Fauna of New Zealand

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Number 8

Calliphoridae

(Insecta: Diptera)

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with three contributed sections:

Immature stages of New Zealand Calliphoridae
by B. A. Holloway[1]

Fly strike in New Zealand
by A. C. G. Heath[2]

Rearing Calliphoridae
by Pritam Singh[1]

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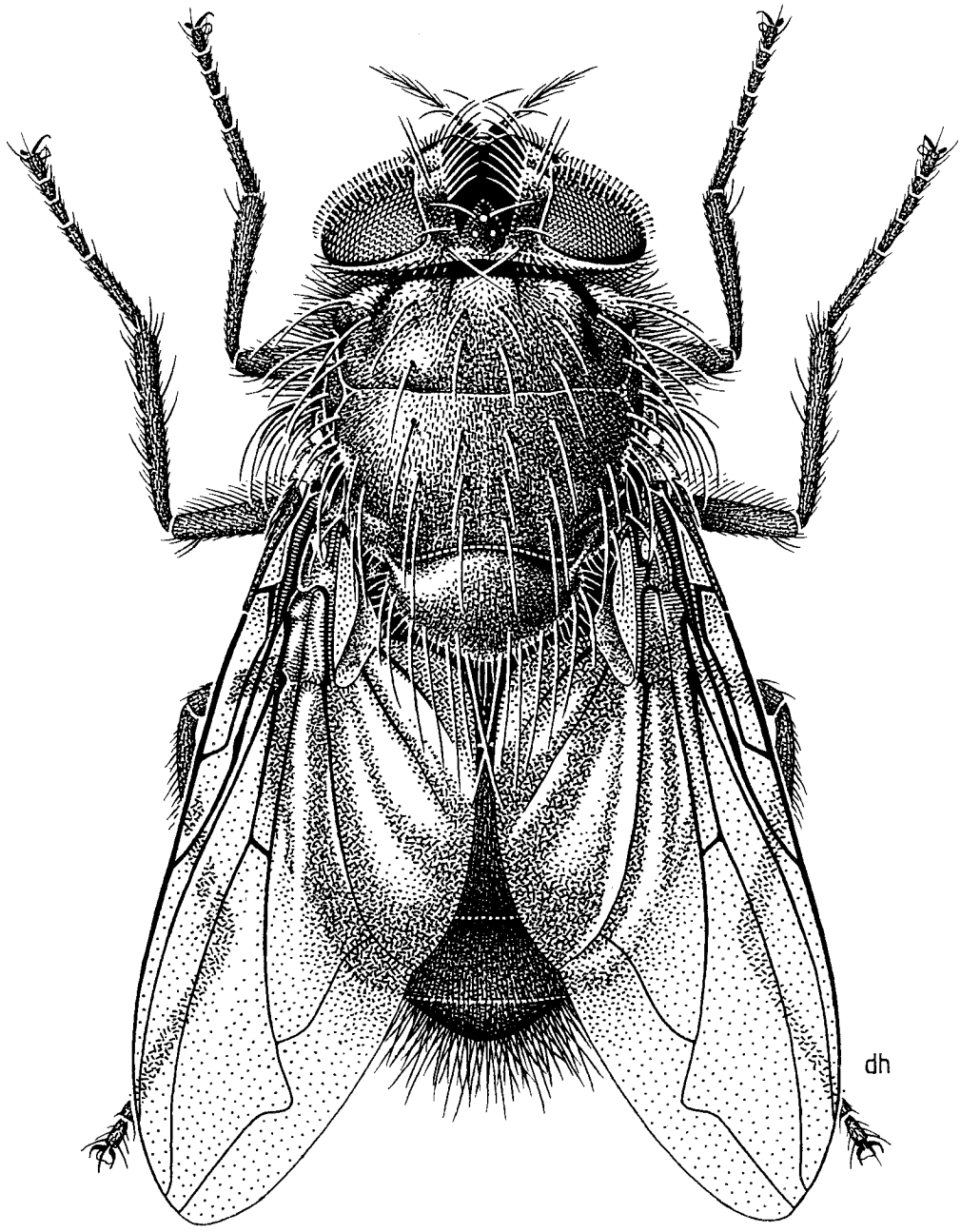

Frontispiece *Calliphora quadrimaculata* resembles Northern Hemisphere members of its genus and yet is confined to New Zealand. It epitomises the biogeographical complexities of the subregion. *Artist: D.W. Helmore.*

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Front cover: The insect depicted is *Calliphora quadrimaculata* (Swederus), female

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ABSTRACT

New Zealand's Calliphoridae are revised. Keys are given to genera and species, and characters of diagnostic and systematic importance are illustrated. All taxa are fully described, and (where known) reference is made to their biology. The 7 genera included contain 54 species, of which 31 — 27 in *Pollenia* and 4 in *Xenocalliphora* — are new. *Huttonophasia* Curran, 1927 is synonymised under genus *Pollenia* Robineau-Desvoidy, 1830. *Pollenia demissa* var. *minor* Malloch, 1930 is absorbed into *P. demissa* (Hutton, 1901). *Calliphora rufipalpis* Macquart, 1851 becomes a junior synonym of *Xenocalliphora hortona* (Walker, 1849). Two new combinations are proposed: *Gymnophania pernix* Hutton, 1901 is transferred to *Pollenia*; and *Calliphora flavipes* Lamb, 1909 is moved into *Xenocalliphora*. Three names — *Pollenia atrifemur* Malloch, 1930, *Pollenia demissa* var. *cuprea* Malloch, 1930, and *Calliphora nothocalliphoralis* Miller, 1939 — are considered to be of uncertain identity. Lectotypes are designated for 10 nominal species: *Calliphora hilli* Patton, 1925; *Calliphora dasyphthalma* Le Guillou, 1842 (and Macquart, 1843); *Pollenia auronotata* Macquart, 1855; *Sepimentum fumosum* Hutton, 1901; *Calliphora antipodea* Hutton, 1902; *Calliphora eudypti* Hutton, 1902; *Calliphora rufipalpis* Macquart, 1851; and *Calliphora aureopunctata* Macquart, 1855. Sections by contributing authors cover three topics: immature stages and life history (B.A. Holloway); fly strike (A.C.G. Heath); and rearing (Pritam Singh). A note by K. Rognes reports the occurrence of two *Pollenia* species in the *rudis*-group, apparently recently introduced from the Northern Hemisphere.

CHECKLIST OF TAXA

(Note: the many names in synonymy are listed in the Taxonomic Index, p. 82)

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ACKNOWLEDGMENTS

I am very grateful to the following colleagues who have lent me material for study from the collections in their care: Dr R. J. Gagné (USNM); Dr R. A. Harrison (LCNZ); Dr B. A. Holloway (NZAC); Dr R. Contreras-Lichtenberg (NHMW); Dr L. Lyneborg (ZMKD); M L. Matile (MNHN); Dr K. R. Norris (ANIC); and Mr R. A. Savill (CMNZ). I am also grateful to Mr Adrian Pont (BMNH) and Loic Matile for their help with historical facts about the Bigot and Macquart collections, and to Roy Harrison for the useful suggestions he supplied while the work was in progress.

This work was originally conceived as a straightforward systematic revision for publication as a journal paper. I welcome the opportunity to have it remodelled as a *Fauna* contribution, and am indebted to the authors of the new text sections for their willingness to contribute. Adrian Pont has kindly acted on my behalf to see the publication through its processing stages into print, and with Beverley Holloway has read the MS. and proofs; their help has been of exceptional value.

INTRODUCTION

The dipteran family Calliphoridae, to which belong the familiar blowflies, bluebottles, and greenbottles, is represented in New Zealand by 52 species. These are contained in 2 subfamilies comprising 7 genera. Six of the genera — *Calliphora*, *Hemipyrellia*, *Lucilia*, *Pollenia*, *Ptilonesia*, and *Xenocalliphora* — belong to the subfamily Calliphorinae. The seventh, *Chrysomya*, belongs to the Chrysomyinae, a group represented here by only two species. Two other subfamilies, the Ameniinae and Rhiniinae, have been recorded from New Zealand by early workers, but these records are based on erroneous locality data (see Miller 1950, pp. 138, 139, and 142).

In general appearance the New Zealand species of Calliphoridae are very much like the other members of this large and cosmopolitan family, which are mostly stout, large to moderate in size, and often metallic in appearance, at least on the abdomen. They can be distinguished from all other calyptrate flies in New Zealand by the presence of a row of hypopleural setae, an undeveloped postscutellum, and a haired propleuron (if the propleuron is bare then the outer posthumeral seta is absent). However, in structural details some of the species differ from the normal calliphorid pattern. These anomalies are discussed below under the genera *Pollenia*, *Ptilonesia*, and *Xenocalliphora*.

There is a long history of work on New Zealand's calliphorids. The first species was described by Swederus (1787) from material collected during Cook's first voyage to New Zealand. By the early twentieth century a few species had been described by European workers such as Macquart and Walker, and Hutton had recognised species endemic to the offshore islands. Subsequent workers such as Malloch (1924, 1927, 1930), Miller (1939b), and Murray (1954) continued to describe new species, and in general they had a good eye for valid species, although they often confused the nomenclature because of the inaccessibility of much type material in European museums at that time. Miller (1939b, p. 11) gave a very interesting account of the history

of blowflies in New Zealand, including their significance in Maori lore. Harrison (1976, p. 147) has given a useful revision of the species from the southern islands.

Calliphorids are generally ubiquitous. They fly mainly by day, though a number of specimens I have examined were collected at light traps. Most species of *Pollenia* appear to be restricted to higher altitudes, whereas *Ptilonesia* and *Xenocalliphora* are often found at the seashore. Adults are often attracted to sweet liquids, and can be collected at flowers, where they feed on nectar. They also feed on the liquid products of organic decomposition, which provide the proteins essential to the female for egg maturation. Most species breed in carrion, but *Pollenia* may parasitise earthworms as it does in other geographical regions. Some of the species of *Calliphora*, *Chrysomya*, and *Lucilia* are of significant veterinary importance, causing the cutaneous myiasis of livestock known as 'fly strike', but the life history details of most New Zealand Calliphoridae are unknown.

This revision is based on almost 1400 specimens, from numerous sources. Virtually all type material has been examined.

Genus *Calliphora*

The genus *Calliphora* in New Zealand contains four species, two introduced from Australia and one from Europe, and the fourth endemic. The Australian species, *Calliphora stygia* and *C. hilli*, are two of the well known golden blowflies, or golden-haired blowflies. The first record of their appearance in New Zealand dates from 1841, when Dr A. Sinclair collected specimens of both (used in the type series of *laemica* White) in the Bay of Islands. In 1845 he made further collections of both species, and these are preserved in the BMNH collections. Colonel Bolton collected *stygia* in 1845 at the Auckland Islands. French expeditions visited New Zealand in 1824, 1827, and 1831, but when in Paris (MNHN) I found no golden blowflies collected on these expeditions. In his narrative of Cook's first voyage, Hawkesworth refers to "flesh flies" being like those of Europe (see Miller 1939b, p. 58); this probably refers to the endemic species, which has the appearance of European blowflies. Joseph Banks collected this species during Cook's voyage of 1768, and would surely have taken a golden blowfly had he seen one (he did while in Australia). During this voyage Cook was mapping the North and South islands, and Banks went ashore at every opportunity. It seems unlikely, then, that golden blowflies were in New Zealand at that time; or at best they were present only in very small numbers. It seems most probable that they were introduced from Australia between 1779 and 1841. J.S. Pollack in 1838 mentions a "gad fly" or oestrus depositing larvae on meat (see Miller 1939b, p. 61); this may refer to a golden blowfly. Hennig (1966, p. 10) accepts a passive dispersal from Australia in recent geological time, saying that man may not have been the agent.

The two golden blowflies *C. hilli* and *C. stygia* have been confused taxonomically by most authors. Hutton (1901, p. 64) mentions neither of them in his New Zealand synopsis. Malloch, in his Australian paper (1927, p. 309), discusses the confusion, keys the flies successfully, and also mentions that he has females of *hilli* from New Zealand, but he does not refer to them in his New Zealand work (1930, p. 313). Hardy (1937, p. 21) gives a rather confusing list of species and synonymies, including the names *hilli*, *laemica*, *milleri*, *rufipes*, and *stygia*. He does not mention *stygia* as occurring in New Zealand, but gives *laemica* and *milleri* as the two golden blowflies of New Zealand. He alludes to his new species *milleri* as the common New Zealand blowfly, and gives *hilli* as a synonym of *rufipes* (*milleri* is here referred to *hilli*). Miller (1939b, pp. 30 and 32) and Murray (1954, p. 719) both refer to *hilli*, as recognised here, as *rufipes* and to *stygia* as *laemica*. The name *rufipes* has in the past caused great confusion, as Macquart described both a *Pollenia rufipes* and a *Calliphora rufipes*, and both names have been applied to blowflies in New Zealand. Dr K.R. Norris (pers. comm.) has studied the type specimens of these species in conjunction with his work on Australian blowflies, and has found that the syntypes of *P. rufipes* are *Calliphora stygia* and that the holotype of *C. rufipes* is an Austro-Oriental *Calliphora* species. Kurahashi (1971, p. 158) placed *C. stygia* in his subgenus *Neocalliphora* (see below) and referred to *C. hilli* as *C.* (*Paracalliphora*) *rufipes* ssp. *milleri*, but I can find no justification for subspecific status for this species.

Calliphora quadrimaculata is an endemic species of striking appearance, being large, robust, and metallic. It is mentioned in Maori folklore, and was recorded by all the early authors, having been described by Swederus from material collected by Banks during Cook's first voyage. Malloch (1930, p. 316) unaccountably referred to this species as *Calliphora sacra* (Fabricius). Kurahashi (1971, p. 155) placed this species in his subgenus *Neocalliphora* along with five others, of which I find that only two, namely *C. nigrithorax* from Tasmania and *C. ochracea* from Australia, are closely related to *quadrimaculata*. These three species constitute a distinct group, and are probably living examples of something near to the ancestral stock of present-day *Calliphora* species. They have in common densely haired eyes, holoptic head in the male, very large thoracic spiracles, unicolorous undusted

abdomen, and curved paralobes in the male genitalia. *Calliphora testaceifacies* is closely related to this group, but in having bare eyes and a dusted fifth tergite is reminiscent of the Australian *Calliphora robusta* group. It may be a relatively recent offshoot from the ancestral line of the numerous species of the *robusta* group found in Australia today.

Similarly, *C. stygia* is closely related to the *nigrithorax – ochracea* group but has a golden-dusted abdomen, sparsely haired eyes, and straight paralobes. The thoracic spiracles are very large, and this is a characteristic feature of the ancestral group; enlargement is found to some degree in other golden blowfly species, but less strikingly so. It is probable that *stygia* is still quite close in its characters to the ancestral stock, and marks the first step in a morphological progression to the numerous golden blowfly species found in Australia today.

C. quadrimaculata has been geographically and genetically isolated in New Zealand, and may form the stock for future speciation. Indeed, on Campbell Island and the Auckland Islands it differs from the mainland form in having the abdomen blue-green and metallic rather than violet. This subantarctic form was described by Hutton (1904, p. 155) as a distinct species, but I do not believe that it deserves this status. However, speciation appears to be rapid in the New Zealand subregion, with its many islands.

Calliphora vicina, accidentally introduced from Europe, was first recorded in New Zealand by G.V. Hudson in 1889, but under the name *C. vomitoria*, a misidentification. This species has now reached all geographical regions of the world, most probably dispersed passively by human agency in the days of sail.

Genus *Hemipyrellia*

This genus is very closely allied to *Lucilia*, and may at some time be considered synonymous. Like *Lucilia*, *Hemipyrellia* species breed in decaying animal matter, but adults are attracted to sweet-smelling substances.

In material received from Lincoln College I found a single specimen of *Hemipyrellia ligurriens* (Wiedemann), possibly incorrectly labelled. As with *Chrysomya megacephala*, this species is tropical and would probably not become established in New Zealand, but I have identified it amongst material collected at airports in New Zealand. The genus has been included in the key so that it may be identified should it turn up in imported cargo.

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Genus *Lucilia*

The genus *Lucilia* is represented here by the well known, cosmopolitan sheep blowfly *L. sericata* Meigen, which was first recorded from New Zealand in 1872 by Hutton (1901, p. 63). Miller (1939b, p. 52) gave a key to three species, one *sericata* and the others called simply "A" and "B". His species B can be eliminated as it obviously did not originate in New Zealand, having a yellow third tergite; it fits the description of, and most likely is, the Australian species *Hemipyrellia fergusoni* Patton. Miller separates his species A from *sericata* using a poorly diagnostic colour character, but his genitalia drawings show quite marked differences. However, these may be artefacts due to distortion during slide mounting and to over-clearing of the aedeagus. I have not found a second species in the material I have examined. Material recently received from New Zealand airport authorities included a specimen of the tropical species *L. cuprina* Wiedemann. This is unlikely to become established in New Zealand, but I have included it in the key on p. 27 for the benefit of those identifying insects found in imported cargo.

Genus *Pollenia*

Pollenia has previously been considered a predominantly Palearctic genus, with one or two migrant species reaching North Africa, America, and northwestern India. It is now clear that this is erroneous, and that *Pollenia* is substantially represented in the Southern Hemisphere. Many species await description from southern Australia, and new species are described here from New Zealand.

Apart from two recent introductions from the Northern Hemisphere, all New Zealand species are endemic. *Pollenia* is by far the largest — as well as the least known — genus of Calliphoridae in this country.

A few members of the tribe Polleniini were described from the Oriental and Austro-Oriental regions by early authors such as Francis Walker, but these have subsequently been transferred to other genera within the Calliphorinae and Rhininae. No Polleniini have been recorded from the Afrotropical and Neotropical regions. In North America the tribe is represented by two introduced species and the genus *Melanodexia* Williston, which is confined to river gullies in California and Idaho.

There are, then, four distinct geographical groups of Polleniini: Palearctic *Pollenia* (30+ species); Nearctic *Melanodexia* (8+ species); Oriental and Austro-Oriental *Pollenia* (8+ species, including *Xanthotryxus*); and the Australian and New Zealand *Pollenia* (60+ species, including *Anthracomyia*). Basic external and genital morphology is identical

in the four groups, head shape (Figure 12) and the bare prosternum and propleuron in particular distinguishing them from other Calliphoridae. The Oriental – Australasian genus *Polleniopsis* Townsend has a *Pollenia*-like head but a haired propleuron and prosternum, short, larviparous ovipositor, and *Onesia*-like aedeagus.

The question of origins and phylogenetic relationships of the Polleniini within the Calliphoridae is especially difficult, and its detailed resolution is outside the scope of this study. However, the existence of a large number of very similar species indicates that the Polleniini are a comparatively recent group, possibly originating in and dispersing from the Palearctic region. It is likely that this dispersal took place across the Bering land-bridge and along the island chains of South-west Asia to Australia and New Zealand. Whatever their origin, once established the groups would have been isolated by changes in sea level during Pleistocene interglacials and the post-Pleistocene period, and rapid speciation apparently took place in the more temperate areas. The distinct Oriental and Austro-Oriental group consists of the few species that were able to adapt to a subtropical climate.

In basic structure and general appearance the New Zealand *Pollenia* species resemble the Palearctic representatives, with only a few minor differences, and I regard the two groups as congeneric. New Zealand *Pollenia* do not have the facial carina that is present in most Palearctic species, nor such long, crinkled thoracic ground setulae. In some of them the abdomen is metallic blue or green, without distinct dusting, and often with pale ground colour to the thorax.

A few Palearctic species placed by some authors in a separate genus, *Nitellia* Robineau-Desvoidy, have shorter ground setulae and an undusted, metallic black abdomen. These are much more similar to the New Zealand species than they are to the rest of the Palearctic *Pollenia* (the *rudis*-group; see note on p. 47), which have long, crinkled, golden thoracic hairing and the abdomen densely dusted and olivaceous. The male genitalia of the New Zealand and Palearctic species are of very similar construction, but unlike any of the New Zealand species the *rudis*-group has a strongly sclerotised rod on the basal half of the hypophallus. In the *Nitellia*-group the marginal spines are confined to the dorsal portion of the hypophallus, and the lower portion is not produced forwards into a spine-like projection as in many of the New Zealand species. The aedeagus of *Melanodexia* resembles that of the *Nitellia*-group but has a broader, blunter paraphallus.

The Australian species are generally darker, and often have the thoracic hairing typical of the *rudis*-group. In structure of the aedeagus they are identical with the New Zealand species.

I wholeheartedly endorse the view of Mihályi (1976) concerning the Hungarian *Pollenia* species: "*Pollenia* is the most difficult genus of the Calliphoridae". I have experienced considerable difficulty in producing useful taxonomic conclusions to the problems encountered while preparing a key to the New Zealand species of *Pollenia*, as with the Palearctic species. These problems have arisen mostly because of infraspecific variability, the general similarity of the species as regards external morphology, and the relative paucity of material available. Although infraspecific variability has been accounted for in the key, the figures of the male genitalia should always be used to confirm an identification.

A separate key to females has been given, and again variability has been accounted for, but as more material becomes available this key may prove unsatisfactory. Except where I have had reliably associated sexes, the females have not been assigned to species but left unnamed, and instead referred to as "species *a*" to "species *q*".

Hutton (1901) was the first to describe any New Zealand *Pollenia* species, but placed his new species *demissum* and *fumosum* in the genus *Sepimentum*. Malloch (1924) synonymised this genus with *Pollenia* and considered Hutton's two species to be conspecific. In a subsequent paper (1930), published after examination of more material, Malloch reversed his opinion and restored them as distinct species. He also described three new species, and two new varieties of *demissa*; these latter are discussed under *P. demissa* (p. 36).

Although unhappy about the validity of the generic characters of *Huttonophasia* as distinct from *Pollenia*, Malloch (1930) considered it a good genus. I consider it to be synonymous with *Pollenia*, as I can find no characters important enough to warrant its distinction (see Remarks under *P. pernix*).

Genus *Ptilonesia*

Ptilonesia is a very unusual calliphorid genus found only in New Zealand and two localities in Australia. It is monotypic, and in general appearance is very *Onesia*-like, with wide parafacials and jowls and the eyes reduced. It is also reminiscent of the endemic New Zealand genus *Xenocalliphora*, and was placed as a subgenus of it by Kurahashi (1971). I prefer to keep *Ptilonesia* as a distinct genus on the basis of its lack of ocellar and superior orbital setae, modifications to the fifth tergite, hairing on the parafacialia and squamae, facial shape, and male genitalia. The similarity to the Neotropical genus *Toxotarsus* I believe to be due to convergence, rather than an indication of any phylogenetic rela-

tionship, because both genera are seashore flies. Miller (1939b) says that the single species of *Ptilonesia* breeds in decaying seaweed. This may be a mistaken observation, and it may be that the flies were breeding in dead animals tangled in the seaweed masses.

Outside New Zealand *Ptilonesia* is apparently restricted to beaches north and south of Sydney Heads and at Seaford in Victoria (K. R. Norris, pers. comm). The question arises as to whether this disjunct and local distribution represents an introduction or is a relic of a previously wider distribution. Introduction on floating masses of seaweed is unlikely, as ocean currents run away from Australia throughout the year, and prevailing winds blow either towards New Zealand or northwards along the eastern coast of Australia. The other possibility is of dispersal by boats travelling between New Zealand and Australia, but it is strange that, once established, the individual colonies did not disperse rapidly, as is usual with other seashore Diptera. It seems most likely, therefore, that the Australian populations are a relic of a previously wider distribution.

Genus *Xenocalliphora*

This genus is endemic, and contains ten species, four of which are described here as new. Three species occur on the main islands, but the remaining seven are restricted to offshore islands.

Xenocalliphora is reminiscent of *Onesia* and *Ptilonesia* in general habitus, having dichoptic males, wide jowls and parafacialia, and in being larviparous. The species can be divided into two distinct groups which, however, are not distinguishable by their general appearance. The first group has two posterior *ia* setae, no *pd* setae on the fore tibia, and an aedeagus with a bifurcate harpes that is curved for its entire length (Figures 94 and 100). The second group has one posterior *ia* seta, a *pd* seta on the fore tibia, and a non-bifurcate aedeagus that is broad and curved at the tip (Figures 92 and 96). The first group is restricted to the North Island, northern South Island, and central offshore islands, and the second is found only in the southern islands — a distribution suggesting sister-group status. Unfortunately, Hennig (1966) does not mention this genus or any of its species in his work.

The phylogenetic relationships of *Xenocalliphora* within the Calliphoridae are not clear. Kurahashi (1971) suggests that the genus is derived from the same ancestral stock as the old *Calliphora*-group but has evolved in a way differing from modern *Calliphora*. Certainly it is of striking appearance when compared with other genera from the Southern Hemisphere. Kurahashi also suggests that it has affinities with some Holarctic genera such as *Cynomya*, *Cyanus*, *Onesiomima*, and *Abago*. This I find doubtful, and prefer to consider *Xenocalliphora* as a totally isolated group that is now found only in the New Zealand subregion, but which derives ultimately from the common ancestor of the *Calliphora*-group.

Malloch (1930) keyed four species correctly, using the name *Xenocalliphora* and describing one species as new. Miller (1939b) used *Calliphora* for all his blowfly species, including five *Xenocalliphora* species, two of which he described as new. Murray (1954) gave a very good key to all the species of *Calliphora* known to occur in New Zealand; this included six species of *Xenocalliphora*, one of which he described as new. Kurahashi (1971) included five species in his key to *Xenocalliphora* but did not see specimens of most of the species. Harrison (1976) gave a key to *Calliphora* species which included five *Xenocalliphora* species. In general, adequate keys have been given to the known species, but in many instances the nomenclature is incorrect, names being confused and assigned to the wrong species. Misidentifications are discussed under the relevant species.

Genus *Chrysomya*

This genus is represented in New Zealand by *C. rufifacies* (Macquart), which, like other *Chrysomya* species, is a tropical or subtropical blowfly adopting the ecological role of *Lucilia* in temperate regions. It is, however, unusual in being able to extend its geographical range to warm temperate regions (cf. *C. albiceps* in southern Europe). The male genitalia (Figure 19) are not typical of the Chrysomyinae, and the larva is unusual in having fleshy protuberances on the segments (see Figure 116).

The earliest recorded occurrence of *rufifacies* in New Zealand is 1911 (Miller 1939b, p. 56, and specimens in BMNH). Malloch (1930, p. 315) refers to this species as *Chrysomya albiceps* (Wiedemann), with which it may be conspecific (see Zumpt 1956, p. 192).

I have recently received from the Commonwealth Institute of Entomology two samples of *Chrysomya megacephala* (Fabricius) found aboard aircraft arriving in New Zealand from Australia. I also have a record of this species from rotting fruit at Springston, MC (possibly incorrectly labelled; R. A. Harrison, pers. comm.). This species is tropical, and is unlikely to become established in New Zealand, but I have included it in a key (p. 57) so that it can be identified should it turn up in seaports or at airports.

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IMMATURE STAGES OF NEW ZEALAND CALLIPHORIDAE

Contributed by B. A. Holloway*

A comprehensive systematic work on New Zealand's Calliphoridae would include a substantial section on the morphology and biology of the immature life stages. Lack of material of the early stages of the many endemic species of blowflies precludes such a treatment in this contribution. The most that can be offered are simple keys and short descriptions that will enable the user to recognise each of the three larval instars and to identify to species the third-instar larvae of the six commonest calliphorids of urban and rural areas.

Five of these species are of Northern Hemisphere and Australian origin. Their larvae are the conspicuous maggots that may be seen feeding on dead animals, and are either primary or secondary invaders in sheep strike (see Heath 1985, p. 15). The immature stages of some of them may also be discovered inside meat pies, hamburgers, and similar meat-based foods that have been exposed to egg-laying adult females.

The sixth species is the large endemic bluebottle *Calliphora quadrimaculata.* Although its larvae frequently occur on dead animals, they are also able to reach maturity without feeding on carrion. On a recent collecting trip based at Dundas hut in the northern Tararua Range (WN–WA; altitude 1250 m) I found a mature larva and numerous puparia — from which adults subsequently emerged — about 2 cm below the surface in gritty soil surrounding clumps of the broad-leaved snow tussock, *Chionochloa flavescens.* The most likely source of larval food was the deep, wet layer of fermenting leaf sheaths in the base of this species of tussock.

Unlike adult calliphorids, which are easily recognised as bluebottles, greenbottles, and golden-haired blowflies, most larvae — even of quite distantly related species — look very similar to the naked eye. However, at ×50 magnification under a stereomicroscope the distinctive features of the three larval instars are clearly discernible, and it is not difficult to identify third-instar larvae to species. Calliphorid larvae which do not key out to one of the six common species probably belong to the endemic fauna. If sufficient live specimens are available, some should be preserved and the remainder should, if possible, be reared to adults. A well documented collection of correctly associated larvae and adults would be immensely valuable to specialists studying the affinities of New Zealand Calliphoridae.

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Materials and techniques

The material studied, including associated adults, is in the forensic and general collections of the New Zealand Arthropod Collection (NZAC), held by Entomology Division, DSIR, Auckland. Most of the specimens were obtained between 1981 and 1983 during a study of the fauna associated with human corpses in Auckland (Smeeton *et al.* 1984). They were collected by Drs W. M. I. Smeeton and T. D. Koelmeyer, senior lecturers in forensic medicine at the School of Medicine, University of Auckland, from corpses which, because of the circumstances of death, were received for post-mortem examination at the Auckland City Mortuary.

The characters used for identification are most easily seen in fully extended specimens which have been killed by brief immersion in almost boiling water. Freshly killed specimens can either be fixed in PEA solution (1 part petroleum ether, 7–10 parts 95% ethanol, 2 parts glacial acetic acid) or placed directly in 70% ethanol. To examine the structures used in the keys it is not necessary to clear or slide-mount the larvae. They can be viewed adequately in a dish of ethanol under a stereomicroscope at a magnification of about ×50.

The illustrations were made with the aid of a camera lucida. Structures that are not obvious at low magnifications and which have not been used in the key — e.g., the perispiracular bristles associated with the posterior spiracular slits — are omitted from the drawings. Measurements were taken from fully extended larvae.

Morphology and terminology

The body of a blowfly maggot (Figures 115 and 116) consists of a head, three thoracic segments (*T1–T3*), and eight abdominal segments (*A1–A8*). The head is very small, and is often partially retracted into the thoracic segments; it is bilobed, and bears a pair of antennae and a pair of maxillary palps (Figures 117–119). The mouth opens on the ventral surface of the head, and has associated with it a pair of strongly sclerotised mouth hooks and a variably developed oral sclerite (see Figure 126). Numerous oral grooves are present on the integumental surface on either side of the mouth. The mouth hooks are part of a complex cephalopharyngeal skeleton which is not easily seen in uncleared specimens.

The first thoracic segment of larvae in the second and third instars bears a pair of conspicuous, lobed, anterior spiracles (Figures 118 and 119). First-instar larvae lack lobed spiracles on this segment, but have

instead a pair of minute spiracular slits which are barely discernible except under a scanning electron microscope (Kitching 1976a). The body segments are separated by narrow spine bands (Figures 115–119) which are always well developed on the ventral surface but which may be weak or absent dorsally and laterally. The size, shape, arrangement, and density of spines in the bands of third-instar larvae are important characters for identifying different species. The posterior end of the last abdominal segment bears six pairs of papillae (Figure 115) which are arranged approximately in a ring. In some species paired papillae are present on the third thoracic segment and all abdominal segments (Figure 116). The papillae on the last abdominal segment surround a pair of posterior spiracles (Figures 116 and 123–125). Each spiracle consists of a sessile, crescentic to circular peritreme enclosing two or three obliquely arranged slits. The number of slits and the shape of the peritreme are easily visible characters from which the different larval instars can be identified (Figures 120–122).

Various authors (e.g., Miller 1939, Zumpt 1965) have attached considerable taxonomic importance to the number of lobes in the anterior spiracles and the size, shape, and proximity of the posterior spiracles of third-instar larvae. In the species dealt with here these characters are too variable to be taxonomically useful. The most reliable and easily seen characters for identifying these species occur in the oral sclerite and in the spine bands. Illustrations of the posterior spiracles have been included mainly to show how much these structures may vary in similar-sized specimens of the same species (Figures 137 cf. 138, 142 cf. 143, and 147 cf. 148).

Diagnostic characters of larvae

Calliphorid larvae can be distinguished from those of Anthomyiidae, Drosophilidae, Fanniidae, Muscidae, Phoridae, Sarcophagidae, and Sciadoceridae, which may occupy similar ecological niches, by the following combination of character states: spine bands present dorsally on at least some segments; posterior spiracles always sessile (never on stalks or mounds), not located inside a deep pit, encircled by 6 pairs of conspicuous, isolated papillae; peritreme developed as a ring or crescent (never in the form of a uniformly sclerotised disc); slits straight (not coiled or strongly bent), converging towards ventral midline of last abdominal segment.

Key to larval instars

1 *T1* without lobed spiracles; posterior spiracle with a fragmentary, usually crescentic peritreme and 2 partially joined slits; length 1.5–4.5 mm ... **1st instar**

— *T1* with a pair of lobed spiracles; posterior spiracle with a semicircular to circular peritreme and 2 or 3 discrete slits; length 3.0–23.0 mm ... 2

2 Posterior spiracle with 2 slits; length 3.0–9.0 mm ... **2nd instar**

— Posterior spiracle with 3 slits; length 8.0–23.0 mm ... **3rd instar**

Key to third-instar larvae

1 *A1–A7* each bearing several pairs of finger-like papillae (Fig. 116); some spine bands with bifurcate- or trifurcate-tipped spines dorsally ... ***Chrysomya rufifacies***

— *A1–A7* without papillae (Fig. 115); none of the spine bands with bifurcate- or trifurcate-tipped spines ... 2

2 Dorsal part of spine band *A1/A2* comprising mainly large spines which are evenly distributed in somewhat oblique rows (Fig. 127, 131, and 135)... 3

— Dorsal part of spine band *A1/A2* comprising minute spines which are unevenly distributed in broken, undulating, transverse rows (Fig. 140 and 145) ... 5

3 Dorsomedian part of spine band *A7/A8* with close-set spines arranged uniformly in about 7 oblique rows (Fig. 128) ... ***Calliphora hilli***

— Dorsomedian part of spine band *A7/A8* with widely separated spines arranged irregularly in at most 4 oblique rows (Fig. 132 and 136) ... 4

4 Oral sclerite short, notched basally, pointed apically (Fig. 130); spine bands containing very large spines (Fig. 131 and 132) ... ***Calliphora quadrimaculata***

— Oral sclerite long, conspicuously bifurcate basally, truncate apically (Fig. 134); spine bands containing moderately large spines (Fig. 135 and 136) ... ***Calliphora stygia***

5 Oral sclerite well developed (Fig. 139) ... ***Calliphora vicina***

— Oral sclerite vestigial or absent (Fig. 144) ... ***Lucilia sericata***

Descriptive notes on species

Calliphora hilli

THIRD-INSTAR LARVA. Oral sclerite (Figure 126) with apex pointed, base bifurcate. Spine bands dorsally with dense, relatively large, simple spines that are evenly spaced in somewhat oblique rows (Figures 127 and 128). Numbers of spine rows in vicinity of dorsal midline as follows: spine band between head and *T1*, about 10; *T1/T2*, *T2/T3*, *T3/A1*, 9–11; *A1/A2*, 7–9; *A2/A3*, 5–7; *A3/A4*, 2 or 3; *A4/A5*, *A5/A6*, 0; *A6/A7*, 0 or 1; *A7/A8*, 6–8. Anterior spiracle with 9–11 lobes; posterior spiracle, Figure 129.

Miller (1939b) described the third-instar larva of this species (as *C. rufipes*).

Calliphora quadrimaculata

THIRD-INSTAR LARVA. Oral sclerite (Figure 130) small, with apex pointed, base notched. Spine bands dorsally with sparse to moderately close-set, simple, mostly very large spines that are evenly spaced in somewhat oblique rows (Figures 131 and 132). Numbers of spine rows in vicinity of dorsal midline as follows: spine band between head and *T1*, 7–9; *T1/T2*, 6 or 7; *T2/T3*, 6–8; *T3/A1*, *A1/A2*, 5–7; *A2/A3*, 5 or 6; *A3/A4*, 4–6; *A4/A5*, 2–4; *A5/A6*, 0 or 1; *A6/A7*, 1–3; *A7/A8*, 3 or 4. Anterior spiracle with 11–16 lobes; posterior spiracle, Figure 133.

The morphology of the third-instar larva has been described by Miller (1939b); his habitus drawing (Figure 42) incorrectly shows the larva as having only ten post-cephalic segments.

Calliphora stygia

THIRD-INSTAR LARVA. Oral sclerite (Figure 134) with apex truncate, base bifurcate. Spine bands dorsally with sparse to moderately dense, relatively large, simple spines that are evenly spaced in somewhat oblique rows (Figures 135 and 136). Numbers of spine rows in vicinity of dorsal midline as follows: spine bands between head and *T1* and *T1/T2*, 7 or 8; *T2/T3*, *T3/A1*, 4–6; *A1/A2*, 3–5; *A2/A3*, 2–4; *A3/A4*, *A4/A5*, 0–4; *A5/A6*, *A6/A7*, 0 or 1; *A7/A8*, 0–4. Anterior spiracle with 9–14 lobes; posterior spiracle, Figures 137 and 138.

Additional information on the morphology of the third-instar larva is given by Fuller (1932), Miller (1939b; as *C. laemica*), and Zumpt (1965). O'Flynn & Moorhouse (1980) have described the egg and early-instar larvae.

Calliphora vicina

THIRD-INSTAR LARVA. Oral sclerite (Figure 139) with apex pointed, base not bifurcate. Spine bands dorsally with minute, simple spines that are arranged unevenly in undulating, broken, transverse rows (Figures 140 and 141). Numbers of spine rows in vicinity of dorsal midline as follows: spine band between head and *T1*, about 8; *T1/T2*, *T2/T3*, *T3/A1*, 7–9; *A1/A2*, *A2/A3*, 6–8; *A3/A4*, 3–6; *A4/A5*, 0–5; *A5/A6*, 0–2; *A6/A7*, 0–5; *A7/A8*, 4–8. Anterior spiracle with 8–11 lobes; posterior spiracle, Figures 142 and 143.

Further information on the morphology of third-instar larvae is given by Miller (1939b; as *C. erythrocephala*), Schumann (1954), and Zumpt (1965). The egg has been described by Zumpt (1965), and early-instar larvae are described by Schumann (1954) and Zumpt (1965).

Chrysomya rufifacies

THIRD-INSTAR LARVA. (Figure 116). Oral sclerite vestigial or absent. Segmental papillae very conspicuous. Spine bands dorsally with moderately dense, large, scale-like spines, some with bifurcate or trifurcate tips, that are evenly distributed in somewhat oblique rows. Numbers of spine rows in vicinity of dorsal midline as follows: spine band between head and *T1*, 9–11; *T1/T2*, 6–8; *T2/T3*, 5–8; spine bands indistinguishable dorsally on remainder of body. Anterior spiracle with 9–11 lobes; posterior spiracle with a broad peritreme.

Additional information on the morphology of the third-instar larva is available in Fuller (1932), and scanning electron micrographs of the egg and third-instar larva are published in Kitching (1976b). The morphology of early-instar larvae has been studied by O'Flynn & Moorhouse (1980). Zumpt (1965) considered the immature stages of *C. rufifacies* to be indistinguishable from those of *C. albiceps* (Wiedemann).

Lucilia sericata

THIRD-INSTAR LARVA. Oral sclerite (Figure 144) vestigial or absent. Spine bands dorsally with minute, simple spines that are unevenly distributed in undulating, broken, transverse rows (Figures 145 and 146). Numbers of spine rows in vicinity of dorsal midline as follows: spine band between head and *T1*, about 6; *T1/T2*, 5–7; *T2/T3*, 6–8; *T3/A1*, *A1/A2*, 6 or 7; *A2/A3*, 5 or 6; *A3/A4*, 2–4; *A4/A5*, *A5/A6*, *A6/A7*, 0; *A7/A8*, 0–3. Anterior spiracle with 7–9 lobes; posterior spiracle, Figures 147 and 148.

Detailed descriptions of larvae of all three instars have been given by Schumann (1954) and by Zumpt (1965), who includes a description of the egg.

I am grateful to D.W. Helmore, biological illustrator at Entomology Division, for preparing Figures 115 and 116.

References cited in this brief account are listed in the main bibliography, which commences on p. 59.

FLY-STRIKE IN NEW ZEALAND

Contributed by A. C. G. Heath*

Calliphorid flies are able to feed on a wide variety of animal and plant substances. The adults are strongly attracted to moisture, and feed mainly on sweet substances such as nectar and honeydew and on the liquid products of organic decomposition, which provide the proteins essential for egg maturation. The immature stages (larvae or maggots) can develop on various substrates, ranging from kitchen offal and faecal material to carrion and living animals. The ability of the larvae of certain genera of Calliphoridae to attack living animals causes a condition known as myiasis.

The term myiasis is applied to a particular mode of feeding by dipterous larvae, on or in the body of a living vertebrate. These larvae feed on the host's dead or living tissue, liquid body-substances, or ingested food, and are able to complete — or at least for a certain period continue — their normal development in this manner (Zumpt 1965).

A specific type of myiasis, commonly known as 'fly-blow' or 'fly-strike', is a perennial problem to the New Zealand farmer. Fly-strike is an extension of the carrion-feeding habit, and is initiated by only a few species; these are commonly called 'primary flies' (Colless & McAlpine 1970). Gravid females are attracted to certain areas of the sheep's body, and may be stimulated to deposit eggs or live larvae there.

Before a strike can be initiated, a number of conditions must be met. First, a female fly must be at least 3 days old and have had sufficient protein for her eggs to have reached a certain stage in development before she will mate (Webber 1958, Applin 1979, Crystal 1983). Subsequently a diet consisting of adequate carbohydrate, water, and protein is necessary before eggs can mature fully (Webber 1957). Having reached the stage of full egg maturation, the female fly is stimulated to lay eggs or deposit larvae under another circumscribed set of conditions. First, the site must be moist in order that eggs do not become desiccated (Vogt & Woodburn 1980). In fact, flies will not lay eggs unless their tarsi are in contact with water (Barton Browne 1962). It is also helpful if the chosen oviposition site receives low illumination (Barton Browne 1958). Lastly, the site the female chooses must be proteinaceous, thus offering a food supply for larvae.

History. The first official record of fly-strike as a problem in New Zealand appears in the 1896 Annual Report of the Department of Agriculture (pp. 19–20). There is some inconsistency of opinion, however, concerning when the flies causing strike first came to public notice (Hutton 1901, Gilruth 1907); the 1870s are most frequently cited in reports. In the first years of the twentieth century the flies apparently were established nationwide. A farmer with a long memory recalled that "maggot flies have been troublesome for the past 60 years" (Miller 1921). The problem was severe enough by the 1920s for a survey of its prevalence and distribution to be undertaken (Miller 1921).

