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Phylogeny and host-plant relationships of the Australian Myrtaceae leafmining moth genus *Pectinivalva* (Lepidoptera, Nepticulidae), with new subgenera and species

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Abstract

The phylogeny of the mainly Australian nepticulid genus *Pectinivalva* Scoble, 1983 is investigated on the basis of morphology, and a division into three monophyletic subgenera is proposed on the basis of these results. These subgenera (*Pectinivalva*, *Casanovula* Hoare, **subgen. n.** and *Menurella* Hoare, **subgen. n.**) are described and diagnosed, the described species of *Pectinivalva* are assigned to them, and representative new species are described in each: *P.* (*P.*) *mystaconota* Hoare, **sp. n.**, *P.* (*C.*) *brevipalpa* Hoare, **sp. n.**, *P.* (*C.*) *minotaurus* Hoare, **sp. n.**, *P.* (*M.*) *scotodes* Hoare, **sp. n.**, *P.* (*M.*) *acmenae* Hoare, **sp. n.**, *P.* (*M.*) *xenadelpha* Van Nieukerken & Hoare, **sp. n.**, *P.* (*M.*) *quintiniae* Hoare & Van Nieukerken, **sp. n.**, and *P.* (*M.*) *tribulatrix* Van Nieukerken & Hoare, **sp. n.** *Pectinivalva* (*Menurella*) *quintiniae* (from *Quintinia verdonii*, Paracryphiaceae) is the first known member of the genus with a host-plant not belonging to Myrtaceae. *P.* (*M.*) *xenadelpha* from Mt Gunung Lumut, Kalimantan, Borneo, is the first pectinivalvine reported from outside Australia. Keys to the subgenera of Nepticulidae known from Australia, based on adults, male and female genitalia, and larvae, are presented. Host-plant relationships of *Pectinivalva* are discussed with relation to the phylogeny, and a list of known host-plants of *Pectinivalva*, including hosts of undescribed species, is presented. DNA barcodes are provided for most of the new and several unnamed species.

Keywords

Pectinivalva, Myrtaceae, *Eucalyptus*, Paracryphiaceae, rain forest, Borneo, Indonesia, Australia, keys, host-plants, DNA barcodes

Introduction

The subfamily Pectinivalvinae was described by Scoble (1983) for a group of Australian nepticulids retaining a pectinifer on the valva in the male genitalia. The structure of the pectinifer is similar to that in Opostegidae, the sister-group of Nepticulidae (cf. van Nieukerken 1986; Davis 1989). The subfamily remained monobasic, with *Pectinivalva* Scoble, 1983 as sole genus, until a second genus, *Roscidotoga*, was described by Hoare (2000a). *Roscidotoga* has the pectinifer absent (or possibly reduced to a thickening along the apex of the valva), but shares other apomorphies with *Pectinivalva* that support its inclusion in Pectinivalvinae (Hoare 2000a; van Nieukerken et al. 2011). The monophyly of this expanded Pectinivalvinae has been questioned by Puplesis and Robinson (1999), who provisionally follow the classification of Puplesis (1994), recognizing two subfamilies, Nepticulinae (including taxa formerly treated as Pectinivalvinae and Nepticulini) and Trifurculinae (equivalent to Trifurculini of van Nieukerken (1986)). However, Puplesis' (1994) 'cladogram' is not based on cladistic principles, since he frequently lists alternative states of the same binary character as apomorphies for sister-clades (e.g., his 'apomorphies' 10–16 are merely the plesiomorphic states respectively of apomorphies 36–40, 48 and 42). Therefore this classification is rejected here, and we follow van Nieukerken (1986), Johansson et al. (1990) and Hoare (2000a) in our concepts of Pectinivalvinae and Nepticulinae. However, the current cladistic analysis is not designed to test the monophyly of Pectinivalvinae; this issue will be treated in a more comprehensive analysis of the genera and subgenera of Nepticulidae to be presented elsewhere. Ongoing molecular studies (Regier et al., van Nieukerken et al., publication pending) also confirm the monophyly of Pectinivalvinae, but not of Nepticulinae. Whereas these results may challenge the division of Nepticulidae in two subfamilies, the Pectinivalvinae will remain as a clade, and the rank of that clade is of little consequence for the present study.

Scoble (1983) recognized two subgroups within *Pectinivalva*, based on the shape of the male valva (rounded or roughly triangular). Hoare et al. (1997) made additional observations on the distinction between the two groups, which they called the *P. commoni* and *P. funeralis* groups, and assigned all described species to one or the other. Because of the existence of undescribed species that showed character-states of both groups, these authors did not erect a formal subgeneric distinction, in order to avoid the possibility of naming a paraphyletic taxon. The present analysis, which includes several of the 'intermediate' species (i.e. *Pectinivalva brevipalpa*, *P. minotaurus*, *P.* 219 and *P.* 226), was designed to answer the question of whether *Pectinivalva* falls into definable monophyletic groups. In particular, is the *P. commoni* group, which retains a number of probable plesiomorphies, monophyletic or paraphyletic with respect to the rest of the genus? To include characters of the early stages in the cladistic analysis, species were selected that had been reared, and this presented the opportunity to look at host-plant relationships in the genus from a phylogenetic perspective.

Methods and conventions

Preparation techniques. Rearing techniques, and techniques of slide preparation for larvae, pupal exuviae, adult heads, wing venation and genitalia followed Hoare (2000a). In more recent preparations, phenosafranin was substituted for the acid fuchsin + azophloxin stain described by Hoare (*loc. cit.*) and no lactophenol was used.

Morphological terminology. Terminology follows Hoare (2000a). The term 'androconial pocket' is coined here for a longitudinal to elliptical furrow associated with the stem of vein Rs+M in the male hindwing of some species of *Pectinivalva*, surrounded by - usually dark - androconial scales. The pocket is presumed to function in scent production and/or dispersal during courtship, and requires further detailed investigation.

Measurements of genitalia were taken directly with a calibrated eyepiece graticule, or from photographs taken with a Zeiss Axioskop using Axiovision software (see below) and rounded off to the nearest 5µm.

Hostplant names follow the Australian Plant Census (Australian Plant Census 2012) and were checked with APNI (Australian National Botanic Gardens 2011). Hostplant classification for Myrtaceae follows Wilson (2005).

Repositories. The following abbreviations have been used for institutions mentioned in the text:

ANIC	Australian National Insect Collection, CSIRO Entomology, Canberra, Australia.
FMNH	Finnish Museum of Natural History, Helsinki, Finland.
RMNH	Naturalis Biodiversity Center, Leiden, The Netherlands.
MZB	Museum Zoologicum Bogoriense, Research Center for Biology, Indonesian Insititute of Sciences, Cibinong, Indonesia

Material. Type material is cited with the descriptions. All material studied, including rearing records of species that have not been treated and voucher specimens for DNA barcoding, are listed in the Excel sheet in the Online Appendix 3. We have treated specimens with a genitalia slide or other preparation and DNA vouchers as individual records for each species. Other records combine all adults from a single rearing or other single collection event. While compiling this datasheet, the authors no longer had direct access to the ANIC collection in Canberra, and in some cases our notes were not sufficient to enter all fields. This explains why for some slides 'sex unknown' is given, and uncertainties about exactly how many specimens were collected on a given date.

Illustrations. Photographs of moths by B.E. Rhode in Auckland (species described by RJBH) were taken with a Nikon Ri1 digital camera mounted on a Leica M205 A stereo-microscope. Series of images for each specimen were subsequently montaged using Helicon Focus and Zerene Stacker software packages. Post-editing work, i.e. replacing backgrounds, 'removing' pins, and inserting scale bars was done in Photoshop.

Photographs of moths, leafmines (jointly described species) and all genitalia slides were taken by EJvN with a Zeiss AxioCam (HR or MR5) digital camera attached respectively to a Zeiss Stemi SV11 stereo-microscope and a Zeiss Axioskop H, using Carl Zeiss AxioVision software (version 4), for some photographs using the module "Extended focus". Manipulation of photographs, using Adobe Photoshop® was kept to a minimum: disturbing conspicuous shades, protruding parts of pins, dust and air bubbles in slides were removed or obscured, black backgrounds smoothened.

Drawings were prepared by RJBH, using a drawing tube. Drawings on one plate are not necessarily in the same scale.

DNA barcodes. DNA was extracted from caterpillars or from dry adult abdomens. DNA extraction from larvae was usually destructive; from abdomens and some larvae the non-destructive protocol by Knölke *et al.* (2005) was followed, allowing the preparation of the genitalia or larval skin as well. Details of methods are presented by van Nieukerken et al. (2012); we provide here the COI DNA barcode for several named and unnamed species of *Pectinivalva*, collected in 2000 and 2004 by the authors, and material on loan, collected by L. Kaila and co-workers. Barcodes of *Roscidotoga* were published before (van Nieukerken et al. 2011). Details can be found on the Barcode of Life webpages (http://www.barcodinglife.com/views/login.php) under the project "Nepticulidae - Pectinivalvinae Public Records [NEPPP]". Specimen data are also given in the online Appendix 3.

An NJ tree was prepared with Paup 4.0b10 for Windows (Swofford 2003), using uncorrected P distance (Srivathsan and Meier 2012). As outgroups we used *Stigmella anomalella* (Goeze, 1783) and *Opostega salaciella* (Treitschke, 1833)

Cladistic analysis. Choice of terminal taxa: Species were chosen with two overall aims in mind: (a) to cover the morphological diversity of *Pectinivalva* as far as possible, and (b) to cover the host-plant range as fully as possible so that inferences could be made about the evolution of host-plant choice in the genus. Only species for which both sexes of the adults were available were chosen: this criterion excluded most of the previously described species. Again, for the most part, species were chosen for which preserved larvae and mines were available; however, the early stages of *P. caenodora* (Meyrick, 1906) are unknown. The early stages of *P. commoni* Scoble, 1983 have not been preserved, but a very similar species (*P.* 142: see Appendix 3) with genitalia very close to those of *P. commoni* was reared during the course of this study and the scores for the immature stages of *P. commoni* given here are based on the study of this second species.

Details of material examined for species not described in this paper are given in the online Appendix 3. Undescribed species which have been reared are referred to here by their generic name and a rearing number. One new species that has not been reared was also included: this is *P. mystaconota* sp. n. *Pectinivalva mystaconota* diverges in morphology from most typical *Pectinivalva* species in that the pectinifer on the male valva is replaced by rows of strong flattened setae (Fig. 40).

The results of an unpublished phylogenetic analysis including most subgenera of Nepticulidae (Hoare and van Nieukerken, in prep.) and molecular studies (van Nieukerken et al. in prep) suggest that *Roscidotoga* represents the sister-group of *Pectinivalva* (cf. Hoare 2000a). *Roscidotoga callicomae* Hoare, 2000 was therefore included as an outgroup, alongside a representative of Nepticulinae (*Enteucha acetosae* (Stainton, 1854)) and a representative of Opostegidae (*Notiopostega atrata* Davis, 1989).

Cladistic analysis. A maximum parsimony analysis with bootstrap was carried out with Paup 4.0b10 for Windows (Swofford 2003). For the heuristic search the branch swapping algorithm used was tree-bisection-reconnection (TBR). A bootstrap analysis was run for 200 replicates, each with 100 addition-sequence replicates.

Characters were traced onto the most parsimonious trees using the program Mesquite 2.7 (Maddison and Maddison 2009) to generate lists of apomorphies for monophyletic groups. Where the position of a character state change on the tree is ambiguous, the listed apomorphy is annotated according to whether it assumes accelerated transformation (ACC) or delayed transformation (DEL) of states and the alternative interpretations are given. The characters and their states are listed in Appendix 1.

Results and list of apomorphies

A heuristic search in PAUP produced 147 equally most parsimonious trees of length 60 with CI = 0.6667, RI = 0.8450 and RC = 0.5633. The strict consensus tree is presented in Fig. 1 (for bootstrap support see Fig. 2). *Pectinivalva* is consistently recovered as a monophyletic group with moderate support (bootstrap=76%), and within the genus, the three subgenera are almost always recovered, with strong support for *Pectinivalva* s.s. (92%) and *Menurella* (81%) (Fig. 1), but no support for *Casanovula*. *Pectinivalva brevipalpa* is the most problematic species, remaining in an unresolved polytomy with the three subgenera in the strict consensus tree. The 50% majority rule consensus tree is presented in Fig. 2, with bootstrap values; in this *P. brevipalpa* forms a clade with *P. minotaurus*, P. 219 and P. 226 in *Casanovula*. This placement is argued for below, and the 50% majority rule tree is used as the basis for the list of apomorphies given here, even without bootstrap support for *Casanovula*.

The monophyly of the genus *Pectinivalva* is supported by the following apomorphies:

(10–1) Uncus with a pair of well-defined tufts of setae.

(16–1) Vestibulum of female genitalia with a pair of lateral sclerites. The sclerites are absent in the clade *P. mystaconota* + *P.* 138 + *P.* 163; this is unambiguously reconstructed as a secondary loss.

(17–1) Corpus bursae of female genitalia with extensive pectinations. This character is somewhat weak, since pectinations are present in many Nepticulinae (e.g. *Stigmella* and *Acalyptris* spp.). The pectinations are reduced in extent in most species of *Menurella* and lost independently in *P.* 138 + *P.* 163 and in *P. quintiniae*.

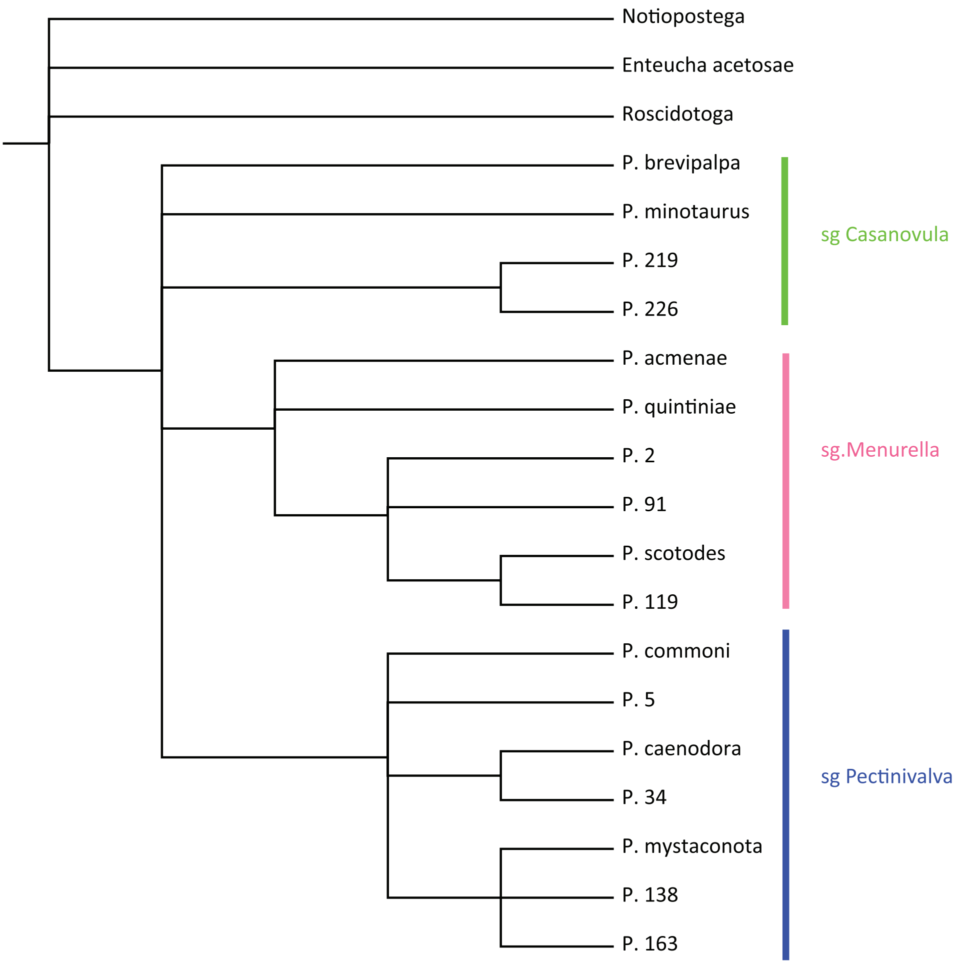


Figure 1. Phylogeny of Pectinivalvinae, based on 27 morphological characters of larva, pupa and adult, and 1 behavioural character of larva. Strict Consensus Tree of 147 equally most parsimonious trees (CI = 0.6667, RI = 0.8450 and RC = 0.5633). Outgroups are *Notiopostega atrata* Davis (Opostegidae), *Enteucha acetosae* (Stainton) and *Roscidotoga callicomae* Hoare (Nepticulidae).

(18–0 ACC) Signum of corpus bursae well-sclerotised and sparsely toothed. Since *Casanovula* and all outgroup taxa lack a signum, the basal state of this character in *Pectinivalva* is ambiguous. However, the form of the signum in *Pectinivalva* s. str. resembles that in *P. (Menurella) acmenae* and *P. (M.) quintiniae*, and similar signa do not occur elsewhere in Nepticulidae, so a single origin of this signum type is considered most likely.

(20–1) Anterior margin of T2 of abdomen with sclerotization interrupted. This character is paralleled in some genera in Trifurculini.

