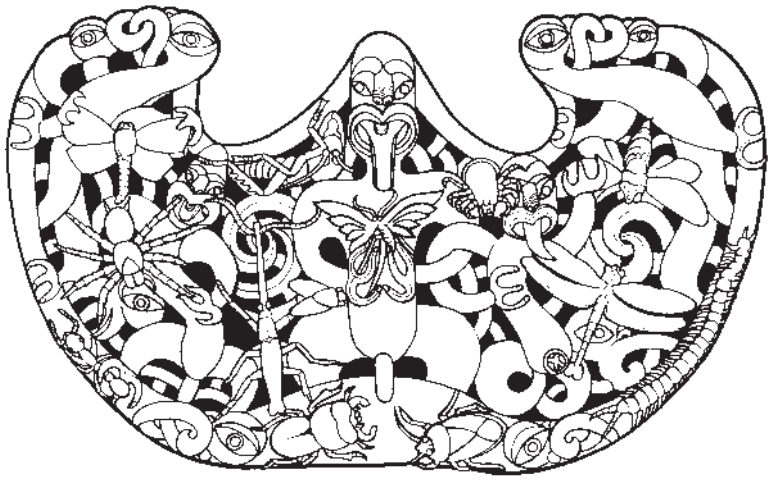

Fauna of New Zealand

Ko te Aitanga Pepeke o Aotearoa

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Fauna of New Zealand
Ko te Aitanga Pepeke o Aotearoa

Number / Nama 46

Nesameletidae

(Insecta: Ephemeroptera)

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Manaaki Whenua PRESS

Lincoln, Canterbury, New Zealand
2003

Cataloguing in publication

HITCHINGS, T. R. (Terry R.)
Nesameletidae (Insecta: Ephemeroptera) / T. R. Hitchings & A. H. Staniczek
– Lincoln, Canterbury, N.Z. : Manaaki Whenua Press, 2003.
(Fauna of New Zealand, ISSN 0111–5383 ; no. 46).
ISBN 0-478-09349-7

I. Staniczek, A. H. II. Title. III. Series.

UDC 595.734

Suggested citation:
Hitchings, T. R.; Staniczek, A. H. 2003 Nesameletidae (Insecta: Ephemeroptera). *Fauna of New Zealand 46*, 72 pp.

Prepared for publication by the series editor using computer-based text processing, layout, and printing at Landcare Research, Mt Albert Research Centre, Private Bag 92170, Auckland, New Zealand

Māori text by H. Jacob, Huatau Consultants, Levin.

Published by Manaaki Whenua Press, Landcare Research, P.O. Box 40, Lincoln, Canterbury, N.Z.
Website: http://www.mwpress.co.nz/

Printed by PrintLink Ltd, Wellington

Front cover: Larval stage of the small swimming mayfly *Nesameletus ornatus.* (Illustrator: L. Barbour).

Publication of the *Fauna of New Zealand* series is the result of a research investment by the Foundation for Research, Science and Technology under contract number C09X0202.

POPULAR SUMMARY **HE WHAKARĀPOPOTOTANGA**

Class **Insecta**

Order **Ephemeroptera**

Family **Nesameletidae**

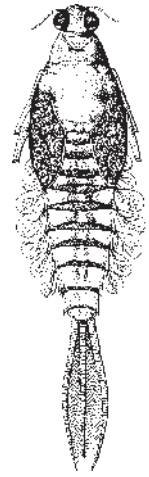


Illustration / Whakaahua: Larval stage of the mayfly *Nesameletus vulcanus* found only on Banks Peninsula, Canterbury (Illustrator / Kaiwhakaahua: L. Barbour).

Swimming mayflies

New Zealand mayflies (Ephemeroptera) are average-sized insects, with the adults having two pairs of membranous wings. The forewings are much larger than the hind wings and held vertically at rest. New Zealand mayfly adults have three tail filaments, at least two of which are very long. The juvenile stage is aquatic and has abdominal gills that resemble small leaves, along each side of the first seven abdominal segments. It also has a tail of three filaments.

Like other orders of insects, mayflies are distributed worldwide except for a few oceanic islands and the polar zones. However, the Ephemeroptera is a small order, far from fully identified; with about 2500 named species at present. In New Zealand, this order is represented by 40 described species classified in 8 families, although the list is by no means complete. Three-quarters of the known species are classified in the family Leptophlebiidae. Most New Zealand leptophlebiids are adapted for clinging to the undersides of stones and boulders in streams. However, the species of the family Nesameletidae, represented in New Zealand by a single genus *Nesameletus,* are free swimming and able to dart about with agility to escape predators. Their torpedo-shaped bodies and three tail filaments, each fringed with lateral hairs, enable them swim rapidly with dorsoventral undulations for short distances. They are sometimes referred to collectively by trout fishermen as "the grey darter". Two other New Zealand families of mayflies also show these body adaptations: the Rallidentidae and the Siphlaenigmatidae. Both of these latter are relatively uncommon. The genus *Nesameletus* and its five described species are all endemic. Other members of the family inhabit southern South America and southeastern Australia.

(continued overleaf)

Ngā rangitahi kauhoe

Kāore e tino nui, kāore rānei e tino iti ngā rangitahi o Aotearoa (Ephemeroptera). E whā ngā parirau kiriuhi o ngā mea pakeke. He rahi noa ake ngā parirau o mua i ngā parirau o muri, ā, kia whakangā te rangitahi, kua tū matika ngā parirau o mua. E toru ngā io i te tou o te rangitahi pakeke o Aotearoa. Ka noho ngā io nei hei 'whiore' mōna. E rua, ko te katoa rānei o ēnei io, he tino roa rawa atu. He noho wai ngā punua, ā, he pihapiha kei ana kaokao he rite ki te rau iti te hanga. Ka noho mai ngā pihapiha nei ki ngā wāhanga tuatahi e whitu o tana puku. E toru anō hoki ngā io i te tou o te punua. Pērā anō i ērā atu pūtoi pepeke, kitea ai ngā rangitahi i ngā tōpito katoa o te ao, hāunga anō ētahi moutere i te aumoana me ngā kōpakatanga o te ao. Heoi anō, he pūtoi iti te Ephemeroptera, ā, kāore anō kia tautohua ōna huānga katoa. Taka mai ki tēnei wā, e 2500 ngā momo kua whakaingoatia. I Aotearoa nei, e 40 ngā rangitahi o te pūtoi Ephemeroptera kua whakaahuatia ā-kupu, nō ētahi whānau e 8, engari kāore e kore arā ētahi huānga kāore anō i mōhiotia. Ko tētahi toru hauwhā o ngā momo e mōhiotia ana, nō te whānau Leptophlebiidae. Ko te nuinga o ngā leptophlebiid o Aotearoa, he whai urutaunga e pai ai tā rātou piri ki te mata whakararo o ngā kōhatu me ngā toka i te kōawa. Engari ko ngā momo o te whānau Nesameletidae, ko ōna uri i Aotearoa nei nō te puninga kotahi e kīia ana ko te *Nesameletus*, ka kauhoe noa, ka āhei anō ki te kōkirikiri ki hea, ki hea hei karo i te

(haere tonu)

The juvenile aquatic stage of mayflies is referred to as a nymph or larva, the latter term being used in this work. New Zealand mayfly species almost invariably develop in unpolluted running water, feeding on algae and plant material and converting it into biomass. This process forms a vital step in the food chain, which is continued by the predators of mayflies such as other insects, crustaceans, fish, and birds.

The Nesameletidae are widely distributed in New Zealand, but three species appear to be confined to the South Island and two of these are known only from restricted areas. All species tend to be found in smaller streams and trickles, often concealed among trailing vegetation where water flow rates are moderate to slow.

Nesameletus larvae develop for a year, increasing in body length to between 10 and 20 mm. This is achieved by a succession of moults. As the last of these is about to take place, the insect leaves the water and climbs a few centimeters up on to a rock surface above the waterline where it sheds its larval shuck and emerges as a subimago, the first of the two successive winged stages. This incompletely developed adult, especially with regard to the reproductive system, flies a short distance to better concealment on streamside vegetation, where it rests for up to two days. A further moult gives rise to the fully mature adult, the imago, which flies, mates, and dies within a day or so. Both subimago and imago have highly atrophied mouthparts, so do not feed. The female imago usually flies in an upstream direction to compensate for the downstream drifting of eggs and larvae. Eggs are laid directly on to a water surface where the current is slow.

The larvae of swimming mayflies are easily recognised by eye, but distinguishing *Nesameletus* from *Rallidens* and *Siphlaenigma* requires a hand lens. Identification of individual species can be done with a low to medium powered stereomicroscope. Confirmation of species may require dissection of the mouthparts and subsequent examination with more powerful magnification.

Subimagos and imagos of the Nesameletidae can be distinguished from other mayfly families by comparison of the fore- and hindwing venation using a hand lens. Identification to species level can also be achieved with low magnification of the forewing pattern of venation. With subimagos, the distinctive patterns of forewing vein clouding can be compared with the photographs of the forewings of reared specimens. In the case of imagos, low magnification of the genitalia and comparison with the diagrams should confirm the identification.

hoariri. Me te waka whāiti te hanga o te tinana, ā, nā tērā me ngā io whai huruhuru e toru i tana tou, ka tere tonu tana kauhoe ki kō i runga i te oreore whakarunga, whakararo o te tinana. Koirā i karangahia ai tēnei whānau e te hunga hī ika ko 'te hanga kōkirikiri kiwikiwi'. E rua atu anō ngā whānau rangitahi o Aotearoa kei a rātou ēnei urutaunga taha tinana, ko ngāi Rallidentidae me ngāi Siphlaenigmatidae. Heoi, me uaua ēnei ka kitea. Ko Aotearoa anake te whenua e kitea ai te puninga *Nesameletus* me ngā momo e rima o tēnei puninga kua whakaahuatia. Ko ērā atu huānga o te whānau nei, kei te taha tonga o Amerika ki te Tonga, ā, kei te tonga-mā-whiti o Ahitereiria.

I tēnei o ngā rangahautanga, e kīia ana ngā punua noho wai o te rangitahi he torongū. Ka tipu ake te tino nuinga o ngā momo rangitahi o Aotearoa i ngā wai rere para kore. Kai ai ngā punua i te pūkohu me ētahi atu tipu, ana ka huri hei 'pūngao koiora'. He tino wāhi kei a rātou i roto i te meka kai. Ka whakawhiti atu te pūngao koiora nei i ngā rangitahi ki ō rātou hoariri, arā, ki ētahi atu pepeke, ki ngā kōurapaka, ki ngā ika, me ngā manu.

Kua marara te noho a ngā Nesameletidae ki te motu whānui, engari e toru ngā momo kei Te Waipounamu anake, ā, e rua o ēnei e noho ana ki ētahi rohe whāiti. Katoa te whānau, ka noho ki ngā kōawa iti me ngā kuikuinga, ki ngā otaota tārewa pea i ngā wāhi kāore e tino tere te rere o te wai.

Ka kotahi tau ngā torongū *Nesameletus* e tipu ana, ka eke te roa o te tinana ki waenga i te 10 mm me te 20 mm. He maha ngā kounutanga i tana kiri e taea ai tēnei. I mua tata mai i te kounutanga whakamutunga, ka puta te torongū i te wai, ka piki mō ētahi henimita ki tētahi toka kei runga paku ake i te mata o te wai, ki reira whakarere ai i tana kahu torongū. Ānana, puta ake ana ko te rangitahi taiohi. Ko te tūātipu whai parirau tuatahi tēnei o ētahi tūātipu whai parirau e rua. Kāore anō i pakeke rawa te hanga o te rangitahi i tēnei wā — ko ngā taonga whakaputa uri tētahi wāhanga ōna kāore anō i pakari. Ka rere te pepeke nei ki tētahi wāhi pātata i te taha o te kōawa, kia pai ai tana huna ki ngā otaota e tipu ana i reira. He tata ki te rua rā he whakatā kau te mahi, kātahi ka kounu anō, ka puta ko te rangitahi pakeke. Ka rere, ka whakaputa uri, ā, he rā noa iho pea i muri mai, ka mate. Kāore he take o ngā wāhanga o te waha o te rangitahi taiohi me te rangitahi pakeke, nō reira kāore ia e kai. Ko te tikanga ka rere te uwha ki runga ake o te kōawa ki te whakaputa i ana hua, he mōhio nōna ka whai ngā hua me ngā torongū i te ia o te wai. Tukuna ai ana hua ki te mata tonu o te wai, ki te wāhi o te kōawa kāore e tino kaha te ia.

He māmā te tautohu ā-karu i ngā torongū o ngā rangitahi kauhoe, engari me whakamahi rawa he arotahi ka puritia ki te ringa hei wehewehe i ngā *Nesameletus* mai i ngā

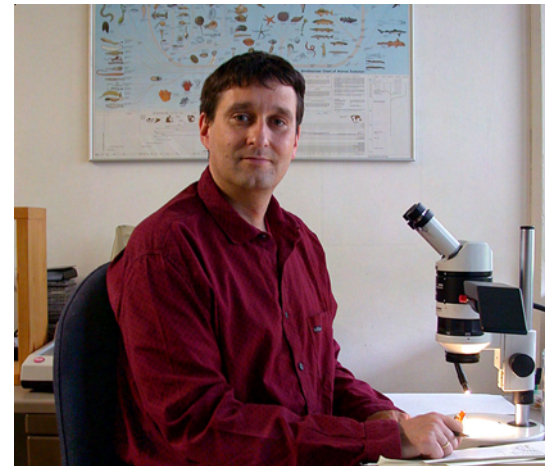
(haere tonu)

Contributor **Terry Hitchings** is an honorary research fellow in Invertebrate Zoology at the Canterbury Museum, Christchurch. His particular responsibilities include the curation and enhancement of the Ephemeroptera collection and its associated database. Particular interests include the distribution, taxonomy, and phylogeny of New Zealand mayflies.

He paewai rangahau utukore a **Terry Hitchings** i raro i te maru o te Mātai Kararehe Tuarā Kore, i te Whare Taonga o Waitaha, Ōtautahi. Ko ana kawenga whāiti, ko te tiaki, ko te whakapai ake i te kohinga Ephemeroptera me te pātengi raraunga e pā ana ki te kohinga. Ko ētahi o ngā kaupapa e arohia nuitia ana e ia, ko te tohanga, te whakarōpūtanga me te kunenga mai o ngā rangitahi o Aotearoa.

Contributor **Arnold Staniczek** studied biology and paleontology at the universities of Tübingen, Germany, and Helsinki, Finland. He became involved with mayflies during his diploma thesis on the postembryonal development of *Baetis rhodani* (Ephemeroptera: Baetidae). Spending several months in New Zealand in 1994, Arnold became focused on the local mayfly fauna. In 2001 he graduated from Tübingen University, where his Ph.D. work on the larval head morphology of the New Zealand mayfly *Oniscigaster wakefieldi* and the position of Ephemeroptera in the phylogenetic system of insects was supported by a research fellowship of the Federal State of Baden-Württemberg, Germany. Arnold joined the Natural History Museum of Stuttgart, Germany, in 2002, with responsibility for the research on fossil and extant mayflies.

Ko te mātauranga koiora me te mātauranga mātātoka ngā kaupapa ako a **Arnold Staniczek**, i ngā whare wānanga o Tübingen, i Tiamana, me Helsinki, i Hinerangi. Nōna e mahi ana i tana tuhinga roa pōkairua e pā ana ki te whanake haere o te *Baetis rhodani* (Ephemeroptera: Baetidae) i muri i te kikiringa, ka tīmata tana aro nui ki ngā rangitahi. I Aotearoa ia mō ētahi marama maha i te tau 1994, ā, koirā te pūtakenga o tana arotahi ki ngā rangitahi o tēnei whenua. Ka whakawhiwhia ia ki tana Tākutatanga i te 2001, i te Whare Wānanga o Tübingen. Ko te kaupapa o tana Tākutatanga, ko te hanga o te ūpoko o te torongū o te *Oniscigaster wakefieldi* (he rangitahi nō Aotearoa) me te tūranga o te Ephemeroptera i roto i te kunenga mai o ngā aitanga pepeke, ā, i tērā wā i whakawhiwhia ia ki tētahi tūranga paewai rangahau e te Rohe Whānui o Baden-Württemberg, i Tiamana. Nō te tau 2002 ka whiwhi tūranga ia i te Whare Taonga mō te Ao Tūroa i Stuttgart, Tiamana. I reira ka riro māna e whakahaere ngā rangahautanga e pā ana ki ngā rangitahi mātātoka me ngā rangitahi e ora tonu ana. Ko ētahi tino kaupapa āna, ko te hanga o te tinana, te whakapapa me te kunenga mai o ngā Ephemeroptera.



Translation by **H. Jacob**
Huatau Consultants, Levin

Rallidens me ngā *Siphlaenigma*. Mā te whakamahi karu whakarahi ahutoru āhua kaha nei e tautohua ai ngā momo. Heoi anō, i ētahi wā, hei whakaū i te tautohunga, me āta tapahi te waha, ka āta tirotiro ki te karu whakarahi kaha tonu.

Hei wehewehe i ngā taiohi me ngā pakeke o te whānau Nesameletidae mai i ērā atu whānau rangitahi, ka tirohia ngā ioio o ngā parirau o mua, o muri anō hoki ki te arotahi ka puritia ki te ringa. Ka taea anō te tautohu ngā momo ina tirohia te tauira ioio o ngā parirau o mua ki te karu whakarahi āhua ngoikore nei. Mō te wāhi ki ngā taiohi, ka whakatairitea te tauira mataauahi i ngā ioio o te parirau o mua ki ngā whakaahua o ngā parirau o mua o ētahi momo kua āta whakatipuria. Mō te wāhi ki ngā mea pakeke, ko tōna tikanga mā te tirotiro i ngā taihemahema ki te karu whakarahi ngoikore nei, me te whakatairite ki ngā hoahoa e whakaūngia ai te tautohunga.

Frontispiece: Small swimming mayfly, *Nesameletus ornatus* (Eaton, 1883). Male imago (top), female imago (bottom) (photographs W. J. Crawford)

ABSTRACT

The New Zealand members of the mayfly family Nesameletidae are revised. The two presently named species, *Nesameletus ornatus* and *Nesameletus flavitinctus,* are redescribed, and three new species (*N. murihiku, N. austrinus,* and *N. vulcanus*) are added to the genus *Nesameletus.* The eggs and larval stages of the different species are also described and associated with their respective adult stages. The diagnosis of the genus *Nesameletus* is specified, and the autapomorphies of the Nesameletidae are listed. The phylogenetic relationships within the genus and family are also discussed. Notes on ecology are given, and distribution maps of the species are provided. Diagnostic characters of the species are illustrated and keys are provided for all life stages.

Keywords: Ephemeroptera, key, mayflies, mayfly, Nesameletidae, new species, New Zealand, phylogeny, phylogenetic systematics, revision, Siphlonuroidea, taxonomy

Hitchings, T. R.; Staniczek, A. H. 2003. Nesameletidae (Insecta: Ephemeroptera). *Fauna of New Zealand 46*, 72 pp.

Received: 11 September 2002. Accepted: 29 January 2003.

CHECKLIST OF TAXA

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ACKNOWLEDGMENTS

We wish to thank S. D. Pollard and J. B. Ward (Canterbury Museum, Christchurch), D. R. Towns (Department of Conservation, Auckland), W. J. Crawford (Taupo), all of New Zealand, J. Peters (Florida A&M University, Florida, USA) and E. Weber (University of Tübingen, Germany) for discussion and proofreading of the manuscript. E. Dominguez (University of Tucuman) and L. Miserendino (National University of Patagonia), both of Argentina, and D. Bickel (Australian Museum, Sydney, Australia) kindly loaned comparative material. Many thanks to J. Hallermann (University of Hamburg, Germany) for his help acquiring a copy of Ulmer's paper. H. Schoppmann (University of Tübingen, Germany) helped with the SEMs, and B. Rhode (Landcare Research, Auckland, N.Z.) did figure layouts. Thanks to L. Barbour (Christchurch, N.Z.) for the larval habitus drawings and I. M. Henderson (Massey University, Palmerston North, N.Z.) for the use of his mapping programme and lending material from his collection. We are also grateful to the many collectors whose efforts made the distribution maps possible and also to S. J. Brooks, D. Carter and D. T. Goodger (all of The Natural History Museum, London, U.K.), T. K. Crosby (New Zealand Arthropod Collection, Auckland, N.Z.), O. S. Flint Jr. (Na-

tional Museum of Natural History, Washington, D.C. USA), R. L. Palma (Museum of New Zealand, Wellington, N.Z.), B. H. Patrick (Otago Museum, Dunedin N.Z.), W. L. Peters (Florida A&M University, Florida, USA) and K. A. J. Wise (Auckland Mueum, Auckland, N.Z.), all of whom made materials from their collections available to us. We also thank the editor and the two referees for their helpful comments and suggestions. The Department of Conservation permitted collecting of mayflies on Stewart Island (permit #93/5/8) and at other times and places. This study was financially supported by the European Union's TMR programme (Training and Mobility of Researchers) to make possible the study of Nesameletidae at The Natural History Museum, London.

INTRODUCTION

TAXONOMIC HISTORY

The Nesameletidae are a family of amphinotic distribution comprising *Ameletoides* Tillyard, 1933 of Australia with one described species, *Metamonius* (Eaton, 1885) of South America with three described species, and *Nesameletus* Tillyard, 1933 of New Zealand with two described species and three more added here. The taxonomic status of each of these genera is in need of review.

In the past, genera of the Nesameletidae have been commonly placed within the subfamily Siphlonurinae, or as a separate subfamily among the Siphlonuridae *sensu lato*. The latter were recognised as a paraphyletic assemblage by McCafferty (1991) and Kluge *et al.* (1995). This consequently led to a split of the Siphlonuridae s.l. ("Siphlonuroidea") into several monophyletic taxa that are now generally classified as families, among them the Nesameletidae (Kluge *et al*., 1995).

The first imago of the Nesameletidae was described as *Siphlurus anceps* by Eaton (1883), who shortly thereafter established for it the new genus *Metamonius* (Eaton, 1885). Eaton (1883) described another species, later to be known as *Nesameletus ornatus*, under the name *Chirotonetes (?) ornatus.* He gave complementary details in successive addenda (Eaton, 1885, 1888). As the larvae were unknown at that time, he did not appreciate its similarity to *Metamonius*, but finally transferred *Chirotonetes (?) ornatus* to the holarctic genus *Ameletus* (Eaton 1899). The larva of *Metamonius* was first described as "Nymphe des Baetis-Typus" by Ulmer (1904), who did not associate it with its corresponding adult forms.

When Tillyard (1923) described the imago of a second species of *Nesameletus*, *N. flavitinctus*, he also placed it in the genus *Ameletus*, but at the same time he noted the considerable difference from its type species, *A. subnotatus*. Phillips (1930) in his revision of New Zealand mayflies gave a detailed account of *Nesameletus ornatus* and for the first time described its larva, but still referred to it as "genus *Ameletus* (New Zealand Type)". The genus *Nesameletus* was formally established by Tillyard, who also described for the first time the Australian genus and single species *Ameletoides lacusalbinae* in this contribution (Tillyard, 1933). He was also the first to provide diagnoses separating the two genera. Navas (1935) described the imago of another South American species, *Metamonius hollermayeri*. Lestage (1935a) was the first to appreciate the similarity of Ulmer's (1904) "Nymphe des Baetis-Typus" with the larva described by Phillips (1930). Lestage (1935a) consequently named Ulmer's South American larva *Ameletus fuegiensis*, but after notice of Tillyard's new genera he transferred it to *Ameletoides* (Lestage 1935b). Ulmer (1938) discussed Lestage's (1935b) placement and concurred. Demoulin (1955a) was the first to suspect a synonymy of the imago of *Metamonius* with the larvae previously described as "Nymphe des Baetis-Typus" by Ulmer (1904) and as *Ameletoides fuegiensis* by Lestage (1935a). The close relationship of the three genera was fully revealed when Demoulin (1955b) managed to associate the adult stages of *Metamonius anceps* with its characteristic larva. Demoulin (1955b) also gave a new diagnosis of the genus *Metamonius* and transferred *Ameletoides fuegiensis* to *Metamonius*. Riek (1955) revised *Ameletoides*.

Kluge *et al.* (1995) discussed some family characters as well as the possible phylogenetic relationship of the family. Kluge (1998b) enumerated autapomorphies of the family and rejected the discriminating characters for the different genera of Nesameletidae as stated by Tillyard (1933), leaving the taxonomy of the family unresolved.

As a first step to a better understanding of the Nesameletidae, we revise the New Zealand genus *Nesameletus* in this contribution. We list the hitherto known autapomorphic characters of the Nesameletidae and give a discriminating diagnosis of the genus *Nesameletus*. Based on museum collections and our own collections undertaken over the past six years, we redescribe the winged stages of the two previously known species, *N. ornatus* and *N. flavitinctus*, and give for the first time descriptions of their respective larvae and eggs. The descriptions of three new species are added.

PHYLOGENETIC RELATIONSHIPS WITHIN THE NESAMELETIDAE

Within the Nesameletidae, the different species are phenetically very similar to each other and previous authors have had difficulty in providing separate diagnoses for the three genera. Kluge (1998b) states that "separate

diagnoses of these taxa are absent". Indeed, the diagnostic generic characters of *Nesameletus* listed by previous authors also apply to the Australian and South American species of the family.

Most of the numerous characters that were set out by Tillyard (1933), particularly by contrast with the Australian genus *Ameletoides*, do not withstand a closer examination. We cannot confirm any of the listed differences regarding the anatomy of the larval mandible, maxilla, tibia, imaginal claws, and hind wings. A strongly reduced paracercus and the basal attachment of MP_2 also apply to *Metamonius*. We also cannot confirm any of the differences noted by Tillyard (1933), Lestage (1935b), and Demoulin (1955a) concerning the serration of the larval claws. Ulmer (1938) repeated Tillyard's assumption of a weak tibiopatellar suture in *Nesameletus*, a difference we also did not observe (Fig. 4). The additional characters Demoulin (1955b) lists for *Metamonius* also apply to *Nesameletus*.

For our cladistic analysis we have chosen 16 characters that were investigated in *Ameletoides lacusalbinae*, *Metamonius anceps*, *Metamonius* sp., and all presently known species of *Nesameletus* (Fig. 7). *Rallidens mcfarlanei* (Rallidentidae) and *Siphluriscus chinensis* (Siphluriscidae) were chosen for outgroup comparison.

The results indicate that each genus of the Nesameletidae is monophyletic. The monophyly of *Nesameletus* (Fig. 7 char. 5–7) is supported by the presence of terminal fibre-clusters in the eggs (Fig. 63, 65, 67, 69, 71, 73), small spines on the aboral side of the larval prementum basal to insertion of labial palps (Fig. 52–56), and the basal narrowing of the penes in the male adults (Fig. 79–83). We did not have the opportunity to investigate eggs of *Ameletoides* and *Metamonius* ourselves, so we base our conclusions on the observations of Koss & Edmunds (1974). However these authors did not observe terminal fibre clusters in *Nesameletus* either, so it may be appropriate to reinvestigate the eggs of *Ameletoides* and *Metamonius* in this respect. The male genitalia of *Nesameletus* (Fig. 79–83), *Ameletoides* (Fig. 84), and *Metamonius* (Fig. 85–86) are similar to each other and have a common medial indention. The monophyly of *Metamonius* (Fig. 7 char. 9) is also supported by the penis morphology (Fig. 85–86).

Autapomorphies of *Ameletoides* (Fig. 7 char. 8, 16) are the basal connection of MP_2 to CuA in the fore wing (Fig. 18, 102), and possibly the long row of setae on the postmentum in the larva (Fig. 57). Demoulin (1955b) mentioned that the wing character was not consistent, but all the specimens in the BMNH show this character. The postmentum character could not be checked in *Metamonius* (Fig. 58). Its absence in *Metamonius* would establish the postmentum setae as further autapomorphic character of *Ameletoides*. Its presence in *Metamonius* would point to a sister-group relationship of both groups.

Zoogeographic extrapolations of other amphinotic mayfly taxa would lead us to assume a sister-group relationship between *Ameletoides* and *Metamonius* (see also Edmunds 1981), but so far we have been unable to determine an unique derived character that would convincingly establish a sister-group relationship between these two of the three genera. The reduced paracercus of *Nesameletus* and *Metamonius* (Fig. 7, char. 15) is in our view also not sufficient to establish a sister-group relationship between these groups, because this character is known to be highly variable within different mayfly taxa. However, as all three genera seem to be separate monophyletic entities, we refrain from synonymising the genera as suggested by Kluge (1998b).

The phylogenetic analysis within *Nesameletus* clearly points to a closer relationship of *N. ornatus* + (*N. flavitinctus* + *N. murihiku*). This clade (Fig. 7 char. 10–12) is very well supported by the presence of clustered cross veins in the apical half of cells Sc and R_1 of the fore wing, the disconnected veins R_{3A} and R_{3B} (Fig. 2, 8, 10, 12), and possibly the two transverse bands of pigments in the subimaginal fore wing (Fig. 92, 94, 96).

A sister-group relationship between *N. flavitinctus* and *N. murihiku* (Fig. 7 char.13–14) is supported by the elongated penes (Fig. 80–81) and the thickening of the cross veins between R_1 and R_2 (Fig. 10, 12, 94, 96). On the other hand, *N. austrinus* and *N. vulcanus* may be sister-groups as well (Fig. 7 char. 12). However, this is only supported by the significantly weaker pigmentation of the subimaginal wings (Fig. 98–101) and the character polarisation of the wing pigmentation is somewhat uncertain with respect to the various character states in the different taxa. While the subimago of *Ameletoides* has numerous irregular blotches (Fig. 102), *Metamonius* has no pigmentation at all in the subimaginal wing. Outgroup comparison with *Rallidens* (no pigmentation in the subimaginal wing) would indicate an unpigmented subimaginal wing in the groundplan (see terminology, p. 14) of the Nesameletidae as well, but *Nesameletus* may have developed a pigmented wing in its groundplan, and the weak or lacking pigmentation in *N. austrinus* + *N. vulcanus* thus may be a secondary reduction within the genus. We are aware of the fact that these are not very strong characters to establish a sister-group relationship, but on the other hand we have not found any indication for a closer relationship of *N. vulcanus* or *N. austrinus* with any other species of *Nesameletus*. So at present a sister-group relationship between *N. austrinus* and *N. vulcanus* remains the best supported hypothesis.

Each species of *Nesameletus* has at least one unique autapomorphy. The strong development of chorionic fibre-coils (Fig. 63,73), the spines on the postmentum shoulders (Fig. 52), and the dark medial band across the larval cerci and paracercus (Fig. 23) are autapomorphies of *N. ornatus.* The wings tinged with greenish yellow and the irregular distribution of the basal prementum spines (Fig. 53) are autapomorphies of *N. flavitinctus*. The suprachorionic tubercles (Fig. 67) in the egg of *N. murihiku*, the reddish tinge of the pterostigma in the adult, and the medial notch of the male subgenital plate (Fig. 81) are autapomorphies of this species. The autapomorphic characters of *N. austrinus* are the elongated female subgenital plate (Fig. 90), the rounded apices of the penes (Fig. 82), and the extension of the pigmentation of abdominal ganglia to several segments. The reduction of the posterior spines on the anterior abdominal terga (Fig.104–107) and the reduction of the lateral abdominal spines are autapomorphies of *N. vulcanus.*

PHYLOGENETIC RELATIONSHIPS WITHIN THE EPHEMEROPTERA

The phylogenetic relationships of the Nesameletidae to other families have been unresolved and under discussion for a long time (McCafferty 1991; Kluge *et al*. 1995), but with the recent discovery of the larva of *Siphluriscus chinensis* (Siphluriscidae) a sister-group relationship between Nesameletidae and Siphluriscidae seems to be possible (Zhou & Peters *in press*). Both families share the unique anatomy of the larval mandible (Staniczek 2000; Zhou & Peters *in press*): its incisors are fused and form an elongated gouge-like scraping tool. The prostheca is reduced in both taxa. In Nesameletidae the prostheca is bipartite. Its ventral part is reduced to two bristles in the right mandible and a single bristle in the left one. In both left and right mandible of *Siphluriscus* the dorsal part is entirely lost and the ventral part is reduced to two bristles (Zhou & Peters *in press*). The middle articulation of the mandible in both taxa is elevated and forms a plate-like knob, the corresponding part of the anterior tentorial arm is kidney-shaped (own observation, AHS). Similar mandibular arrangements with fused incisors as, for example, found in the afrotropical baetid genus *Xyrodromeus* (Lugo-Ortiz & McCafferty 1997) are considered herein to have evolved independently. Further synapomorphic characters of Nesameletidae + Siphluriscidae could be the opisthognathous orientation of the larval head and its mouthparts. Correlated with this character is the extremely elongated larval postmentum in both taxa (own observation, AHS). The posterior projection of the vertex is another synapomorphy of the imaginal life stage of both groups (see also Kluge, 1998b).

Prior to the discovery of the larva of *Siphluriscus chinensis*, all these characters mentioned above were regarded as autapomorphies of the Nesameletidae. However, there still remain some uniquely derived characters that define the Nesameletidae as a monophylum (Fig. 7, char. 1–4). These characters include most likely the arrangement of the quadripartite apex of the maxilla and its spination pattern (Fig. 46–47). The medial part of the lacinia is extended to a membranous lamina (Fig. 46). In the left mandible, the ventral part of the prostheca is reduced to a single bristle (Fig. 39). Finally the tips of glossae, paraglossae, and labial palps are covered with stout setae (Fig. 48–50).

Some characters found in other families and that may be autapomorphic characters of higher taxa were thus not considered. For example, the elongated glossae and paraglossae are also present in the Siphluriscidae and Baetidae and might be also present in the groundplan of Baetoidea (Staniczek 1997). A tubular maxillar gill tuft as in the Nesameletidae is also present in the Rallidentidae (Penniket 1966), whereas similar maxillar and also coxal gill tufts as in the Siphluriscidae are also present within the Setisura. Maxillar gills were even suggested as synapomorphic character of Nesameletidae + Rallidentidae + Setisura by Demoulin (1969). Kluge *et al.* (1995) rejected the homology of the maxillar gills in these groups, but a closer study of the different maxillar gill tufts in these taxa may shed new light on the phylogeny of these taxa.