Species involved. (Unless otherwise indicated, the data presented here and in subsequent sections are from unpublished observations and experiments by A. C. G. Heath and J. D. Tenquist.) Calliphorids identified from cases of fly-strike in New Zealand are the endemic species *Calliphora quadrimaculata* and *Xenocalliphora hortona* and the adventive *C. hilli*, *C. stygia* (both possibly self-introduced), *C. vicina*, *Lucilia sericata*, and *Chrysomya rufifacies* (the three last-named most likely introduced by man). The species most commonly involved in fly-strike in New Zealand are *C. stygia* and *L. sericata*. Material collected over the period 1976–1984 from 91 cases of fly-strike showed *C. stygia* to be present in 54.9% of cases and *L. sericata* in 37.4%. *Chrysomya rufifacies* was found in 5.5% of strikes and *Calliphora vicina* in 1.1%. In 16.7% of cases *C. stygia* and *L. sericata* occurred together in a single fly-strike lesion. Although the actual proportions vary, these figures substantiate the findings of earlier authors (Miller 1922, 1939a; Macfarlane 1941) that *C. stygia* is the species most commonly involved in fly-strike. By contrast, catches of flies from liver-baited fly-traps show proportions of the main strike-fly species that do not correspond with the proportions from cases of fly-strike. Over the period 1978–1981, *C. stygia* constituted 17.7% of the total catch of 146,901 flies from 17 traps (14 in the North Island, 3 in the South Island), whereas *L. sericata* and *C. rufifacies* accounted for 49.1% and 33.1% of the catch respectively.

Prevalence. A number of surveys of varying scale and complexity have investigated the extent of the fly-strike problem in New Zealand (Miller 1921, 1939a; Macfarlane 1941; Tenquist & Wright 1976). The largest and most comprehensive survey (Tenquist & Wright 1976) indicated that there was an average of 1.2% of the national flock affected by fly-strike each year, with differences by region ranging from 0.4% to 2.1%. A survey in Marlborough alone (Macfarlane 1941) arrived at a figure of 6% prevalence, although up to 50% of small flocks have been affected in other parts of the country at other times. These figures indicate the lack of uniformity

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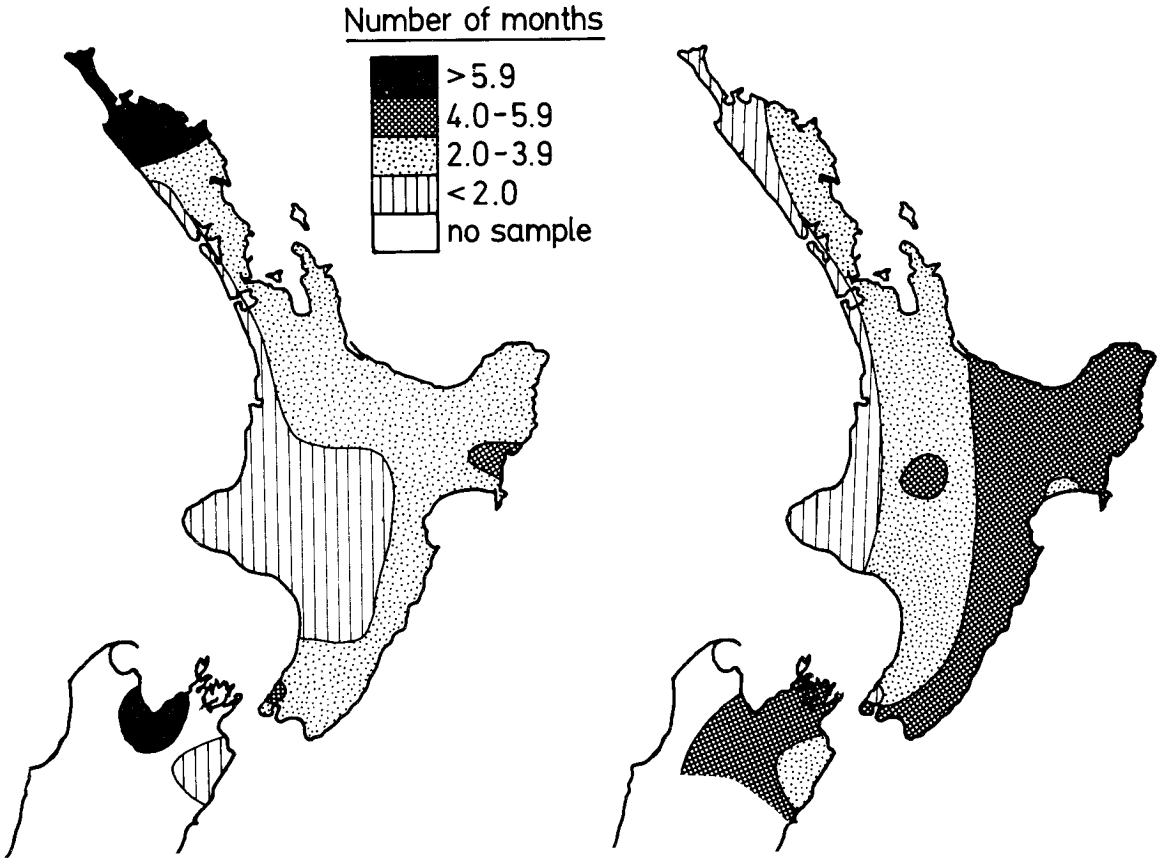

Prevalence of the primary strike-flies *Calliphora stygia* (left map) and *Lucilia sericata* (right map), based on number of months during October–March when trap catches exceeded 50 flies per month (mean of 3 seasons).

in fly-strike prevalence, and show that any 'annual average' must have an inherently large variability. This is understandable when weather patterns year by year are taken into account.

Estimates of within-flock deaths due to fly-strike are also variable, ranging up to 20% in hoggets "where no crutching is done" (Miller 1922). There is some evidence to suggest that many more sheep die of fly-strike than is actually apparent, particularly on large properties, where regular inspection of the flock is impracticable (Heath *et al.* 1983).

Seasonal patterns. There are distinct seasonal patterns both in the abundance and activity of flies as measured by trapping, and in the prevalence of fly-strike. It is difficult to interpret data from many earlier reports, in which months and seasons were used indiscriminately and inconsistently. In general, however, flies were portrayed as being active in spring and summer, with fly-strike most common in spring and autumn (Miller 1921, 1939a; Macfarlane 1941; Murray 1956).

More recent results, from a study of flies trapped over a 3-year period (1978–1981) throughout the North Island and in parts of the South Island, have shown *C. stygia* and *L. sericata* to be most abundant and active in December–February (summer). Smaller numbers were captured in September–December (spring) and February–May (late summer and autumn). In contrast, cases of fly-strike caused by both species were most prevalent in November and December. A smaller number of strikes caused by these species occurred in March and April. It must be remembered that these data refer to the 'average' over 3 years, and that there are differences between districts and between years. This is to be expected, considering that there are variations in weather patterns year by year as well as variations in climate between localities.

In general, the more recent findings are in agreement with those of earlier workers only on the point that *C. stygia* is more prevalent than *L. sericata* in

cases of fly-strike in spring. Otherwise, *L. sericata* was trapped more frequently in spring than in autumn between 1978 and 1981. Furthermore, both *C. stygia* and *L. sericata* were nearly equally represented in trap catches in autumn.

Geographical distribution. Blowflies may be found throughout New Zealand, although there is a change from north to south in the proportion of each species in trapped samples and in cases of fly-strike.

Miller (1939a) concluded that *C. stygia* was the commonest fly (as reared from cases of fly-strike) in the North Island. In the South Island *C. stygia* was likewise the commonest fly in many cases of fly-strike, except on the east coast, where *L. sericata* predominated. In general, *C. stygia* became less common as the annual mean temperature became lower, i.e., moving from north to south.

Data obtained between 1978 and 1981 from 17 fly-traps (14 in the North Island and 3 in the South Island) show a somewhat different picture (see maps, above). *C. stygia* appears to be most abundant in the north, north-east, and east of the North Island, and also in the Nelson area, but uncommon in Taranaki and the central North Island. *L. sericata* is most prevalent on the east coast of the North Island, with pockets of abundance in South Auckland and the King Country. These distributions can be related partly to temperature, but are likely to be influenced by rainfall as well. Rainfall patterns may explain the marked west-to-east change in prevalence of the flies, and particularly *L. sericata.*

Predisposition to fly-strike. When blowfly larvae are deposited or hatch from eggs laid in the damp, dark recesses of a fleece, they are faced with the need to find food. This can be present in the form of blood from a wound, or serum exuded from damp skin with scald, or the bacterial decomposition products causing fleece rot (Merritt 1980, Watts & Merritt 1981). As the larvae grow they become able to attack living host tissues by a combination of the tearing action of their mouth-hooks and the digestive properties of their saliva (Greenberg 1973).

Once an active lesion (fly-strike) is established by the primary flies, other species of flies ('supernumerary' or 'secondary') may be attracted to the site. A 'tertiary' group of flies, the larvae of which occur in healing scabs, is also recognised (Miller 1939b, Colless & McAlpine 1970). This hierarchical classification is not rigid, however; primary flies have been found as secondary invaders, and so-called tertiary flies have been known to initiate fly-strike.

The combination of factors that results in a sheep becoming attractive to flies is still not completely understood. In general, flies deposit eggs or larvae on areas of the sheep's body where persistent wetting of the wool by urine, sweat, or rain has disrupted the skin's waxy layer, allowing serum to exude or bacteria to grow. In addition, other odoriferous materials such as faeces, pus, blood, or the bacterial decomposition products of footrot will attract a female fly with an urgent need to lay eggs. Circumstantial evidence points to lambs — sheep less than 12 months old — perhaps being attractive to flies for different reasons than are older sheep. From 188 cases of fly-strike recorded between 1976 and 1984, 78.7% of the animals affected were lambs. Lambs are more frequently fly-struck around the posterior end (tail, perineum, crutch — nearly 80% of cases), whereas adult animals are about equally infested on these areas or other parts of the body, generally the back or side.

These differences may be explicable in terms of wool fibre density and length, diet or the ability to utilise food, and parasitism or other diseases. The fleece of older animals is denser and longer than that of lambs except after shearing, and will hold sufficient moisture to encourage growth of micro-organisms and hence fleece rot. Faecal staining caused by scouring is accepted as a major predisposing factor leading to fly-strike in lambs.

Pathology. There are numerous pathological effects of fly-strike. First, the host's skin is subjected to both mechanical and chemical attack by the maggots' feeding activity. The skin becomes swollen, inflamed, and weeping — much like a burn, hence the term 'scald'. The combination of fluid loss and release of toxic products into the circulatory system is reflected in a change in blood parameters, such as depressed haemoglobin levels and elevated white cell numbers (Broadmeadow *et al.* 1984). The toxins arise from bacterial invasion of wounds or toxic products from the maggots, either in their saliva or excreta. The skin damage is such that wool fibres break or can be lifted easily and cleanly from their follicles. A prolonged strike (as a consequence of numerous superimposed ovipositions) can result in larvae penetrating the superficial muscle layers and, on occasion, into the body cavity, with fatal results.

If the infestation has not been large and there is no reinfestation nor superimposed strikes, the skin will heal once the maggots leave the site. Healing takes about 25–30 days, and new wool growth becomes apparent about 10 days later. This wool is always shorter than the surrounding, untouched areas of fleece even many months after the initial damage. The skin from animals slaughtered before healing has occurred will show evidence of maggot damage when tanned.

In addition to suffering direct skin damage, the infested sheep starts to lose its appetite within the first 24 hours of a strike becoming established. No further food is eaten while the maggots are present. When they leave to pupate, normal appetite returns in about 21 days in lambs and often about 3 days in older sheep. The anorexia is accompanied by a reduction in liveweight, apparent from 3 to 5 days after the strike has started, and amounting finally to as much as 5.5 kg. The time taken to regain pre-infestation liveweight can range up to 42 days, but most affected animals tend to remain lighter than uninfested sheep.

Other likely effects of fly-strike are the exacerbation of footrot through infestation of the affected digits, and diminished mating or lambing performance due to loss of vigour.

Economics of fly-strike. The earliest estimate of economic loss attributable to fly-strike in New Zealand (Miller 1934) was equivalent to about $NZ15 million a year in present-day terms. More recently Tenquist & Wright (1976) calculated the total annual cost of fly-strike, on the basis of 1–2% of the national flock being affected, to be $5.3 million (in 1984 dollars, post devaluation). This amount was divided among stock losses ($3.6 million), labour costs ($1.0 million), and treatment costs ($0.7 million), but did not take into account the value of production losses from affected animals that survived.

The most recent estimate of the current cost of fly-strike to the New Zealand sheep industry is $13.75 million (Heath *et al.* 1983). This comprises $4.25 million in stock deaths, $2.0 million in wool losses, and $7.5 million for labour and materials associated with dipping. The last figure includes the cost of single statutory dipping for all sheep, together with an additional treatment for one-third of the national flock. This is based on the Tenquist & Wright (1976) survey, in which 35% of farmers were found to specifically treat for fly-strike in addition to the statutory dipping. In the total cost of fly-strike, no estimate has been made of associated handling costs such as crutching and additional shearing, nor has the capital cost of dipping plant and other equipment been taken into consideration. Further costs can result from delays in sending for slaughter lambs which have lost weight owing to fly-strike, since prices may fall as the season progresses.

Because of the periodic fluctuations in the prevalence of fly-strike, due largely to year-to-year weather variations, the costs will also vary year by year. Nevertheless, the disease remains today almost as severe in terms of prevalence and economic impact as it has been over the past 100 or more years, despite the availability of potent and supposedly long-persisting insecticides. The main reason for the continuing success of blowflies is that chemical control measures affect only a small proportion of the total population, there being a large non-parasitic reservoir of maggots. In addition, although today's insecticides are more potent and, in general, more persistent than those in use before the Second World War, none is capable of providing protection for sheep over the entire period of fly activity unless regularly spaced dippings are carried out. It is unlikely that many farmers would contemplate such a course of action, so there will always be unprotected sheep vulnerable to fly-strike.

I am indebted to J.D. Tenquist, who provided technical assistance during collection of data, and to A. Barkus, who prepared the text-figure.

The references cited here are listed in the main bibliography, which commences on p. 59

REARING CALLIPHORIDAE

Contributed by Pritam Singh*

Blowflies are relatively easy to rear throughout the year in the laboratory with relatively simple equipment. They have consequently been used as experimental insects in the study of behaviour, nutrition, vision, neurobiology, physiology, and toxicology. They are also used as tools in forensic entomology, particularly in establishing the time of death (Smeeton *et al.* 1984), and specially reared maggots are occasionally employed in the treatment of suppurating wounds and osteomyelitis. Blowflies are also commercially produced as a bait for anglers, for pollination of greenhouse crops, for rearing of parasites, and as food for captive birds, amphibians, and reptiles.

The life cycle of blowflies is short, and is similar in most species. A female oviposits in a medium, usually carrion, producing clusters of eggs which hatch in 24 hours. There are three larval instars, lasting in total about 8 days. Larvae feed on liquified tissues which have been dissolved partly by proteolytic bacteria and partly by enzymes they secrete themselves. When mature, the third-instar larva ceases feeding and wanders away from the food supply to a suitable pupariation site — generally dry, and under the decomposing carcass or slightly away from it — about 3 cm below the soil surface. It empties its gut, acquires fat deposits, and contracts to form a barrel-shaped puparium. Within this structure the larva moults into a pupa, from which the adult fly emerges, usually within 2 weeks. Adult females have a pre-oviposition period lasting 4–7 days, and in a total lifespan of 2–3 weeks lay 600–800 eggs, depending on the species. At 25°C on meat, the total life cycle from egg to egg takes 20–25 days. All stages are influenced by temperature, humidity, photoperiod, and the type of food available.

Choice of rearing method

This depends on the purpose for which the species selected for rearing is required, and the numbers, life stage, and supply interval needed. It is recommended that blowflies be reared in a well ventilated room, preferably fitted with an exhaust fan to discharge the foul smell outside the building. The room should be maintained at 25–28°C, 50–60% relative humidity, and a 12-hour light:dark cycle. It should be fitted with a door screen to prevent the entry of wild flies from outside.

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To start a colony, insects can be obtained from a well established laboratory, from a fish farm, or from the field. Adults can be trapped in meat-baited cages or with a net near a slaughterhouse or stockyards, on a farm, or even in a back garden. Eggs can be obtained using liver, beef, or fish-heads as oviposition substrates. Whichever bait is used, it is possible that more than one species will be caught in the trap, and therefore precise identification of the adult will be necessary.

Generally three rearing methods are employed.

REARING ON ANIMAL TISSUE. This method is easiest, and is recommended for laboratory colonisation where insects are required for research purposes. About 200 adults are sufficient to provide a continuous supply of the various life stages for experimental use. Commercial production is an extension of this method, and is done on a large scale whereby thousands are produced daily. Meat, liver, or fish is used as food; the rearing temperature is kept high for fast development and quick turnover of the life cycle. These methods are economical to operate.

REARING ON ARTIFICIAL DIET. This method is used for nutritional studies, the numbers involved usually being only a few hundred. Several diets that have been compounded are reviewed by Singh (1977). One successful diet is: casein 10.0 g; yeast extract 1.0 g; cholesterol (dissolved in 1 ml ethanol) 0.2 g; McCollum-Davis salts 0.4 g; *l*-cysteine 0.1 g; agar 3.0 g; mould inhibitor 2.0 ml; and water 150 ml.

REARING AXENIC INSECTS. This technique requires familiarity with aseptic techniques and microbiological routines that are not a usual part of entomological training. Aseptic rearing is undertaken to produce maggots required for surgical use, nutritional studies, and *in vitro* tissue or organ cultures. Rearing can be done either on defined diets of known composition or on sterilised meat, chick embryos, or piglets. The methods are complex, and are given in White (1937), Greenberg (1973), and Greenberg & George (1985).

Bionomics

Of the dozen or so species generally recognised as blowflies in New Zealand, the European greenbottle (*Lucilia sericata*) and the European bluebottle (*Calliphora vicina*) are common examples that may be reared easily, and about which a good deal is known. The bionomics of these two species reared on beef liver at 27 ± 1°C and 50 ± 2% RH with continuous light (ordinary incandescent bulbs) are tabulated below from details given by Kamal (1958).

STAGE	DURATION
	Calliphora vicina
Egg	24 (20–28) hours
1st instar	24 (18–34) hours
2nd instar	20 (16–28) hours
3rd instar	48 (30–68) hours
Prepupa	128 (70–290) hours
Pupa	11 (9–15) days
Total immature	18 (14–25) days
Emergence success	31–43%
Time to copulation	5–9 days
Time to oviposition	8–15 days
Oviposition period	6 (12–15) days
Mating activity	not stated
Adult lifespan	25 (24–35) days
	Lucilia sericata
Egg	18 (12–38) hours
1st instar	20 (12–28) hours
2nd instar	12 (9–26) hours
3rd instar	40 (24–72) hours
Prepupa	90 (48–192) hours
Pupa	7 (5–11) days
Total immature	12 (12–15) days
Emergence success	69–91%
Time to copulation	3–8 days
Time to oviposition	5–14 days
Oviposition period	20 (15–29) days
Mating activity	15 (9–19) days
Adult lifespan	46 (40–59) days

Rearing *C. vicina* in the laboratory

Because *Calliphora vicina* is the most common fly associated with animal and human corpses in New Zealand, it has been chosen here to demonstrate a typical blowfly rearing method, and to illustrate that the rate of development is influenced by temperature. The rearing is done in a well ventilated room maintained at 25±1°C, about 60% RH, and a 12-hour light:dark cycle.

MAINTENANCE OF ADULTS. Adults can be held in cages made of galvanised iron with a 30 × 15 cm rectangular base and covered with a nylon netting sleeve secured with a rubber band at one end. They are fed dry sugar crystals *ad libitum* in a petri dish, and water via a cotton wick. Bovine liver is provided for about 12 hours during the dark period, for oviposition. Some 50–60 flies are kept in each cage, and 3 or 4 cages are maintained so as to provide for a continuous supply of eggs. As the egg batches are obtained they can be transferred to larval rearing cages.

REARING OF LARVAE. The larvae can be reared on beef liver replenished as needed in ventilated clear plastic boxes (19 × 12 × 6 cm). Vermiculite or untreated sawdust 1–2 cm deep is provided for pupariation of mature larvae. The rearing containers are kept covered so that mature larvae do not escape. Puparia are collected by tipping the contents of the larval rearing box over a screen, and are transferred to adult cages for emergence.

Rearing on various foods at 15, 20, 25, and 30°C, about 60% RH, and a 12-hour photoperiod shows that rearing temperature can have a profound effect on the rate of development and the size of *C. vicina*. The best rearing temperature is 25°C so far as larval establishment, pupariation, puparial weights, adult emergence, and rate of development are concerned. At 15°C and 20°C development is much slower, and at 30°C larval establishment is poor, puparial weights are greatly reduced, and no adults emerge. At 25°C larval development (from egg hatch to pupariation) on bovine muscle and liver takes 6–9 days, puparial weights average respectively 70 and 79 mg, and adult emergence exceeds 70%. It takes 17 days for 50% of flies to emerge, and these flies lay eggs 4–5 days after emergence.

NOTE. The references cited in this supplementary contribution are listed in the main References section (page 59).

TEXT CONVENTIONS

Repositories

Abbreviations used for museums and other institutions where material is located are as follows (after Watt 1979):

ANIC	Australian National Insect Collection, CSIRO, Canberra
BMNH	British Museum (Natural History), London
CMNZ	Canterbury Museum, Christchurch, New Zealand
NZAC	New Zealand Arthropod Collection, DSIR, Auckland
HCOE	Hope Entomological Collections, University Museum, Oxford
LCNZ	Lincoln College, Canterbury, New Zealand
MNHN	Muséum National d'Histoire Naturelle, Paris
NHMW	Naturhistorisches Museum, Vienna
USNM	United States National Museum, Washington, D.C.
ZMKD	Zoologisk Museum, Copenhagen

Morphology

The abbreviations for structural features used in the keys, descriptions, and figures are those most commonly used by workers on calyptrate Diptera, and are as follows.

HEAD: *ori*, inferior orbital setae; *ors*, superior orbital setae; *vte*, external vertical setae; *vti*, internal vertical setae.

THORAX (mesonotum – Figure 1): *ac*, acrostichal setae; *dc*, dorsocentral setae; *h*, humeral setae; *ia*, intra-alar setae; *pa*, postalar setae; *ph*, posthumeral setae; *pra*, pre-alar setae; *sa*, supra-alar setae; *stpl*, sternopleural setae. The term "pleurotergite" has been used in preference to "supra-spiracular convexity", and refers to the convex pleuron immediately below the squama.

WING: *R5*, first posterior cell; *r–m*, discal cross-vein.

ABDOMEN: *St*, sternite; *T*, tergite.

Measurements of parafacial and jowlar widths used for various ratios referred to in the descriptions and keys are of the narrowest part, measured with the head in profile. Genitalia drawings have been made with the hypopygium intact and resting in a natural position on cotton wool in glycerine under a coverslip.

Material examined

Collection data for non-type specimens are summarised, for the sake of brevity. The full data, in typescript form, are held at NZAC, and may be seen on request.

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KEY TO GENERA OF CALLIPHORIDAE KNOWN FROM NEW ZEALAND

01 Stem-vein setulose dorsally (Fig. 21); head of characteristic shape (Fig. 14); squamae haired to margin. Metallic blue-green flies
... (p. 57) .. CHRYSOMYINAE (***Chrysomya***)

— Stem-vein bare dorsally; head not shaped as in Fig. 14; squamae haired or bare. Metallic or non-metallic flies
... CALLIPHORINAE .. 2

02(01) Lower squama haired above ... 3
— Lower squama bare ... 5

03(02) Subcostal sclerite setulose (Fig. 22) ... 4
— Subcostal sclerite pubescent; head shape as in Fig. 10. (p. 21) .. ***Calliphora***

04(03) Eyes densely haired; ocellar setae absent; palpi brown to black; *ors* absent; male with tergites 5 and 7 greatly enlarged; female tergite 5 with strong marginal setae and a dorsal marginal incision; head shape as in Fig. 11 ... (p. 47) .. ***Ptilonesia***
— Eyes bare or indistinctly haired; ocellar setae present; palpi yellow to orange; *ors* present; abdominal tergites normal in both sexes; head shape as in Fig. 13
... (p. 48) .. ***Xenocalliphora***

05(02) Prosternum, propleuron, and supra-squamal ridge bare; head shape as in Fig. 12 ... (p. 28) .. ***Pollenia***
— Prosternum, propleuron, and supra-squamal ridge setulose (Fig. 23) ... 6

06(05) Pleurotergite haired
... (p. 27) .. ***Hemipyrellia***
— Pleurotergite bare ... (p. 27) .. ***Lucilia***

DESCRIPTIONS

Subfamily CALLIPHORINAE

Genus *Calliphora* Robineau-Desvoidy

Calliphora Robineau-Desvoidy, 1830: 433. Type-species *Musca vomitoria* Linnaeus, 1758, by original designation.

Neocalliphora Brauer & Bergenstamm, 1891: 87. Type-species *Calliphora dasyphthalma* Macquart, 1843 (= *Musca quadrimaculata* Swederus, 1787), by original designation.

Paracalliphora Townsend, 1916: 151. Type-species *Calliphora oceaniae* Robineau-Desvoidy, 1830 (= *Musca augur* Fabricius, 1775), by original designation.

Head of male holoptic or narrowly dichoptic. Arista long plumose. Outer *ph* setae present. Suprasquamal ridge bare. Prosternum and propleuron haired. Subcostal sclerite pubescent. Stem-vein bare. Lower squama haired but bare marginally. Male genitalia of the normal calliphorid type; female ovipositor telescopic. Oviparous.

Remarks. *Calliphora* can be distinguised from all other New Zealand Calliphoridae by the bare stem-vein, haired lower squama, and pubescent subcostal sclerite.

Aspects of general morphology are illustrated in Figures 2, 8, 9, 19, and 24.

KEY TO SPECIES OF *CALLIPHORA* KNOWN FROM NEW ZEALAND

01 Abdomen brassy, with a dense, tessellate golden dusting and bright yellow hairs ventrally; pleura covered with dense yellow hairs; femora and tibiae orangy yellow ... 2

— Abdomen metallic blue-green or violet, undusted or with a thin, tessellate silvery dusting; pleura with dark hairs; femora and tibiae blackish-brown ... 3

02(01) Acrostichal setae 3 + 3; *stpl* 2(3) + 1; head of male holoptic, the eyes with large facets anteriorly; female with frons wider than an eye width; interfrontalia expanded centrally ... ***stygia***

— Acrostichal setae 2 + 3; *stpl* 1 + 1; eyes in male separated by 3× width of anterior ocellus, the facets not enlarged anteriorly; female with frons as wide as eye; interfrontalia parallel-sided ... ***hilli***

03(01) Abdomen metallic violet or blue-green and undusted; eyes densely haired; thoracic spiracles very large, orange ... ***quadrimaculata***

— Abdomen metallic blue with a tessellate silvery dusting; eyes bare; thoracic spiracles normal, the posterior one brown ... ***vicina***

—⊛—

Calliphora hilli Patton

Figures 10 and 14

Calliphora hilli Patton, 1925: 400. Lectotype male, Australia, Bamawm, Victoria (BMNH); see designation below.

Pollenia rufipes of authors, not Macquart [misidentifications].

Calliphora rufipes of authors, not Macquart [misidentifications].

Calliphora milleri Hardy, 1937: 22. Type material either lost or never designated.

Calliphora varifrons of authors, not Malloch [misidentifications].

HEAD dichoptic in female. Eyes bare, separated in male by 3× width of anterior ocellus, in female by an eye width. Ground colour black. Parafacialia and jowls orangy-yellow. Interfrontalia matt reddish-brown. Parafrontalia densely dusted brassy yellow with darker shifting spots and numerous fine, dark hairs. Parafacialia with a brassy dusting and a few dark hairs above. Jowls golden-dusted anteriorly, brassy yellow posteriorly and with fine black setulae and golden-yellow hairs. Interfacial membrane with some dark hairs basally. Occiput dusted brassy yellow, with golden hairs. Male with 10 or 11 *ori* setae and a pair of *vti*; female with 6 or 7 *ori*, 2 *ors*, and a pair each of preverticals, *vti*, and *vte*. Vibrissae strong, crossed. Facial ridge with short setulae for two-thirds of its length. Antennal segments orangy, brownish apically; arista plumose for two-thirds of its length. Palpi yellow, flattened and dilated apically. Mentum glossy brown.

THORAX. Ground colour black. Mesonotum with dense silvery-grey dusting and a shifting pattern of spots and streaks. *Ac* 2 + 3, *dc* 3 + 3, 4 *h*, 2 *ph*, *ia* 3 + 2, 2 *pra*, 2 *sa*, 2 *pa*. Pleura dusted grey and brassy yellow, and covered with golden-yellow hairs. Propleural depression haired. Mesopleuron with a complete row of setae and a few black setulae above. Pleurotergite with a pale, short pile. Spiracles yellow. *Stpl* 1 + 1. Scutellum with a pair each of apical, basal, and discal setae.

WINGS. Veins yellowish-brown. Epaulet and basicosta yellow. Subcostal sclerite with yellow pile. Squamae infuscated yellow; lower lobe with long, yellow hairs on disc, one or two black ones apically, and yellow marginal hairs; upper lobe with a dark margin and dark marginal hairs posteriorly.

LEGS. Coxae brown, with a dense grey dusting and yellow hairs. Trochanters, femora, and tibiae yellow; fore tibia with 2 or 3 weak *ad* setae and 1 *pv*; middle tibia with 2 or 3 *ad* setae, 1 *pd*, 2 *p*, and 1 *v*; hind tibia with a row of short *ad* setae, 3 *pd*, and 2 or 3 *av*. Tarsi dark brown.

ABDOMEN. Ground colour black, with metallic green and brassy reflections and a dense, tessellate golden dusting. Dorsal ground setulae black; ven-

tral surfaces with long, golden hairs. *T1+2* with orangy hairs laterally; *T3* with a row of fine marginal setulae; *T4* with a row of strong marginal setae; *T5* with a row of marginal setae and a few stronger orange and black discal setulae. Sternites dusted grey and yellow, with long, golden setulae.

GENITALIA. Male hypopygium, Figures 10 and 14.

DIMENSIONS. Length of body 7.5–10.0 mm; length of wing 6.5–8.5 mm.

Type data. Patton described *Calliphora hilli* from four male specimens, three from Bamawm and one from Seaford, both localities in Victoria. Under this name in the BMNH I have found two males with type data. One is labelled "Bamawm, Vic., W.F. Hill", "ex coll. W. S. Patton", "Pres. by Liverpool Sch. Trop. Med.", "Calliphora hilli Patton, Det. W. S. Patton", in good condition but with the abdomen mounted separately and the left hind leg missing. The second is labelled "Seaford, V. W. F. Hill", "ex. coll. W. S. Patton", "Pres by Liverpool Sch. Trop. Med", "Calliphora hilli Patton det. W. S. Patton", and is in poor condition — the abdomen and right hind and middle legs are missing. I have labelled, and here designate, the Bamawm specimen as **lectotype** and the Seaford specimen as **paralectotype**. The lectotype agrees with the most recent interpretation of this species (Kurahashi 1971; as *C. milleri*), but the paralectotype is a specimen of *Calliphora bezzii* Hardy, according to Dr K.R. Norris.

Material examined. Type specimens, plus 32 non-type examples (3 males, 29 females; ANIC, BMNH, LCNZ, NZAC).

Three Kings Is / ND (Fanal I.), TO, TK, WN / NN, KA / SI.

Collected at around sea level up to 1500 m (Mount Owen, NN) and even 2500 m (Mount Egmont summit, TK).

Taken in January, March, August, November, and December.

Habitat records: "open scrub" (Fanal I.). Collection methods noted: "swept".

Remarks. *Calliphora hilli* occurs on sheep with the more common species *C. stygia*, but appears to be of little significance as an agent of fly-strike. Zumpt (1965, p. 63) says that only a few cases of sheep myiasis have been recorded for this species. It has been reared from human corpses (Smeeton *et al.* 1984), carrion, dead crayfish, and dead moths. Diagnostic characters of the larvae are described and illustrated by Holloway (1985, p. 14; Figures 126–128).

This species is known only from Australia and New Zealand.

Calliphora quadrimaculata (Swederus)

Figures 8, 9, 19, 24, 27, 28, and frontispiece

Musca quadrimaculata Swederus, 1787: 289. Holotype female, New Zealand (Banks Collection, BMNH).

Musca sacra Fabricius, 1805: 291. Holotype female, Cape of Good Hope [error] (ZMKD).

Calliphora dasyphthalma Le Guillou, 1842: 315. Lectotype female, New Zealand, Auckland Islands (MNHN); see designation below.

Calliphora dasyphtalma Macquart, 1843: 287 [reprint 130]. Lectotype female, New Zealand, Auckland Islands (MNHN); see designation below.

Musca violacea Walker, 1853: 335. Holotype female, New Zealand (BMNH).

Calliphora cockaynei Hutton, 1904: 155. Holotype female, New Zealand, Campbell Island (CMNZ).

HEAD holoptic in male, dichoptic in female. Eyes densely haired, separated by 1.4× width of eye; anterior facets enlarged in male. Ground colour reddish-brown except on occiput, which is black. Interfrontalia matt, with long, fine, black hairs. Parafrontalia thinly grey-dusted, with a shifting silvery spot centrally, densely haired. Parafacialia densely haired in upper part, with an indistinct band dusted silvery-yellow. Jowls brownish-dusted anteriorly, grey-dusted posteriorly, with long, dark setulae. Occiput grey-dusted, with yellowish hairs. Male with 7 or 8 *ori* setae and a pair of *vti*. Female with 12–14 *ori* setae, a prevertical, *vti*, and *vte*, and 2 pairs of *ors*. Vibrissae strong, crossed with a second, slightly weaker pair. Facial ridge with short, strong setulae over its entire length. Antennal segments brown; 3rd segment orangy basally; arista plumose on basal two-thirds. Palpi yellow, flattened and dilated apically. Mentum dusted black and grey.

THORAX. Ground colour black except on scutellum, which is brownish. Mesonotum evenly grey-dusted except for a small shiny patch at humeri. Some specimens less densely dusted between setal rows *ac* and *dc*. *Ac* 2 + 3, *dc* 3 + 3, 3 *h*, 2 *ph*, *ia* 2 + 2, 1 or 2 *pra*, 2 or 3 *sa*, 2 *pa*. Pleura grey-dusted, with dark hairs. Spiracles very swollen, bright orange. Small knob above infra-alar bulla orange, with orangy hairs. Pleurotergite pubescent. *Stpl* 1 + 1. Scutellum with a pair of apical setae, 4 pairs of laterals, 2 pairs of basals, and 2 pairs of discals.

WINGS. Bases slightly infuscated. Veins brown. Basicosta and epaulet orangy-yellow. Squamae brown, with brown marginal hairs; lower lobe with brown hairs on disc.

LEGS. Coxae, trochanters, and femora blackish-brown with a thin grey dusting. Tibiae reddish-brown; fore tibia with a row of short *ad* setae and a *pv* seta; middle tibia with 3–5 *ad* setae, a row of *pd*, and 2 *v* setae in female, and 2 *ad*, 1 *pd*, 2 *p*, and 2 *v* in male; hind tibia with a row each of *ad*

and *pd* setae, including one or two stronger setae in the rows, and 2 *av* setae which are stronger in the female. Tarsi blackish-brown.

ABDOMEN. Ground colour black, with metallic violet or blue-green reflections; without dusting. All tergites punctured by numerous large setal pores; *T3* with lateral marginal setae; *T4* with numerous fine marginal setae; *T5* with a row of marginal setae and some longer discal setae. Sternites thinly grey-dusted on margins. Campbell Island and Auckland Islands material: abdomen less punctured, more greenish-blue; male parafrontalia more silvery-dusted.

GENITALIA. Male hypopygium, Figures 27 and 28.

DIMENSIONS. Length of body 9.5–15.0 mm; length of wing 8.5–13.5 mm.

Type data. *Musca quadrimaculata*: Swederus described this species from New Zealand material in the Banks Collection (BMNH), where I have found a single female under this name. It is rather dirty and dusty, the right foreleg is missing, and setae are abraded from the mesonotum. I have labelled it **holotype**, and it agrees with the most recent interpretation of this species (e.g., Harrison 1976).

Musca sacra: Fabricius described this species from an unknown number of specimens, of unstated sex, supposedly collected at the Cape of Good Hope. From ZMKD I have received for study a single female found under this name. Although the specimen jumped its pin in transit, and was loose in the box, it is still in fair condition. It is labelled by Fabricius "M. sacra e Cap. b. sp.". This specimen is undoubtedly the holotype; Fabricius must have made a mistake with the locality, as it is a specimen of *Calliphora quadrimaculata*.

Calliphora dasyphthalma: Le Guillou and Macquart described this species independently, from material collected by the *Astrolabe* and *Zelée* expedition — an unstated number of female specimens from the Auckland Islands. From MNHN I have received for study three females found under this name. One is labelled "9 Calliphora dasyphthalma nobis hi les iles Auckland", "130", and apart from being dusty is in excellent condition. Another is labelled "Type de Leguillon, Macq. 2,3,130,8" and on a small red disc "1136.41", and is in fair condition but has the distal half of the abdomen missing. I consider all three specimens to be syntypes, and here designate the specimen labelled "9 Calliphora dasyphthalma" as **lectotype** and the others as **paralectotypes**. All specimens agree with the most recent interpretation of *Calliphora quadrimaculata* (e.g., Harrison 1976).

Calliphora cockaynei: Hutton used this name when describing a single female from Campbell Island, which I have received for study from the Canterbury Museum. It is rather dirty but otherwise in good condition. It is labelled "1.844", "Calliphora cockaynei Hutton Holotype", "Camp. Is.", "Campbell Is. Dr. L. Cockayne", "Calliphora cockaynei Hutt, F.W. Hutton det.", and agrees with the most recent interpretation of *C. quadrimaculata* (e.g., Harrison 1976). The distinguishing character given by Hutton — the colour of the abdomen — is no more than a colour variation of *quadrimaculata* found on the Auckland Islands and Campbell Island.

Material examined. Type specimens, plus 222 non-type examples (73 males, 149 females; ANIC, BMNH, LCNZ, NZAC).

WO, BP, TO, TK, HB, WN / NN, BR, KA, NC, MC, SC, MK, WD, CO, DN, SL / SI / Auckland Is / Campbell I.

Collected at around sea level up to 1250 m (Dundas Hut, Tararua Range, WN).

Taken in all months.

Habitat records: several from "house" and "window"; also noted from "dung", "rotting matter", and "dead elephant seal" (Venus Cove, Campbell Island). Collection methods noted: "swept" and "malaise trap".

Remarks. *Calliphora quadrimaculata* is restricted to New Zealand, where it is very common, especially in houses during summer and autumn. Tolerance of cooler conditions by the adult fly is suggested by winter records, especially one from Tucker Cove, Campbell Island, dated 6 August 1962 (LCNZ). It will readily "blow" bedding, clothes, and meat, and will develop in various kinds of decaying matter. Holloway (1985, p. 12) found puparia and a mature larva under tussock, where they had developed in the absence of carrion. It has occasionally been recorded as causing strike in sheep, but as a secondary agent and not a primary invader. Holloway (1985, p. 14; Fig. 130–133) describes and figures the diagnostic characters of the larvae.

Calliphora stygia (Fabricius)

Figures 10, 29, and 30

Musca stygia Fabricius, 1781: 438. Holotype female, America [error] (Banks Collection, BMNH).

?*Calliphora villosa* Robineau-Desvoidy, 1830: 437. Type material Australia, Port Jackson, N.S.W. (not in MNHN).

Pollenia rufipes Macquart, 1835: 271. Lectotype female, Australia, Port Western (BMNH); see designation below.

Musca laemica White, 1843: 291. Lectotype female, New Zealand (BMNH); see designation below.

HEAD holoptic in male, dichoptic in female. Frons 1.25× as wide as eye. Eye in male with enlarged facets anteriorly. Ground colour reddish-brown. Interfrontalia matt, with numerous fine, black setulae. Parafrontalia grey-dusted above, golden brown below, with numerous black setulae. Parafacialia densely dusted golden brown, with darker shifting spots, and with black setulae in the upper part. Jowls dusted golden brown anteriorly, greyish posteriorly, with black setulae and golden hairs. Face darkened centrally. Occiput grey-dusted, with numerous yellow hairs. Interfacial membrane bare, coppery-dusted. Male with 9–11 *ori* setae and a pair of *vti*; female with 8–12 *ori* setae, a prevertical, a pair each of *vti* and *vte*, and 2 pairs of *ors*. Vibrissae strong, crossed. Facial ridge with short setulae for two-thirds of its length. Antennal segments orangy; 3rd segment browned apically; arista plumose for its entire length. Palpi yellow, flattened and dilated apically. Mentum glossy brown.

THORAX. Ground colour black. Mesonotum dusted steel-grey with indistinct, shifting, dusted streaks; ground setulae black except for a few golden-yellow hairs anteriorly. *Ac* 3 + 3, *dc* 3 + 3, 3 *h*, 2 *ph*, *ia* 2 + 1, 1 *pra*, 2 *sa*, 2 *pa*. Pleura dusted grey and brown, with long, golden-yellow hairs. Pleurotergite with yellow pile. Hypopleural setae yellow. Spiracles large, pale orangy-brown. *Stpl* 2(3) + 1. Scutellum with a pair each of apical, lateral, and discal setae and 2 pairs of basals.

WINGS. Veins yellow basally, brownish apically. Basicosta and epaulet yellow. Squamae infuscated brownish-yellow, with yellow hairs basally and dark hairs apically on disc. Marginal hairs pale yellow to golden brown.

LEGS. Coxae yellow, with a dense grey dusting and yellow setulae. Trochanters and base of femora with yellow setulae. Femora and tibiae bright orangy-yellow. Fore tibia with a well spaced row of short *ad* setae and 1 *pv* seta; middle tibia with 3 *ad* setae, 1 *pd*, 2 *p*, and 1 *v*; hind tibia with 1 or 2 stronger setae in an *ad* row, 2 or 3 *pd*, and 2 *av*.

ABDOMEN. Ground colour black, with brassy green reflections and a dense, tessellate golden dusting. Dorsal ground setulae black, laterally and ventrally golden yellow. *T1+2* with the dusting more greyish; *T3* (viewed from behind) with a distinct, undusted median vitta and some long, fine, lateral marginal setae; *T4* with a row of marginal setae; *T5* with ground setulae longer and sparser, some of them yellow, and without distinct marginals. All sternites golden-dusted and with golden hairs.

GENITALIA. Male hypopygium, Figures 29 and 30.

DIMENSIONS. Length of body 8–13 mm; length of wing 7–11 mm.