(23–1) Posterior lobes of larval head with sclerotization interrupted. This character is not known elsewhere in Nepticulidae. The posterior lobes are continuously sclerotized in *P.* 119, a presumed reversion to the ancestral state.

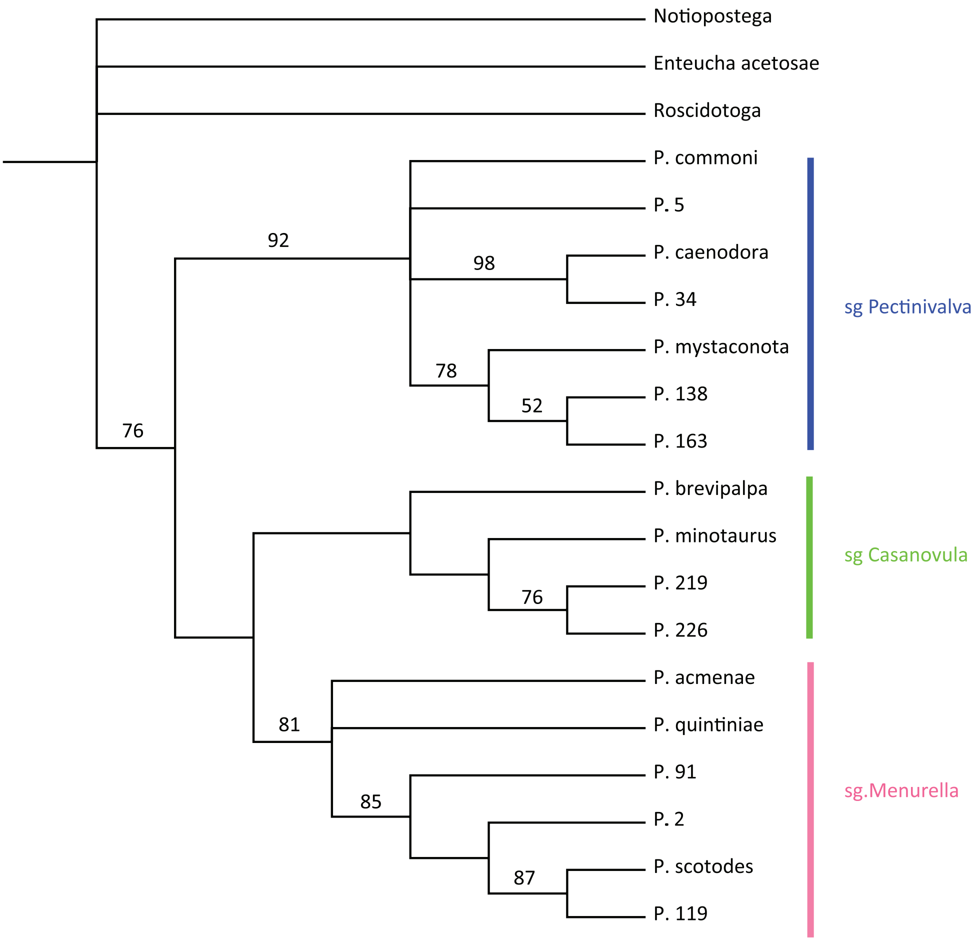


Figure 2. Phylogeny of Pectinivalvinae, characters and outgroups as for Fig. 1. 50% Majority Rule Consensus Tree from 147 equally most parsimonious trees; bootstrap support (200 replicates) shown on branches.

The monophyly of *Pectinivalva* s. str. has very strong bootstrap support (92%). The group shares the following apomorphies:

(22–1) Larval head elongate and pyriform. The larva of *P. (Menurella) brevipalpa* has a similar head-shape (Fig. 105); this is a presumed parallelism (see below).

(25–1) Larval mesothorax with only one pair of D setae (D1 absent). This character is constant within the group, but paralleled in *P.* (*C.*) 226 and *P.* (*M.*) 91, and in many Nepticulinae (e.g., *Simplimorpha*, *Stigmella* spp., *Ectoedemia* (*Fomoria*) spp.).

(26–1) Cuticle of larva lacking spines. The larvae of all other species of *Pectinivalva* and *Roscidotoga*, and all known opostegid larvae, have a spinose cuticle. The spines are reduced or modified in some genera of Nepticulinae (e.g. the *Ectoedemia* (*Fomoria*) *vannifera* group: see Hoare 2000b), but rarely completely absent.

(27–1) Cuticle of larva with sculptured texture. This is a unique condition within the Nepticuloidea. It could be argued that characters 26 and 27 are not independent and that the sculpturing of the cuticle in *Pectinivalva* s. str. is homologous to the spines of other Nepticulidae. However, there are two reasons for rejecting this idea. Firstly, the sculpturing is particularly marked on the prothorax, where other species of Pectinivalvinae lack any spines (although some Nepticulinae have a spiny larval prothorax). Secondly, the sculpturing is present on the prothoracic sternite, an area that is never spined in other nepticulids. The two characters are therefore considered to be independent.

The following possible apomorphies are problematic:

(5–0) Forewing venation with R2+3 present. This is recovered as an unambiguous apomorphy of *Pectinivalva* s. str. in the analysis, since all other *Pectinivalva* species and all three outgroup taxa lack R2+3. However, loss of veins probably occurs rather easily in the evolution of these tiny moths, and independent losses are likely. Regaining a lost vein may not be impossible as supposed, e.g., by Meyrick (1898), but since R2+3 is present in most genera and subgenera of Nepticulinae except *Enteucha*, the character state evolution recovered here may be an artifice of taxon choice.

(15–0 DEL) Cathrema of aedeagus supported by 2 or 3 interconnected sclerites. This form of cathrema is paralleled in *P. brevipalpa*, and therefore could equally be interpreted as an apomorphy of *Pectinivalva* as a whole, with subsequent reduction in *P. minotaurus* + *P*. 219 + *P*. 226 (ACC) and fusion into a sclerotised tube in *Menurella*.

The subgenera *Menurella* and *Casanovula* together form a monophyletic group supported by the following synapomorphies (but without bootstrap support):

(9–1) Uncus bifid. The undivided, hood-like or V- or Y-shaped uncus of most Nepticulidae (including *Pectinivalva* s. str.) appears to be the plesiomorphic state in the family (cf. Scoble 1983; van Nieukerken 1986).

(21–1) Larval antenna 2-segmented (second and third segments fused). The antenna in *Pectinivalva* s. str. and in *Roscidotoga* is 3-segmented, as it is in most Lepidoptera. The basal state of this character for *Pectinivalva* is recovered as ambiguous, due to the reduced larval antennae of two of the outgroups (*Notiopostega* with two segments and *Enteucha* with one). However, independent reductions in the antenna are considered far more likely than the regaining of a lost segment, so this is regarded as a robust synapomorphy of the two groups. In *P. quintiniae*, a further reduction to one segment has occurred, in parallel with Nepticulinae.

(24–1) Prothoracic sternite of larva much longer than broad. The Opostegidae lack a ventral prothoracic sclerotization, but most Nepticulidae, including *Roscidotoga* and *Pectinivalva* s. str., have a rather broad sclerite in this position.

If presence of vein R2+3 in *Pectinivalva* s str. is considered plesiomorphic, its loss (5–1) constitutes another probable synapomorphy of *Menurella* plus *Casanovula*, paralleled in *Roscidotoga* and *Enteucha*.

The monophyly of *Casanovula* has no bootstrap support. However, the last two of the three characters listed below are both unique within *Pectinivalva* and constant within this clade, so they are considered sufficient evidence to name this clade as a subgenus. The hostplant range is also distinctive (see below). Monophyly of the subgenus is supported by the following apomorphies:

(1–1 ACC) Basal flagellar segments of male antenna expanded and flattened. The flattened antenna occurs in *P. brevipalpa* and *P. minotaurus*, but not in the other two species of the group included in the analysis. Since this antennal character is unique amongst Nepticulidae, it seems very unlikely to have evolved independently in *P. brevipalpa* and *minotaurus*, and is therefore best reconstructed as an apomorphy of *Casanovula* in the tree topology in Fig. 2, with subsequent loss in *P*. 219 + *P*. 226. The unresolved position of *P. brevipalpa* in the strict consensus tree (Fig. 1) is due to the pyriform larval head (22–1), an apomorphy that it shares with *Pectinivalva* s. str. This is straightforwardly regarded as a parallelism, whereas the antennal character is not. For this reason, and because it shares the other two apomorphies listed below, *P. brevipalpa* is confidently assigned to *Casanovula*.

(3–3) Forewing metallic, with shining fascia. Many Nepticulinae have a similar pattern, but as other species of *Pectinivalva* have drab, more or less unicolorous forewings, such coloration is apomorphic within the genus. One species of this group, not treated here (but included in the key to subgenera below) lacks a transverse fascia, but retains weakly metallic forewings with purplish reflections. Reflective coloration is known to correspond in Lepidoptera with diurnal activity, and members of this group have not been collected at light, in contrast with members of *Pectinivalva* s. str. and *Menurella*. The small eyes of the known species (interocular index less than 0.7) further confirm that the moths are diurnal.

(18–3 DEL) Corpus bursae of female genitalia lacking signum. All other species of *Pectinivalva* have a well developed signum. Although a signum is also lacking in many opostegids, including *Notiopostega*, and in the nepticulid outgroups *Roscidotoga* and *Enteucha*, the presence of a very similar form of signum (the 'toothed band') in *Pectinivalva* s. str. and in three plesiomorphic species of *Menurella* (*P. acmenae, xenadelpha* and *quintiniae*) strongly suggests that the loss of the structure in *Casanovula* is apomorphic.

The monophyly of *Menurella* has strong bootstrap support (81%). Members of the group share the following apomorphies:

(12–1) Pectinifer of male valva with fewer than 20 elements. There are more than 20 elements in the pectinifer in all species of *Pectinivalva* s. str. and *Casanovula* that retain the structure, and usually more than 20 in the Opostegidae (e.g. 45 in *Notiopostega atrata*, 35 in *Eosopostega issikii* Davis, 1989). The pectinifer elements have probably been lost more than once in *Menurella* : they are absent, e.g., from *P. quintiniae* and *P. warburtonensis* (Wilson). Conversely, several species of *Pectinivalva* in ANIC (not treated here) clearly belong to *Menurella* on the basis of apomorphies 15–1, 16–2, 17–1 and 18–2 (see below), but have a pectinifer with more than 20 elements.

(15–1) Cathrema of aedeagus supported by a smooth sclerotized tube. The tube is always present within the group and not found in other pectinivalvines. It could possibly represent a fusion of the sclerites associated with the cathrema in *Pectinivalva* s. str. A similar smooth tubular structure is associated with the cathrema in species of *Enteucha* (see van Nieukerken 1986), although not in *E. acetosae*; this is presumed to be a parallelism.

(16–2) Lateral sclerites of female vestibulum strongly developed. These sclerites are always narrow (occasionally absent) in *Pectinivalva* s. str. and *Casanovula*. In *P. acmenae* they are still relatively narrow, but have deeply forked tips. In the remaining species of *Menurella* the sclerites are very broad and robust.

(17–1) Pectinations of corpus bursae of female restricted to posterior part of corpus. More extensive pectinations are found in most other species of *Pectinivalva* s. str. and *Casanovula* (except *P.* 138 and *P.* 163).

Within the three subgenera, some species-groups are recovered in all most parsimonious trees. Within *Pectinivalva* s. str., *P. caenodora* and *P.* 34 form a monophyletic unit with 98% bootstrap support (here referred to as the *P. caenodora* group). At least one other species (*P.* 89), not included in the current analysis, is known from this group. *P. caenodora* and *P.* 34 share the following apomorphies:

(3–1) Forewing with a pale costal streak. This streak is lacking in the third member of the group mentioned above.

(10–2) Tufts of setae on dorsum of uncus mounted on lobes. These lobes are found in other species of *Pectinivalva* s. str. which were not included in the current analysis and do not share the other synapomorpies of *P. caenodora* + *P.* 34: hence this apomorphy may define a broader species-group which includes the *P. caenodora* group.

(11–1) Central element of gnathos broad and cordate. Shared by the third member of the *P. caenodora* group, but again also present in a few other species of the *P. commoni* group.

(14–1) Sublateral processes of transtilla strongly reduced.

(18–1) Signum continuously toothed.

Pectinivalva 163, *P.* 138 and *P. mystaconota* (bootstrap 78%) share the following apomorphies:

(6–1) Male hindwing strongly expanded at base. This is paralleled in *Menurella* in the group of species including *P. scotodes*, *P.* 2 and *P.* 119.

(7–1) Male hindwing with androconial pocket. Again, this structure is present in the *Menurella* species listed above and in *P.* 91.

(16–0) Vestibulum of female lacking lateral sclerites. The sclerites, which constitute an autapomorphy of *Pectinivalva*, are most parsimoniously regarded as secondarily lost in these species.

P. 138 and *P.* 163 (52% bootstrap support) share the following apomorphy:

(17–2) Pectinations of corpus bursae absent.

The position of *P. commoni* and *P.* 5 within *Pectinivalva* s. str. cannot be resolved on the basis of the characters used in the current analysis. *P. commoni* most closely resembles the group formed by *P.* 163 + *P.* 138 + *P. mystaconota* on the basis of head and forewing colour. It also shares with these species the presence of androconial scales on the male hindwing (Hoare et al. 1997: fig. 5), although it does not have a true androconial pocket. *Pectinivalva* 5 most closely resembles the members of the *P. caenodora* group on the basis of the narrow valva with a strongly expanded apex (cf. Hoare et al. 1997: fig. 38): however, this could represent a plesiomorphic condition.

Within *Casanovula*, *P. minotaurus*, *P.* 219 and *P.* 226 form a monophyletic group with 76% bootstrap support, based on the following synapomorphy:
(8–1) Anterior extension of vinculum H-shaped.

A further problematic synapomorphy is:
(15–2 ACC) Cathrema moderately developed, with 0–1 associated sclerites. Since this state is shared with *Roscidotoga*, the presumed sister-group of *Pectinivalva*, it may alternatively be a retained plesiomorphy (DEL) (see above, under *Pectinivalva*). In the latter case, *Pectinivalva* s. str.and *P. brevipalpa* have independently converged on a weaker cathrema with 2–3 sclerites.

Pectinivalva 219 and *P.* 226 (76% bootstrap support) share the following behavioural apomorphy:
(28–1) Exit hole a large slit; larva pupating in mine. This habit has not been observed in any other species of Pectinivalvinae.

Pectinivalva 226 has only one pair of D setae on the larval mesothorax (25–1); the state of this character is unknown in *P.* 219, which was reared from pupae. It may prove to be a further apomorphy of this subgroup (paralleled in *Pectinivalva* s. str. and in P. 91).

Within *Menurella*, *Pectinivalva acmenae* and *P. quintiniae* form an unresolved basal trichotomy with a clade containing the remaining species. The remaining species in the current analysis (*P. scotodes*, *P.* 2, *P.* 91 and *P.* 119; 85% bootstrap support) share the following apomorphies:
(7–1) Male hindwing with androconial pocket. This character is paralleled in *P. mystaconota* + *P.* 138 + *P.* 163.
(13–1 ACC) Pectinifer elements of male valva broad and tooth-like. The pectinifer elements are narrow (13–0) in *P.* 2, which is interpreted as a reversal. Alternatively, broad elements must have evolved independently in *P.* 91 and in *P. scotodes* + *P.* 119.
(18–2) Signum in form of parallel spinules. This form of signum is highly characteristic of this group and not known elsewhere in Nepticulidae.

Pectinivalva tribulatrix (not included in the analysis) shares all these characters and also belongs to this group.

Pectinivalva scotodes, *P.* 119 and *P.* 2 form a monophyletic group supported by the following apomorphy (but without bootstrap support):

(6–1) Male hindwing strongly expanded at base. This character is paralleled in *P. mystaconota* + *P.* 138 + *P.* 163 in *Pectinivalva* s. str.

Pectinivalva scotodes and *P.* 119 are sister species amongst the sampled taxa (bootstrap support 87%) on the basis of the following synapomorphies:

(2–1) Sexual colour dimorphism pronounced (male forewing blackish; female forewing brown or yellowish).
(4–1) Male forewing with dorsal fringe of long narrow androconial scales.

Amongst the described species of *Pectinivalva*, *P. funeralis* (Meyrick, 1906) and *P. libera* (Meyrick, 1906) (each known only from the male) share apomorphy 4–1, and resemble *P. scotodes* and *P.* 119 in their male genitalia; they are therefore considered to belong to the same species group within *Menurella*.

Phylogeny and classification of Pectinivalvinae: conclusions

The genus *Pectinivalva* falls into three monophyletic clades, each described and diagnosed as a subgenus of *Pectinivalva* below: subgenus *Pectinivalva* Scoble, 1983, subgenus *Casanovula* subgen. n. and subgenus *Menurella* subgen. n. It would be possible to regard these as informal species-groups. However, a more profound subdivision seems necessary, because all three subgenera contain recognizable species-groups (some of them outlined above), which are likely to be of use in the future, especially in the highly speciose subgenera *Pectinivalva* and *Menurella*. Two other possible classifications would have been consistent with the results of the cladistic analysis: (i) To give all three subgenera generic rank; (ii) to give *Pectinivalva* (*sensu stricto*) generic rank, and to erect a new genus containing *Casanovula* and *Menurella* as subgenera. Genera and subgenera are essentially artificial and subjective concepts: therefore the only criteria for judging between such classifications are considerations such as usefulness, informativeness and consistency of ranking within the family (i.e. a subgenus in *Pectinivalva* should be roughly equivalent to a subgenus in *Ectoedemia*, although sister-groups need not have the same taxonomic rank). Admittedly, the use of subgenera can be rather cumbersome; however, it also allows one to convey more information about the relationships of a species in its name. Because Scoble (1983) and van Nieukerken (1986) are followed here and elsewhere (Hoare 2000b) in recognizing subgenera in the Trifurculini, and because the degree of distinction between the three groups within *Pectinivalva* as here defined is comparable to that between trifurculine subgenera, the most conservative classification has been adopted.