DISTRIBUTION

The phylogeny of *Nesameletus* fits well with the distribution of the various species. *N. ornatus* (map 1) is widely spread throughout both the North Island and South Island. In the southern South Island, the northern distribution limits of *N. murihiku* (map 3) and the southern limits of *N. flavitinctus* (map 2) remain uncertain. However, our present knowledge points to an allopatric distribution pattern of both species.

Nesameletus austrinus (map 4) is confined to the South Island. The restriction of *N. vulcanus* (map 5) to Banks Peninsula points to an earlier dispersal event from the South Island by the stem species of *N. vulcanus* + *N. austrinus.* This probably took place at a time when Banks Peninsula was still separated from the South Island. A volcanic island formed in the late Miocene and Pliocene (Stipp & McDougall 1968), Banks Peninsula has been joined to the South Island and separated from it by broad straits during the higher sea levels of interglacial periods (Fleming 1980). Several species of cicadas, stoneflies, ground beetles, and other invertebrate groups are also

restricted to the peninsula (Johns 1986). Except for Banks Peninsula and Stewart Island, no species of *Nesameletus* has been found on the other adjacent islands of New Zealand.

MATERIALS, METHODS, AND CONVENTIONS

Larvae and winged stages of *Nesameletus* were collected throughout New Zealand including Stewart Island by many collectors. To associate larvae with the respective imagos, older instar larvae were usually kept in rearing cages in their native waters until they emerged. Specimens, including type-species, have been stored in 80% ethanol.

SEM. Larval material used for scanning electron microscopy was gained from late instar larvae. Dissected mouthparts, legs, and eggs were dehydrated through a stepwise immersion in ethanol and acetone, and then dried by critical point drying. The mounted material was coated with a 20 nm Au/Pd layer and examined with a Cambridge Stereoscan 250 MK 2 scanning electron microscope at 10 kV.

Light microscopy. Material used for drawings was dissected, mounted on microscopic slides, embedded in Euparal, and viewed under a regular light microscope at 100– 400x magnitude.

Dimensions. For the imagos and larvae of each species, a range of body lengths and their means (in parentheses), and lengths of fore- and hindwings, are given. Length ratios of foreleg segments (femur : tibia : tarsomeres 1–5) are based on length of tibia (absolute measurement in mm, in parentheses).

Collecting sites are grouped into regions of New Zealand using the system proposed by Crosby *et al.* (1976, 1998). Each region has been allocated a two-letter code as follows: **AK** – Auckland; **BP** – Bay of Plenty; **BR** – Buller; **CL** – Coromandel; **CO** – Central Otago; **DN** – Dunedin; **FD** – Fiordland; **GB** – Gisborne; **HB** – Hawkes Bay; **KA** – Kaikoura; **MB** – Marlborough; **MC** – Mid Canterbury; **MK** – McKenzie; **NC** – North Canterbury; **ND** – Northland; **NN** – Nelson; **OL** – Otago Lakes; **RI** – Rangitikei; **SC** – South Canterbury; **SD** – Marlborough Sounds; **SI** – Stewart Island; **SL** – Southland; **TK** – Taranaki; **TO** – Taupo; **WA** – Wairarapa; **WD** – Westland; **WI** – Wanganui; **WN** – Wellington; **WO** – Waikato.

Abbreviations in site descriptions: Br – Bridge, Ck – Creek, L – Lake, R – River, Ra – Range, Stm – Stream, Trib – Tributary.

Map references and altitudes are given in metric coordinates from the map series NZMS 260. The first group of 5 figures gives the east-west grid coordinate to the nearest 100 metres. The second group of 5 figures gives the north-south grid coordinate similarly. The final group of 1 or more figures gives the height above mean sea level in metres. Information relating these grid references to the Canterbury Museum mayfly database is given elsewhere (Hitchings 2001). The equivalent latitude and longitude coordinates are provided in Appendix 2.

Collections. Where stated, material examined is held at the following locations:

AMNZ Auckland Institute and Museum, Auckland, New Zealand
BMNH The Natural History Museum, London, U.K.
FAMU Florida A&M University, Tallahassee, Florida, U.S.A.
IMHC I.M. Henderson private collection, Massey University, Palmerston North, New Zealand.
MONZ Museum of New Zealand Te Papa Tongarewa, Wellington, New Zealand
NMNH National Museum of Natural History, Washington D.C., U.S.A.
NZAC New Zealand Arthropod Collection, Landcare Research, Auckland, New Zealand
OMNZ Otago Museum, Dunedin, New Zealand
SMNS Staatliches Museum für Naturkunde, Stuttgart, Germany

Otherwise it is deposited at:

CMNZ Canterbury Museum, Christchurch, New Zealand

Collectors. ACH, A. C. Harris; ACM, A. C. Maturin; ADH, A. D. Huryn; AGM, A. G. McFarlane; AHS, A. H. Staniczek; ALM, A. C. McLellan; ARM, A. R. Mackintosh; B&H, B. & H. Patrick; BHP, B. H. Patrick; BJS, B. J. Smith; BML, B. M. Lyford; CHE, C. Herd; DRT, D. R. Towns; EDW, E. Edwards; GCP, G. C. Penney; GHO, G. Holmes; GWG, G. W. Gibbs; H&C, T. R. Hitchings & W. J. Crawford; H&G, T. R. Hitchings & M. T. Gillies; H&H, T. R. Hitchings & G. Holmes; H&Q, T. R. Hitchings & P. J. Quinn; IDM, I. D. McLellan; IMH, I. M. Henderson; J&B, J. B. Ward & B. J. Smith; J&G, J. B. & G. M. Ward; J&S, J. B. Ward & S. J. Morris; JBJ, J. B. Ward, B. H. Patrick & J. S. Dugdale; JBW, J. B. Ward; JGP, J. G. Penniket; JRJ, J. R. Jackson; JSH, J. S. Harding; KAW, K. A. J. Wise; KFO, K. J. Fox; KSH, K. Shearer; L&J, L.

Chadderton & J. Harding; LJS, L. J. Seear; LOG, R. Logan; M&H, K. R. McSweeney & T. R. Hitchings; MAP, M. A. Provis; MTG, M. T. Gillies; MWH, M. W. Hitchings; O&C, O. J. & C. Flint; PHI, D. Phibbs; PHN, P. H. Norrie; PLE, P. T. Leaf; PMJ, P. M. Johns; RLP, R. L. C. Pilgrim; RSA, R. A. Savill; SJM, S. J. Morris; T&B, T. R. Hitchings & B. J. Smith; TRH, T. R. Hitchings; WJC, W. J. Crawford.

Terminology. Commonly used names for some of the external features of a mayfly adult are given in Fig. 1 and for the larva in Fig. 5. Wings are described according to the terminology of Edmunds and Traver (1954) (Fig. 2, 3), labia according to Snodgrass (1935) (Fig. 48–58). Names of larval mouthparts are given in Fig. 6 and for the larval leg in Fig. 4. Egg terminology is based on Koss & Edmunds (1974). The term groundplan is used herein sensu Hennig (1950) and refers to the entire character set of the last common stem species of a monophyletic taxon.

KEYS TO TAXA

Some species of *Nesameletus* may show geographic variation. Identifications based on the following keys should be verified by comparison with the diagrams of the imaginal genitalia. With the larval stage it may be necessary to confirm identification by rearing through to the imago. The key for eggs is based on observations by SEM and only of limited use for observations undertaken by light microscopy. These separations are based on the use of fresh specimens in alcohol. Other additional species of *Nesameletus* remain to be identified and described.

Imago

1 Forewing in its distal 1/2 with pterostigmatic region showing evenly distributed cross-veins between Sc and R_1 2

—Forewing in its distal 1/2 with pterostigmatic region showing clustering of cross-veins between Sc and R_1 3

2(1) Bullae of forewing surrounded by dark blotches of pigmentation and thus conspicuous, each femur without a dark band ..... (p. 26) ... ***vulcanus***

—Bullae of forewing without blotches of pigmentation and thus inconspicuous, each femur with a dark band ..... (p. 24) ... ***austrinus***

3(1) Clustered cross-veins in the pterostigmatic region of forewing between R_1 and R_2 thinner than cross-veins between Sc and R_1 ..... (p. 18) ... ***ornatus***

—Clustered cross-veins in the pterostigmatic region of forewing between R_1 and R_2 at least as thick as cross-veins between Sc and R_1 4

4(3) Pterostigmatic region of forewing tinted reddish; cross-veins between C and Sc in this region reticulated .... (p. 22) ... ***murihiku***

—Pterostigmatic region of forewing neither tinted reddish nor with many reticulated cross-veins .... (p. 20) ... ***flavitinctus***

Subimago

(the subimago can also be identified by using the key for the imago)

1 Forewing without 2 oblique pigmented bands 2

—Forewing with 2 oblique pigmented bands 3

2(1) Forewing with uniform grayish tinge .... (p. 26) ... ***vulcanus***

—Forewing without tinge, totally translucent .... (p. 24) ... ***austrinus***

3(1) Hind wing apically with broad transverse, dark pigmented band ..... (p. 20) ... ***flavitinctus***

—Hind wing apically without broad transverse, dark pigmented band 4

4(3) Pterostigmatic region with many reticulated cross-veins ..... (p. 22) ... ***murihiku***

—Pterostigmatic region with few reticulated cross-veins ..... (p. 18) ... ***ornatus***

Late instar larva

1 Abdominal ganglia strongly pigmented and thus well visible through sterna of segments III–VIII .... (p. 24) ... ***austrinus***

—Abdominal ganglia at most pigmented on sterna V–VII 2

2(1) Posterior borders of abdominal terga VIII and IX only with well developed transverse row of spines. .... (p. 26) ... ***vulcanus***

—Posterior borders of abdominal terga V–IX at least with well developed transverse row of spines present ... 3

3(2) Without dark patches or longitudinal marks on femur I ..... (p. 22) ... ***murihiku***

—With dark patches or longitudinal marks on femur I . 4

4(3) Caudal filaments with distinct dark medial band; labium with several stout spines on postmentum shoulder .. .. (p. 18) ... ***ornatus***

—Caudal filaments rarely with distinct dark medial band; labium without stout spines on postmentum shoulder .....(p. 20) ... ***flavitinctus***

Egg

1 Meshwork of chorionic ridges entirely covered by strongly developed rings of fibre-coils .... (p. 18) ... ***ornatus***

—Chorionic ridges not covered by fibre-coils, only thin rings of fibre-coils present 2

2(1) Chorion ground in the centre of each polygon protruding through large central hole of fibre-cluster, terminal fibre-cluster made up of loosely packed fibres with spiral progression..... (p. 24) ... ***austrinus***

—Chorion ground not visible through centres of fibre-clusters, terminal fibre-clusters made up of densely packed fibres with vertical progression 3

3(2) Terminal fibre-clusters with scattered tubercles centrally and along outer margins(p. 22) ... ***murihiku***

—Terminal fibre-clusters without tubercles 4

4(3) Chorionic ridges about 2 µm thick, chorion ground granulate or smooth .....(p. 20) ... ***flavitinctus***

—Chorionic ridges about 1 µm thick, chorion ground rugose ..... (p. 26) ... ***vulcanus***

DESCRIPTIONS

Family Nesameletidae Kluge *et al.*, 1995

Genus *Nesameletus* Tillyard, 1933

Chirotonetes(?) Eaton, 1883: Pl. 19, fig. 33c. —Eaton, 1885: 208. —Eaton, 1888: 321.

Ameletus Eaton, 1899: 291. —Tillyard, 1923: 228. —Phillips, 1930: 311–331.

Nesameletus Tillyard, 1933: 11. —Lestage, 1935b: 349–350. —Koss & Edmunds, 1974: 301. —Kluge *et al.*, 1995: 115–119. Kluge, 1998b.

Dimensions (mm): Male imagos: body length 10.5–16.5, forewings 11.6–17.5, hind wings 3.9–6.5. Mature male larva: body length 10.4–16.0. Female imagos: body length 9.4–18.0, forewings 10.5–20.0, hind wings 4.0–8.3. Mature female larva: body length 10.0–19.4.

Imago. Eyes of male contiguous medially, with lower portion of each eye 0.75–0.8x as long as the upper portion; eyes of female separated medially by 0.6x the maximum width of the eye; vertex of both genders with a medial projection directed posteriorly.

Legs: Length ratios of foreleg segments in male: 1.04–1.32 : 1.00 (2.4–3.5mm) : 0.31–0.50 : 0.42–0.62 : 0.52–0.70 : 0.41–0.56 : 0.20–0.34. Claws paired, alike, apically hooked with an opposing hook (Fig. 29).

Wings (Fig. 8–21): Forewing: Width one-third of length. Bullae present approximately at midlength on veins Sc, R_1, R_2, and R_{4+5}. Bullae on R_1 and R_{4+5} inconspicuous. Pterostigmatic area with a cluster of numerous cross-veins in the distal half of costal cell. Vein Rs forked at one-third, or a little more or less, of the distance from base to margin. Vein R_{2+3} forked approximately at midlength, fork additionally marked by R_2 bulla. Vein MA symmetrically forked at three-fifths or a little more or less of the distance from base to margin, fork additionally marked by thickened vein MA. Vein MP_2 attached at the base to MP_1 only or MP_2 basally connected to MP_1 and CuA by cross-veins. CuA and CuP connected basally at an acute angle. Distal half of cubital field with a series of more or less sinuous and unforked veins that run from CuA to the hind margin of the wing.

Hind wing: Rounded at the apex with an obtuse-angled costal projection at one-sixth its length. Width of hind wing a little more than half the length. Vein RS basally connected to MA or to cross-veins between R_1 and MA. Vein MA forked at approximately midlength. MP forked at approximately one-fourth of the distance from base to margin. CuA and CuP not forked.

Genitalia (Fig. 22, 79–83): Male styliger plate shallowly to moderately emarginated; forceps with four segments, border between segment 1 and 2 sometimes indistinct; segment 2 at least 3x segment 3; penis lobes fused basally and narrowed at midlength, diverging apically. Penis basally with slight thickening. Female (Fig. 87–91): Sternum IX apically cleft, shallowly to moderately, subgenital plate 0.4–1.1x length of sternum VIII. Terminal filament strongly reduced (Fig. 22), 1.5–3.0 mm. Cerci 13–20 mm.

Late instar larva. Siphlonuroid habitus (Fig. 23–27). Mouthparts slightly opisthognathous (Fig. 28). Antennae filiform, 1/2–3/4 the length of the head, with up to 17 segments. Head with pronounced lower frons, which pro-

trudes between the antennae. Frons with 3 ocelli. Continuous epistomal suture present. Clypeus with convex lateral margins.

Mouthparts: Labrum (Fig. 33): Width a little less than that of clypeus. Length 1/3–2/3 width. Obtuse-angled tormae define lateral corners of basal margin. Lateral margins of labrum convex, labrum entirely covered with scattered hairs. In its proximal half with parasagittal patches of denser hairs. In its distal part with transverse band of very long and densely distributed setae. Distal margin slightly emarginated and bearing several very dense parallel setal fringes. Mandible (Fig. 35–40): Incisors modified to a single elongated tapering gouge perpendicular to the axis of articulation (Fig. 35), often worn to a roughened edge distally (Fig. 36). The prostheca bipartite, dorsally with small group of pennate hairs, ventrally with two long bristles in the left mandible (Fig. 39) and with a single bristle in the right mandible (Fig. 40). Molar surface of the right mandible forming an elongated smooth curve and comprising 15–17 parallel cuticular, serrated ridges, the most ventral of which is the most thickened (Fig. 38). The posteroventral margin with several bristles directed medially, some bristles also present at anterodorsal tip of mola. Left mola (Fig. 37) with almost quadrilateral surface and only about 10 ridges, otherwise similar to the right one. Molar surface of left mandible directed anteriorly, molar surface of right mandible directed posteromedially. Middle articulation of mandible with plate-like elevated knob on outer basal margin of mandible. Hypopharynx (Fig. 34): Lingua flattened laterally and at its widest subapically; the apex well covered with hairs. Superlinguae with ventrolaterally pointed membraneous lobes that are well supplied with hairs, particularly at the apices. Maxilla (Fig. 41–47): maxillary lobes fused to form a galeolacinia, the suture between each well visible (Fig. 43–47). Lacinia expanded medioapically, forming a membraneous lamina with a marginal row of 15–20 larger spines directed medioventrally (Fig. 46, *lam*), but with two spines (dentisetae sensu Kluge *et al.* 1995, Kluge 1998a) markedly thicker than the others (Fig. 46). Posterior lacinia with submarginal row of 3-6 setae present parallel to the marginal row (Fig. 44, 47). Lacinia with a third basal row of 5–6 setae in the mediobasal corner of the posterior side (Fig. 44, 45) and with a single seta distally to this row directed ventrally (Fig. 44, 45). Galea with a row of 4–8 laterodistal marginal setae (Fig. 43–47). Apex of galeolacinia with 4 massive projections that form a gouge (Fig. 46, 47), each projection basally desclerotised (Fig. 46, arrows) and thus passively moveable, and with an additional, bifid seta (Fig. 47, arrow) within the cavity thus formed. Maxillary palp with three segments (Fig. 41–43). Segment 2 four-fifths as long as segment 1 and segment 3 one-third as long as segment 2, the apical portion of segment 3 covered with fine spines. Posterior maxilla with a membranous, tubular extension ("maxillary gill" sensu Phillips, 1930) between cardo and stipes, the extension apically curved and pointed anterolaterally (Fig. 41, 42). Labium (Fig. 48–58): Glossae and paraglossae of equal width and both elongated, paraglossae somewhat crescent shaped and slightly shorter than the glossae (Fig. 48, 49). Apices of glossae with numerous stout spines (Fig. 50, 51). Aboral apical half of glossae and paraglossae with scattered long hairs (Fig. 48). Oral lateral margin of glossae with single row of setae (Fig. 49). Oral side of paraglossae with numerous long hairs along the entire lateral margins as well as apical half of medial margins (Fig. 49). Paraglossae laterobasally with a cluster of long hairs (Fig. 49, 52–56). Aboral side of prementum with a paired group of each (1–)2–3(–5) stout spines and additional finer setae (Fig. 52–56) medially to the basal segment of the labial palp. Aboral side of prementum with a paired diagonal or irregular row of 7–11 stout spines and additional finer setae basally to the first segment of labial palp. Lateroapical shoulder of postmentum on aboral side with a cluster of several stout spines or at least some fine setae. Aboral side of postmentum basally without longitudinal row of setae. Labial palp: segment 2 half to four-fifths as long as segment 1 and segment 3 two-thirds to four-fifths segment 2. Segments 2 and 3 movable against each other, but partially fused; the suture between segments 2 and 3 is only visible on the medial half of the palp and effaced on its lateral half. Aboral side of segment 1 with scattered stout spines along the apical half of its medial margin, and with a few thicker spines located at its lateroapical corner. Oral side of segment 1 with several stout spines along its lateral margin as well as a cluster of fine hair laterobasally. Aboral side of segment 2, particularly laterally, with scattered spines, and a small cluster of several thicker spines in its lateroapical corner. Oral side of segment 2 with several stout spines along its lateral margin and with a longitudinal row of about 6 long, very fine setae in its medioapical corner. Aboral side of segment 3 covered with numerous hairs that become thicker apically, and with the apex covered with stout spines. Oral side of segment 3 with hairs only at margins.

Pronotum: without spines on the posterior margin.

Legs (Fig. 4): All leg segments except coxa with scattered spines, particularly on the distal margins. Femur, tibia, and tarsus dorsally with long hairs. Tibia of fore leg with incomplete tibiopatellar suture, tibiae of middle and hind leg with complete tibiopatellar suture (sensu Kluge *et al*., 1995). Claws (Fig. 30) hooked and narrow apically, ventrally with two parallel rows of 10–20 denticles.

Abdomen (Fig. 23–27): Somewhat rounded in cross

section and tapering posteriorly with posterolateral projections from segment II, becoming acuminate toward segment IX. The posterior margins of abdominal tergites and sternites with dark brown denticles (Fig. 59–61) that are directed caudally. Tergites brownish, sternites paler. Gills (Fig. 32) on segments I–VII single and lamellate with rounded distal edges; the edges fringed with fine hairs and a row of spines, the latter longer apically but absent proximally. Gill I about half the size of gills III–V, which are the largest. Tracheae dark brown and dendritic. Gills II–VII, and sometimes gill I, traversed by a brown curved rib longitudinally between the main branch of the trachea and the proximal edge of the gill to the apex. Terminal filament a little shorter than the cerci and fringed with hair on both sides; cerci fringed similarly but only on the inner margins. Each segment of the terminal filament and cerci bounded by two coaxial rings of denticles, one of which with larger spines (Fig. 31).

Egg (Fig. 62–73): ovoid, length 125–225 µm, width 110–150 µm. Egg without polar caps, but with about three to eight tagenoform micropyles, the number of micropyles varying inter- and even intraspecifically. Micropyles scattered along the equatorial or subequatorial region of the egg. Eggs of larvae, subimagos, and imagos are, except for the micropyles, generally entirely covered by a thin suprachorionic outer layer, below which a meshwork of chorionic ridges forms more or less regular polygons (Fig. 64–72) distributed over the entire egg. Each polygon includes a fibrous attachment structure of an outer ring of fibre-coils and a central terminal plate-like fibre cluster. Fibre-coils always without terminal knob. Chorionic ground below the fibrous attachment structures elevated or flat, with different textures.

Habitat. Members of *Nesameletus* are widespread and occasionally very common in New Zealand streams from Northland to Stewart Island. At least one species is found in steep mountain torrents to 1200 m, others to sea level, in indigenous forest, and open country. Their disappearance from some areas has coincided with the increased human activity and may indicate a lower tolerance of reduction in water quality than other genera such as *Deleatidium*. Phillips' (1930, 1931) remarks on the behaviour of *Nesameletus ornatus* apply generally to the genus.

Remarks. The morphology of the imaginal claws of *Nesameletus* has been subject of some dispute by previous authors. Each of the paired imaginal claws of *Nesameletus* is apically hooked with an opposing hook (Fig. 29). However, "on account of the leg markings" Eaton (1899) transferred *Chirotonetes (?) ornatus* to the holarctic *Ameletus,* a genus of which Eaton (1899) himself noticed that "in every tarsus the outer or posterior claw is narrow and hooked, the inner broad and obtuse". Eaton's transferral presumably influenced Tillyard (1933) to such an extent that he described the claws of *Nesameletus* as "distinctly dissimilar". Also, in a lengthy paragraph he explicitly negated Phillips' (1930) correct observation, that the claws were "alike, narrow and hooked on each tarsus". Lestage (1935b) repeated Tillyard's incorrect diagnosis, but Penniket (1966) considered otherwise, distinguishing *Rallidens* with tarsal claws dissimilar from *Nesameletus* with tarsal claws similar. Recently Kluge *et al.* (1995) and Towns & Peters (1996) concluded that the tarsal claws of *Nesameletus* adults are best described as similar. We concur.

The species of *Nesameletus* can be distinguished from all other known mayflies by the following combination of characters:

Imago.

(1) Head with posteromedial projection.

(2) Forewing with all or almost all of the cubital intercalaries pectinate and attached to the hind margin.

(3) Hind wing costal margin strongly obtuse. Forks on veins RS and MA about 1/2 the wing length and the fork on MP about 1/4 the wing length.

(4) First tarsal segment 1/5 to 1/3 as long as the tibia.

(5) Tarsal claws of a pair alike.

(6) Penes of male fused for 1/3 to 2/3 the length and without appendages.

(7) Sternum IX of female cleft apically and subgenital plate 2/5–6/5 the length of sternum VIII.

Larva.

(1) Abdominal gills present on segments I–VII, gill I being the smallest; single, lamellate, and with a rounded distal edge, a dendritic tracheal pattern and, except for gill I, a dark curved brace.

(2) Antennae shorter than the head and of about 20 segments.

(3) Terminal filament shorter than the cerci.

(4) Mandible modified, with fused incisors.

(5) Maxilla with four apical projections, medioapical membranous lamina, and "maxillar gill tuft" between cardo and stipes.

In New Zealand, imagos of *Nesameletus* are most likely to be confused with those of *Rallidens* but can be distinguished by the following characters:

(1) in the forewing all, or almost all cubital intercalaries unforked;

(2) tarsal claws of a pair alike;

(3) in the forewing many cross-veins thickened; and

(4) in the hind wing RS and MA forked at mid-wing and MP forked basally.

The larvae of *Nesameletus* are most likely to be confused with those of *Rallidens* and *Siphlaenigma*. They can be distinguished from the former by the absence of abdominal gills with fibrillar tufts, and from the latter by the presence of antennae shorter than the head.

Nesameletus ornatus (Eaton, 1883)

small swimming mayfly

Fig. 2–4, 8, 9, 22, 23, 28–32, 36–38, 41, 42, 46, 47, 50–52, 59–63, 73, 74, 79, 87, 92, 93, 103, Map 1

Chirotonetes (?)*ornatus* Eaton, 1883: Pl. 19, fig. 33c (figures of male genitalia). —Eaton, 1888: 321.

Ameletus ornatus: Eaton, 1899: 291 and Pl. 10, fig. 5 (figure fore wing of female imago). —Tillyard, 1923: 228, fig. b, c, h (figures of hind costal wing margin, female sternum 9 and hind tarsus). —Phillips, 1930: 313–322. Fig. 56–66 (figures of larval thoracic terga and abdominal segments I and II, legs, tarsal claw, gill, caudal filaments, and mouthparts, male legs and genitalia, female foreleg), Pl. 58, fig. 15 and 16 (photographs of nymph and female imaginal wing). —Mosely, 1932: 6 (repeat of Phillips' diagnosis of adults), fig. 14 (photograph, male imaginal fore wing).

Nesameletus ornatus: Tillyard, 1933:11.

Dimensions (mm): Male imago: length of body 12.7–14.6 (13.7), forewing 13.2–14.0 (13.6), hind wing 4.1–4.5 (4.4). Male mature larva: body length 11.5–15.0 (13.0). Female imago: length of body 12.8–14.1 (13.5), forewing 14.0–14.3 (14.1), hind wing 4.8–6.0 (5.3). Female mature larva: body length 12.3–18.5 (15.2).

Male imago: Head dark brown to black, paler near the base of the ocelli. Eyes with upper portion pale grey, lower portion darker. Antennal scape brownish black.

Thorax: Pronotum yellowish, mesothorax and metathorax darker. Scutum yellowish with paired darker parasagittal longitudinal patches converging posteriorly; scutal sutures darker. Scutellum dark brown to black. Thoracic sterna brownish with sutures darker. Carina yellow. Legs: Fore legs yellowish and others pale grey, all with dark brown bands at mid femur and at the articulations of all joints. Length ratios of fore leg segments: 1.10–1.18 : 1.00 (2.8–3.2 mm) : 0.36–0.43 : 0.39–0.48 : 0.50–0.56 : 0.43–0.5 : 0.23–0.31.

Wings (Fig. 8, 9): Forewing width 0.32–0.33 (0.32)x length. Wings of newly emerged specimens weakly tinged greenish yellow in cells C and Sc, rapidly fading in alcohol to pale brownish; longitudinal and cross-veins brownish black, thickened in cells C and Sc, and more so at mid length close to the bullae and apically. In the pterostigmatic region a cluster of cross-veins present between C, Sc, and R_1. Veins R_3A and R_3B basally disconnected.

Abdomen (Fig. 74): Terga I–VI dark brown with pale grey posterior transverse bands and paired parasagittal circular marks. Tergum VII yellowish white with a median and two parasagittal dark brown longitudinal bands. Terga VIII and IX dark brown. Terga I–VIII with darker posterolateral triangular marks. Sterna I–VII grey washed with brown. Abdominal ganglia and connectives visible on sterna II–VIII, and particularly pigmented on VII and VIII. Terminal ganglion dark brown.

Genitalia (Fig. 22, 79): greyish yellow; distal edges of penes and forceps dark brown. Penis lobes strongly divergent apically. Penes indented subapically on medial sides of penis lobes. Styliger plate apically emarginated. Length ratio of penis : styliger plate less than 2:1. Cerci greyish yellow with annulations darkening posteriorly.

Female imago: As in male except as follows. Head whitish, with dark brown medial longitudinal band widening near the ocelli and base of antennae. Eyes grey. Pronotum greyish yellow washed with parasagittal dark brown longitudinal bands. Scutellum whitish with darker medial patch and washed with dark brown on the margins. Forewing width 0.33–0.34x length. Hind wing width 0.56–0.61x length and length 0.34–0.38 (0.35)x that of fore wing. Abdominal terga I–VI pale grey-brown with darker posterior transverse bands and with parasagittal circular marks. Tergum VII whitish. Sterna pale yellowish with abdominal ganglia and connectives darker. Sternum VII with tapering subgenital plate apically rounded and extending to half the length of sternum VIII (Fig. 87); sternum IX with pronounced apical cleft.

Subimago: As in the imago except as follows: Eyes of female greyish black; male with upper portion pale grey and lower portion blackish. Pronotum yellowish brown; mesonotum greyish brown with a darker longitudinal band divided by a paler median notal suture. Scutum darker brown and whitish yellow medially. Scutellum whitish with dark brown lateral margins and paired parasagittal crescent shaped marks. Pleura yellowish white washed with dark brown. Sterna yellowish grey washed laterally with brown. Wings (Fig. 92, 93) with membrane translucent; longitudinal veins and cross-veins dark brown; broad greyish clouds at many cross-veins, sometimes filling wing cells. Forewing with clusters of clouded cells, particularly around bullae, below pterostigmatic region in cells Sc and R_1, posterior to the fork of M, and apically. Most of the cross-veins of hind wing bordered by dark pigment. Hind wing only apically with few entirely clouded cells. Abdomen with markings darker. Penes whitish.

Late instar larva (Fig. 23): Head pale yellowish, clypeus hyaline with dark brown transverse band at basal margin; labrum pale yellowish; antennae greyish. Eyes pale grey to black; antennae 2/3–3/4 the length of head.

Mouthparts: Labrum: Length 0.88–0.95 (0.92)x that of clypeus, and width 0.82–0.86 (0.84)x that of clypeus. Maxilla: Lacinia with marginal row of 10–14 spines, submarginal row of 5–8 setae, basal row of 5–6 setae. Galea with marginal row of 4–5 setae. Palp segment 2 0.66–0.75 (0.69)x as long as segment 1, and segment 3 0.29–0.38 (0.33)x as long as segment 2.

Labium (Fig. 52): Aboral side of prementum between basal segments of labial palp with a paired group of each 2–4 thick spines, aboral side of prementum proximally to the insertion of labial palps with a paired diagonal row of 6–11 thick spines, each shoulder of postmentum with fine hairs and up to 6 thick spines. Medial side of palp segment 1 with several thick spines. Spination of labial palp generally stronger than in other species of *Nesameletus*. Palp segment 2 0.73–0.80 (0.76)x as long as segment 1, and segment 3 0.58–0.73 (0.66)x as long as segment 2.

Thoracic terga greyish yellow, washed with dark brown to blackish on lateral margins; and with a paler median dorsal longitudinal band. Pleura paler with blackish ventral margins. Sterna whitish. Legs whitish with dark brown bands at mid femur, darker at all joints including the tarsus. Tarsal claws yellowish brown, darker peripherally.

Abdomen greyish white washed with dark brown to black on dorsal surfaces. Terga II–VI with paired parasagittal whitish circular maculae and posterolateral black triangular marks. Posterolateral projections becoming more acuminate from segments III or IV to IX. Each tergum with narrow blackish transverse posterior band and spines directed caudally, well developed on terga II–IX (Fig. 59–61). Tergum VIII paler and tergum X darker than the others. Sterna whitish, each with a posterior transverse band of denticles directed caudally. Abdominal ganglia not pigmented and thus inconspicuous. Cerci and terminal filament white in the proximal and distal portions and black medially, 0.38–0.45x as long as the body. Some final instars may show darkening medially on the terminal filament only.

Egg (Fig. 62, 63, 73): Length 180–210 µm, width 110 µm.

Chorionic ridges of large-mesh reticulation present, but entirely covered and overlapped by heavily developed broad rings of fibre-coils (Fig. 73), which are terminated in a central fibre-cluster. Terminal fibre-clusters usually with small central gap. Attachment structures connected to the chorion in the centre of each polygon. Chorion ground below attachment structures flat, chorion ground texture granulate or smooth.

Type data: *Nesameletus ornatus* is the type species of the genus. Eaton figured the male genitalia (Eaton 1883), forewing of female imago (Eaton 1899), and gave a description of a subimago and imago from Christchurch (Eaton 1888), from Hudson's material in the McLachlan Collection. These specimens are now missing. Kimmins (1960) noticed that already in 1888 Eaton had some doubt whether the original type specimens were still in existence. Eaton (1899) referred to 'Wellington (Hudson no. 42)' as additional locality. Kimmins (1960) had been able to find three examples with this label in the McLachlan collection, and consequently designated a female imago of Hudson's specimens from Wellington as neotype of *Nesameletus ornatus*. This neotype (Fig. 103) is located in the BMNH (Kimmins 1960; 1971). It has a spatulate genital extension a little less than half the length of sternum VIII. Although both forewings are damaged, cross-veins in the pterostigmatic region of C and Sc are thicker than those in the corresponding section of R_1. All legs have a dark medial band on each femur. Seen (TRH, AHS).

In spite of searches of the holotype locality, Christchurch, we were unable to find specimens of the genus within the city waterways. The nearest specimens of *Nesameletus* consistent with the descriptions of *N. ornatus* given by Eaton (1885–1899) and also the neotype from Wellington designated by Kimmins (1960), were collected from a tributary of the Ashley river some 40 km from the city. Our redescription is based on specimens from there. A pinned specimen in the Canterbury Museum (Christchurch, New Zealand) bearing the labels "WAINUIOMATA 12.II.1920 G.V. Hudson, 42s" and "*Ameletus ornatus* (Eat.) imago R.J. Tillyard det." is morphologically consistent with the Ashley tributary specimens and with recently collected specimens from Wainuiomata.