Type data. *Musca stygia*: Fabricius described this species from specimens in the Banks Collection (BMNH), where I have found a single female under this name. It has no locality label, but stands over a drawer-label referring to Fabricius's name and description. It is a specimen of a golden blowfly originating in Australia or New Zealand; the locality given by Fabricius is therefore erroneous. The specimen is in fair condition but is rather dusty, both middle legs are missing, and the mesonotum is cracked. I have labelled it as **holotype**. It agrees with the most recent interpretation of this species (e.g., Harrison 1976).

Pollenia rufipes: Macquart described this species from an unstated number of female specimens from Port Western, Australia. In the BMNH collections I have found under this name two females, one labelled "Pollenia rufipes ♀ Macq. S a B", "Brauer WIEN CVIII (No. 126)", and the other unlabelled. The labelled specimen is in poor condition after being damaged in the post. It has the abdomen, right wing, and a leg glued to a card mount; all other legs and most of the left wing are missing. The unlabelled specimen is rather dusty but otherwise in good condition, with only the right hind leg missing. I have labelled, and here designate, the unlabelled specimen as **lectotype** and the labelled specimen as **paralectotype**. Both specimens agree with the most recent interpretation of *Calliphora stygia* (e.g., Harrison 1976).

Musca laemica: White described both sexes of this species from New Zealand material collected by Dr Andrew Sinclair RN. In the BMNH collections I have found two female specimens labelled "New Zealand", "42.55", the accession number referring to material presented by Sinclair from New Zealand. I am therefore treating these two specimens as syntypes. The larger specimen is in good condition but has the forelegs, left middle tarsi, and right middle leg missing. The smaller specimen, also in good condition, has only the right and left middle tarsi missing. I have labelled, and here designate, the larger specimen as **lectotype** and the smaller specimen as **paralectotype**. The lectotype agrees with the most recent interpretation of *Calliphora stygia* (e.g., Harrison 1976), and the paralectotype is a specimen of *Calliphora hilli* Patton.

Material examined. Type specimens, plus 108 non-type examples (17 males, 91 females; ANIC, BMNH, LCNZ, NZAC).

ND, AK, CL, BP, GB, TO, TK, RI, WN / NN, MB, KA, BR, NC, MC, SC, WD, SL / SI / Chatham Is / Antipodes Is.

Collected at around sea level up to 1100 m (Chateau Tongariro, TO).

Taken in all months except June and September.

Habitat records: "house", "grass", "native [bush] reserve", "clover and ryegrass pasture", and "ex culture" (no further details). Collection methods noted: "swept", "light trap", and "pitfall trap". Has frequently been reared from human corpses (Smeeton *et al.* 1984).

Remarks. *Calliphora stygia* occurs throughout New Zealand, and is common from late spring to autumn. Economically it is a very important blowfly, as it is a primary agent of strike on livestock (see Heath 1985, pp. 15–17). As with other *Calliphora* species, *C. stygia* can produce larvae rather than eggs in very hot weather, as the eggs hatch while still in the ovipositor. Diagnostic characters of the larvae are described and illustrated by Holloway (1985, p. 14; Figures 134–138).

This species is also known from Australia, New Guinea, and the Solomon Islands.

Calliphora vicina Robineau-Desvoidy

Figures 20, 31, and 32

Calliphora vicina Robineau-Desvoidy, 1830: 435. Holotype female, U.S.A., Philadelphia (HCOE).
Musca erythrocephala Meigen, 1826: 62 [preoccupied – De Geer, 1776].
Calliphora vomitoria of authors, but not Linnaeus [misidentifications].

HEAD dichoptic in female; frons 3× as wide as anterior ocellus in male, 1.25× an eye width in female. Ground colour black except on jowls, interfacial membrane, and facial ridges, which are orangy. Interfrontalia with numerous fine, black setulae. Parafrontalia dusted silvery-grey to brassy, with numerous fine, black setulae; female with irregular, shifting patches centrally. Parafacialia dusted silvery to brassy, with numerous fine setulae. Jowls golden-dusted anteriorly, silvery-grey posteriorly. Face with a thin, grey dusting. Occiput grey-dusted, with creamy hairs centrally. Male with 10–12 *ori* setae and a pair of *vti*; female with 8 or 9 *ori*, a prevertical, a pair each of *vti* and *vte*, and 2 pairs of *ors*. Vibrissae strong, crossed, with 1 or 2 pairs of stronger setae just above them. Facial ridge with short, stout setae for two-thirds of its length. Antennal segments blackish-brown; 3rd segment orangy basally; arista plumose for two-thirds of its length. Palpi orangy-yellow, flattened and slightly dilated apically. Mentum matt brown.

THORAX. Ground colour black, with silvery-grey dusting. Mesonotum with indistinct, undusted vittae between setal rows *ac* and *dc*. Tip of scutellum brownish-red in some specimens. *Ac* 2 + 3, *dc* 3 + 3, 4 *h*, 2 *ph*, *ia* 2 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Pleurotergite with pale pile. Anterior spiracle orangy, posterior one brown. *Stpl* 2 + 1. Scutellum with a pair each of apical and discal setae and 2 pairs of lateral and basal setae.

WINGS. Veins dark brown. Epaulet brown; basicosta orange. Squamae infuscated brown; lower lobe with a broad, white margin and long hairs dorsally. Marginal hairs white on upper lobe, brown on lower lobe.

LEGS blackish brown. Femora and coxae thinly grey-dusted. Fore tibia with a row of short *ad* setae and 1 *pv*; middle tibia with 2–4 *ad* setae, 1 or 2 *pd*, 3 *p*, and 2 *v*; hind tibia with a row of *ad* setae containing 1 or 2 stronger setae, 3 *pd*, and 2 *av*.

ABDOMEN. Ground colour black, with metallic blue reflections and a dense, tessellate silvery dusting. *T1+2* and *T3* with strong lateromarginal setae; *T4* with a complete row of marginal setae; *T5* with a row of strong marginal setae and some stronger discal setae. Sternites slightly metallic, thinly grey-dusted, with black setulae.

GENITALIA. Male hypopygium, Figures 31 and 32.

DIMENSIONS. Length of body 7–12 mm; length of wing 6–11 mm.

Type data. *Calliphora vicina*: Desvoidy described this species from an unstated number of specimens collected at Philadelphia, from Dejean's collection. This collection was acquired by Bigot (Robineau-Desvoidy 1863, p. 1114), and in Bigot's exotic Diptera collection at Oxford I have found a female specimen labelled "Calliphora vicina RD" in Desvoidy's own handwriting. The specimen is in poor condition, covered in fungus and dust, but recognisable as the common European bluebottle. I have labelled it as **holotype**.

Material examined. Holotype, plus 80 non-type examples (31 males, 49 females; ANIC, BMNH, LCNZ, NZAC).

AK, CL, TO, HB, WI / NN, KA, BR, NC, MC, SC, OL, SL / Chatham Is.

Collected at around sea level up to 650+ m (Mount Robert, Nelson Lakes National Park, BR).

Taken in all months except June.

Habitat records: "*Prunus mahlaleb* flowers", "soil under [dead] blackbird" (larvae), "window", "*Euphorbia*", "*Rhododendron*", "tree lucerne", "flowering barberry (*Berberis*)", and "roadside". Collection methods noted: "swept", "light", and "baited cylinder traps". Has been reared from human corpses (Smeeton *et al.* 1984).

Remarks. *Calliphora vicina* is fairly common in New Zealand, and is one of the first blowflies to appear in spring and to disappear in autumn (Zumpt 1965). It will breed in any foul-smelling

decomposing matter, but generally carrion is preferred. It has been recorded as causing many types of myiasis, and in some regions is a secondary agent of strike. In Tasmania it is a very important primary agent of strike in sheep, but its role in New Zealand is not clear (see Heath 1985, p. 15). Diagnostic characters of the larvae are described and illustrated by Holloway (1985, p. 14; Figures 139–143).

This species is cosmopolitan in temperate and subtropical regions.

Genus *Hemipyrellia* Townsend

Hemipyrellia Townsend, 1918: 154. Type-species *Hemipyrellia curriei* Townsend, 1918 (= *Lucilia fernandica* Macquart, 1855), by original designation.

Head of male holoptic or narrowly dichoptic. Arista plumose. Outer *ph* setae present. Prosternum, propleuron, and suprasquamal ridge setulose. Stem-vein bare. Squamae bare dorsally. Subcostal sclerite setulose. Thorax and abdomen metallic green-blue. Pleurotergite haired.

Remarks. *Hemipyrellia* can be distinguished from all other New Zealand Calliphoridae by the bare stem vein and squamae, and haired propleuron and pleurotergite.

Hemipyrellia ligurriens (Wiedemann)

Musca ligurriens Wiedemann, 1830: 655.

Material examined. 1 male, Springston, MC, rotting apple, 31 Apr 1973 (LCNZ).

Remarks. The provenance of this specimen is open to doubt.

Genus *Lucilia* Robineau-Desvoidy

Lucilia Robineau-Desvoidy, 1830: 452. Type-species *Musca caesar* Linnaeus, 1758, by subsequent designation of Macquart (1843, p. 162).

Head of male holoptic or dichoptic. Arista plumose. Outer *ph* setae present. Suprasquamal ridge setulose. Prosternum and propleuron haired. Subcostal sclerite with or without setulae. Thorax and abdomen metallic blue-green. Lower squama bare dorsally. Stem-vein bare. Pleurotergite bare.

Remarks. *Lucilia* can be distinguished from all other New Zealand Calliphoridae by the bare stem-vein, metallic colouring, setulose suprasquamal ridge, and bare pleurotergite.

Aspects of general morphology are illustrated in Figures 1, 3, and 23.

KEY TO SPECIES OF *LUCILIA* OCCURRING IN NEW ZEALAND

01 Upper occiput with 6–8 setulae on each side, just below vertex; fore femora metallic blackish-blue; setulae on sternite of male as long as those on femora ... ***sericata***

— Upper occiput with a single seta on each side, just below vertex; fore femora bright metallic green-blue; setulae on sternites of male longer than those on femora ... ***cuprina***

Lucilia cuprina (Wiedemann)

Figure 33

Musca cuprina Wiedemann, 1830: 654.

See remarks under genus *Lucilia* in Introduction, p. 9.

Lucilia sericata (Meigen)

Figures 3, 23, 34, and 35

Musca sericata Meigen, 1826: 53. Syntype males, Austria, not in MNHN or NHMW and apparently lost.

Lucilia caesar of authors, but not Linnaeus [misidentifications].

HEAD dichoptic in female; frons 4× as wide as anterior ocellus in male, 1.6× as wide as an eye in female. Ground colour black. Interfrontalia covered with fine, black setulae. Parafrontalia, parafacialia, face, and jowls densely dusted silvery-grey. Parafrontalia with numerous fine, black setulae. Parafacialia and interfacial membrane bare. Jowls covered with fine, black setulae. Occiput shiny black, with weak, metallic reflections and black setulae above, grey-dusted and with pale hairs below. Male with 8 or 9 *ori* setae and a pair of *vti*; female with 6 or 7 *ori*, a prevertical, a pair each of *vti* and *vte*, and 2 pairs of *ors*. Vibrissae strong, crossed. Facial ridge with a few setae just above vibrissa. Antennal segments dark brown to black; arista long plumose to tip. Palpi orange, flattened and dilated apically. Mentum shiny black.

THORAX. Ground colour black, with blue-green metallic reflections and a very thin silvery-grey dusting. *Ac* 2 + 3, *dc* 3 + 3, 4 *n*, 2 *ph*, *ia* 3 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Propleuron grey-dusted. Pleurotergite bare. Both spiracles black. Scutellum with a

pair each of apical and discal setae and 2 pairs of lateral and basal setae.

WINGS. Veins pale brown. Epaulet black; basicosta yellow. Subcostal sclerite pubescent. Squamae white, with white marginal hairs.

LEGS black to dark brown. Femora with weak metallic reflections and a thin greyish dusting. Fore tibia with a row of short *ad* setae and 1 *pv*; middle tibia with 1 *ad*, 1 *pd*, 2 *p*, and 1 *v*; hind tibia with a row of short *ad* setae including 1 or 2 longer ones, 2 *pd*, and 2 *av*.

ABDOMEN. Ground colour black, with metallic green-blue reflections and a very thin silvery dusting which is denser in female. *T1+2* without metallic reflections anteriorly; *T3* and *T4* with a row of marginal setae; *T5* with a row of marginal setae and some stronger discal setae. Sternites black, with weak metallic reflections, black hairs which are longer in the male, and strong marginal setae in the female.

GENITALIA. Male hypopygium, Figures 34 and 35.

DIMENSIONS. Length of body 6.0–10.0 mm; length of wing 5.0–8.5 mm.

Type data. Meigen's syntype males cannot be found.

Material examined. Sixty-eight non-type examples (35 males, 33 females; ANIC, BMNH, LCNZ, NZAC).

AK, HB, WN / SD, NN, BR, KA, NC, MC, WD, CO.

Collected at around sea level up to 630 m (Lake Rotoiti, Nelson Lakes National Park, BR).

Taken in January–May, July, August, November, and December.

Habitat records: "dead stingray", "compost", "grass", "garden", "bush clearing", and "flowers". Collection methods noted: "swept". Has been reared from human corpses (Smeeton *et al.* 1984).

Remarks. Adults of *Lucilia sericata* are attracted to carrion, soiled or wet fleece, and open wounds, but will also feed on sweet and fermenting fluids, as the female requires a protein meal for the eggs to mature. Eggs are laid in nine or ten batches which total between two and three thousand eggs. The rate of development is dependent on temperature and humidity (see Zumpt 1965, p. 49). Characters of the larvae are described and illustrated by Holloway (1985, p. 14; Figures 144–148).

In the Northern Hemisphere *L. sericata* is a primary agent in sheep strike, and in New Zealand too it appears to play a major role (see Heath 1985, pp. 15–17).

This species is also known from the Palearctic and Nearctic regions, South Africa, Tristan da Cunha, St Helena, Brazil, Argentina, India, Burma, China, Japan, Australia (N.S.W., Victoria, Tasmania), Hawaii, Henderson Island, and Rapa Island.

Genus *Pollenia* Robineau-Desvoidy

Pollenia Robineau-Desvoidy, 1830: 412. Type-species *Musca rudis* Fabricius, 1794, by original designation.

Sepimentum Hutton, 1910: 66. Type-species *Sepimentum fumosum* Hutton, 1901, by subsequent designation of Townsend (1916, p. 8).

Huttonophasia Curran, 1927: 354. Type-species *Gymnophania pernix* Hutton, 1901, by original designation. **New synonymy.**

Head of male holoptic or dichoptic. Arista haired for two-thirds of its length or almost bare. Outer *ph* seta present or absent. Suprasquamal ridge, prosternum, propleuron, and stem-vein bare. Subcostal sclerite bare (rarely setulose, but not in New Zealand species). Thorax usually with long, fine ground setulae. Male genitalia of the normal calliphorid type. Ovipositor telescopic.

Remarks. The genus *Pollenia* can be distinguished from all other New Zealand Calliphoridae by the bare stem-vein, squamae, subcostal sclerite, propleuron, and prosternum.

Aspects of general morphology are illustrated in Figures 4, 11, and 15–18.

KEY TO SPECIES OF *POLLENIA* KNOWN FROM NEW ZEALAND*

MALES

01 Femora bright orangy-yellow ... 02
— Femora brownish-yellow to blackish-brown ... 13

02(01) Frons exceptionally broad, at least 1.5× as wide as ocellar triangle; middle tibia with 2–5 *ad* setae ... 03
— Frons narrow, at most 3× as wide as anterior ocellus; middle tibia with 1 or 2 *ad* setae, and sometimes a smaller one above ... 05

03(02) Frons (Fig. 17) at narrowest point 0.27× as wide as head; epistome protruding above and in front of oral margin; base of vibrissae reaching beyond frons (Fig. 18); middle tibia

*Diagnostic features of the *rudis*-group species recently recorded in New Zealand are not included in this key, but may be found in the note on p. 47.

with 2 *ad* setae; interfrontalia almost parallel-sided, not constricted centrally (Fig. 17); frons with a pair of suberect orbital setae; parafacialia 1.67× as wide as antennae; jowl height below eye 0.62× height of eye; 3 humeral setae; postsutural area of mesonotum evenly dusted on posterior two-thirds, without distinct vittae ... ***eurybregma***

— Frons (Fig. 15) at narrowest point 0.16–0.17× as wide as head; epistome protruding in front of oral margin, but base of vibrissae level with frons or only a little beyond (Fig. 16); middle tibia with 3–5 *ad* setae; frons with or without orbital setae; parafacialia less than 1.32× as wide as antennae; jowl height below eye less than half height of eye; 5 humeral setae; postsutural area of mesonotum mostly dull metallic green, with distinct dusted vittae when viewed at various angles relative to incident light ... 04

04(03) Frons with a pair of long, fine orbital setae at level of ocellar triangle, the setae curving outwards across eye; sternopleuron with some pale yellow hairs; mesonotum (viewed at an angle from behind) showing a distinct, silvery-dusted, presutural median vitta between acrostichal rows of setae; middle tibia with 3 *ad* setae; parafacialia 1.32× as wide as antenna ... ***uniseta***

— Frons without orbital setae; sternopleuron totally black-haired; mesonotum with no presutural median vitta; middle tibia with 4 or 5 *ad* setae; parafacialia 1.21× as wide as antenna ... ***consanguinea***

05(02) Larger, more robust species; length of body 8–10 mm, width 3–5 mm ... 06

— Smaller, slender species; length of body less than 6 mm, width up to 2 mm ... 09

06(05) Pleura extensively yellowish-orange; infra-alar bulla totally orangy; abdomen metallic green and coppery, with a thin, tessellate dusting that shifts about a dorsal median line; 1 *ph* seta; middle tibia without a *v* seta ... ***sandaraca***

— Pleura dark brown; infra-alar bulla mostly dark; abdomen metallic blue or green, without distinct dusting except when viewed at an extreme angle from behind; 1 or 2 *ph* setae; middle tibia with a *v* seta ... 07

07(06) Vein *R1* meeting wing margin beyond level of *r–m*; thorax matt bluish-black, with a bluish-grey dusting; pleura totally black-haired; paralobes (Fig. 42) long, thin; lunule bare ... ***atricoma***

— Vein *R1* meeting wing margin a little in front of *r–m* or level with it; thorax shiny olive, with greyish-white dusting; sternopleuron mostly haired golden yellow; paralobes (Fig. 52) shorter, broader; lunule with a few small setulae ... 08

08(07) Head holoptic; eyes separated by less than width of anterior ocellus; parafrontalia without setulae for a distance greater than length of 3rd antennal segment; parafacialia as wide as antenna; head height 0.79× head width; jowls 0.38× as high as eye ... ***astrictifrons***

— Head with the eyes separated by width of anterior ocellus; frons without setulae for a distance much less than length of 3rd antennal segment; parafacialia 1.67× as wide as antenna; head height 0.86× head width; jowls 0.56× as high as eye ... ***dyscheres***

09(05) Middle tibia with no median ventral seta, usually with 1 *ad* seta; squamae creamy yellow; usually 1 *ph* seta present ... ***aerosa***

— Middle tibia with a median ventral seta and 1 or 2 *ad* setae; squamae golden brown; usually 2 *ph* setae present ... 10

10(09) Abdomen with distinct, silvery-grey tessellate dusting; face dark, almost black; jowls dark above; parafacialia 1.5× as wide as antenna; ground setulae of *T4* and *T5* equally strong and sparse; thorax with distinct, dusted vittae; cerci much shorter than paralobes (Fig. 59, 85) ... 11

— Abdomen without distinct dusting; face orange to brownish-orange; jowls orangy-yellow; parafacialia as wide as antennae; ground setulae weaker and denser on *T4* than on *T5*; thorax with or without distinct vittae; cerci as long as paralobes or longer ... 12

11(10) Abdomen with some metallic reflections; tarsi yellow ... ***pulverea***
— Abdomen without metallic reflections; tarsi black ... ***fumosa***

12(10) Thorax densely dusted silvery-grey, not appearing very metallic, with distinct presutural vittae on mesonotum; paralobes as long as cerci (Fig. 45) ... ***commensurata***
— Thorax thinly dusted, appearing metallic, without distinct presutural vittae; paralobes much longer than cerci ... ***demissa***

13(01) Frons very broad, at least 2× as wide as antenna; vertex with *vte* setae ... 14
— Frons narrow, at most as wide as antenna, or head holoptic; vertex without *vte* setae ... 15

14(13) Cell *R5* closed with a petiole 2× as long as *r–m*; palpi and tarsi dark brown; parafacialia very narrow, much narrower than antenna; apical scutellar setae much weaker than lateral setae ... ***advena***
— Cell *R5* closed in margin; palpi and tarsi yellowish-brown; parafacialia broader than antenna; apical and lateral scutellar setae equal in length and strength ... ***lativertex***

15(13) Tibiae bright yellow, contrasting with colour of femora ... 16
— Tibiae brownish-yellow to black, not contrasting with femora ... 18

16(15) Abdomen metallic green-blue, without a distinct dusting; tarsi yellow ... 17
— Abdomen matt olive green, with dense, silvery-grey dusting; tarsi dark brown ... dark femora form of ***fumosa***

17(16) Presutural *ia* seta present; wings yellowish; arista with hairs shorter than antennal width. The Snares islands ... ***scalena***
— Presutural *ia* seta absent; wing dark brown basally; arista with hairs longer than antennal width. Mainland localities ... ***fulviantenna***

18(15) Mesonotum with 1 *ph* seta ... 19
— Mesonotum with 2 *ph* setae ... 25

19(18) Abdomen densely dusted silvery-grey; thoracic dusting almost obscuring metallic ground colour ... 20
— Abdomen bright metallic blue or green, without distinct dusting; thorax with distinct metallic reflections ... 21

20(19) Frons 3× as wide as anterior ocellus; cell *R5* open in wing margin; squamae white ... ***oreia***
— Frons as wide as anterior ocellus; cell *R5* with a short petiole; squamae brown ... dark tibia form of ***fumosa***

21(19) Palpi dark brown to black; presutural *ia* seta present ... 22
— Palpi yellowish-brown to yellow; presutural *ia* seta absent ... 23

22(21) Frons 3× as wide as anterior ocellus; vibrissae inserted at epistomal level; vein *R4+5* ending at wing tip ... ***nigripalpis***
— Head holoptic; vibrissae inserted above epistomal margin; vein *R4+5* ending well before wing tip ... ***opalina***

23(21) Aristal hairs much shorter than antennal width; ground setulae long, almost as long as thoracic setae; leg setulae long, fine; tarsi yellowish; wings hyaline ... ***limpida***
— Aristal hairs longer than antennal width; setulae on thorax and legs of normal length; tarsi brown; wings brownish ... 24

24(23) Antennal segments bright orange; middle tibia with 2 *ad* setae and a shorter third seta above ... ***nigripes***
— Antennal segments blackish-brown, only base of 3rd segment orangy; middle tibia with 1 *ad* setae ... ***dysaethria***

25(18) Palpi black or brown ... 26
— Palpi orangy or yellow ... 29

26(25) Body black, mostly shiny; jowls undusted, rugose; *stpl* 0 + 1; legs shiny black; presutural *ia* seta absent ... ***pernix***
— Abdomen metallic green or blue; thorax matt, with dusting or with metallic olive reflections; legs matt brown; jowls dusted, smooth; presutural *ia* seta present ... 27

27(26) Aristal rays much shorter than antennal width; antennal segments partially yellowish-orange; middle tibia with 1 *ad* seta ... 28

— Aristal rays much longer than antennal width; antennal segments entirely blackish-brown; middle tibia with 1 *ad* seta ... ***nigrisquama***

28(27) Head dusted brownish-grey; 2nd antennal segment entirely orangy; parafacialia almost 2× as wide as antenna; hind tibia and all tarsi yellowish-brown; abdomen coppery-green, with distinct dusting; cell *R5* with a short petiole ... ***insularis***
— Head dusted silvery-grey; 2nd antennal segment brown, 3rd mostly orangy; parafacialia slightly wider than antenna; all tibiae and tarsi dark brown; abdomen bright metallic blue-green, without distinct dusting; cell *R5* open in wing margin ... ***notialis***

29(25) Presutural *ia* seta absent ... 30
— Presutural *ia* seta present ... 31

30(29) Thorax and abdomen densely dusted silvery-grey, the metallic ground colour almost obscured; frons 3× as wide as anterior ocellus ... ***primaeva***
— Thorax and abdomen dark metallic blue, without distinct dusting; frons as wide as anterior ocellus ... ***consectata***

31(29) Very large species, 12–13 mm ... ***immanis***
— Much smaller species, less than 6.5 mm ... 32

32(31) Abdomen metallic coppery-grey; legs black; cell *R5* with a short petiole; scutellum with 1 pair of distinct discal setae ... ***antipodea***
— Abdomen dark metallic blue; legs yellowish-brown; cell *R5* closed or open at margin; scutellum with 2 pairs of distinct discal setae ... 33

33(32) Frons 3× as wide as anterior ocellus; middle tibia with 3 or 4 *ad* setae; *ori* not distinct from general setulosity of parafrontalia; jowls black, with a small orangy patch below ... ***hispida***
— Head holoptic; middle tibia with 2 *ad* setae; *ori* fine but distinct; jowls orangy on anterior half ... ***enetera***

FEMALES

(Unless otherwise stated, specimens from localities listed in parenthesis are deposited in NZAC)

01 Femora orangy-yellow ... 02
— Femora brownish-yellow to blackish-brown ... 22

02(01) Middle tibia with 4 or 5 distinct *ad* setae ... 03
— Middle tibia with 1–3 *ad* setae (when 3 present, uppermost smaller) ... 04

03(02) Epistomal region protruding in front of profrons; parafacialia at least 1.5× as wide as antenna ... **species *a*, *?eurybregma***
(Rock and Pillar Range, CO)
— Epistomal region not protruding in front of profons; parafacialia as wide as antenna ... **species *b*, *?consanguinea / uniseta***
(Old Man Range, CO; Tutoko Bench, FD)
OR with wider frons and yellow humeri ... **species *c***
(Arthurs Pass, NC–WD)

04(02) Middle tibia with 1 *ad* seta ... 05
— Middle tibia with 2 or 3 *ad* setae ... 10

05(04) Tarsal segments yellowish, like femora and tibiae ... 06
— Tarsal segments dark brown, contrasting with yellow femora and tibiae ... 09

06(05) Thorax and abdomen densely dusted silvery-grey, almost obscuring metallic ground colour; presutural *ia* seta present ... **species *d***
(Otago, CO; Southland, SL)
— Abdomen metallic blue, green, or purple, without distinct dusting; presutural *ia* seta present or absent ... 07

07(06) Presutural *ia* seta present ... **species *e***
(Lochnagar Ridge, BR)
— Presutural *ia* seta absent ... 08

08(07) Thoracic pleura mostly yellow... **species *f***
(Lake Paringa, WD)
— Thoracic pleura black or brown (Ross, WD) ... **species *g***

09(05) Frons wider than one-third of head width ... **species *h***
(Huia and Titirangi, AK; Taupo, TO; Orongorongo, WN (ANIC))
— Frons narrower than one-third of head width ... **species *i***
(Takaka Hill, NN)

10(04) Middle tibia with 3 *ad* setae ... 11
— Middle tibia with 2 *ad* setae ... 15

11(10) Tarsal segments dark brown, contrasting with yellow femora and tibiae ... 12
— Tarsal segments yellow, like femora and tibiae ... 14

12(11) Thorax and abdomen densely dusted silvery-grey, obscuring metallic ground colour ... ***fumosa*** (Dunstan Range, CO)
— Abdomen metallic green, blue, or coppery ... 13

13(12) Presutural *ia* setae absent; parafrontalia with brownish dusting ... **species *h*** (Huia, AK; Orongorongo, WN (ANIC); Karamea River, NN)
— Presutural *ia* seta present; parafrontalia with a silvery-grey dusting (Tiwai Point, SL) ... **species *j***

14(11) Abdomen metallic coppery to purple, with distinct, tessellate, silvery-grey dusting ... ***cuprea*** (Arthurs Pass, NC–WD; Lake Paringa, WD; Hollyford, FD; SI)
— Abdomen metallic blue or green, without distinct dusting; pleura dark (Takaka Hill, NN) ... **species *k*** OR pleura extensively yellowed ... ***dyscheres***

15(10) Presutural *ia* seta absent ... 16
— Presutural *ia* seta present ... 18

16(15) Tarsal segments dark brown, contrasting with yellow tibiae ... **species *h***
— Tarsal segments yellow, like tibiae ... 17

17(16) Abdomen metallic blue or green, without distinct dusting; mesonotal dusting brownish ... ***demissa***
— Abdomen coppery, with distinct, tessellate, silvery-grey dusting; mesonotal dusting silvery-grey ... ?***aerosa***

18(15) Tarsal segments dark brown, contrasting with tibiae ... ***fumosa***
— Tarsal segments yellow, like tibiae ... 19

19(18) Abdomen metallic coppery-purple, with distinct greyish dusting ... ***cuprea***
— Abdomen metallic blue or green, without distinct dusting ... 20

20(19) Slender species; pleura without yellow patches; parafrontalia with dark ground colour ... **species *l*** (Rainbow Valley, MB)
— Robust species; pleura partly yellow; parafrontalia with yellowish ground colour ... 21

21(20) Mesopleuron and sternopleuron extensively yellowish-orange ... **species *m*** (Canaan and Tophouse, NN; Blackball, BR; Pyke River, WD)
— Mesopleuron and sternopleuron blackish-grey, only humeri yellowed ... **species *n***
(Tapu, CL; Reporoa and Taupo, TO; Wallaceville, WN (ANIC); Belgrove, NN)

22(01) Body shiny metallic black, without dusting; jowls rugose; *stpl* 0 + 1; arista bare, or with short hairs on basal quarter ... ***pernix***
— Body not so coloured; jowls not rugose; *stpl* 1 + 1; arista with rays for two-thirds of its length ... 23

23(22) Apical scutellar setae very weak, much shorter than lateral setae; posterior thoracic spiracle without a lappet; cell *R5* petiolate, the petiole 2× as long as *r–m* ... ***advena***
— Apical scutellar setae as long as lateral setae; posterior thoracic spiracle with a lappet; cell *R5* open, closed, or with a petiole shorter than *r–m* ... 24

24(23) Tibiae bright yellow, contrasting with brown femora ... ***scalena***
— Tibiae brown or black, like femora ... 25

25(24) Palpi yellowish-orange ... 26
— Palpi blackish-brown ... 27

26(25) Face dark; abdomen distinctly dusted; squamae white ... **species *o*** (Piano Flat, CO)
— Face orangy; abdomen without distinct dusting; squamae creamy yellow ... ***nigripalpis***

27(25) Vibrissae inserted at epistomal level ... **species *p*** (Cobb Lake and Tophouse, NN)
— Vibrissae inserted a little above epistomal margin ... 28

28(27) Epistome protruding in front of profrons ... ***nigrisquama***
— Epistome level with frons ... **species *q*** (Dun Mountain, NN)

Pollenia advena new species

Figures 36 and 37

HEAD. Frons in male 3× as wide as antenna, in female slightly wider. Ground colour blackish-brown. All parts with a thin, greyish-brown dusting. Parafrontalia narrow, with a few scattered black setulae. Parafacialia with a distinct row of small,

black setulae. Frons with 6 or 7 *ori* setae and 3 *ors*, the anterior pair proclinate, the others outcurving. Vertex with a pair each of *vti* and *vte* setae. Vibrissae strong, crossed, inserted at epistomal margin. Facial ridges with 1 or 2 small setulae just above vibrissae. Antennal segments brown; 3rd segment orangy basally in male; 2nd segment yellow in female; aristal rays longer than antennal width. Parafacialia half as wide as antenna. Jowl height 0.28× eye height. Palpi brown, clubbed.

THORAX. Ground colour blackish-brown. Mesonotum with olive-green metallic reflections and an even, greyish-brown dusting which is less dense in female. *Ac* 2 + 3, *dc* 2 + 3, 3 *h*, 1 *ph*, *ia* 2 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Pleural hairing dark. Posterior spiracle open, without a lappet. *Stpl* 1 + 1. Scutellum with a weak pair of crossed, apical setae, a very long pair of laterals, a normal pair of basals, and a pair of weak discals.

WINGS yellowed, lightly infuscated apically. Epaulet brown; basicosta brownish-yellow. Cell *R5* closed and with a petiole twice as long as *r–m*. Vein *R1* ending just in front of level of *r–m*. Squamae pale yellow.

LEGS dark brown. Fore tibia with a row of short *ad* setae and 2 *p* setae; middle tibia with 1 *ad* seta, 2 *pd*, 2 *p*, and 1 *v*; hind tibia with 3 or 4 *ad* setae, 3 or 4 *pd*, and 1 or 2 *av*.

ABDOMEN. Ground colour dark brown, with metallic green reflections. *T3* with some lateromarginal setae; *T4* with a complete row of marginal setae; *T5* with a row of finer marginal setae and some stronger discals.

GENITALIA. Male hypopygium, Figures 36 and 37.

DIMENSIONS. Body length 3.0–4.0 mm; wing length 3.0–4.0 mm.

Type data. Holotype: male, Three Kings Islands, Great Island, Castaway Camp, November 1970, at light, J. McBurney (NZAC). **Paratypes** (8 males, 11 females; BMNH, NZAC): 3 males, 5 females, same data as holotype; 1 male, 1 female, same data but collected by G. Kuschel; 2 males, 1 female, same data but on *Leptospermum ericoides* and *Coprosma* sp.; 1 female, AK, Auckland, Mt Eden, on window, 7 April 1946, R. Harrison; 1 female, same data but in garden, 4 December 1948; 1 female, same data but 30 December 1949; 1 male, TO, Taupo, at light, 10 April 1931; 1 male, 1 female, SD, Stephens Island, January 1971, J. McBurney.

Remarks. This small, dark species is a rather unusual *Pollenia*, with some tachinid-like features. Examination of the male hypopygium, however, shows it to be a calliphorid with a slightly modified aedeagus of the basic *Pollenia* form (Figure 36); the paraphallus is much more sharply curving than in any other *Pollenia* known to me. Unlike all other New Zealand *Pollenia* species, *advena* has no lappet to the posterior thoracic spiracle (a feature shared with the Rhinophoridae), weak, crossed apical scutellar setae, very long lateral scutellar setae, and a very long petiole to cell *R5*.

Pollenia aerosa new species

Figures 38 and 39

MALE. Basic description as for *P. sandaraca* (p. 45), but differing in the following characters.

HEAD. Frons as wide as anterior ocellus. Interfrontalia with some fine hairs above. Parafrontalia narrower than antenna. Aristal hairs two-thirds as wide as antenna. Jowl height 0.50× eye height.

THORAX. Ground colour mostly dark; humeri and margins of pleura with orangy ground colour. Mesonotum with a broad median vitta and a pair of broad lateral vittae dusted silvery-grey presuturally. 1 or 2 *ph* setae. Mesopleuron and sternopleuron mostly dark-haired.

WINGS. Vein *R1* ending a little beyond *r–m*. Squamae creamy.

LEGS. Middle tibia with 1 or 2 *ad* setae.

ABDOMEN metallic bronzy, with a weak, brownish dusting which is denser ventrally and on anterior margin of *T3* and *T4*.

GENITALIA, Figures 38 and 39. Aedeagus indistinguishable from that of *sandaraca* (see Figure 86).

DIMENSIONS. Body length 6.0 mm; wing length 5.0 mm.

Type data. Holotype: male, WD, Lake Paringa, 6–10 December 1960, J.I. Townsend & P.R. Kettle (NZAC). **Paratypes**: 5 males, same data as holotype (BMNH, NZAC).

Remarks. *Pollenia aerosa* and *P. sandaraca* are closely related; each lacks the ventral seta of the middle tibia and has partially yellowed thoracic ground colouring, and the genitalia are similar. The structure of the cerci and paralobes (Figures 39 and 87), however, shows that undoubtedly two species are present. This view is supported by their differing general appearance and the possible isolation of *sandaraca* on Stewart Island.

In the NZAC material I have found seven female specimens with the same label data as the holotype of *aerosa*. These are all basically similar, but may represent three species. Two specimens have a metallic green abdomen and dark tarsi, and so are not *aerosa*; the remainder can be divided into two possible species using ratios of frons width to head width. It is difficult to assign any of these females

to *aerosa*, and I have therefore not done so. Unlike the males, all these females have the ventral seta of the middle tibia present.

Pollenia antipodea new species

Figures 40 and 41

MALE. HEAD. Frons as wide as anterior ocellus. Ground colour black; interfacial membrane orangy. All parts densely grey-dusted. Parafrontalia, parafacialia, and jowls with black setulae. Frons with 7 *ori* setae. Vibrissae inserted slightly above epistomal margin. Facial ridges with setulae on lower half. Antennal segments orangy, but brownish anteriorly. Aristal rays longer than antennal width. Jowl height 0.42× eye height. Palpi yellow.

THORAX. Ground colour black, with olive-green reflections and even, silvery-grey dusting. *Ac* 2 + 3, *dc* 2 + 3, 4 *h*, 2 *ph*, *ia* 2 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Pleural hairs black. Scutellum with a pair each of apical, lateral, and basal setae and a much weaker pair of discals.

WINGS yellowish; epaulet brown; basicosta yellowish-brown. Cell *R5* closed, with a short petiole. *R1* ending a little in front of level of *r–m*. Squamae pale brown.

LEGS black. Fore tibia with a row of *ad* setae and 2 *p* setae; middle tibia with 2 *ad* setae, 2 *p*, 2 *pd*, and 1 *v*; hind tibia with 4 *av* setae.

ABDOMEN. Ground colour black, with metallic green and coppery reflections. *T4* with a row of marginal setae; *T5* with a row of marginal setae and some longer discal ones.

GENITALIA. Male hypopygium, Figures 40 and 41.

DIMENSIONS. Body length 5.0 mm; wing length 4.0 mm.

Type data. Holotype: male, SL, Tiwai Point, sweeping, 26 January 1976, L.L. Deitz (NZAC).

Pollenia astrictifrons new species

MALE. Basic description as for *P. sandaraca* (p. 45), but differing in the following characters.

HEAD. Frons narrower than anterior ocellus. Occiput and posterior jowls entirely dark. Parafrontalia with 10 *ori* setae. Vertex without distinct *vti*. Bare area of parafrontalia longer than antenna. All parts dusted pale brown. Facial ridge with weak setulae for half its length. Third antennal segment not darkened anteriorly; arista with rays as wide as antenna. Parafacialia as wide as antenna. Jowl height 0.38× eye height.

THORAX. Ground colour dark olive, with a thin, pale grey dusting. Mesonotum with 5 or 6 *h* setae and 2 *ph*. Sternopleural and pteropleural hairing golden yellow.

WINGS. Cell *R5* closed in margin with a short petiole. *R1* ending in margin level with *r–m*.

LEGS. Middle tibia with 2 *ad* setae, 1 or 2 *pd*, 3 *p*, and 1 *v*; hind tibia with a row of *ad* setae including 4 or 5 stronger ones, 3 or 4 *pd*, and 3 *av*.

ABDOMEN metallic green-blue to purple. Ground setulae very dense. *T1+2* thinly dusted ventrally; *T3* with a row of weak marginal setulae; *T5* with long marginal and discal setulae.

GENITALIA indistinguishable from those of *P. dyscheres* (see Figures 52 and 53).

DIMENSIONS. Body length 9.0 mm; wing length 8.5 mm.

Type data. Holotype: male, NN, Mount Murchison, 4500–4800 ft [1350–1440 m], 29 February 1972, J.S. Dugdale (NZAC). **Paratype** male, WD, Bruce Bay, 10 December 1960 (NZAC).

Remarks. Two additional male specimens which are rather teneral and distorted may belong to this species. They both have the correct head shape, as far as can be seen, and the genitalia match those of *astrictifrons*. However, one, from Dun Mountain (NN), has only 1 *ph* seta and 1 *ad* on the middle tibia and rather bluish thoracic dusting; and the second (Mount Arthur, NN) has very dark jowls. I am reluctant to assign these two specimens to *astrictifrons* as they may represent closely related species. Until more material of this group of species becomes available the problem cannot be properly resolved.

Pollenia atricoma new species

Figures 42 and 43

MALE. Basic description as for *P. sandaraca* (p. 45), but differing in the following characters.

HEAD. Frons narrower than anterior ocellus. Occiput and posterior jowls entirely dark. Vertex without distinct *vti* setae. Facial ridges setulose for more than half their length. Arista with rays as wide as antenna. Parafacialia 1.25× as wide as antenna. Jowl height 0.45× eye height.

THORAX. Ground colour bluish-black, with even, bluish-grey dusting. Two *ph* setae and 3 *sa*. Pleura with black hairs.

WINGS. Epaulet reddish-brown. Cell *R5* closed in margin with a short petiole. *R1* ending beyond level of *r–m*.

LEGS. Middle tibia with 1 *pd* seta, 3 *p*, and 1 *v* with a smaller one above; hind tibia with setal rows

ad and *ph*, and 4 or 5 *av* setae.

ABDOMEN metallic coppery-green with a thin, whitish dusting on *T4* and *T5*; when viewed at an angle from behind, an undusted dorsomedian vitta may be seen. *T1+2* and *T3* grey-dusted ventrally; *T3* with long lateromarginal setulae; *T4* with a row of marginal setae; *T5* with a row of marginal setae and a few discal setae. Sternites grey-dusted, with dark hairs; *st1* with some yellow.

GENITALIA. Aedeagus indistinguishable from that of *sandaraca* (see Figures 42 and 86).

DIMENSIONS. Body length 8.5 mm; wing length 8.0 mm.

Type data. Holotype: male, BR, Lewis Pass, 3500 ft [1050 mm], 8–12 December 1957, M.J. Esson (NZAC). **Paratype** male, WN, Days Bay, April 1921 (Miller Collection, ANIC; legs missing).

Pollenia commensurata new species

Figures 44 and 45

MALE. Basic description as for *P. demissa* (p. 36), but differing in the following characters.

HEAD. Parafacial dusting denser.

THORAX. Mesonotum distinctly dusted, with a presutural median vitta and a pair of lateral vittae.

GENITALIA. Paralobes and cerci, Figures 44 and 45. Aedeagus indistinguishable from that of *P. sandaraca* (see Figure 86).

DIMENSIONS. Body length 6.0 mm; wing length 6.0 mm.

Type data. Holotype: male, MC, Mount Somers, 18–19 January 1958, E.S. Gourlay (NZAC).

Pollenia consanguinea new species

Figures 15, 16, 46, and 47

Very similar to *P. uniseta* (p. 46), and in general appearance to *P. eurybregma* (p. 38), but differing from both in the following characters.

HEAD. Frons 0.16× as wide as head, without *ors* setae. Parafacialia 1.21× as wide as antenna. Jowl height 0.47× eye height. Epistome protruding a little beyond frons.