The hypothesis that *Roscidotoga* falls outside *Pectinivalva*, and is not derived from within that genus, is corroborated by the cladistic analysis.

Host-plant relationships of *Pectinivalva*

The host-plant relationships of *Roscidotoga* were discussed by Hoare (2000a) and van Nieukerken et al. (2011); their hosts are in the Cunoniaceae and Elaeocarpaceae, which belong to the Oxalidales in the eurosid I or fabid clade of the eudicots (Stevens 2008; APG III 2009). The eurosid I clade was of key significance in the early evolution of phytophagous insects (Ward et al. 2003), including Lepidoptera, and is the most important plant group in the host spectrum of Nepticulidae (Menken et al. 2010). Cunoniaceae and Elaeocarpaceae can both be considered ancient Gondwanan families based on current distribution and diversity (see discussion and references in Hoare 2000a).

As stated before, almost all known host-plants of *Pectinivalva* belong to the Myrtaceae, but one species is known from Paracryphiaceae (*Quintinia*) (see below for discussion). A full list of known host-plants is provided in Appendix 2; this includes myrtaceous hosts from which no moths have been reared, but where nepticulid mines assumed to belong to *Pectinivalva* have been collected. The assumption is based on the fact that no other genera of Nepticulidae have been reared from Myrtaceae in Australia. The Myrtaceae is an old Gondwanan family, with a long history in the southern continents (Johnson and Briggs 1981). Myrtaceae belongs to the order Myrtales in the eurosid II or malvid clade of eudicots (Stevens 2008; APG III 2009). The family reaches its greatest diversity, both at the generic and specific levels, in Australia: *Eucalyptus* L'Hérit., with approximately 800 species, dominates the vegetation over much of the continent. The dominance of Myrtaceae is certainly a relatively recent phenomenon, associated with the drying of the Australian climate during the mid to late Tertiary, and the replacement of rainforest with sclerophyllous vegetation (cf. Carpenter et al. 1994; Christophel 1994). Nevertheless, the association of *Pectinivalva* s.l. with myrtaceous hosts may predate this diversification considerably. A fossil myrtaceous leaf from the early Oligocene (ca. 35 million years B.P.) of Cethana, Tasmania (Carpenter et al. 1994: fig. 12.3e) shows an unmistakeable nepticulid mine, very similar, for example, to that of *P.* (*Casanovula*) *brevipalpa*.

The discovery of one species of *Pectinivalva* (*quintiniae*) feeding on a host other than Myrtaceae is an interesting development. *P. quintiniae* is in the subgenus *Menurella*, and although it apparently occupies a basal position in this subgenus (Fig. 2), it remains most parsimonious to assume that its host relationship is the result of a secondary shift from Myrtaceae. *P. quintiniae* is a rainforest species. *Quintinia verdonii* F. Muell., the host-plant of *P. quintiniae*, has been recently referred to the family Paracryphiaceae (APG III 2009). Winkworth et al. (2008) recovered Paracryphiaceae as sister-group to the Dipsacales, and the family now has its own order, Paracryphiales in the campanulids clade within the core eudicots (Stevens 2008; APG III 2009). Three genera are placed in the family: *Quintinia* DC., with 25 species distributed in New Guinea, Australia, New Caledonia and the Philippines, *Sphenostemon* Baill., with ten species occurring in New Guinea, Australia and New Caledonia, and *Paracryphia* Baker f., which is monotypic and endemic to New Caledonia. The distribution is consistent with a Gondwanan origin for the family, although there exists a late Cretaceous fossil from Sweden (*Silvianthemum suecicum* Friis) that has features in common with *Quintinia* (Friis 1990). Related groups, according to the phylogeny of Winkworth et al. (2008) (i.e. Dipsacales, Apiales), contain few known host-plants of Nepticulidae (van Nieukerken 1986).

Each subgenus of *Pectinivalva* has a distinctive host-plant range. Subgenus *Pectinivalva* has only been reared from species of *Eucalyptus*, the most speciose genus of Myrtaceae in Australia. *Casanovula* is the only subgenus without species on *Eucalyptus*: known host-plants are *Tristaniopsis* Peter G. Wilson, *Lophostemon* Peter G. Wilson and *Melaleuca* L. The widest range of host-plants is shown by members of *Menurella*: species have been reared from *Leptospermum* Forst. et f., *Syzygium* R.Br. ex Gaertn., *Rhodomyrtus* (DC.) Rchb., *Angophora* Cav., and *Corymbia* K.D. Hill & L.A.S. Johnson, as well as *Eucalyptus*. Leafmines found on the genera *Pilidiostigma* Burret and *Gossia* N.Snow & Guymer (both in Myrteae) and *Syncarpia* Ten. in Syncarpieae cannot yet been associated with one of the subgenera, although we predict that at least the mines on Myrteae most likely belong to *Menurella*.

In general the observation that closely-related moths tend to feed on closely-related plants (cf. van Nieukerken 1986; Hoare 2000a) is corroborated. This is clearly the case for subgenus *Pectinivalva*, where all species apparently feed on a single genus of hosts. It also applies to the *P.* (*C.*) 219 species group of *Casanovula,* all of whose species feed on *Melaleuca*; the inclusion of *Callistemon* R. Br. in this genus by Craven (2006) is followed here. *Pectinivalva* (*C.*) *brevipalpa* and *P.* (*C.*) *minotaurus* appear very similar and closely related, although not recovered as sister-species in the cladistic analysis; however, whilst their host-plants (respectively *Tristaniopsis* and *Lophostemon*) were formerly placed together in the genus *Tristania* R. Br., recent molecular phylogenetic evidence from the matK gene suggests that they belong in different tribes of Myrtaceae (Kanieae and Lophostemoneae) (Wilson et al. 2005; Biffin et al. 2010). Finally, within subgenus *Menurella*, the group of relatively 'derived' species (*P.* (*M.*) 91 + *P.* (*M.*) *scotodes* Hoare + *P.* (*M.*) 119), which have a pectinifer consisting of broad tooth-like elements, all feed on *Eucalyptus* and closely-related myrtaceous genera in the tribe Eucalypteae of Wilson et al. (2005), with the exception of *P.* (*M.*) *tribulatrix*, which feeds on *Rhodomyrtus* in the tribe Myrteae. *Angophora*, the host genus of *P.* (*M.*) 119, is sister to *Corymbia* (Hill and Johnson 1995; Wilson et al. 2005); at least one of the two (unnamed) species of *Pectinivalva* to have been reared from *Corymbia* also belongs within this 'derived' group of subgenus *Menurella* on the basis of the pectinifer.

The phylogeny suggests that the common ancestor of modern *Pectinivalva* was a Myrtaceae-feeder, and that the presence of a species on *Quintinia* is the result of a host-shift. It seems most likely that the split between *Roscidotoga* and *Pectinivalva* predates the Miocene aridification of Australia (ca. 24 - ca. 5 million years B.P.), and that the original hosts of *Pectinivalva* (like those of *Roscidotoga*) were rainforest plants. It is interesting that rainforest Myrtaceae still host species of subgenera *Casanovula* (*brevipalpa* and *minotaurus*) and *Menurella* (*acmenae, xenadelpha*, *quintiniae* and *tribulatrix*); the position of these species in the phylogeny is consistent with the hypothesis that their hosts may be ecologically and/or phylogenetically close to the original *Pectinivalva* host-plant.

The subgenus *Pectinivalva* appears to lack representatives on rainforest plants, and has only been reared from the sclerophyllous genus *Eucalyptus*. The earliest macrofossils currently accepted as belonging to *Eucalyptus* are leaves of *E. kitsoni* Deane from the Berwick Quarry, Victoria; these date from the late Oligocene or very early Miocene (ca. 25 million years B.P.), a time when south-east Australia was probably beginning to dry climatically, though still dominated by rainforest (Pole et al. 1993). However, the clade to which *Eucalyptus* belongs (tribe Eucalypteae of Wilson et al. 2005) may have originated as long ago as the Cretaceous, as evidenced by the presence of the relictual genus *Arillastrum* Panch. ex Baillon in New Caledonia (Ladiges et al. 2003), although the relaxed molecular clock analysis by Biffin et al. (2010) gives a range of dates from late Cretaceous to Eocene for the split of Eucalypteae from Syncarpieae. A date for the split between *Pectinivalva* s.s. and the other subgenera (e.g. from molecular data) would be of great interest to shed further light on the pattern of host-plant choice.

DNA barcodes

We provide the DNA barcodes (Fig. 3) for seven of the eight new species named in this paper (only missing *P. brevipalpa*), and for one previously named species (*P. caenodora*). In addition we include barcodes for a further nine or ten unnamed species that were available for barcoding. The main reason for including barcodes is to aid recognition of species and identification of immature stages without rearing. We do not intend to use these data for phylogenetic purposes, for which data on more genes are required.

Taxonomy

Subfamily Pectinivalvinae Scoble

Description. Scoble (1983) gave a detailed description of the Pectinivalvinae, but recently much more material of this subfamily (especially immature stages) has become available, and the concept of the Pectinivalvinae has been expanded by Hoare (2000a) to include the previously unrecognized genus *Roscidotoga*. For these reasons a complete redescription of the subfamily is provided here. A revised diagnosis of the subfamilies of Nepticulidae is provided by Hoare (2000a: table 1).

Adults. Head (Figs 19–30): Labial palpi 2- or 3-segmented; galeae short; maxillary palpi 5-segmented; antennae with sensillum vesiculocladum usually or always 5-branched (needs more detailed study in some species). Collar usually consisting of piliform scales. Forewing: underside sometimes with androconial scales in male; subdorsal retinaculum absent. Hindwing: upperside often with androconial scales in male. Wing venation (Figs 31–36): forewing without closed cell, Cu present, long; 1+2A unthickened, running

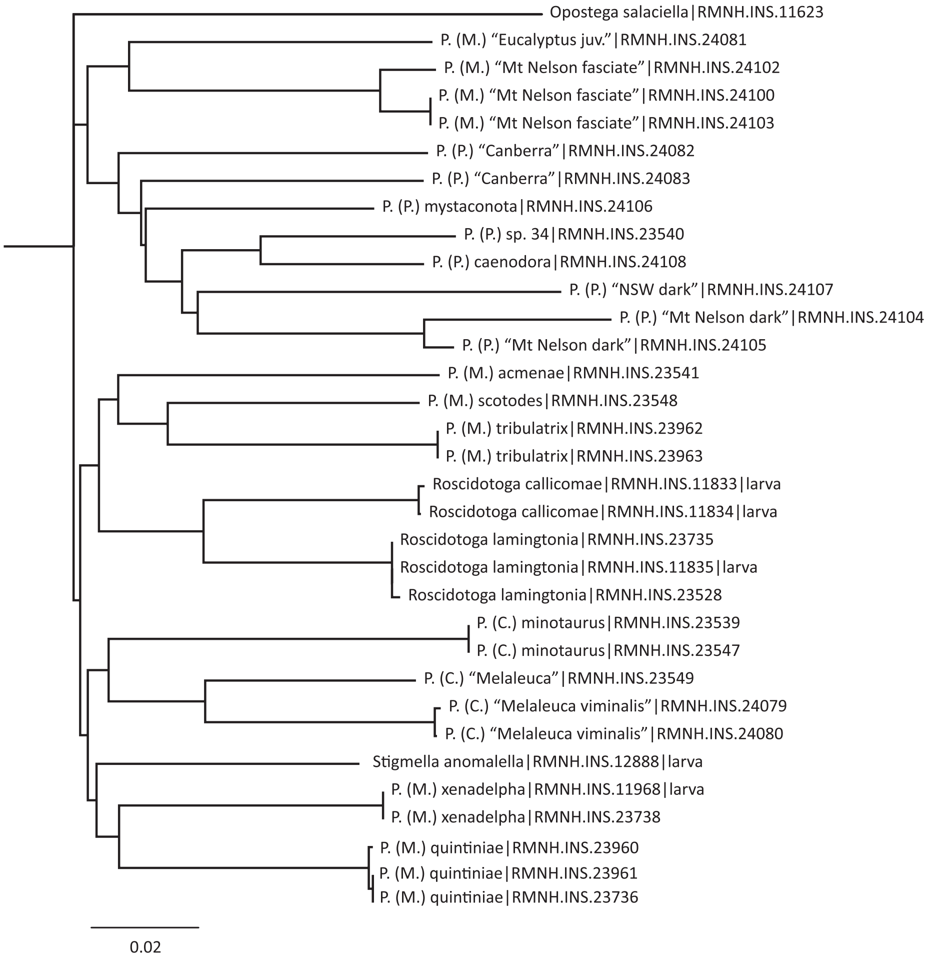


Figure 3. Neighbor Joining Tree of DNA barcodes of Pectinivalvinae species, showing specimen registry numbers. Outgroup is *Opostega salaciella* (Treitschke, 1833). *Stigmella anomalella* (Goeze, 1783) chosen as extra outgroup, but groups here with *Pectinivalva* subgenus *Menurella*.

obliquely from base of wing to meet dorsum before tornus; hindwing with trunk of Rs+M usually more or less deflected towards costa. Abdomen sometimes with specialized scales dorsally in male; S2a more or less pentagonal, usually with transverse rows of minute spines. Legs: fore-tibia of males sometimes thickened with specialized scales.

Male genitalia (Figs 39, 40, 42–72). Tegumen band-like, occasionally with lateral corners extended anteriorly into 'shoulders'. Uncus either well-sclerotized and hood-like (*Pectinivalva*) or reduced (*Roscidotoga*). Gnathos (if present) with single central element. Valva usually with well-developed pectinifer. Aedeagus often with asymmetrical apical processes; striate thickening round base of ejaculatory duct (cathrema) weakly developed; vesica usually with numerous cornuti.

Female genitalia (Figs 73–103). S8 usually broadly squared off. Vestibulum often with lateral sclerites. Corpus bursae with single signum, or without signa.

Larva. Head (Figs 104–108): antennae 2- or 3-segmented (1-segmented in *P. quintiniae*); labial palpi 3-segmented; stipes with 2 setae; frontoclypeus approximately square or rectangular; anterior tentorial arms approximately 2 times as long as posterior. Chaetotaxy (Figs 115, 116): T1 with 13 pairs of setae; T2 with 10 or 11 pairs (3 setae ventral to SV1); T3 with 9 pairs (1 D seta and 2 L setae present); A1–8 with 6 pairs of setae; A9 with 3 pairs; A10 with 3 or 4 pairs. Anal rods apically pointed or forked.

Cocoon. Usually reddish brown; usually spun outside the mine.

Pupa. Head: Clypeus squarish; frons with a pair of conspicuous setae posteriorly; labial palpi distinctly longer than maxillae. Eclosion more or less dorsal, so that suture between eyecaps and frons remains largely intact ventrally. Abdominal segments 2–8 each with 3–4 rows of spines on dorsum, and a prominent pair of dorsal setae.

Biology. Most known larvae of *Pectinivalva* are leaf-miners on Myrtales (Myrtaceae), one species is known from Paracryphiales (Paracryphiaceae); those of *Roscidotoga* are leaf-miners on Oxalidales (Cunoniaceae (including Eucryphiaceae) and Elaeocarpaceae).

Distribution. Australia, Borneo. Probably more widespread in Australian and Oriental regions than currently known.

Checklist of Pectinivalvinae

- *Roscidotoga* Hoare, 2000a
    - *eucryphiae* Hoare, 2000a
    - *callicomae* Hoare, 2000a
    - *lamingtonia* Van Nieukerken, Van den Berg & Hoare, 2011
    - *sapphiripes* Hoare, 2000a
- *Pectinivalva* Scoble, 1983
    - Subgenus *Pectinivalva*
        - *caenodora* (Meyrick, 1906)
        - *chalcitis* (Meyrick, 1906)
        - *commoni* Scoble, 1983
        - *endocapna* (Meyrick, 1906)
        - *gilva* (Meyrick, 1906)
        - *melanotis* (Meyrick, 1906)
        - *mystaconota* Hoare, sp. n.
    - *Casanovula* Hoare, subgen. n.
        - *brevipalpa* Hoare, sp. n.
        - *minotaurus* Hoare, sp. n.
    - *Menurella* Hoare, subgen. n.
        - *anazona* (Meyrick, 1906)
        - *funeralis* (Meyrick, 1906)
        - *libera* (Meyrick, 1906)
        - *planetis* (Meyrick, 1906)
        - *primigena* (Meyrick, 1906)

trepida (Meyrick, 1906)
warburtonensis (Wilson, 1939)
scotodes Hoare, sp. n.
acmenae Hoare, sp. n.
xenadelpha Van Nieukerken & Hoare, sp. n.
quintiniae Hoare & Van Nieukerken, sp. n.
tribulatrix Van Nieukerken & Hoare, sp. n.