Material examined: The following non-type examples (see Appendix 3 for collection details). **ND** Waipoua R. **AK** Anderson Stm, Waitakere; Cascade Stm, Waitakere; Nihotupu between Reservoirs. **CL** Tarawaere Stm, Kauaeranga; Whangaeterenga Stm. **WO** Kaniwhaniwha Stm; Tiwarawara Stm. **BP** Mangorewa R Ecological Area; Oweka Stm; Punaruku Stm, Cape Runaway; Te Puia Stm, East Cape; Whangapoa Stm Trib; Uretara Stm, Kaimai Ra; Wheao R, Rotorua. **TK** Tangarakau Gorge. **TO** Makomiko Stm; Mohaka R, Auroa Rd; Mohaka R, Jock Sutton Rd; Mohaka R, McVicar Rd; Otamatea R; Rangitaiki R; Retaruke R; Taringamotu R; Te Arero Stm; Tongariro R; Waewaeru Stm; Waimarino Stm; Waimiha Stm; Wanganui R; Whakapapaiti Stm; Whakapapaiti Stm, Trib. **RI** Coppermine Ck. **GB** Tolaga Bay, unnamed Stm. **HB** Ngaheranui Stm, Kaweka Ra. **WN** Catchpool Stm; George Ck; Gollans Stm. **NN** Burke Ck; Myttons Ck, Cobb V;

Oparara R; Roding R; The Brook, Nelson; Welcome Ck, Mohikinui. **BR** Ten Mile Ck, Paparoa Ra; Thirteen Mile Ck; Ahaura R Trib; Arnold R at Kokiri; Blackwater Ck; Camp Ck, Inchbonnie; Clear Grey R at Br; Crooked R at Bell Hill Br; Fuchsia Ck; Goose Ck; Gowan R at L Rotoroa; Howard R at Br; Inangahua R at Br; Jinks Ck, Trib; Larrys Ck; Maori Gully Ck; Mariua R at Station Ck; Maruia Falls; Maruia R, at Mitchells Ck; Matakitaki R, Trib; Mitchells Stm, Maruia; Nelson Ck; Pigeon Ck; Porika Stm Ford; Rahu Stm, Mariua; Rahu Stm, Trib; Rough & Tumble Ck; Sawyers Ck, Boddytown; Springlands Ck, Maruia; Station Ck; Stony R, Inangahua; Taramakau R Trib; Station Ck Trib; Two Mile Ck, Buller; Taramakau R Trib, Inchbonnie;Arnold R Trib; Taramakau R Trib; Upper Grey R, at Br; Waimea Stm, Maori Gully; Waitahu R. **WD** Jackson R; La Fontaine Stm; Martyr R; Martyr R Trib; Octopus Ck, Cook Saddle; The Windbag; Turnbull R. **MB** Chimney Stm, Pudding Hill; Dog Stm Tribs, Hanmer; Goat Stm, Branch R; Omaka R, Renwick; Stanley R; Waiau R. **KA** Chilly Stm Trib, Hawkswood Ra; Dawn Ck, Hawkswood Ra; Fern Flat Stm, Hawkswood Ra; Medina R, Hawkswood Ra; Okarahia Stm. **NC** Ashley R, Trib; Coopers Ck East Branch; Coopers Ck Forks; Glentui R above Falls; Grey R; Grey R, Loburn; Grey R, Smarts Rd; Okuku Downs Stm; Hurunui R,Trib; Waiau R; Wooded Gully, Mount Thomas Forest. **MC** Bowyers Stm, Staveley; Bush Stm; Cass Stm at Field Station; Charteris Bay Stm; Ford Stm, Selwyn R; French Farm Stm; Lee R; Narbey Stm; Okuti Sm; Peraki Stm;Potts R Stm, trib; Purau Stm; Scamander Stm; Waimakariri R, trib; Waterfall Ck. **SC** Firewood Stm, Mt Dobson; Hook Bush, Hunter Hills; Orari R at Gorge; Otaio R headwaters; Trotters Ck. **OL** Greenstone R. **CO** Burgan Stm; Deep Stm; Little Pomahaka R, Old Man Ra; Pigroot Ck; Stony Ck; Taieri R, near Patearoa. **DN** Flat Stm, Taieri Gorge; Waianakarua R, South. **FD** Borland Burn; Cleddau R, South Branch Trib. **SL** Hamilton Burn; Ruhtra Stm, Hokonui Hills.

Distribution and habitat (Map 1). Phillips (1930) included information on the ecology of *Nesameletus ornatus* in his general revision of New Zealand Ephemeroptera. The species is distributed widely throughout New Zealand particularly in smaller streams and trickles, from sea level to nearly 1000 metres. Occasionally, in some streams at certain times, it may be the most abundant invertebrate species present. Like other species in the genus, it is most commonly found on the edges of forest streams, among trailing vegetation where flow rates are moderate to slow, particularly as it prepares to emerge.

ND, AK, CL, WO, BP, TK, TO, RI, GB, HB, WN / NN, BR, WD, MB, KA, NC, MC, SC, OL, CO, DN, FD, SL / –.

Intraspecific variation. Compared with other material, North Island adults show more pigmented abdominal terga with paired parasagittal maculae which become whitish bands divergent posteriorly, on terga I–VII. Male North Island imagos show penis lobes with more rounded apices. Some South Island adults show a small amount of reticulation in the pterostigmatic region of the fore wing. Eggs vary considerably in their chorionic ground texture.

Remarks. Tillyard's (1923: fig. 2e) illustration of the sternum IX of *N. ornatus* is not consistent with any specimens of this species so far seen. However, his fig. 2d (labelled *Ameletus perscitus*, now *Ameletopsis perscitus*) is similar to the emargination of segment IX of *N. ornatus.* If labels to fig. 2d and 2e were interchanged, the illustrations would then be consistent with our observations of the female genitalia of these two species.

Phillips's (1930) illustration of the penes differed significantly from that of Eaton (1883). No specimens of any of the species of the genus *Nesameletus* have been found which correspond to Phillips's drawing, which, however, does closely resemble the penes of *Coloburiscus humeralis* (Phillips 1930: fig. 47). Moreover, in the slide collection of Phillips hosted in the BMNH, we found a slide preparation of male genitalia labelled "Nesameletus ornatus, J.S.Phillips Coll., B.M.1933-528." However, the slide contains instead the male genitalia of *C. humeralis*. It is most likely that Phillips's drawing was made from this erroneously labelled slide preparation.

Nesameletus flavitinctus Tillyard, 1923

Fig. 10, 11, 24, 53, 64, 65, 75, 80, 88, 94, 95, Map 2

flavitinctus Tillyard, 1923: 226–228 (*Ameletus)* Fig. 1 female imaginal fore and hind wing. Fig. 2c humeral angle of hind wing, fig. 2f ventral valve, fig. 2g hind tarsus. —Phillips, 1930: 322–326 Fig. 67 legs of male imago and female forelegs, Fig. 68 genitalia of male imago, Pl. 59 Fig. 17 and 18 wings of female imago and male subimago. —Tillyard, 1933: 11 (*Nesameletus).* —Kluge *et al*., 1995 118–119 Fig. 43–49 female imaginal pterothorax, apex of abdomen, head, larval apex of left maxilla, subimaginal skin of mesonotum. Fig. 78 egg.

Dimensions (mm): Male imago: body length 14.5–16.5 (15.3), forewing 16.6–17.0 (16.7), hind wing 6.0–6.5 (6.2). Mature male larva: body length 13.0–16.0 (15.1). Female imago: body length 12.0–18.0 (16.4), forewing 14.5–20.0 (18.2), hind wing 4.6–8.3 (7.1). Mature female larva: body length 13.0–19.4 (18.0).

Male imago: Head and antennal scape whitish, eyes with the upper portion pale grey and lower portion darker. Tho-

rax: Notum yellowish white, darker at the margins. Scutum with dark brown parasagittal patches. Legs yellowish with brown bands at mid femur and at the articulations of all joints. Length ratios of foreleg segments: 1.20–1.32 : 1.00 (3.2–3.5 mm) : 0.36–0.40 : 0.51–0.62 : 0.60–0.70 : 0.51–0.56 : 0.27–0.34.

Wings (Fig. 10, 11): Forewing width 0.32–0.33 (0.33)x length. Wings of newly emerged specimens tinged with greenish yellow, fading in alcohol after some days. In pterostigmatic region a cluster of cross-veins present between C, Sc, and R_1. Longitudinal veins and cross-veins dark brown, bordered by dark pigment in cells C, Sc, and R_1, the latter more so at midlength and in pterostigmatic region. Veins R_3A and R_3B basally disconnected.

Abdomen (Fig. 75): Terga I–VII pale brown with dark brown posterior transverse bands and paired parasagittal darker brown maculae which become elongated posteriorly on terga V–VII. The lateral margin of each tergum washed with dark brown. Terga VIII and IX brownish with less distinct markings. Sterna pale grey. Sterna I–VIII each with a pair of dark parasagittal oblique marks divergent posteriorly and also a dark median mark on each posterior margin. Darkened abdominal ganglia sometimes visible on sternum VIII only.

Genitalia (Fig. 80): Greyish with distal margins of penes and forceps brownish. Penes elongated and fused for most of their length and slightly divergent apically, apices tapering to blunt points. Length ratio of penis : styliger plate at least 2:1. Styliger plate shallowly emarginated. Caudal filaments greyish with annulations brown, darkening posteriorly.

Female imago: As in male except as follows: Eyes dark grey. Scutum whitish and posteriorly with paired parasagittal dark brown maculae. Forewing width 0.34–0.35x length. Hind wing width 0.51–0.61x length, and length 0.36–0.38 (0.37)x that of forewing. Abdomen: Sternum VII with triangular genital extension, rounded apically and extending a little less than half the length of sternum VIII (Fig. 88); sterna VII and VIII with dark brown abdominal ganglia; sternum IX with pronounced apical cleft and with a median dark brown longitudinal cleavage mark.

Subimago: As in the imago except as follows. Eyes of both male and female with upper portion pale grey and lower portion darker. Pleura and sterna whitish, washed with dark brown at margins. Wings (Fig. 94, 95) with membrane translucent, longitudinal veins and cross-veins dark brown; brownish clouds at cross-veins, sometimes filling wing cells. These pigmented areas form two roughly diagonal bands across the forewing. Hind wing apically also with broad transverse, dark pigmented band that extends to the posterior wing margin up to MA or MP. R_1, R_2, and MA basally also with entirely pigmented wing cells. Abdomen with markings darker and with a pigmented ganglion visible through sternum VII. Male genitalia greyish with dark brown margins.

Late instar larva (Fig. 24): Head pale yellowish brown, clypeus whitish to black at epistomal suture; antennae yellowish. Eyes black; antennae 1/2–2/3 the length of the head.

Mouthparts: Labrum: length 0.83–0.94(0.88)x that of clypeus and width 0.88–0.94 (0.91)x that of the clypeus. Maxilla: Lacinia with marginal row of 17–20 spines, submarginal row of 4–5 setae, and basal row of 5 setae. Galea with marginal row of 5 setae. Palp segment 2 0.85–0.92 (0.89)x as long as segment 1, and segment 3 0.33–0.36 (0.35)x as long as segment 2.

Labium (Fig. 53): Aboral side of prementum medially of insertion of labial palps with paired group of 1–2 thick spines, proximally of insertion of labial palps with paired irregular row of 4–5 thick spines, postmentum without thick spines. Palp segment 2 0.73–0.91 (0.83)x as long as segment 1, and segment 3 0.64–0.89 (0.78)x as long as segment 2.

Thorax yellowish brown, with dark brown lateral margins; a paler dorsal median longitudinal band; scutum with paired parasagittal dark brown maculae. Pleura paler with blackish ventral margins. Sterna whitish. Legs pale brown with darker longitudinal marks at mid femur; each tarsal segment with distinct dark bands apically and basally. Tarsal claws yellowish brown with two rows of 14–18 denticles on inner margins.

Abdomen yellowish brown. Terga II–IX with dark brown paired parasagittal longitudinal marks divergent posteriorly; anterior margins darker. Posterior margins dark brown with a row of spines directed caudally, well developed on terga III–IX. Tergum IX without conspicuous markings. Sterna whitish yellow. Sternum II or III to VIII each with a narrow, posterior dark brown transverse band of spines directed caudally. Posterolateral projections become pronounced on segments V or VI to IX. Abdominal ganglion sometimes visible on sternite VIII. Caudal filaments yellowish, darker dorsally and medially, 0.42–0.48x as long as the body.

Egg (Fig. 64, 65): length 190–200 µm, width 100–105 µm. Chorionic ridges about 2 µm thick, diameter of chorionic polygon 9 µm, 5–8 micropyles present. Attachment structures: Fibre-coils few and with big inner terminal fibre-cluster in each polygon. Chorion ground texture smooth or granulate.

Type data. Tillyard (1923) described the female subimago and reared imago collected at Waihi Stream, Lake Taupo on 26 November 1919. He figured the fore- and hind wings, the humeral angle of the hind wing, and ventral valve of the female imago, from the holotype specimen now in the NZAC (seen TRH).

Phillips (1930) repeated Tillyard's diagnosis of the female adult and supplemented it with a description of the larva and subimaginal wings of the male. Legs of the male and forelegs of the female imago and genitalia of the male were figured. He described the distribution of the species as "...besides the locality previously mentioned, the Whakatiki and little Wainui Rivers, Wellington district and in the Gowan River, Nelson district". Two pinned specimens, male and female imagos, designated as *Ameletus flavitinctus*, now in the CMNZ, are believed to have been donated by Phillips. The male is labelled "Ameletus flavitinctus Wainui-o-mata 23.3.30" in what appears to be his handwriting.

Material examined. The following non-type examples (see Appendix 3 for collection details). **AK** Cascade Stm, Waitakere R. **BP** Mangorewa R. **TO** Mahuia Rapids; Makomiko Stm; Makomiko Stm trib; Te Arero Stm Trib; Waihi Stm; Waimarino Stm; Whakapapaiti Stm. **RI** Ohutu Stm at hut. **HB** Ngaheranui Stm, Kaweka. **WN** Akatarawa Rd Ck; George Stm; Mangahao R.

Distribution and habitat (Map 2). *Nesameletus flavitinctus* has been mainly collected from forested streams and smaller rivers in the North Island. Phillips's (1930) reported locality in the Nelson district has been confirmed recently, and other South Island locations added on the map.

AK, BP, TO, RI, HB, WN / NN, BR, WD, MC

Intraspecific variation. Lower North Island adults are about 4/5th the size of those from the type region. They also show less contrasting colour patterns. Clouding in the subimaginal wings is less strongly accentuated, as in the subimagos from South Island. Some South Island male adults have forceps segment 1 with a distinct medial shoulder as in *N. murihiku*. Some female imagos show emargination of the occipital projection.

Remarks: The statement by Tillyard (1923) that the tarsal claws of *Nesameletus flavitinctus* were dissimilar appears to be an error.

Nesameletus murihiku Hitchings & Staniczek, new species

Fig. 12, 13, 25, 54, 66, 67, 76, 81, 89, 96, 97, Map 3

Dimensions (mm): Male imago: body length 10.5–14.0 (12.7), forewing 12.8–15.9 (14.3), hind wing 3.9–5.0 (4.5). Mature male larva: body length 12.5–13.2 (13.0) Female imago: body length 9.4–15.0 (13.2), forewing 12.0–17.5 (14.8), hind wing 4.8–5.8 (5.3). Mature female larva: body length 11.5–14.5 (12.4).

Male imago: Head greyish brown, darker at the base of ocelli, eyes pale grey, darker basally, antennal scape yellowish.

Thorax: Pronotum yellowish brown, metathorax and scutellum whitish yellow, the latter with darker parasagittal crescent-shaped marks. Margins dark brown. Pleura brownish with darker margins. Sterna, including carina, yellowish with dark brown margins. Legs whitish, a darker band at midlength on each femur and darkening distally on each joint. A dark margin at the tibiofemoral articulation and subsequent tarsal joints. Length ratios of forelength segments: 1.04–1.11 : 1.00 (3.3–3.5 mm) : 0.32–0.37 : 0.52–0.54 : 0.50–0.57 : 0.41–0.46 : 0.23–0.28.

Wings (Fig. 12, 13): Width of forewing 0.32–0.35 (0.34)x length. Longitudinal veins and cross-veins reddish brown, thicker toward costal margins. Cross-veins of pterostigmatic region somewhat reticulated. Cells C and Sc reddish brown in pterostigmatic region in fresh specimens. A cluster of cross-veins present between C, Sc, and R_1 in the pterostigmatic region. Prominent bullae at midlength on Sc and R_2 and sometimes R_1. Veins R_3A and R_3B basally disconnected.

Abdomen (Fig. 76): Terga I–V with paired parasagittal brownish maculae becoming elongated through terga VI–VIII. Terga I–VIII with paired dark brown posterolateral patches and posterior transverse bands. Sterna reddish grey with abdominal ganglia sometimes visible on sternum VIII only.

Genitalia (Fig. 81): Penes yellowish and fused 4/5th length, apices tapered, rounded apically and separated by a v-shaped emargination. Penis lobes expanded basally and subapically. Styliger plate shallowly emarginated with a small median notch. Length ratio of penis : styliger plate at least 2:1. Forceps 1 with a distinct medial shoulder. Caudal filaments with yellowish annulations darkening posteriorly.

Female imago: As in male except as follows. Eyes grey, scutellum brownish with blackish margins. Forewing width 0.31–0.37 (0.33)x length. Hind wing length 0.32–0.38 (0.35)x length of forewing. Sternum VII with triangular subgenital plate, rounded apically, 1/3–1/2 the length of sternum VIII (Fig. 89). Sternum IX apically cleft.

Subimago: As in the imago except as follows. Head grey, darker at dorsal midline, eyes black. Pronotum dark brown, mesonotum and metanotum whitish, dark brown laterally and blackish at the sutures. Scutellum whitish with brownish diamond-shaped macula divided by a white medial longitudinal band. Pleura whitish with dark brown transverse band. Sterna whitish. Wings (Fig. 96, 97) translucent. Forewing with dark brown longitudinal veins and cross-veins with greyish clouds at all, or almost all, cross-veins, particularly anteriorly. Some cells clouded in C, Sc, and R_1 at midlength around the bullae and in R_1 and R_2 below the pterostigmatic region. Hind wing with similar pattern of coloration as in *N. flavitinctus*, but with weaker pigmentation and without any filled wing cells.

Late instar larva (Fig. 25): Head pale grey, clypeus and labrum greyish brown, both darker basally, the latter also at the lateral margins. Antennae hyaline, pedicel darker distally. Eyes greyish. Antennae 0.6x as long as head. Labrum: Length 0.91–1.00 (0.96)x that of clypeus; width 0.81–0.86 (0.83)x that of clypeus. Maxilla: Lacinia with marginal row of 16–22 larger spines, submarginal row of 4-6 setae and basal row of 6 setae. Galea with marginal row of 6 setae. Palp segment 2 0.79–0.82 (0.81)x as long as segment 1 and segment 3 0.18–0.33 (0.26)x as long as segment 2. Labium (Fig. 54): Aboral side of prementum medially of insertion of labial palps with paired group of 1–2 thick spines and proximally of insertion of labial palps with paired diagonal row of 3–5 thick spines, postmentum without thick spines. Palp segment 2 0.67–0.82 (0.73)x as long as segment 1 and segment 3 0.88–0.89 (0.89)x as long as segment 2.

Thorax: greyish, pleura brownish white with darker ventral margins. Sterna whitish. Legs whitish, darker at the articulations but without dark brown marks at mid femur. Tarsal claws yellowish brown with two rows of 11–17 denticles on inner margins.

Abdomen dorsoventrally flattened, brown-washed with dark brown on dorsal sufaces. Each dorsal segment with indistinct paired parasagittal brown maculae, becoming elongated on tergae VI–VIII. Posterior edges dark brown with a row of well developed spines directed caudally on sterna III–IX. Sterna brownish with darker posterior transverse bands, each with a row of spines directed caudally. Abdominal ganglion visible on sternum VIII only. Posterolateral projections well developed on segments II or III–IX. Caudal filaments yellowish brown and 0.40x as long as body.

Egg (Fig. 66, 67): length 150–170 µm, width 90–110 µm. Chorionic ridges 2 µm thick, diameter of chorionic polygon 7–8 µm, 5–7 micropyles present. Attachment structures: Fibre-coils few and confined to a thin outer ring around each terminal fibre-cluster. Terminal fibre-clusters with numerous tubercles that are mainly located in the centre and at the margins of each fibre-cluster. Chorion ground flat, sometimes with small mesh reticulation.

Type data: **Holotype**: male imago, SI, Mill Creek, 18 January 1999. T. R. Hitchings (CMNZ). **Allotype**: female imago, same data as the holotype (CMNZ). **Paratypes**: BMNH—1 male imago, 1 female imago, 1 larva. CMNZ—1 male imago, 1 female imago, 1 male subimago, 1 female subimago, 7 larvae. FAMU—1 male imago, 1 female imago, 1 larva. NZAC—1 male imago, 1 female imago, 2 larvae. SMNS—1 male imago, 1 female imago, 1 larva.

Material examined. The following non-type examples (see Appendix 3 for collection details). **FD** Gap Bay Stm, Secretary I. **SL** Bare Hill, Hokonui Hills;Bald Hill, Longwood Ra. **SI** Hicks Road Stm; Mill Ck; Mt Rakeahua; Table Stm; unnamed stm East Long Harry.

Distribution and habitat (Map 3). *Nesameletus murihiku* has only been collected from streams on Stewart Island and from three sites on watersheds of rivers flowing into Foveaux Strait, in the south of the South Island. The altitudinal range is from sea level to 500 m on Mt Rakeahua. All specimens were collected from forested or otherwise undeveloped land.

– / FD, SL, SI.

Remarks. *Nesameletus murihiku* is most similar to *N. flavitinctus*, from which it can be distinguished in the adult by the following:

(1) in the forewing cells C and Sc in the pterostigmatic region tinged reddish brown;

(2) apices of the male penes generally without medial indentation;

(3) forceps 1 with a distinct shoulder medially;

(4) styliger plate with a small medial notch.

Although the larvae of *N. murihiku* tend to be smaller, they are not readily distinguished except:

(1) abdominal tergae V or VI–X only with dark brown paired parasagittal maculae,

(2) prementum with paired diagonal row of 3–5 thick spines.

Etymology. Maori, **murihiku** = 'the last joint of the tail'. Noun in apposition. A name given by the original inhabitants to the extreme southern portion of the South Island of New Zealand, including Fiordland and Stewart Island.

Nesameletus austrinus Hitchings & Staniczek, new species

Fig. 14, 15, 26, 33, 34, 39, 40, 48, 49, 55, 68, 69, 72, 77, 82, 90, 98, 99, Map 4

Nesameleus sp. A of Winterbourn, in press

Dimensions (mm): Male imago: body length 11.6–14.5 (13.2); forewing 11.8–14.8 (13.7); hind wing 4.5–5.6 (5.2), mature male larva: body length 12.0–13.3(12.7). Female imago: body length 13.6–16.7 (15.0); forewing 13.0–19.6 (16.2) hind wing 4.4–7.5 (5.8), mature female larva: body length 14.0–16.0 (14.8).

Male imago: Head dark brown, paler near the base of the ocelli. Eyes pale grey, lower portion darker. Antennal scape yellowish brown.

Thorax: Pronotum whitish with broad paired parasagittal brown maculae. Mesothorax yellowish brown with darker paired medial longitudinal bands; scutellum whitish with dark brown medial macula widening almost the length of the posterior margin. Pleura brown, darker at the margins. Sterna pale brown, sutures and margins darker. Carina brown. Legs whitish with fore tibiae and tarsi yellowish; articulation of the femora with tibiae and subsequent tarsal joints darker; a dark band at each mid femur. Length ratios of the foreleg segments: 1.07–1.27 : 1.00 (2.8–3.2 mm) : 0.37–0.45 : 0.47–0.61 : 0.53–0.66 : 0.48–0.53 : 0.23–0.28.

Wings (Fig. 14, 15): Forewing width 0.34–0.36 (0.35)x length, longitudinal veins and cross-veins dark brown, thickened in costal and subcostal area; distal half of cells C and Sc pale brownish. Bullae of Sc, R_1, and R_2 present, but inconspicuous. Cross-veins between R_1 and R_2 evenly distributed. Veins R_3A and R_3B basally connected.

Abdomen (Fig. 77): Terga I–VI each with brownish transverse posterior band. Some specimens show dark brown paired parasagittal crescent-shaped marks on terga IV–VI at most. Terga 1–7 with brownish posterolateral triangular marks. Sterna greyish brown. Dark brown abdominal ganglia visible on terga I–VII.

Genitalia (Fig. 82): Penes greyish, dark brown dorsolaterally at midlength, fused to midlength, somewhat divergent and rounded apically. Styliger plate shallowly emarginated. Length ratio of penis : styliger plate less than 2:1. Caudal filaments greyish with annulations darkening posteriorly.

Female imago: As in male except as follows: Head whitish. Eyes greyish brown.

Thorax: Pronotum yellowish grey, scutellum whitish washed with dark brown at margins. Pleura pale brown. Tergum pale brown with whitish medial longitudinal band. Legs whitish and marked as in male.

Wings: Forewing width 0.34–0.42x length. Hind wing width 0.54–0.66x length and length 0.32–0.37 (0.34)x that of forewing.

Abdomen: Terga VII–IX whitish. Sternum VII with spatulate subgenital plate of varying length, usually extending almost the length of sternum VIII, or even beyond it. Subgenital plate apically rounded and diverging from the abdomen (Fig. 90). Sternum IX with shallow to pronounced apical cleft.

Subimago: As in the imago except as follows: Eyes of the male and female greyish black. Pronotum yellowish brown, mesonotum yellowish. Anterior portion of lateral scutal suture washed in dark brown. Scutum and scutellum whitish. Pleura yellowish white, margins darker. Sterna yellowish white. Wings (Fig. 98, 99) translucent; longitudinal and cross-veins dark brown; faint clouding at all, or almost all, cross-veins, particularly anteriorly in forewing. Some cells of forewing faintly clouded at midlength around the bullae of C, Sc, and R_1, with broad brownish clouds at cross-veins. Hind wing without any coloured bandings. Penes of male whitish.

Late instar larva (Fig. 26): Head whitish, clypeus hyaline with dark brown band at basal margin; labrum yellowish, black at lateral margins; antennae hyaline. Eyes pale grey to black; antennae 1/2–2/3 length of head.

Mouthparts: Labrum: Length 1.13–1.29 (1.23)x that of clypeus, width 0.74–0.88 (0.82)x that of clypeus. Maxilla: Lacinia with marginal row of 16–26 larger spines, submarginal row of 5–8 setae, and basal row of 5 setae. Galea with marginal row of 5 setae. Palp segment 2 0.65–0.83 (0.74)x as long as segment 1, and segment 3 0.25–0.30 (0.27)x as long as segment 2. Labium (Fig. 55): Aboral side of prementum medially of insertion of labial palps with paired group of 1–3 thick spines, proximally of insertion of labial palps with paired diagonal row of 3–9 thick spines, postmentum without thick spines. Palp segment 2 0.71–0.87 (0.80)x as long as segment 1 and segment 3 0.60–0.75 (0.68)x as long as segment 2.

Thorax grey with blackish lateral margins; a whitish grey dorsal median longitudinal band. Pleura whitish with blackish ventral margins. Sterna whitish. Legs whitish with darker patches at mid femur. Fore tarsus dark brown including articulations with the tibiae. Mid and hind tarsi darker distally. Tarsal claws yellowish brown with two rows of 9-18 denticles on inner margins.

Abdomen grey. Dorsal segments II–IX each with a median longitudinal biconvex white mark and brownish black paired parasagittal longitudinal marks. Posterior margins brownish black with a row of well developed spines directed caudally, well developed on terga (IV–)V–IX. Tergum X without conspicuous markings. Sterna

whitish. Sterna IV–VIII each with a narrow posterior transverse band of spines directed caudally. Abdominal ganglia strongly pigmented and well visible from segments III to VIII. Posterolateral projections small but more developed on sterna IV–VIII and more so on IX. Caudal filaments yellowish, 0.41–0.43x as long as body.

Egg (Fig. 68, 69, 72): length 180–205 µm, width 100–125 µm. Chorionic ridges 2 µm thick, diameter of chorionic polygon 7-8 µm, 4-6 micropyles present. Attachment structures: Outer ring of fibre-coils and inner ring of terminal fibre-cluster in each polygon. Fibres of terminal fibre-cluster run in an oblique direction and not perpendicular to surface of fibre-cluster; thus terminal fibre-cluster appears as a second, inner ring of fibre-coils. Centre of terminal fibre-cluster with prominent circular gap through which heavily domed chorion ground protrudes. Domed chorion ground in centre of each chorionic polygon visible through outer suprachorionic layer giving egg characteristic appearance (Fig. 68). Chorion ground texture with small mesh reticulation (Fig. 72).

Type data: **Holotype**: male imago, Camp Stream, Craigieburn Range, New Zealand. 24044 57843, 1000 m, 30 December 1997, Terry R. Hitchings (CMNZ). **Allotype**: female imago, same data as holotype; (CMNZ). **Paratypes**: BMNH—1 male imago, 1 female imago, 1 larva; CMNZ—1 male imago, 1 female imago, 1 male subimago, 1 female subimago, 1 larva; FAMU—1 male imago, 1 female imago, 1 larva; NMNH—1 male imago, 1 female imago, 1 larva; NZAC—1 male imago, 1 female imago, 1 male subimago, 1 female subimago, 1 larva; SMNS—1 male imago, 1 female imago, 1 larva.

Material examined. The following non-type examples (see Appendix 3 for collection details). **NN** Cobb Reservoir Stm; Peel L outlet; Roding R. **BR** Ahaura R Trib; Buller R Trib; Camp Ck;Five Mile Ck; Goings Ck;Hopeless Ck;Mitchells Stm; Mole Ck Trib; Rainbow Skifield; Rough Ck; Safety Ck; Spargo Ck; Te Wiriki Stm; Thirteen Mile Ck; Upper Grey R. **WD** Haast R; Kiwi Jacks Ck Trib; Pegleg Ck, Arthurs Pass;Robinson Ck; Spring Ck, Landsborough R. **MB** Bushy Corner Gully; Hanmer R Trib; Pass Stm; Pass Sm Trib; Rogerson Stm; L. Guyon Inlet Stm; Waiau R Trib. **KA** Fyffe-Palmer Scenic Reserve. **NC** Ashley R Trib; Deer Ck; Glacier Stm; Glentui R; Kedron R; Kowhai R Trib; Lewis Pass; Rough Ck; Twin Ck. **MC** Broken R; Bruce Stm; Bush Stm; Camp Stm; Cave Stm Trib; Cuckoo Ck;Dry R; Lillian Stm; Power Stm; Ryton R Trib; Bowyer Stm; Tims Stm; Wall Ck Trib. **SC** Firewood Stm; Fox Pk Skifield; Mt Dobson Skifield. **OL** Cardrona R; Greenstone R Trib; Leaping Burn; Mick Ck; Roaring Meg Trib; Rob Roy Stm; Treble Cone. **CO** Black Gully; Burgan Stm; Clearwater Ck;Coal Ck; Fraser R Trib; Jordan R; Lammermoor Ra; McPhees Rock; Mt Evelyn; Nevis R; Nevis R Trib; North Dunstan Mountains; Old Man Ra; Omeo Ck; Pisa Ra; Pisgah Spur; Princess Burn; Quartz Reef Ck; Rastus Burn; Rough Ck; The Remarkables; Thomsons Ck. **DN** Waitati R. **FD** Borland Burn; Borland Saddle; Monkey Ck Trib. **SL** John O Groats Hill; Little Pomahaka R; Pomahaka Headwaters; Spence Burn, Takitimu Mountains.

Distribution and habitat (Map 4). *N. austrinus* has been found to be the most common species of the genus in subalpine regions of the Southern Alps and adjacent mountains. It is rarely reported from below 300 m. The species forms significant populations in the stable sections of first and second order streams above the forest line.

– / NN, BR, WD, MB, KA, NC, MC, SC, OL, CO, DN, FD, SL.

Intraspecific variation. Some specimens show indeterminate markings on the abdominal terga. Female imagos vary in the extent of emargination on sternum IX, ranging from quite pronounced to almost none. Some adult specimens from the southern South Island show a small amount of reticulation in the apical costal region. Some adults show no banding at mid femur.

Remarks. *Nesameletus austrinus* is most similar to *N. flavitinctus,* from which it can be distinguished in the imago by:

(1) the absence of a pronounced greenish tinge to the fore- and hind wings,

(2) inconspicuous bullae in the fore wing,

(3) the presence of prominent brownish black ganglia on sterna I–VII,

(4) the absence of a dark brown median mark on the posterior margin of sterna I–VI,

(5) apices of the male penes rounded without tapering, and

(6) female subgenital plate of sternum VII extending up to the length of sternum VIII or even longer.

In the larva it can be distinguished by:

(1) the presence of median longitudinal biconvex white maculae on abdominal terga,

(2) ventral abdominal ganglia visible on sterna III–VIII, and

(3) the absence of distinct darkened areas apically and basally on the tarsomeres.

Etymology. Latin ***austrinus*** = southern.

Nesameletus vulcanus Hitchings & Staniczek, new species

Fig. 16, 17, 27, 35, 43–45, 56, 70, 71, 78, 83, 91, 100, 101, 104–107, Map 5

Dimensions (mm): Male imago body length 13.9–14.8 (14.3), forewing 14.3–15.7 (15.1), hind wing 5.1–5.7 (5.3), mature larva 13.9–14.6 (14.3). Female body length 13.6–16.5 (14.8), forewing 14.3–18.5 (16.1), hind wing 5.7–6.9 (6.2), mature larva 13.6–16.5 (15.0).

Male imago. Head pale yellowish, black at base of the ocelli, which are whitish. Eyes whitish, darker basally, antennal scape whitish.

Thorax: Pronotum, mesonotum, and metanotum pale greyish yellow washed with dark brown parasagittally and at the lateral parapsidal sutures. Scutellum darker brownish with pale parasagittal maculae. Pleura greyish yellow washed with dark brown at the sutures. Sterna brownish grey, darker at the margins. Legs pale yellowish, darker brown at the articulations of the femur and to a lesser extent at the tibiotarsal joints. Length ratios of foreleg segments: 1.10–1.29 : 1.00 (2.6–3.1 mm) : 0.35–0.45 : 0.50–0.60 : 0.53–0.55 : 0.35–0.45 : 0.20–0.25.