THORAX. Mesonotum without a distinct presutural vitta; postsutural area with distinct, dusted vittae. Five humeral setae. Sternopleuron entirely dark-haired. Scutellar discal setae weaker than lateral seta.

LEGS. Middle tibia with 4 or 5 *ad* setae; hind tibia with 4 *ad*.

ABDOMEN. *T4* dusted ventrally.

GENITALIA. Male hypopygium, Figures 46 and 47.

DIMENSIONS. Body length 6.5 mm; wing length 6.0 mm.

Type data. Holotype: male, CO, Old Man Range, Hyde Rock, 1550–1650 m, 22 February 1974, J.S. Dugdale (NZAC).

Remarks. *Pollenia consanguinea*, *P. eurybregma*, and *P. uniseta*, all from the Old Man Range (CO), represent a dinstinct high-altitude species-group, having entirely orangy-yellow legs, the middle tibia with numerous *ad* setae, a prominent epistomal region (Figures 16 and 18), and a very broad frons (Figures 15 and 17). Unfortunately the group is represented in the material available to me by only three male specimens, each of which appears to be a distinct species. These species can be distinguished from each other using the key characters. *P. eurybregma* is quite distinct on external morphological features from the other two, but *uniseta* and *consanguinea* are separated on less convincing characters. I have dissected each male, and find the genitalia to be practically identical. Some ratios of parts do vary between the species, and the sclerotisation in *uniseta* is more extensive, but these differences are not obvious enough to be appreciated in illustrations. I have therefore figured the hypopygium of only one species as an example of the group.

Also in the NZAC material I have found eleven female specimens which almost certainly belong to this group. A series of five from the Rock and Pillar Range have a very protruding frons and epistome, and are possibly conspecific with *P. eurybregma*. They differ from the male of *eurybregma* in having stronger general setulosity, cell *R5* with a short petiole, and four or five *ad* setae on the middle tibia. A single specimen from Hyde Rock and a series of four from the Darran Mountains (FD) are possibly conspecific with *uniseta* or *consanguinea*; they differ from the males in having stronger general setulosity and the dorsum of the abdomen with a tessellate, greyish-white dusting. Finally, a single female from Arthurs Pass (NC–WD) with four *ad* setae on the middle tibia closely resembles the Darran Mountains series but has yellow humeri, denser abdominal dusting, and different frons and parafacialia widths.

Pollenia consectata new species

Figures 48 and 49

MALE. HEAD. Frons as wide as anterior ocellus. Ground colour dark brown; interfacial membrane orangy. All parts brownish dusted.

Parafrontalia, parafacialia, and jowls with black setulae. Frons with 7 *ori* setae; vertex with a pair of weak *vti*. Vibrissae inserted slightly above epistomal margin. Facial ridges with a few setulae just above vibrissae. Antennal segments orangy-brown; aristal rays longer than antennal width. Parafacialia slightly narrower than antenna. Jowl height 0.43× eye height. Palpi yellow.

THORAX. Ground colour black, with weak, metallic blue reflections and even, grey dusting. *Ac* 2 + 3, *dc* 2 + 3, 4 *h*, 2 *ph*, *ia* 1 + 2, 1 *pra*, 1 *sa*, 2 *pa*. Pleural hairs black. Scutellum with a pair each of apical, lateral, and basal setae and a weaker discal pair.

WINGS brownish; epaulet and basicosta pale brown. Cell *R5* closed in margin. *R1* ending a little beyond level of *r–m*. Squamae brown.

LEGS brown. Fore tibia with a row of *ad* setae and 2 *p* setae; middle tibia with 1 *ad* seta, 2 *p*, 2 *pd*, and 1 *v*. Hind tibia with a row of *ad* setae, 3 or 4 *pd*, and 1 *av*.

ABDOMEN. Ground colour black, with metallic blue reflections but without distinct dusting. *T4* and *T5* with a row of marginal setulae; *T5* also with a few stronger discals.

GENITALIA. Male hypopygium, Figures 48 and 49.

DIMENSIONS. Body length 3.5 mm; wing length 3.0 mm.

Type data. Holotype: male, AK, Huia, in house, 26 May 1967, B.M. May (NZAC).

Pollenia demissa (Hutton)

Sepimentum demissum Hutton, 1901: 67. **Holotype** female, New Zealand, Wellington (CMNZ) [examined].

Pollenia demissa var. *minor* Malloch, 1930: 32. **Holotype** female, New Zealand, Wanganui (CMNZ) [examined]. **New synonymy.**

HEAD. Frons narrower than anterior ocellus in male, in female one-third as wide as head. Ground colour orangy-yellow, except on upper part of occiput in male and on parafrontalia and parafacialia in female, which are brown. All parts thinly grey-dusted, but more yellowish in female. Parafrontalia, parafacialia, and jowls covered with long, black setulae. Male with 9 or 10 *ori* setae and a pair of *vti*; female with 10 or 11 *ori*, a pair of preverticals, 2 pairs of *ors*, and a pair each of *vti* and *vte*. Vibrissae strong, crossed, in male slightly above oral margin. Facial ridges with a few small setulae just above vibrissae. Antennal segments orangy; 3rd segment with distal two-thirds darkened; aristal rays almost as long as antennal width. Parafacialia as wide as antenna. Jowl height 0.44–0.45× eye height. Palpi yellow, almost parallel-sided, upcurving apically.

THORAX. Ground colour dark brown, with metallic bluish-green reflections and very thin, whitish dusting obvious only when viewed at extreme angles. Humeri in female yellowed. *Ac* 2 + 3, *dc* 2 + 3, 5 *h*, 2 *ph*, *ia* 2 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Sternopleural hairs usually totally dark; *stpl* 1 + 1. Female with denser, more brownish mesonotal dusting, only 1 *ph*, and sternopleural hairs mostly yellow. Scutellum with a pair each of apical, marginal, and basal setae and 2 pairs of weaker discals.

WINGS yellowed. Epaulet brownish-yellow; basicosta yellow. Cell *R5* closed in margin. *R1* ending a little beyond level of *r–m*. Squamae brownish.

LEGS orangy-yellow. Fore tibia with a row of short *ad* setae and 2 *p* setae; middle tibia with 2 *ad* setae, 1 *pd*, 2 *p*, and 1 *v*; hind tibia with a row of *ad* setae including 3 or 4 stronger ones, 3 or 4 *pd*, and 2 or 3 *av*.

ABDOMEN. Ground colour black, with metallic blue-green reflections and, in female, whitish-grey dusting. *T3* with weak lateromarginal setulae; *T4* with a row of marginal setulae; *T5* with a row of marginal setulae and a few stronger discal ones.

GENITALIA. Male hypopygium indistinguishable from that of *P. pulverea* (see Figures 84 and 85).

DIMENSIONS. Body length 4.5–6.0 mm; wing length 4.5–5.5 mm.

Type data. *Sepimentum demissum*: Hutton described this species from a single specimen, which I have received for study from the Canterbury Museum. It is labelled "Type", "Wellington, Hudson", "Sepimentum demissum Hutt. F.W. Hutton det.", "T.841", and "Sepimentum demissum Hutton, Holotype", and is in poor condition, with the abdomen missing, most of the legs damaged, and much of the thoracic setulosity abraded.

Pollenia demissa var. *minor*: Malloch described this taxon from three female specimens, and from the Canterbury Museum I have received for study a single female labelled by Malloch as "type". It is in good condition, and although it has the presutural *ia* seta absent it is apparently conspecific with *demissa*. Two paratype females from USNM are also conspecific.

Material examined. Type specimens, plus 45 non-type examples: 2 males, 42 females, BR, Lake Rotoiti, 29 Oct 1964; 1 male, SL, Bluff, Greenhills, 17 Jan 1959 (BMNH, NZAC).

Remarks. Malloch (1930, p. 322) described two new varieties of *P. demissa*, namely *minor* and

cuprea. He separated them using the length of the palpi and the presence or absence of the posterior sublateral setae (presutural *ia*). I cannot see any difference in the palpi, and the presutural *ia* is such an unstable seta in this group that it is of little use — indeed, the holotype of *demissa* has a strong one on one side and a very weak one on the other. I find the type specimens of *P. d. minor* to be conspecific with *demissa* and those of *P. d. cuprea* to belong to a distinct species (see "New Zealand *Pollenia* of uncertain identity", p. 46).

Pollenia dysaethria new species

Figures 50 and 51

MALE. Basic description as for *P. nigripes* (p. 42), but differing in the following characters.

HEAD holoptic. Jowls orangy anteriorly. Aristal rays longer than antennal width. Jowl height 0.43× eye height. Antennal segments brown, orangy only at base of 3rd segment.

THORAX. Mesonotum with thin, greyish dusting.

WINGS. Vein *R1* ending level with *r-m*.

LEGS. Middle tibia with 1 *ad* seta (other legs damaged in both specimens).

GENITALIA, Figures 50 and 51.

Type data. Holotype: male, AK, Titirangi, ex light trap, 19 December 1952, C.R. Thomas (NZAC). **Paratypes**: 1 male, TO, Taupo, Waikato River, 31 December 1932 (NZAC).

Pollenia dyscheres new species

Figures 4, 11, 52, and 53

MALE. Basic description as for *P. sandaraca* (p. 45), but differing in the following characters.

HEAD. Frons as wide as anterior ocellus. Occiput and posterior part of jowls darkened. Parafrontalia with 12–16 *ori* setae, and with bare area shorter than antenna. Vertex without distinct *vti*. All parts brownish-dusted. Facial ridge with setulae on half its length. Third antennal segment not darkened anteriorly; arista with rays as long as antennal width. Parafacialia 1.67× as wide as antenna. Jowl height 0.56× eye height.

THORAX. Ground colour dark olive with a pale, thin, grey dusting. Mesonotum with 5 or 6 *h* setae and 2 *ph* (sometimes 1). Sternopleuron and pteropleuron with golden hairs.

WINGS. Cell *R5* closed in margin with a very short petiole. *R1* meeting margin level with *r-m*.

LEGS. Middle tibia with 2 *ad* setae, 1 or 2 *pd*, 2–4 *p*, and 1 *v*; hind tibia with a row of *ad* setae including 4 or 5 longer ones, 3 or 4 *pd*, and 2 *av* (rarely 3).

ABDOMEN metallic blue-green, without distinct dusting except ventrally on *T1+2* and *T3*; *T3* with a row of weak marginal setulae; *T4* with a row of marginal setae and a few stronger lateral discals; *T5* with discal and marginal setae.

GENITALIA. Male hypopygium, Figures 52 and 53.

FEMALE. Associated females differ from males in the following characters.

HEAD. Frons 0.30× as wide as head. Ground colour orangy-yellow, except for lateral patches on upper occiput, which are dark brown. All parts dusted pale brownish-yellow. Parafrontalia with 12–14 *ori* setae, a pair of outcurving *ors*, and 2 pairs of reclinate *ors*. Vertex with a pair each of *vti* and *vte* setae. Parafacialia 2× as wide as antenna.

THORAX. Ground colour orangy-yellow; mesonotum, lower pteropleuron, and hypopleuron dark. Mesonotum densely dusted brownish-grey, with distinct vittae presuturally and irregular tessellate patterns postsuturally. Humeri and notopleura orangy. Pleural hairs mostly golden. Always only 1 *ph* seta.

ABDOMEN metallic green with a thin but distinct, whitish, tessellate dusting on all tergites which shifts about a median dorsal line.

DIMENSIONS. Body length 8.5–9.0 mm; wing length 7.5–9.0 mm.

Type data. Holotype: male, NN, Mount Owen, 5000 ft [1500 m], 23–26 February 1960, J.I. Townsend & W.P. Thomas (NZAC). **Paratypes** (16 males, 14 females; BMNH, NZAC): 1 male, TO, Mt Ruapehu, 11 March 1957, R.A. Cumber; 1 male, NN, Dun Mountain, 11 March 1928, E.S. Gourlay; 14 males, 14 females, NN, same data as holotype.

Remarks. *Pollenia astrictifrons*, *P. atricoma*, *P. dyscheres*, and *P. sandaraca* constitute a high-altitude species-group. They are distinctively robust, large, and hairy, with legs entirely yellowish-orange. However, *sandaraca* may not be related to the other three, as it is closer on genital characters to *P. aerosa*, under which it is discussed. The remaining three species were difficult to key satisfactorily, but this has been achieved using head ratios and colour characters. Their chaetotaxy is rather unstable, so has not been used in the key. They can be divided on genital characters into two groups, those with long, thin paralobes and those with short, broad ones. The three nominal species keyed and described may not reflect the true situation: there may be two variable species or, more probably, many sibling species present. These possibilities can

be properly investigated only when much more material becomes available.

Pollenia enetera new species

Figures 54 and 55

MALE. HEAD holoptic. Ground colour black; interfacial membrane and anterior part of jowls orangy. All parts with brownish dusting and fine, black setulae. Parafacial dusting slightly greyish. Frons with 8 *ori* setae. Facial ridges with setulae on lower half. Vibrissae inserted at epistomal margin. Antennal segments orangy-brown; 3rd segment with distal two-thirds darker; aristal rays as long as antennal width. Parafacialia slightly wider than antenna. Jowl height 0.38× eye height. Palpi yellow.

THORAX. Ground colour black, with metallic blue reflections and very thin, greyish dusting. *Ac* 2 + 3, *dc* 2 + 3, 5 *h*, 2 *ph*, *ia* 2 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Pleural hairs black. Scutellum with a pair each of apical, lateral, and basal setae and 2 pairs of discals.

WINGS brownish; epaulet brown; basicosta yellow. Cell *R5* open in margin. *R1* ending level with *r–m*. Squamae dark brown.

LEGS orangy-brown. Fore tibia with a row of *ad* setae and 2 *p* setae; middle tibia with 2 *ad* setae, 2 *p*, 2 *pd*, and 1 *v*; hind tibia with 3 *av* setae.

ABDOMEN. Ground colour black, with dark metallic blue reflections and thin, even, brownish-grey dusting. *T3* with stronger marginal and discal setulae laterally; *T4* with a row of marginal setulae and a few stronger discal ones; *T5* with a row of marginal setulae and numerous stronger discals.

GENITALIA. Male hypopygium, Figures 54 and 55.

DIMENSIONS. Body length 5.0 mm; wing length 4.5 mm.

Type data. Holotype: male, FD, Fiordland National Park, Milford, sweeping, 3 February 1976, L. Deitz (NZAC).

Pollenia eurybregma new species

Figures 17 and 18

MALE. HEAD. Frons 0.27× as wide as head. Ground colour orangy-yellow except on occiput, parafrontalia, and parafacialia, which are dark grey. All parts thinly dusted greyish-white. Interfrontalia matt, with some fine, black hairs marginally. Frons with 5 or 6 *ori* setae and a pair each of *ors*, *vti*, and *vte*. Parafrontalia, parafacialia, jowls, and occiput with fine, black setulae. Lower part of jowls with some pale hairs. Parafacialia 1.67× as wide as antenna. Jowl height 0.62× eye height. Vibrissae strong, crossed. Oral margin with a few stronger setae. Epistome protruding above and in front of oral margin and beyond profrons. Arista with short hairs, the longest only 3× basal diameter of arista. Palpi yellow, slightly clubbed.

THORAX. Ground colour dark grey, with slight metallic olive reflections and a greyish-brown dusting. Mesonotum with a pair of presutural, lateral, dusted vittae and a broad, dusted patch on two-thirds of the postsutural area. *Ac* 2 + 3, *dc* 2 + 3, 3 *h*, 1 *ph*, *ia* 2 + 2, 1 *pra*, 1 *sa*, 2 *pa*. Pleura dusted greyish-white, with long, black setulae. *Stpl* 1 + 1. Scutellum with a pair each of apical, lateral, basal, and (weak) discal setae. Hairs below scutellum black.

WINGS yellowed. Epaulet brown; basicosta yellowish-orange. Cell *R5* closed in margin. Squamae creamy, with yellow marginal hairs.

LEGS orangy-yellow except for distalmost 3 or 4 segments of each tarsus, which are brownish. Coxae with a thin, white dusting. Fore tibia with a row of weak *ad* setae and 1 or 2 *p* setae; middle tibia with 2 *ad*, 2 *pd*, 2 *p*, and 1 *v*; hind tibia with a row of *ad* setae containing 3 or 4 stronger ones, 4 *pd*, and 3 short *av*.

ABDOMEN metallic coppery-green, dorsally undusted, ventrally thinly grey-dusted. Ground setulae long, dense. *T1+2* and *T3* with longer setulae laterally; *T4* with a row of fine marginal setulae; *T5* with some stronger discal setae and a row of marginal setulae. Sternites with black setulae; first 3 segments grey-dusted.

GENITALIA indistiguishable from those of *P. consanguinea* (see Figures 46 and 47).

DIMENSIONS. Body length 6.0 mm; wing length 5.5 mm.

Type data. Holotype: male, CO, Old Man Range, Hyde Rock, 1550–1650 m, 22 February 1974, J.S. Dugdale (NZAC).

Remarks. See *P. consanguinea* (p. 35).

Pollenia fulviantenna new species

Figures 56 and 57

MALE. Basic description as for *P. scalena* (p. 46), but differing in the following characters.

HEAD holoptic. Face orange. Anterior part of jowls orangy, with orangy dusting. Vibrissae inserted above epistomal margin. Facial ridges setulose for half their length. Antennal segments orange; aristal hairs longer than antennal width. Jowl height 0.40× eye height.

THORAX. Mesonotum with indistinct, dusted, presutural vittae. Two *ph* setae, *ia* 1+2.

WINGS dark brown basally. Cell *R5* open. Squamae dark brown.

LEGS. Middle tibia with 2 *ad* setae.

GENITALIA. Male hypopygium, Figures 56 and 57.

DIMENSIONS. Body length 6.5 mm; wing length 6.0 mm.

Type data. Holotype: male, BR, Nelson Lakes National Park, west side of Lake Rotoiti, 1 February 1972, swept from tussock, R.A. Harrison (LCNZ). **Paratypes**: 3 males, same data as holotype (BMNH, LCNZ).

Pollenia fumosa (Hutton)

Figures 58 and 59

Sepimentum fumosum Hutton, 1901: 67. Lectotype male, New Zealand, Christchurch or Ashburton (CMNZ); see designation below.

HEAD. Frons in male as wide as anterior ocellus, in female one-third as wide as head. Ground colour yellow in female, in male dark brown except on interfacial membrane and lower part of jowls, which are orangy. All parts densely grey-dusted. Vibrissae inserted above epistomal margin. Aristal hairs longer than antennal width. Parafacialia slightly wider than antenna. Jowl height 0.39× eye height. Palpi yellow.

THORAX. Ground colour black to matt olive green, with even, dense, silvery-grey dusting. Female with yellow humeri. *Ac* 2 + 3, *dc* 2 + 3, 4 *h*, 1 or 2 *ph*, *ia* 2 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Pleural hairs yellow. *Stpl* 1 + 1. Scutellum with a pair each of apical, lateral, and basal setae and a weaker discal pair.

WINGS brownish along costa. Epaulet and basicosta brownish-yellow. Cell *R5* closed in margin. *R1* ending level with *r–m*. Squamae brown.

LEGS. Femora yellow to brown; tibiae yellow to brownish-yellow; tarsi black. Fore tibia with a row of short *ad* setae and 2 *p* setae; middle tibia with 1 *ad* seta, 1 or 2 *pd*, and 2 or 3 *p*; hind tibia with 1 or 2 *av* setae.

ABDOMEN matt olive green with a dense, silvery-grey dusting. *T1+2* with some longer lateromarginal setulae; *T3* with a distinct row of marginal setulae; *T4* with a row of marginal setae; *T5* with a row of marginal setae and some stronger discals.

GENITALIA. Paralobes and cerci, Figures 58 and 59. Aedeagus indistinguishable from that of *P. pulverea* (see Figure 86).

DIMENSIONS. Body length 6.0 mm; wing length 5.5 mm.

Type data. Hutton described *Sepimentum fumosum* from an unstated number of specimens of both sexes collected at Christchurch and Ashburton. From the Canterbury Museum I have received for study two males and two females found under this name: a male labelled "Christchurch or Ashburton"; a male and a female labelled "Ashburton, W. W. Smith"; and a female labelled "Christchurch". Both males and the Christchurch female are in good condition, but the Ashburton female has the abdomen, right hind leg, and all the left legs missing. I have labelled, and here designate, the male labelled "Christchurch or Ashburton" as **lectotype**, and the other three specimens as **paralectotypes**. All four specimens agree with Hutton's description and the description given here.

Material examined. Type specimens, plus 5 non-type examples: 1 male, 1 female, "1902-316, Capt F.W. Hutton"; 1 male, 1 female, "97–86, Clark"; 1 male, OL, Crown Range, 3620 ft [1085 m], 19 Feb 1954 (BMNH, NZAC).

Remarks. This species has rather variable leg colouration, and for that reason occurs in three separate couplets in the key. Males of each colour form have been dissected, and the genitalia proved to be identical. Apart from the leg colour all other characters are constant, and I am therefore treating the three forms as a single variable species.

Pollenia hispida new species

Figures 60 and 61

MALE. HEAD. Frons 3× as wide as anterior ocellus. Ground colour black; interfacial membrane and a small patch on lowermost part of jowls orangy. All parts dusted brownish-grey and with fine, black setulae. Post buccae with yellow hairs. Frons with only 2 *ori* setae, the upper ones indistinct. Vibrissae inserted slightly above epistomal margin. Facial ridges with setulae on lower one-third. Antennal segments orangy; 3rd segment brownish at apex; aristal rays as long as antennal width. Parafacialia narrower than antenna. Jowl height 0.44× eye height. Palpi yellow.

THORAX. Ground colour black, with metallic olive-green reflections and thin, greyish dusting which forms irregular, undusted vittae when viewed at various angles. *Ac* 2 + 3, *dc* 2 + 3, 6 *h*, 2 *ph*, *ia* 2 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Pleural hairs black except around prostigmatal seta, where they are yellowish. Scutellum with a pair each of apical, lateral, and basal setae and 2 pairs of discals.

WINGS brownish-yellow; epaulet and basicosta pale brown. Cell *R5* open in margin. *R1* ending a

little beyond level of *r–m*. Squamae creamy-brown.

LEGS orangy-brown. Fore tibia with a row of *ad* setae and 2 *p* setae; middle tibia with 3 or 4 *ad* setae, 2 or 3 *pd*, 2 *p*, and 1 *v*; hind tibia with 4 or 5 *av* setae.

ABDOMEN. Ground colour black, with dark, metallic blue-green reflections and thin, brownish-grey dusting. *T3* with some longer lateromarginal setulae; *T4* and *T5* with a row of marginal setulae; *T5* also with longer discal setulae.

GENITALIA. Male hypopygium, Figures 60 and 61.

DIMENSIONS. Body length 6.5 mm; wing length 6.0 mm.

Type data. Holotype: male, CO, Old Man Range, Hyde Rock, 1550–1650 m, 22 February 1974, J.S. Dugdale (NZAC).

Pollenia immanis new species

Figures 62 and 63

MALE. HEAD. Frons 1.5× as wide as anterior ocellus. Ground colour black; anterior jowls orangy. All parts covered with long, fine, black hairs except the post buccae, which have orange hairs. Parafrontalia and occiput greyish-dusted; jowls with orangy dusting. Frons with 12–14 *ori* setae; vertex without distinct *vti*. Vibrissae inserted well above epistomal margin. Facial ridges setulose on lower half. Antennal segments orangy; 3rd segment brownish at apex; aristal rays as long as antennal width. Parafacialia 1.75× as wide as antenna. Jowl height 0.41× eye height. Palpi yellow.

THORAX. Ground colour black, with olive reflections and even, grey dusting. Mesonotum with irregular, undusted vittae apparent when viewed at various angles of light. *Ac* 2 + 3, *dc* 2 + 3, 5 or 6 *h*, 2 *ph*, *ia* 2 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Pleural hairs yellow. Scutellum with a pair each of apical, lateral, and basal setae and 2 pairs of weaker discals.

WINGS yellowish; epaulet and basicosta pale brown. Cell *R5* closed, with a short petiole. *R1* ending beyond level of *r–m*. Squamae creamy.

LEGS brown. Tarsi with proximal 3 segments orangy. Fore tibia with a row of *ad* setae and 2 *p* setae; middle tibia with 3 *ad* setae, 2 or 3 *pd*, 2 or 3 *p*, and 1 *v*; hind tibia with a row each of *ad* and *pd* setae and 4 or 5 *av*.

ABDOMEN. Ground colour black, with metallic green-blue reflections and thin, tessellate, silvery dusting. *T4* with a row of longer marginal setulae; *T5* with all ground setulae longer and very close-set along posterior margin.

GENITALIA. Hypandrium very exposed. Hypopygium, Figures 62 and 63.

DIMENSIONS. Body length 12–13 mm; wing length 10.0 mm.

Type data. Holotype: male, CO, Old Man Range, 1375–1470 m, 24 February 1974, R.R. Forster & J.S. Dugdale (NZAC). **Paratypes**: 1 male, CO, Old Man Range, west side, 1570 m, 19 Feb 1974; 1 male, OL, Cainard Stream, ridge south of Mount Dick, Mataura Valley, 4000–5000 ft [1200–1500 m], 17 Jan 1971 (NZAC).

Pollenia insularis new species

Figures 64 and 65

MALE. HEAD. Frons as wide as anterior ocellus. Ground colour black; only interfacial membrane orangy. All parts with brownish-grey dusting. Parafrontalia, parafacialia, and jowls with fine, black setulae. Post buccae with yellow hairs. Frons with 7 *ori* setae and a pair of *vti*. Vibrissae inserted just above epistomal margin. Facial ridges with setulae on lower one-third. Antennal segments: 2nd orangy, the others brown. Aristal rays shorter than antennal width. Parafacialia twice as wide as antenna. Jowl height 0.45× eye height. Palpi brown.

THORAX. Ground colour black, with olive-green reflections and greyish dusting which forms indistinct presutural vittae. *Ac* 2 + 3, *dc* 2 + 3, 4 *h*, 2 *ph*, *ia* 2 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Pleural hairs pale brown to black. Scutellum with a pair each of apical, lateral, and basal setae and a weaker pair of discals.

WINGS brownish; epaulet brown; basicosta yellow. Cell *R5* closed, with a short petiole. Vein *R1* ending a little beyond *r–m*. Squamae brown.

LEGS brown. Fore tibia with a row of *ad* setae and 2 *p* setae; middle tibia with 2 *ad* setae, 2 *p*, 2 *pd*, and 1 *v*; hind tibia with a row of *ad* setae, 3 *pd*, and 2 *av*.

ABDOMEN. Ground colour black, with metallic green and coppery reflections and an even, greyish dusting. *T3* with a few stronger lateromarginal setae; *T4* with a row of marginal setae and a few lateral discal ones; *T5* with a row of marginal setae and numerous discal ones.

GENITALIA. Male hypopygium, Figures 64 and 65.

DIMENSIONS. Body length 5.5 mm; wing length 5.0 mm.

Type data. Holotype: male, Stewart Island (SI), Table Hill, 1400–2350 ft [425–715 m], 14 February 1968, J.S. Dugdale (NZAC).

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Pollenia lativertex new species

Figures 66 and 67

MALE. HEAD. Frons 2.5× as wide as antenna. Ground colour brown. Interfrontalia and interfacial membrane orangy. All parts with a dense, grey dusting which becomes brownish centrally on jowls. Parafrontalia, parafacialia, and jowls with numerous black setulae. Frons with 9 *ori* setae. Vertex with a pair each of *vti* and *vte* setae. Vibrissae strong, crossed, inserted at epistomal margin. Epistome projecting in front of oral margin. Facial ridge with a few small setulae just above vibrissa. Antennal segments orangy; 3rd segment with distal two-thirds brown; aristal rays as long as antennal width. Parafacialia as wide as antenna. Jowl height 0.42× eye height. Palpi brownish-yellow.

THORAX. Ground colour dark brown, with some metallic olive reflections and an even, greyish-brown dusting. *Ac* 2 + 3, *dc* 2 + 3, 4 *h*, 1 *ph*, *ia* 2 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Pleural hairing dark. *Stpl* 1 + 1. Scutellum with a pair each of apical, lateral, and basal setae and 2 weaker pairs of discals.

WINGS brownish; epaulet and basicosta pale brownish-yellow. Cell *R5* closed in margin. *R1* ending a little beyond level of *r–m*. Squamae pale brown.

LEGS brown; tarsi yellowed. Fore tibia with a row of short *ad* setae and 2 *ph* setae; middle tibia with 1 *ad* seta, 2 *p*, 2 *pd*, and 1 *v*; hind tibia with 4 *ad* setae, 3 *pd*, and 3 *av*.

ABDOMEN. Ground colour dark brown, with metallic green reflections and a thin, greyish dusting. *T3* with a few lateromarginal setae; *T4* with a row of marginal setae; *T5* with a row of marginal setae and a few stronger discal setae.

GENITALIA. Male hypopygium, Figures 66 and 67.

DIMENSIONS. Body length 4.0 mm; wing length 3.0 mm.

Type data. Holotype: male, Stewart Island (SI), Table Hill, 1400–2350 ft [425–715 m], 14 February 1968, J.S. Dugdale (NZAC).

Pollenia limpida new species

Figures 68 and 69

MALE. HEAD. Frons as wide as parafacialia. Ground colour dark brown, except on anterior part of jowls, which is orangy-brown. Parafrontalia densely setulose; *ori* setae not distinct. Parafacialia and jowls with long, black setulae. Vibrissae inserted above epistomal margin. Facial ridges with fine setulae for half their length. Antennal segments mostly orangy; 3rd segment brownish distally; aristal rays shorter than antennal width. Parafacialia as wide as antenna. Jowl height 0.40× eye height. Palpi yellowish.

THORAX. Ground colour black, with bluish-black, shiny reflections and thin, greyish dusting. Mesonotum with a pair each of median and lateral vittae, the median pair reaching beyond suture, the lateral pair almost reaching scutellum. *Ac* 2 + 3, *dc* 2 + 3, 4 *h*, 1 *ph*, *ia* 1 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Pleural hairs black. Scutellum with a pair each of apical, lateral, and basal setae and a weaker discal pair.

WINGS hyaline; epaulet dark brown; basicosta yellowish-brown. Cell *R5* closed in margin. *R1* ending in margin beyond level of *r–m*. Squamae dark brown.

LEGS. Femora and tibiae brown; tarsi brownish-yellow. Fore tibia with a row of fine *ad* setae and 2 *p* setae; middle tibia with 1 *ad* seta, 2 *pd*, and 3 *p*; hind tibia with a row of fine *ad* setae, a row of *pd*, and 5 or 6 short *av*.

ABDOMEN. Ground colour black with metallic blue reflections, but without distinct dusting. Ground setulae long, dense; marginal and discal setulae not distinct.

GENITALIA. Male hypopygium, Figures 68 and 69.

DIMENSIONS. Body length 5.0 mm; wing length 4.5 mm.

Type data. Holotype: male (with puparium), Mount Barber, 3800 ft [1155 m], under stones, 19 January 1970, J. S. Dugdale (NZAC).

Pollenia nigripalpis new species

Figures 70 and 71

HEAD. Frons in male 3.0× as wide as anterior ocellus, in female 0.30× as wide as head. Ground colour dark brown to black; membranous parts orangy in some specimens. All parts with a thin, grey dusting. Parafrontalia, parafacialia, and jowls with black setulae. Frons with 7 *ori* setae, and additionally in female with 3 *ors*. Vertex with a pair each of *vti* and *vte* in female. Vibrissae crossed, inserted at epistomal margin. Facial ridges with a few short setulae just above vibrissae. Antennal segments dark brown; 3rd segment orangy at base in some specimens; aristal rays as long as antennal width. Parafacialia narrower than antenna. Jowl height 0.40× eye height. Palpi black in male, yellowish-brown in female.

THORAX. Ground colour black, with metallic olive reflections and irregular, silvery-grey dusting. Mesonotum with a distinct median vitta and a pair of lateral presutural dusted vittae. *Ac* 2 + 3, *dc* 2

+ 3, 3 *h*, 1 *ph*, *ia* 2 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Pleural hairs black. *Stpl* 1 + 1. Scutellum with a pair each of apical, lateral, and basal setae, and a weaker discal pair.

WINGS brownish-tinged; epaulet and basicosta brown. Cell *R5* open in wing margin. *R4+5* curving downwards, ending at wing tip. *R1* ending slightly in front of *r–m*. Squamae brown.

LEGS dark brown. Fore tibia with a row of short *ad* setae and 2 *p* setae; middle tibia with 1 *ad* seta, 2 *pv*, 2 *p*, and 1 *v*; hind tibia with 3 *ad* setae, 3 *pd*, and 1 or 2 *av*.

ABDOMEN. Ground colour black, with metallic green and coppery reflections. *T3* with a few stronger marginal setulae laterally; *T4* with a row of marginal setulae; *T5* with a row of marginal setulae and a few stronger discal ones.

GENITALIA. Male hypopygium, Figures 72 and 73.

DIMENSIONS. Body length 3.5–4.0 mm; wing length 3.5–4.0 mm.

Type data. Holotype: male, Three Kings Islands, Great Island, at light, 1 November 1970, J. McBurney (NZAC). **Paratypes**: 14 males, 6 females, type locality, Nov 1970 (BMNH, NZAC); collection details include "Castaway Camp", "Tasman Valley", "*Leptospermum ericoides* and *Coprosma*", and "*Cordyline* flowers".

Pollenia nigripes Malloch

Figures 72 and 73

Pollenia nigripes Malloch, 1930: 320. **Holotype** male, New Zealand, WD, Kumara (USNM) [examined].

MALE. HEAD. Frons half as wide as anterior ocellus. Ground colour black. All parts brownish-dusted. Frons with *ori* setae and numerous short, black setulae. Parafacialia and jowls with black setulae. Vibrissae inserted at epistomal margin. Facial ridges with short setulae for half their length. Antennal segments orange; aristal rays as long as antennal width. Parafacialia slightly narrower than antenna. Jowl height 0.33× eye height. Palpi brownish-yellow.

THORAX. Ground colour black, with olive reflections, rather matt but without distinct dusting. *Ac* 2 + 3, *dc* 2 + 3, 4 *h*, 1 *ph*, *ia* 1 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Pleural hairs black. Scutellum with a pair each of apical, lateral, and basal setae and a weaker discal pair.

WINGS brownish; epaulet and basicosta brown. Cell *R1* ending a little beyond level of *r–m*. Squamae almost black.

LEGS brown. Fore tibia with a row of weak *ad* setae and 2 *p* setae; middle tibia with 2 *ad* setae and a shorter one above, 2 *pd*, 2 *p*, and 1 *v*; hind tibia with a row of *ad* setae, 3 or 4 *pd*, and 2 or 3 *av*.

ABDOMEN. Ground colour black, with metallic green reflections but without distinct dusting. *T3* with a row of weak marginal setae; *T4* and *T5* with a row of marginal setae and a few stronger discal ones.

GENITALIA. Male hypopygium, Figures 72 and 73.

DIMENSIONS. Body length 4.5 mm; wing length 4.0 mm.

Type data. As given under authorship citation, above.

Material examined. Holotype male, plus 2 non-type examples: 1 male, BR, Reefton Saddle, Tawhai State Forest, to mercury vapour light, 8 Mar 1972; 1 male, BR, Reefton side of Inangahua Junction, 5 Nov 1958 (NZAC).

Pollenia nigrisquama Malloch

Figures 74 and 75

Pollenia nigrisquama Malloch, 1930: 319. **Holotype** male, New Zealand, WD, Kumara (USNM) [examined].

HEAD. Frons in male slightly wider than anterior ocellus, in female 0.31× as wide as head. Ground colour black. All parts dusted silvery-grey, and with fine, black setulae. Male with 10–12 *ori* setae; female with 9–11 *ori* and a pair each of *vti* and *vte*. Vibrissae inserted just above epistomal margin. Facial ridges setulose on lower half. Antennal segments black; aristal rays longer than antennal width. Parafacialia 1.5× as wide as antenna. Jowl height 0.40× eye height. Palpi brown.

THORAX. Ground colour black, with metallic olive-green reflections and thin, irregular, greyish dusting. *Ac* 2 + 3, *dc* 2 + 3, 3 *h*, 2 *ph* (1 in female), *ia* 2 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Pleural hairs brown. Scutellum with a pair each of apical, lateral, and basal setae and 2 pairs of discals.

WINGS yellowish to brownish; epaulet and basicosta dark brown. Cell *R5* open. *R1* ending at level of *r–m*. Squamae yellowish-brown to brown.

LEGS dark brown. Fore tibia with a row of *ad* setae and 2 *p* setae; middle tibia with 1 *ad* seta, 2 *p*, 2 *pd*, and 1 *v*; hind tibia with a row of *ad* setae, 3 or 4 *pd*, and 1 *av*.

ABDOMEN. Ground colour black, with metallic blue-green reflections. *T1+2* and *T3* with latero-marginal setulae; *T4* and *T5* each with a row of marginal setulae; *T5* with a few stronger discal setae.

GENITALIA. Male hypopygium, Figures 74 and 75.

DIMENSIONS. Body length 6.5 mm; wing length 5.5– 6.0 mm.

Type data. As given under authorship citation, above.

Material examined. Holotype, plus 11 non-type examples (8 males, 3 females; BMNH, NZAC).

CL, TO / BR.

Collected at moderate altitudes (e.g., 300–450 m, Little Barrier Island, CL; up to 900–1200 m, Tongariro National Park, TO).

Taken in January and November.

Habitat records: "window" and "scrub and grass".

Pollenia notialis new species

Figures 76 and 77

MALE. Basic description as for *P. insularis* (p. 40), but differing in the following characters.

HEAD. Frons slightly wider than anterior ocellus. All parts dusted silvery-grey. Frons with 8 *ori* setae; *vti* not distinct. Post buccae with black hairs. Facial ridges setulose for two-thirds of their length. Antennal segments: 3rd orangy in proximal half, others brown; aristal rays very short, less than half antennal width. Jowl height 0.41× eye height.

THORAX evenly thinly dusted. *Dc* 3 + 3, 3 *h*. Pleural hairs black.

WINGS. Basicosta blackish-brown. Cell *R5* open.

LEGS. Middle tibia with 2 *ad* setae and a shorter one above. (Hind legs missing.)

ABDOMEN as broad as thorax, metallic green-blue with a thin, whitish dusting which is visible only when viewed at an angle from behind.

GENITALIA. Male hypopygium, Figures 76 and 77.

DIMENSIONS. Body length 6.0 mm; wing length 5.5 mm.

Type data. Holotype: male, Stewart Island (SI), Table Hill, Hut Creek, 1000 ft [300 m], 16 February 1968, J.S. Dugdale (NZAC).

Pollenia opalina new species

Figures 78 and 79

MALE. HEAD holoptic. Ground colour dark brown. Parafrontalia with 9 *ori* setae. Vibrissae inserted above epistomal margin. Facial ridges setulose for half their length. Base of 3rd antennal segment orangy; aristal rays as long as antennal width at 3rd segment. Parafacialia as wide as antenna. (Jowls damaged.) Palpi black.

THORAX. Ground colour black, with opalescent, greenish-blue, metallic reflections. All parts with a thin, greyish dusting. *Ac* 2 + 3, *dc* 2 + 3, 3 *h*, 1 *ph*, *ia* 2 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Pleural hairs black. *Stpl* 1 + 1. Scutellum with a pair each of apical, lateral, basal, and discal setae.

WINGS hyaline; epaulet and basicosta dark brown. Cell *R5* open. *R4+5* ending in margin well before wing tip. *R1* ending level with *r-m*. Squamae brown.

LEGS dark brown. Fore tibia with a row of *ad* setae and 2 *p* setae; middle tibia with 1 *ad* seta, 2 *pd*, and 1 *v*; hind tibia with 4 *ad* setae and 3 *pd*.

ABDOMEN. Ground colour black, with opalescent, metallic greenish-blue reflections but without distinct dusting. *T3*, *T4*, and *T5* each with a distinct row of marginal setae; *T4* and *T5* also with some stronger discal setulae.

GENITALIA. Paralobes and cerci, Figures 78 and 79. Aedeagus similar to that of *P. nigripalpis* (see Figure 70), but paraphallus more sclerotised, and anterior projection of distiphallus pointed.

DIMENSIONS. Body length 6.5 mm; wing length 6.0 mm.

Type data. Holotype: male, NN, Takaka Hill, 2000 ft [610 m], 14 December 1953, E.S. Gourlay (NZAC).

Pollenia oreia new species

MALE. Basic description as for *P. fumosa* (p. 39), but differing in the following characters.

HEAD. Frons 3× as wide as anterior ocellus. Parafacialia 2× as wide as antenna. Palpi brownish-yellow.

THORAX. One *ph* seta. Pleural hairs white.

WINGS. *R5* open in wing margin. Squamae white.

GENITALIA. Paralobes and cerci indistinguishable from those of *P. fumosa* (see Figures 58 and 59). Aedeagus indistinguishable from that of *P. pulverea* (see Figure 84).

DIMENSIONS. Body length 6.0 mm; wing length 5.5 mm.

Type data. Holotype: male, CO, Dunstan Range [= Dunstan Mountains], summit, 1590–1650 m, 23 February 1974, J.S. Dugdale (NZAC).

Pollenia pernix (Hutton) new combination

Figures 80 and 81

Gymnophania pernix Hutton, 1901: 61. Lectotype female, by subsequent designation of Malloch (1930, p. 324), New Zealand, MC, Christchurch (CMNZ) [examined].

HEAD. Frons in male twice as wide as anterior ocellus, in female 0.28× as wide as head. Ground colour shiny black; membranous areas orangy in female. Parafrontalia and parafacialia dusted silvery-grey. Parafrontalia, parafacialia, and jowls with long, black setulae. Post buccae with some orangy hairs. Jowls rugose. Frons in male with 12–14 *ori* and a pair each of *vti* and *vte*. Vibrissae and oral setae strong; vibrissae inserted above epistomal margin. Facial ridges with setulae for two-thirds of their length. Antennae: 1st and 2nd segments black; 3rd segment orangy-brown; arista bare, or with short rays on proximal one-third. Parafacialia 1.5× as wide as antenna. Jowl height 0.50× eye height. Palpi dark brown.

THORAX. Ground colour black, mostly shiny. Mesonotum with thin, irregular dusting. *Ac* 2 + 1, *dc* 2 + 1 (posterior ones indistinct), 3 *h* , 2 *ph* (1 in female), *ia* 0 + 2. Pleural hairs black. *Stpl* 0 + 1. Scutellum with a pair each of apical, lateral, and basal setae and 2 pairs of discals.

WINGS brownish; epaulet and basicosta black. Cell *R5* widely open. Vein *R1* ending beyond level of *r–m*. Squamae brownish.

LEGS shiny black. Fore tibia with a row of short *ad* setae and 2 *p* setae; middle tibia with 1 or 2 *ad* setae, 2 *pd*, 2 *p*, and 1 *v*; hind tibia with 4–6 *ad* setae, 3 or 4 *pd*, and 2 *av*.