Genus *Pectinivalva* Scoble

http://species-id.net/wiki/Pectinivalva

Pectinivalva Scoble, 1983: 12.

Type species. *Pectinivalva commoni* Scoble, 1983, by original designation.

A large and diverse genus, here subdivided into three subgenera on the basis of the phylogenetic reconstruction presented above. The following overview of the morphology of the genus should be taken in conjunction with the more detailed descriptions of the subgenera given below. Because of the great number of species in the genus, a complete revision is impractical at present. Species have been selected for description in order to represent the range of host-plants, morphology and distribution so far known in *Pectinivalva*.

Description. Adults. Head capsule (Figs 19–27): labial palpi 2- or 3-segmented. Underside of forewing and upperside of hindwing often with androconial scales in male. Costal bristles of male hindwing absent or replaced by lamellate scales. Legs: foretibia of male sometimes thickened with specialized scales. Upperside of abdomen sometimes with androconial scales in male. Anterior edge of T2 weakly sclerotized medially.

Male genitalia (Figs 39, 40, 42–72). Anterior extension of vinculum usually rather short. Lateral arms of vinculum occasionally more or less forked apically. Uncus hoodlike, dorsally with a pair of well-defined tufts of strong setae. Gnathos present, 1 central element. Valva (Figs 40, 44, 47, 50, 53, 56) rounded, squarish or triangular, usually with well-developed pectinifer along distal edge. Transverse bar of transtilla usually absent. Juxta in the form of 2 elongate sclerotized flaps connecting bases of valvae with apex of aedeagus. Aedeagus very variable (see subfamily description).

Female genitalia (Figs 73–103). S8 usually very broad and squared off. Vestibulum usually with a pair of lateral sclerites associated with apophyses anteriores. Corpus bursae well sclerotized, without diverticulum, usually with single signum.

Larva. Head (Figs 104–108): antennae 2- or 3-segmented; posterior lobes usually not continuously sclerotized caudally. Chaetotaxy (Figs 115, 116): see subgeneric descriptions.

Pupa. As described for subfamily.

Biology. Most known larvae leaf-miners on Myrtaceae, with one species on Paracryphiaceae (*Quintinia* A. DC.).

Diagnosis. Distinguished from *Roscidotoga*, the only other known genus of Pectinivalvinae, externally by the forewing pattern (without silver streak from mid-costa or suffusion of metallic scales towards apex); in the male genitalia by the presence of a gnathos and a well-sclerotized uncus with strong tufts of setae; and in the female genitalia by the simple (unexpanded) apophyses anteriores and the well-sclerotized corpus bursae, which lacks a diverticulum.

Distribution. Australia (known from all states and territories), Borneo (a single species, *P. xenadelpha*, described below).

Subgenus *Pectinivalva* Scoble

Type species: *Pectinivalva commoni* Scoble, 1983: 13 (original designation and monotypy).

Description. Adults. Head capsule (Fig. 19): labial palpi 3-segmented; interocular index 0.77–0.84. Antennae unmodified. Collar consisting of piliform scales (lamellate scales in one undescribed species). Wingspan ca. 4.5–8.4 mm. Forewing usually more or less unicolorous, greyish to fuscous, without transverse fascia, occasionally yellowish or with yellow costal streak. Hindwing in male often with longitudinal furrow (here termed 'androconial pocket') surrounded by androconial scales. Underside of forewing in male often with androconia. Wing venation (Figs 31, 32): R2+3 in forewing present. Abdomen usually without specialized scales; S2a always spinose. Fore-tibia of male usually thickened with blackish scales in those species with an androconial pocket.

Male genitalia (Figs 39, 40, 42, 58, 59). Lateral arms of vinculum not or weakly forked apically. Tegumen occasionally extended laterally. Valva either apically rounded, with conspicuous pectinifer of ca. 25–55 peg-like elements, or elongate and triangular, with pectinifer replaced by stiff setae. Sublateral processes sometimes reduced or absent. Aedeagus (Figs 42, 59): cathrema very weak, associated with 2 or 3 interconnected sclerites of variable length.

Female genitalia (Figs 73, 80–82). Lateral sclerites of vestibulum narrow, occasionally absent. Accessory sac absent. Signum an elongate toothed band with lacunae.

Larva. Head (Fig 104): antennae 3-segmented, segments 2 and 3 each with 1 sensillum chaeticum and 1 sensillum basiconicum; head-shape distinctly elongate and pyriform. Thorax: prothoracic sternite (Fig. 109) broad, rounded or squarish; chaetotaxy (Fig. 115): T2 with 10 pairs of setae (1 pair of D setae). Abdomen: as described for subfamily. Cuticle of all segments completely lacking spines, and with raised reticulate texture, especially on prothorax.

Biology. Host-plants: *Eucalyptus* L'Hérit. spp. (Myrtaceae). Mine: usually a short gallery leading to a blotch; exit-hole a semicircular slit.

Diagnosis. See Table 1.

Distribution. Australia (known from all states and territories).

Included species. In addition to the six previously and newly described species, also approximately 65 undescribed species in the ANIC, of which the following, cited

Table 1. Diagnosis of the subgenera of *Pectinivalva*. Character states regarded as apomorphic are marked with an asterisk.

Character	*P.* (*Pectinivalva*)	*P.* (*Casanovula*)	*P.* (*Menurella*)
Forewing coloration	± unicolorous, or with costal streak	*purplish, usually with shining fascia	± unicolorous, or with white fascia or opposite spots
Forewing venation: R2+3	Present	*Absent	*Absent
Male genitalia: uncus apex	Undivided	*Bifid	*Bifid
Male genitalia: vinculum	Rounded or weakly concave	*Strongly concave to H-shaped	Rounded to strongly concave
Male genitalia: cathrema	With 2–3 associated sclerites	Usually 1 or no associated sclerites (2–3 in *brevipalpa*)	*Supported by a sclerotized tube
Female genitalia: vestibulum	Lateral sclerites narrow or absent	Lateral sclerites narrow	*Lateral sclerites forked or broad
Female genitalia: signum	Longitudinal toothed band with lacunae	*Absent	*Oval toothed band or concentric ovals of parallel spinules
Larva: antenna	3-segmented	*2-segmented	*2-segmented or 1-segmented
Larva: D setae of mesothorax	*1 pair	2 pairs (occasionally 1)	2 pairs (occasionally 1)
Larva: spinosity of cuticle	*Spines absent	Spines present	Spines present
Larva: texture of cuticle	*Sculptured and reticulate	Smooth	Smooth

by their ANIC rearing numbers, have been studied in detail for the current work: *P.* (*P.*) 5; *P.* (*P.*) 34; *P.* (*P.*) 138; *P.* (*P.*) 142; *P.* (*P.*) 163.

Discussion. *Pectinivalva* (*Pectinivalva*) is a relatively diverse subgenus, and could probably be subdivided into several species groups. One such group, the *P.* (*P.*) *caenodora* group, was diagnosed above. We do not propose to erect any further named species groups here, but we describe below a species that diverges strongly from most other members of the subgenus, and has several close relatives. Their placement in *P.* (*Pectinivalva*) is argued for below, but as the larvae are as yet unknown, this decision may have to be revised.

Pectinivalva (*Pectinivalva*) is equivalent to the *P. commoni* group of Hoare et al. (1997).

***Pectinivalva* (*Pectinivalva*) *mystaconota* Hoare, sp. n.**

urn:lsid:zoobank.org:act:D150BB4B-4D0A-41CE-830A-1B188F63DE6E
http://species-id.net/wiki/Pectinivalva_mystaconota

Material examined. Holotype. ♂, 35.16S, 149.06E, Black Mt., A.C.T., light trap, 26.iv.1963, I.F.B. Common. Genitalia slide 10164 (ANIC). Paratypes. Same locality and collector as holotype: 2♂, 28.xi.1957, 4♀, 9.xii.1957, 28.xi.1963, 14.ii.1964 and 19.

ii.1964; same locality, blended light, R.J.B. Hoare: 2♂, 27.xi.1996 and 6.i.1997, slides 10161 and 12064 (ANIC); 6♂, Wellington, N.S.W., 28.x.1957, I.F.B. Common; 1♂, 1♀, 4 miles [6.5 km] SW of Gosford, N.S.W., 30, 31.iii.1965, I.F.B. Common, M.S. Upton; 1♂, 9 miles [14.5 km] NE of Windsor, N.S.W., 31.iii.1965, I.F.B. Common, M.S. Upton; 2♂, 220m, Mt Nelson, Hobart, Tasmania, m.v. light, 7.i.1980, 14.i.1981, P.B. McQuillan; 1♂, 42.56S 147.20E, Mt. Nelson, Tasmania, 330 m, 7.ii.2009, L. Kaila & J. Kullberg (FMNH), slides 11501–11503, 10165 (ANIC), EJvN 4106.

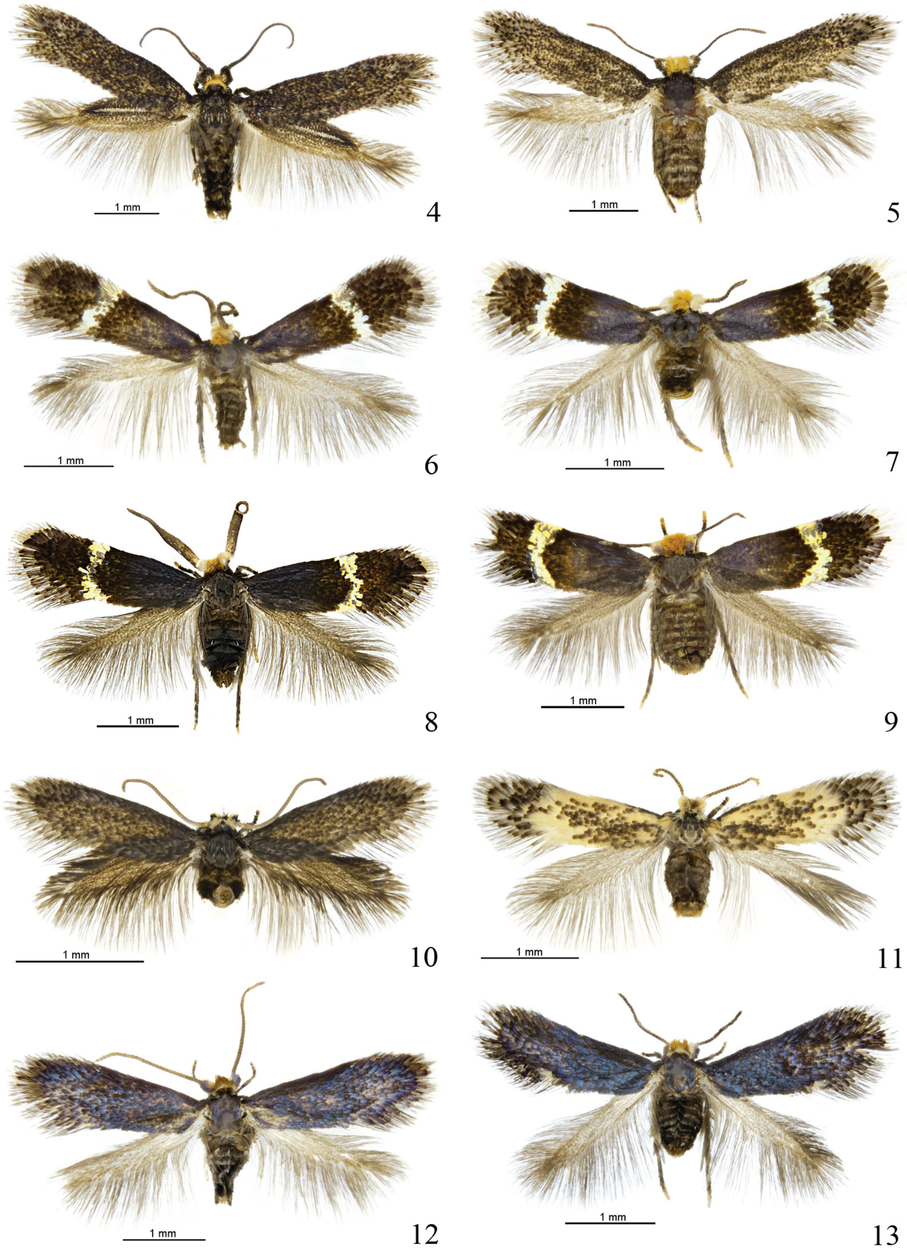
Description. Male (Fig. 4). Wingspan 5.8–7.6 mm. Head capsule: labial palpi distinctly longer than galeae; maxillary palpi with ratio of segments from base approximately 0.3: 0.4: 0.6: 1.5: 1.0; interocular index 0.74. Frontal tuft orange; collar inconspicuous, white; eyecaps black, thinly scaled and almost transparent towards base; antennae blackish, 37–42 segments. Thorax and forewing blackish fuscous, weakly shining; cilia concolorous. Hindwing broadened at base, clothed in dark brown scales with iridescent reflections; an elongate androconial pocket in anterior ½ of wing, surrounded by shining granular blackish scales; cilia dark grey. Underside: forewing and hindwing dark fuscous; costa of hindwing with a series of blunt rectangular lamellate scales. Wing venation as in Fig. 31: base of R1 in forewing well separated from base of R2+3; trunk of Rs+M in hindwing not strongly deflected towards costa. Legs: fore-tibia somewhat thickened with blackish scales. Abdomen dark fuscous, with a moustache-like patch of hair-scales on T5 (Fig. 41).

Female (Fig. 5). Wingspan 7.5–8.0 mm. Similar to male, but head broader; antennae shorter, 30 segments; forewing somewhat broader; hindwing unmodified. Wing venation as in Fig. 32: base of R1 in forewing close to base of R2+3; trunk of Rs+M in hindwing strongly deflected towards costa. T5 of abdomen without hair-scales.

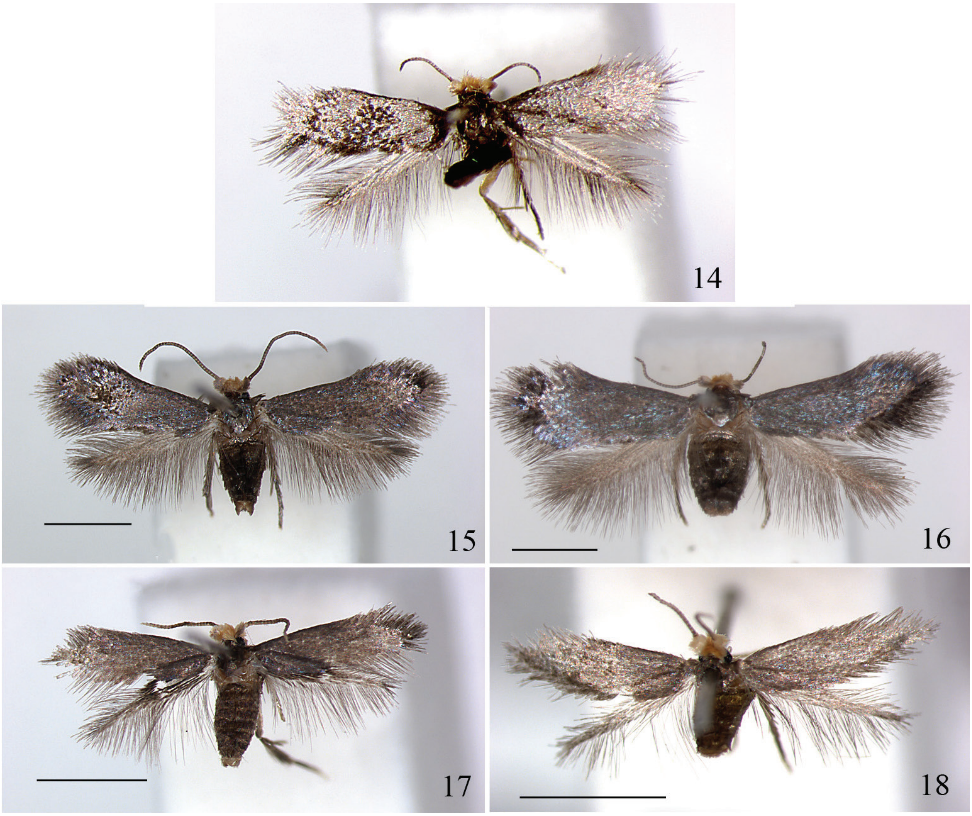
Male genitalia (Figs 39, 40, 42, 58, 59). Capsule ca. 480 µm long. Vinculum with anterior margin W-shaped; lateral arms and tegumen forming a triangle. Tegumen very narrow, caudally rounded. Uncus hood-like with well-sclerotized tip. Gnathos with enlarged basal plate, lateral arms slightly curved, central element short, triangular. Valva (Fig. 40) ca. 280–335 µm long, triangular and pointed; a spine-like process at base of medial edge; inner (dorsal) surface with numerous strong flattened setae in apical ½; exterior surface with a tuft of very robust, long setae extending beyond tip of valva (visible without dissection); sublateral processes well developed; pectinifer absent. Aedeagus (Figs 42, 59) ca. 550–575 µm including processes; 3 large blunt interconnected processes at apex, the left hand one curved; vesica with a large field of small cornuti, cathrema with 3 loosely interconnected elongate sclerites.