Wings (Fig. 16, 17): Forewing width 0.28–0.34 (0.31)x length, longitudinal veins and cross-veins dark brown, thickened in costal and subcostal regions. Costal cells in the pterostigmatic region sometimes with reticulation. Prominent bullae at midlength in Sc, R_1, and R_2. Cross-veins between R_1 and R_2 evenly distributed. Veins R_3A and R_3B basally connected.

Abdomen (Fig. 78) greyish. Terga II–VII with paired parasagittal oval dark brown maculae, paler within, and becoming elongated longitudinally through III–VII. Terga I–VIII each with transverse dark brown posterior bands and paired posterolateral maculae. Sterna brownish grey, ganglia visible on sterna II–VIII; terminal ganglion darkest.

Genitalia (Fig. 83): Penes whitish yellow with apical and distal surfaces brown. Penis lobes narrowly divided at midlength, diverging more widely at 3/4 length. Penis lobes taper to rounded apices. Styliger plate emarginated in a smooth curve between obtuse angled, posteriorly directed parasagittal projections. Length ratio of penis : styliger plate about 2:1.

Female imago as in the male except as follows: Head whitish with a median dorsal dark brown longitudinal band. Eyes greyish yellow.

Thorax: Pronotum and mesonotum greyish yellow. Scutum whitish with paired parasagittal brown maculae. Scutellum whitish with median greyish yellow macula. Forewing width 0.31–0.34(0.33)x length. Hind wing length 0.38–0.40 (0.39)x length of forewing. Abdominal sternum VII with triangular, apically rounded subgenital plate 1/3rd length of sternum VIII at most (Fig. 91). Sternum IX emarginated.

Subimago as in the imago except as follows. Head grey, eyes grey, darker basally. Pronotum and mesonotum whitish, washed with brown. Metanotum whitish, scutellum white with paired parasagittal brownish maculae. Pleura whitish with brown margins. Sterna whitish. Wings (Fig. 100, 101) translucent, brown longitudinal veins and cross-veins, with faint uniform clouding throughout the forewing. Cells C and Sc darker apically from midlength. Hind wings slightly darker at the apex and hind margin. Penes white.

Late instar larva (Fig. 27): Head grey, eyes grey, antennae 1/2 length of head. Clypeus whitish, dark brown at basal margin.

Mouthparts: Labrum: whitish coloured and with blackish lateral margins. Labrum length 0.86–0.94 (0.91)x that of clypeus and width 0.86–0.91(0.88)x that of clypeus. Maxilla: Lacinia with marginal row of 17–18 larger spines, submarginal row of 3–5 setae, and basal row of 6 setae. Galea with marginal row of 6 setae. Length of palp segment 2 0.80–0.87 (0.84)x that of segment 1, and segment 3 0.13–0.25 (0.20)x that of segment 2. Labium (Fig. 56): Aboral side of prementum medially of insertion of labial palps with paired group of 2–3 thick spines, proximally of insertion of labial palps with paired diagonal row of 5–7 thick spines, postmentum generally without thick spines. Length of palp segment 2 0.67–0.80 (0.75)x that of segment 1, and segment 3 0.50–0.67 (0.59)x that of segment 2.

Thorax greyish yellow. Terga darker at the margins; pleura paler; sterna whitish; legs whitish, tarsi darker; tarsal claws brown with two rows of 14–22 denticles on inner margins.

Abdomen greyish brown, dorsoventrally flattened. Terga II–IX with paired parasagittal and lateral dark brown patches; transverse posterior brown bands on terga I–IX and a row of spines directed caudally on terga (VII–)VIII and IX, well developed on the latter only (Fig. 104–107). Sterna whitish with paired lateral dark brown lines directed longitudinally, on segments I–VII. Sterna III–VIII pale yellowish brown with posterior transverse bands. Posterior segment borders with rows of spines directed caudally. Abdominal ganglia VIII and usually also VII well visible. Posterolateral projections small, acuminate on segments VIII and IX only. Caudal filaments yellowish brown 0.46–0.58x as long as body.

Egg (Fig. 70, 71): length 195-200 µm, width 110 µm. Chorionic ridges 1 µm thick, diameter of chorionic polygon 10 µm, 4–5 micropyles present. Attachment structures: Fibre-coils few and confined to thin outer ring, and with a large inner terminal fibre-cluster in each polygon. Chorion ground domed, chorion ground texture rugose.

Type data: **Holotype**: male imago, MC, Narbey Stream, Banks Peninsula, 22 October 1997, Terry R. Hitchings (CMNZ). **Allotype**: female imago, same data as holotype (CMNZ). **Paratypes**: BMNH—1 male imago, 1 female imago, 3 larvae; CMNZ—1 male imago, 1 female imago, 1 male subimago, 1 female subimago, 10 larvae; FAMU—1 male imago, 1 female imago, 3 larvae; NZAC—1 male imago, 1 female imago, 3 larvae; SMNS—1 male imago, 1 female imago, 3 larvae.

Material examined. The following non-type examples (see Appendix 3 for collection details). **MC** Armstrong Reserve; Boundary Falls, Hinewai; Charteris Bay Stm; Flea Bay Stm; Fuchsia Falls, Hinewai; Grehan Stm; Hinewai Beech Forest; Hinewai Reserve; Little Akaloa Stm; Narbey Stm; Okuti Stm; Peraki Stm; Te Kawa Stm Trib.

Distribution and habitat (Map 5). *N. vulcanus* has been collected from ten streams of Banks Peninsula. *N. vulcanus* is found from sea level to the limits of permanent stream flow, at about 500 m. Almost all of the mature forest has been removed from the peninsula but tall shrub vegetation remains along many of the watercourses. Mature larvae tend to gather under vegetation in streams with a low angle of descent. This species appears to be endemic to Banks Peninsula.

– / MC.

Intraspecific variation. Some female imagos show paired occiputal projections. Larvae rarely with 1 or 2 thick spines on postmentum shoulder.

Remarks. *N. vulcanus* is most similar to *N. austrinus* from which it can be distinguished in the imago by:

(1) the absence of a dark band at midlength of each femur,

(2) the presence of a small dark blotch around the bullae in the forewing,

(3) in the male, penes tapering, with proximal shoulders, and

(4) in the female, sternum VII with genital extension triangular and less than half the length of sternum VIII.

In the larva it can be distinguished by:

(1) the absence of dark patches at midlength of each femur,

(2) posterolateral projections small and acuminate on sterna VIII and IX only, and

(3) well developed spines directed caudally on posterior margins of abdominal terga VIII and IX only.

Etymology. Lat. **vulcanus**, from Vulcan, the Roman god of fire. Refers to the volcanic origin of Banks Peninsula, the present known distribution of the species.

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APPENDIX 1: Abbreviations in figures

bu	bulla
ca	cardo
ce	cercus
cp	costal process
cvc	cross-vein cluster
cx	coxa
fe	femur
galc	galeolacinia
gl	glossa
inc	incisor
lam	lamina
lb	labium
lbr	labrum
li	lingua
md	mandible
mo	mola
mtb	maxillar tubule
mx	maxilla
pe	penis
pgl	paraglossa
plb	labial palp
pmt	postmentum
pmx	maxillary palp
prmt	prementum
pta	pretarsus
pte	pterostigma
sli	superlingua
st	stipes
stp	styliger plate
sty	styliger
ta	tarsus
tf	terminal filament
ti	tibia
tps	tibiopatellar suture
tr	trochanter

APPENDIX 2: Geographical coordinates of collection sites. Coordinates should read as 00° 00'S/000° 00'E. The two letter area codes follow Crosby *et al*.(1998).

Ahaura R, BR 4230/17149
Akatarawa Ck, WN 4058/17507
Anderson Stm, AK 4653/17431
Armstrong Res, MC 4350/17300
Arnold R, BR 4129/17109
Ashley R, NC 4313/17210
Awaroa Stm, CL 3649/17537

Bald Hill, SL 4610/16750
Bare Hill, SL 4600/16836
Black Gully, CO 4554/16921
Blackwater Ck, BR 4203/17216
Borland Bn, FD 4544/16725
Boundary Falls, MC 4349/17302
Bowyers Stm, MC 4338/17125
Broken R, MC 4306/17142
Bruce Stm, MC 4302/17138
Buller R, BR 4150/17141
Bullock Ck, BR 4206/17121
Burgan Stm, CO 4534/16957
Burke Ck, NN 4134/17201
Bush Stm, MC 4325/17143
Bushy Corner Gully, MB 4218/17240

Camp Ck, BR 4241/17132
Camp Stm, MC 4309/17146
Cardrona R, OL 4458/16858
Cascade Stm AK 3653/17431
Cass Stm, MC 4302/17145
Catchpool Stm WN, ... 4121/17456
Cave Stm, MC 4309/17143
Charteris Bay Stm, MC 4339/17242
Chilly Stm, KA 4239/17322
Chimney Stm, MB 4212/17305
Christmas Village Stm, SI 4645/16759
Clear Grey R, BR 4224/17207
Clearwater Ck, CO 4456/16924
Cleddau R, FD 4445/16757
Coal Ck, CO 4521/16913
Cobb Reservoir Stm, NN 4108/17237
Coopers Ck, NC 4315/17206
Coppermine Ck, RI 4015/17554
Crooked R, BR 4238/17136
Cuckoo Ck, MC 4310/17141

Dawn Ck, KA 4240/17323
Deep Stm, CO 4540/16959
Deer Ck, NC 4224/17221
Dog Stm, MB 4231/17251
Dry R, MC 4315/17029

Fern Flat Stm, KA 4241/17324
Firewood Stm, SC 4357/17040
Five Mile Ck, BR 4222/17215
Flat Stm, DN 4540/17017
Flea Bay Stm, MC 4351/17259
Ford Stm, MC 4326/17142
Four Mile R, BR 4158/17126
Fox Peak Skifield, OL 4352/17049
Fraser R, CO 4520/16912
French Farm Stm, MC 4347/17254
Fuchsia Ck, BR 4150/17141
Fuchsia Falls, MC 4349/17301
Fyffe-Palmer Sc. Res, KA 4420/17338

George Ck, WN 4116/17500
Glacier Stm, NC 4214/17238
Glentui R, NC 4312/17215
Goat Stm, MB 4143/17311
Goings Ck, BR 4224/17224
Gollans Ck, WN 4119/17454
Goose Ck, BR 4210/17213
Gorge Ck, CO 4537/16746
Gowan R, BR 4148/17236
Greenstone R, OL 4453/16809
Grehan Stm, MC 4348/17300
Grey R, NC 4308/17232

Haast R, WD 4402/16922
Hamilton Bn, SL 4539/16806
Hanmer R, MB 4228/17250
Harris Ck, WD 4356/16907
Hicks Road Stm, SI 4653/16807
Hinewai Beech For, MC 4349/17301
Hinewai Res., MC 4349/17301
Hook Bush, SC 4439/17058
Hopeless Ck, BR 4156/17245
Howard R, BR 4145/17209
Hurunui R, NC 4218/17220

Inangahua R, BR 4159/17153

Jackson R, WD 4405/16839
Jinks Ck, BR 4202/17157
John O Groats Hill, SL 4556/16924
Jordan R, CO 4535/16910

Kaniwhaniwha Stm, WO 3755/17505
Kedron R, NC 4233/17213
Kiwi Jacks Ck, WD 4324/17008
Kowhai R, NC 4308/17233
Kuripaka R, WO 3747/17504

L. Guyon Inlet Stm, MB 4217/17239
La Fontaine Stm, WD 4305/17031
Lammermoor Ra., CO 4540/16947
Langdon Ck, BR 4226/17122
Larrys Ck, BR 4202/17157
Leaping Bn, OL 4432/16850
Lee R, MC 4352/17217
Lewis Pass, NC 4223/17223
Lillian Stm, MC 4310/17130
Little Akaloa Stm, MC 4342/17258
Little Pomahaka R, CO 4532/16910
Long Harry Stm, SI 4642/16747

Mahuia Rapids, TO 3909/17530
Makomiko Stm, TO 3915/17524
Mangahao R, WN 4039/17528
Mangorewa R, BP 3758/17610
Maori Gully Ck, BR 4231/17122
Martyr R, WD 4405/16831
Maruia R, BR 4208/17213
Matakitaki R, BR 4147/17219
McPhees Rock, CO 4512/17001
Medina R, KA 4241/17326
Mick Ck, OL 4451/16819
Mill Ck, SI 4654/16807
Mitchell Stm, BR 4208/17213
Mohaka R, TO 3906/17642
Mole Ck, BR 4153/17234
Monkey Ck, FD 4449/16800
Mount Evelyn, CO 4506/17028
Mount Rakeahua, SI 4657/16753
Mount Dobson Skifield, SC 4357/17040
Myttons Ck, NN 4107/17235

Narbey Stm, MC 4350/17303
Nelson Ck, BR 4224/17131
Nevis R, CO 4511/16900
Ngaheranui Stm, HB 3918/17625
Nihotupu, AK 3656/17433
North Dunstan Mts, CO 4450/16940

Octopus Ck, WD 4327/17004
Ohutu Stm, RI 3938/17604
Okarahia Stm, KA 4233/17327
Okuku Downs Stm 4303/17219
Okuti Stm, MC 4347/17251

APPENDIX 3: Collection details of specimens examined.

Specimen stage, localities (including 10-figure grid references from the NZMS260 1:50,000 map series — for latitudes and longitudes refer Appendix 2), dates collected, collectors, and institutions of specimens examined. For abbreviations used, see page 13.

Nesameletus ornatus (Eaton, 1883)

AK ♂♂i, Anderson Stm, Waitakere, 26461 64781, 80m, 25 Apr 1977, DRT (FAMU); ♂♂ and ♀♀ si & i, Cascade Stm, Waitakere, 26461 64782, 45 m, 21 December 1968, PHN; larvae, Nihotupu between Reservoirs, 26493 64727, 260m, 6 Feb 1997, TRH. **BP** larvae, Mangorewa R Ecological Area 27887 63554, 360 m, 12 Jan 1995, TRH; ♂♂ and ♀♀ si, i, and larvae, Mangorewa R Ecological Area, 27888 63951, 380 m, 15 Feb 1997, MWH; larvae, Oweka Stm, 29651 63880, 60 m, 24 May 1996, GCP; larvae, Punaruku Stm, Cape Runaway, 29790 63857, 10 m, 24 May 1996, GCP; ♂ i, Te Puia Stm, East Cape, 29483 63821, 210 m, 24 Jan 1993, JBW; larvae, Whangapoa Stm Trib, 27775 63143, 260 m, 1 Jun 1992, TRH; larvae, Uretara Stm, Kaimai Range, 27625 64000, 160 m, 18 Feb 1997, RLP; larvae, Wheao R, Rotorua, 28215 62795, 400 m,16 Sep 1997, BJS. **BR** ♂ si, Ten Mile Ck, Paparoa Range, 23670 58729, 10 m, 3 Sep 1964, IDM; ♂♂ and ♀♀ si, Thirteen Mile Ck, 23686 59764, 20m, 26 Oct 1960, JGP (FAMU); ♂ si, ♂♂ i and larvae, Ahaura R Trib, 24123 58563, 150 m, 16 Dec 1996, TRH; larvae, Ahaura R Trib, 24106 58597, 160 m, 16 Dec 1996, TRH; ♂♂ and ♀♀ si, Arnold R at Kokiri, 23776 58554, 90m, 15 Apr 1960, JGP (FAMU); larvae, Blackwater Ck, 24494 59063, 390m, 16 Dec 1998, TRH; ♀ si, Camp Ck, Inchbonnie, 23919 58326, 700 m, 15 Feb 1995, RSA; larvae, Clear Grey R at Br., 24375 58675, 430 m, 28 Jan 1995, TRH; ♂ si, Crooked R at Bell Hill Br., 23948 58409, 130 m, 13 Nov 1993, IDM; ♂♂ si, Fuchsia Ck, 24007 59293, 20m, 2 May 1965, IDM (FAMU); larvae, Goose Ck, Maruia, 24446 58935, 320 m,14 Dec 1995, TRH; ♀♀ i, Gowan R at L. Rotoroa, 24763 59346,460m, 26 Nov 1972, ALM (FAMU); larvae, Howard R at Br., 24386 59402, 450 m, 8 Jan 1996, J&G; ♂ si, Inangahua R at Br., 24179 59129, 110 m, 29 Mar 1993, PHI; larva, Jinks Ck, Trib, 24127 58963, 180 m, 10 Dec 1997, TRH; ♀ si, Larrys Ck, 24226 59076, 170 m, 31 Dec 1992, PHI; larvae, Maori Gully Ck 23752 58541, 95 m, 20 Mar 1993, AHS; larvae, Mariua R at Station Ck, 24452 58902, 340 m, 14 Dec 1993, TRH; larva, Maruia Falls, 24478 59273, 150 m, 10 Oct 1997, GCP; ♂♂ and ♀♀ si & i, Maruia R, at Mitchells Ck, 24451 58979, 310 m, 13 Dec 1995, TRH; ♂♂ & ♀♀ si, Matakitaki R, Trib, 24533 59363, 210 m, 12 Mar 1993, JBW; larvae, Mitchells Stm, Maruia, 24451 58978, 340 m, 15 Dec 1994, TRH; larvae, Nelson Ck., 23882 58658, 120 m, 11 Nov 1994, JBW; larvae, Pigeon Ck, 23780 58431, 90m, 15 Nov 1998, TRH; larva, Porika Stm Ford, 24820 59388, 500 m, 8 Jan 1996; J&G; larvae, Rahu Stm, Mariua, 24430 58789, 480 m, 16 Dec 1993, TRH; larvae, Rahu Stm, Trib, 24398 58725, 480 m, 28 Jan 1995, TRH; larvae, Rough & Tumble Ck, 23935 58440, 140m, 11 Oct 1998, LJS; larvae, Sawyers Ck, Boddytown, 23629 58568, 30 m, 17 Mar 1993, TRH; larvae, Springlands Ck, Maruia, 24426 58746, 430 m, 18 May 1995, TRH; larva, Station Ck, 24465 58907, 370 m, 16 Nov 1997, GHO; ♀ si, Stony R, Inangahua, 24143 59112, 110 m, 22 Nov 1993, PHI; larvae, Taramakau R Trib, 23854 58297, 150 m, 13 Dec 1996, TRH; larvae, Station Ck Trib, Mariua, 24482 58889, 410 m, 13 Dec 1993, TRH; larvae, Two Mile Ck, Buller, 24678 59459, 280 m, 10 Feb 1994, TRH; larvae, Taramakau R Trib, Inchbonnie, 23854 58297, 150 m, 15 Sep 1960, JGP; larvae, Arnold R Trib, 23766 58570, 60 m, 16 Mar 1993, TRH; larvae, Taramakau R Trib, 23854 58297, 150 m, 17 Mar 1993, TRH; larvae, Upper Grey R, at Br., 24385 58676, 440 m, 28 Jan 1995, TRH; ♀♀ si, Waimea Stm, Maori Gully, 23752 58541, 120 m, 4 Jan 1992, J&G; larva, Waitahu R, 24221 58976, 270 m, 11 Nov 1997, GHO. **CL** larva, Tarawaere Stm, Kauaeranga, 27477 64554, 180 m, 6 Apr 1993, AHS; larva, Whangaeterenga Stm, 27453 64542, 170 m, 6 Apr 1993, AHS. **CO** ♂ si, Burgan Stm, 22719 55114, 830 m, 15 Jan 1992, ADH; ♀ si, Burgan Stm, 22721 55114, 830 m, 6 Apr 1992, ARM; ♂♂ and ♀♀ si and larvae, Deep Stm, 22752 54995, 350 m, 13 Jan 1992, ARM; ♂ si, Little Pomahaka R, Old Man Range, 22107 55127, 730 m, 12 Dec 1994, BHP; larvae, Pigroot Ck, 23077 55537, 520 m, 1 Nov 1995, B&H; ♂♂ si and i, Stony Ck, 22678 55086, 820 m, 28 Nov 1992, ADH; ♂♂ and ♀♀ si, Stony Ck, 22683 55089, 810 m, 26 Oct 1991, ARM; ♂♂ and ♀♀ si, Taieri R, near Pateroa, 22703 55390, 380 m, 4 Nov 1992, BHP. **DN** ♂ i, Flat Stm, Taieri Gorge, 22985 55012, 200 m, 26 Oct 1993, BHP; ♀ si, Waianakarua R, South, 23350 55458, 10 m, 24 Nov 1993, BHP. **FD** ♀ si, Borland Burn, 20771 54819, 640m, 8 Jan 1997, J&G; ♂ i, Cleddau R, South Branch Trib, 21108 55946, 350 m, 2 Feb 1998, SJM. **GB** larva, Tolaga Bay, Unn., Stm, 29743 62992, 10 m, 24 May 1996, GCP. **HB** ♂ i, Ngaheranui Stm, Kaweka Ra., 28045 62069, 940 m, 5 Jan 1995, BHP. **KA** larva, Chilly Stm Trib, Hawkswood Ra., 25395 58395, 260 m, 21 Apr 1995, TRH; larva, Dawn Ck., Hawkswood Ra., 25419 58376, 300 m, 22 Apr 1995, TRH; larva, Fern Flat Stm, Hawkswood Ra., 25428 58361, 160 m, 22 Apr 1995, TRH; larvae, Medina R, Hawkswood Ra., 25451 58351, 10 m, 21 Apr 1995, TRH; larva, Okarahia Stm, 25470 58516, 110 m, 21 Apr 1993, TRH; **MB** larvae, Chimney Stm, Pudding Hill, 25162 58899, 850 m, 14 Jan 1996, TRH; ♀ si, Dog Stm Tribs., Hanmer, 24976 58560, 440 m, 2 Dec 1994, J&G; larva, Goat Stm, Branch R, 25248 59437, 405 m, 31 Dec 1995, J&G; larva, Omaka R, Renwick , 25783 59645, 70 m, 20 May 1993, TRH; larva, Stanley R, 24851 58782, 900 m, 24 Nov 1993, TRH; larvae Waiau R, 24787 58823, 780 m, 21 Feb 1995, TRH. **MC** larvae, Bowyers Stm, Staveley, 23841 57285, 390 m, 6 Jan 1995, J&G; larva, Bush Stm, 24067 57544, 580 m, 23 Jan 1996, TRH; ♂♂ and ♀♀ i, Cass Stm at Field Station, 24088 57962, 570 m, 17 Dec 1993, KSH; larvae, Charteris Bay Stm, 24868 57265, 50 m, 27 Dec 1995, TRH; larva, Charteris Bay Stm, 24871 57526, 115 m, 29 Oct 1997, JBW; ♂ i, Charteris Bay Stm, Trib, 24868 57265, 50 m, 27 Dec 1995, T&B; larvae, Ford Stm, Selwyn R, 24044 57514, 490 m, 6 Jan 1996, TRH; larvae, French Farm Stm, 25016 57143, 40 m, 21 Oct 1997, TRH; larvae, Lee R, 24528 57036, 5m 31 Mar 1992, TRH; ♂ and ♀ si, Narbey Stm, 25136 57090, 60 m, 22 Oct 1997, TRH; larvae, Okuti Stm, 24977 57137, 180 m, 27 Jun 1993, TRH; larvae, Peraki Stm, 24795 57087, 140 m, 26 Jun 1993, TRH; larvae, Peraki Stm, 24969 57080, 70 m, 26 Jun 1993, TRH; larva, Potts R Stm, trib., 23445 57350, 555 m, 18 Feb

1996, J&S; larvae, Purau Stm, 24901 57289, 30 m, 27 Dec 1995, TRH; ♂♂ i, Scamander Stm, 23933 57657, 500m, 3 Dec 1965, AGM (FAMU); larvae, Waimakariri R, trib., 24524 57489, 130 m, 31 Jul 1997, H&H; ♀ i Waimakariri R Trib, 24135 57933, 470 m, 1 Oct 1995, SJM; ♀♀ si, Waterfall Ck, 23996 57960, 670 m, 13 Dec 1996, M&H. **NC** larvae, Ashley R, Trib, 24424 57760, 400 m, 3 Sep 1995, TRH; larvae, Coopers Ck East Branch, 24365 57716, 380 m, 14 Nov 1995, SJM; larvae, Coopers Ck Forks, 24340 57725, 440 m, 10 Oct 1993, TRH; larvae, Glentui R above Falls, 24492 57706, 350 m, 3 Nov 1993, TRH; larvae, Grey R, 24716 57843, 280 m, 7 Apr 1998, LJS; ♂♂ and ♀♀ si and i, Grey R, Loburn, 24702 57820, 210 m, 13 Oct 1997, TRH; larvae, Grey R, Smarts Road, 24700 57821, 210 m, 3 Oct 1997, MAP; larvae, Okuku Downs Stm., 24539 57934,550 m, 3 Sep 1995, TRH; larvae, Hurunui R,Trib, 24559 58227, 470 m, 12 Dec 1993, TRH; larvae, Waiau R, 24799 58857, 790 m, 21 Feb 1995, TRH; larvae, Wooded Gully, Mount, Thomas Forest, 24561 57792, 310 m, 2 Jan 1997, TRH. **ND** larvae, ♂♂ and ♀♀ i, Waipoua R, 25611 66165, 70 m, 28 Dec 1961, JGP. **NN** larvae, Burke Ck, 24279 59604, 50m, 29 Jan 1998, TRH; ♂ i, Myttons Ck, Cobb Valley, 24753 60109, 850 m, 28 Dec 1996, EDW; larvae, Oparara R, 24427 60056, 200 m, 27 Jan 1998, TRH; larva, Roding R, 25222 59774, 150 m,5 Jan 1996, J&G; ♂ i, The Brook, Nelson, 25345 59880, 140 m, 28 Dec 1994, JBW; larvae, Welcome Ck, Mohikinui, 24295 60688, 70m, 29 Jan 1998, TRH. **OL** ♂♂ and ♀♀ si, Greenstone R, 21271 55790, 590 m, 15 Feb 1995, ACM; ♂♂ i, Greenstone R, Trib, 21273 55788, 595 m, 27 Jan 1997, ACM. **RI** larvae, Coppermine Ck, 27565 61025, 340m, 11 Feb 1998, O&C (SM). **SC** ♂♂ i, Firewood Stm, Mount Dobson, 23224 56934, 1740 m, 30 Jan 1994, J&G; larvae, Hook Bush, Hunter Hills, 23492 56161, 190m, 31 Oct 1998, H&Q; ♂ i, Orari R at Gorge, 23648 56962, 290m, 24 Nov 1962,AGM (FAMU); larvae, Otaio R headwaters, 23421 56231, 430m, 30 Jan 1999, TRH; larvae, Trotters Ck, 23363 55314, 40 m, 22 Sep 1994, BHP. **SL** larvae, Hamilton Burn, 21276 54950, 370 m, 29 Jan 1997, MTG; ♂ si, Ruhtra Stm, Hokonui Hills, 21690 54538, 280 m, 21 Oct 1994, BHP. **TK** ♀ i, Tangarakau Gorge, 26690 62457, 150 m, 5 Nov 1976, KFO. **TO** ♂♂ i, Makomiko Stm, 27166 62154, 760 m, 31 Mar 1998, WJC; ♂♂ and ♀♀ si and i, Mohaka R, Auroa Road, 28306 62279, 260 m, 28 Oct 1997, WJC; ♂♂ and ♀♀ si and i, Mohaka R, Jock Sutton Road, 28287 62261, 270 m, 12 Dec 1996, WJC; ♂♂ i, Mohaka R, McVicar Road, 28226 62167, 400 m, 7 Apr 1997, WJC; larvae, Otamatea R, 27048 62676, 630 m, 16 Apr 1998, H&C; larvae, Rangitaiki R, 28076 62712, 600 m, 16 Apr 1998, H&C; larvae, Retaruke R, 27070 62220, 280m, 29 Dec 1998, H&C; larvae, Taringamotu R, 27053 62591, 180 m, 18 Jan 1967, AGM; ♂ i, Te Arero Stm, 27893 62447, 750 m, 30 Dec 1997, WJC; ♂ i, Tongariro R, 27523 62222, 690 m, 27 Nov 1996, BJS; larvae, Waewaeru Stm, 27343 62366, 670 m, 28 Oct 1993, TRH; ♀ si, Waimarino Stm, 27173 62180, 740 m, WJC; ♂ i, Waimiha Stm, 27124 62855, 230 m, 8 Jan 1967, AGM; larvae, Wanganui R, 27345 62366, 670 m, 28 Oct 1993, TRH; ♀ si, Whakapapaiti Stm., 27235 62218, 880 m, 28 Feb 1959, KAW (AMNZ); ♀i, Whakapapaiti Stm., Trib, 26283 62179, 1240 m, WJC. **WD** larvae, ♂♂ and ♀♀ si and i, Jackson R, 21617 56713, 50 m, 27 Feb 1992, TRH; ♂♂ and ♀♀ si, La Fontaine Stm, 23084 57893, 15 m, 28 Jan 1993, TRH; larvae, Martyr R, 21512 56701, 10 m, 26 Feb 1994, TRH; larvae, Martyr R Trib, 21510 56697, 15 m, 26 Feb 1994, TRH; ♂ i, larvae, Octopus Ck, Cook Saddle, 22722 57474, 310m, 5 Nov 1995, J&B; The Windbag, 22187 57104, 40m, 5 Jan 1999, B&H (OMNZ); larvae, Turnbull R, 21839 56857, 25 m, 26 Feb 1992, TRH. **WN** larvae, ♂♂ and ♀♀ i, Catchpool Stm, 26712 59824, 50 m, 11 Nov 1997, TRH; larvae, George Ck, 26775 59916, 160 m, 11 Nov 1997, TRH; larva, Gollans Stm, 26689 59865, 30 m, 27 Mar 1993, AHS. **WO** larvae, ♂♂i, Kaniwhaniwha Stm, 26931 63627, 80 m, 26 Nov 1996, BJS; ♂♂ & ♀♀ i, Tiwarawara Stm, 26975 63502, 220m, 10 Mar 1966, JGP (FAMU).

