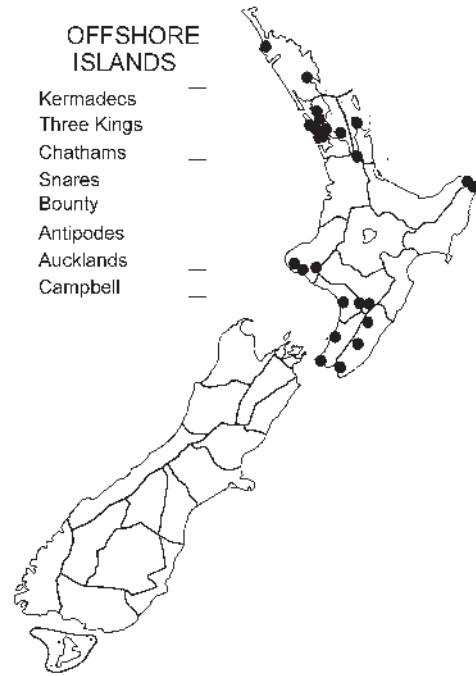
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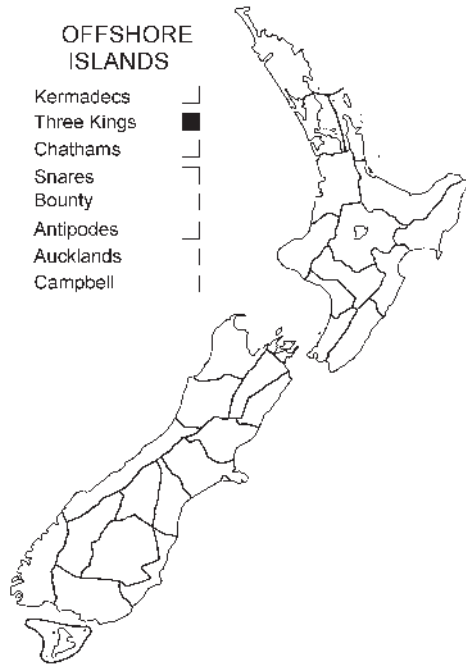
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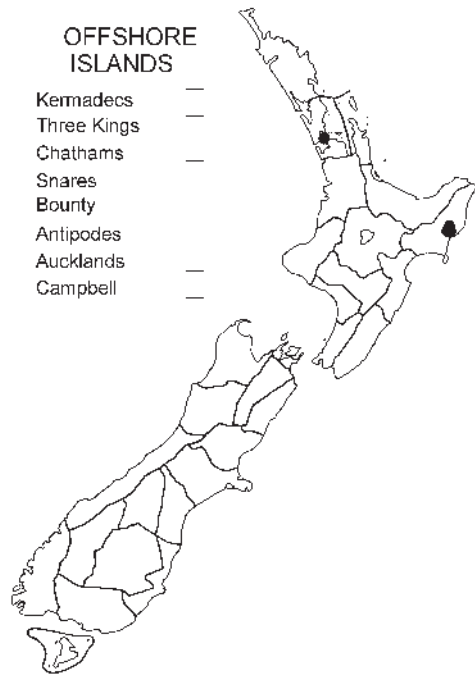