Female genitalia (Figs 73, 80–82). Total length ca. 935 µm. T9 not forming distinct anal papillae, 8–9 setae on each side. T8 with ca. 9–10 setae on each side. Apophyses anteriores slightly longer than posteriores (Fig. 81). Lateral sclerites of vestibulum absent. Corpus bursae with elongate posterior portion and oval anterior portion; anterior portion with strong transverse folds and numerous strong close-set pectinations. Signum (Fig. 82) an elongate weakly toothed band along anterior edge of corpus.

Diagnosis. Both sexes can be distinguished from similar members of the subgenus by the black eyecaps with their weakly scaled transparent bases. In addition, the combination of the pointed valvae with their long, strong setae (visible in undissected



Figures 4–13. *Pectinivalva* spp., adults. **4** *P.* (*P.*) *mystaconota*, male paratype, Black Mt., A.C.T., 27.xi.1996 **5** *P.* (*P.*) *mystaconota*, female paratype, 4 miles [6.5 km] SW of Gosford, N.S.W., 30.iii.1965 **6** *P.* (*Casanovula*) *brevipalpa*, male paratype, Fitzroy Falls, N.S.W., emg. 28.x.1996 **7** *P.* (*C.*) *brevipalpa* female paratype, Fitzroy Falls, emg. 9.xii.1996 **8** *P.* (*C.*) *minotaurus* male paratype, Leslie St., Toowoomba, Qld, emg. 8–9.ii.1996 **9** *P.* (*C.*) *minotaurus* female paratype, Leslie St., emg. 19.ii.1996 **10** *P.* (*Menurella*) *scotodes*. male paratype, Leslie St, Toowoomba, Qld, emg. 8.x.1995 **11** *P.* (*M.*) *scotodes* female paratype, McAfee's Lookout, Brisbane Forest Park, Qld, emg. 1.x.1995 **12** *P.* (*M.*) *acmenae* male paratype, Mt Dromedary, N.S.W., emg. 22.x.1995 **13** *P.* (*M.*) *acmenae* female paratype, Kioloa State Forest, N.S.W., emg. 11.x.1995.



Figures 14–18. *Pectinivalva* (*Menurella*) spp., adults. **14** *P.* (*M.*) *xenadelpha*, female holotype, Indonesia, Kalimantan, Gunung Lumut, emg. 15.xii.2005 **15** *P.* (*M.*) *quintiniae*, male holotype, Tullawalal, Lamington N.P., Qld, emg. 25.ix.-6.x.2004 **16** *P.* (*M.*) *quintiniae*, female paratype, Tullalwalal, emg. 25.ix.–6.x.2004 **17** *P.* (*M.*) *tribulatrix*, male holotype, Cape Tribulation, Qld, emg. 8.ix.2004 **18** *P.* (*M.*) *tribulatrix*, female paratype, Cape Tribulation, emg. 8.ix.2004. Scales 1 mm.

males) and the moustache-like patch of hair-scales on T5 of the abdomen is characteristic of the male. In the female genitalia, the absence of lateral sclerites in the vestibulum and the transversely rugose corpus bursae are diagnostic.

Distribution. Collected in scattered localities in eastern Australia from Wellington, N.S.W. south to Mt Nelson, Hobart, Tasmania; presumably widespread, but not yet known from Victoria.

DNA barcode. RMNH.INS.24106, Genbank KC292479

Derivation. The specific name is derived from the Greek *mystax* (a moustache) and *notos* (a back) and refers to the tuft of hair-scales on T5 in the male. It is an adjective.

Remarks. Several species related to *P.* (*P.*) *mystaconota* are known: all lack a pectinifer and have more or less dense tufts of setae on the dorsal surface of the valva. The group seems to be best represented in Western Australia. As the larvae are unknown, and the only definite apomorphies for the subgenus *Pectinivalva* are characters of the larva, the assignment of this group to the subgenus remains to be confirmed. The undivided uncus and the form of the sclerites associated with the cathrema in the male genitalia, and the form of the signum in the female genitalia, are characteristic of the subgenus *Pectinivalva*, but these features may be plesiomorphic within the genus as a whole. However, in the most parsimonious trees resulting from the cladistic analysis presented above, *P. mystaconota* was placed as sister species to *P.* (*P.*) 138 + *P.* (*P.*) 163. For these reasons, it is here placed in the subgenus *Pectinivalva*.

Subgenus *Casanovula* Hoare, subgen. n.

Type species. *Pectinivalva* (*Casanovula*) *brevipalpa* sp. n.

Description. Adults. Head capsule (Figs 23–30): labial palpi either normal, 3-segmented, or with segments 2 and 3 reduced (Fig. 27), or 2-segmented (Fig. 26); interocular index 0.55–0.68. Antennae sometimes dilated and flattened at base. Head colour blackish or orange; eyecaps white, often blackish posteriorly. Collar consisting of piliform scales. Wingspan 3.8–6.0 mm. Forewing with dark blue or purplish lustre and (except in one species) transverse shining silver or pale gold fascia. Hindwing without androconial pocket. Underside of male forewing without androconia. Wing venation (Fig. 33): R2+3 in forewing absent. Upperside of abdomen in male sometimes with specialized lamellate scales; S2a strongly spinose or without spines. Legs: fore-tibia of male not thickened above with scales.

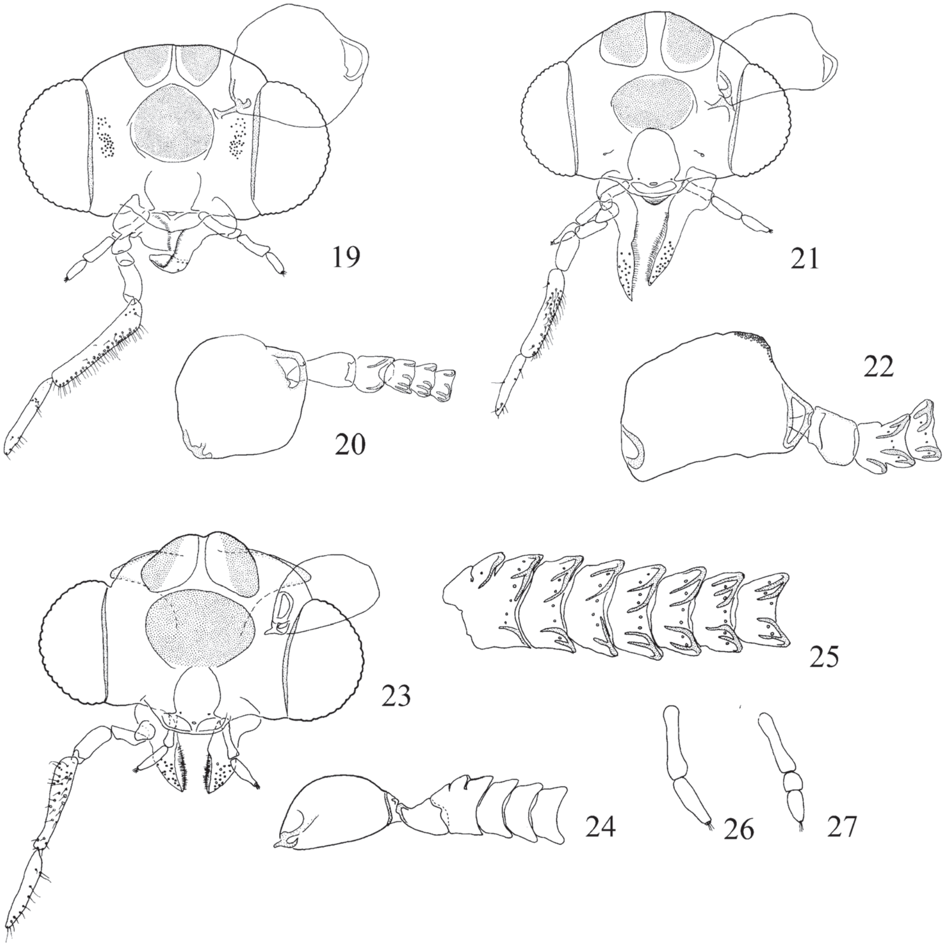
Male genitalia (Figs 43–48, 60–63). Anterior extension of vinculum more or less H-shaped, with strong medial excavation. Tegumen simple. Uncus apically bifid, basally with 2 weakly sclerotized areas. Gnathos central element narrow and pointed. Valva (Figs 44, 47) relatively stout, apically rounded or squared off, pectinifer consisting of ca. 22–29 more or less peg-like elements. Aedeagus (Figs 45, 48, 61, 63): vesica with numerous small cornuti; cathrema moderately weak, with or without associated sclerites.

Female genitalia (Figs 74, 75, 83–88). Lateral sclerites of vestibulum present, narrow. Accessory sac more or less developed. Corpus bursae with numerous pectinations, signum absent.

Larva. Head (Figs 105, 106): antennae 2-segmented; segment 2 with 1 pair of sensilla chaetica and 1 pair of sensilla basiconica; head-shape cordate or pyriform. Thorax: prothoracic sternite (Figs 110, 111) more or less narrow, subtriangular; chaetotaxy (Fig. 116): T2 with 10 or 11 pairs of setae (2 pairs of D setae (except in *P.* (*C.*) 226, which has 1 pair of D setae); L3 present or absent). Abdomen: as described for subfamily. Cuticle not textured, all segments except T1 and A10 with covering of fine spines.

Biology. Host-plants: *Lophostemon* Peter G. Wilson spp., *Tristaniopsis* Peter G. Wilson spp., and *Melaleuca* L. spp. (including species formerly assigned to *Callistemon* R. Br.) (all Myrtaceae). Mine (Figs 117, 118): either a narrow gallery more or less filled with frass, or a gallery expanding into a blotch; exit-hole a small semicircular slit, a small semicircular hole, or a large slit: in the last case larva pupating in mine.

Diagnosis. See Table 1.

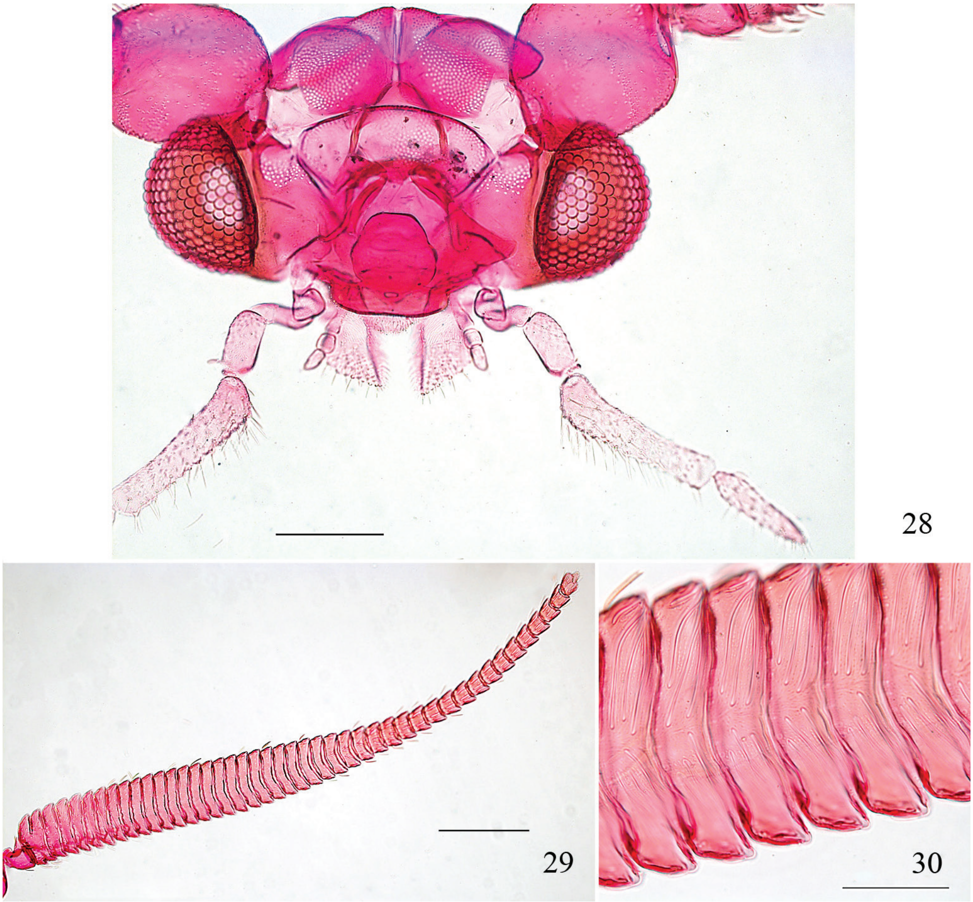


Figures 19–27. *Pectinivalva* spp, adult male heads, anterior view. **19** *P.* (*P.*) 138, head **20** *P.* (*P.*) 138 antennal base **21** *P.* (*Menurella*) *scotodes*, head **22** *P.* (*M.*) *scotodes* antennal base **23–26** *P.* (*Casanovula*) *brevipalpa*: **23** head **24** antennal base **25** flagellomeres 1–7, showing sensillum vesiculocladum **26** labial palpus **27** *P.* (*C.*) *minotaurus* labial palpus.

Distribution. Known only from eastern Australia: Queensland, N.S.W., A.C.T. and Tasmania; to be expected in Victoria.

Derivation. The subgenus is named (in the diminutive) after the famous Italian adventurer and philanderer Giacomo Casanova, in reference to the unusual sexual ornamentation of the males of some species (e.g. *P.* (*C.*) *minotaurus* sp. n., in which the male has strongly dilated antennae and specialized scales on the abdomen upperside). It is considered feminine (in spite of its derivation) to accord with the gender of *Pectinivalva*.

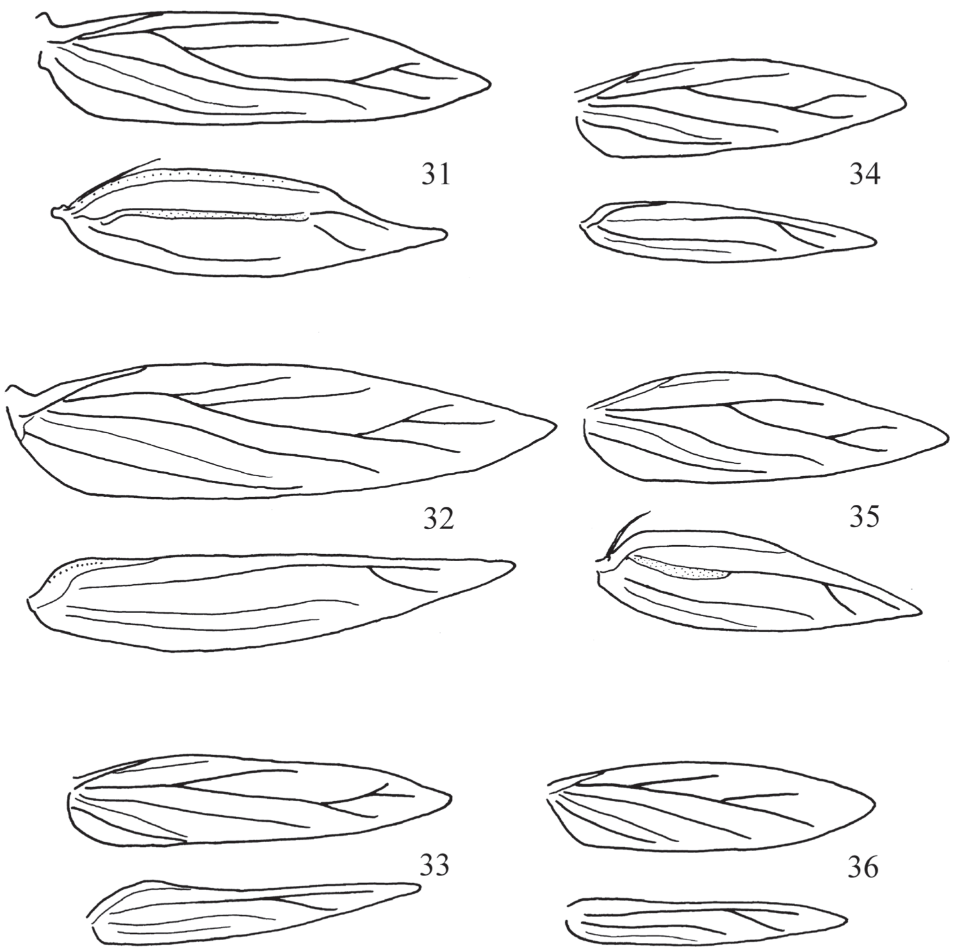
Included species. No previously described species are referable to this subgenus. The following species are described below: *Pectinivalva* (*C.*) *brevipalpa* sp. n. and *P.* (*C.*) *minotaurus* sp. n. Also at least five undescribed species in the ANIC, of which the



Figures 28–30. *Pectinivalva* (*Casanovula*) *minotaurus*, adult male head, anterior view. **28** Head **29** whole antenna, excluding scape **30** portion of basal ½ of flagellum, showing sensillum vesiculocladum. All from slide ANIC11325. Scales 100 µm (28), 200 µm (29), 50 µm (30).

following, cited by their ANIC rearing numbers, have been studied in detail for the current work: *P.* (*C.*) 219; *P.* (*C.*) 226.