Nesameletus austrinus

BR larvae, Ahaura R Trib, 24136 58524, 170 m, TRH; ♀ si, Buller R Trib, 24013 59295, 30 m, 4 Sep 1994, IDM; larvae, Camp Ck, 23901 58345, 170 m, 13 Dec 1996, TRH; larvae, Five Mile Ck, 24483 58713, 530 m, 28 Oct 1996, SJM; larvae, Goings Ck, 24605 58672, 800 m, 28 Oct 1996, SJM; ♀ si, Hopeless Ck, 24898 59197, 1100m, 22 Feb 1984, AKW (NAC); larvae, Mitchells Stm, 24448 58978, 330 m, 14 Dec 1993, TRH; larvae, Mole Ck Trib, 24737 59255, 960 m, 25 Jan 1995, TRH; larvae, Rainbow Skifield, 24983 59259, 1450 m, 6 Jan 1996, J&G; larvae, Rough Ck, 24506 58696, 625 m, 28 Oct 1996, SJM; larvae, Safety Ck, 24116 58588, 180 m, 16 Dec 1996, TRH; larvae, Spargo Ck, 24507 59065, 420m, 16 Dec 1998, TRH; larvae, Te Wiriki Stm, 24731 59334, 600 m, 24 Jan 1995, TRH; larvae, Thirteen Mile Ck, 23685 58763, 10m, 15 Aug 1960, JGP; Upper Grey R, 24384 58696, 450 m, 28 Jan 1995, TRH. **CO** larvae, Black Gully, 22268 54728, 330 m, 13 Jan 1995, JBJ; ♀ i, Burgan Stm,22721 55114, 830 m, 7 Apr 1994, ARM; ♂ i, Clearwater Ck, 22265 55797, 540 m, 21 Jan 1997, H&G; ♀ i, Coal Ck, 22142 55325, 1450 m, 21 Jan 1997, LOG; larvae and ♀ i, Fraser R Trib, 22123 55346, 1550 m, 30 Jan 1997, SJM; ♂♂ and ♀♀ subimagos, Jordan R, 22109 55076, 600m, 19 Dec 1998, BHP; ♂ si, Lammermoor Range, 22588 54993, 1125 m, 21 Dec 1991, BHP; ♀♀ i, McPhees Rock, 22753 55222, 1250 m, 26 Feb 1993, BHP; larva, Mount Evelyn, 23100 55648, 1000 m, 8 Feb 1993, BHP; larvae, Nevis R, 21954 55517, 650 m, 22 Jan 1997, TRH; larvae, Nevis R Trib, 22012 55466, 1600 m, 1 Jan 1996, BHP; larvae, ♂♂ and ♀♀ i, North Dunstan Mountains, 22462 55920, 1350 m, 9 Dec 1993, BHP; larvae, ♂♂ and ♀♀ i, Old Man Range, 22140 55335, 1450 m, 11 Jan 1992, BHP; larvae, Omeo Ck, 22133 55391, 1310 m, 23 Jan 1997, SJM; ♀ i, Pisa Range, 22067 55859, 1665 m, 3 Jan 1992, BHP; ♂ i, Pisgah Spur, 23076 55678,1350 m, 7 Feb 1995, BHP; larvae, Princess Burn, 22062 55912, 1300 m, 16 Mar 1995, P&M; ♀♀ i, Quartz Reef Ck, 22230 55659, 1550 m, 2 Jan 1993, BHP; ♂♂ and ♀♀ i, Rastus Burn, 21800 55651, 1440 m, 8 Mar 1997, BML; ♂♂ i, Rastus Burn, 21799 55655, 1640 m, 15 Feb 1988, BML; larvae and ♀♀ i, Rough Ck, 22125 55413, 1260 m, 29 Jan 1997, SJM; ♂ si, The Remarkables, 21799 55655, 1800 m, 20 Feb 1992, BHP; larva, Thomsons Ck, 22376 55746,750 m, 21 Jan 1997, H&G. **DN** ♂ i, Waitati R, 23165 54873, 340 m, 12 Dec 1996, B&H. FD larva, Borland Burn, 20751 54822, 750 m, 5 Jan 1997, J&G; ♀ i, Borland Saddle, 20731 54815, 1400 m, 24 Dec 1992, BHP; ♂♂ and ♀♀ si and i, Borland Burn, 20767 54806, 980 m, 11 Feb 1996, BHP; ♀ i, Monkey Ck Trib, 21147 55883, 1080m, 3 Feb 1998, SJM. **KA** ♂♂ and ♀♀ si, Fyffe-Palmer Scenic Reserve, 25624 58746, 245 m, 6 Feb 1991, JBW. **MB** larvae, Bushy Corner Gully, 24825 58786,920 m, 19 Feb 1997,

TRH; larvae, Hanmer R Trib, 24958 58594, 870 m, 20 Apr 1997, TRH; larvae, Pass Stm, 24893 58771, 1050 m, 13 Jan 1998, SJM; larvae, Pass Stm Trib, 24900 58772, 1000 m, 25 Nov 1997, TRH; ♀ si, Rogerson Stm, 24926 58553, 440 m, 29 Jan 1980, PMJ; larvae, L. Guyon Inlet Stm, 24806 58803, 810 m, 22 Nov 1993, TRH; larvae, Waiau R Trib, 24802 58811, 860 m, 21 Nov 1994, TRH. **MC** larvae, Broken R, 24036 57855, 1140 m, 30 Dec 1997, TRH; ♀ si, Broken R, 24049 57877, 1200 m, 23 Nov 1991, BHP; larvae, Bruce Stm, 23984 57962, 630 m, 14 Feb 1992, TRH; larvae, Bush Stm, 24067, 57544, 580 m, 23 Jan 1996, TRH; ♂♂ and ♀♀ si and i, Camp Stm, 24044 57843, 1000 m, 6 Feb 1996, TRH; larvae, Cave Stm Trib, 24054 57835, 870 m, 15 Jan 1993, JSH; larvae, Cuckoo Ck, 24029 57816, 1060 m, 15 Jan 1993, JSH; larvae, Cuckoo Ck, 24031 57812, 1020 m, 31 Dec 1995, SJM; larvae, Dry R, 23051 57708, 780 m, 1 Sep 1995, SJM; larvae, Lillian Stm, 23874 57807, 970 m, 24 Jan 1996, TRH; ♂ i, Power Stm, 23939 57958, 920m, 20 Jan 1963, JRJ (FAMU); larvae, Ryton R Trib, 23968 57760, 1050 m, 26 Jan 1996, TRH; ♂♂ and ♀♀ si and i, Bowyer Stm, 23816 57302, 600 m, 17 Dec 1991, JBW; larvae, Tims stream, 24035 57803, 965 m, 1 Jan 1996; larvae, Wall Ck Trib, 24018 57827, 1520 m, 31 Dec 1995, SJM. **NC** larvae, Ashley R Trib, 24424 57760, 400 m, 3 Sep 1995, TRH; larvae, Deer Ck, 24565 58667, 840 m, 15 Dec 1995, TRH; larvae, Glacier Stm, 24795 58857,820 m, 21 Feb 1995, TRH; larvae, ♂♂ and ♀♀ si and i, Glentui R, 24488 57788, 500 m, 1 Dec 1994, TRH; ♂ i, Kedron R, 24463 58508, 1160 m, 15 Feb 1997, SJM; larvae, Kowhai R Trib, 24728 57863, 680 m, 28 Oct 1997, LJS; ♂ si, Lewis Pass, 24590 58700, 880 m, 4 November1996, BHP; ♂ si, Rough Ck, 23931 58056, 780 m, 6 Jan 1975, PLE; larvae, Twin Ck, 23929 58096, 875 m, 7 Nov 1995, J&B. **NN** ♀ si, Cobb Reservoir Stm, 24775 60082, 840 m, 22 Jan 1997, IMH; ♀ si, Peel L. outlet, 24768 60067, 1350 m, 1 Jan 1996, EDW; larvae, Roding R, 25387 59852, 700 m, 17 Dec 1998, SJM. **OL** larvae, Cardrona R, 21912 55755, 770 m, 24 Jan 1997, TRH; larvae, Greenstone R Trib, 21266 55803, 640 m, 26 Jan 1997, ACM; ♂♂ and ♀♀ si and i, Leaping Burn, 21786 56227,1350 m, 12 Feb 1997, BHP; ♂♂ i, Mick Ck, 21398 55842, 1450 m, 14 Feb 1995, BHP; ♀♀ i, Roaring Meg Trib, 22023 55849, 1495 m, 6 Jan 1993, JBW; ♂ i, Rob Roy Stm, 21704 56280, 850 m, 6 Dec 1992, BHP; ♂♂ si, Treble Cone, 21845 56113, 1250 m, 22 Jan 1991, BHP; ♂♂ and ♀♀ si and i, Treble Cone 21845 56113, 1250m, 24 Dec 1990, BML. **SC** larvae, Firewood Stm, 23237 56905, 1190 m, 30 Jan 1994, J&G; larvae, Fox Peak Skifield, 23344 57033, 1320 m, 19 Feb 1996, J&S; ♀♀ si, Mount Dobson Skifield, 23224 56934, 1800 m, 5 Mar 1994, BHP. **SL** ♀ i, John O Groats Hill, 22308, 54683, 570 m, 15 Dec 1996, J&B; ♂ i, Little Pomahaka R, 22147 55200, 1260 m, 12 Dec 1994, BHP; ♂♂ and ♀♀ i, Pomahaka Headwaters, 22125 55215, 1360 m, 13 Dec 1994, BHP; ♀♀ i, Spence Burn, Takitimu Mountains, 21100 54878, 1100 m, 4 Mar 1997, BHP. **WD** larvae, Haast R, 22188 56792, 120 m, 2 Jun 1997, GCP; larvae, Kiwi Jacks Ck Trib, 22772 57526, 230 m, 5 Nov 1995, B&H; ♀ si, Pegleg Ck, Arthurs Pass, 23924 58115, 830 m, 28 Dec 1961, JRJ; larvae, Robinson Ck, 22196 56744, 450 m, 2 Nov 1995, J&B; larvae, Spring Ck, Landsborough R, 22509 57033, 405 m, 26 Jan 1996, SJM.

Nesameletus flavitinctus Tillyard, 1923.

AK ♀♀ si and i, Cascade Stm, Waitakere R, 26461 64782, 45 m, 21 Sep 1967, PHN. **BP** larvae, Mangorewa R Ecological Area, 27888 63551, 380 m, 15 Feb 1997, MWH. **HB** ♀ i, Ngaheranui Stm, Kaweka, 29045 62069, 940 m, 5 Jan 1995, BHP. **RI** ♂si, Ohutu Stm at hut, 27737 61699, 660 m, 6 Mar 1989, IMH. **TO** ♂si, Mahuia Rapids, 27267 62256, 850 m, 14 Jan 1967, KAW (AMNZ); larvae, Makomiko Stm, 27166 62162, 760 m, 4 Jan 1992, CHE; ♂i, Makomiko Stm trib., 27169 62159, 760 m, 7 Apr 1998, WJC; larvae, Te Arero Stm Trib, 27914 62458, 800m, 27 Oct 1998, WJC; larvae, ♂♂ and ♀♀ si and i, Waihi Stm, 27471 62475, 520 m, 22 Apr 1998, WJC; larvae, ♀♀ si, Waihi Stm, 27474 62475, 500 m, 14 Feb 1962, AGM; larvae, Waihi Stm, 27472 62475, 540 m, 27 Oct 1993, TRH; larvae, ♂♂ si, Waihi Stm, 27474 62475, 500 m, 16 Jan 1965, JGP (FAMU); ♂♂ si and i, Waimarino Stm, 27171 62180, 570 m, 6 Jan 1996, WJC; ♂♂ and ♀♀ i and si, Whakapapaiti Stm, 27233 62223, 880 m, 14 Jan 1965, JGP. **WN** larvae, Akatarawa Road Ck, 26879 60256, 440m, 2 Oct 1998, O&C (SM); larvae, George Stm, 26775 59916, 160 m, 11 Nov 1997, TRH; ♂♂ i, Mangahao R, 27184 60584, 400 m, 7 Jan 1997, IMH.

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FD larva, Gap Bay Stm, Secretary Island, 20379 55280, 5 m, 9 Jan 1983, ACH. **SI** larvae, Hicks Road Stm, 21378 53579, 40m, 18 Jan 1999, TRH; larva, Mill Ck, 21375 53570, 5 m, 25 Mar 1993, AHS; ♀♀ i, Mill Ck, 21377 53520, 30 m, 17 Jan 1993, TRH; ♂♂ and ♀♀ i, Mill Ck, 21375 53570, 30 m, 15 Dec 1992, ARM; larvae, ♂♂ and ♀♀ si and i, Mill Ck, 18 Jan 1999, TRH; ♀ i, Mount Rakeahua, 21203 53501, 500 m, 19 Jan 1996, GWG; larvae, Table Stm, 21220 53768, I20 m, 17 Jan 1989, L&J; ♀ si, unnamed stream East Long Harry, 21113 53782, 5 m, 3 Mar 1993, AHS; larvae, unnamed stream East Long Harry, 21131 53775, 80 m, 16 Jan 1989, L&J. **SL** larvae, Bare Hill, Hokonui Hills, 21685 54584, 500 m, 21 Oct 1994, BHP; ♀ i, Bald Hill, Longwood Range, 21106 54375, 750 m, 26 Sep 1993, BHP.

Nesameletus vulcanus

MC larvae, Armstrong Reserve, 25104 57078, 440 m, 3 Feb 1994, TRH; larvae, Boundary Falls, Hinewai, 25125 57103, 290 m, 1 Feb 1994, TRH; larvae, Charteris Bay Stm, 24863 57279, 10 m, 15 Oct 1994, JBW; larvae, Flea Bay Stm, 25085 57070, 500 m, 28 Apr 1994, TRH; larvae, Fuchsia Falls, Hinewai, 25119 57106, 380 m, 2 Feb 1994, TRH; larvae, Grehan Stm, 25105 57114, 340 m, 31 Jan 1994, TRH; larvae, Hinewai Beech Forest, 25113 57103, 470 m, 1 Feb 1994, TRH; ♀♀ i, Hinewai Reserve, 25120 57107, 390 m, 26 Oct 1990, JBW; larvae, Hinewai Reserve, 25114 57118, 700 m, 2 Feb 1997, SJM; ♂ si, Little Akaloa Stm,25070 57229, 200 m, 25 Feb 1995, J&G; larvae, ♂♂ and ♀♀ si and i, Narbey Stm, 25137 57087, 25 m, 22 Oct 1997, TRH; larvae, Okuti Stm, 24977 57132, 180 m, 1 Jan 1996, TRH; larvae, Peraki Stm, 24983 57086, 350 m, 26 Jun 1993, TRH; larvae, Te Kawa Stm Trib, 24911 57223, 500 m, 15 Oct 1994, JBW.

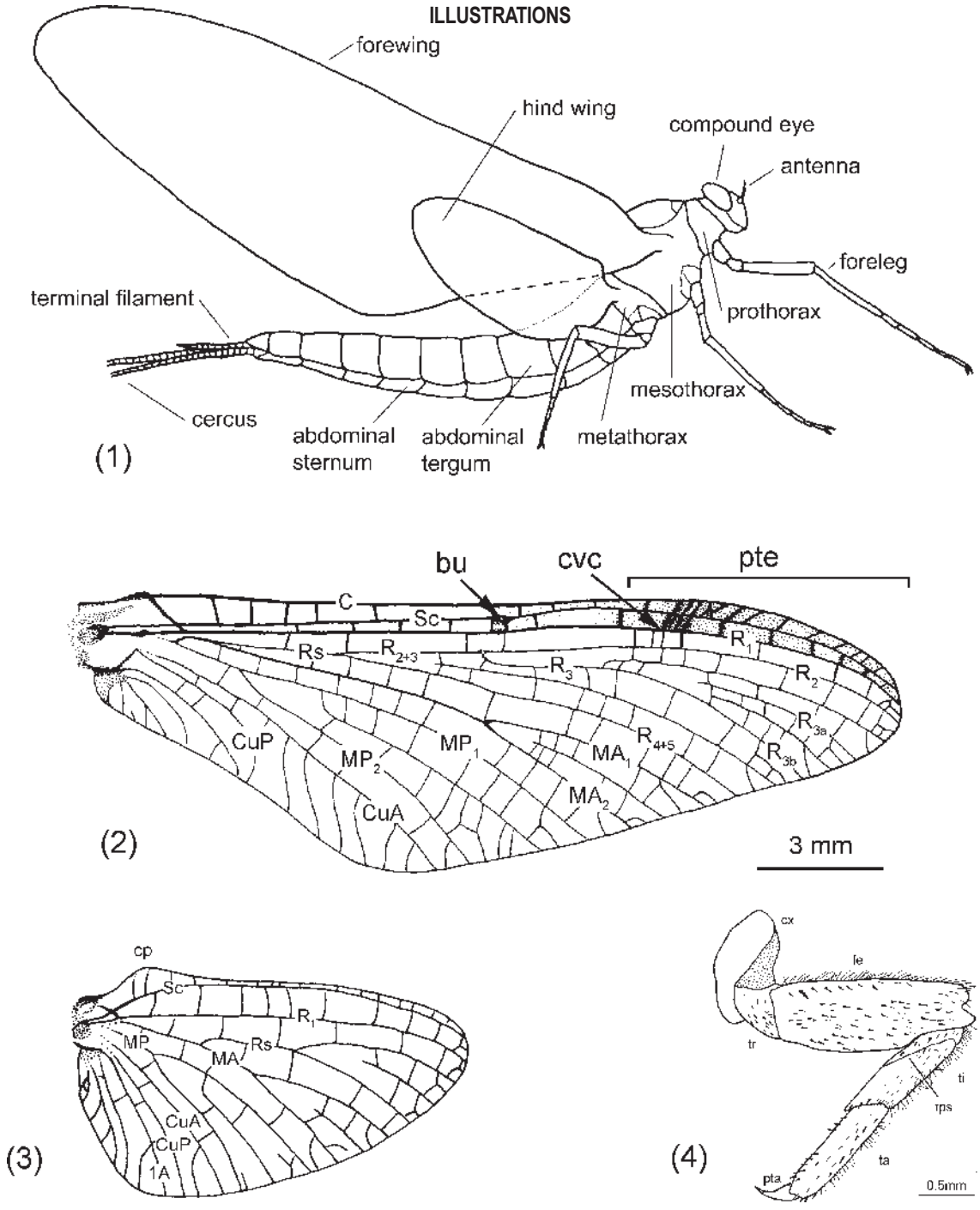


Fig. 1–4 Morphology (1–3 adult, 4 larva): (1) winged stages of female, lateral (cerci truncated); (2) forewing, showing venation; (3) hind wing showing venation; (4) *Nesameletus ornatus*, mesothoracic leg of larva showing tibiopatellar suture.

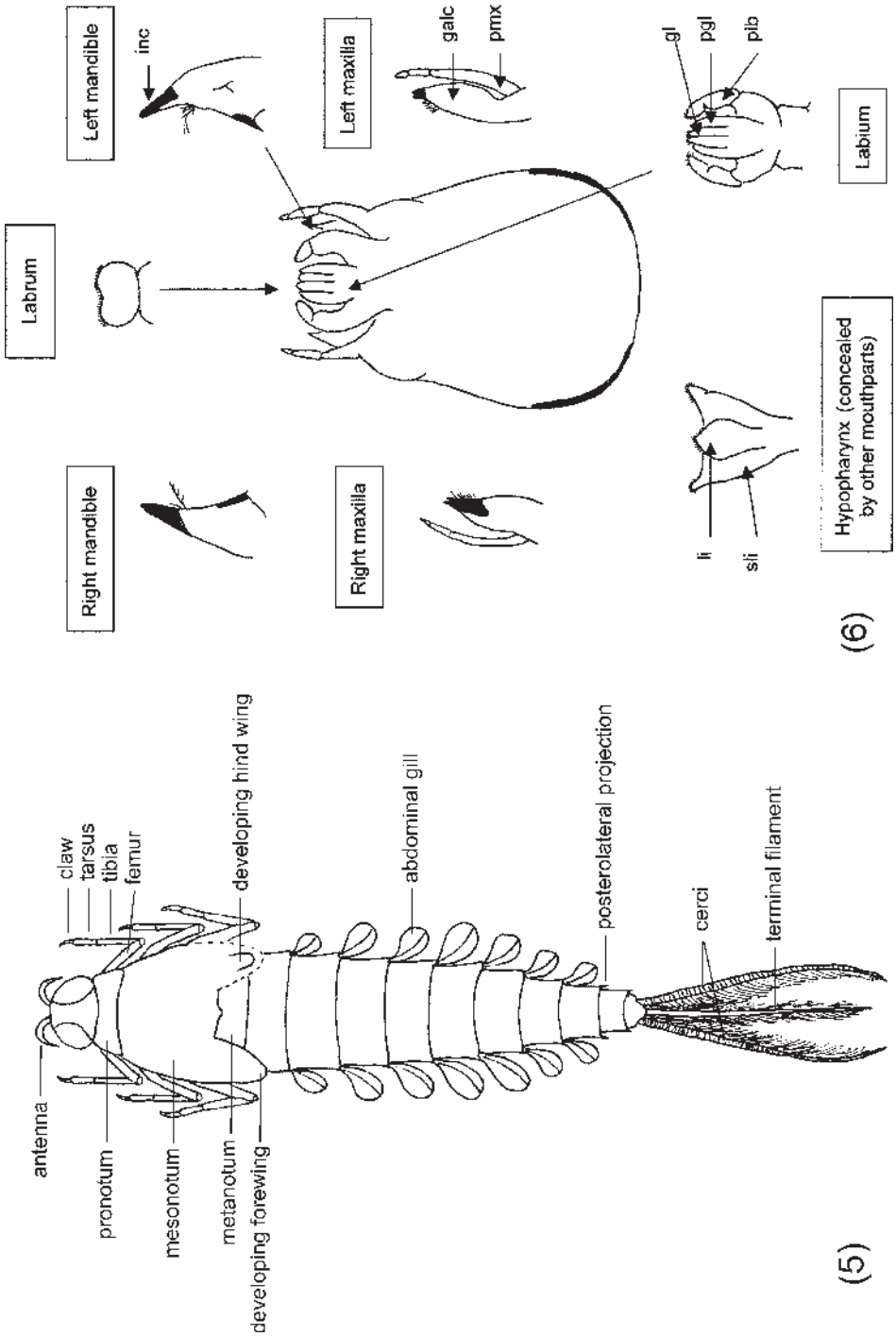


Fig. 5–6 Morphology of larva: (5) dorsal (same scale as Fig. 2); (6) Mouth parts (simplified).

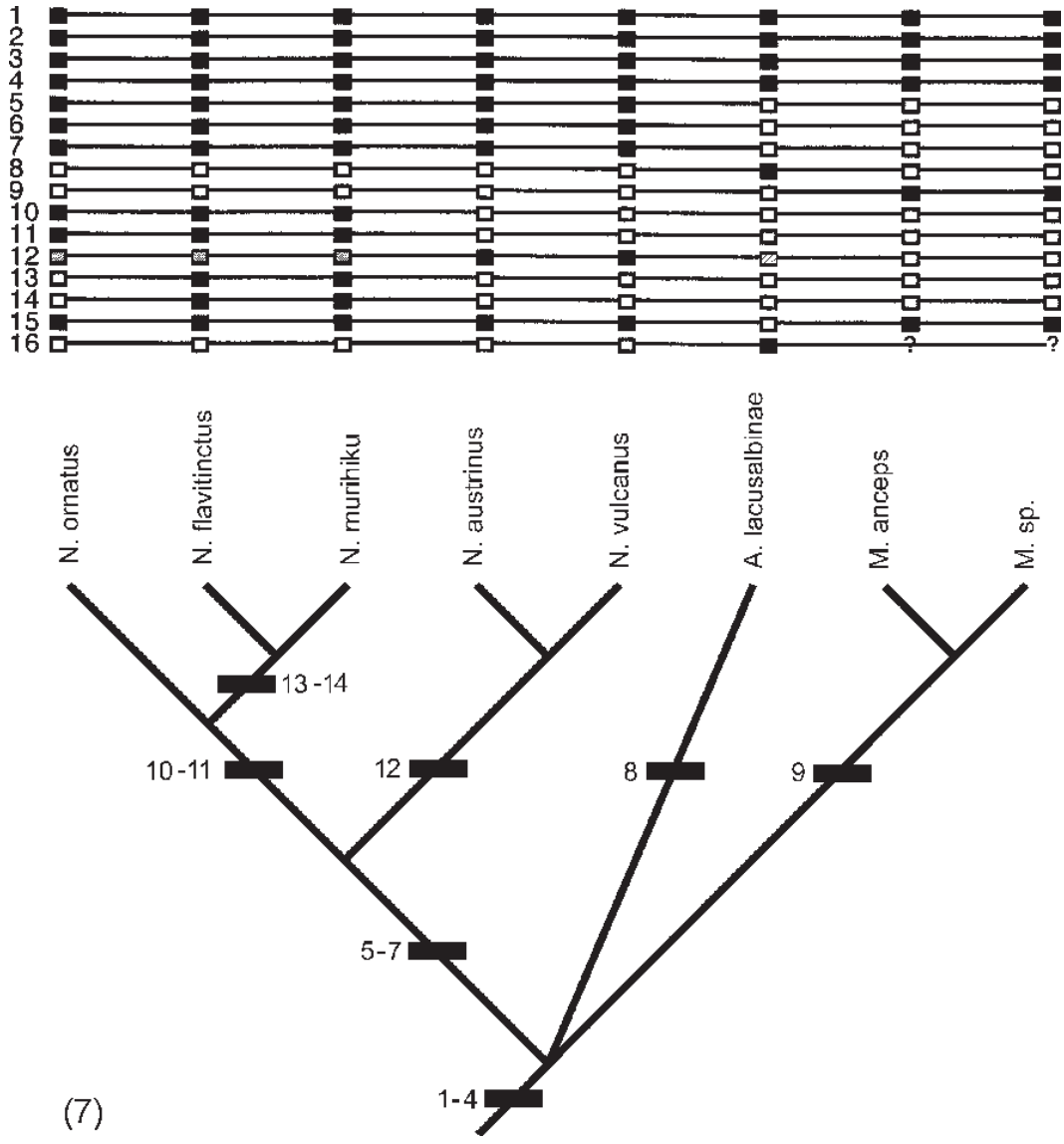


Fig. 7 Phylogeny of Nesameletidae, characters used (E, egg; L, larva; SI, subimago; I, imago. 0, plesiomorphic; 1–3, apomorphic character state): **1** (L) Prostheca of left mandible ventrally (0) with two separate bristles (1) with one bristle. **2** (L) Apex of maxilla (0) tripartite (1) quadripartite. **3** (L) Maxilla medially (0) without (1) with extended membraneous lamina. **4** (L) Glossae, paraglossae, and labial palp apically (0) without (1) with numerous stout spines. **5** (E) Fibre-coils (0) without (1) with terminal fibre-cluster. **6** (L) On aboral side of prementum, spines basally to the insertion of labial palps (0) absent (1) present. **7** (I) Penes basally (0) without (1) with narrowing. **8** (I) MP_2 of fore wing basally connected to (0) MP_1 (1) CuA. **9** (I) Penes laterally (0) without (1) with convexity. **10** (I) Fore wing crossveins between Sc, R_1, and R_2 in apical half (0) without (1) with cluster. **11** (I) Fore wing veins R3A and R3B basally (0) connected (1) disconnected. **12** (SI) Wings (0) without (1) with irregular (2) with regular (3) with reduced pigmentation. **13** (I) Ratio of length of penes to length of styliger plate (0) equal to or less than 2.0 (1) more than 2.0. **14** (I) Crossveins between R_1 and R_2 in apical half (0) not (1) thickened. **15** (I) Paracercus (0) not (1) strongly reduced. **16** (L) Postmentum (0) without (1) with longitudinal row of setae.

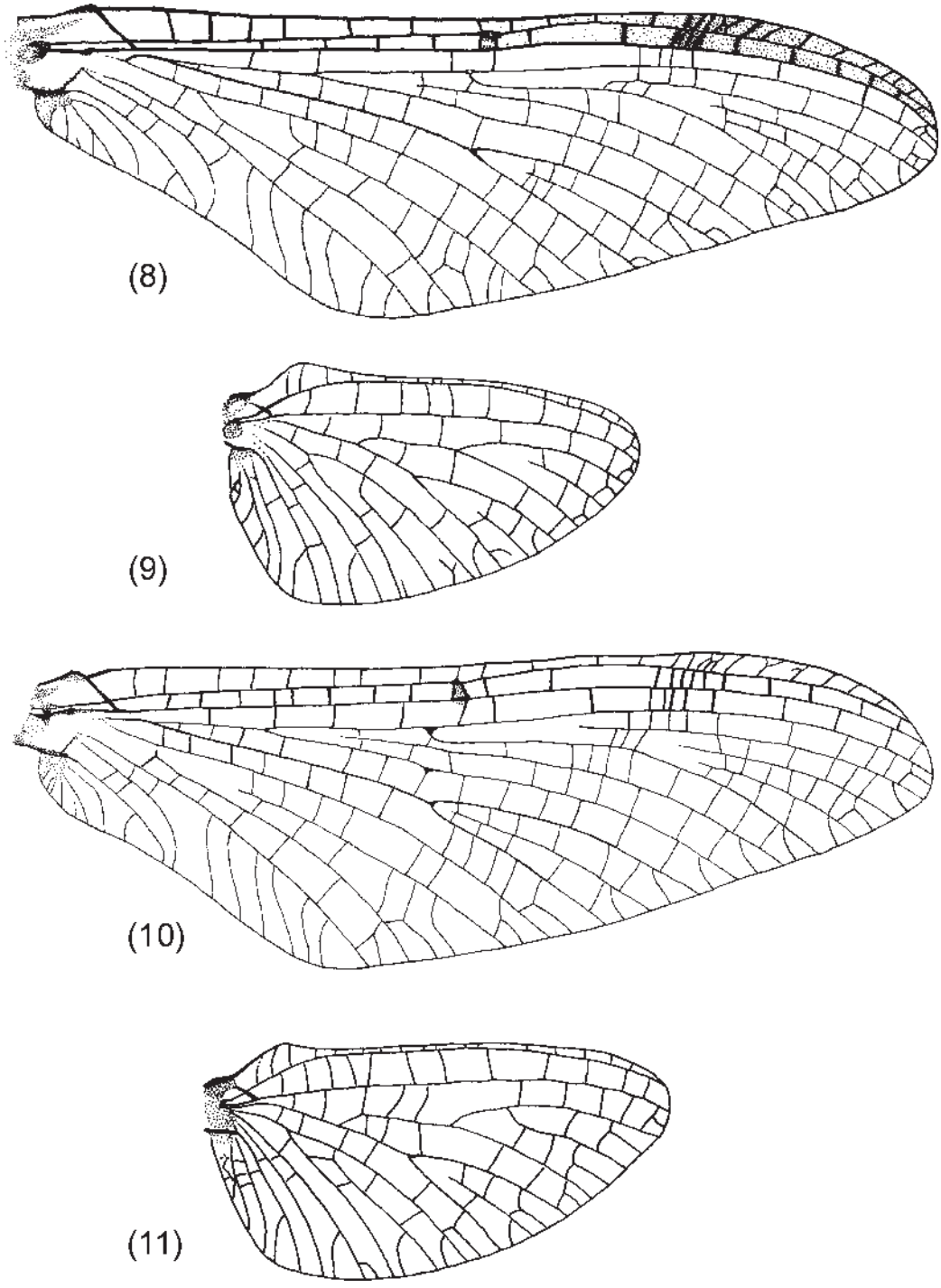


Fig. 8–11 Fore- and hind wings of male imago (same scale as Fig. 2): (8, 9) *N. ornatus*; (10, 11) *N. flavitinctus*.

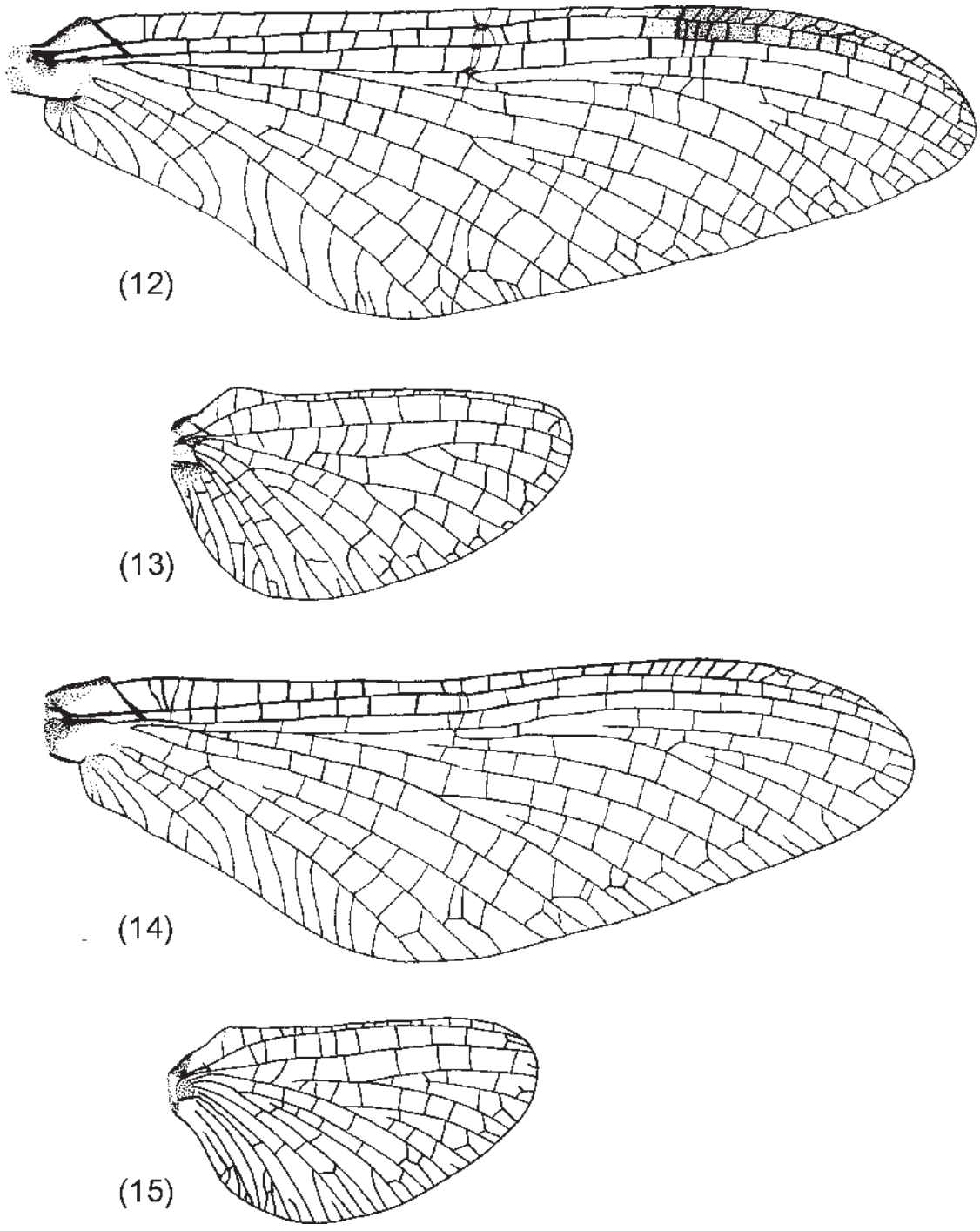


Fig. 12–15 Fore- and hind wings of male imago (same scale as Fig. 2): (12,13) *N. murihiku*; (14, 15) *N. austrinus*.