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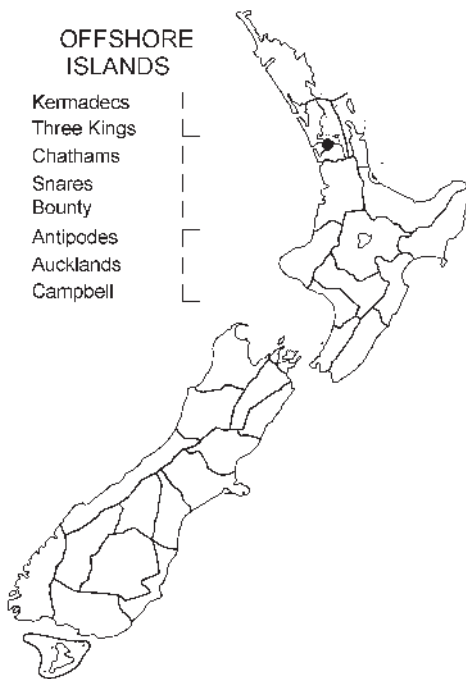
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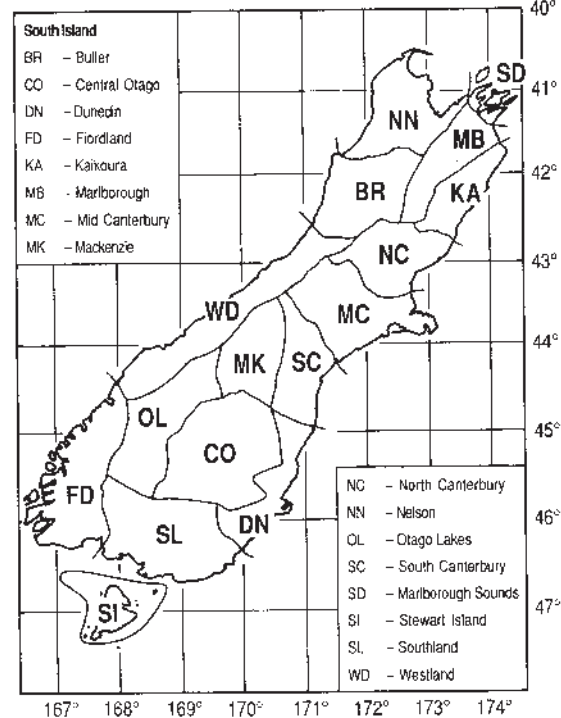
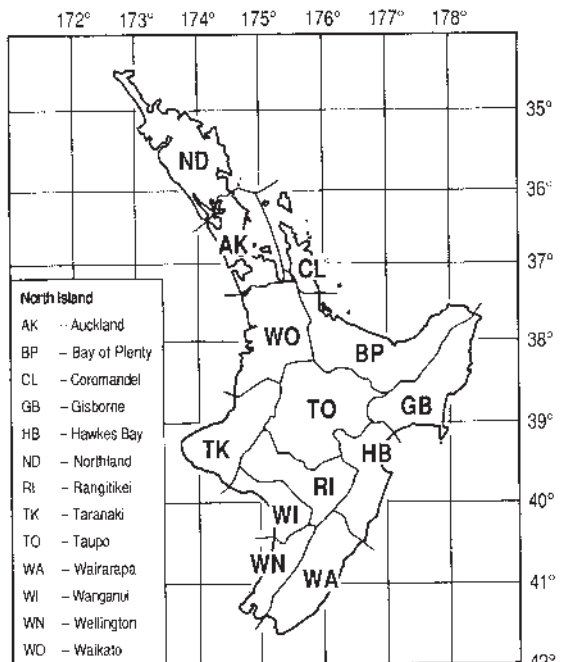
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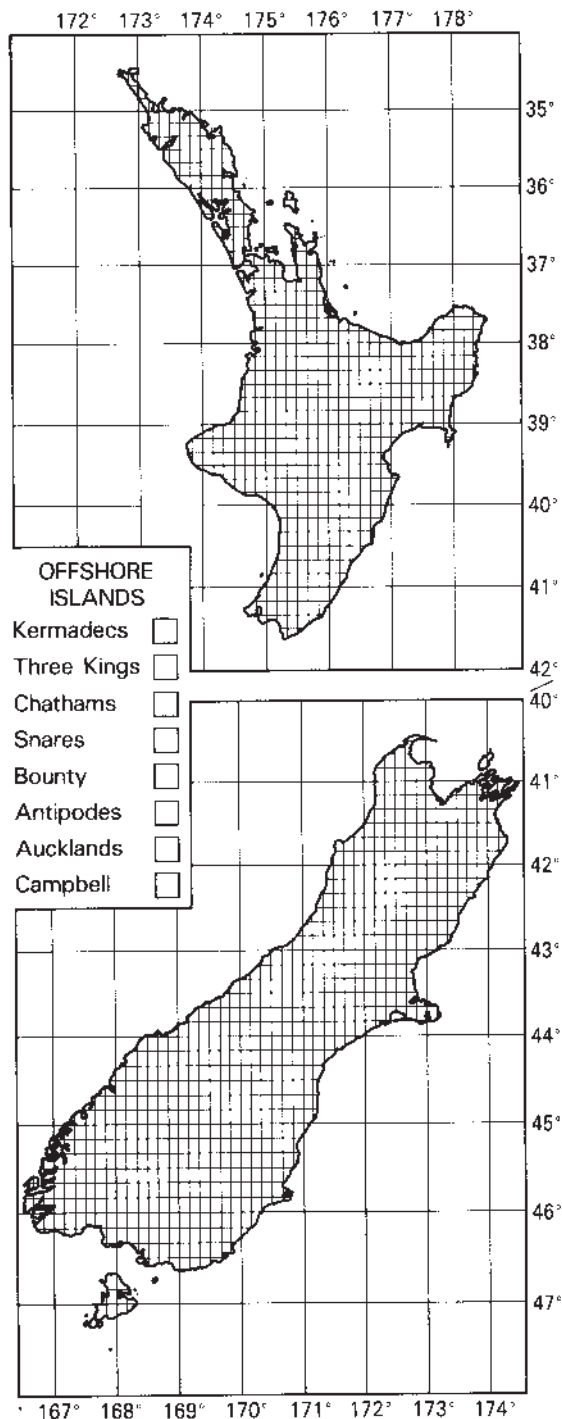