Discussion. This is the least speciose of the three subgenera of *Pectinivalva*. Two species-groups can conveniently be recognised. In the *P.* (*C.*) *brevipalpa* group (not monophyletic according to the cladistic analysis), the antenna of the male is dilated and flattened at the base, the vertex bears a pair of sclerotized crests, and the labial palpus is modified, with segments 2 and 3 reduced or fused. Abdominal sternite 2a is strongly spinose. The host-plants are *Tristaniopsis* and *Lophostemon* spp. and pupation is outside the mine. In addition to *P. brevipalpa* and *P. minotaurus*, a single undescribed species (*P.* 41, feeding on *Lophostemon confertus*), is referable to this species group. In the *P.* (*C.*) 219 group, the labial palpi and the vertex are unmodified; S2a lacks spines; the host-plants belong to *Melaleuca* (including *Callistemon*), and pupation may be within the mine. About four species are known in this species group.



Figures 31–36. *Pectinivalva* spp., wing venation. **31** *P.* (*P.*) *mystaconota*, male **32** *P.* (*P.*) *mystaconota*, female **33** *P.* (*Casanovula*) *brevipalpa* male **34** *P.* (*Menurella*) *scotodes* female **35** *P.* (*M.*) *scotodes* male **36** *P.* (*M.*) *acmenae* female.

***Pectinivalva* (*Casanovula*) *brevipalpa* Hoare, sp. n.**

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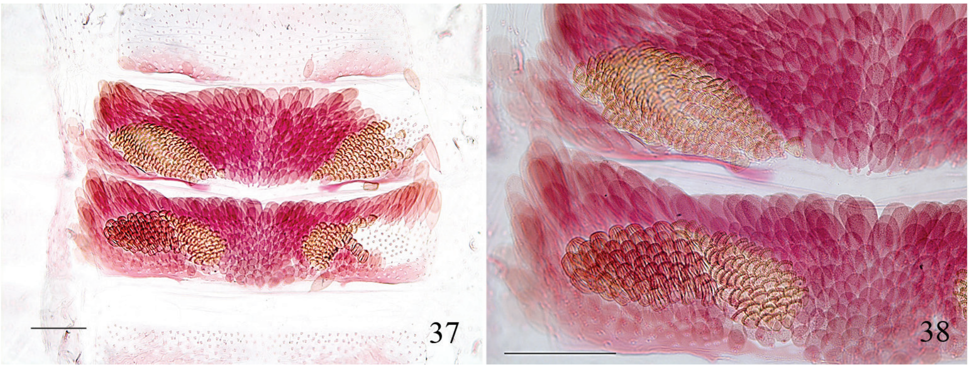
http://species-id.net/wiki/Pectinivalva_brevipalpa

Material examined. Holotype. ♂, 34.39S, 150.29E, Fitzroy Falls, N.S.W., emg. 25.x.1996, *Tristaniopsis collina*, R.J.B. Hoare. Genitalia slide 12111 (ANIC). Paratypes. 6♂, 5♀, same data as holotype, emg. 17.x.-9.xii.1996; 2♂, 4♀, 34.48S, 150.34E, Cambewarra Lookout, N.S.W., *Tristaniopsis collina*, emg. 15.x.-22.xii.1995, R.J.B. Hoare and E.S. Nielsen; 1♂, 1♀, 35.37S, 150.16E, 1 km SE of East Lynne, Kioloa State Forest, N.S.W., emg. 26, 28.x.1995, *Tristaniopsis collina*, R.J.B. Hoare; 1♀,



Figures 37, 38. *Pectinivalva* (*Casanovula*) *minotaurus*, male androconia. **37** Abdominal tergites 4–5, partially descaled **38** close-up of androconia on one side of T4–5, showing the two distinct types. Slide ANIC11325, scales 100 µm.

Clyde Mt., N.S.W., [host unidentified], emg. 28.x.1963, I.F.B. Common. Slides 11237, 11238, 11328, 12065, 12136 (ANIC).

Description. Male (Fig. 6). Wingspan 4.3–5.9 mm. Head capsule (Figs 23–26): labial palpi reduced, 2-segmented; maxillary palpi with ratio of segments from base approximately 0.2: 0.4: 0.5: 1.2: 1.0; interocular index 0.67; vertex with a pair of sclerotized crests. Frontal tuft ferruginous; collar white; eyecaps white; antennae with basal segments dilated and flattened, gradually tapering, shining lead-grey, whitish beneath, ca. 32 segments. Thorax and tegulae dark fuscous with purplish reflections. Forewing to 2/3 dark fuscous with purplish reflections; a shining silver to pale golden fascia at 2/3, slightly broader on costa, apex of wing dark fuscous without reflections; cilia pale grey beyond a line of fuscous-tipped scales. Hindwing grey, unmodified; cilia grey. Abdomen lead-grey, slightly shining.

Female (Fig. 7). Wingspan 4.3–5.2 mm. Similar to male, but antennae not dilated at base, 18 segments.

Male genitalia (Figs 43–45, 60, 61). Capsule ca. 250 µm. Anterior extension of vinculum with semicircular excavation. Uncus squarish, bilobed, with a tuft of 5–6 setae arising from dorsal side of each lobe near tip, centre of uncus with two weakly sclerotized ‘windows’. Gnathos with elongate central element and short lateral arms. Valva (Fig. 44) ca. 190 µm, squarish; pectinifer consisting of ca. 27 narrow elements. Transtilla absent. Aedeagus (Fig. 45, 61) 360 µm, a single rather broad, blunt spine at apex on left. Vesica with numerous close-set rather broad cornuti.

Female genitalia (Fig. 74, 83–85). Total length 520 µm. T9 with 7 setae on each side. Apophyses anteriores rather narrow with slightly incurved tips; apophyses posteriores slightly narrower and longer than anteriores. Lateral sclerotizations of vestibulum narrow, bent inwards, tips unmodified. Ductus spermathecae with 1 indistinct convolution. Posterior part of corpus bursae very convoluted; anterior part with many coarse pectinations; 2 or 3 indistinct elongate sclerotizations ½ way down corpus.

Larva. Green. Head (Fig. 105) elongate, pyriform; length of head ca. 410 µm; width ca. 295 µm. Thorax: prothoracic sternite as in Fig. 110. Chaetotaxy (Fig. 116) as described for subgenus; T2 with 10 pairs of setae (L3 absent); A10 with 4 pairs. Anal rods distinctly forked posteriorly.

Biology. Host plant: *Tristaniopsis collina* Peter G. Wilson & Waterhouse (Myrtaceae). Egg: on underside of leaf. Mine (Fig. 117): commences as very long narrow gallery either filled with greenish frass or with black linear frass, broadens rather abruptly into gallery with central line of black frass; exit-hole on upperside, a semicircular slit. Cocoon: reddish brown. Occupied mines have been collected on 25 June, 1 July, 13 July and 3 August.

Diagnosis. The male is superficially similar to that of *P.* (*C.*) *minotaurus*, but differs in its much less strongly expanded antennae. The male of *P.* (*C.*) *minotaurus* also differs in having shell-like androconial scales on the upperside of the abdomen, visible on dissection, and a more distinctly H-shaped vinculum (Figs 46, 62). The female of *P. brevipalpa* is also very similiar to that of *minotaurus* but can be distinguished on dissection by the presence of the indistinct sclerites ½ way down the corpus bursae.

Distribution. New South Wales.

Derivation. The specific name is derived from the Latin *brevis* (short) and *palpus* (the sensitive palm of the hand: hence, in zoology, a palp) and refers to the reduced, 2-segmented labial palpi of the adult male. It is an adjective.

Pectinivalva (*Casanovula*) *minotaurus* Hoare, sp. n.

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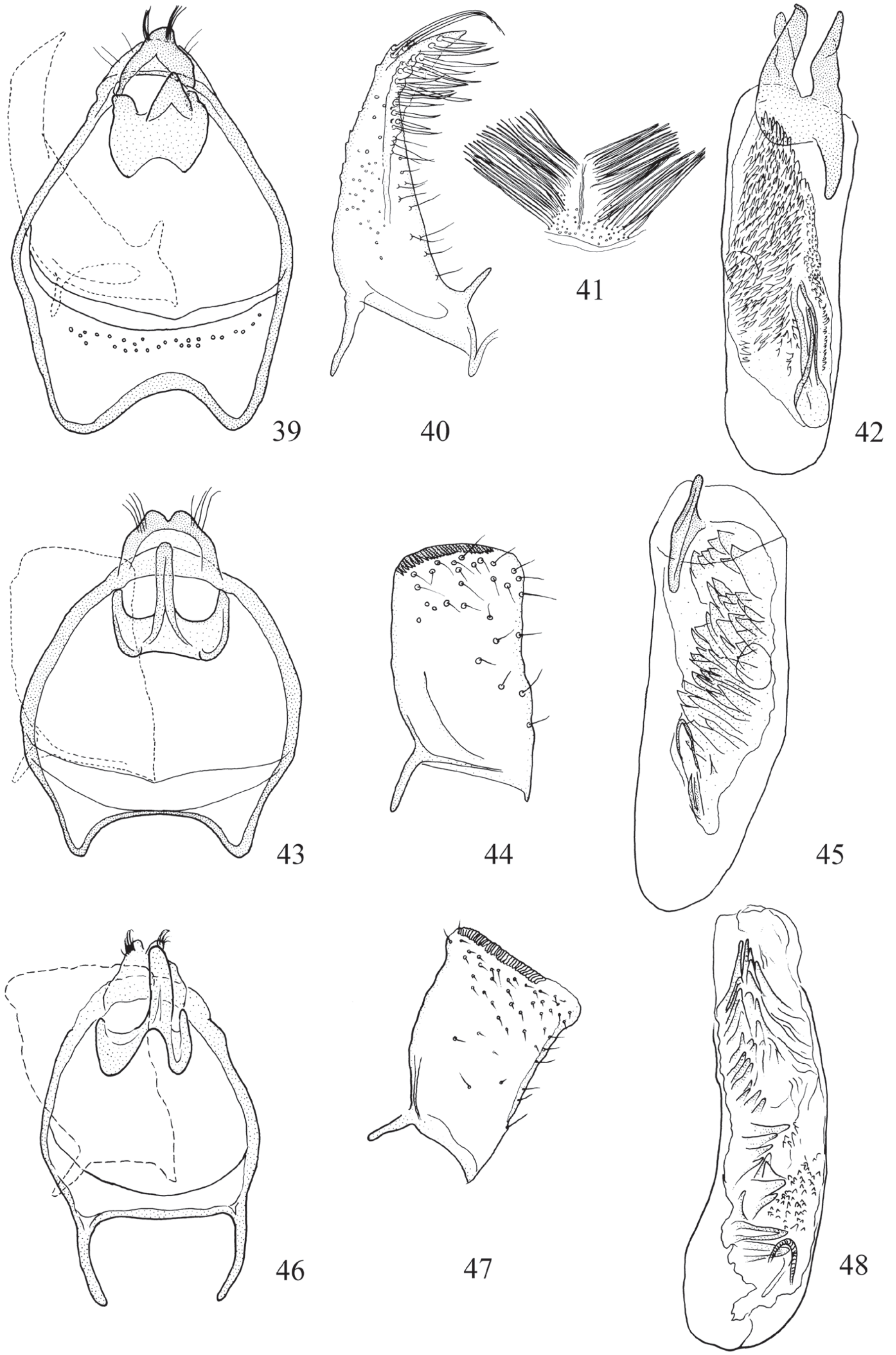
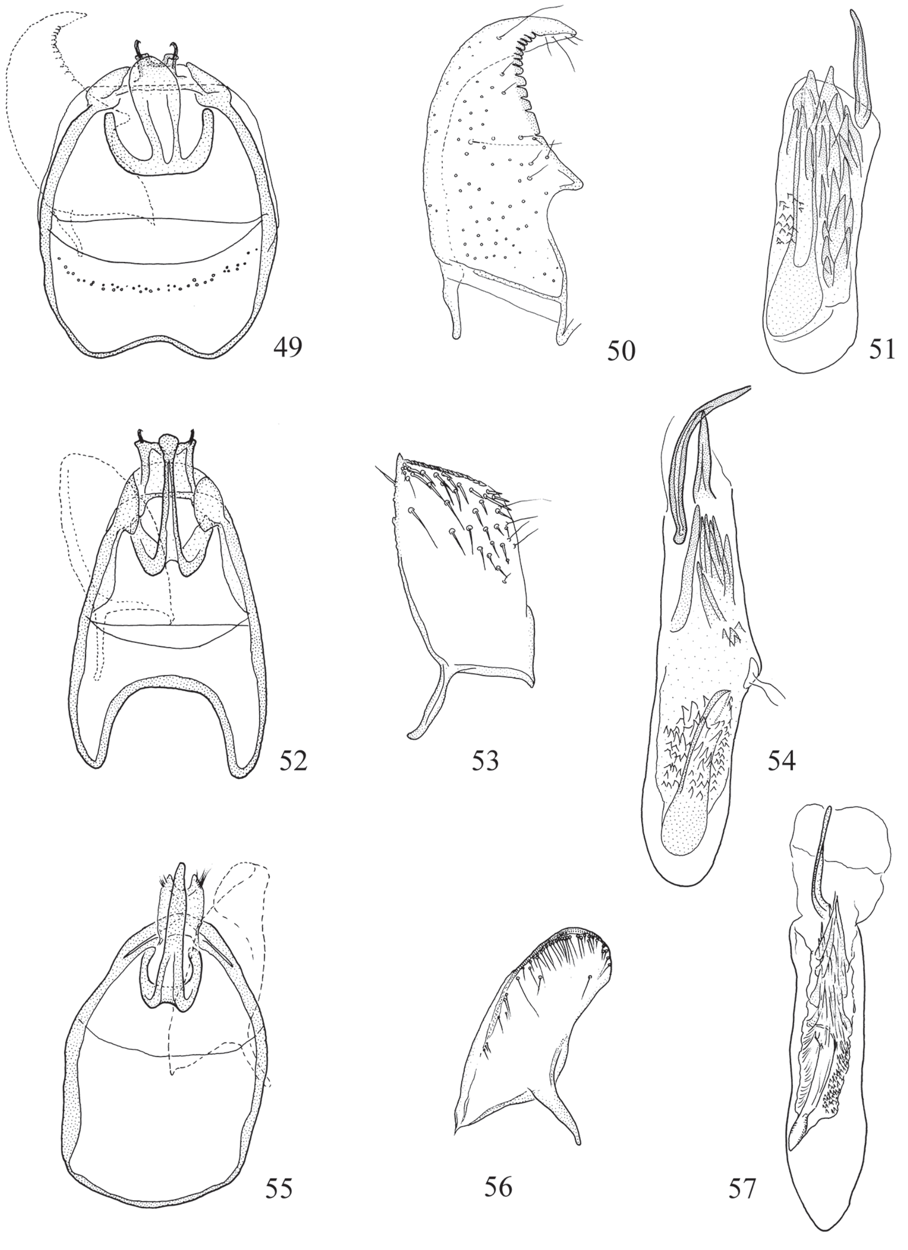
http://species-id.net/wiki/Pectinivalva_minotaurus

Material examined. Holotype. ♂, 27.36S 151.59E, Leslie St., Toowoomba, Qld, emg. 19.ii.1996, *Lophostemon confertus*, R.J.B. Hoare, I.F.B. Common. Paratypes. 2♂, 6♀, same data as holotype, emg. 2.-27.ii., 1.iii.1996, slide 11325 (ANIC); 11♂, 17♀, same locality, emg. 2.i.-2.ii.2001, *Lophostemon confertus*, R.J.B. Hoare, C. van den Berg, genitalia slides CvdB110, EvN 3539, 3547 (RMNH); 3♀, 27.33S, 151.59E, Prince Henry Heights, Toowoomba, Queensland, emg. 15, 18.ii.1986, *Lophostemon confertus*, I.F.B. Common, slide 10209 (ANIC); 1♂, 1♀, Brisbane, Queensland, emg. 30.xii.1957, *Lophostemon suaveolens*, I.F.B. Common, slides 11507, 11582 (ANIC); 1♂, Goodna, [Queensland], 8.iv.1906, [A.J. Turner], slide 11506 (ANIC).