ABDOMEN. Ground colour black, with metallic bluish-black to green reflections but without distinct dusting. *T4* and *T5* with a row of marginal setulae and some stronger discal setulae.

GENITALIA. Male hypopygium, Figures 80 and 81.

DIMENSIONS. Body length 7.0–9.0 mm; wing length 6.5–7.5 mm.

Type data. As given under authorship citation, above.

Material examined. Lectotype, plus 42 non-type examples (11 males, 31 females; ANIC, BMNH, LCNZ, NZAC).

WN / NN, SD, NC, MC / SI.

Collected at around sea level up to 1500 m (Mount Owen, NN).

Taken in January–April and September–December.

Habitat records: "near shore". Collection methods noted: "sweeping".

Remarks. This unusual species was originally described as a tachinid, but Malloch (1930) correctly assigned it to the Calliphoridae. As he had little material, Malloch was in some doubt as to whether *pernix* represented a distinct genus. I consider it to be a *Pollenia*. It has some unusual characters such as its shiny black ground colour, rugose jowls, 0 + 1 *stpl* setation, and weak posterior *ac* setae, but its general appearance is like that of other New Zealand *Pollenia*, and the aedeagus is of the basic *Pollenia* form.

Pollenia primaeva new species

Figures 82 and 83

MALE. HEAD. Frons 3× as wide as anterior ocellus. Ground colour black; interfacial membrane orangy. All parts densely dusted greyish-brown. Parafrontalia, parafacialia, and jowls with black setulae. Post buccae with orangy hairs. Frons with 11 *ori* setae; vertex with a pair of weak *vti*. Vibrissae inserted above epistomal margin. Facial ridges with a few setulae just above vibrissae. Aristal rays as long as antennal width. Antennal segments orangy; 3rd segment brownish on distal two-thirds. Parafacialia a little less than twice as wide as antenna. Jowl height half eye height. Palpi yellow.

THORAX. Ground colour black, with olive and brown reflections. Rather matt; mesonotum with irregular, dusted vittae. *Ac* 2 + 3, *dc* 2 + 3, 2 *ph*, 3 *h*, *ia* 1 + 2, 1 *pra*, 2 *sa*, 1 or 2 *pa*. Pleural hairs mostly golden-yellow. Scutellum with a pair each of apical, lateral, and basal setae and a weaker discal pair.

WINGS yellowish-brown; epaulet dark brown; basicosta yellowish. Cell *R5* open. *R1* ending before level of *r–m*. Squamae creamy, with a broad, brown margin.

LEGS brown; tibiae orangy at some angles of light. Fore tibia with a row of *ad* setae and 2 *p* setae; middle tibia with 1 *ad* seta, 2 *p*, 2 *pd*, and 1 *v*; hind tibia with a row of *ad* setae, 4 *pd*, and 1 *av*.

ABDOMEN. Ground colour black, with metallic olive-green reflections and a dense, silvery-grey dusting which almost obscures reflections. *T1+2* and *T3* with some lateral marginal setulae; *T4* and *T5* with a row of marginal setulae and some stronger discals.

GENITALIA. Male hypopygium, Figures 82 and 83.

DIMENSIONS. Body length 6.0 mm; wing length 5.0 mm.

Type data. Holotype: male, MC, Mount Somers, 18–19 January 1958, E.S. Gourlay (NZAC). **Paratype** male, same data as holotype but collected by M. J. Esson (NZAC).

Pollenia pulverea new species

Figures 84 and 85

HEAD. Frons as wide as anterior ocellus. Ground colour blackish-brown, except on interfrontalia, interfacial membrane, and lower part of jowls, which are orangy. All parts thinly grey-dusted. Parafrontalia, parafacialia, and jowls covered with fine, black setulae. Frons with 7 or 8 *ori* setae. Vertex with a weak pair of *vti*. Vibrissae strong, crossed, inserted well above epistomal margin. Facial ridge with setulae on half its length. Antennal segments orangy; 3rd segment darkened apically; aristal rays almost as long as antennal width. Parafacialia 1.5× as wide as antenna. Jowl height 0.48× eye height. Palpi yellow, almost parallel-sided, upcurving apically.

THORAX. Ground colour dark brown, with olive metallic reflections and silvery-grey dusting. Mesonotum with a pair of lateral vittae and a median dusted vitta presuturally, postsuturally with an irregular, tessellate dusting. Humeri and notopleura densely dusted. *Ac* 2 + 3, *dc* 2 + 3, 5 *h*, 2 *ph* (rarely 1), *ia* 2 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Sternopleuron with pale and dark hairs. Scutellum with a pair each of apical, lateral, basal, and (weaker) discal setae.

WINGS slightly brownish. Epaulet brownish-yellow; basicosta yellow. Cell *R5* closed in margin with a petiole half as long as *r–m*. Squamae pale brown. *R1* ending slightly anterior to level of *r–m*.

LEGS orangy-yellow, except for distalmost 2 tarsal segments of each leg and dorsal surface of femora, which are brownish. Fore femora with thin, whitish dusting. Fore tibia with a row of short *ad* setae and 2 *p* setae; middle tibia with 2 *ad* setae, 2 *pd*, 2 *p*, and 1 *v*; hind tibia with a row of *ad* setae containing 3 or 4 stronger ones, 4 or 5 *pd*, and 2 or 3 *av*.

ABDOMEN. Ground colour black, with metallic green and coppery reflections and tessellate, silvery-grey dusting. *T1+2* with some longer lateromarginal setulae; *T3* with a distinct row of weak marginal setulae; *T4* with a row of marginal setae; *T5* with a row of marginal setae and some stronger discals.

GENITALIA. Male hypopygium, Figures 84 and 85.

DIMENSIONS. Body length 5.0 mm; wing length 5.0 mm.

Type data. Holotype: male, Stewart Island (SI), Table Hill, 1400–2350 ft [425–715 m], 14 February 1968, J.S. Dugdale (NZAC). **Paratypes**: 3 males, Stewart Island, Rakeahua Valley, 8–19 Feb 1968 (BMNH, NZAC). Collection details: "to light", "flats and bush", "in bogs".

Remarks. Two sibling species may be included under the name *P. pulverea*, as the specimens labelled "to light" and "in bogs" differ from the other two in having paler sternopleural hairs, squamae, and jowls. Only more material for comparison can resolve this question.

Pollenia sandaraca new species

Figures 86 and 87

MALE. HEAD. Frons as wide as anterior ocellus. Ground colour yellowish-orange, except on occiput, parafrontalia, and upper parafacialia, which are dark brown. All parts thinly dusted yellowish-grey. Interfrontalia orange, bare. Frons with 8 long, fine *ori* setae. Vertex with a pair of weak *vti*. Parafrontalia, parafacialia, and jowls covered with long, fine, black setulae; posterior part of jowls with golden hairs. Vibrissae distinct, crossed, well above epistomal margin. Facial ridge with 5 or 6 setulae just above vibrissa. Antennal segments orangy; 3rd segment brownish anteriorly; arista with rays half as wide as antenna. Parafacialia slightly wider than antenna. Jowl height 0.55× eye height. Palpi yellow, parallel-sided, upcurving apically.

THORAX. Ground colour reddish-orange; mesonotum and parts of pleura darkened. All parts with grey dusting. Mesonotum with irregular lateral vittae when viewed at an angle from behind. Humeri and notopleura not darkened. *Ac* 2 + 3, *dc* 2 + 3, 4 *h*, 1 *ph*, *ia* 2 + 2, 1 *pra*, 2 *sa*, 2 *pa*. Sternopleuron and pteropleuron mostly orangy, with yellow hairs; mesopleuron with dark hairs. *Stpl* 1 + 1. Scutellum with a pair each of apical, lateral, and basal setae, 2 pairs of discal setae, and tessellate, grey dusting.

WINGS yellowed. Epaulet and basicosta orangy-yellow. Cell *R5* closed in margin. *R1* ending in margin at level of *r–m*. Squamae pale brown, with golden-brown marginal hairs.

LEGS orangy-yellow except for brown tarsal apices. Fore coxae with whitish dusting. Fore tibia with a row of short *ad* setae and 2 *p* setae; middle tibia with 2 *ad* setae, a small third one above on one side, and 4 setae in a row slightly behind *pd* position; hind tibia with a row of *ad* setae containing 4 or 5 stronger ones, 5 or 6 *pd*, and 2 *av*.

ABDOMEN metallic coppery-green, with a thin, tessellate, whitish dusting which shifts about a dorsal median line and is denser ventrally. *T1+2* with some stronger setulae laterally; *T3* with a row of weak marginal setulae; *T4* with a row of marginal setae and some distinct lateral discal setae; *T5* with a row of marginal setae and numerous discal setae.

GENITALIA. Male hypopygium, Figures 86 and 87.

DIMENSIONS. Body length 8.0 mm; wing length 7.0 mm.

Type data. Holotype: male, Stewart Island (SI), Rakeahua Valley, 10 February 1968, to mercury vapour light, J.S. Dugdale (NZAC).

Remarks. See Remarks to *P. dyscheres*, p. 37.

Pollenia scalena new species

Figures 88 and 89

HEAD. Frons in male twice as wide as anterior ocellus, in female 0.35× as wide as head. Ground colour dark brown, except on interfrontalia and interfacial membrane, and in female on face, all of which are orangy. All parts grey-dusted, but more brownish in female. Vibrissae strong, crossed, at epistomal margin. Aristal hairs short, one-third as wide as antenna. Parafacialia wider than antenna. Jowl height 0.50× eye height. Palpi yellow.

THORAX dark brown, with metallic olive reflections and even, brownish-grey dusting which forms a pair of lateral, presutural vittae when viewed at an angle from behind. *Ac* 2 + 3, *dc* 2 + 3, 5 *h*, *ia* 2 + 2, 1 *ph* (with or without a weaker second one), 1 *pra*, 2 *sa*, 2 *pa*. Pleural hairs black. *Stpl* 1 + 1. Scutellum with a pair each of apical, lateral, and discal setae, the discals weak.

WINGS. Epaulet and basicosta yellow. Cell *R5* closed with a short petiole. *R1* ending at level of *r–m*. Squamae pale brown.

LEGS. Femora brown in male, yellow in female. Tibiae yellow. Distalmost 3 tarsal segments brown; basal segments yellow. Fore tibia with a row of short *ad* setae and 2 *p* setae; middle tibia with 1 *ad* seta, 2 or 3 *p*, and 1 *v*; hind tibia with 4 *av* setae.

ABDOMEN metallic blue-green, with a thin, grey dusting in female. *T3* with a weak row of marginal setae; *T4* and *T5* with a row of marginal setae and some stronger discals laterally.

GENITALIA. Male paralobes and cerci, Figures 88 and 89. Aedeagus indistinguishable from that of *P. dyscheres* (see Figure 52).

DIMENSIONS. Body length 4.0–6.0 mm; wing length 4.0–6.0 mm.

Type data. Holotype: male, The Snares islands, Biological Station, on *Hebe elliptica*, 9 March 1972, D.S. Horning (NZAC). **Paratypes** (32 males, 14 females; BMNH, NZAC): 3 males, 3 females, same data as holotype; 12 males, 5 females, Penguin Colony, 3 Jan 1972, beating mixed foliage, D.S. Horning; 3 males, 5 females, Biological Station, Feb 1971, on foliage of *Poa astonii*, H.A. Best; 1 male, same locality, 11 Mar 1971, sweeping *Poa annua*, D.S. Horning; 1 female, same data but 20 Jan 1972; 1 male, same data but 12 Jan 1971; 1 male, east end of ridge, South-west Promontory, 13 Feb 1972, sweeping *Anisotome acutifolia*, D.S. Horning; 11 males, near Biological Station, *Poa astonii*, 3 Feb 1967, P.M. Johns.

Pollenia uniseta new species

Very similar to *P. eurybregma*, but differing in the following characters.

HEAD. Frons 0.17× as wide as head, with a pair of outcurving *ors* at level of ocellar triangle. Interfrontalia not yellowed anteriorly. Parafacialia 1.32× as wide as antenna. Jowl height 0.51× eye height. Epistome protruding a little beyond frons. Ocellar setae stronger than in *eurybregma*, as strong as an *ori*.

THORAX. Mesonotum with a distinct presutural median vitta; postsutural area with dusted vittae. Five humeral setae. Scutellar discal setae almost as strong as laterals. Sternopleuron and pteropleuron with some pale hairs.

LEGS. Middle tibia with 3 *ad* setae; hind tibia with 5 or 6 *av*.

GENITALIA similar to those of *P. consanguinea*, but upper part of paralobes less bulbous, and aedeagus more sclerotised on hypophallus.

DIMENSIONS. Body length 6.0 mm; wing length 5.5 mm.

Type data. Holotype: male, CO, Old Man Range, west side, 1570 m, 19 February 1974, J.S. Dugdale (NZAC).

Remarks. See *P. consanguinea* (p. 35).

NEW ZEALAND *POLLENIA* OF UNCERTAIN IDENTITY

Pollenia atrifemur Malloch

Pollenia atrifemur Malloch, 1930: 321. Holotype male, New Zealand, MC, Upper Hororata (CMNZ) [examined].

The holotype is very badly damaged, having only the two wings, the top of the thorax, and a leg remaining. It is therefore impossible to place the name satisfactorily in my key, even when the holotype is used in conjunction with Malloch's description. It runs out near *P. notialis*, but cannot be placed with certainty.

—ꕥ—

Pollenia cuprea Malloch

Pollenia demissa var. *cuprea* Malloch, 1930: 323. Holotype female, New Zealand, WI, Wanganui (USNM) [examined].

The holotype is in poor condition, with only the wings, two legs, and part of the thorax left on the pin. I have examined a number of females, including two paratypes from USNM, which appear to be conspecific with the holotype. I cannot conclusively associate them with any males that I have, so the name is included only in the key to females, and as a distinct species.

NOTE ON TWO HOLARCTIC SPECIES OF *POLLENIA* RECENTLY INTRODUCED TO NEW ZEALAND

[The substance of this note was kindly provided by Knut Rognes, a dipterist from Norway who is currently examining the taxonomy of Northern Hemisphere *Pollenia*. See also note on p. 61.]

Two Holarctic species of *Pollenia* Robineau-Desvoidy, 1830 have recently been collected in or near Auckland, and specimens (now in NZAC) were loaned to me for study by Dr B. A. Holloway. A male and a female of *Pollenia rudis* (Fabricius, 1794) were intercepted in cargo from the U.S.A. on 11 March 1981. Subsequently 9 males and 9 females of a different species were captured at a suburban location, indoors as well as outdoors.

The latter specimens belong to a widespread but hitherto unrecognised species allied to *rudis* but easily distinguished from it in both sexes by the presence of a bundle of pale hairs on the underside of the wing, at the junction of veins *h* and *sc*. The male can also be recognised by the absence from the middle third of the hind tibia of any erect *av* hairs — only normal decumbent setulae are present besides the *av* setae (in *rudis* males there are numerous erect, longish *av* hairs in addition to the *av* setae in this position). The ventral vestiture of the male abdominal tergites is less dense and fine than in *rudis* males; rather, it is similar to the dorsal vestiture. There are also constant and distinct differences in the structure of the distiphallus. Both *rudis* and the unnamed species have at least 2 or 3 *ad* setae on the middle tibia.

Unfortunately the undescribed species cannot be named with certainty as yet. The holotype of *Pollenia obscura* Bigot, 1888 belongs to this taxon, but Bigot's name cannot be used as it is a junior secondary homonym preoccupied in *Pollenia* by *Musca obscura* Fabricius, 1794. Bigot's *obscura* has long been treated as a synonym of *rudis*, but this is an error.

There is a possibility that a third Holarctic species — *angustigena* Wainwright, 1940 — may turn up in New Zealand. Like *rudis* it lacks the bundle of pale hairs on the underside of the *h–sc* junction, but it differs from *rudis* in having only one *ad* seta (rarely two) on the middle tibia, a narrower frons in the male, and normal (not dense) vestiture on the ventral part of the male abdominal tergites.

Genus *Ptilonesia* Bezzi

Ptilonesia Bezzi, 1927: 242 (as a subgenus of *Calliphora*). Type-species *Pollenia auronotata* Macquart, 1855, by original designation.

Head dichoptic in both sexes. Eyes densely haired. Arista plumose. Both sexes without *ors*. Ocellars absent. Suprasquamal ridge bare. Stem-vein bare. Outer *ph* present. Prosternum and propleuron haired. Lower squama haired to margin. Subcostal sclerite setose. Pleurotergite bare. Male 5th tergite greatly enlarged and concave laterally. Female 5th tergite with strong marginal setae and a deep dorsal incision.

Remarks. *Ptilonesia* can be distinguished from all other New Zealand Calliphoridae by the bare stem-vein and pleurotergite, haired squamae and propleuron, densely haired eyes, and black palpi.

Aspects of general morphology are illustrated in Figures 5 and 12.

Ptilonesia auronotata (Macquart)

Figures 5, 12, 90, and 91

Pollenia auronotata Macquart, 1855: 135 (reprint 115). Lectotype female, New Zealand (BMNH); see designation below.

Calliphora hortona of authors, but not Walker [misidentifications].

HEAD dichoptic in both sexes; eyes densely haired, separated by 0.4× width of an eye in male and by an eye width in female. Ground colour black. Interfrontalia thinly dusted grey, with fine, black setulae. Parafrontalia dusted grey and brown, with numerous fine, black setulae. Parafacialia densely dusted grey and brown, with long, fine, black setulae. Jowls grey-dusted, with black setulae. Face grey-dusted, ridged medially. Interfacial membrane thinly grey-dusted, bare. Occiput dusted silvery-grey, with yellow hairs. Male with 10–12 *ori* setae and a pair of *vti*; female with 13–15 *ori* and a pair each of preverticals, *vti*, and *vte*. Vibrissae strong, crossed. Facial ridge with short, stout setulae for half its length. Antennal segments brown; 3rd segment thinly grey-dusted; arista with long hairs dor-

sally on proximal two-thirds and fine, short hairs ventrally. Palpi blackish-brown, rounded and slightly dilated apically. Mentum glossy brown.

THORAX. Ground colour black. Mesonotum grey-dusted, with indistinct undusted vittae between setal rows *ac* and *dc*. *Ac* 2 + 3, *dc* 3 + 3, 4 *h*, 2 *ph*, *ia* 3 + 2, 2 or 3 *pra*, 2 or 3 *sa*, 2 *pa*. Pleura grey-dusted, with black setulae. Pleurotergite with brown pile. Both spiracles orange. *Stpl* 2 + 1. Scutellum with a pair each of apical, marginal, and discal setae and 2 pairs of laterals.

WINGS. Veins blackish-brown. Basicosta and epaulet orange. Subcostal sclerite orange, setulose. Squamae infuscated brown; lower lobe with a white margin bearing white hairs and with long, dark hairs on dorsal surface; upper lobe paler basally, with brown marginal hairs.

LEGS black. Coxae, trochanters, and femora greyish-dusted. Fore tibia with a row of short *ad* setae and 2 *pv*; middle tibia with 3 or 4 *ad* setae, 1 *pd*, 2–4 *p*, and 1 *v*; hind tibia with 3 or 4 *ad*, 3 or 4 *av*, and 2 or 3 *pd*.

ABDOMEN. Ground colour black, with green or blue metallic reflections and a thin, tessellate, silvery dusting dorsally. *T1+2* black anteriorly and along hind margin; *T3* with a thin, undusted median vitta, a dark hind margin, and some long lateromarginal setae; *T4* with hind margin dark and bearing a complete row of setae; *T5* in male concave, constricted laterally, with long setulae on all surfaces, and in female dusted silvery-grey laterally, with strong marginal setae and a median dorsal fold; *T6* present in male as a non-metallic crescent with a few dorsal setulae. Pregenital tergite large, non-metallic, grey-dusted, with numerous fine setulae. Sternites in male short, broad, with tufts of hair centrally; in female long, thin, with fine marginal setulae, the 6th sternite shiny black, triangular, and with strong marginal setae.

GENITALIA. Male hypopygium, Figures 90 and 91.

DIMENSIONS. Length of body 8.0–10.5 mm; length of wing 7.0–9.0 mm.

Type data. Macquart described this species from an unstated number of female specimens collected in New Zealand, from Bigot's collection. In the BMNH I have found four female specimens labelled "Pollenia auronotata Macquart, ex Bigot collection BM. 1966-539". Three of the specimens fit the description perfectly, but the fourth differs in having bare eyes and orange palpi. It closely resembles the other specimens in general appearance, and was probably included in the series by Macquart in error. One specimen is also labelled "Pollenia auronotata ♀ Macq" and "Brauer WIEN CVIII (No. 119)", and is in good condition, with the left middle leg missing and a film of glue on the ventral surface of the abdomen. The other three are in fair condition. I have labelled, and here designate, the specimen with the additional label as **lectotype** and the others as **paralectotypes**. The lectotype and two of the paralectotypes agree with the most recent interpretation of this species (e.g., Kurahashi 1971). The third paralectotype, with orange palpi, is a specimen of *Xenocalliphora hortona* (Walker).

Material examined. Type specimens, plus 82 non-type examples (19 males, 63 females; ANIC, BMNH, LCNZ, NZAC).

ND, WO, GB, WI, WN / NN, NC, SC, OL / SI / Chatham Is / Antipodes Is.

Collected largely around sea level, or at low elevations; highest altitude recorded 360 m (Paradise, OL).

Taken in January, February, May, August, and October–December.

Habitat records: "beach", "near shore", "foredune", "*Pimelea arenarea*", "*Cotula coronopifolia* flowers". Collecting methods noted: "sweeping".

Remarks. *Ptilonesia auronotata* is referred to as *Calliphora hortona* (Walker) by Miller (1939b), Murray (1954), and Harrison (1976). It is especially common on seashores, where it is said to breed in decaying seaweed, though this may be a mistaken observation. Miller (1939b) illustrates the diagnostic characters of the larvae.

The seemingly relict distribution of this species in Australia is discussed in the Introduction, under genus *Ptilonesia* (p. 11).

Genus *Xenocalliphora* Malloch

Xenocalliphora Malloch, 1924: 639. Type species *Calliphora eudypti* Hutton, 1902, by original designation.

Head dichoptic in both sexes. Eyes bare or with sparse hairing. Arista plumose. Both sexes with *ors* setae. Outer *ph* seta present. Prosternum and propleuron haired. Suprasquamal ridge bare. Stem-vein bare. Subcostal sclerite setulose. Lower squama haired to margin. Pleurotergite bare. Abdomen metallic blue, green, or violet. Fifth tergite normal.

Remarks. The genus *Xenocalliphora* can be distinguished from all other New Zealand Calliphoridae by the bare stem-vein, haired squama, setulose subcostal sclerite, and yellow palpi.

Aspects of general morphology are illustrated in Figures 6, 13, and 22.

KEY TO SPECIES OF *XENOCALLIPHORA*

01 Two postsutural *ia* setae; fore tibia without a *pd* seta ... 2
— One postsutural *ia* seta; fore tibia with a *pd* seta ... 5

02(01) Abdomen with a dense, tessellate, silvery dusting; posterior thoracic spiracle brown. Pitt Island, Chatham group ... ***solitaria***
— Abdomen with indistinct dusting visible only at an angle from behind; posterior thoracic spiracle yellow or orange ... 3

03(02) Jowls reddish-brown with yellowish-grey dusting; interfacial membrane orangy; face reddish-brown; antennal segments orangy-brown to orange; knob above infra-alar bulla yellowish-orange; 6th tergite of female a complete arch. Three Kings Islands ... ***vetusta***
— Jowls black, with grey dusting; interfacial membrane black or brown; antennal segments brown; squamae creamy to white; knob above infra-alar bulla brown to orangy-brown; 6th tergite of female bisected ... 4

04(03) Fifth tergite glossy, metallic, undusted, contrasting with other tergites, which are metallic but dulled; 6th sternite of female with marginal setae only ... ***clara***
— Fifth tergite similar in brilliance to other tergites; 6th sternite of female covered with dense, brown pile ... ***hortona***

05(01) Acrostichal setae 2 + 1; tibiae and tarsi yellow; abdomen metallic green, without distinct dusting. Campbell Island ... ***viridiventris***
— Acrostichal setae 2 + 2 ... 6
— Acrostichal setae 2 + 3 ... 7

06(05) Legs, including coxae, yellow; *stpl* 2 + 1. Auckland Islands ... ***flavipes***
— Coxae and basal half of femora brown, grey-dusted; *stpl* 1 + 1. The Snares ... ***eudyptis***

07(05) Abdomen metallic violet; 5th tergite brilliant, undusted, contrasting with other tergites; wings slightly darkened basally; 6th tergite of female divided, consisting of 2 shiny black plates with fine marginal setae; frons of male wider than eye ... ***neozealandica***
— Abdomen metallic green or purple, with even or tessellate dusting; 5th tergite not contrasting in brilliance with other tergites; wings hyaline; 6th tergite of female not as above; frons of male wider than eye ... 8

08(07) Abdomen metallic green, with even, thin, silvery dusting. Antipodes Islands ... ***antipodea***
— Abdomen metallic blue to purple, with dense, tessellate, silvery dusting. Stewart Island and its outliers ... ***divaricata***

Xenocalliphora antipodea (Hutton)

Figures 92 and 93

Calliphora antipodea Hutton, 1902: 171. Lectotype male, New Zealand, Antipodes Islands (CMNZ); see designation below.

HEAD dichoptic in both sexes. Frons 1.3× as wide as eye in male, 1.7× as wide in female. Ground colour black, except on facial ridges, which are reddish-brown. Eyes with very sparse, minute hairs. Interfrontalia reddish-brown anteriorly, with black hairs. Parafrontalia densely dusted silvery-grey, with a slightly brassy shifting spot centrally and numerous fine, black hairs. Parafacialia densely dusted silvery and brassy, with a median shifting spot and numerous fine setulae. Jowls densely grey-dusted, with black setulae. Gular region well developed, with yellow setulae. Occiput densely grey-dusted, with pale hairs. Frons with 7 *ori* setae, 2 *ors*, a prevertical, *vti*, and *vte*. Vibrissae strong, crossed. Facial ridges with short, stout setulae on their entire length, those nearer the vibrissa stronger. Antennal segments brown; 3rd segment orangy at base; arista brown, paler centrally, plumose to tip. Palpi yellow, flattened and dilated apically. Mentum matt blackish-brown.

THORAX. Ground colour black. Mesonotum densely dusted bluish-grey to brown, with shifting undusted patches and streaks. *Ac* 2 + 3, *dc* 3 + 3, 4 *h*, 2 *ph*, *ia* 3 + 1, 1 *pra*, 2 or 3 *sa*, 2 *pa*. Pleura dusted brownish-grey, with fine, back setulae. Propleural depression with pale hairs. Mesopleural row complete. Pleurotergite with short, pale pile. Spiracles bright yellow. *Stpl* 1 + 1. Scutellum with a pair each of apical, lateral, and discal setae and 2 pairs of basals.

WINGS. Veins brown; epaulet and basicosta bright yellow. Epaulet with some strong setae on anterior margin. Subcostal sclerite with yellow pile and black setulae. Stem-vein ventrally with 1 or 2 small hairs. Squamae creamy white; lower lobe with

brown hairs dorsally; marginal hairs white on lower lobe, brown on upper lobe.

LEGS. Coxae, trochanters, and femora dark brown with grey dusting; tibiae and tarsi reddish-brown. Fore tibia with 3 or 4 *ad* setae, 1 *pd*, and 1 *pv*; middle tibia with 2 *ad* setae, 1 *pd* , 2 *p*, and 1 *v*; hind tibia with 4 or 5 *ad* setae, 3 *pd*, and 2 *av*.

ABDOMEN. Ground colour black, with metallic green-blue reflections and very thin, silvery-white dusting. *T1+2* with a few lateral marginal setae; *T3* and *T4* with a row of marginal setae; *T5* with a row of marginal setae and some stronger discal ones. Sternites blackish-brown, slightly metallic, with tessellate grey dusting and black setulae.

GENITALIA. Male hypopygium, Figures 92 and 93.

DIMENSIONS. Body length 7.0–10.0 mm, wing length 6.0–9.0 mm.

Type data. Hutton described *Calliphora antipodea* from specimens of unstated number and gender collected at the Antipodes Islands. From the Canterbury Museum I have received for study two specimens found under this name. One, a female labelled "Antipodes", "Antipodes Island Hutton", "I.846", "Type", "Calliphora antipodea Hutt. F. W. Hutton det.", is in fair condition but has the fore and middle legs and some hind tarsal segments missing, and setae are abraded from the head. The second specimen is a male labelled "Antipodes", "Calliphora antipodea Hutton", in excellent condition. I have labelled, and here designate, the male specimen as **lectotype** and the female as **paralectotype**. Both specimens agree with the most recent interpretations of this species (e.g., Harrison 1976).

Material examined. Type specimens, plus 20 non-type examples (4 males, 16 females) from Antipodes Island, Reef Point, 8 Feb 1969 (BMNH, LCNZ, NZAC).

Xenocalliphora clara new species

Figures 94 and 95

HEAD dichoptic in both sexes. Frons 1.2× as wide as eye in male, 1.7× as wide in female. Ground colour black. Interfrontalia matt, with fine setulae in upper half. Parafrontalia grey-dusted above, brassy below, with a shifting spot centrally and fine, black setulae. Parafacialia with dense, brassy dusting, a median shifting spot, and a few fine, black setulae. Jowls grey-dusted, with black setulae. Gular region prominent, with some golden hairs. Face grey-dusted. Interfacial membrane thinly grey-dusted, bare. Occiput dusted silvery-grey, with black setulae above and yellow to golden hairs below. Frons with 7 or 8 *ori* setae, 2 *ors*, a prevertical, *vti*, and *vte*. Vibrissae strong, crossed. Facial ridges with short, stout setulae on two-thirds of their length. Antennal segments brown; 3rd segment orangy at base; arista dark brown, plumose to tip. Palpi orangy-yellow, flattened and dilated apically. Mentum shiny brown.

THORAX. Ground colour black, with grey dusting. Mesonotum with indistinct undusted streaks. *Ac* 2 + 3, *dc* 3 + 3, 4 *h*, 2 *ph*, *ia* 3 + 2, 1 *pra*, 2 or 3 *sa*, 2 *pa*. Propleural depression with pale hairs. Mesopleural row complete. Pleurotergite with pale pile. Spiracles bright orange. *Stpl* 1 + 1. Scutellum with a pair each of apical, lateral, and discal setae and 2 pairs of basals.

WINGS. Veins brown; basicosta and epaulet bright orangy-yellow. Subcostal sclerite orangy-yellow, with black setulae. Squamae white; lower lobe with brown hairs dorsally and pale marginal hairs; upper lobe with brown marginal hairs.

LEGS. Coxae, trochanters, and femora brown, with thin, grey dusting; tibiae and tarsi brown. Fore tibia with a row of *ad* setae and 1 *pv* seta; middle tibia with 2 *ad* setae, 1 *pd*, 2 *p*, and 1 *v*; hind tibia with a row of *ad* setae, 2–4 *pd*, and 3 short *av*.

ABDOMEN. Ground colour black, with metallic blue-green and violet reflections. *T1+2*, *T3*, and *T4* with thin, silvery dusting; *T5* undusted, glossy, metallic, contrasting with other tergites; *T1+2* and *T3* with a few long lateromarginal setae; *T4* and *T5* with a complete row of marginal setae; *T5* also with some longer discal setae. Female: 6th tergite divided; 6th sternite almost twice as broad as long; 9th sternite shaped as an equilateral triangle.

GENITALIA. Male hypopygium, Figures 94 and 95.

DIMENSIONS. Body length 6.0–7.5 mm; wing length 5.5–6.5 mm.

Type data. Holotype: male, NN, Crow River hut, Upper Karamea River, 17–20 December 1972, A.K. Walker (NZAC). **Paratypes** (4 males, 6 females; BMNH, NZAC): 1 female, TO, Taupo, 19 Oct 1940, J.S. Armstrong; 1 female, TO, same data but 17 Dec 1957; 2 males, WN, Orongorongo Valley, A.E.D. [= Ecology Division] Field Station, 22–26 Sep 1969, J.S. Dugdale; 1 female, NN, same data as holotype; 1 female, MC, Goldney Saddle, Cass, 19 Dec 1959, J.I. Townsend; 1 female, MC, Mt Somers, 18–19 Jan 1958, E.S. Gourlay; 1 male, 1 female, MK, Hooker Valley, Hermitage area, malaise trap, 3–4 Apr 1977, J.S. Dugdale; 1 male, MK, Hooker Valley, Stocking Creek, 3 Apr 1977, J.S. Dugdale.

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Xenocalliphora divaricata new species

Figures 96 and 97

HEAD dichoptic in both sexes. Frons in male 1.3× as wide as eye, in female 1.5× as wide. Eyes with very sparse, pale, minute hairs. Ground colour black, except on facial ridges and interfacial membrane, which are orangy. Interfrontalia matt brown, with black hairs above. Parafrontalia densely dusted greyish-brassy, with a shifting spot centrally and with numerous fine, black setulae. Parafacialia densely brassy-dusted, with a median shifting patch and numerous fine, black hairs above. Jowls dusted silvery-grey, with black setulae. Gular region well developed, with orange hairs. Face dusted silvery-grey. Interfacial membrane bare. Frons with 8 *ori* setae, 2 *ors*, a prevertical, and a pair each of *vti* and *vte*. Occiput grey-dusted, with black setulae above and orange below. Vibrissae strong, crossed. Facial ridges with short, stout setulae in 2 or 3 rows on two-thirds of their length. Antennal segments brown; 3rd segment almost black at apex, orangy at base; arista dark brown, plumose to tip. Palpi orangy-yellow, slightly flattened and dilated apically. Mentum matt brown.

THORAX. Ground colour black, with dense, grey dusting. Mesonotum with indistinct undusted patches and streaks. *Ac* 2 + 3, *dc* 3 + 3, 4 *h*, 2 *ph*, *ia* 3 + 1, 1 *pra*, 2 or 3 *sa*, 2 *pa*. Propleuron and prosternum with orangy hairs. Mesopleural row complete. Pleurotergite with pale pile. Spiracles bright orangy-yellow. *Stpl* 1 + 1. Scutellum with a pair each of apical, lateral, and discal setae and 2 pairs of basals.

WINGS. Veins brown; epaulet and basicosta bright orangy-yellow; subcostal sclerite brownish-yellow, setulose. Stem-vein with fine hairs on ventral surface. Squamae slightly infuscated; lower lobe with long, brown dorsal hairs and white marginals; upper lobe white, with long, brown marginal hairs.

LEGS. Coxae and femora brown, with grey dusting; tibiae and tarsi reddish-brown; hind tibiae pale yellowish-brown ventrally. Fore tibia with a row of short *ad* setae, 1 *pd*, and 1 *pv*; middle tibia with 2 *ad* setae, 1 *pd*, 2 *p*, and 1 *v*; hind tibia with a row of *ad* setae containing 3–5 stronger ones, 2 or 3 *pd*, and 2 *ad*.

ABDOMEN. Ground colour black, with metallic blue and purple reflections and a tessellate, silvery dusting which is dense in some specimens. *T1+2* with 2 or 3 strong lateromarginal setae; *T3*, *T4*, and *T5* each with a complete row of marginal setae; *T5* with some stronger discal setae. Sternites with slight metallic sheen, silvery-grey dusting, and black setulae. Female with 6th tergite divided.

GENITALIA. Male hypopygium, Figures 96 and 97.

DIMENSIONS. Body length 6.0–7.5 mm; wing length 6.0–7.0 mm.

Type data. Holotype: male, SI, north-east Long Island, coastal rocks, 9 November 1968, ?collector (NZAC). **Paratypes** (8 males, 5 females, all SI; BMNH, NZAC): 1 male, 3 females, same data as holotype; 1 male, type locality, 6–13 Nov 1968, at light, ?collector; 1 male, type locality, 11 Nov 1968, to light, J. McBurney; 1 female, type locality, 18 Nov 1968, ?collector; 2 males, Long Island, Pu Wai Bay, 23 Feb 1969, to light, J. McBurney; 1 male, 1 female, Stewart Island, Port Pegasus, Twilight Bay, 27 Feb 1968, J.S. Dugdale; 2 males, Codfish Island, Sealers Bay, sweeping near shore, 8 Dec 1966, J.I. Townsend.

Remarks. The type series of *X. divaricata* consists of specimens from three separate island localities. When I originally sorted and identified material of this genus I had thought of them as possibly representing three species. After examination of the male hypopygium and further comparisons, however, I concluded that they belong to a single species with slightly variable dusting and frons ratios. This may indicate that speciation is in progress, and specimens from elsewhere in the Stewart Island area may show a degree of further variation.

Xenocalliphora eudyptis (Hutton)

Figures 6, 13, 22, 98, and 99

Calliphora eudypti Hutton, 1920: 170. Lectotype male, New Zealand, The Snares (CMNZ); see designation below.

Calliphora huttoni Miller, 1950: 115 [unnecessary replacement name].

HEAD dichoptic in both sexes. Eyes in male separated by 1.2× eye width, in female by 1.3× eye width. Eyes with very sparse, minute, pale hairs. Ground colour black, except on interfacial membrane, which is pale brown. Interfrontalia matt reddish-brown anteriorly, with numerous fine, black setulae. Parafrontalia densely dusted greyish-brown, with a shifting patch centrally and numerous fine, black setulae. Parafacialia with a dense, shifting, grey dusting and numerous fine, black setulae. Jowls grey-dusted, with sparse, short, stout setae. Gular region well developed, with yellow hairs. Interfacial membrane bare. Occiput grey-dusted, with yellow hairs. Frons with 6 *ori* setae, 2 *ors*, a prevertical, and a pair each of *vti* and *vte*. Vibrissae strong, crossed. Facial ridges with short, stout setulae on their entire length, those near the vibrissae stronger. Antennal segments orangy; 3rd segment brownish apically; arista dark brown, plumose

almost to tip. Palpi brownish-yellow, flattened and dilated apically. Mentum blackish-brown.

THORAX. Ground colour black. Mesonotum with dense, brownish-grey dusting and a shifting pattern of undusted patches and streaks. *Ac* 2 + 2, *dc* 2 + 3, 4 *h*, 2 *ph*, *ia* 2 + 1, 1 *pra*, 1 *sa*, 2 *pa*. Pleura dusted silvery-grey, with fine, black setulae. Propleural depression with pale hairs. Mesopleural row complete. Pleurotergite with pale pile. Spiracles bright yellow. *Stpl* 1 + 1. Scutellum with a pair each of apical, lateral, and discal setae and 2 pairs of basals.

WINGS. Veins brownish-yellow; epaulet and basicosta yellow; subcostal sclerite yellow, with black setulae. Stem-vein with 2 or 3 black hairs on ventral surface. Squamae creamy-white; lower lobe with fine, brown hairs dorsally; upper lobe with brown marginal hairs.

LEGS. Coxae brown, with grey dusting; trochanters brown, with pale hairs; femora yellow on distal one-third, otherwise blackish-brown; tibiae and tarsi yellow; distal segments of tarsi slightly brownish. Fore tibia with 3 *ad* setae, 1 *pd*, and 1 *pv*; middle tibia with 2 *ad* setae, 1 *pd*, 2 *p*, and 1 *v*; hind tibia with 4 or 5 *ad* setae, 2 *pd*, and 2 *av*.

ABDOMEN. Ground colour black, with metallic grey reflections and a tessellate grey dusting that shifts about a median line. *T1+2* less shiny, with 1 or 2 lateromarginal setae; *T3* with a row of marginal setae that are weaker medially; *T4* and *T5* with a row of marginal setae; *T5* also with some discal setae. Sternites black, grey-dusted, with black setulae.

GENITALIA. Male hypopygium, Figures 98 and 99.

DIMENSIONS. Body length 7.5–8.0 mm; wing length 6.5–7.0 mm.

Type data. Hutton described *Calliphora eudypti* from specimens of unstated number and gender collected at The Snares, the Auckland Islands, and Campbell Island. From CMNZ I have received for study two males and two females found under this name and labelled "Snares", "Calliphora eudypti Hutton". Except for one male which is in good condition, these are rather teneral and have one leg or more missing. Under this name in the BMNH collections I have found three additional specimens with type data; a male and female labelled "Snares, Southern Is., New Zealand. Jan. 1901, Capt. F. W. Hutton", "1902-316", and (male only) "Calliphora eudypti", and a female labelled "Campbell Is., Southern Is., New Zealand, Jan. 1901, Capt. F. W. Hutton, 1902-316". I have labelled, and here designate, the male in good condition from CMNZ as **lectotype** and the other six specimens as **paralectotypes**. The lectotype and five of the paralectotypes agree with the most recent interpretation of this species (e.g., Harrison 1976). The BMNH specimen from Campbell Island is, however, a specimen of *X. viridiventris* Malloch, and is the paratype of Malloch's description. I have also labelled the holotype of *viridiventris* as a **paralectotype** of *eudypti*, since Malloch took his type material for *viridiventris* from the Campbell Island material used in Hutton's description of *eudypti*.

Material examined. Type series, plus 29 non-type examples (10 males, 19 females; BMNH, NZAC).

— / The Snares.

Collected at around sea level.

Taken in January, February, and December.

Habitat records: "*Hebe elliptica* flowers", "stony beach, upper littoral / low supralittoral" (the latter record for a male with puparium collected 23 Dec). Collecting methods noted: "attracted to white light", "attracted to 15W u.v. light".

Remarks. Hutton based his description of *eudypti* on material from three island groups each having an individual endemic species, and he therefore had a mixed series of three species. Malloch (1930) noticed this anomaly and, using the female specimens from Campbell Island from the *eudypti* series, described one new species, *viridiventris*. Miller (1930) unaccountably placed *eudypti* as a synonym of *viridiventris*, and furthermore said that *eudypti* was a preoccupied name. Miller (1950) further confused the situation by unnecessarily proposing a new name, *huttoni*, for *eudypti*. Kurahashi (1971) followed Miller and placed *eudypti* as a synonym of *viridiventris*. Harrison (1976) used the name *huttoni* for *eudypti* and discussed the necessity for an investigation into the nomenclatural problems. I am unable to find a previously described *Calliphora eudypti*, and therefore reinstate Hutton's name *eudypti* here, but in the grammatically correct form *eudyptis* (after the subantarctic penguin genus *Eudyptes*).

Xenocalliphora flavipes (Lamb) new combination

Figures 100 and 101

Calliphora flavipes Lamb, 1909: 134. Holotype female, New Zealand, Auckland Islands, Carnley Harbour (BMNH) [examined].

HEAD dichoptic in both sexes. Frons in male as wide as eye, in female 1.3× as wide as eye. Ground colour black on jowls and back of head, elsewhere brownish-orange. Eyes with very sparse, minute, pale hairs. Interfrontalia matt, with numerous fine, black hairs. Parafrontalia densely dusted sandy brown, with a shifting spot centrally and numerous

fine, black setulae. Parafacialia sandy-dusted, with black setulae. Gular region prominent, with orange hairs. Interfacial membrane bare. Occiput grey-dusted, with pale hairs below. Frons with 7 or 8 *ori* setae, 2 *ors*, a prevertical, and a pair each of *vti* and *vte*. Vibrissae strong, crossed. Facial ridges with short, stout setulae on their entire length. Antennal segments orange; 3rd segment brown on anterior edge; arista brown, paler centrally, plumose to tip. Palpi yellow, flattened and dilated apically. Mentum matt brown.