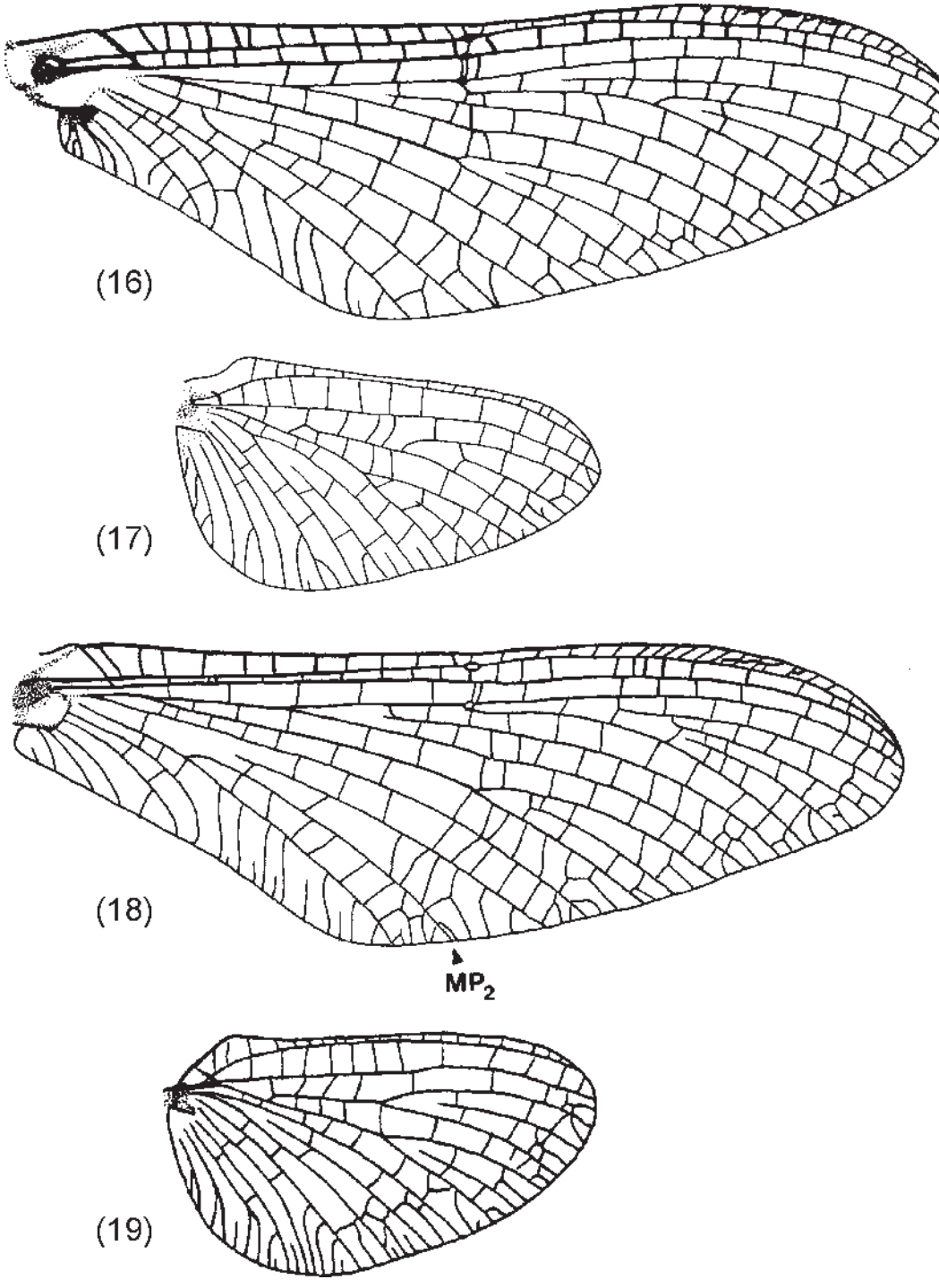
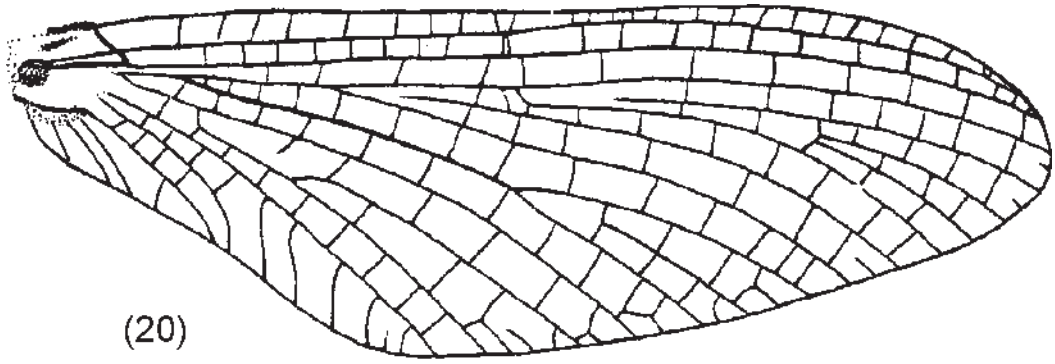
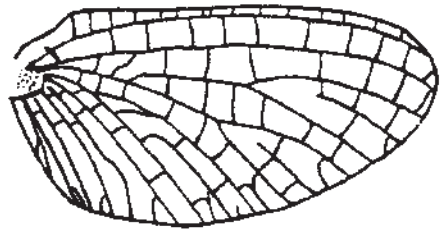


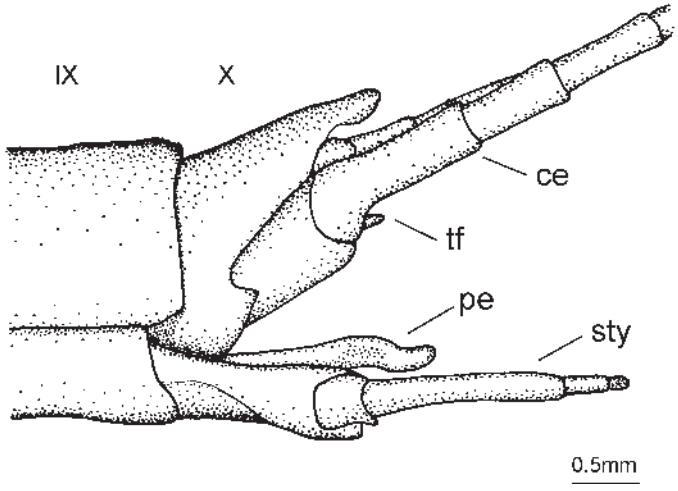
Fig. 16–19 Fore- and hind wings of male imago (same scale as Fig. 2): (16, 17) *N. vulcanus*; (18, 19) *Ameletoides lacusalbinae*.



(20)



(21)



(22)

Fig. 20–22 (20, 21) Fore- and hind wings of male imago *Metamonius sp.* (same scale as Fig. 2); (22) Lateral view of male genitalia of *N. ornatus*.

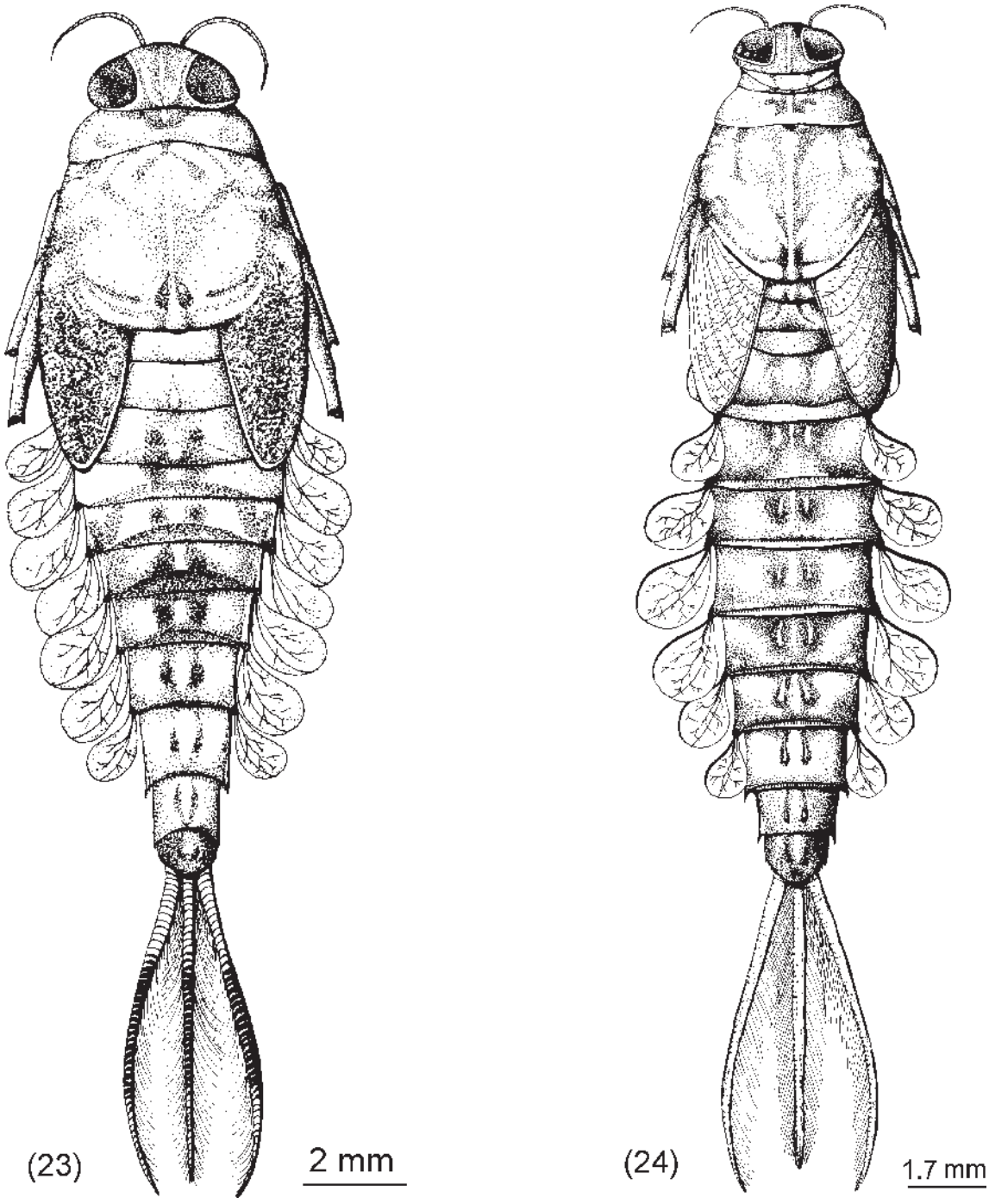


Fig. 23–24 Dorsal view of late instar larva: (23) *N. ornatus*; (24) *N. flavitinctus*.

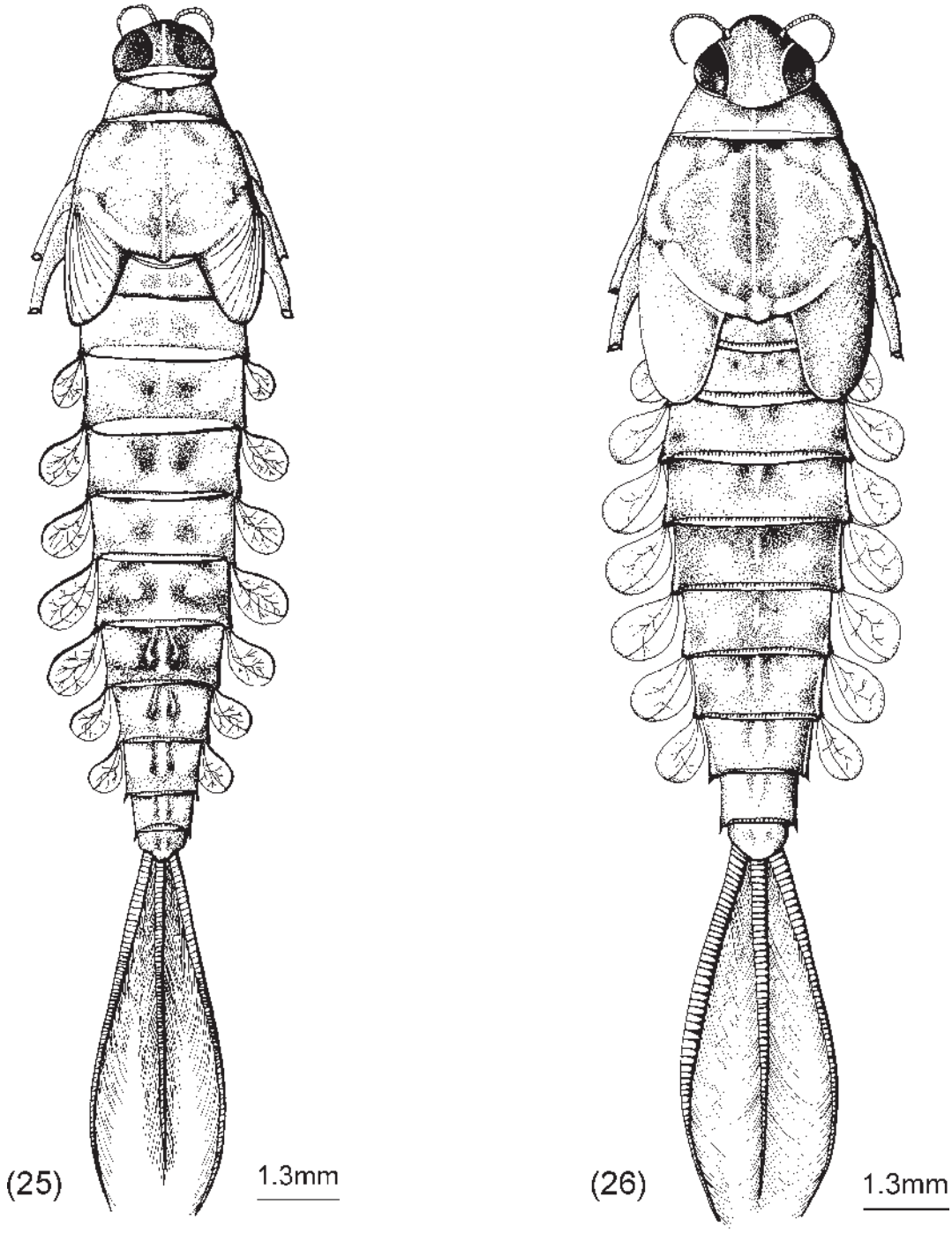


Fig. 25–26 Dorsal view of late instar larva: (25) *N. murihiku*; (26) *N. austrinus*.

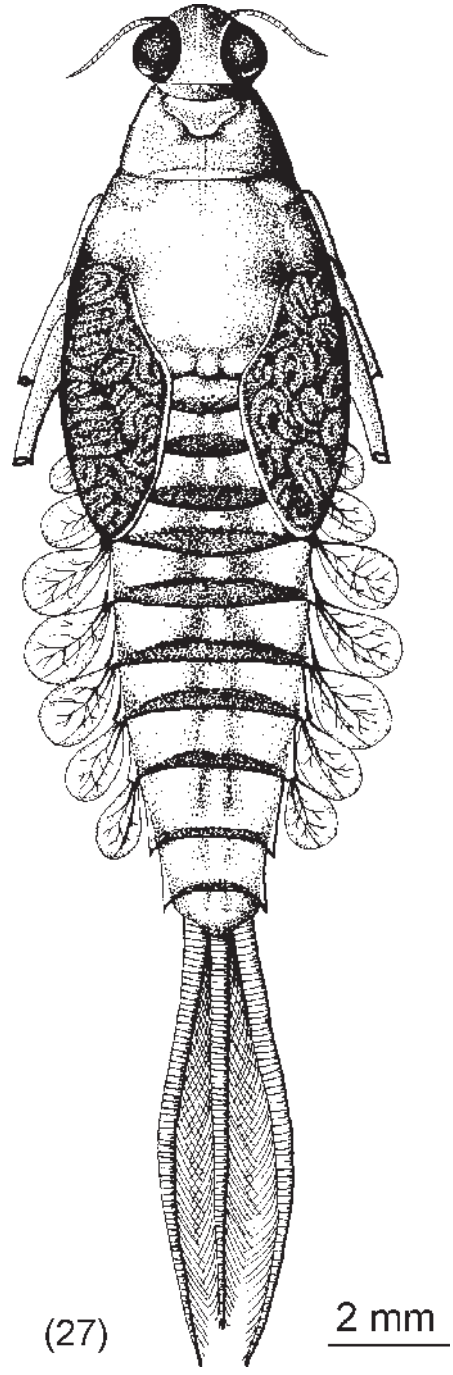


Fig. 27. Dorsal view of late instar larva *N. vulcanus*.

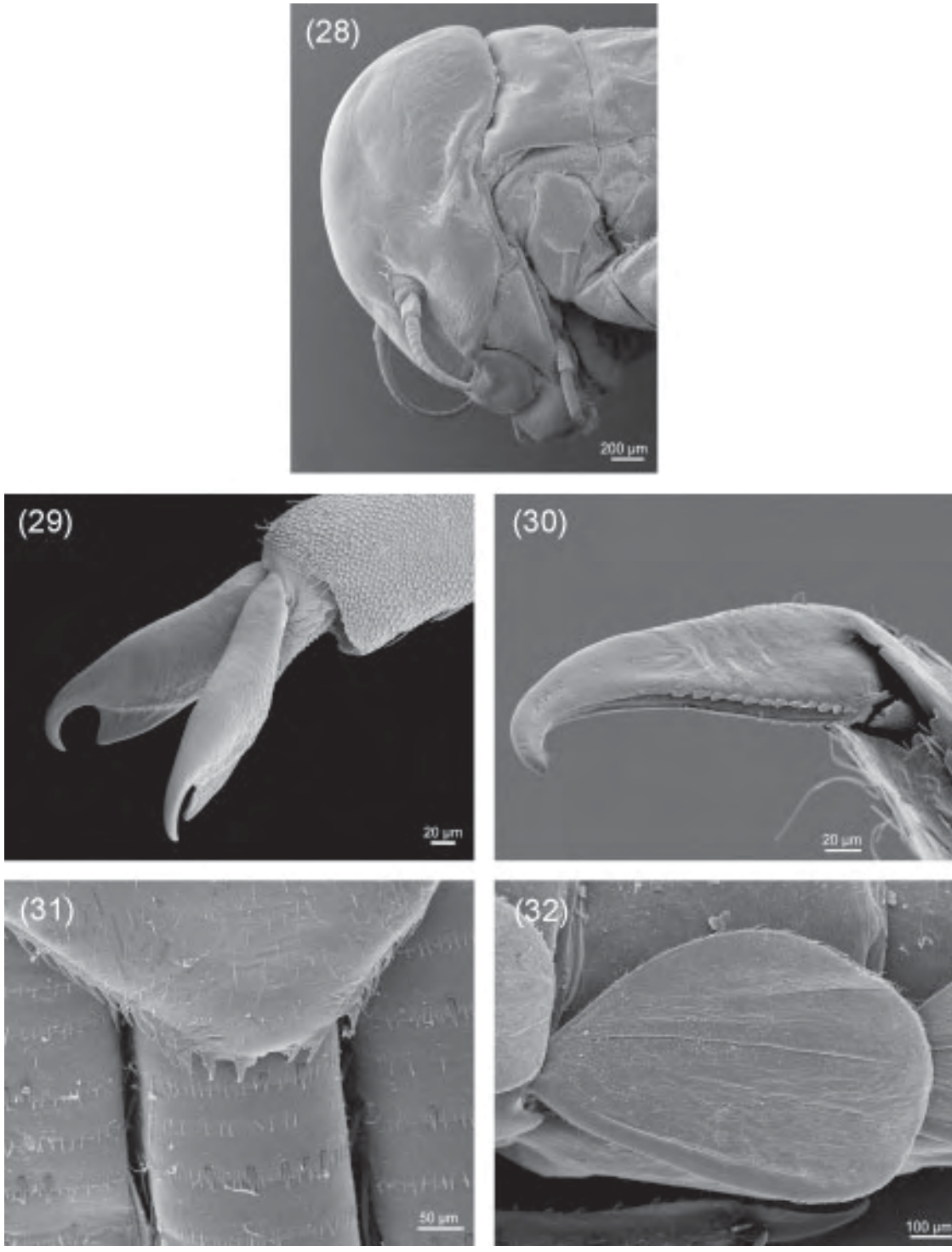


Fig. 28–32 *Nesameletus ornatus*, SEM: (28) head and prothorax of larva in lateral view; (29) imaginal claws; (30) larval claws; (31) larva, tergum X and terminal filaments; (32) larva, left gill of abdominal segment III.

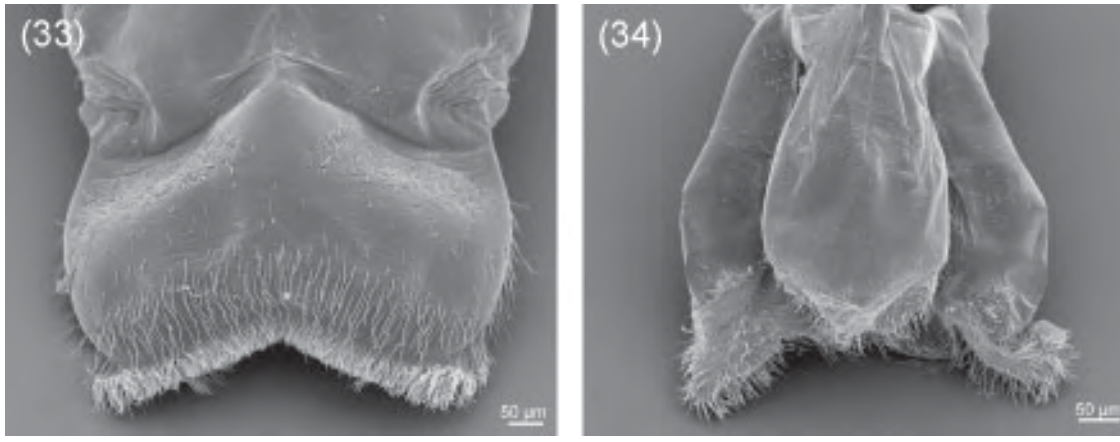


Fig. 33–34 *Nesameletus austrinus*, SEM, anterior view: (33) labrum; (34) hypopharynx.

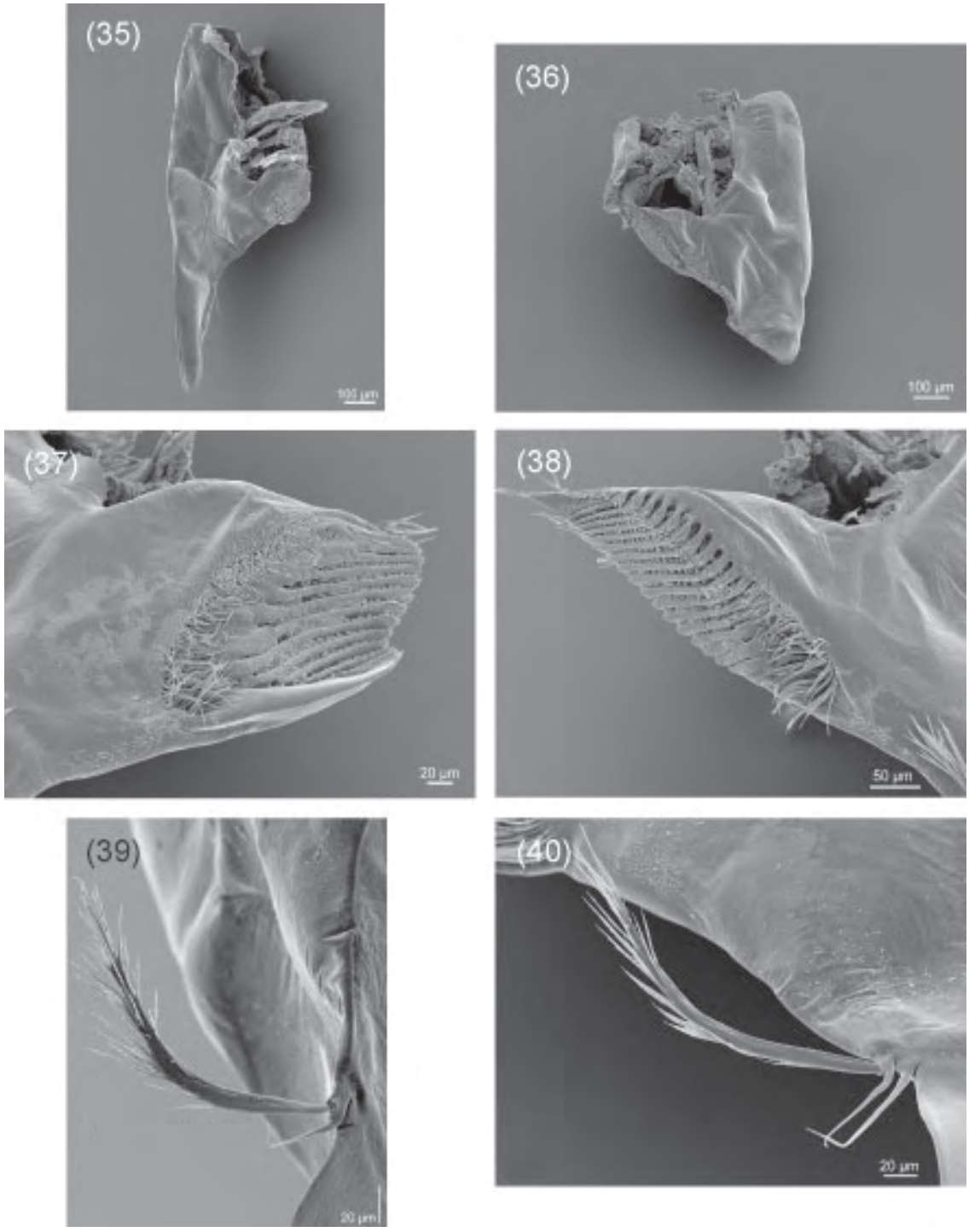


Fig. 35–40 Mandible of *Nesameletus*, SEM: (35) unworn left mandible of *N. vulcanus*; (36) worn right mandible of *N. ornatus*; (37–38) mola of *N. ornatus* (37) left, (38) right; (39–40) prostheca of *N. austrinus* (39) left, (40) right.

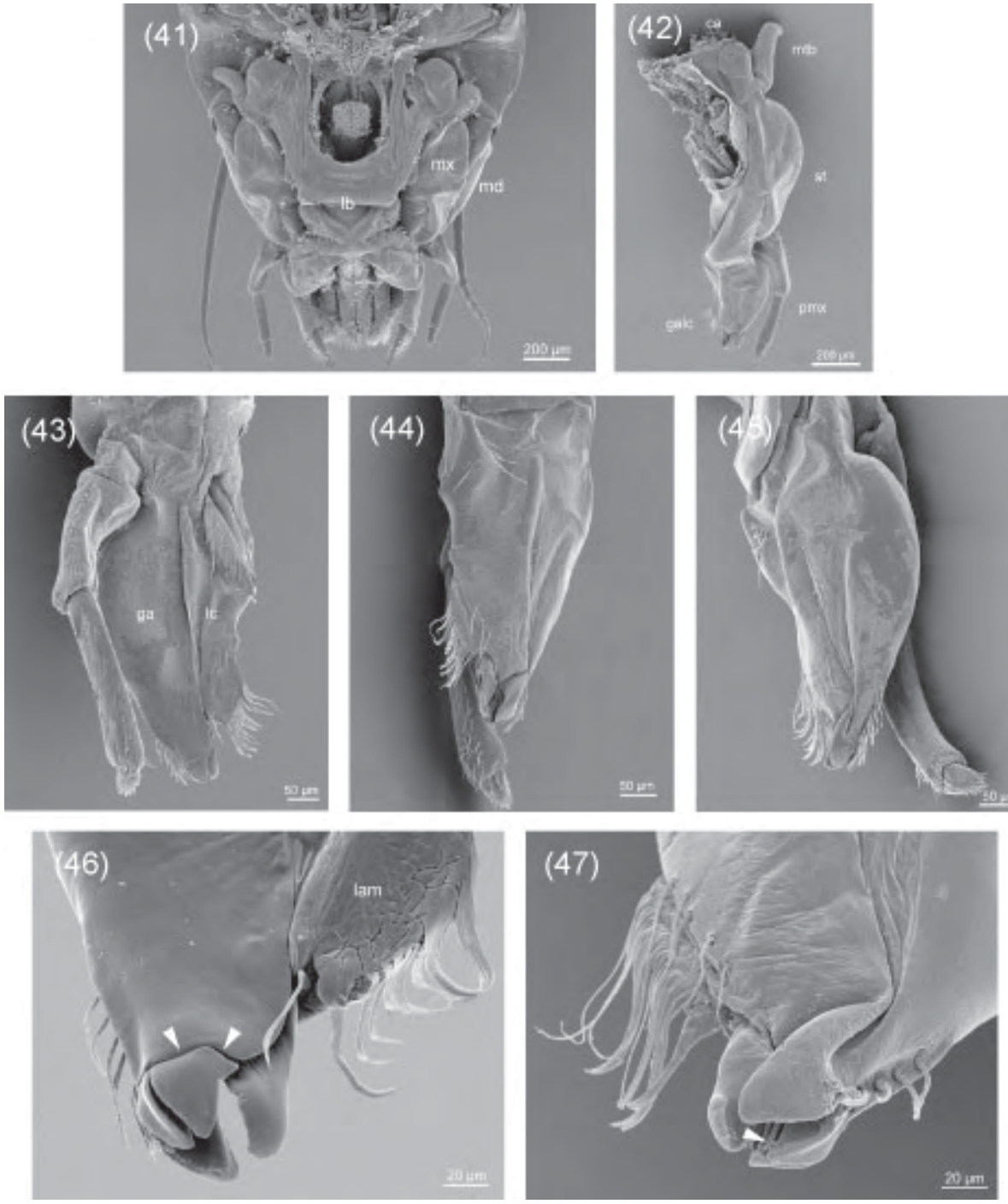


Fig. 41–47 Maxilla of *Nesameletus*, SEM: (41–42) *N. ornatus,* posterior view (41) exarticulated head, (42) right maxilla; (43–45) right galeolacinia of *N. vulcanus* (43) anterior view, (44) medial view, (45) posterior view; (46–47) apex of right maxilla of *N. ornatus* (46) anterior view, (47) posterior view.

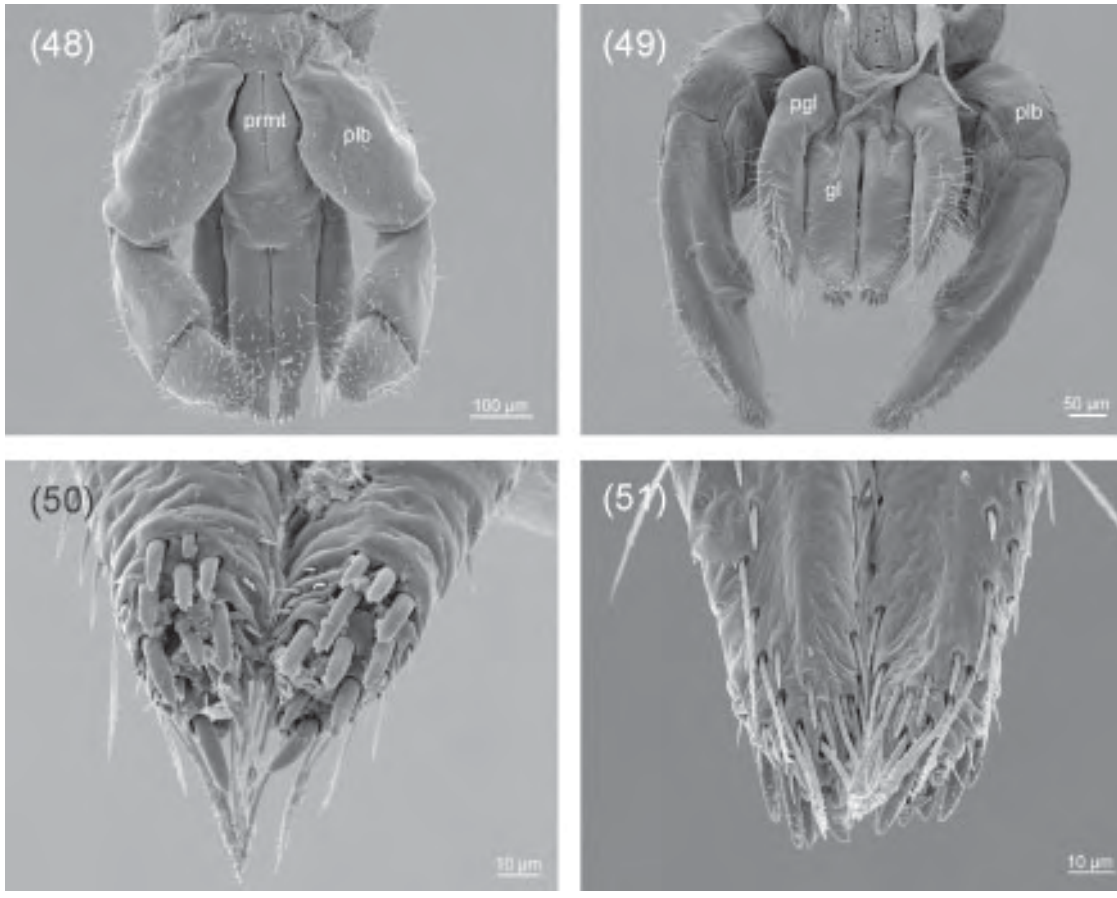


Fig. 48–51 Labium of *Nesameletus*: (48–49) prelabium of *N. austrinus* (48) posterior view, (49) anterior view; (50–51) apices of glossae of *N. ornatus* (50) posterior view, (51) anterior view.