Description. Male (Fig. 8). Wingspan 4.7–5.5 mm. Head capsule (Figs 27–30): labial palpi 3-segmented; segment 2 reduced, maxillary palpi with ratio of segments from base approximately 0.3: 0.8: 0.6: 1.7: 1.0; interocular index 0.57; vertex with a pair of sclerotized crests. Frontal tuft ferruginous; collar ferruginous; eyecaps white, posteriorly leaden; antennae with flagellomeres in basal ½ greatly dilated and flattened, tapering beyond this, shining lead-grey, yellowish beneath, ca. 43–48 segments. Thorax and tegulae dark fuscous with purplish reflections. Forewing to ½ dark fuscous with bluish and purplish reflections; beyond this dark fuscous with bronzy reflections; a shining pale golden

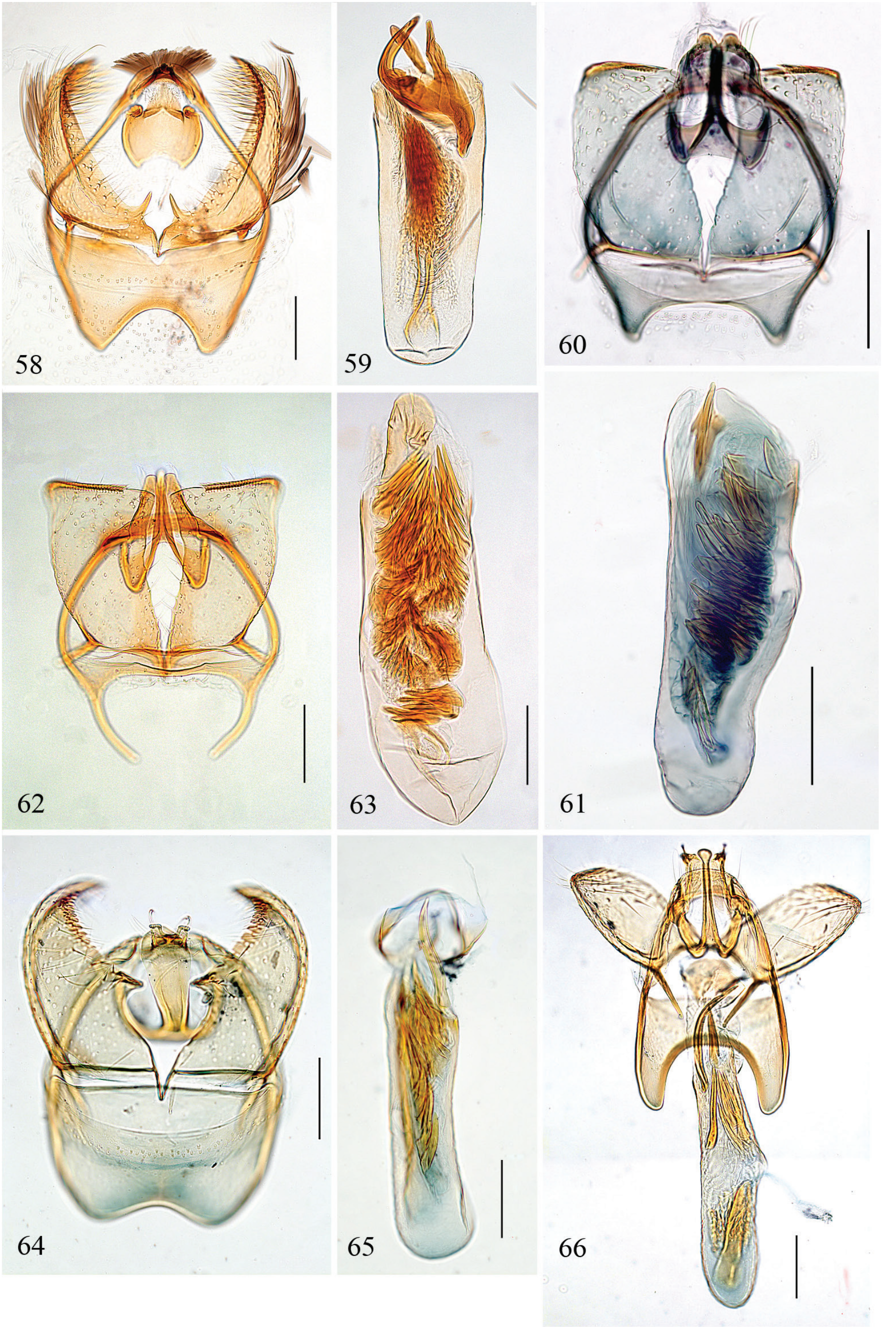


Figures 39–48. *Pectinivalva* spp., male androconia and genitalia, ventral view. **39–42** *P.* (*P.*) *mystaconota*: **39** genital capsule **40** left valva **41** androconial scales on T5 **42** aedeagus **43–45** *P.* (*Casanovula*) *brevipalpa*: **43** genital capsule **44** left valva **45** aedeagus **46–48** *P.* (*C.*) *minotaurus*: **46** genital capsule **47** left valva **48** aedeagus.



Figures 49–57. *Pectinivalva* (*Menurella*) spp., male genitalia, ventral view. **49–51** *P.* (*M.*) *scotodes*: **49** genital capsule **50** left valva **51** aedeagus **52–54** *P.* (*M.*) *acmenae*: **52** genital capsule **53** left valva **54** aedeagus **55–57** *P.* (*M.*) *quintiniae*: **55** genital capsule **56** left valva **57** aedeagus.

fascia at 2/3, apex of wing at base of cilia with purplish reflections; cilia grey beyond a line of fuscous-tipped scales, pale brownish around apex. Hindwing grey, unmodified; cilia grey. Abdomen with T2–3 shining brassy golden, remaining tergites shining dark lead-



Figures 58–66. *Pectinivalva* spp., male genitalia, ventral view. **58, 59** *P.* (*P.*) *mystaconota*, paratype, slide EJvN 4106: **58** genital capsule **59** aedeagus **60, 61** *P.* (*Casanovula*) *brevipalpa*, holotype, slide ANIC12111: **60** genital capsule **61** aedeagus **62, 63** *P.* (*C.*) *minotaurus*, paratype, slide CvdB110: **62** genital capsule **63** aedeagus **64, 65** *P.* (*Menurella*) *scotodes*, paratype, slide ANIC11262: **64** genital capsule **65** aedeagus **66** *P.* (*M.*) *acmenae*, paratype, slide ANIC10213 **66** genital capsule with aedeagus almost *in situ*. Scales 100 µm (59 same scale as 58).

en with green and violet reflections; T4 laterally with contiguous groups of androconial scales of two types: inner scales scallop-shaped, finely ridged; outer scales calyx-shaped, coarsely ribbed; T5 with similar area of androconia consisting entirely of scallop-shaped scales (Figs 37, 38), these showing as velvet black crescents on abdomen *in situ*.

Female (Fig. 9). Wingspan 4.7–5.8 mm. Similar to male, but antennae not dilated at base, ca 21–24 segments; abdomen entirely leaden with brassy reflections.

Male genitalia (Figs 46–48, 62, 63). Capsule ca. 360–375 µm. Anterior extension of vinculum reduced to curved lateral struts, i.e. vinculum anteriorly H-shaped. Uncus subtriangular, bilobed, with a compact tuft of setae arising from dorsal side of each lobe near tip. Gnathos with elongate central element and short lateral arms. Valva (Fig. 47) ca. 235 µm, squarish, caudal margin very straight; pectinifer consisting of ca. 29 narrow elements. Transtilla absent. Aedeagus (Figs 48, 63) 545 µm, with single broad, blunt apical process. Vesica with numerous close-set spine-like cornuti in several groups.

Female genitalia (Fig. 75, 86–88). Total length 800–880 µm. T9 with ca 9 setae on each side. Apophyses anteriores reduced to rounded stubs; apophyses posteriores narrow, much longer than anteriores. Lateral sclerotizations of vestibulum narrow, bent inwards, tips squared off. Ductus spermathecae with 1 ½ convolutions. Posterior part of corpus bursae very convoluted; anterior part with many coarse pectinations in right half; left half with a few fine pectinations only; no further sclerotizations in corpus.

Larva. Green. Head (Fig. 106) parallel-sided; length of head ca. 250 µm; width ca. 215 µm. Thorax: prothoracic sternite as in Fig. 111. Chaetotaxy as described for subgenus; T2 with 11 pairs of setae (L3 present), A10 probably with 3 pairs (but 1 pair possibly lost in slide examined). Anal rods distinctly forked posteriorly.

Biology. Host plants: *Lophostemon confertus* (R.Br.) Peter G.Wilson & J.T.Waterh. and *L. suaveolens* (Sol. ex Gaertn.) Peter G.Wilson & J.T.Waterh. (Myrtaceae). Egg: invariably on upperside of leaf. Mine (Fig. 118): commences as very long narrow gallery with black linear frass, leaving narrow clear margins, broadens rather abruptly into an irregular wide gallery or elongate blotch, sometimes with gallery parts, with central line of black frass or in the case of the blotch, frass concentrated on one or both sides; exit-hole on underside, an almost circular hole. Cocoon (Fig. 125): dark reddish brown. Occupied mines have been collected on 6 and 17 July and 15 August. A male pupa (pharate adult) is shown in Figs 126, 127.

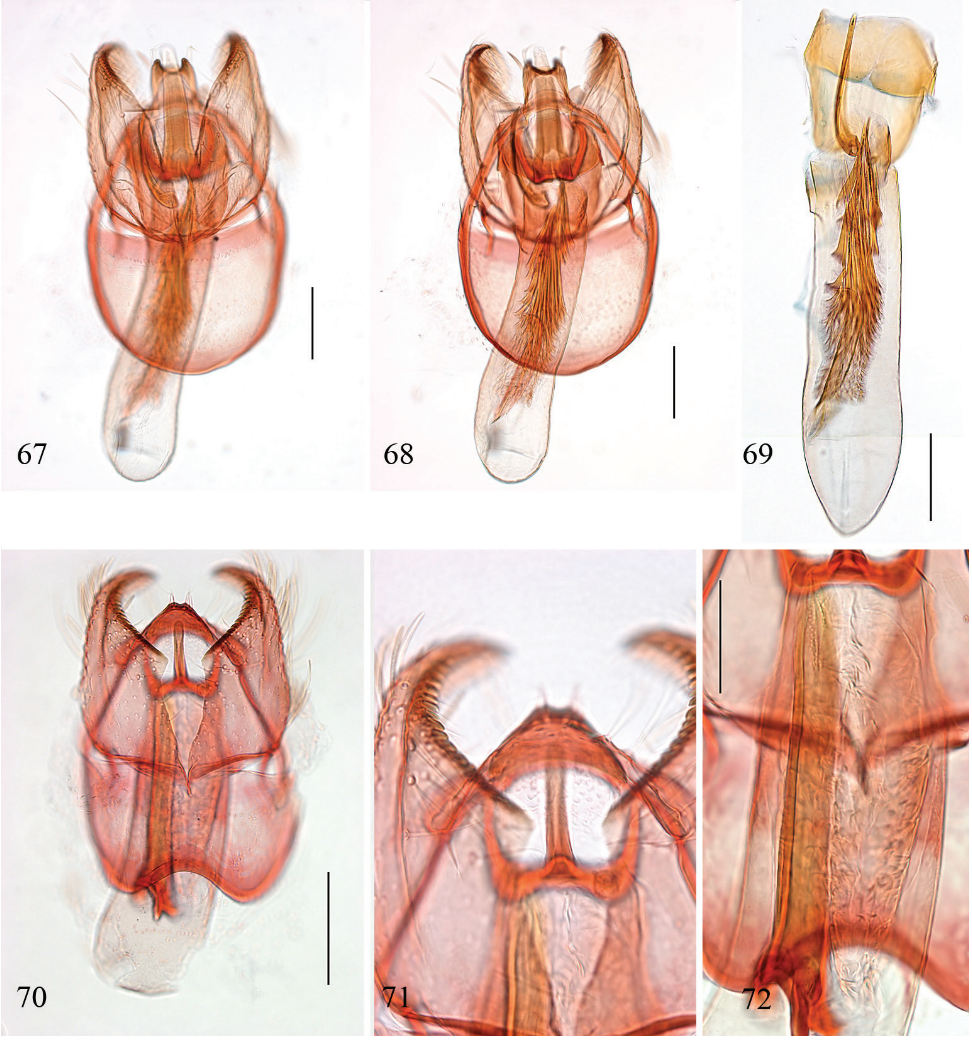
Diagnosis. Very similar externally to *P.* (*C.*) *brevipalpa* in both sexes; diagnostic characters are listed under that species.

Distribution. Southern Queensland.

DNA barcode. RMNH.INS.23539, Genbank KC292478 and RMNH.INS.23547, Genbank KC292477, both identical.

Derivation. The species is named after the famous beast of Greek mythology, the Minotaur. The name (a noun in apposition) refers to the extraordinarily expanded and flattened male antennae, which are likened to the Minotaur's horns.

Remarks. The antennae of the male are the most strongly modified of any known species of Nepticulidae. Although many male-specific head structures in other insects



Figures 67–72. *Pectinivalva* (*Menurella*) spp., male genitalia, ventral view. **67–69** *P.* (*M.*) *quintiniae*, holotype, slide ANIC18720 and paratype, slide EJvN3736 (69): **67**, **68** genitalia with aedeagus *in situ* **69** aedeagus **70–72** *P.* (*M.*) *tribulatrix*, holotype, slide ANIC18721: **70** genitalia with aedeagus *in situ* **71** close-up of gnathos and pectinifer **72** close-up of aedeagus showing tubular sclerite associated with cathrema. Scales 100 µm, 50 µm (71, 72).

are utilized in male-male competitive interactions over mates (e.g. the lateral cephalic projections of *Phytalmia* spp, Tephritidae (Moulds 1977)), such direct competition is unknown in Lepidoptera, and the antennae of *minotaurus* are more likely to function in close-range courtship, along with the androconial scales on the male abdomen. Similar widened flagellomeres are known from the genus *Thisizima* Walker, 1864 in Tineidae (Yang et al. 2012). The androconial scales are also remarkable, two distinct types being present in contiguous patches on the abdominal dorsum.

Subgenus *Menurella* Hoare, subgen. n.

Type species. *Pectinivalva* (*Menurella*) *scotodes* sp. n.

Description. Adults. Head capsule (Figs 21, 22): labial palpi 3-segmented; interocular index 0.49–0.84. Antennae in male occasionally broadened in middle, or with pedicel and segment 1 of flagellum modified as in Fig. 22. Collar consisting of piliform scales (lamellate scales in one undescribed species). Wingspan 3.2–7.0 mm. Thorax and forewing usually unicolorous greyish to fuscous, or with transverse pale fascia or opposite pale spots on costa and tornus at 2/3, occasionally yellowish with dark markings. Costa of forewing in male sometimes with a tuft of very narrow stiff scales towards base. Hindwing of male occasionally expanded at base; androconial pocket often present. Underside of forewing in male sometimes with androconia. Wing venation (Figs 34–36): R2+3 in forewing absent. Abdomen: S2a with or without spines. Legs: fore-tibia in male of those species with androconial pocket usually thickened above with blackish scales.

Male genitalia (Figs 49–57, 64–72). Vinculum with lateral arms often conspicuously forked apically; the lower branch supporting the uncus and the upper branch the tegumen. Uncus apically bifid. Valva (Figs 50, 53, 56) variable in shape; pectinifer with ca. 9–34 (usually fewer than 20) peg-like, spine-like or broad tooth-like elements, or reduced to a thickening along caudal edge of valva. Transverse bar of transtilla absent (present in *P.* (*M.*) 119). Aedeagus (Figs 51, 54, 57, 65, 66, 69, 72): cathrema associated with the apex of a long tubular sclerotization.

Female genitalia (Figs 76–79, 89–103). Lateral sclerites of vestibulum present: forked or thickened. Accessory sac absent. Corpus bursae with extent of pectinations more or less reduced; signum either a small weakly toothed band (*P.* (*M.*) *acmenae*, *P.* (*M.*) *xenadelpha* and *P.* (*M.*) *quintiniae*) or 2 concentric ovals of fence-like marks.

Larva. Head (Figs 107, 108) always more or less cordate, never pyriform. Chaetotaxy: T2 with 10 or 11 pairs of setae (D1 usually present; L3 present or absent). Otherwise not distinguished from that of *Pectinivalva* (*Casanovula*).

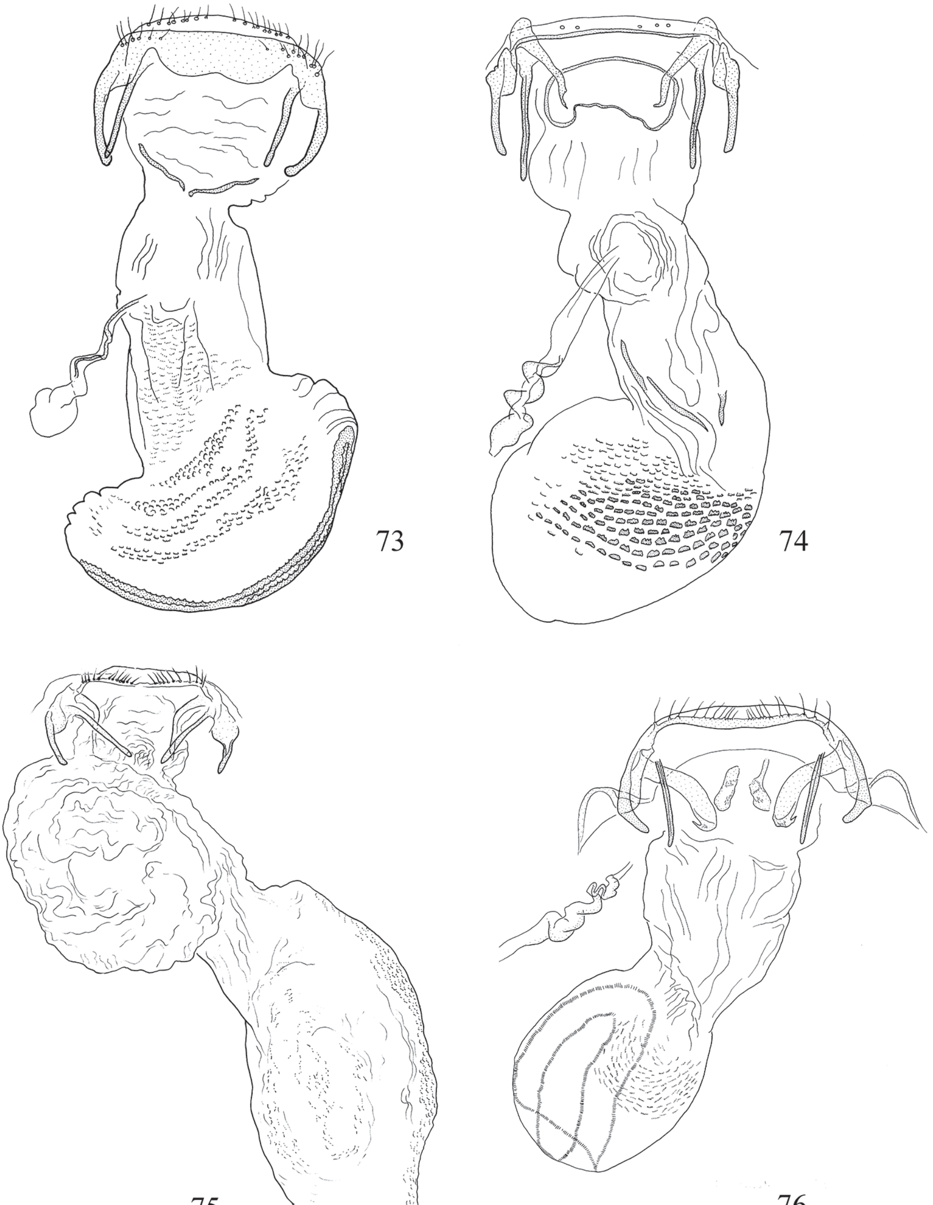
Biology. Host-plants: *Syzygium* R.Br. ex Gaertn. species (formerly in *Acmena*), *Leptospermum* Forst. et f. spp., *Angophora* Cav. spp., *Corymbia maculata* (Hook.) K.D. Hill & L.A.S. Johnson, *Rhodomyrtus macrocarpa* Benth., *Eucalyptus* spp., probably other Myrtaceae, and with one species on Paracryphiaceae (*Quintinia*). Mine (Figs 119–124): usually a narrow gallery more or less filled with frass, occasionally a very short gallery leading to and enveloped by a blotch; exit-hole usually a small semicircular hole.