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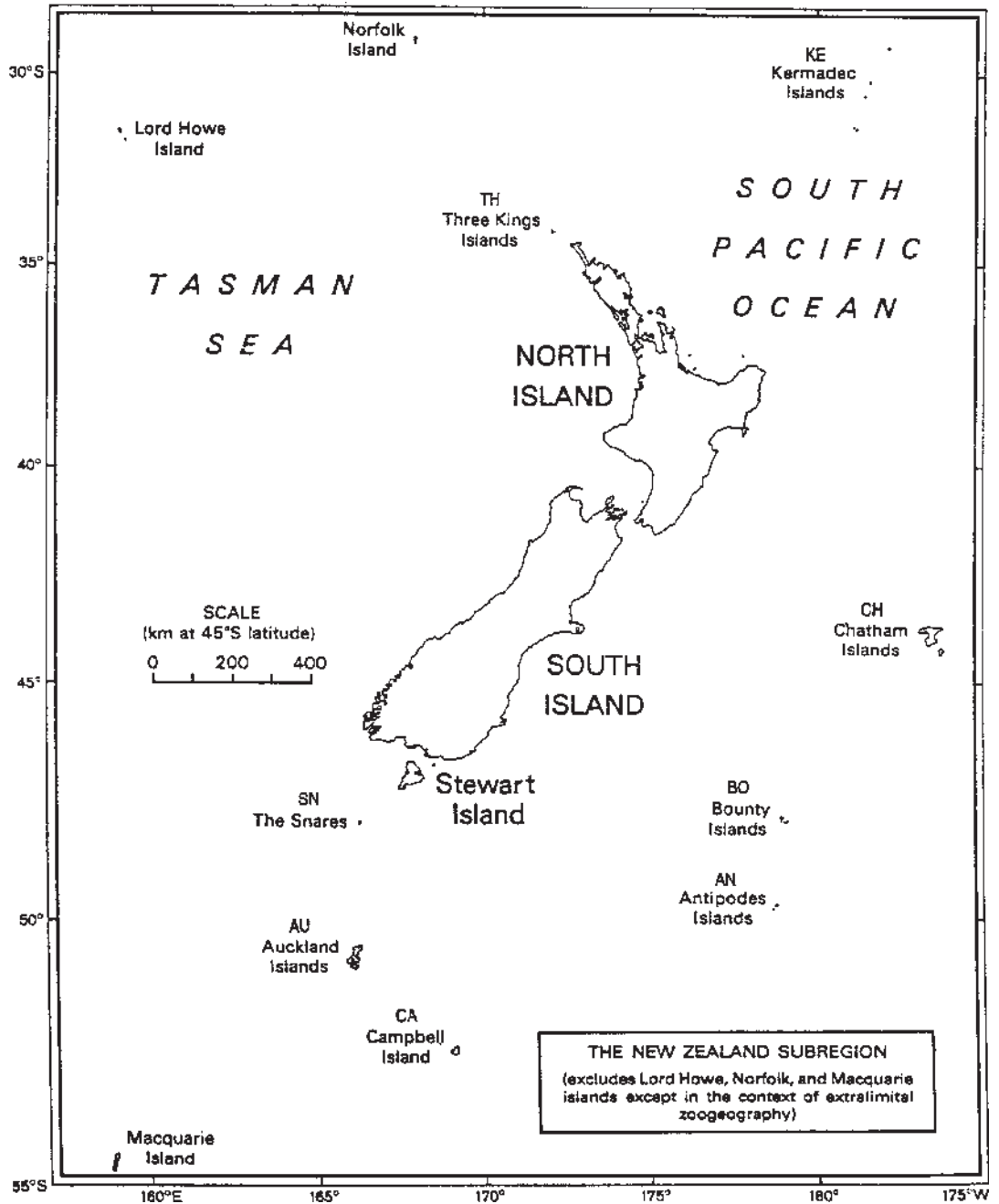
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Area codes and boundaries used to categorise specimen locality data (after Crosby *et al.* 1976)