THORAX. Ground colour black. Mesonotum densely dusted greyish-brown, with shifting, undusted patches and streaks. *Ac* 2 + 2, *dc* 3 + 3, 4 *h*, 2 *ph*, *ia* 2 + 1, 2 *pra*, 2 *sa*, 2 *pa*. Pleura grey-dusted, with fine, black setulae. Infra-alar bulla and the knob above it yellow. Propleuron with pale hairs. Mesopleural row complete. Pleurotergite with pale pile. Spiracles bright yellow. *Stpl* 1(2) + 1. Scutellum with a pair each of apical and discal setae and 2 pairs of laterals and basals.

WINGS. Veins, epaulet, basicosta, and subcostal sclerite yellow, the sclerite with black setulae. Stem-vein with 1 or 2 small hairs ventrally. Squamae creamy white or slightly brownish; lower lobe with dark hairs dorsally and white marginals; upper lobe with brown marginals.

LEGS yellow. Coxae, trochanters, and base of femora with a thin, white dusting. Fore tibia with 4 *ad* setae, 1 *pd*, and 1 *pv*; middle tibia with 2 *ad* setae, 1 *pd*, 2 *p*, and 1 *v*; hind tibia with a row of *ad* setae containing 4 or 5 stronger ones, 3 *pd*, and 2–5 *av*.

ABDOMEN. Ground colour black, with metallic purple reflections and thin, grey dusting. *T1+2* with a few lateromarginal setae; *T3* and *T4* with a row of marginals; *T5* with a row of marginal setae that are weaker medially, and a few stronger discals. Sternites blackish-brown, slightly metallic, with grey dusting and black setulae.

GENITALIA. Male hypopygium, Figures 100 and 101.

DIMENSIONS. Body length 7.0–11.0 mm; wing length 6.5–10.0 mm.

Type data. The **holotype** is in good condition, with only the right foreleg missing. It is mounted on a papered rectangle of cork which has written on it "J. [or G.(?)] V. Hudson, Calliphora flavipes Type C.G. Lamb, Carnley Harb., Auckland Is. Nov. 09". It is also labelled "Brit. Mus. 1931-156".

Material examined. Holotype, plus 9 non-type examples (6 males, 3 females; BMNH, LCNZ, NZAC).

— / Auckland Is.

Collected at around sea level up to 500 m (Mount Eden).

Taken in January and November.

Habitat records: "fern", "near shore", "stream rocks". Collecting methods noted: "malaise trap".

Remarks. Harrison (1976) was the first to mention this species since its description. Its status as a good species is here confirmed.

Xenocalliphora hortona (Walker)

Figures 102 and 103

Musca hortona Walker, 1849: 894. Holotype female, New Zealand (BMNH) [examined].

Musca icela Walker, 1849: 897. Holotype female, New Zealand (BMNH) [examined].

Calliphora rufipalpis Macquart, 1851: 216 (reprint 243). Lectotype female, America [error] (MNHN) [examined]; see designation below. Preoccupied by *rufipalpis* Macquart, 1834. **New synonymy**.

Calliphora aureopunctata Macquart, 1855: 130 (reprint 110). Lectotype male, New Zealand and Australia (BMNH); see designation below.

Somomya americana Rondani, 1863: 29 (replacement name for *rufipalpis* Macquart, 1851).

HEAD dichoptic in both sexes. Frons in male 1.3× as wide as eye, in female 1.5× as wide. Ground colour black. Eyes with very short, sparse, pale pile. Interfrontalia matt, with numerous fine, black setulae. Parafrontalia grey-dusted above, brassy-dusted below, with a shifting spot centrally and numerous fine, black setulae. Parafacialia with dense, brassy dusting and a few fine, short setulae. Jowls grey-dusted, with black setulae. Gular region prominent, with golden hairs. Occiput grey-dusted, with black setulae above and golden ones below. Frons with 7 or 8 *ori* setae, 2 *ors*, a prevertical, and a pair each of *vti* and *vte*. Vibrissae strong, crossed. Facial ridges with short, stout setulae for half their length. Antennal segments brown; apex of 2nd and base of 3rd orangy; arista blackish-brown, pale centrally, plumose for two-thirds of its length. Palpi yellow, flattened and dilated apically. Mentum matt brown.

THORAX. Ground colour black. Mesonotum with steel-grey dusting, indistinct brownish vittae, and less densely dusted areas. *Ac* 3 + 3, *dc* 3 + 3, 4 *h*, 2 *ph*, *ia* 3 + 2, 1 or 2 *pra*, 2 *sa*, 2 *pa*. Propleuron with pale hairs. Mesopleural row complete. Pleurotergite with pale pile. Spiracles bright orangy-yellow. *Stpl* 1 + 1. Scutellum with a pair each of apical, lateral, and discal setae and 2 pairs of basals.

WINGS. Veins brown; basicosta and epaulet bright orangy-yellow, the epaulet with strong setulae. Subcostal sclerite with black setulae. Ventral surface of stem-vein with 1 or 2 hairs. Squamae off-white; lower lobe with small, black setulae dorsally and white marginal hairs; upper lobe with long, brown marginal hairs.

LEGS. Coxae and femora blackish-brown, with grey dusting; trochanters, tibiae, and tarsi reddish-brown. Fore tibia with a row of short *ad* setae and 1 *pv* seta; middle tibia with 2 *ad* setae, 1 *pd*, 2 *p*, and 1 *v*; hind tibia with a row of *ad* setae including 3 or 4 stronger ones, 2–4 *pd*, and 2 *av*.

ABDOMEN. Ground colour black, with metallic blue reflections and thin, silvery, tessellate dusting. *T1+2* and *T3* with some long lateromarginal setae; *T4* with a complete row of marginal setae; *T5* with sparser, longer discals and a row of fine marginal setae. Sternites slightly metallic, with grey dusting and black setulae. Female: 6th tergite bisected; 6th sternite with long, dense, brown hairs; 9th sternite large, oval.

GENITALIA. Male hypopygium, Figures 102 and 103.

DIMENSIONS. Body length 5.5–5.8 mm; wing length 5.0–8.0 mm.

Type data. *Calliphora rufipalpis* Macquart, 1851: Macquart described this species from an unstated number of female specimens supposedly collected in America. From Paris I have received for study four females found under this name, two of which I find to be syntypes of *Calliphora rufipalpis* Macquart, 1843 (see discussion in Dear 1979, p. 180). The remaining two are without doubt syntypes of *Calliphora rufipalpis* Macquart, 1851, and belong in *Xenocalliphora*; their locality data must therefore be in error. One, labelled by Macquart "Calliphora rufipalpis ♀, Macq. n. sp.", is also labelled "3125.40" and has a recent label "Museum Paris Chili Pissis 124.38". It is in fair condition, with the left middle and hind legs missing and the mesonotum with pin damage. The second specimen is labelled "Museum Paris Chili Pissis 124.38" and is in poor condition. I have labelled, and here designate, the specimen with Macquart's label as **lectotype** and the second specimen as **paralectotype**. Both agree with the most recent interpretation of *Xenocalliphora hortona* (Walker) (e.g., Kurahashi 1971).

Calliphora aureopunctata: Macquart described this species from an unstated number of female specimens taken in Australia and New Zealand, from Bigot's collection. In the BMNH collections I have found under this name two male and two female specimens labelled "Ex coll. Bigot Brit. Mus. 1930-221". Although Macquart's description refers to the female only, I believe all four specimens to be syntypes as the males have the frons as broad as in the females. One male is labelled "Calliphora aureopunctata ♀ Macq. n.sp."; it is rather dusty. I have labelled, and here designate, the male with the determination label as **lectotype** and the other three specimens as **paralectotypes**. All four agree with the most recent interpretation of *Xenocalliphora hortona* (Walker) (e.g., Kurahashi 1971).

Material examined. Type series, plus 114 non-type examples (68 males, 46 females; BMNH, LCNZ, NZAC).

ND, AK, GB, TO, WN / SD, MC, SL / Chatham Is / Auckland Is / Campbell I. (also one record from "Otago" — BMNH, BM. 1936-768).

Collected at around sea level up to moderately low altitudes (highest apparently 360+ m, Taupo, TO).

Taken in all months except July.

Habitat records: "window", "dead stingray", "garden", "*Cotula coronopifolia*", "*Pimelea arenaria*", "roadside", "house". Collecting methods noted: "baited cylinder trap", "light trap", "swept", "general beating", "malaise trap".

Remarks. There has been some confusion in the use of the two Walker species names *hortona* and *icela*. Generally the name *hortona* has been applied to the hairy-eyed species *Ptilonesia auronotata*, and the *Xenocalliphora* species recognised here as *hortona* has been called *icela*. Hutton (1901, 1902), Miller (1939b, 1950), Murray (1954), and Harrison (1976) all made this error. Malloch (1924, 1930) and Kurahashi (1971) correctly assigned the names.

Xenocalliphora neozealandica (Murray)

Figures 104 and 105

Calliphora neozealandica Murray, 1954: 713. Holotype male, New Zealand, Orongaronga (NZAC) [examined].

?*Calliphora neohortona* Miller, 1939: 51. Holotype female, New Zealand, Lake Moana (lost or destroyed).

HEAD dichoptic in both sexes. Frons in male as wide as eye, in female 1.25× as wide as eye. Ground colour black, except on facial ridges and interfacial membrane, which are reddish-brown. Eyes with very short, sparse hairing. Interfrontalia matt, with numerous setulae, some of them strong. Parafrontalia grey-dusted above, brassy anteriorly, with shifting spots and numerous fine, black setulae. Parafacialia with brassy dusting, a median, golden, shifting spot, and numerous fine, black setulae. Jowls with slightly tessellate, grey dusting, black setulae, and a few orangy setulae posteriorly. Occiput dusted silvery-grey, with black setulae above and orange hairs below. Frons with 8 or 9 *ori* setae, 2 *ors*, a prevertical, and a pair each of *vti* and *vte*. Vibrissae strong, crossed. Facial ridges with short, stout setulae on two-thirds of their length. Antennal segments orangy-brown; 3rd segment more orangy at base; arista dark brown, plumose to tip.

Palpi yellow, flattened and dilated apically. Mentum matt brown.

THORAX. Ground colour black, with steel-grey dusting. Mesonotum with indistinct, undusted streaks. *Ac* 2 + 3, *dc* 3 + 3, 4 *h*, 2 *ph*, *ia* 3 + 1, 1 *pra*, 2 or 3 *sa*, 2 *pa*. Propleuron with pale hairs. Mesopleural row complete. Pleurotergite with pale pile. Spiracles bright yellow. *Stpl* 1 + 1. Scutellum with a pair each of apical, lateral, and discal setae and 2 pairs of basals; some specimens with an additional lateral.

WINGS slightly darkened basally; veins brown; epaulet and basicosta bright orangy-yellow. Subcostal sclerite with black setulae. Stem-vein with 2 or 3 hairs on ventral surface. Squamae off-white, only slightly infuscated brown; lower lobe with brown hairs dorsally and pale marginals; upper lobe with long, brown marginal hairs.

LEGS. Coxae and femora blackish-brown, with thin, grey dusting; trochanters, tibiae, and tarsi brown. Fore tibia with a row of short *ad* setae, 1 *pd*, and 1 *pv*; middle tibia with 3 *ad* setae, 1 *pd*, 2 *p*, and 1 *v*; hind tibia with a row of *ad* setae including some longer ones, 2 or 3 *pd*, and 2 or 3 short *av*.

ABDOMEN. Ground colour black, with metallic blue and purple reflections and very thin, grey dusting on *T1+2* to *T4*; *T5* brilliant metallic, contrasting with the other tergites. *T1+2* more densely dusted anteriorly, with a few laterc marginal setae; *T3* with a row of weak marginal setae which are stronger laterally; *T4* with a row of marginal setae; *T5* with a row of weak marginal setulae and some weak discals. Sternites black, grey-dusted, with black setulae. Female: 6th tergite bisected; 6th sternite as long as wide; 9th sternite long, triangular.

GENITALIA. Male hypopygium, Figures 104 and 105.

DIMENSIONS. Body length 8.0–11.0 mm; wing length 7.0–9.5 mm.

Type data. Holotype: male, "Orongaronga" [= Orongorongo Valley, WN], November 1950, J. Rudge (NZAC; transferred from ANIC). **Paratypes**: 1 male, 10 females, same data as holotype (BMNH); possibly also 36 females, same data as holotype (ANIC, BMNH).

Material examined. Type series, plus 50 non-type examples (9 males, 41 females; ANIC, BMNH, NZAC).

TK, HB, WN / NN, KA, NC, MC, WD, MK, FD.

Collected from somewhat above sea level to around 1500 m (Mount Fell, Mount Richmond, NN); several records indicate a propensity for higher altitudes.

Taken in January–April, August, and October–December.

Collecting methods noted: "malaise trap".

Xenocalliphora solitaria new species

Figures 106 and 107

MALE. HEAD dichoptic. Frons 1.25× as wide as eye. Ground colour black, except on interfacial membrane and facial ridges, which are orangy. Interfrontalia orangy-brown, with dark hairs above. Parafrontalia thinly dusted yellowish-grey, with a median, shifting spot and fine, dark setulae. Parafacialia with a yellowish dusting which is shifting basally, and with small, black setulae above. Jowls dusted silvery-grey, with black setulae. Gular region well developed, with black setulae. Occiput grey-dusted, with black setulae above and pale hairs below. Frons with 8 *ori* setae, 2 *ors*, a prevertical, and a pair each of *vti* and *vte*. Vibrissae strong, crossed. Facial ridges with short, stout setulae on two-thirds of their length. Antennal segments brown; 3rd orangy basally; arista brown, plumose to tip. (Palpi damaged.) Mentum matt brown.

THORAX. Ground colour black, with bluish-grey dusting. Mesonotum with indistinct, undusted streaks when viewed at various angles. *Ac* 2 + 3, *dc* 3 + 3, 4 *h*, 2 *ph*, *ia* 3 + 2, 1 *pra*, 2 (3) *sa*, 2 *pa*. Prosternum and propleuron with pale hairs. Mesopleural row complete, but lower setae weaker. Pleurotergite with pale pile. Anterior spiracle yellow, posterior one brown. *Stpl* 2 + 1. Scutellum with a pair each of apical, lateral, and discal setae and 2 pairs of basals.

WINGS. Veins brown; epaulet and basicosta yellow; subcostal sclerite yellow, with black setulae. Stem-vein with some hairs on ventral surface. Squamae weakly infuscated; lower lobe with brown dorsal hairs and white marginal ones; upper lobe with dark hairs ventrally and a brown fringe.

LEGS brown; coxae and femora grey-dusted. Fore tibia with a row of short *ad* setae and 1 *pv* seta; middle tibia with 2 *ad* setae, 1 *pd*, 2 *p*, and 1 *v*; hind tibia with a row of *ad* setae including 2 stronger ones, 2 *pd*, and 2 *av*.

ABDOMEN. Ground colour black, with dense, tessellate, silvery-grey dusting and weak, metallic brown reflections. *T1+2* with a few longer marginal setae; *T3*, *T4*, and *T5* each with a row of marginal setae; *T5* also with some stronger discal setae. Sternites grey-dusted, with black setulae.

GENITALIA. Male hypopygium, Figures 106 and 107.

DIMENSIONS. Body length 8.0 mm; wing length 7.5 mm.

Type data. **Holotype**: male, Chatham Islands, Pitt Island, Tipuangi [*sic*; Tupuangi] Gully, 29 February 1967, J.S. Dugdale (NZAC).

Xenocalliphora vetusta new species

Figures 108 and 109

HEAD dichoptic in both sexes. Frons in male as wide as eye, in female 1.25× as wide as eye. Eyes with very sparse, minute, pale hairs. Ground colour dark brown, except on interfacial membrane, which is orangy-brown, and on facial ridges and anterior jowls, which are orangy. Interfrontalia matt, reddish-brown anteriorly, with fine, dark setulae. Parafrontalia with dense, pale, brassy dusting which is shifting anteriorly, and with fine, black setulae. Parafacialia pale brassy-dusted, with a shifting spot medially and a few short, fine setulae above. Jowls dusted yellowish-silvery, with black setulae anteriorly and golden ones posteriorly. Gular region prominent, with golden hairs. Oral margin with some golden hairs. Occiput grey-dusted, with black hairs above and golden ones below. Frons with 6–8 *ori* setae, 2 *ors*, a prevertical, and a pair each of *vti* and *vte*. Vibrissae strong, crossed. Facial ridges with short, stout setulae for half their length. Antennal segments brownish-orange to orange; arista brown, paler centrally, plumose to tip. Palpi orangy-yellow, flattened and dilated apically. Mentum matt brown.

THORAX. Ground colour black, with grey dusting. Mesonotum with indistinct, undusted streaks when viewed at an angle. *Ac* 2 + 3, *dc* 3 + 3, 4 *h*, 2 *ph*, *ia* 3 + 2, 1 *pra*, 2 or 3 *sa*, 2 *pa*. Prosternum and propleuron with pale golden hairs. Mesopleural row complete; lower setae weaker. Pleurotergite with pale pile. Spiracles bright orangy-yellow. *Stpl* 1 + 1. Scutellum with a pair each of apical, lateral, and discal setae and 2 pairs of basals.

WINGS. Veins brown; epaulet and basicosta yellow; subcostal sclerite yellow, with black setulae. Squamae weakly infuscated; lower lobe with brown hairs dorsally and a fringe of pale hairs; upper lobe with brown marginal hairs.

LEGS. Coxae, trochanters, femora, and tarsi brown; tibiae reddish-brown, but orangy apically. Fore coxae densely grey-dusted; other coxae and all femora thinly grey-dusted. Fore tibia with a row of short *ad* setae and 1 *pv* seta; middle tibia with 2 *ad* setae, 1 *pd*, 2 *p*, and 1 *v*; hind tibia with a row of *ad* setae including some stronger ones, 2 or 3 *pd*, and 2 *av*.

ABDOMEN. Ground colour black, with bright metallic violet reflections and thin, silvery dusting visible only when viewed at an angle. *T1+2* with a few stronger lateromarginal setae; *T3* with a row of marginal setae that are stronger laterally; *T4* and *T5* with a row of strong marginal setae; *T5* also with a few stronger discal setae. Sternites with some metallic reflections, grey-dusted, with black setulae. Female with 6th tergite a complete arch.

GENITALIA. Male hypopygium, Figures 108 and 109.

DIMENSIONS. Body length 6.0–8.0 mm; wing length 5.5–7.0 mm.

Type data. **Holotype**: male, Three Kings Islands, Great Island, 1–3 January 1963, E.S. Gourlay (NZAC). **Paratypes** (15 males, 21 females, all Three Kings Is; BMNH, NZAC): 3 males, 7 females, same data as holotype; 10 males, 9 females, Castaway Camp, Nov 1970, at light, J. McBurney; 1 male, same data except coll. G. Ramsay; 3 females, Tasman Valley, Nov 1970, at night, G. Ramsay; 1 male, 2 females, same data but from *Leptospermum ericoides* and *Coprosma*.

Xenocalliphora viridiventris Malloch

Figures 110 and 111

Xenocalliphora viridiventris Malloch, 1930: 319. Holotype female, New Zealand, Campbell Island (CMNZ) [not examined].

HEAD dichoptic in both sexes. Frons in male as wide as eye, in female 1.3× as wide as eye. Ground colour black, except on facial ridges, which are orangy-brown. Interfrontalia matt, reddish-brown anteriorly, with numerous fine, black hairs. Parafrontalia brownish-dusted above, densely dusted greyish-brown below, with numerous fine, black setulae. Parafacialia densely dusted silvery-grey to brownish, with a shifting spot basally and numerous short, black setulae. Jowls grey-dusted, with numerous long, fine setulae. Gular region well developed, with orangy hairs. Occiput grey-dusted, with pale yellow hairs. Frons with 7 or 8 *ori* setae, 2 *ors*, a prevertical, and a pair each of *vti* and *vte*. Vibrissae strong, crossed. Facial ridges with short, stout setulae on their entire length, those near the vibrissae stronger. Antennal segments orangy; 3rd brownish anteriorly; arista brown, pale centrally, plumose almost to tip, the hairs below shorter. Palpi yellow, flattened and dilated apically. Mentum matt blackish-brown.

THORAX. Ground colour black. Mesonotum with dense, silvery-grey to brownish dusting and a shifting pattern of undusted patches and streaks. *Ac* 2 + 1, *dc* 2 + 3, 4 *h*, 2 *ph*, *ia* 1 + 1, 1 *pra*, 3 *sa*, 2 *pa*. Pleura dusted, brownish-grey, with fine, black setulae. Propleuron with pale and dark hairs. Mesopleural row complete. Pleurotergite with pale pile. Spiracles yellow. *Stpl* 2 + 1. Scutellum with

a pair each of apical and discal setae and 2 pairs of laterals and basals.

WINGS. Veins brownish-yellow; epaulet indented medially, brownish basally, yellow apically; basicosta yellow; subcostal sclerite yellow, with black setulae. Squamae creamy; lower lobe with fine, brown hairs dorsally and white marginal hairs; upper lobe with 1 or 2 hairs on disc and long, brown marginal hairs.

LEGS. Coxae dusted blackish-brown and grey; trochanters shiny brown; femora black, with grey dusting on proximal two-thirds and orangy-yellow dusting on distal one-third; tibiae and tarsi yellow. Fore tibia with 3 *ad* setae, 1 *pd*, and 1 *pv*; middle tibia with 2 or 3 *ad* setae, 2 *pd*, 2 *p*, and 1 *v*; hind tibia with a row of *ad* setae including 4 or 5 stronger ones, 2 *pd*, and 2 *av*.

ABDOMEN. Ground colour black, with bright metallic green reflections and very thin, silvery dusting which, when viewed at an angle, shifts about a median line. *T1+2* less metallic, with a few stronger lateromarginal setae; *T3* with lateromarginal setae; *T4* with a complete row of marginal setae; *T5* with a row of fine marginal setae and some fine discal setae. Sternites black, with grey dusting and black setulae.

GENITALIA. Male hypopygium, Figures 110 and 111.

DIMENSIONS. Body length 7.5–10.0 mm; wing length 7.0–8.5 mm.

Type data. As listed under authorship citation, above.

Material examined. Probable paratype female, plus 16 non-type examples (7 males, 9 females; BMNH, LCNZ, NZAC).

— / Campbell I.

Collected at around sea level up to 180 m (Beeman Hill).

Taken in January, November, and December.

Habitat records: "on ground". Collecting methods noted: "malaise trap".

NOTE ON *CALLIPHORA NOTHOCALLIPHORALIS* MILLER

Miller (1939b, p. 49) described this species from a single male collected in Nelson, but also mentions in a footnote the rearing of a male and female from fly-struck sheep. All three specimens appear to have been destroyed or lost. Miller's description suggests a very peculiar insect (unfortunately he lost the genitalia during dissection), and I believe it possible that he had a repaired specimen with the head of *C. quadrimaculata* and the abdomen and thorax of a golden blowfly. At any rate, I do not consider his description to represent any existing New Zealand calliphorid.

Subfamily CHRYSOMYINAE

Genus *Chrysomya* Robineau-Desvoidy

Chrysomya Robineau-Desvoidy, 1830: 444. Type-species *Chrysomya regalis* Robineau-Desvoidy, 1830, by subsequent designation of Coquillett (1910, p. 523).

Chrysomyia Agassiz, 1847: 85 (unjustified emendation of *Chrysomya* Robineau-Desvoidy).

Head of male holoptic or narrowly dichoptic. Arista plumose. Outer *ph* seta absent. Thoracic ground setulae reduced. Thorax and abdomen metallic green-blue. Suprasquamal ridge haired. Subcostal sclerite setose. Stem-vein haired dorsally. Lower squama haired to margin. Ovipositor telescopic. Oviparous.

Remarks. *Chrysomya* can be distinguished from all other New Zealand Calliphoridae by the hairs on the dorsal surface of the stem-vein.

Aspects of general morphology are illustrated in Figures 7, 14, and 21.

KEY TO SPECIES OF *CHRYSOMYA* OCCURRING IN NEW ZEALAND

01 Anterior thoracic spiracle blackish-brown; jowls orange, with orange hairs; head holoptic in male, the facets enlarged anteriorly; frons bowed anteriorly in female ... ***megacephala***

— Anterior thoracic spiracle white; jowls orange, darkened posteriorly and with white hairs; eyes in male separated by 2× width of anterior ocellus, the facets not enlarged anteriorly; frons parallel-sided in female ... ***rufifacies***

Chrysomya megacephala (Fabricius)

Figure 112

Musca megacephala Fabricius, 1794: 317. Holotype: "Guinea (Kiel Museum)" [not examined, no further data available].

Material examined. 1 female, MC, Springston, rotting apple, 31 Apr 1973 (LCNZ).

Remarks. The provenance of this specimen is open to doubt. *Chrysomya megacephala* is commonly found near houses, but not often indoors. It is especially attracted to sweet-smelling substances

such as rotting fruit, but breeds in carrion. The larvae can become facultative parasites in traumatic lesions of man and animals. Detailed notes on biology are given by Wijesundara (1957), and diagnostic characters of the larvae are illustrated by Zumpt (1965, p. 97).

This species has also been recorded from the Oriental and Austro-Oriental regions, Hawaii, Japan, southern China, the Philippines, and northern Australia.

Chrysomya rufifacies (Macquart)

Figures 7, 14, 21, 113, and 114

Lucilia rufifacies Macquart, 1843: 303 (reprint 146). Syntype males, Australia (lost or destroyed); see Type Data, below.

Chrysomya albiceps of authors, but not Wiedemann [misidentifications].

HEAD dichoptic in female; frons 2× as wide as anterior ocellus in male, 0.80× as wide as eye in female. Ground colour black except on face, interfacial membrane, and anterior jowls. Interfrontalia absent in male, in female reddish-brown with a thin, greyish dusting. Parafrontalia in male silvery-dusted on anterior half, with black setulae for entire length; female densely silvery-dusted, with black setulae on posterior third and white hairs anteriorly. Parafacialia, interfacial membrane, and jowls densely silvery-dusted, with white hairs. Occiput with slight metallic reflections, dusted silvery-grey, with white hairs. Male with an undusted margin below postocular setal row and without *ori* setae but with a pair each of *vti* and *vte*; female with 21–24 *ori* setae plus a prevertical, a *vti*, and a *vte*. Vibrissae strong, crossed with a second pair almost as strong; other setulae on oral margin pale. Facial ridge bare or with only 1 or 2 hairs on basal fifth. Antennal segments brown; apex of 2nd and base of 3rd more orangy; arista plumose to tip. Palpi yellow, flattened, slightly dilated apically. Mentum glossy brown.

THORAX. Ground colour black, with metallic green and blue reflections. Mesonotum with short, black vittae presuturally between setal rows *ac* and *dc*; suture black. Anterior postsutural area and postalar region black. Scutellum black anteriorly near suture. In frontal view, presutural area appearing silvery-dusted, and postsutural area brownish-dusted anteriorly and silvery posteriorly; scutellum brownish-dusted. In posterior view, only presutural area silvery-dusted. *Ac* 1 + 1, *dc* 3 + 4(5), 4 *h*, 2 *ph*, *ia* 1 + 1, 2 *pra*, 1 *sa*, 2 *pa*. Pleura undusted except at base of sternopleuron, all covered with white to pale golden hairs. Pleurotergite bare. Anterior spiracle white, posterior one brown. *Stpl* 1 + 1. Scutellum with a pair each of apical and basal setae, 4 pairs of laterals, and 2 pairs of discals.

WINGS. Veins blackish-brown. Basicosta and epaulet black. Stem-vein setulose dorsally. Squamae white; lower lobe triangular, slightly infuscated brown, haired to margin. Basal hairs pale, posterior ones brown.

LEGS black; fore femora with a slight metallic green reflection. Fore tibia with a row of short *ad* setae and 1 *pv* seta; middle tibia with 1 *ad*, 1 *pd*, 2 *pv*, and 1 *v*; hind tibia with 1 *ad*, 1 *av*, and 1 *pd*.

ABDOMEN. Ground colour black, with blue and green metallic reflections; without dusting dorsally, but with silvery-grey dusting ventrally. *T1+2* mostly black, the posterior margin with metallic reflections; *T3* with posterior margin black, a black median vitta, and 1 or 2 longer marginal setulae; *T4* with hind margin black, bearing a row of short setae; *T5* without distinct marginal setae but with longer, sparser ground setulae that are mostly white laterally, and in female with a dorsal incision on posterior margin. Sternites metallic blue-green, grey-dusted, with dark and pale setulae.

GENITALIA. Male hypopygium, Figures 113 and 114.

DIMENSIONS. Length of body 8.0–8.5 mm; length of wing 7.5 mm.

Type data. Macquart described this species from males collected in Australia, from the Guérin-Méneville Collection. I have found no material of this species in MNHN or Lille (Macquart's personal collection), and the fate of the Guérin-Méneville Collection is unknown. In the BMNH collections I have found two male specimens, one labelled by Macquart "Lucilia rufifacies Macq, ♂" and on the Bigot drawer label "S. rufifacies ♂, Lucilia id G., Australia. Guérin". The second specimen is unlabelled. Neither specimen bears the distinctive Guérin label, and so they are not considered to be syntypes.

Material examined. 70 non-type examples (19 males, 51 females; ANIC, BMNH, LCNZ, NZAC).

AK, WO, HB, ?WI, WN / NN, SD, KA.

Collected only at low elevations above sea level, even for inland records.

Taken in January–May, July, and November.

Habitat records: "human corpse", "dead stingray", "lagoon", and "swamp". Collection methods noted: "swept".

Remarks. The life history of *Chrysomya rufifacies* is described by Morris (1959). It is a typical agent of secondary myiasis, being unable to strike sheep without prior infestation by primary invad-

ers. It appears to strike only in hot, dry weather, but unlike other blowfly invaders can cause extensive tissue damage, and even invade the muscles. The larvae are unusual in having fleshy processes, and in being predatory on other fly larvae in the breeding medium. Characters of the larvae are described and illustrated by Holloway (1985, p. 14; Figure 116).

This species has also been recorded from the Oriental, Austro-Oriental, and Australasian regions, Japan, the Philippines, Fiji, and Samoa.

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NOTE ADDED IN PRESS

The note on p. 47 supplied by Knut Rognes is now amplified by a publication brought to our notice in November 1985. In this, the name *pseudorudis* is proposed for the *rudis*-like species recently recorded in New Zealand.

Rognes, K. 1985: A check-list of Norwegian blow-flies (Dipt., Calliphoridae). *Fauna norvegica, series B, 32*: 89–93.

ILLUSTRATIONS

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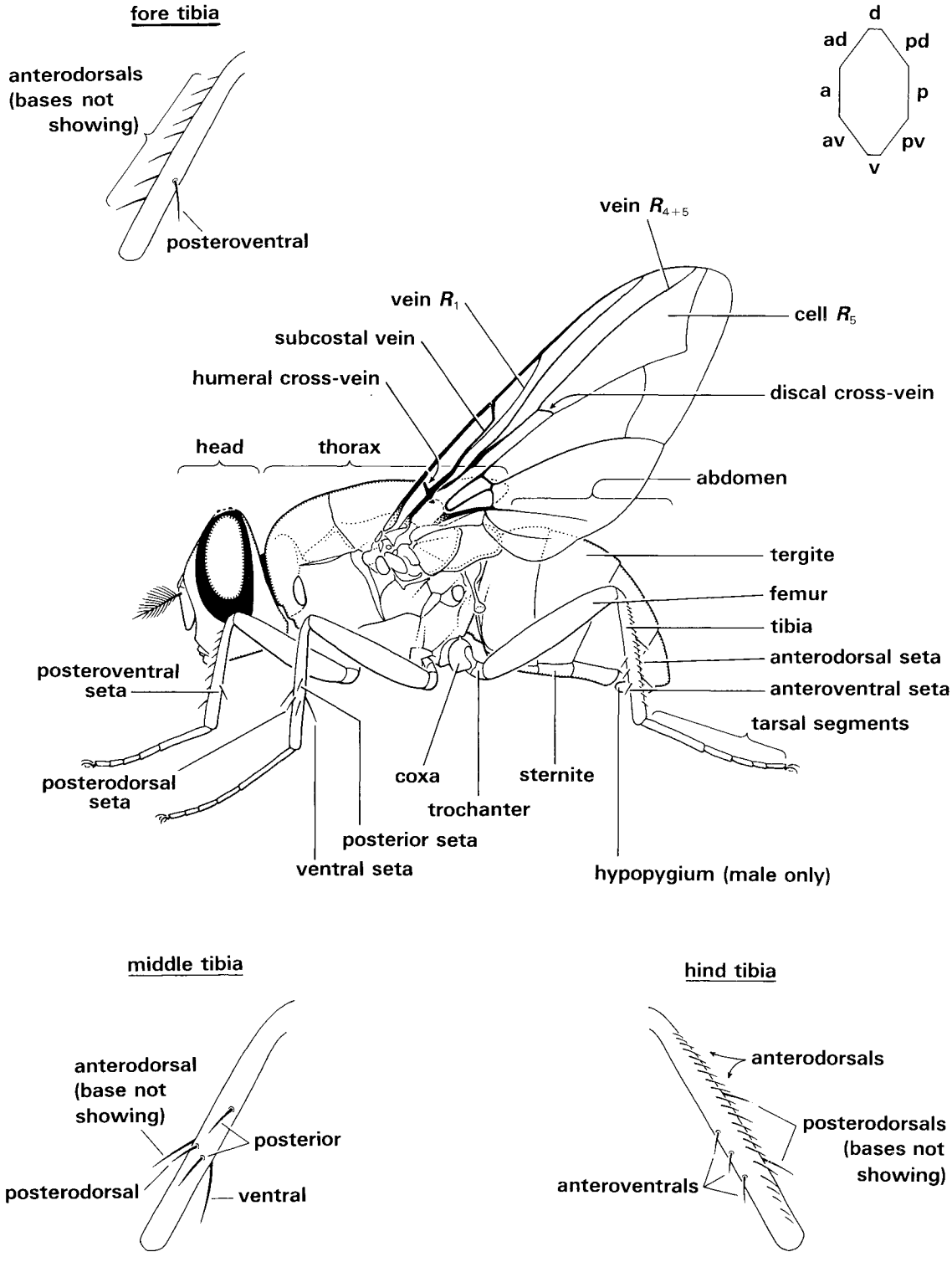
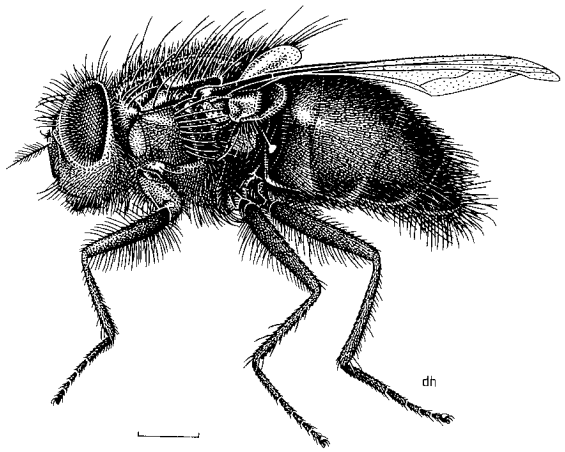
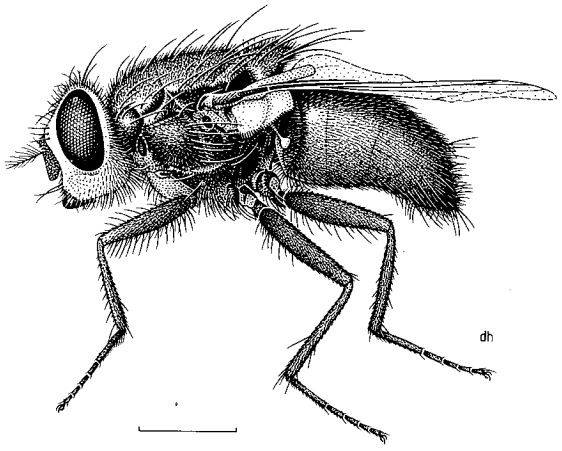
Figure 1 Schematic drawing of lateral aspect of a typical calliphorid (based on *Lucilia sericata*), showing major structural features, leg setation, and wing venation. Key to section through leg: a, anterior; ad, anterodorsal; av, anteroventral; d, dorsal; p, posterior; pd, posterodorsal; pv, posteroventral; v, ventral.

Figures 2–7 Habitus drawings, in lateral view, of species representing the genera of New Zealand Calliphoridae; scale lines represent 2.0 mm. *Artist: D.W. Helmore.*

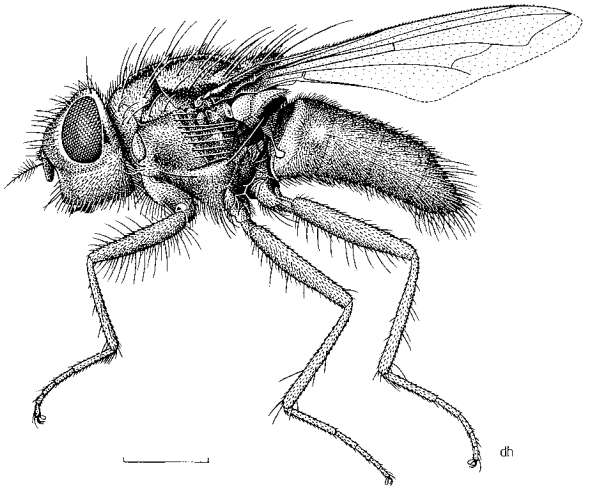

fore tibia
anterodorsals (bases not showing)
posteroventral
d
ad
pd
a
p
av
pv
v
vein R_{4+5}
vein R_1
cell R_5
subcostal vein
humeral cross-vein
discal cross-vein
head
thorax
abdomen
tergite
femur
tibia
anterodorsal seta
anteroventral seta
tarsal segments
posteroventral seta
posterodorsal seta
coxa
sternite
trochanter
posterior seta
ventral seta
hypopygium (male only)
middle tibia
anterodorsal (base not showing)
posterior
posterodorsal
ventral
hind tibia
anterodorsals
posterodorsals (bases not showing)
anteroventrals



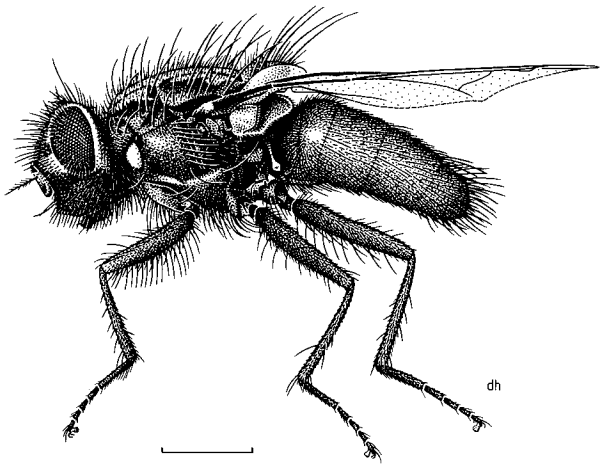
2. *Calliphora quadrimaculata*, ♀



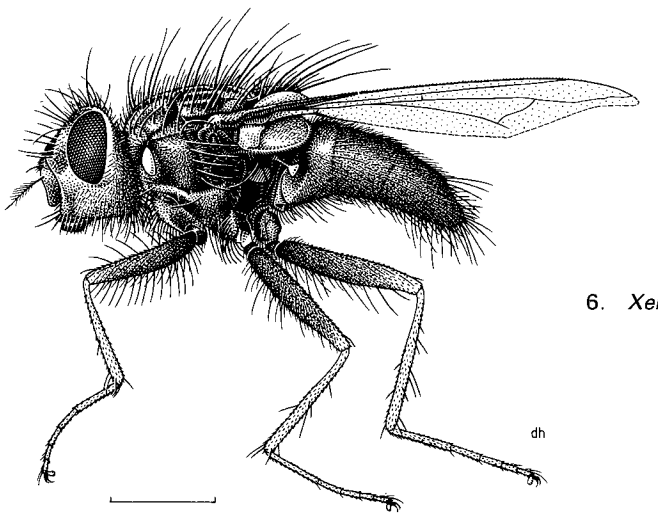
3. *Lucilia sericata*, ♀



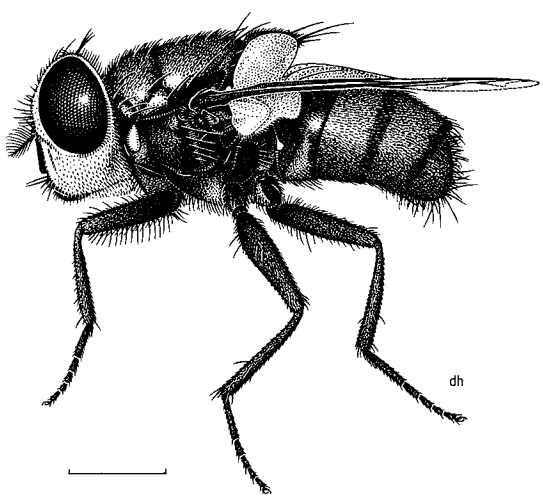
4. *Pollenia dyscheres*, ♀



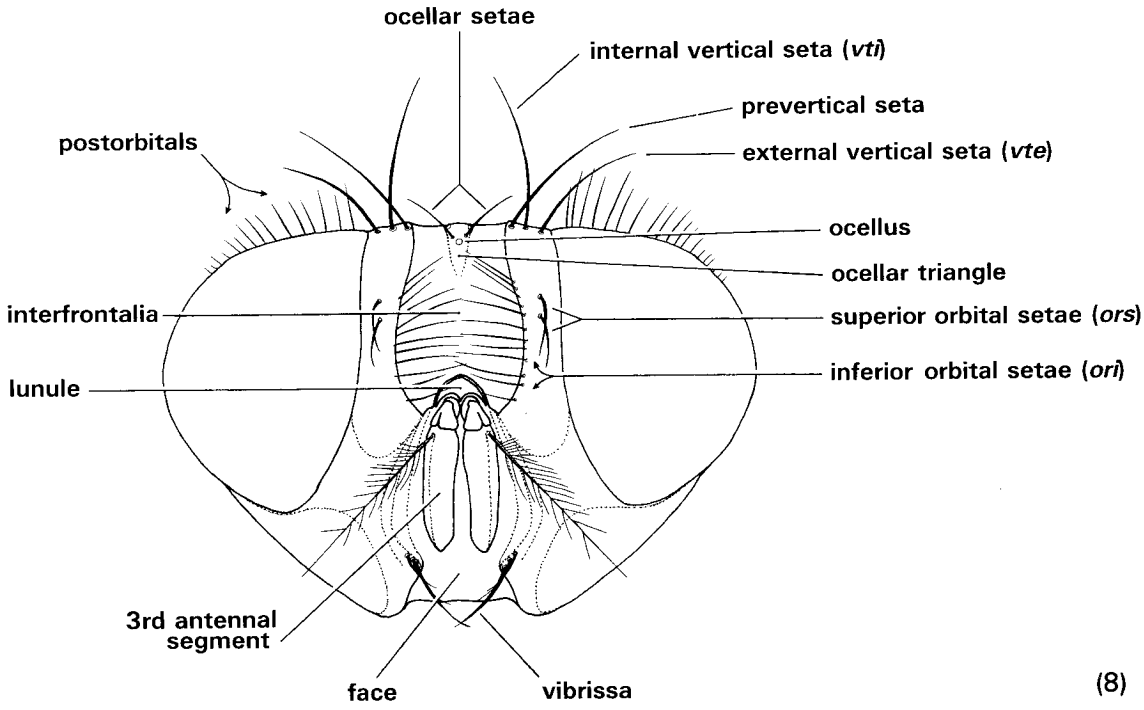
5. *Ptilonesia auronotata*, ♀



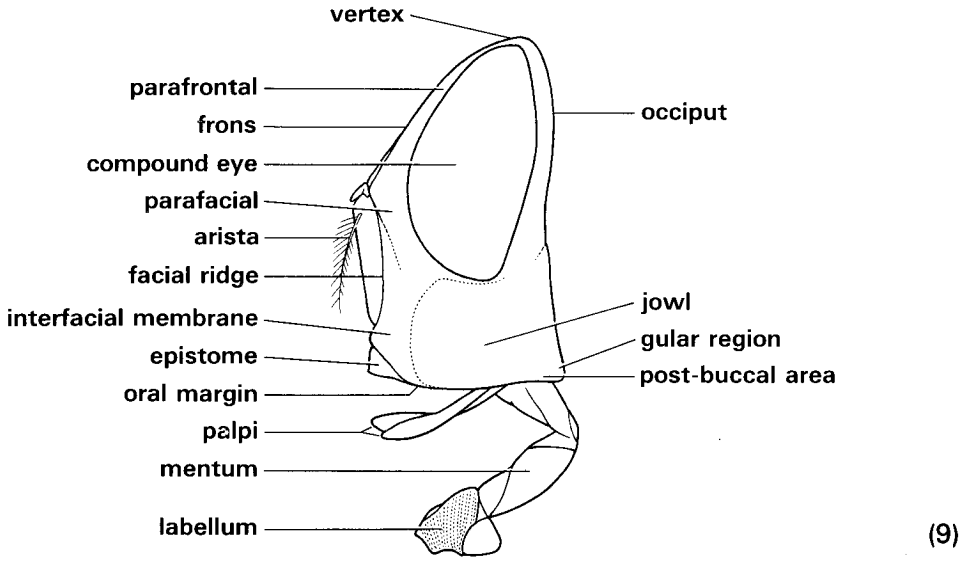
6. *Xenocalliphora eudyptis*, ♀

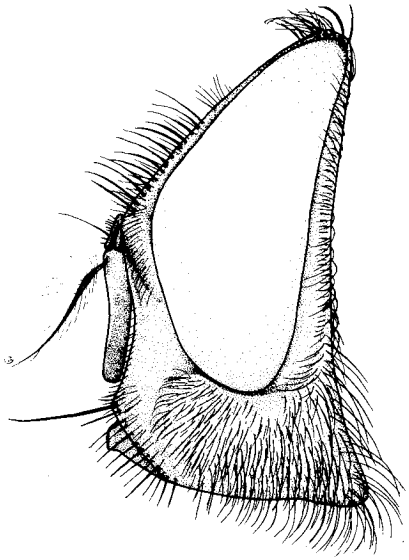


7. *Chrysomya rufifacies*, ♀

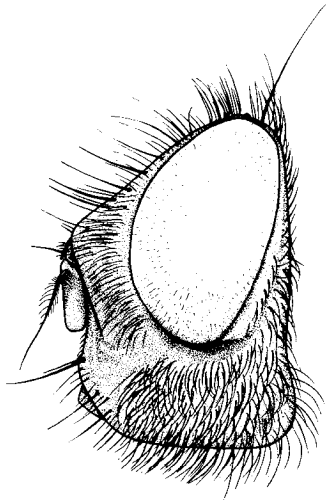


Figures 8 and 9 Schematic diagrams of head of *Calliphora quadrimaculata*: (8) female, frontal view; (9) male, lateral view.