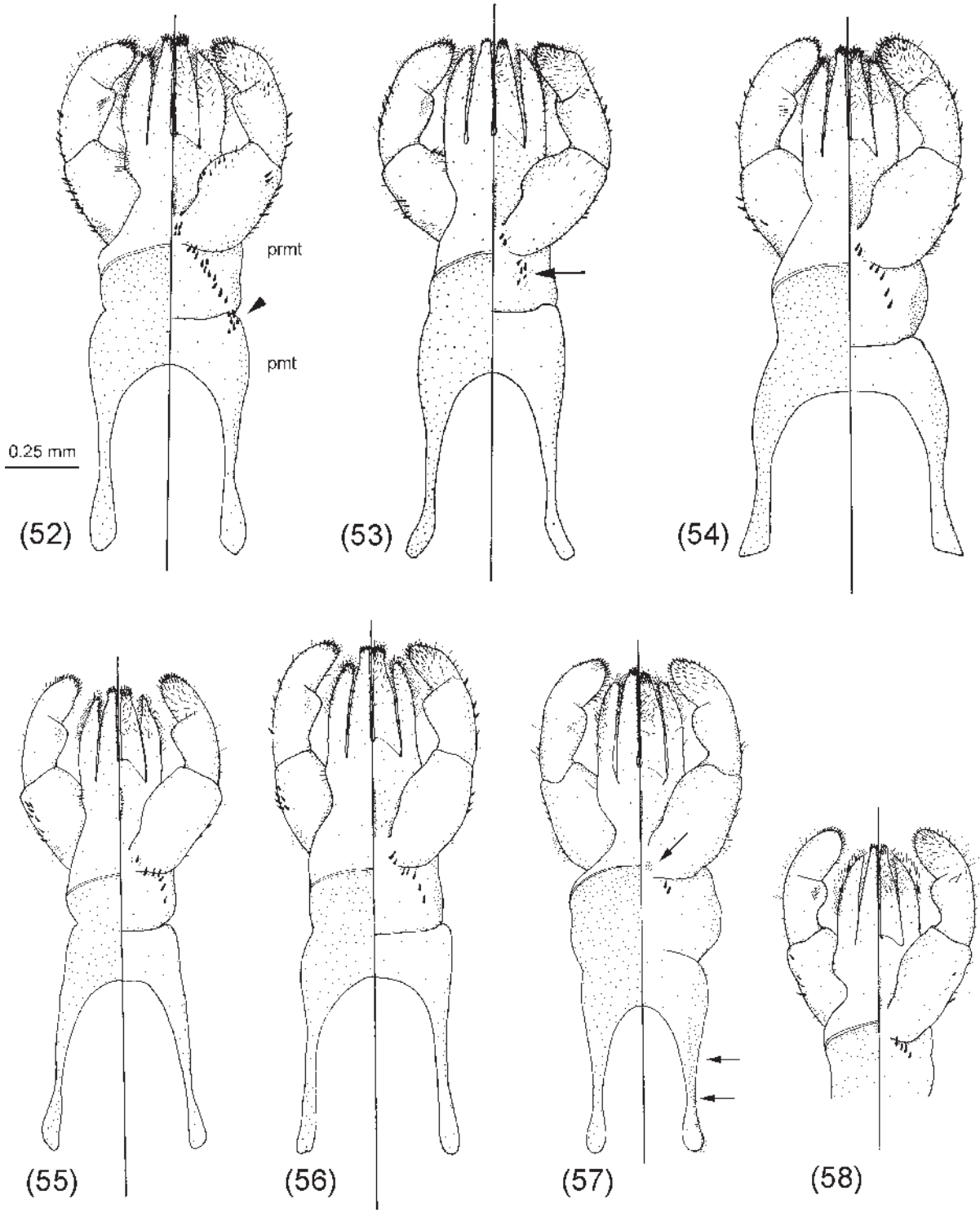


Fig 52–58 Labium of Nesameletidae (all to same scale), left half = anterior view, right half = posterior view: (52) *N. ornatus*; (53) *N. flavitinctus*; (54) *N. murihiku*; (55) *N. austrinus*; (56) *N. vulcanus*; (57) *A. lacusalbinae*; (58) *Metamonius sp.*

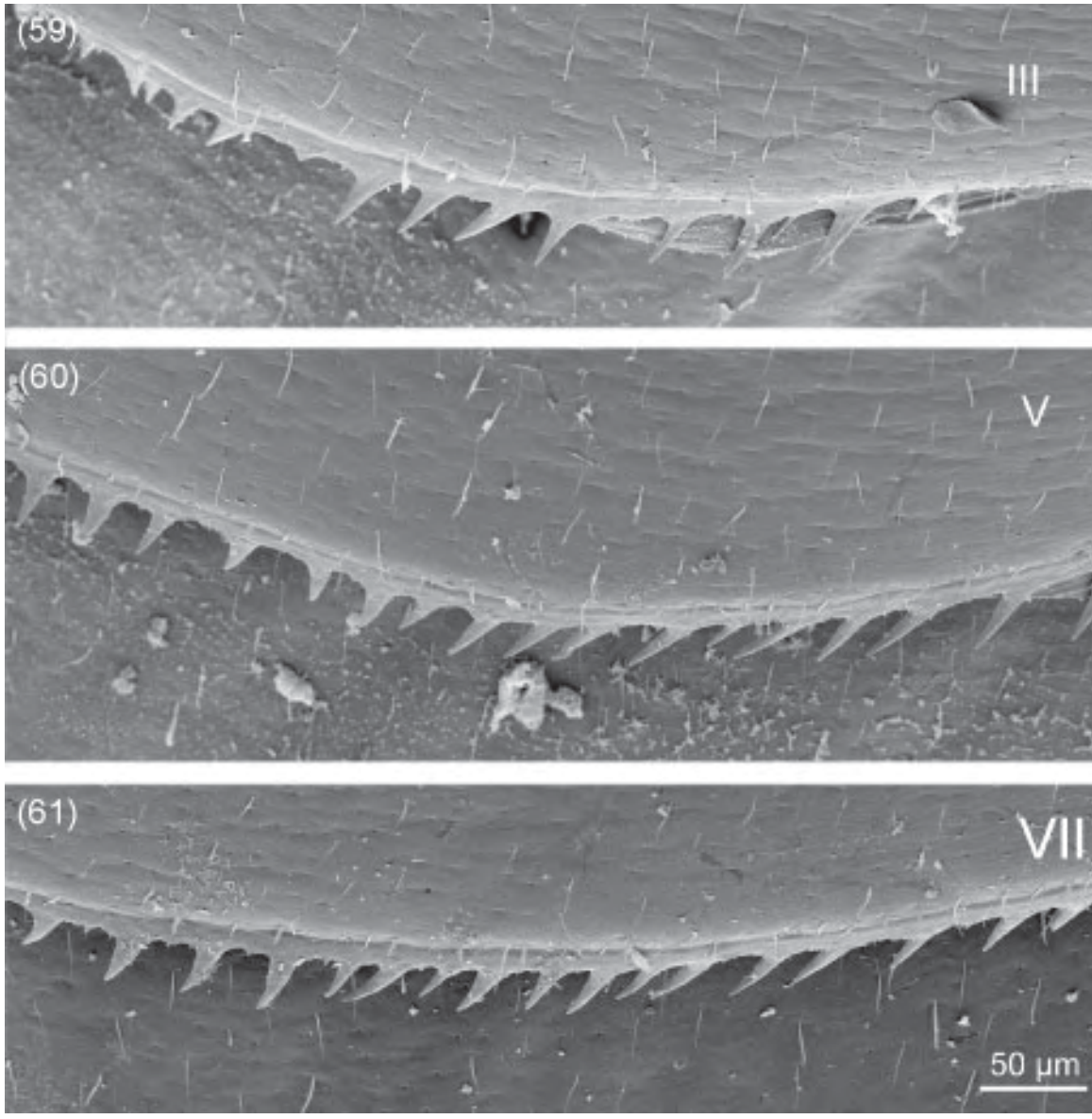


Fig. 59–61 *Nesameletus ornatus*, larva, posterior segment borders of abdominal tergum (all same scale): (59) III; (60) V; (61) VII.

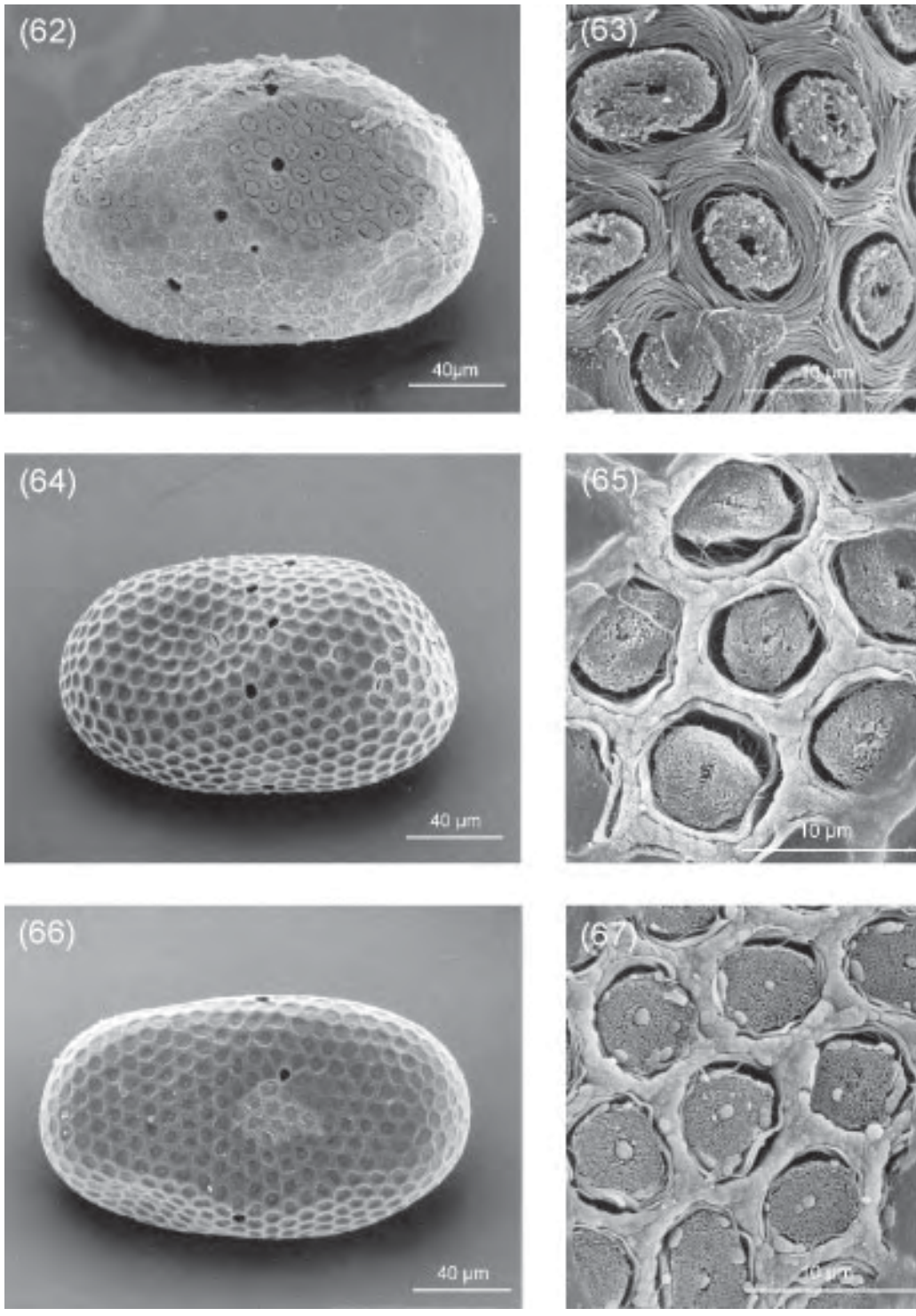


Fig. 62–67 Egg, SEM: (62, 63) *N. ornatus*; (64, 65) *N. flavitinctus;* (66, 67) *N. murihiku*.

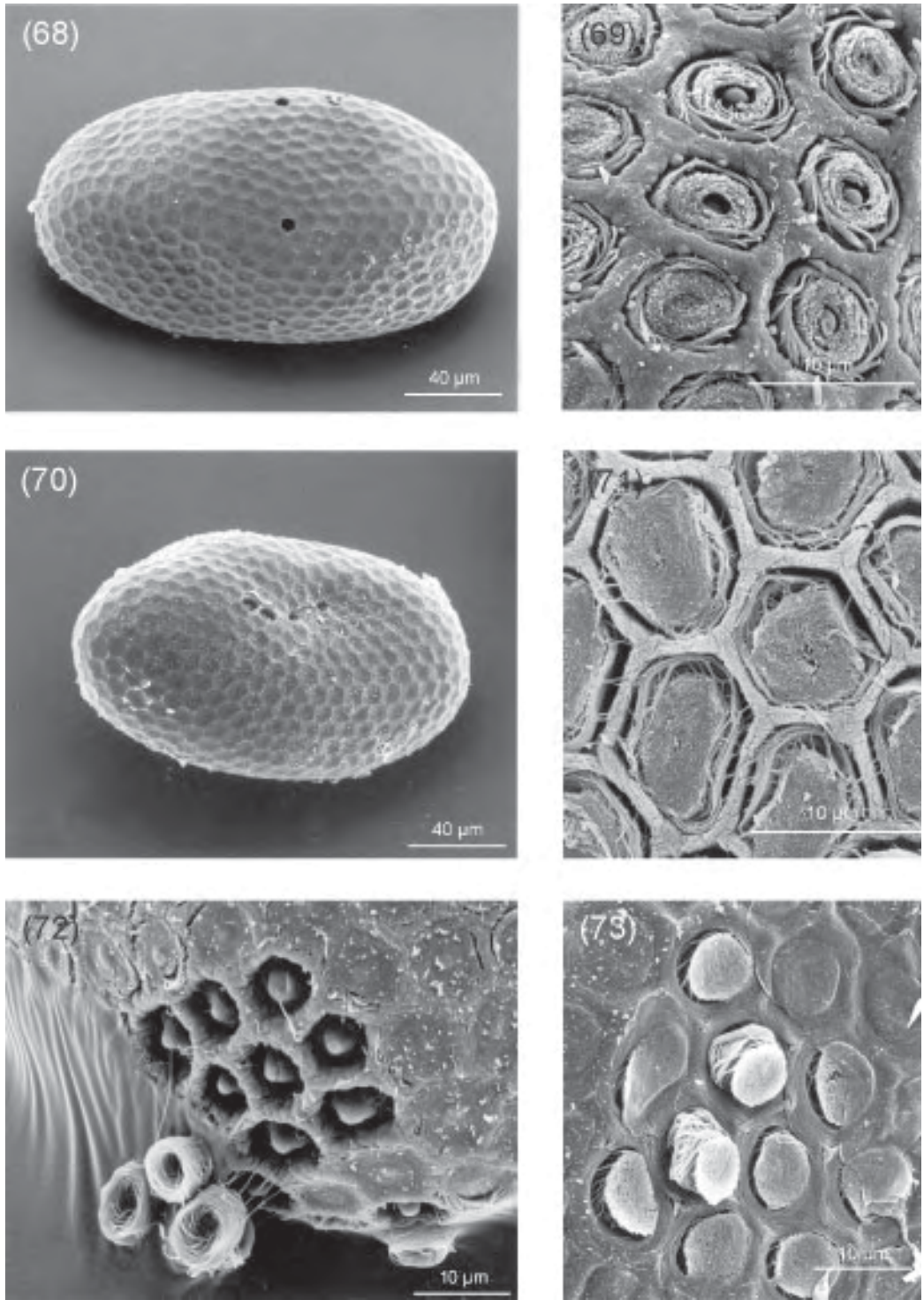


Fig. 68–73 Egg, SEM: (68, 69) *N. austrinus;* (70, 71) *N. vulcanus*; (72) *N. austrinus*, domed chorion ground with small mesh reticulation; (73) *N. ornatus*, activated fibre coils.

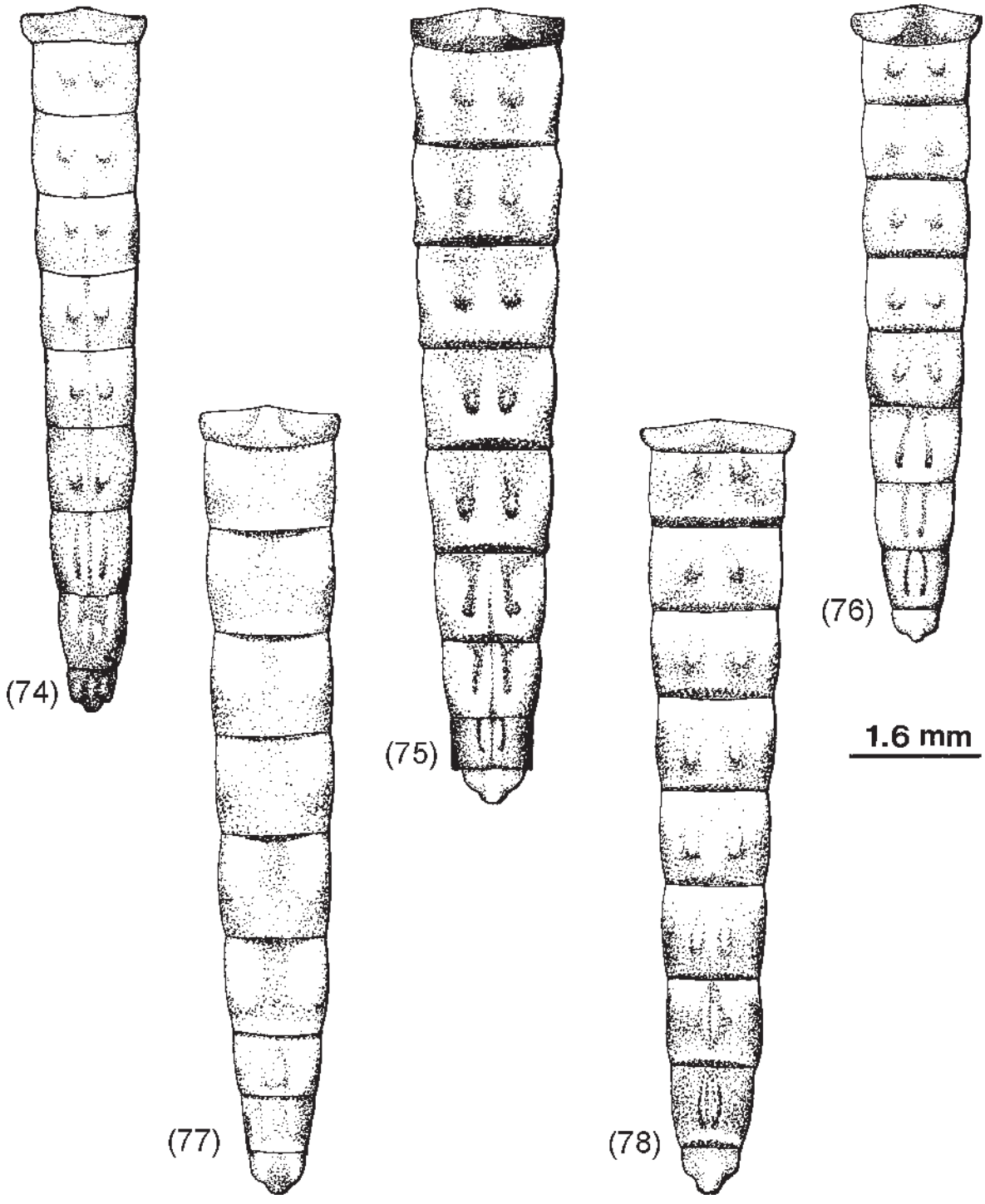


Fig. 74–78 Dorsal view of abdomen of male imago (to same scale): (74) *N. ornatus*; (75) *N. flavitinctus*; (76) *N. murihiku*; (77) *N. austrinus*; (78) *N. vulcanus*.

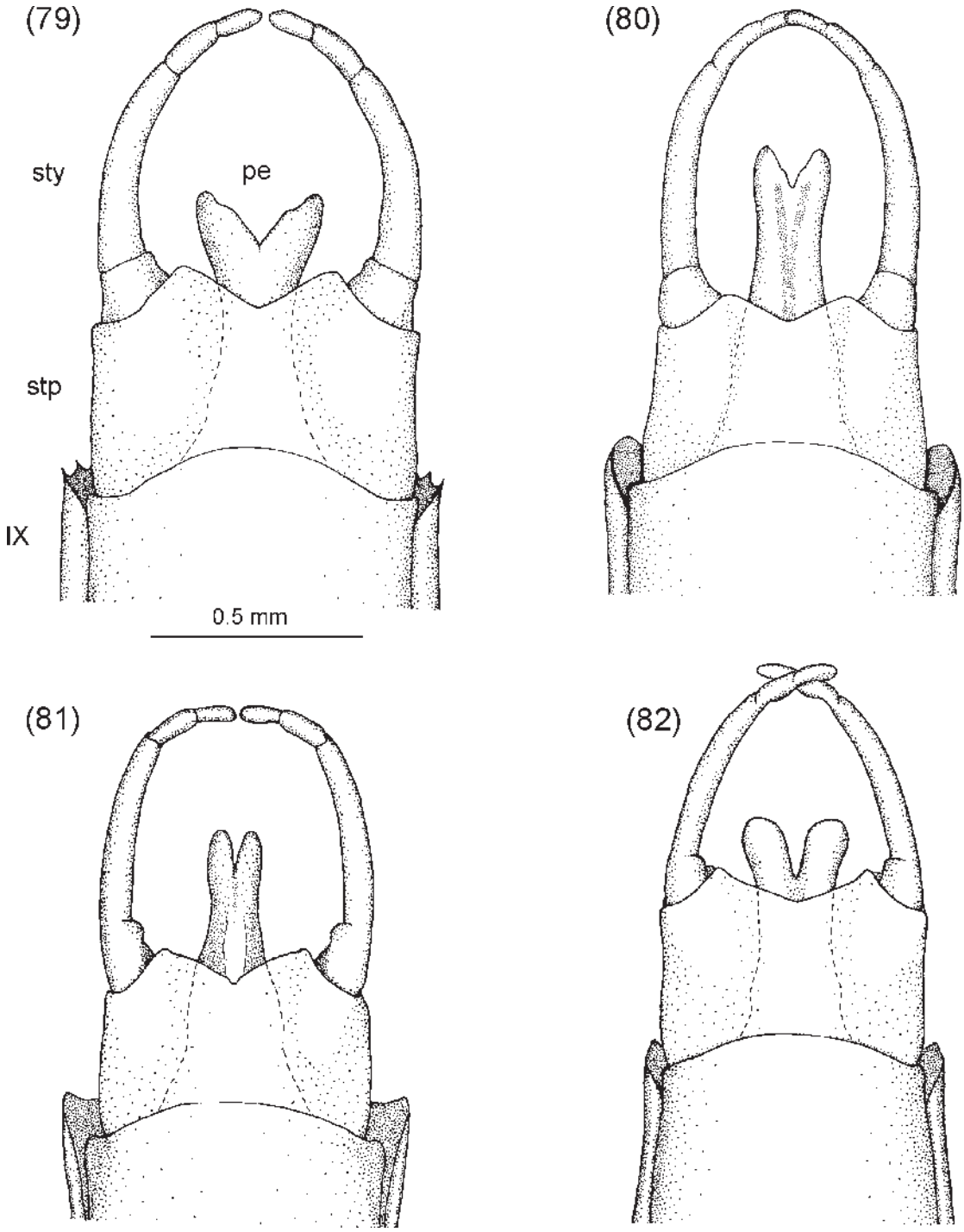


Fig. 79–82 Ventral view of male genitalia: (79) *N. ornatus*; (80) *N. flavitinctus*; (81) *N. murihiku*; (82) *N. austrinus*.

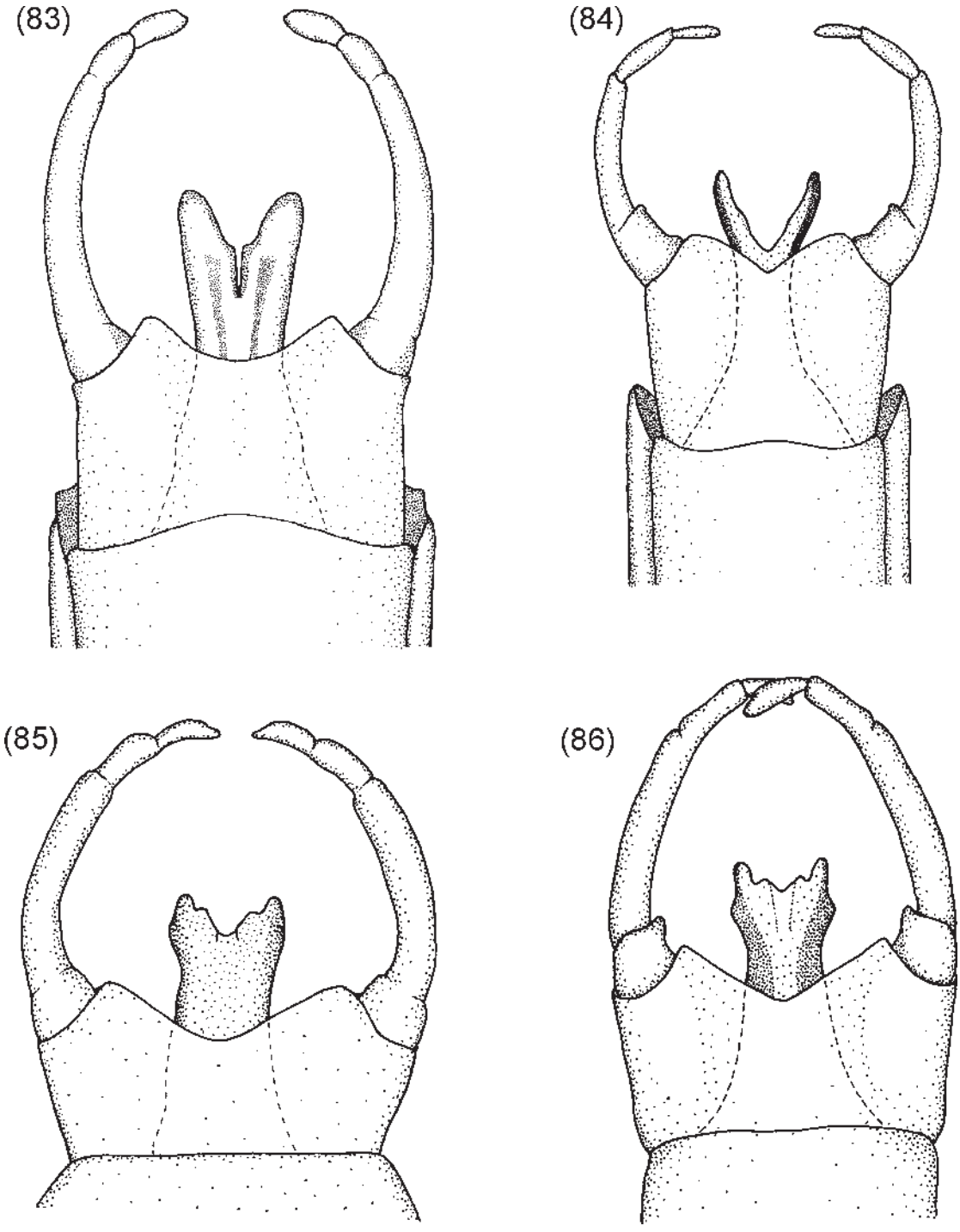


Fig. 83–86 Ventral view of male genitalia: (83) *N. vulcanus*; (84) *Ameletoides lacusalbinae*; (85) *Metamonius anceps*; (86) *Metamonius sp.*

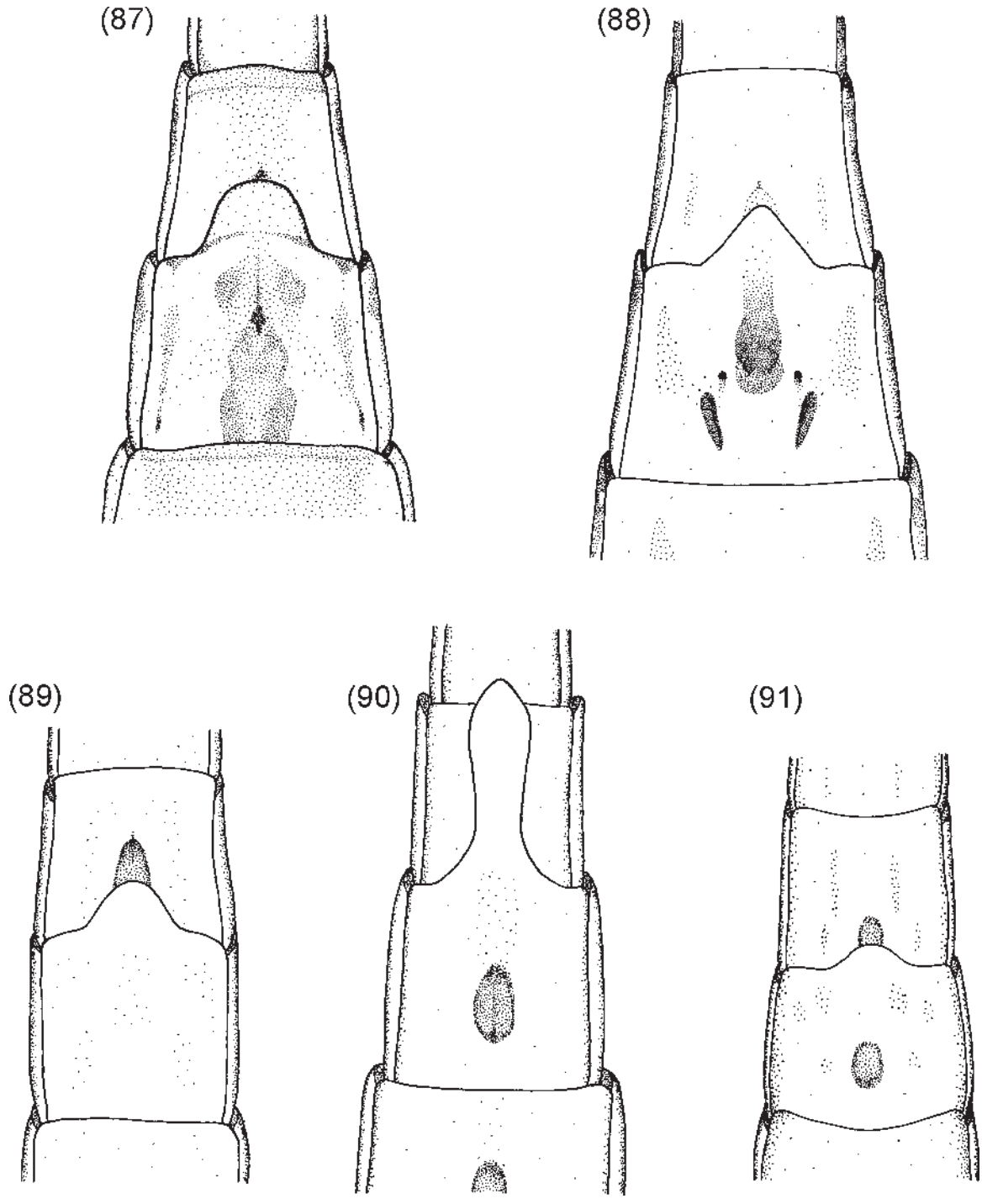


Fig. 87–91 Ventral view of female genitalia (to same scale): (87) *N. ornatus*; (88) *N. flavitinctus*; (89) *N. murihiku*; (90) *N. austrinus*; (91) *N. vulcanus*.

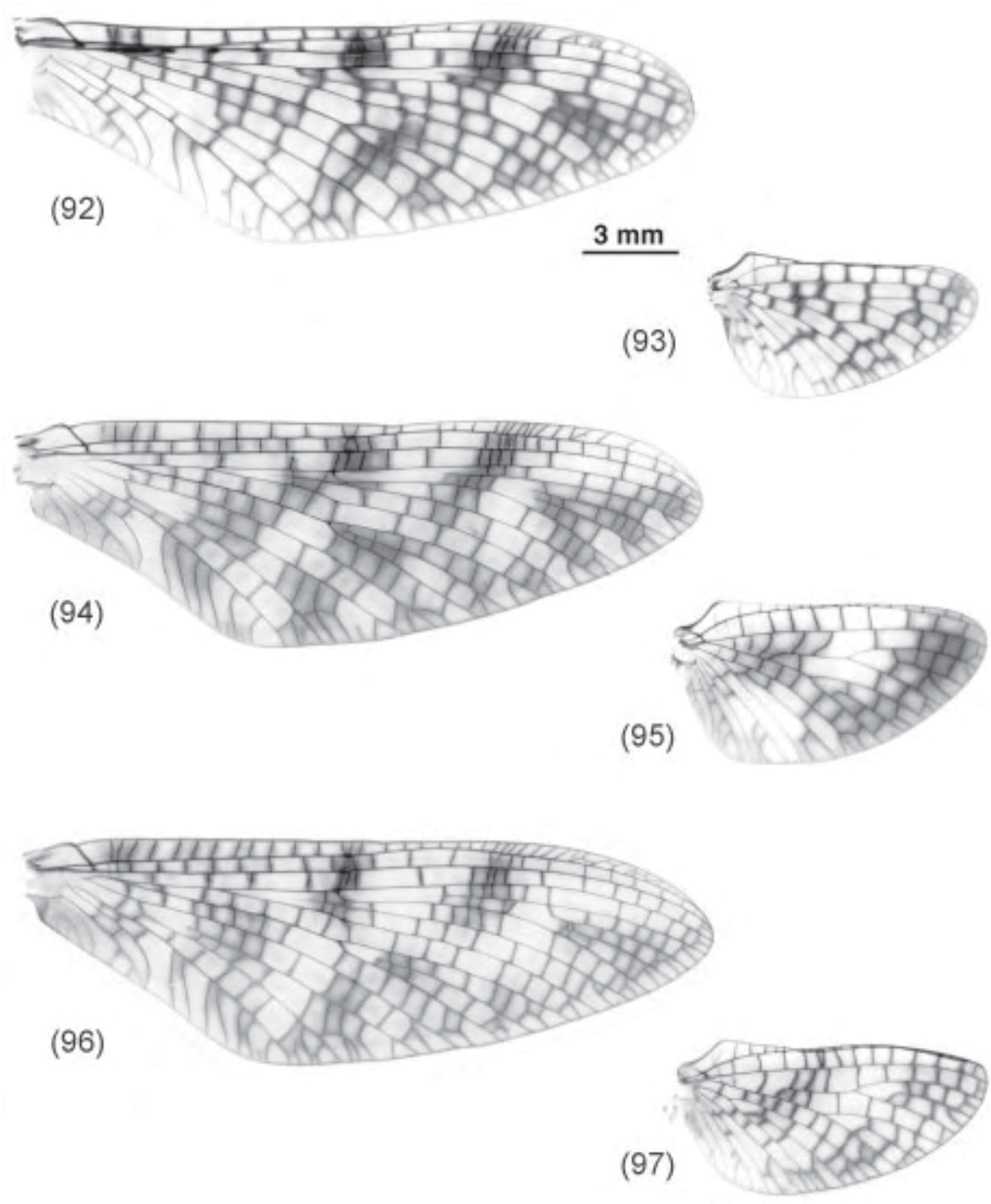


Fig. 92–97 Fore- and hind wings of subimago (to same scale): (92, 93) *N. ornatus*; (94, 95) *N. flavitinctus*; (96, 97) *N. murihiku*.

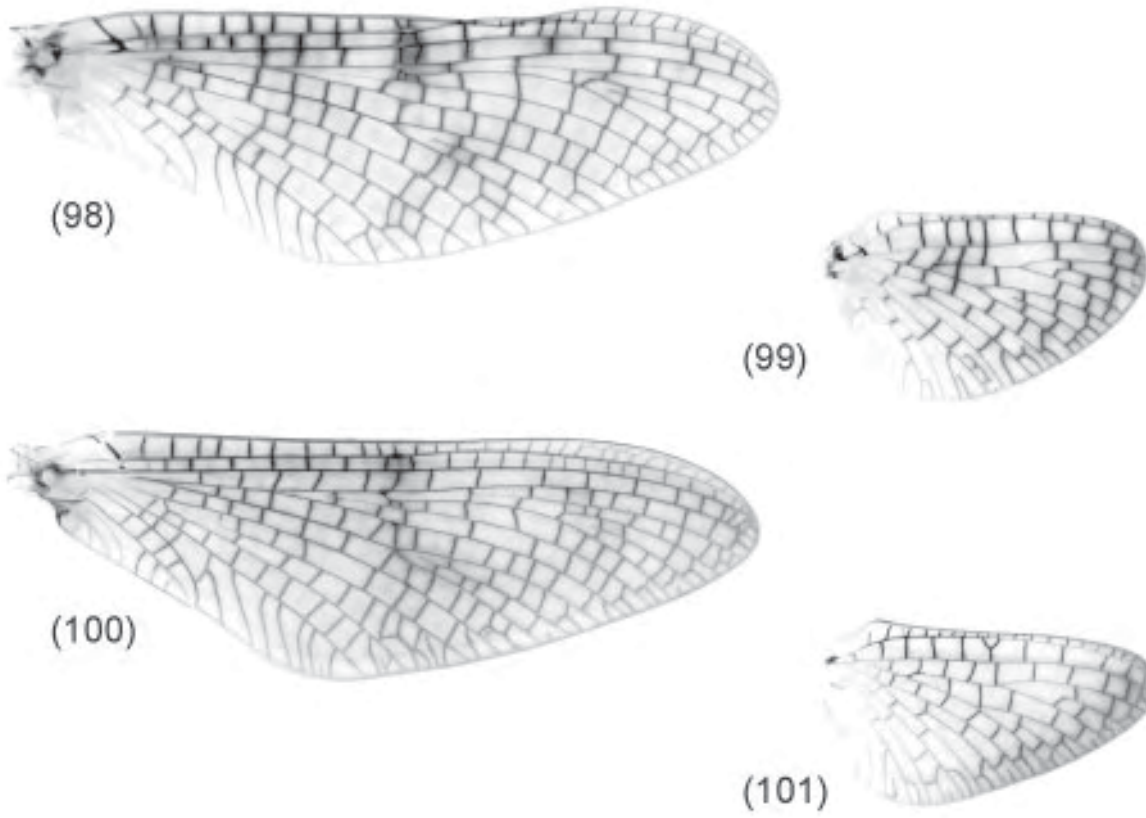


Fig. 98–101 Fore- and hind wings of subimago (to same scale): (98, 99) *N. austrinus*; (100, 101) *N. vulcanus*.