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Amphipoda

- Talitridae (*K.W. Duncan*, FNZ 31, 1994)

Mollusca

Gastropoda

- Naturalised terrestrial Stylommatophora (*G.M. Barker*, FNZ 38, 1999)

Nematoda

- Tylenchida: Criconeematina (*W. M. Wouts*, FNZ 55, 2006)

NOTICES

This series of refereed publications has been established to encourage those with expert knowledge to publish concise yet comprehensive accounts of elements in the New Zealand fauna. The series is professional in its conception and presentation, yet every effort is made to provide resources for identification and information that are accessible to the non-specialist.

Fauna of N.Z. deals with non-marine invertebrates only, since the vertebrates are well documented, and marine forms are covered by the series *Marine Fauna of N.Z.*

Contributions are invited from any person with the requisite specialist skills and resources. Material from the N.Z. Arthropod Collection is available for study.

Contributors should discuss their intentions with a member of the Invertebrate Systematics Advisory Group or with the Series Editor before commencing work; all necessary guidance will be given.

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NGĀ PĀNUI

Kua whakatūria tēnei huinga pukapuka hei whakahauhau i ngā tohunga whai mātauranga kia whakaputa i ngā kōrero poto, engari he whaikiko tonu, e pā ana ki ngā aitanga pepeke o Aotearoa. He tōtika tonu te āhua o ngā tuhituhi, engari ko te tino whāinga, kia mārāma te marea ki ngā tohu tautuhi o ia ngārara, o ia ngārara, me te roanga atu o ngā kōrero mō tēnā, mō tēnā.

He tirotohi whāiti tā tēnei pukapuka ki ngā mea noho whenua, kāore he tuarā; i pēnei ai i te mea kei te mōhio whānuitia ngā mea whai tuarā, ā, ko ngā mea noho moana, koirā te tino kaupapa o te huinga pukapuka *Marine Fauna of N.Z.*

Ka āhehi te tangata ki te **whakauru tuhituhinga** mehemea kei a ia ngā tohungatanga me ngā rauemi e tutuki pai ai tana mahi. Heoi anō, e wātea ana te Kohinga Angawaho o Aotearoa hei āta tirotohi mā te tangata mehemea he āwhina kei reira.

Me whāki te kaituhi i ōna whakaaro ki tētahi o te Kāhui Ārahi Whakarōpūtanga Tuarā-Kore, ki te ġtita rānei i mua i te tīmatanga, ā, mā rātou a ia e ārahi mō te wāhi ki tana tuhinga.

Ko te hunga pīrangi **hoko pukapuka**, me tuhi ki *Fauna of N.Z.*, Manaaki Whenua Press, Manaaki Whenua, Pouaka Poutāpeta 40, Lincoln 8152, Aotearoa.

E rua ngā tūmomo kaihoko: “A” – kaihoko tūmau, ka tukua ia pukapuka, ia pukapuka, me te nama, i muri tonu i te tānga; “B” – ka tukua ngā pānui whakatairanga me ngā puka tonu i ōna wā anō.

Te utu (tirohia “Titles in print”, whārangi 261). Ko te kōpaki me te pane kuini kei roto i te utu. Me utu te hunga e noho ana i Aotearoa me Ahitereiria ki ngā tāra o Aotearoa. Ko ētahi atu me utu te moni kua tohua, ki ngā tāra Merikana, ki te nui o te moni rānei e rite ana.

E toe ana he pukapuka o ngā putanga katoa o mua. Mehemea e hiahia ana koe ki te katoa o ngā pukapuka, ki ētahi rānei, tonoa mai kia whakaheke te utu. Tekau ōrau te heke iho o te utu ki ngā toa hoko pukapuka.