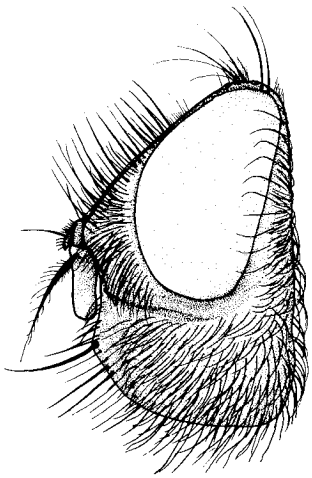




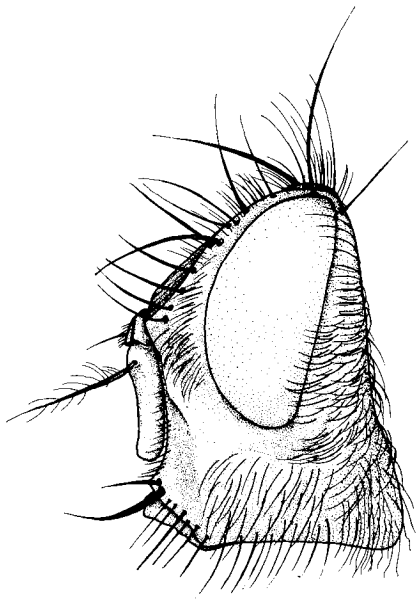
10. *Calliphora stygia*



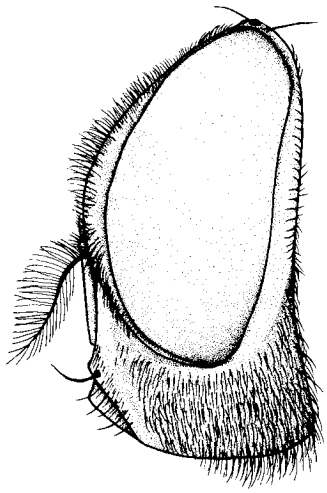
11. *Pollenia dyscheres*



12. *Ptilonesia auronotata*

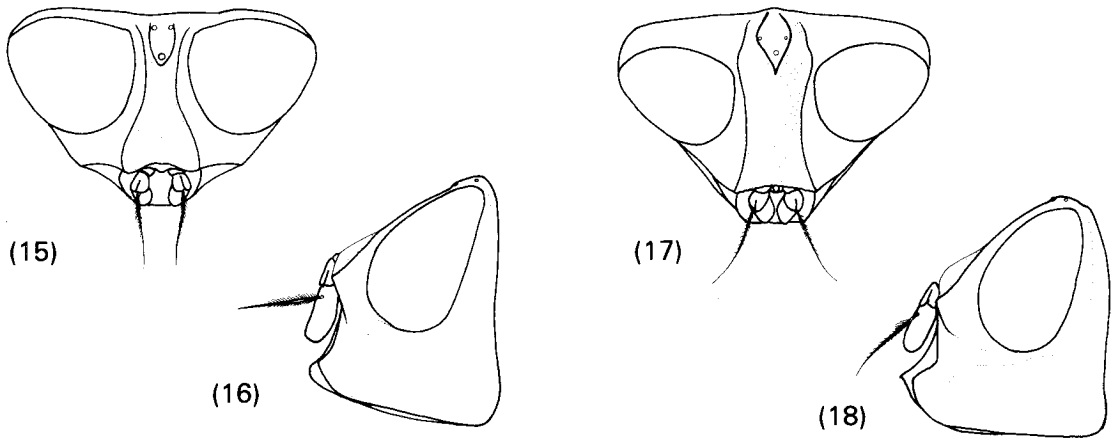


13. *Xenocalliphora eudyptis*



14. *Chrysomya rufifacies*

Figures 10–14 Details of head shape and setation, in lateral view, of males representing five calliphorid genera.



Figures 15–18 Diagrams of head structure, in dorsal and lateral view, of (15, 16) *Pollenia consanguinea* and (17, 18) *P. eurybregma.*

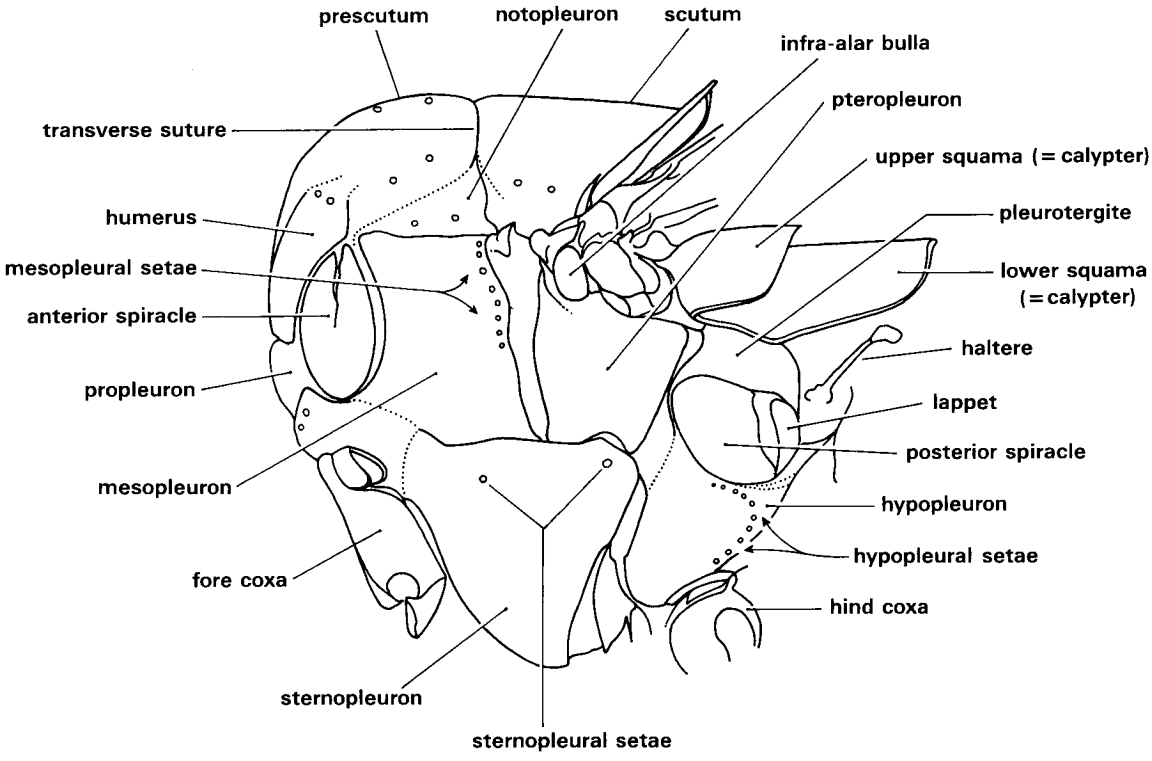


Figure 19 Schematic diagram, in lateral view, of thorax of *Calliphora quadrimaculata.*

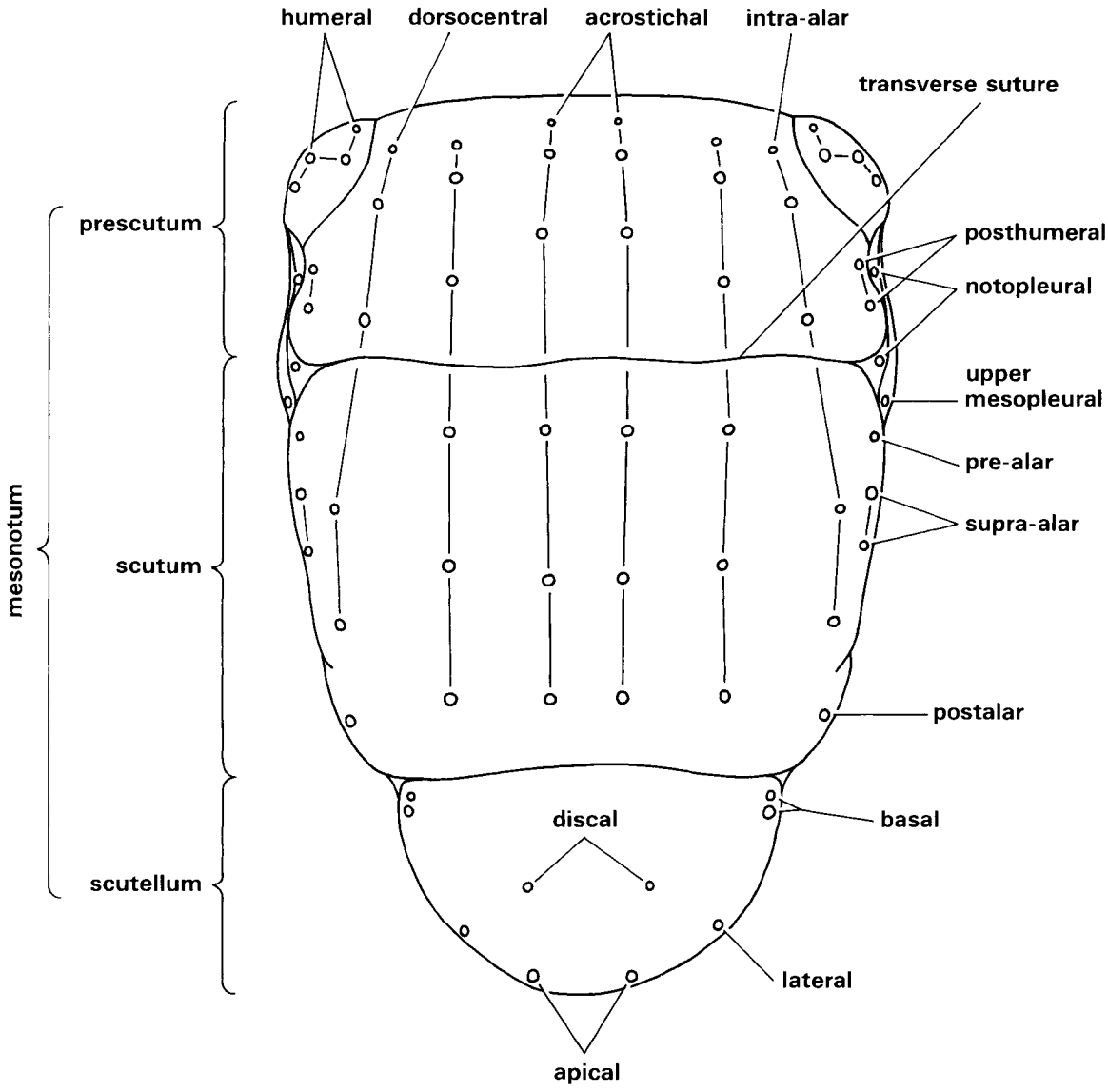
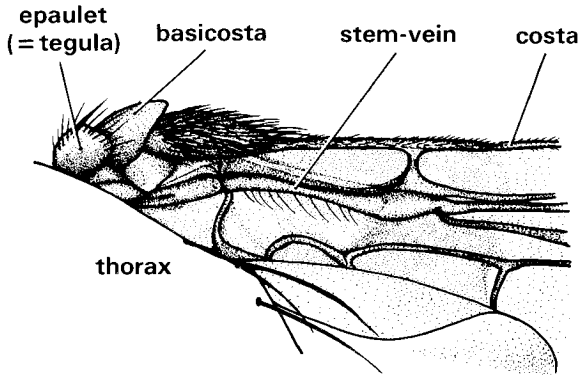


Figure 20 Schematic diagram, in dorsal view, of thorax of *Calliphora vicina*, showing disposition of setal insertions.



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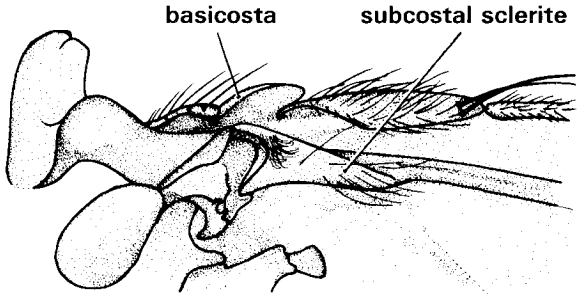


(22)

Figures 21 and 22 Details of wing base structure in (21) *Chrysomya rufifacies*, dorsal view, and (22) *Xenocalliphora eudyptis*, ventral view.

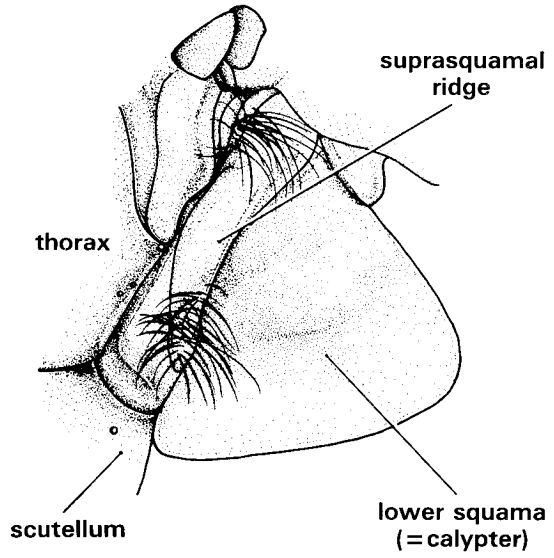


Figure 23 Details of squamal region of *Lucilia sericata*, in dorsal view.

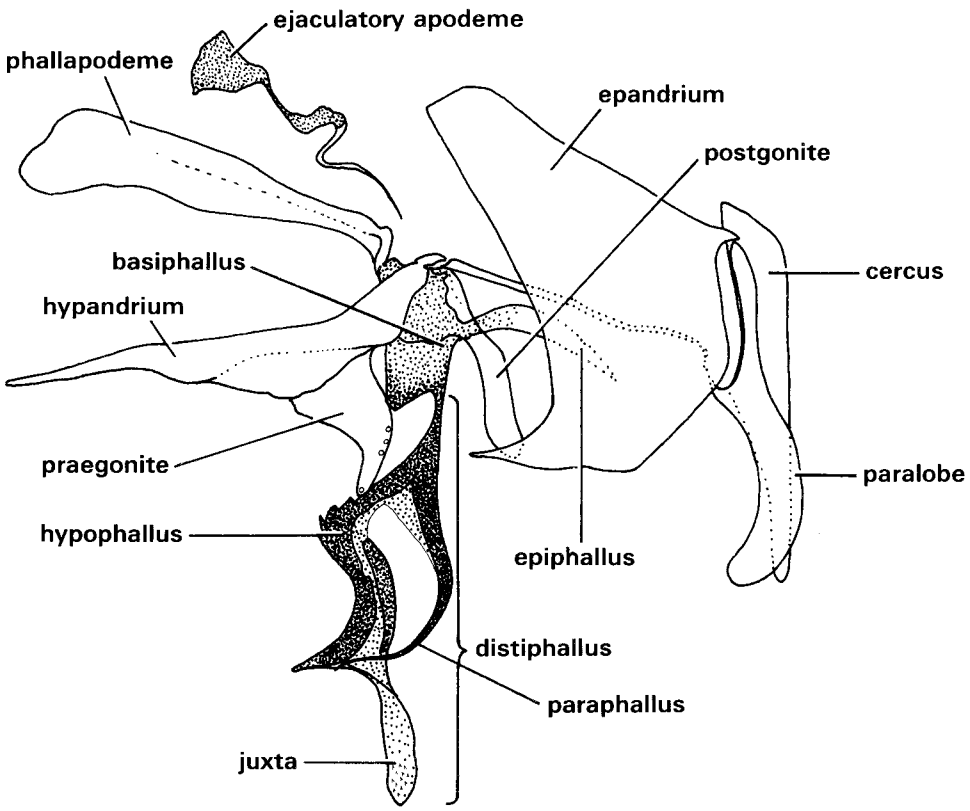
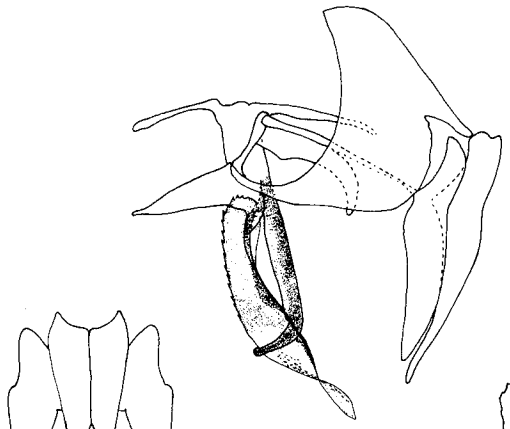


Figure 24 Schematic diagram, in lateral view, of male hypopygium of *Calliphora quadrimaculata.*



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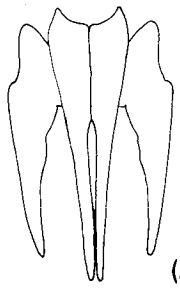
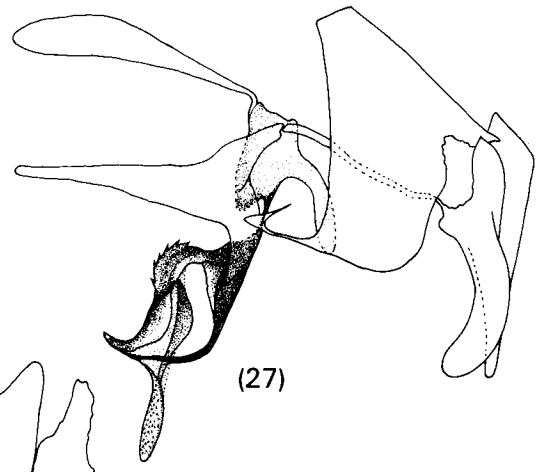


(26)

25, 26. *Calliphora hilli*



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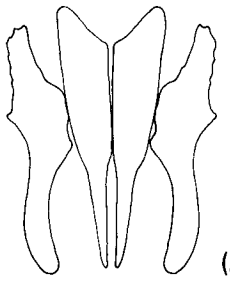
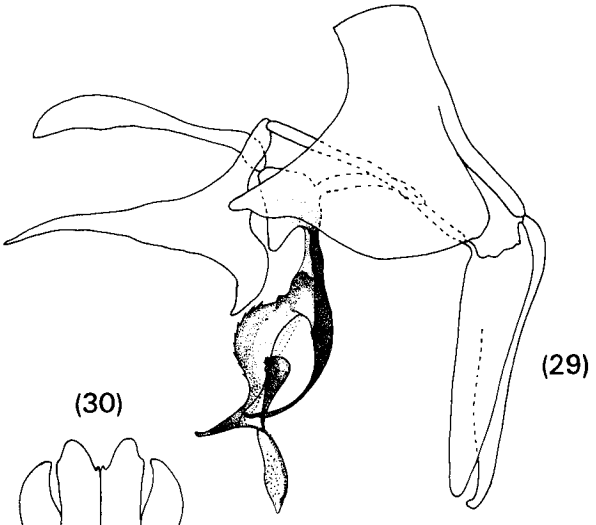


(28)

27, 28. *Calliphora quadrimaculata*



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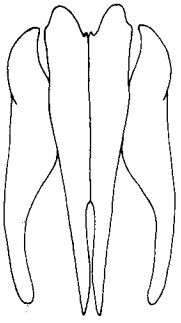
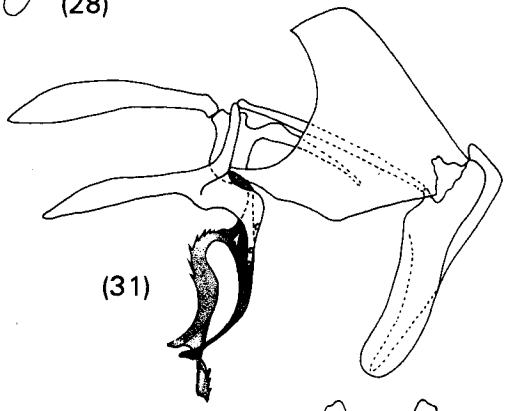


29, 30. *Calliphora stygia*



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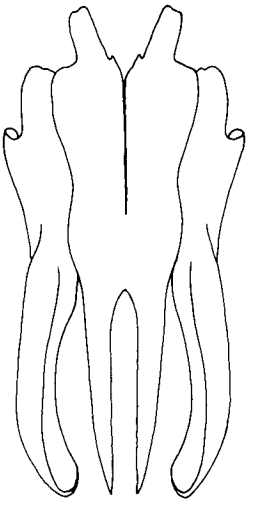
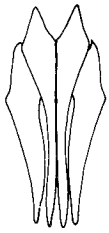


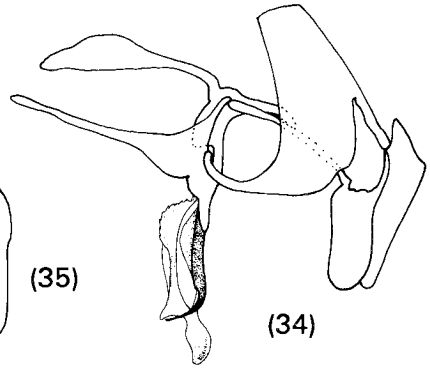
31, 32. *Calliphora vicina*

Figures 25–114 Diagrams of hypopygium structure in males of Calliphoridae, comprising left lateral views with (stippled) or without details of internal organs, and cerci plus paralobes in caudal view.



33. *Lucilia cuprina*

(33)



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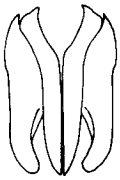
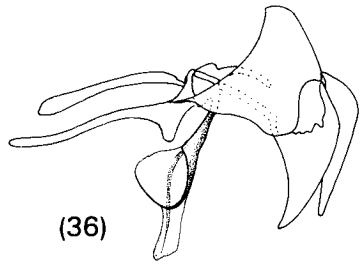


(35)

34, 35. *Lucilia sericata*



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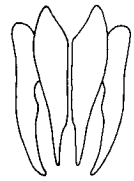
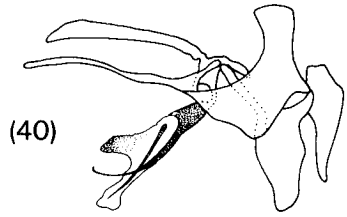


(37)

36, 37. *Pollenia advena*



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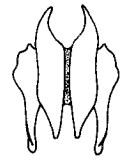
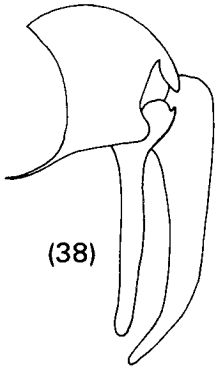


(41)

40, 41. *Pollenia antipodea*



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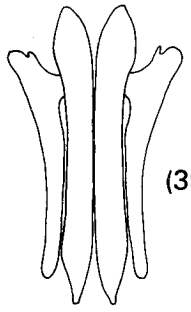
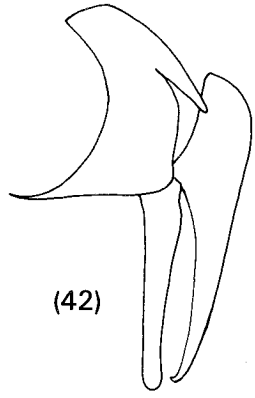


(39)

38, 39. *Pollenia aerosa*



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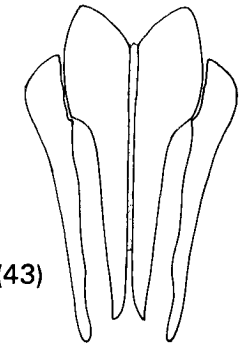
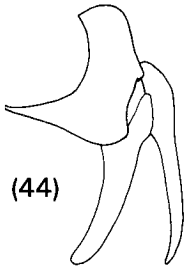


(43)

42, 43. *Pollenia atricoma*



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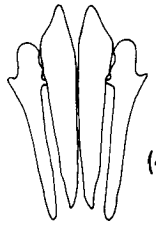
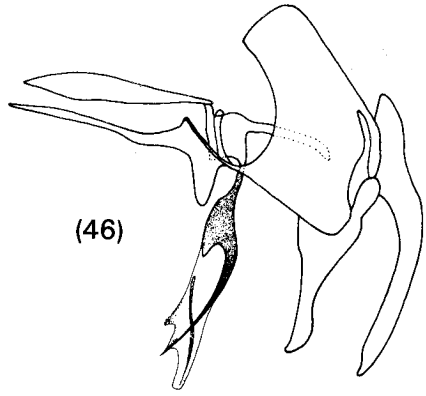
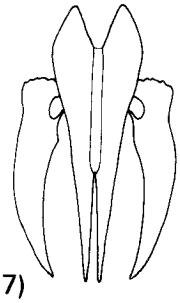


(45)

44, 45. *Pollenia commensurata*

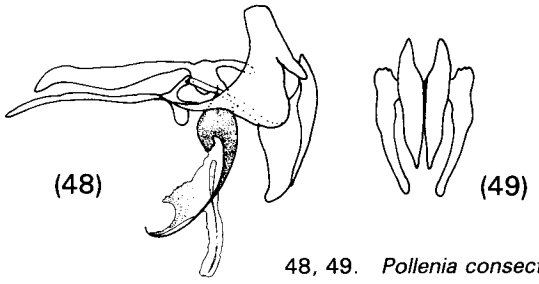


(46)

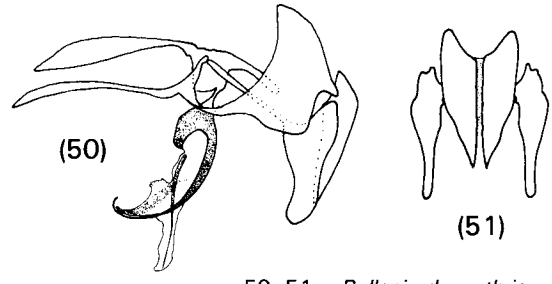


(47)

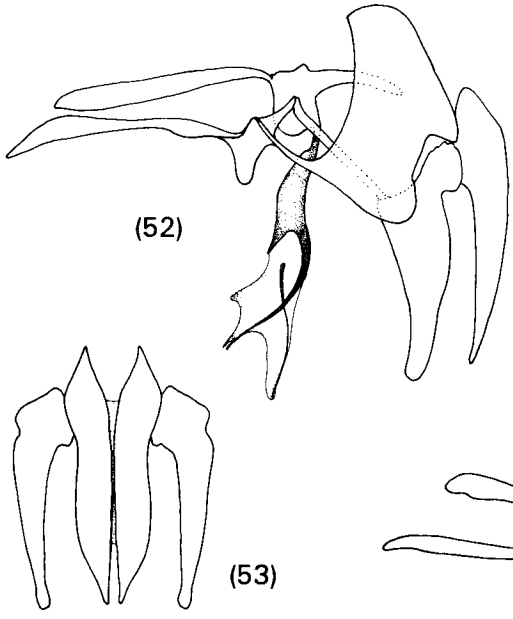
46, 47. *Pollenia consanguinea*



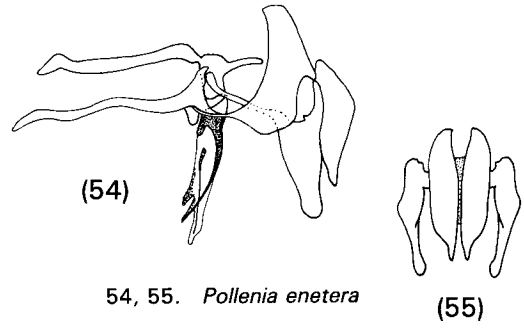
48, 49. *Pollenia consectata*



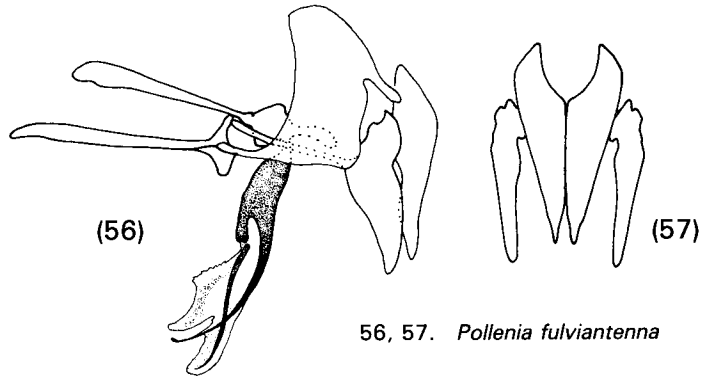
50, 51. *Pollenia dysaethria*



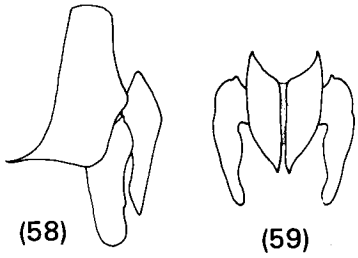
52, 53. *Pollenia dyscheres*



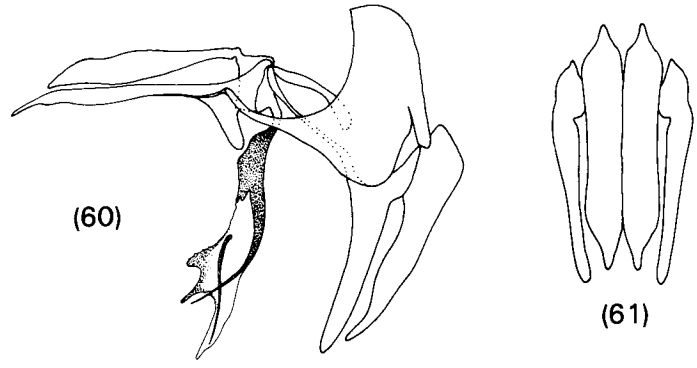
54, 55. *Pollenia enetera*



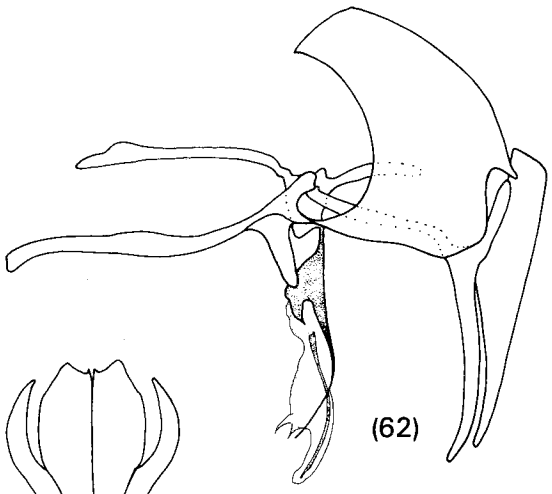
56, 57. *Pollenia fulviantenna*



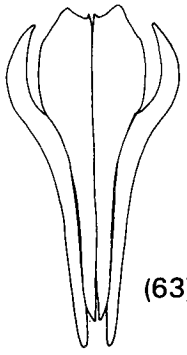
58, 59. *Pollenia fumosa*



60, 61. *Pollenia hispida*

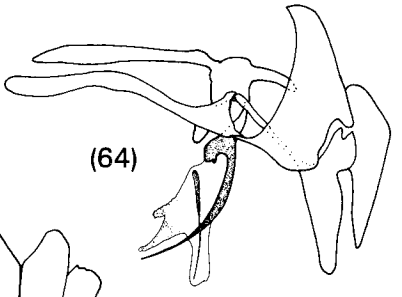


(62)



(63)

62, 63. *Pollenia immanis*



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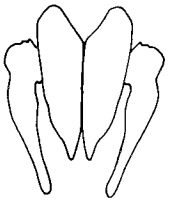

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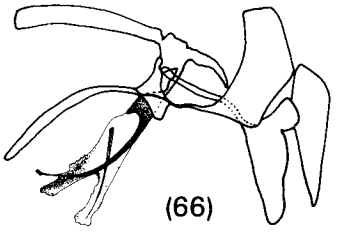
64, 65. *Pollenia insularis*



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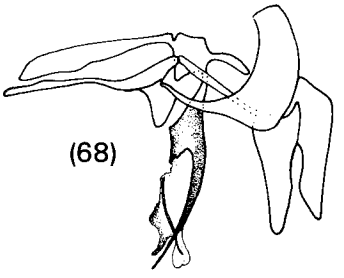
66, 67. *Pollenia lativertex*



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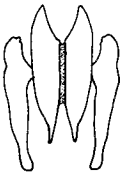

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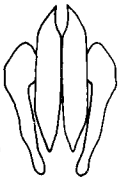
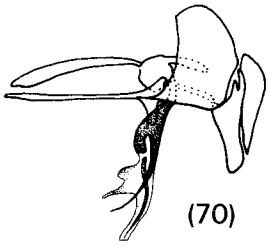


(69)

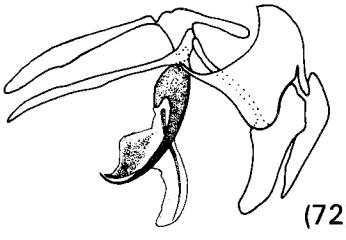
68, 69. *Pollenia limpida*



(70)

(71)

70, 71. *Pollenia nigripalpis*



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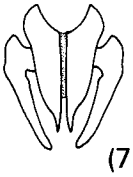
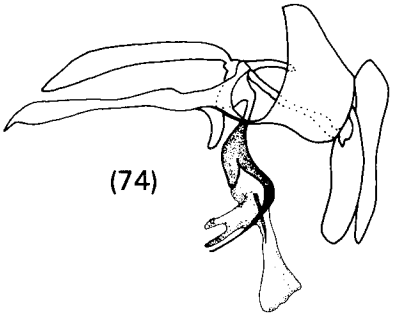


(73)

72, 73. *Pollenia nigripes*



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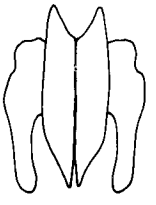
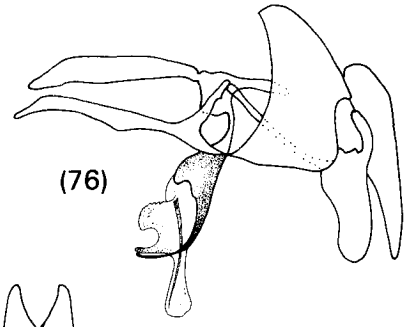
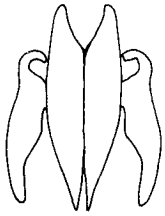


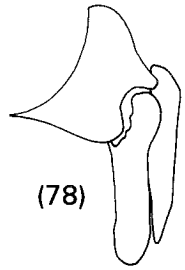
(75)