Fig. 102–103 (102) *A. lacusalbinae*, fore- and hind wing of subimago; (103) *N. ornatus*, neotype in BMNH.

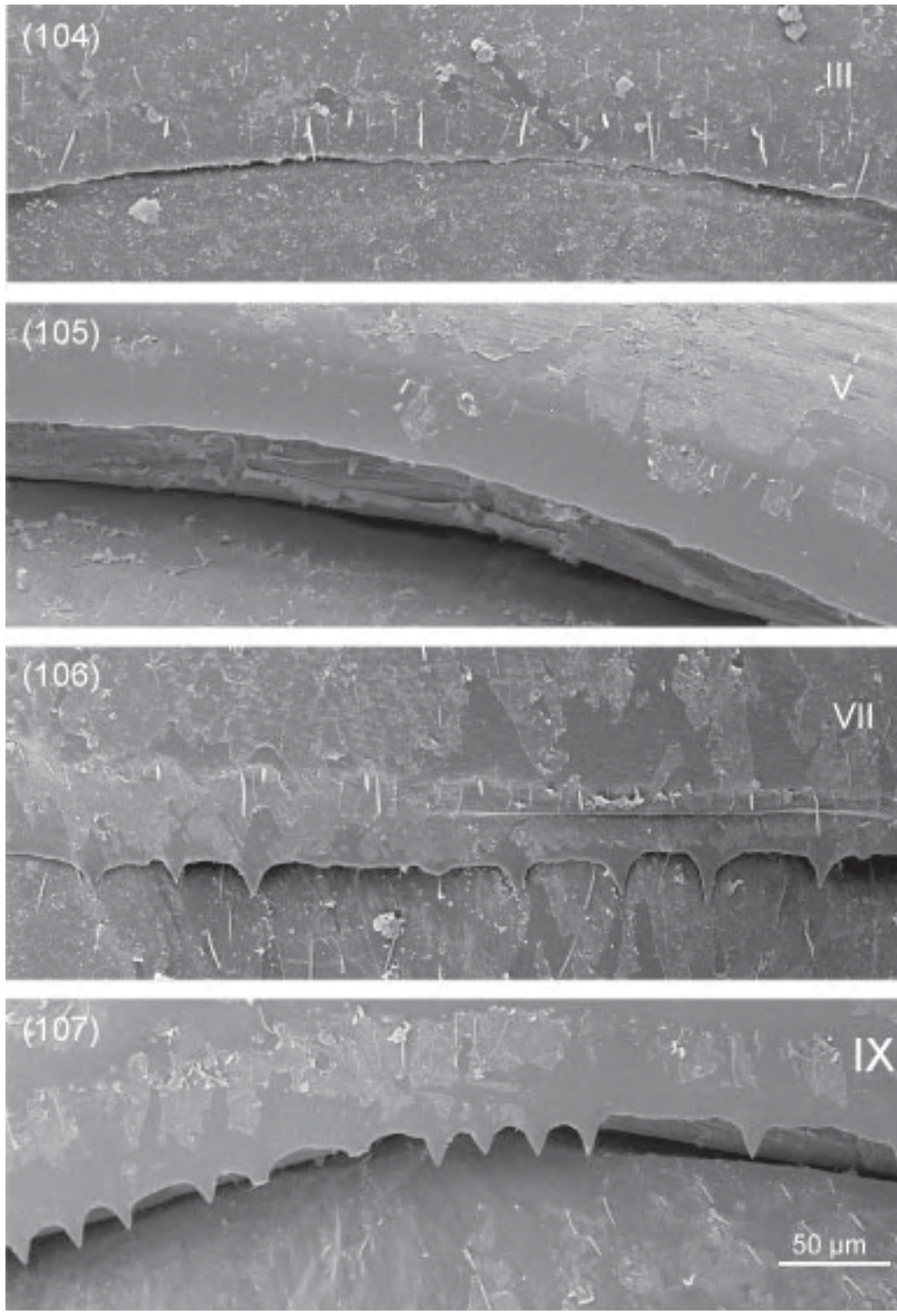
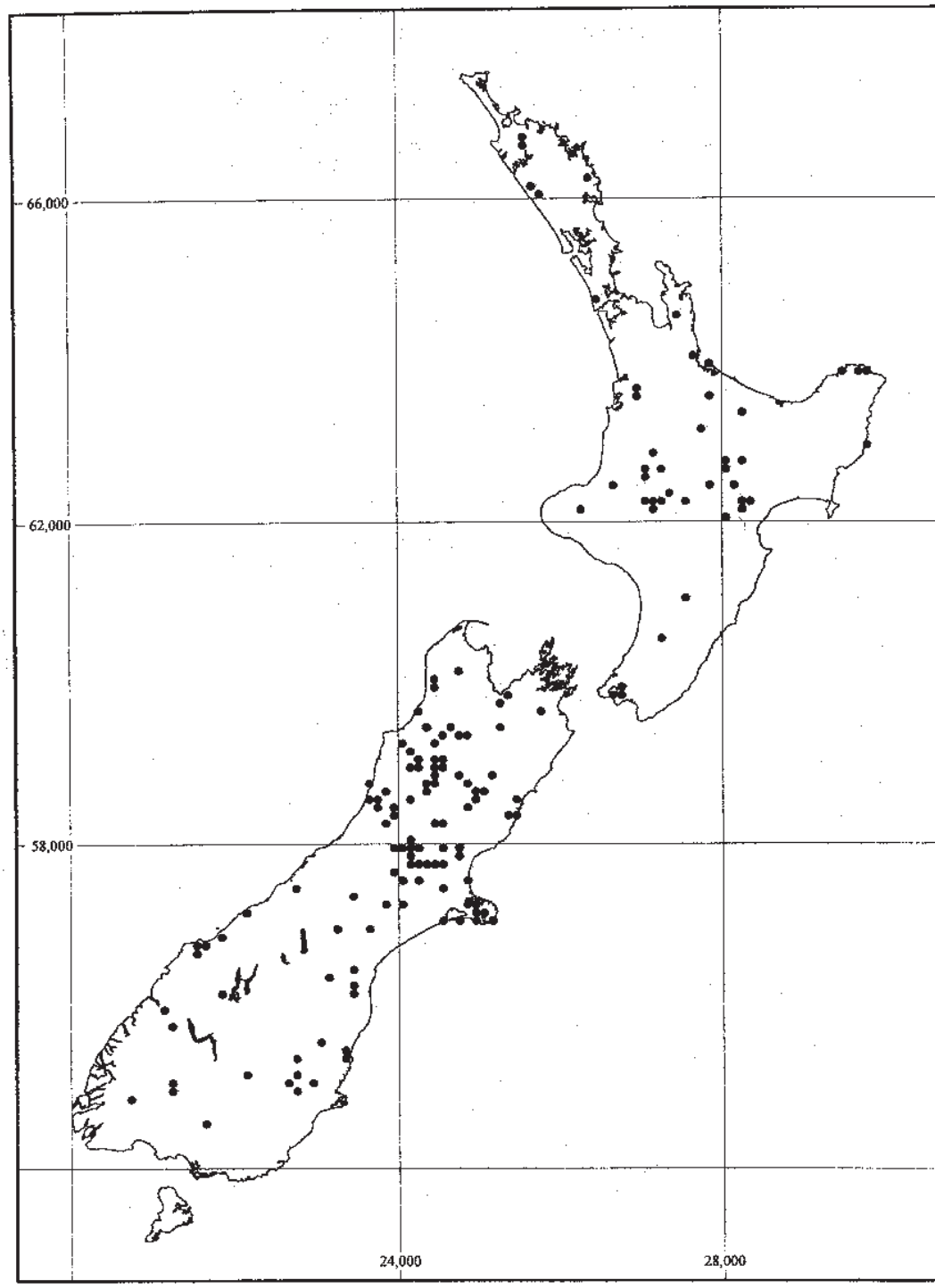
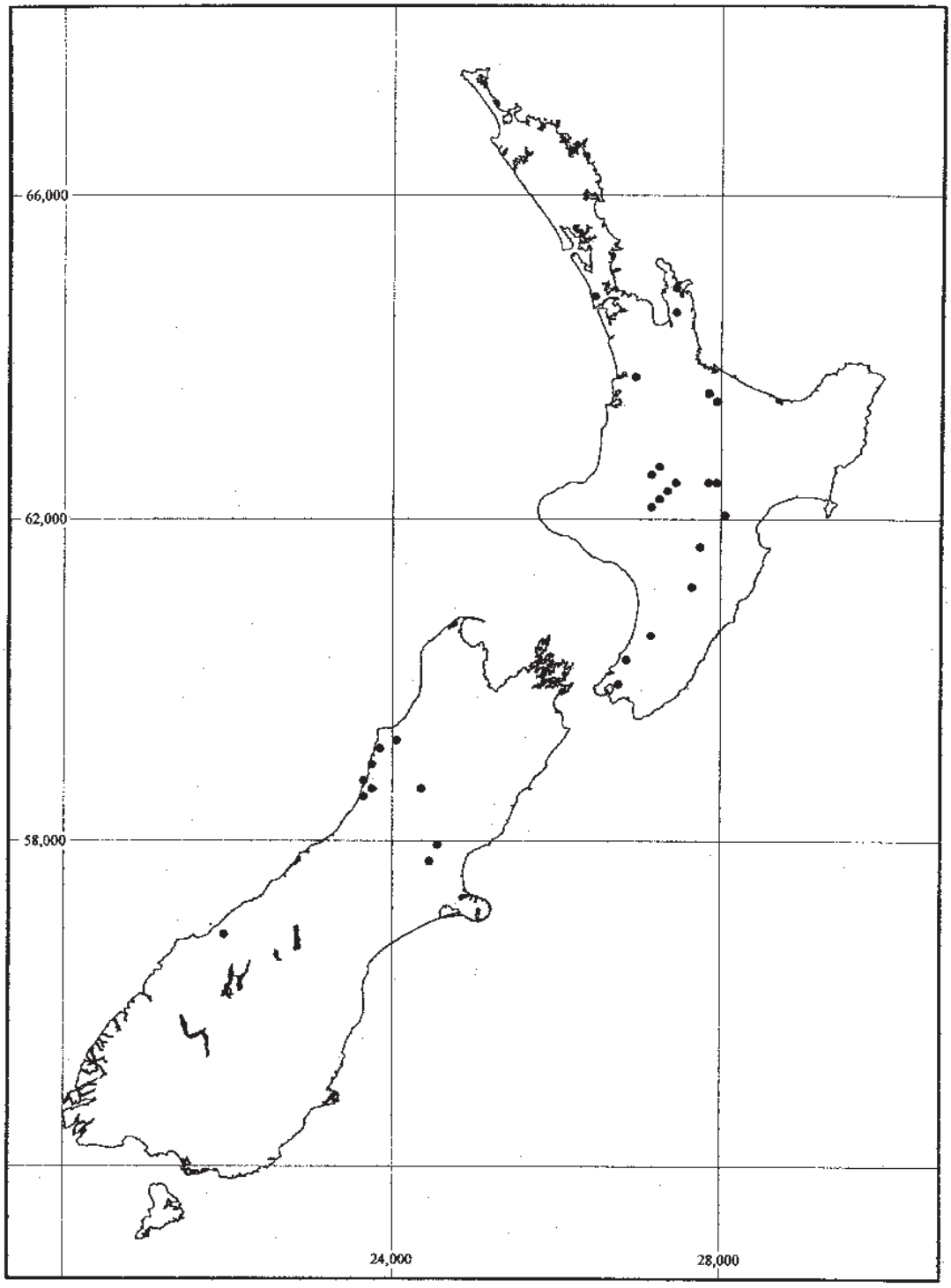


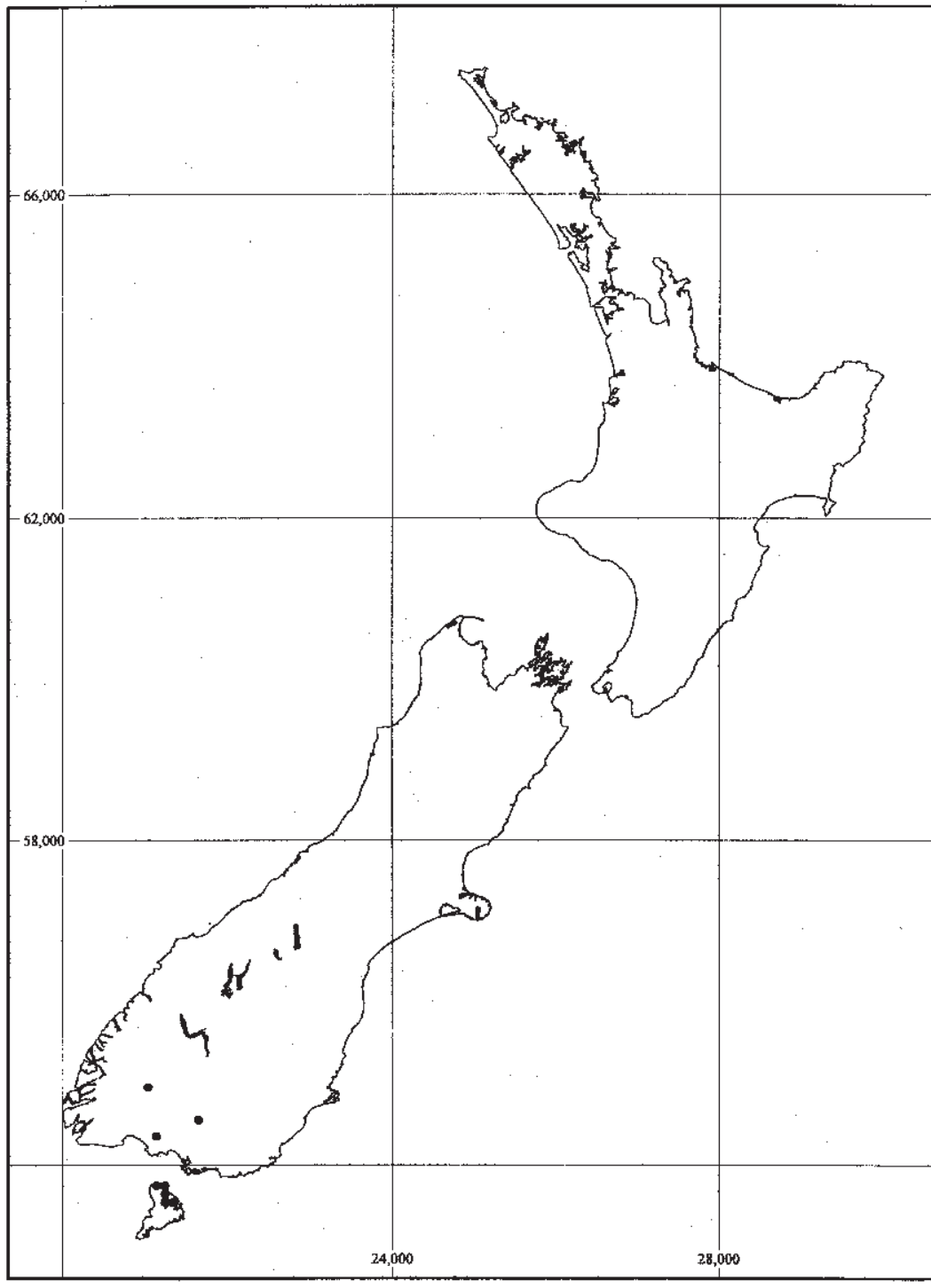
Fig. 104–107 *Nesameletus vulcanus*, larva, posterior segment borders of abdominal tergum, SEM (to same scale): (104) III; (105) V; (106) VII; (107) IX.



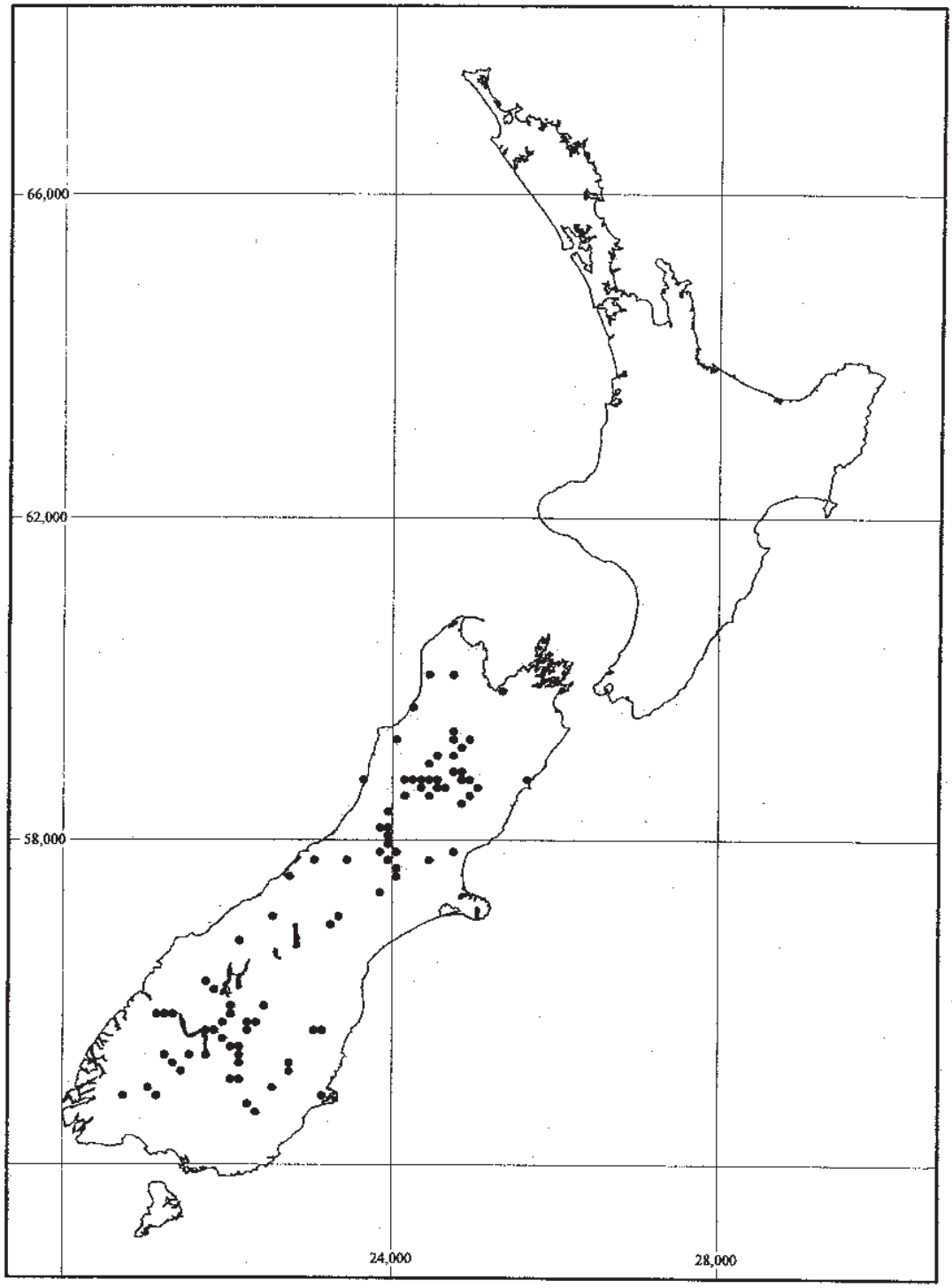
Map 1 Collection sites of *Nesameletus ornatus.*



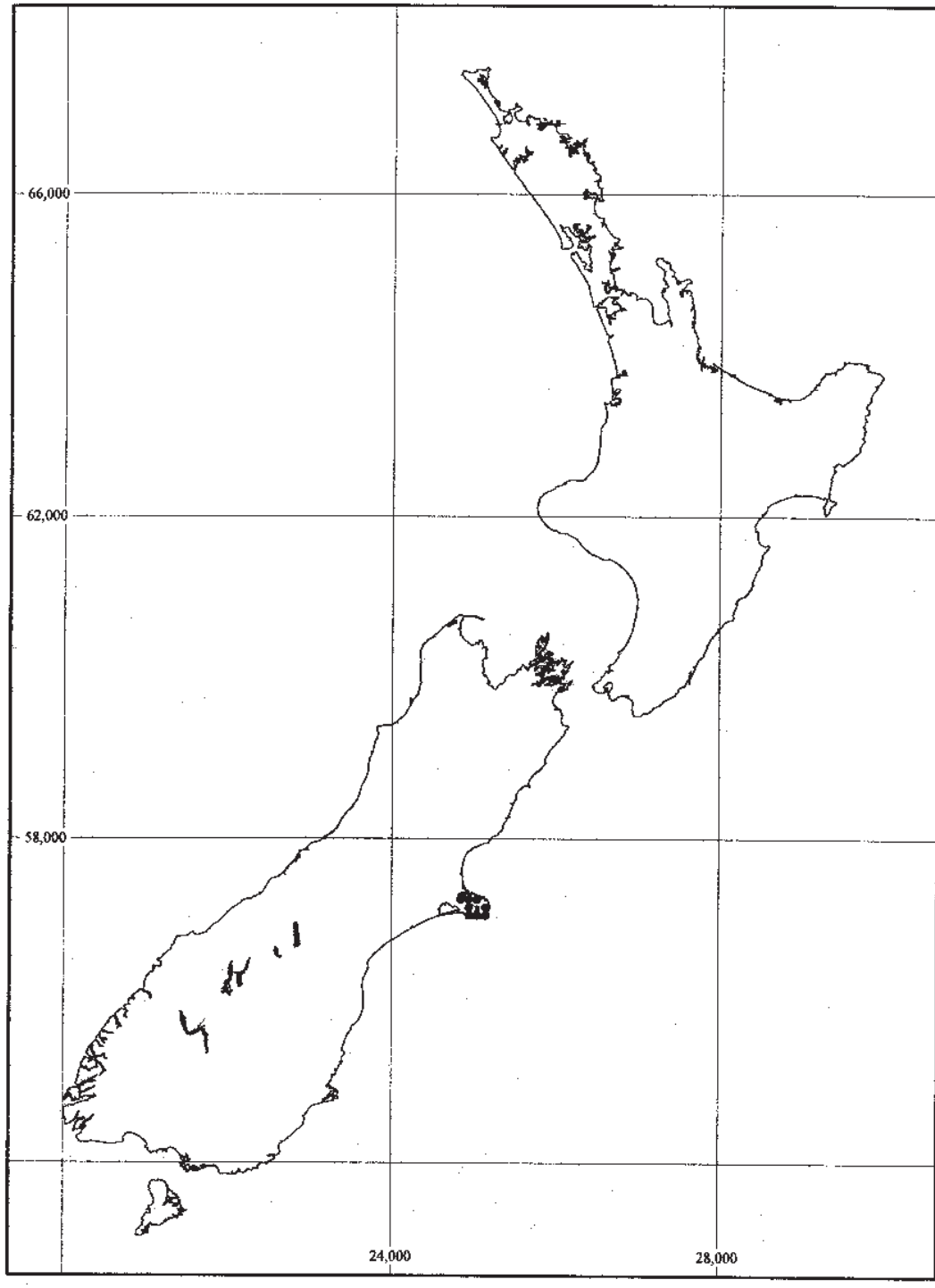
Map 2 Collection sites of *Nesameletus flavitinctus*.



Map 3 Collection sites of *Nesameletus murihiku.*



Map 4 Collection sites of *Nesameletus austrinus.*



Map 5 Collection sites of *Nesameletus vulcanus.*

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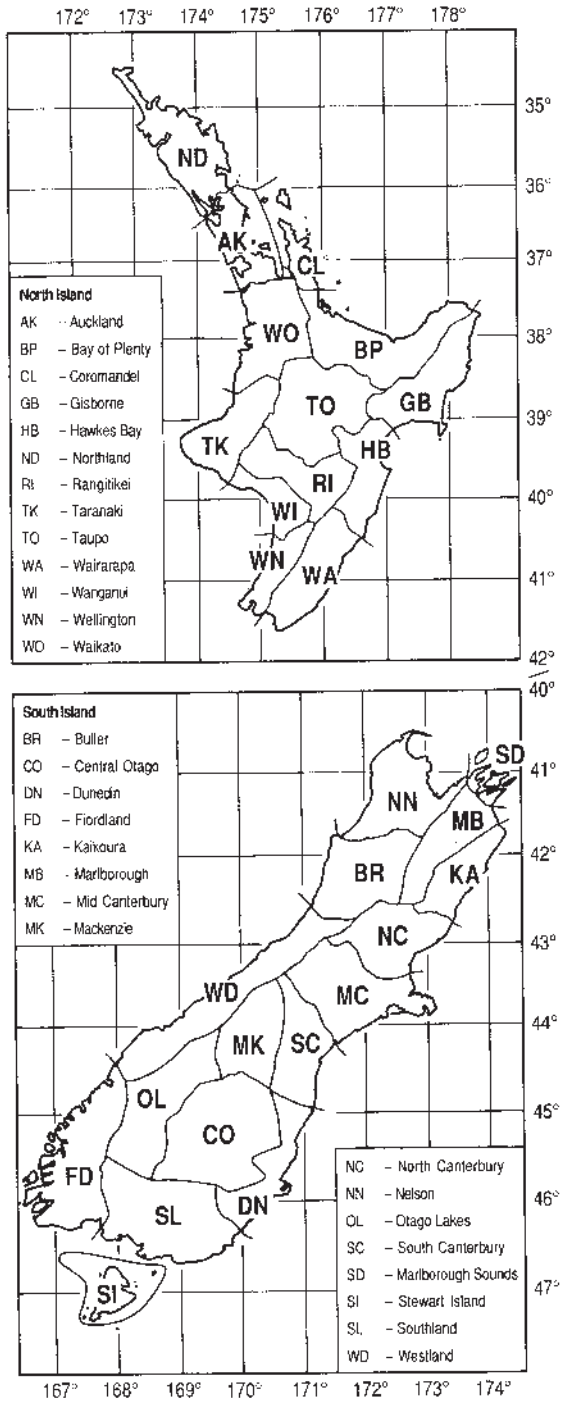
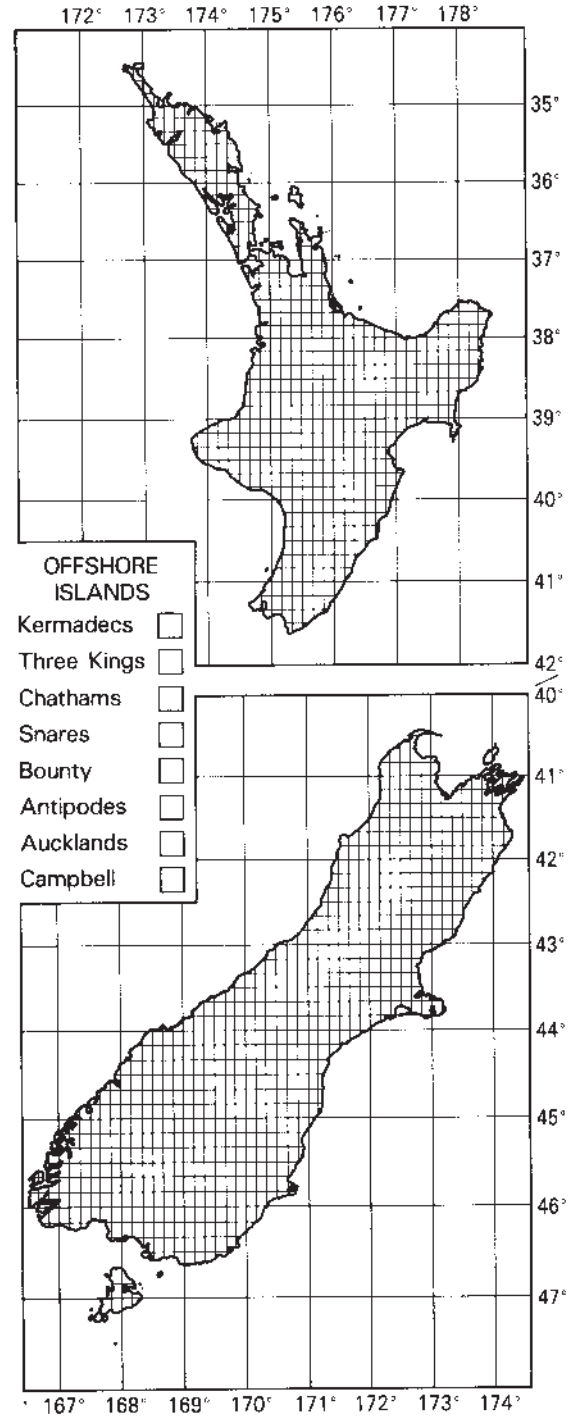
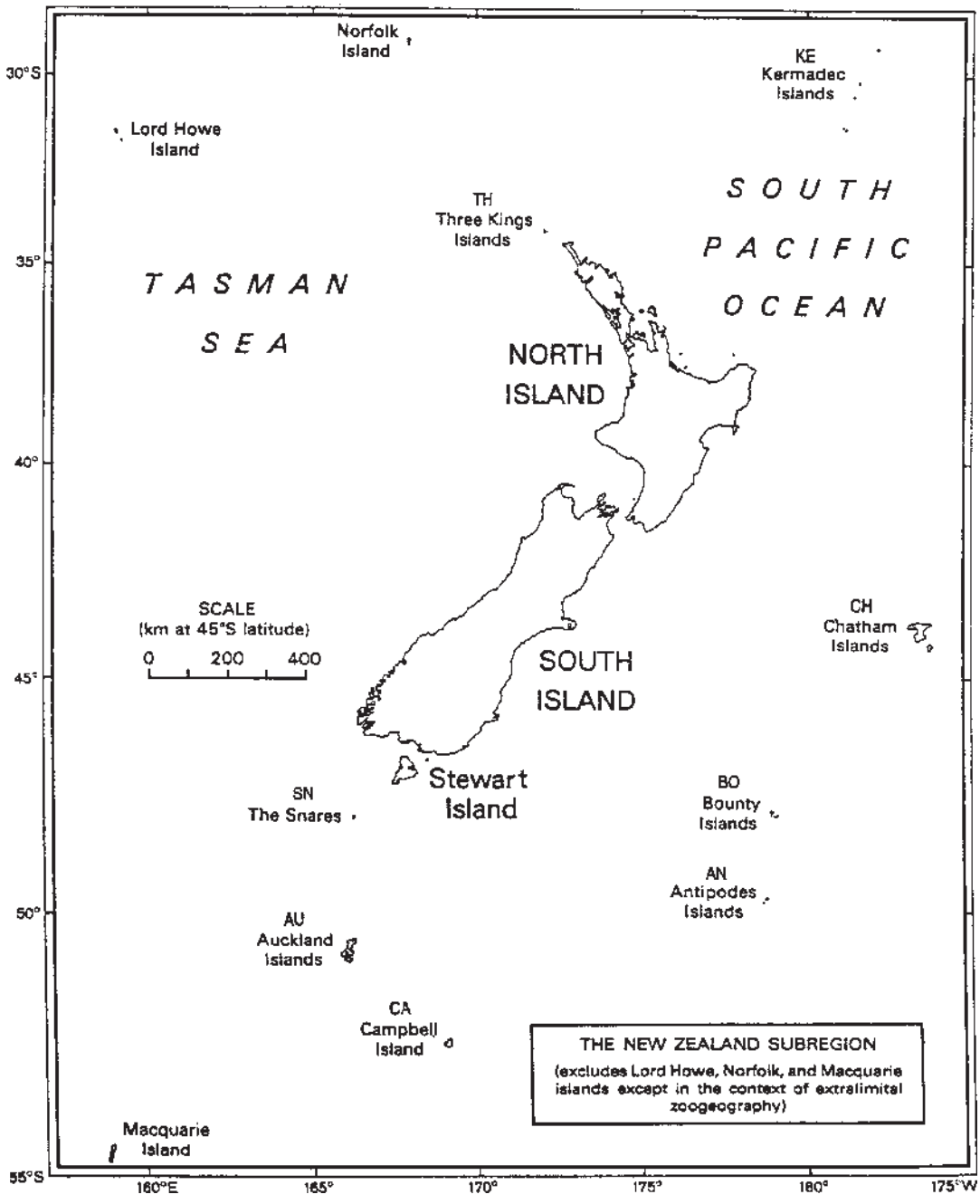
Page numbers in **bold** type denote a description, and in *italic* type illustrations. A suffixed letter 'k' indicates a key, and 'm' a map.



Area codes and boundaries used to categorise specimen locality data (after Crosby *et al.* 1998)



Base-map for plotting collection localities; this may be photocopied without copyright release



The New Zealand subregion with area codes (from Crosby *et al.* 1998).

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He titiro 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 āhei 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 tirotiro 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 ģtita 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.

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Te utu (tirohia "Titles in print", whārangi 70). 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 whakahekea te utu. Tekau ōrau te heke iho o te utu ki ngā toa hoko pukapuka.