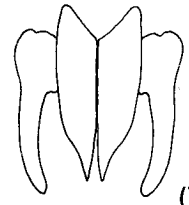
74, 75. *Pollenia nigrisquama*



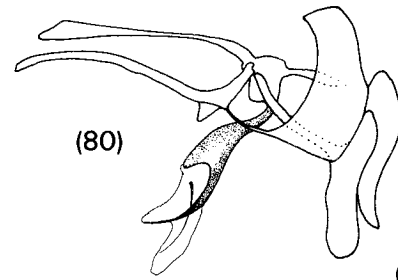


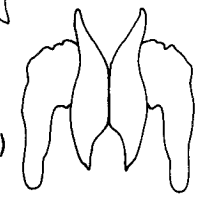
76, 77. *Pollenia notialis*



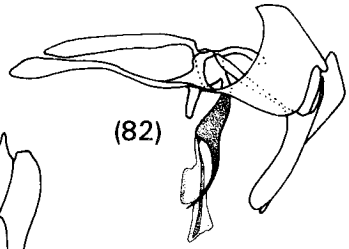


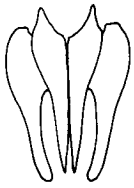
78, 79. *Pollenia opalina*



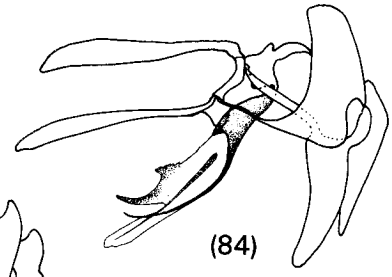


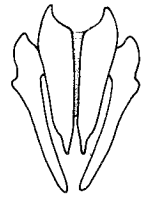
80, 81. *Pollenia pernix*



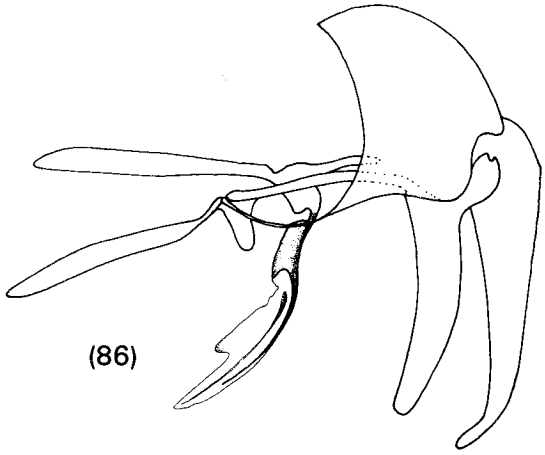


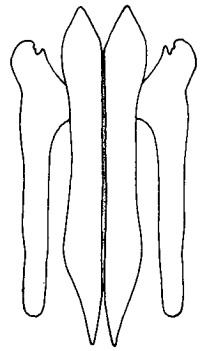
82, 83. *Pollenia primaeva*



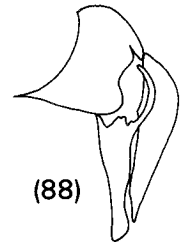


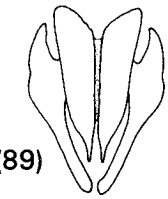
84, 85. *Pollenia pulverea*



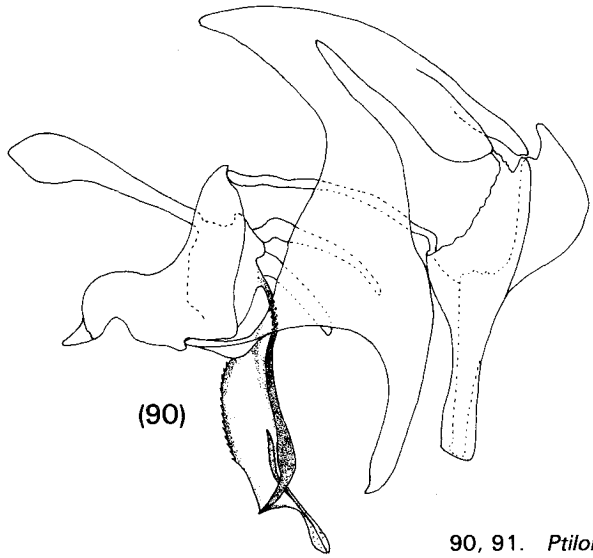


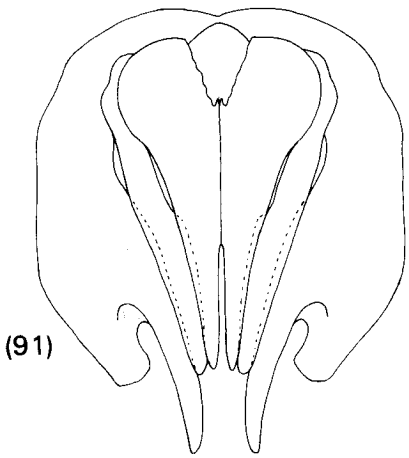
86, 87 *Pollenia sandaraca*



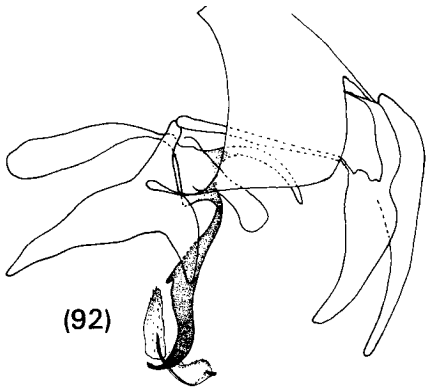


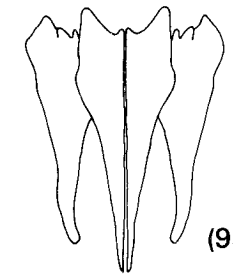
88, 89. *Pollenia scalena*



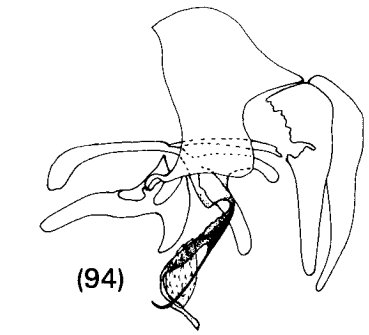


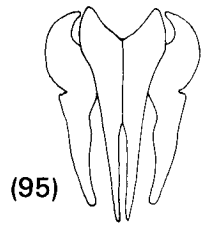
90, 91. *Ptilonesia auronotata*



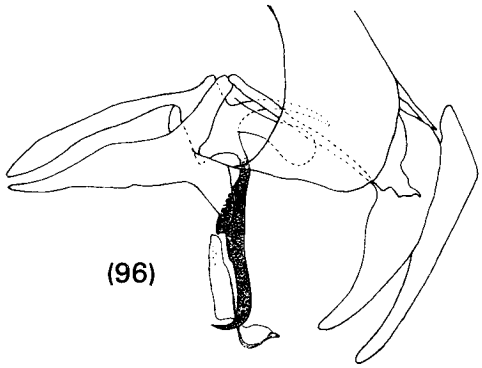


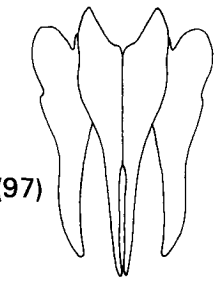
92, 93. *Xenocalliphora antipodea*



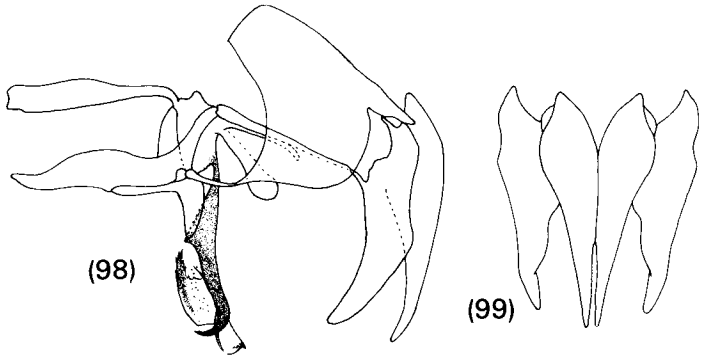


94, 95. *Xenocalliphora clara*

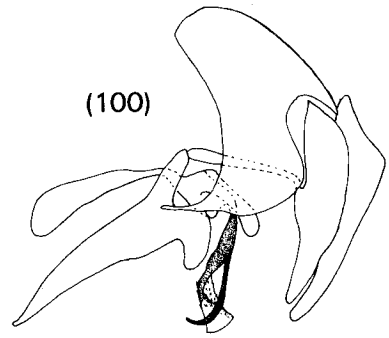


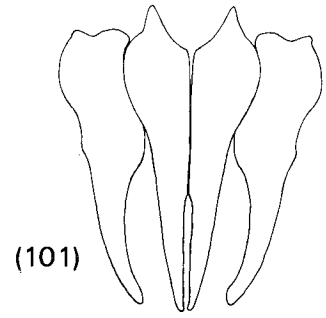


96, 97. *Xenocalliphora divaricata*

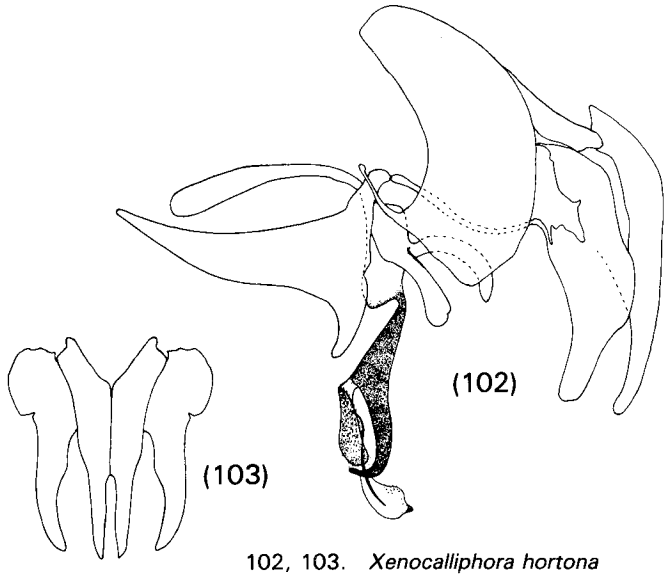


98, 99. *Xenocalliphora eudyptis*

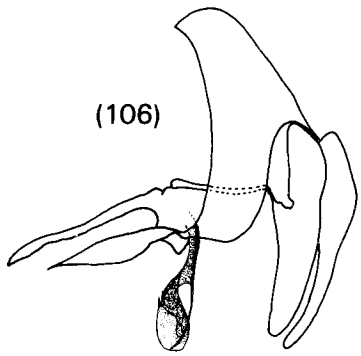


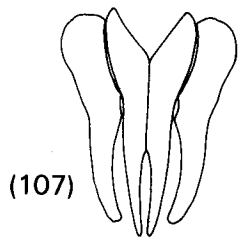


100, 101. *Xenocalliphora flavipes*

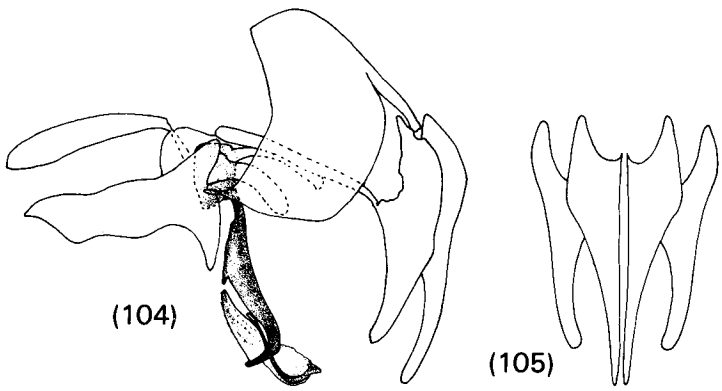


102, 103. *Xenocalliphora hortona*

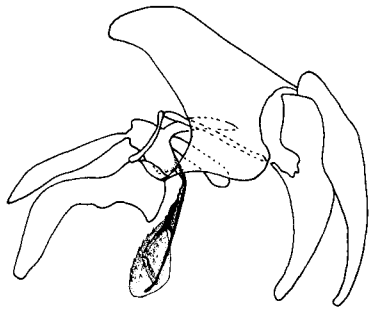




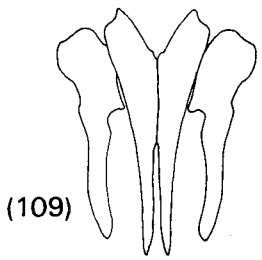
106, 107. *Xenocalliphora solitaria*



104, 105. *Xenocalliphora neozealandica*

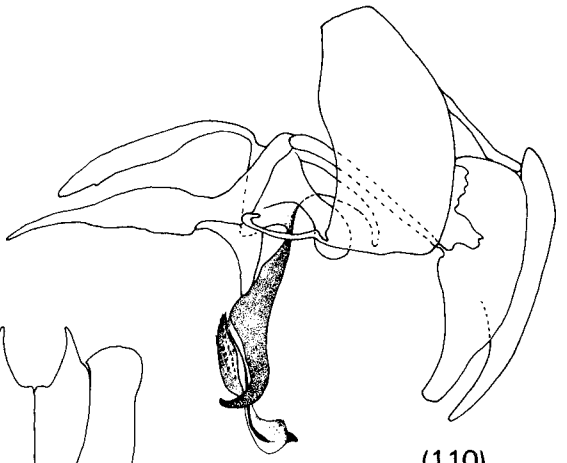


(108)



(109)

108, 109. *Xenocalliphora vetusta*



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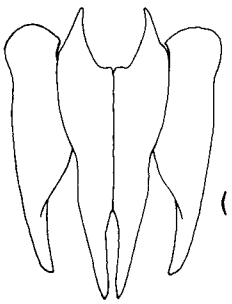
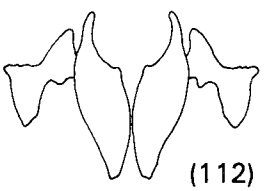


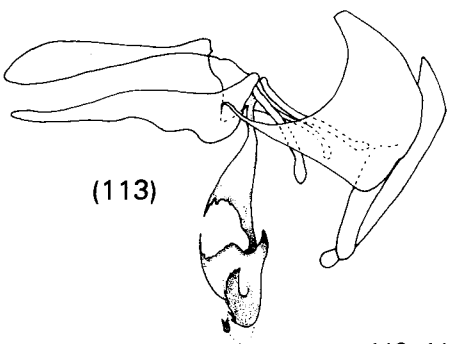
(111)

110, 111. *Xenocalliphora viridiventris*



(112)

112. *Chrysomya megacephala*



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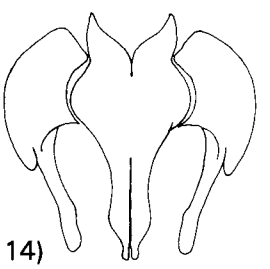
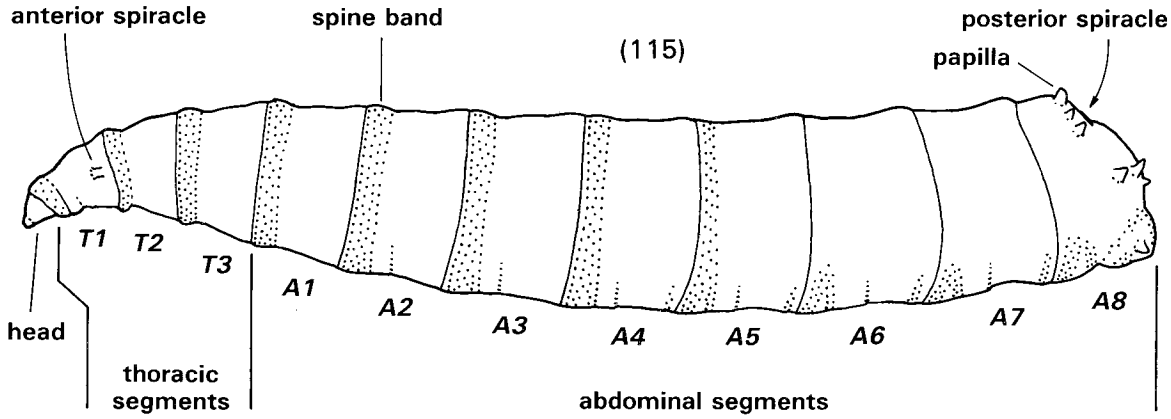
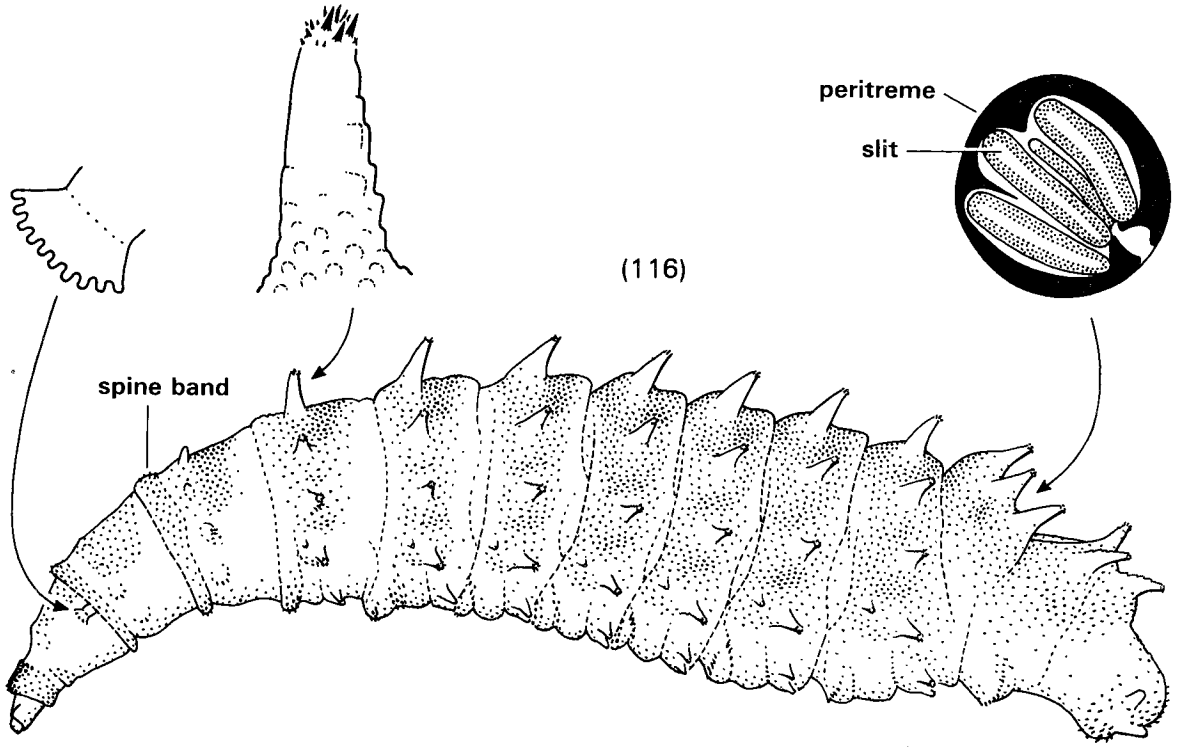


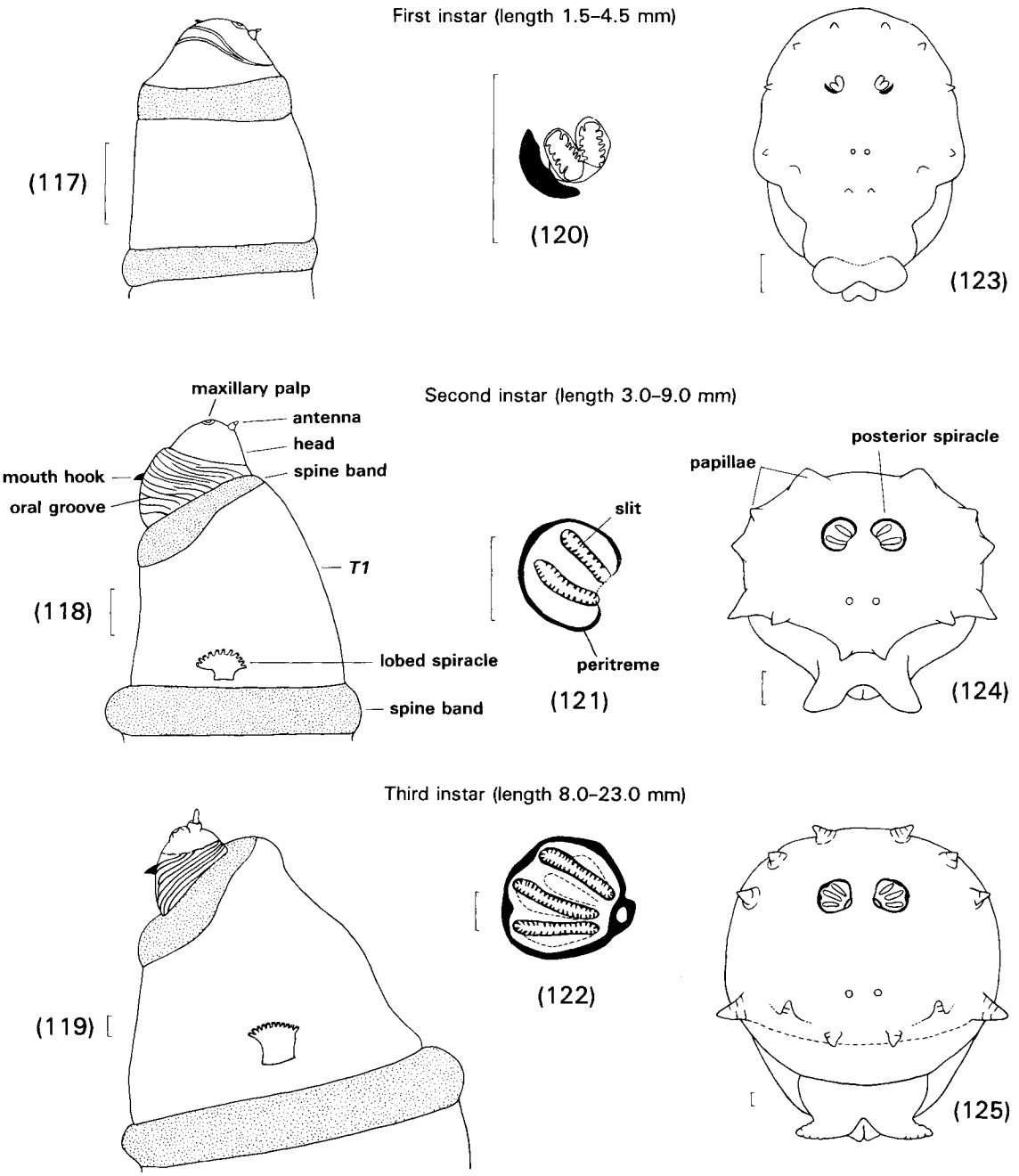
(114)

113, 114. *Chrysomya rufifacies*



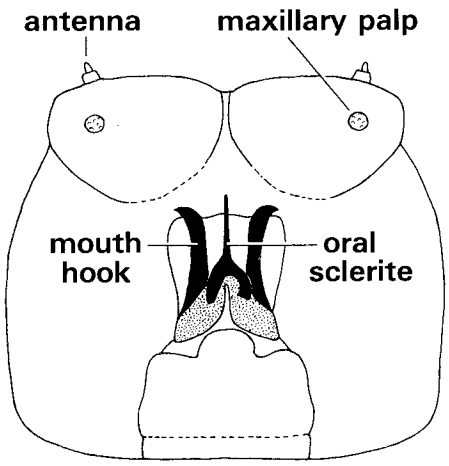
Figures 115 and 116 Morphology of 3rd-instar larvae of (115) *Calliphora stygia* and (116) *Chrysomya rufifacies*, in lateral view, with details of anterior spiracle, papilla, and posterior spiracle of *C. rufifacies*.





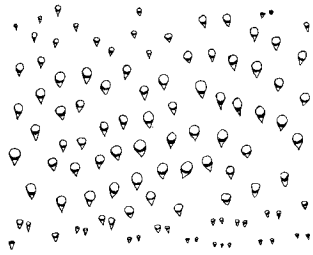
Figures 117–125 Relative development of external structures in larval instars of *Calliphora stygia*: (117–119) head and *T1*, left lateral view; (120–122) posterior spiracle; (123–125) posterior end of body, caudal aspect. Scale lines represent 0.1 mm.

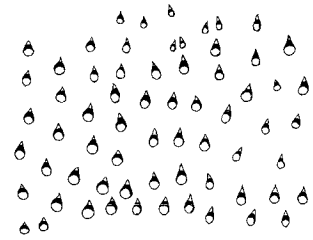
(126)



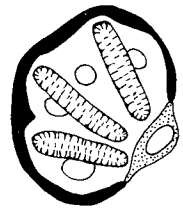
126–129. *Calliphora hilli*

(127)



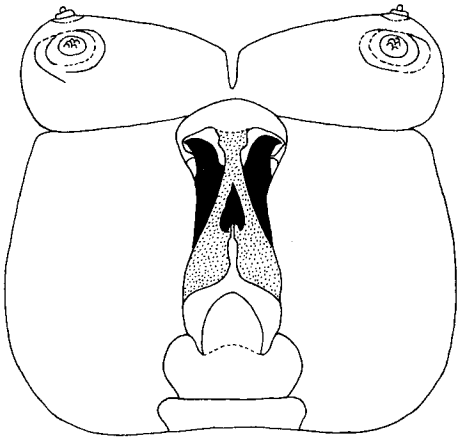


(128)



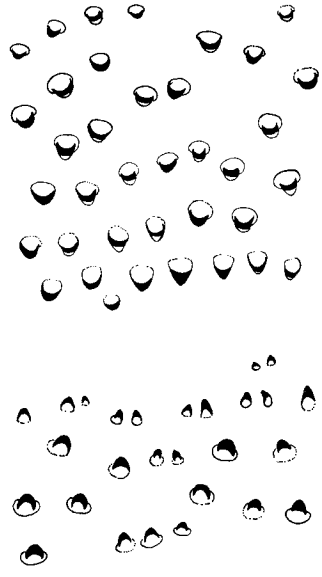
(129)

(130)

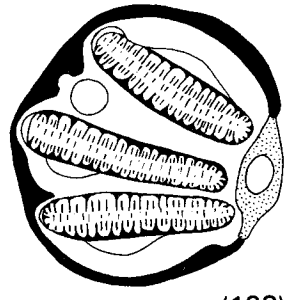


130–133. *Calliphora quadrimaculata*

(131)

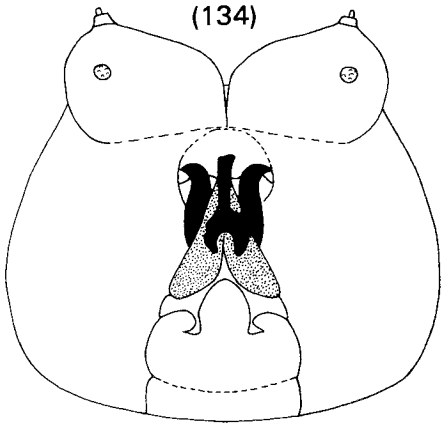


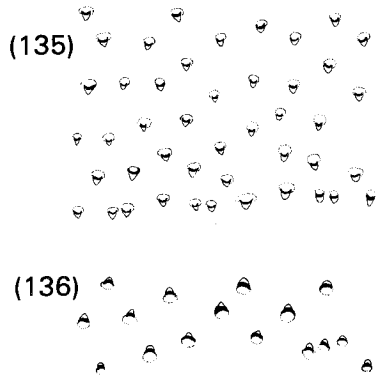
(132)

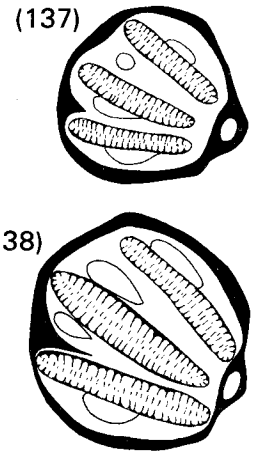


(133)

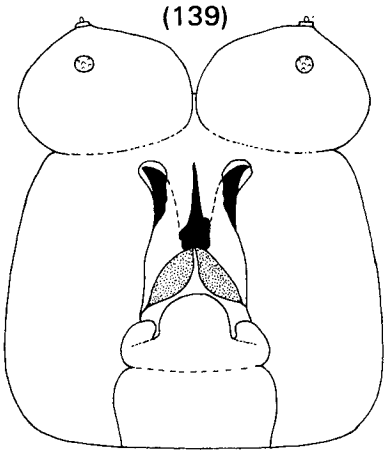
Figures 126–148 Diagnostic features of 3rd-instar larvae of five common species of Calliphoridae. From left to right: head, ventral view (oral grooves omitted); dorsomedian area of spine bands *A1/A2* (above) and *A7/A8* (below); and posterior spiracle. Where two spiracles are shown, they represent variants recorded from specimens of similar size.

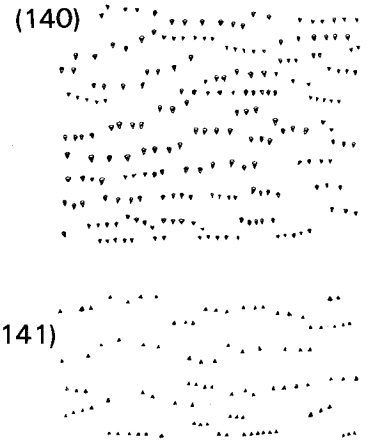


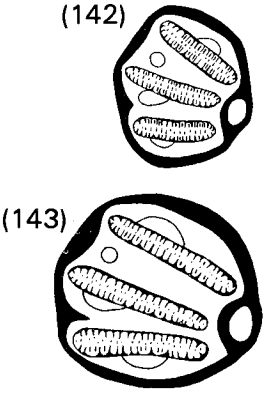




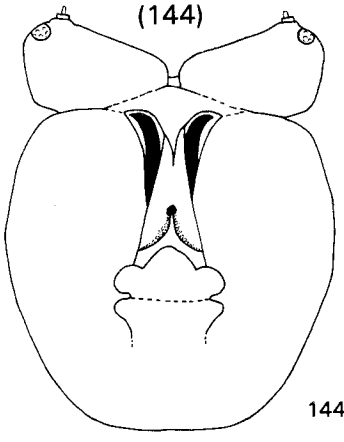
134–138. *Calliphora stygia*

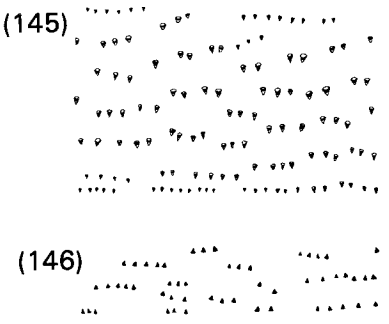


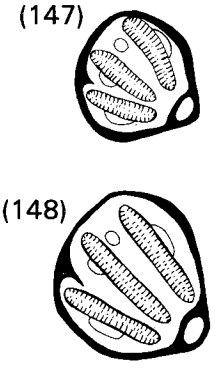




139–143. *Calliphora vicina*







144–148. *Lucilia sericata*

TAXONOMIC INDEX

This index covers the nominal taxa of Calliphoridae mentioned in the text, regardless of their current status in taxonomy. Page numbers in bold type indicate the beginning of a major descriptive section. Numbers in italic type indicate pages on which an illustration appears. Suffixed letters are used to indicate the location of keys (k) and mention of larval stages (l).

ERRATA

Page v: In the cataloguing-in-publication citation, the International Standard Serial Number should be 0111-5383; 8. In the cataloguing-in-publication citation and the suggested form of citation, the year of publication should be 1986.

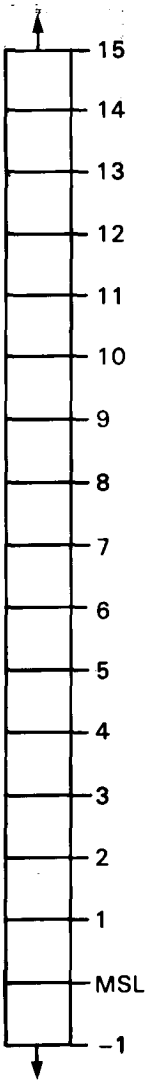
Page 7: In the list of contents, the taxonomic index is shown as commencing on page 82; this should be page 85.

Page 21: In the key to genera, couplets 04 and 05, the figure numbers for *Ptilonesia* and *Pollenia* are transposed (see Fig. 11 and 12, p. 67, which are correctly numbered).

Page 69: In Figure 20, the label "dorsocentral" points to the intra-alar setae; the dorsocentrals are in fact beneath the label, between the intra-alar and acrostichal setae.

Page 82: In Figures 126–148, all comparable drawings are to the same scale (omitted from caption).

TAXON :



ALTITUDINAL DISTRIBUTION

(MSL, mean sea level) The range of altitude for each scale division may be set according to need, but should be in metric units.

OFFSHORE ISLANDS

- Kermadecs ☐
- Three Kings ☐
- Chathams ☐
- Snares ☐
- Bounty ☐
- Antipodes ☐
- Aucklands ☐
- Campbell ☐

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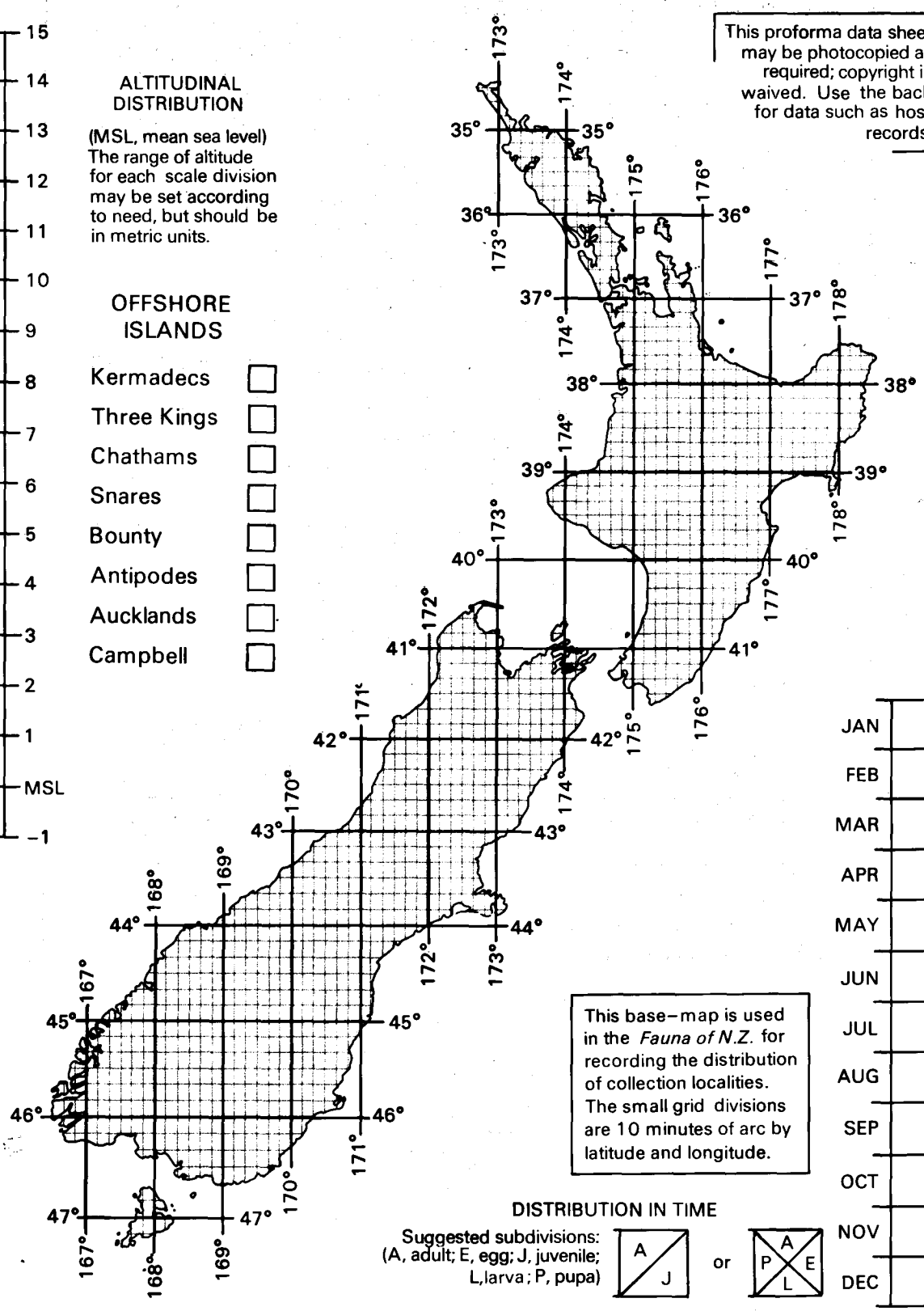
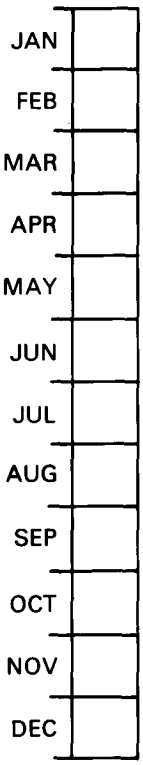


This base–map is used in the *Fauna of N.Z.* for recording the distribution of collection localities. The small grid divisions are 10 minutes of arc by latitude and longitude.

DISTRIBUTION IN TIME

Suggested subdivisions: (A, adult; E, egg; J, juvenile; L,larva; P, pupa)

or



V. R. Ward, Government Printer, Wellington, New Zealand—1985

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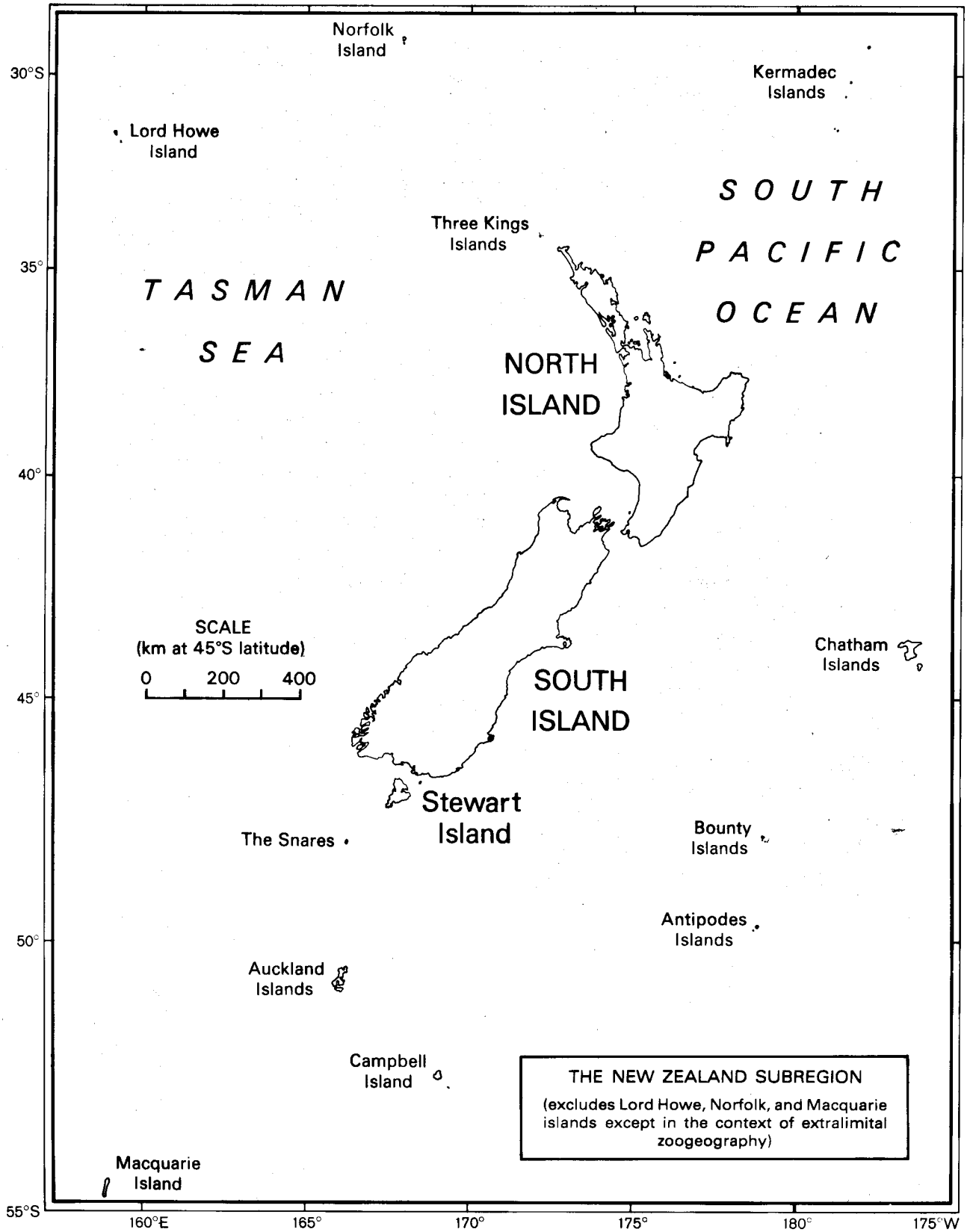
Fauna of New Zealand

Number 8

Calliphoridae

(Insecta: Diptera)

James P. Dear



THE NEW ZEALAND SUBREGION

(excludes Lord Howe, Norfolk, and Macquarie islands except in the context of extralimital zoogeography)

AK – Auckland

BP – Bay of Plenty

CL – Coromandel

GB – Gisborne

HB – Hawke's Bay

ND – Northland

RI – Rangitikei

TK – Taranaki

TO – Taupo

WA – Wairarapa

WI – Wanganui

WN – Wellington

WO – Waikato

BR – Buller

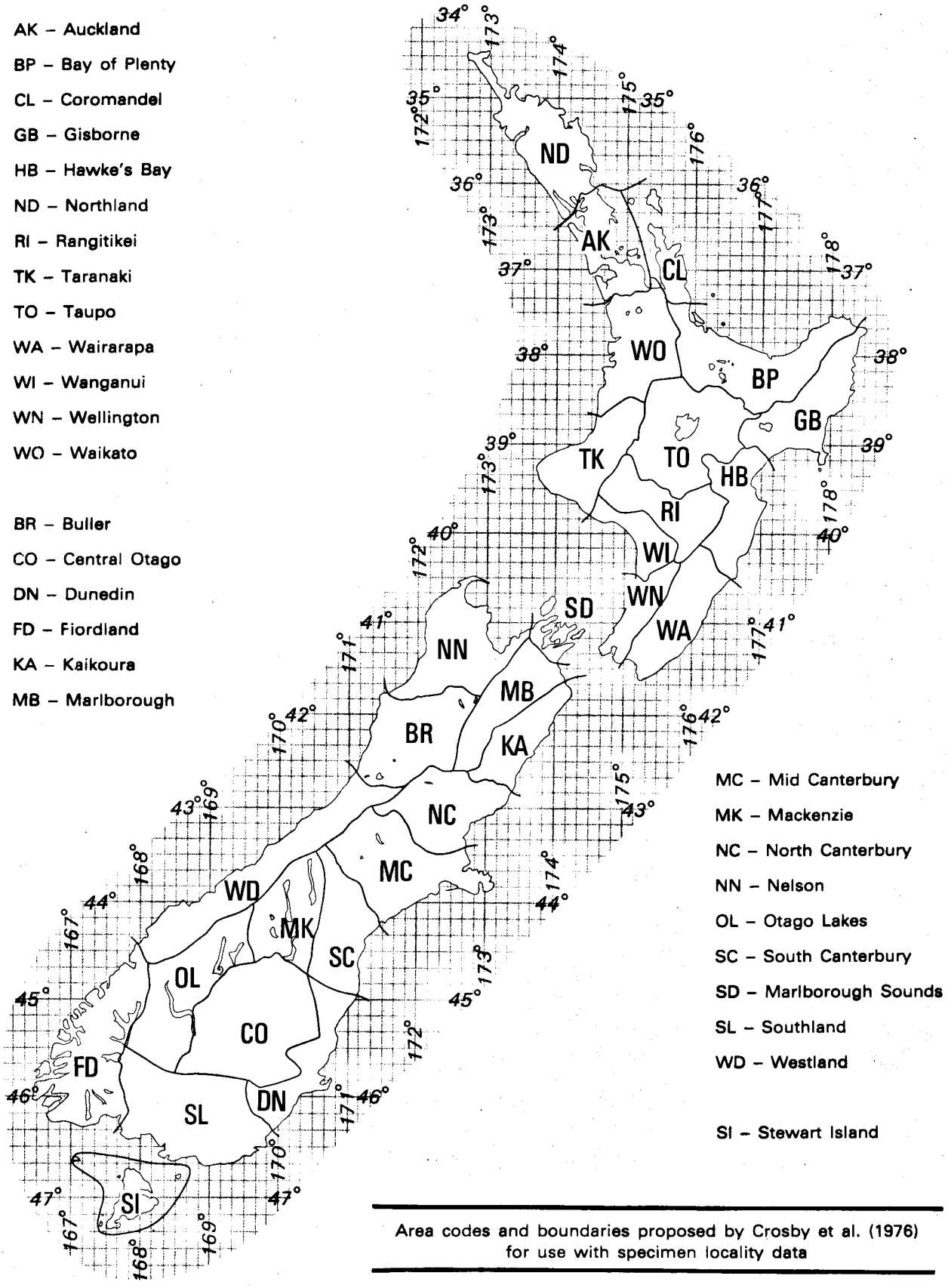
CO – Central Otago

DN – Dunedin

FD – Fiordland

KA – Kaikoura

MB – Marlborough



MC – Mid Canterbury

MK – Mackenzie

NC – North Canterbury

NN – Nelson

OL – Otago Lakes

SC – South Canterbury

SD – Marlborough Sounds

SL – Southland

WD – Westland

SI – Stewart Island

Area codes and boundaries proposed by Crosby et al. (1976) for use with specimen locality data

Fauna of New Zealand

This series of occasional publications has been established with two major objectives: to encourage those with expert knowledge of elements in the New Zealand fauna to publish concise yet comprehensive accounts; and to provide a means of identification accessible to the non-specialist. It will deal largely with non-marine invertebrates, since the vertebrates are well documented, and marine forms are covered by the series *Marine Fauna of New Zealand*.

Contributors should discuss their intentions with an appropriate member of the Editorial Advisory Group or with the Series Editor before commencing work (for names and addresses, see page ii). All necessary guidance will be given.

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DESCRIPTIONS

ILLUSTRATIONS

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