Diagnosis. See Table 1.

Distribution. Australia (known from all states and territories), Indonesia (Borneo: Kalimantan).

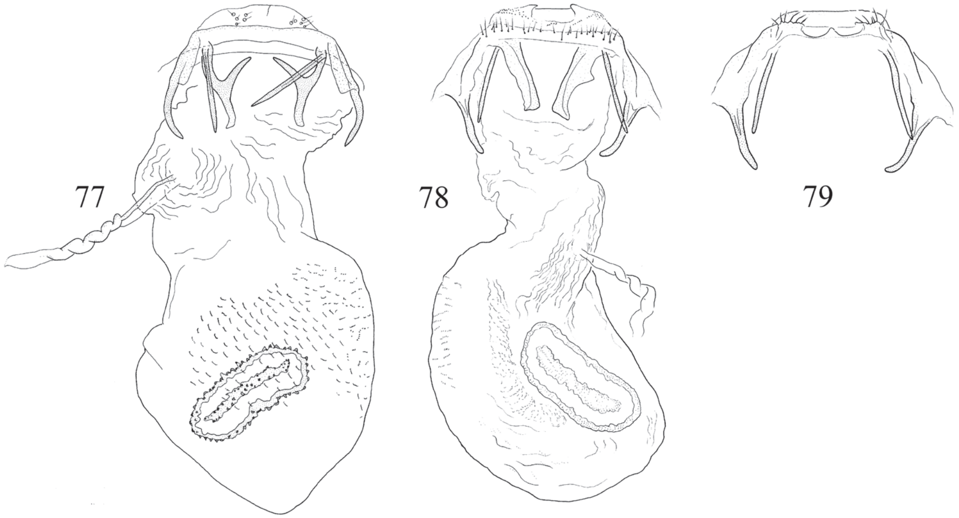
Derivation. The subgeneric name is the diminutive of *Menura*, the genus to which the lyre-bird belongs. It stems from a fancied resemblance between the uncus in some species of the group and the tail of the male lyre-bird. It should be treated as feminine.

Included species. In addition to eleven described and new species, also approximately 70 undescribed species in the ANIC, of which the following, cited by their ANIC rearing numbers, have been studied in detail for the current work: *P.* (*M.*) 2; *P.* (*M.*) 91; *P.* (*M.*) 119.



Figures 73–76. *Pectinivalva* spp., female genitalia, ventral view. **73** *P.* (*P.*) *mystaconota* **74** *P.* (*Casanovula*) *brevipalpa* **75** *P.* (*C.*) *minotaurus* **76** *P.* (*Menurella*) *scotodes*.

Discussion. *Menurella* is the most diverse of the three subgenera of *Pectinivalva*, in terms of numbers of species, morphology and host-plant choice. Below we describe the type species *P.* (*M.*) *scotodes*, three morphologically unusual rainforest species *P.*



Figures 77–79. *Pectinivalva* (*Menurella*) spp., female genitalia, ventral view. **77** *P.* (*M.*) *acmenae* **78** *P.* (*M.*) *quintiniae* **79** *P.* (*M.*) *quintiniae*, apophyses and papillae anales.

acmenae, *P. xenadelpha, P. tribulatrix*, and *P. quintiniae* with unusual morphology and host-plant.

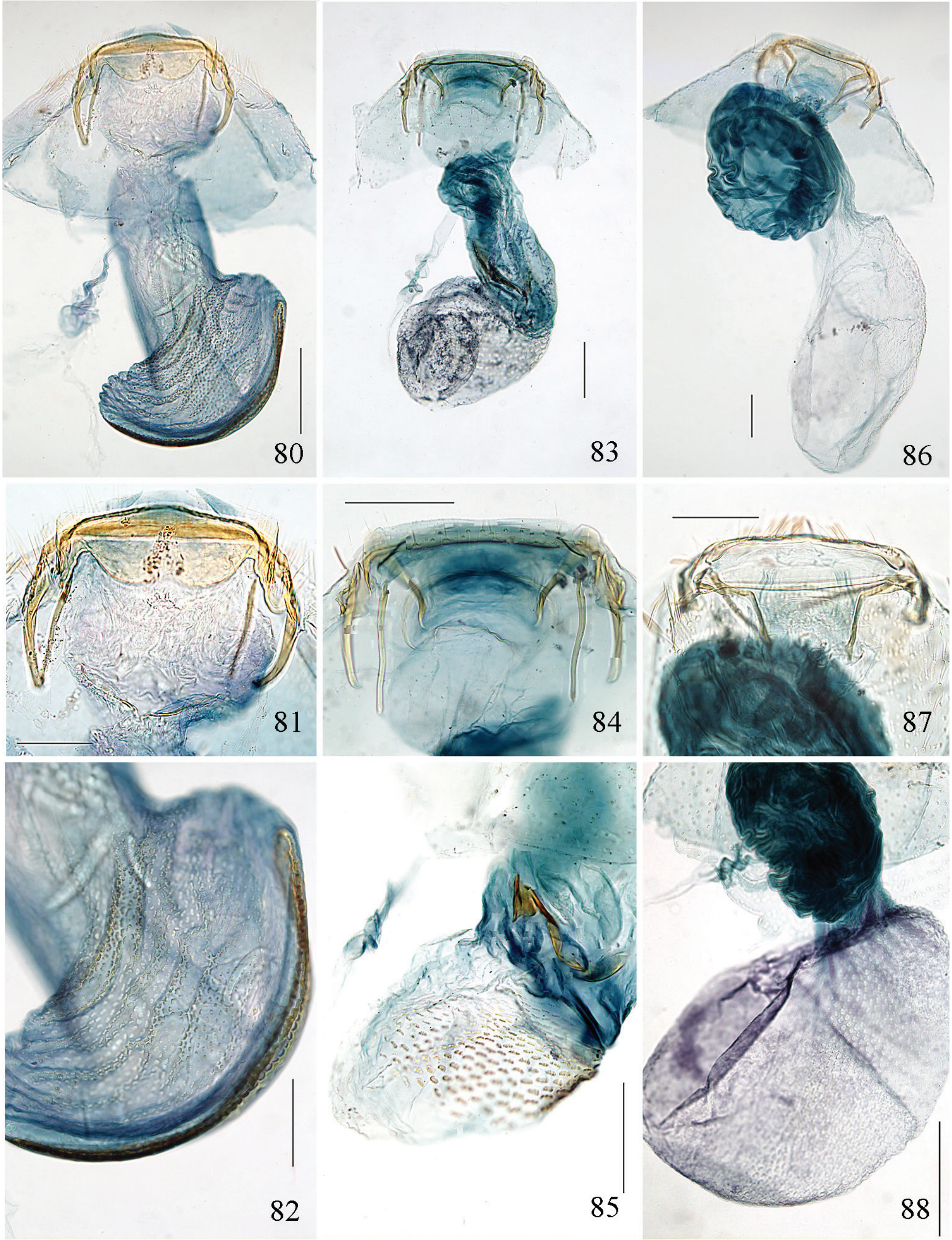
Pectinivalva (*Menurella*) is equivalent to the *P. funeralis* group of Hoare et al. (1997).

Pectinivalva (*Menurella*) *scotodes* Hoare, sp. n.

urn:lsid:zoobank.org:act:62D9A762-334E-4FDE-A191-0282BED3FC18
http://species-id.net/wiki/Pectinivalva_scotodes

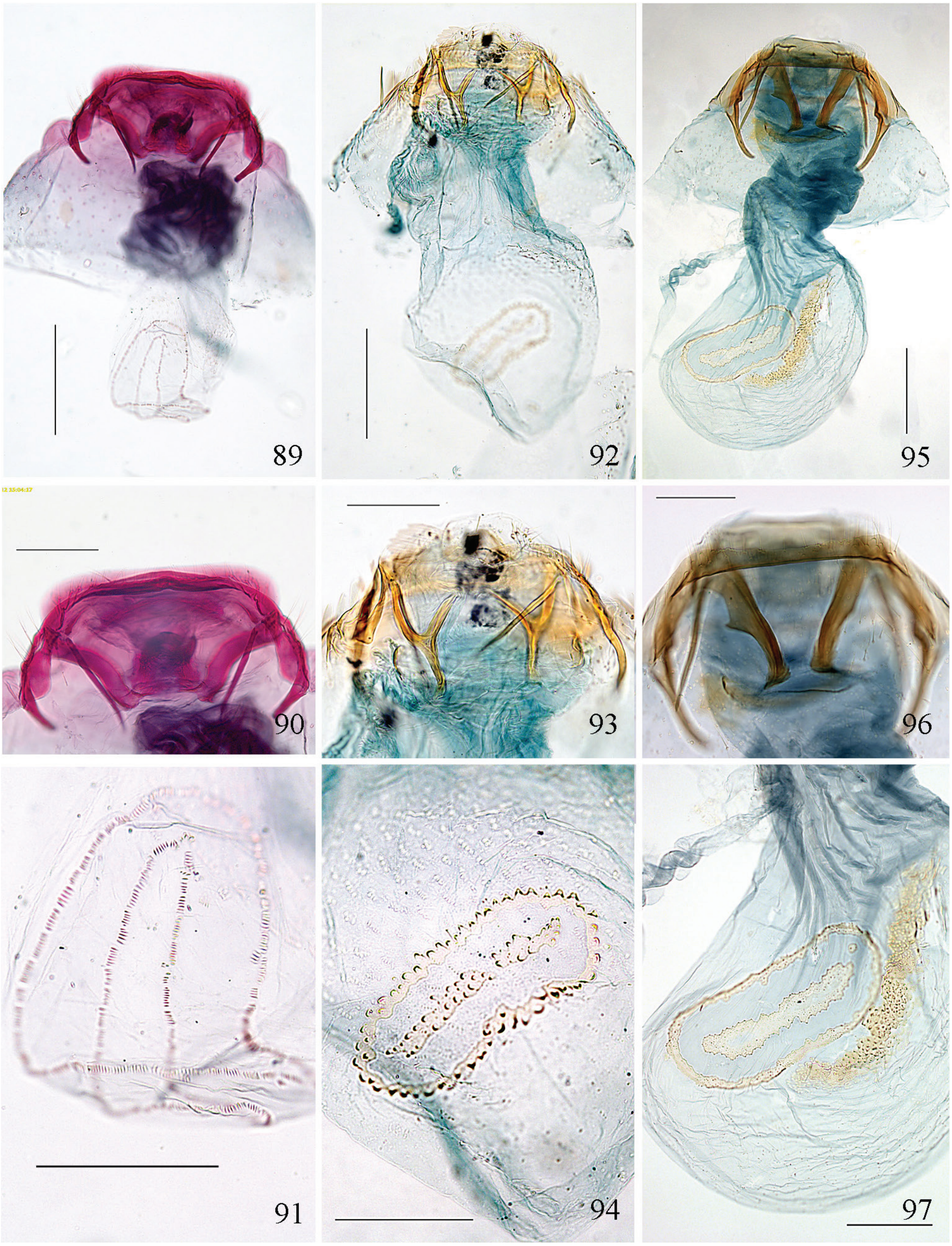
Material examined. Holotype. ♂, 27.36S, 151.59E, Leslie St., Toowoomba, Queensland, emg. 8.x.1995, *Eucalyptus pilularis*, R.J.B. Hoare, I.F.B. Common. Paratypes. 6♂, 4♀, same data as holotype, emg. 3–10.x., 9.xi., 13.xii.1995, slides 11330, 12066 (ANIC); 5♂, 4♀, 27.36S, 151.59E, J.E. Duggan Park, Leslie St., Toowoomba, Queensland, 6.vii.2000, emg. 11.viii.-27.ix.2000, *Eucalyptus pilularis*, R.J.B. Hoare, C. van den Berg, bred in NL, slide EJvN3548 (RMNH); 4♂, 2♀, McAfee's Lookout, Brisbane Forest Park, Queensland, emg. 1–10.x.1995, *Eucalyptus carnea*, R.J.B. Hoare, slides 11262, 11263 (ANIC). 4♂, 3♀, Lisarow, N.S.W., emg. ix.1954, ix.-x.1955, x.1956, *Eucalyptus acmenoides*, K.M. Moore; 1♀, Mollymook, N.S.W., 21.xii.1996, emg. 28.i.1997, *Eucalyptus pilularis*, R.J.B. Hoare.

Description. Male (Fig. 10). Wingspan 5.2–5.7 mm. Head capsule (Figs 21, 22): labial palpi distinctly shorter than galeae; maxillary palpi with ratio of segments from base approximately 0.4: 0.3: 0.4: 1.4: 1.0; interocular index 0.69; scape slightly expanded posteriorly into a setose 'bump'; 1st 2 flagellar segments of antenna fused and narrower than remaining segments so that base of flagellum appears slightly invaginated posteri-



Figures 80–88. *Pectinivalva* spp., female genitalia, ventral view. **80–82** *P.* (*P.*) *mystaconota*, paratype, slide ANIC10161 **83–85** *P.* (*Casanovula*) *brevipalpa*, paratypes, slides ANIC11328, ANIC11238 (85) **86–88** *P.* (*C.*) *minotaurus*, paratypes, slides ANIC11327 (86), ANIC10209. Scales 100 µm, 200 µm (80, 88).

orly. Frontal tuft black, collar white; eyecaps white, black-bordered posteriorly beneath; antennae shining grey, ca. 42 segments. Thorax and forewing entirely blackish brown; a row of long blackish androconial scales projecting from dorsum; cilia shining dark



Figures 89–97. *Pectinivalva* (*Menurella*) spp., female genitalia, ventral view. **89–91** *P.* (*M.*) *scotodes*, paratype, slide ANIC11263 **92–94** *P.* (*M.*) *acmenae*, paratype, slide ANIC11242 **95–97** *P.* (*M.*) *quintiniae*, paratype, slide EJvN3961. Scales 200 µm (89, 92, 95), 100 µm.

brown, cilia-line indistinct. Hindwing rather broad, dark brown, with a small narrow androconial pocket basally; cilia shining blackish. Underside: forewing dark brown, costa black with a knob of black granular scales at base forming retinaculum; hindwing dark brown with blackish lamellate scales along basal ½ of costa. Wing venation as in Fig. 35. Legs: fore-tibia thickened above with blackish scales. Abdomen shining blackish.

Female (Fig. 11). Wingspan 5.0–5.2 mm. Head: frontal tuft brownish, collar white; eyecaps shining white, unmodified, antennae shining grey, ca. 24 segments, basal flagellar segments unmodified. Thorax and forewing paler than in male, yellowish overlain more or less extensively with brownish fuscous scales, leaving following markings yellow: a diffuse streak just beneath costa reaching ½ way along wing and diffuse opposite spots on costa and tornus at 2/3, cilia grey with moderately distinct cilia-line. Hindwing narrower than in male, grey; cilia grey. Underside: forewing shining dark brown; hindwing shining grey. Wing venation as in Fig. 34. Legs unmodified. Abdomen shining dark grey, paler beneath.

Male genitalia (Figs 49–51, 64, 65). Capsule ca. 370 µm long. Vinculum with slight anterior excavation; lateral arms inconspicuously forked apically, the caudal bifurcations from each side uniting to form straight bar along base of tegumen. Tegumen narrow, lateral corners produced anteriorly into distinct 'shoulders'. Uncus small, boat-shaped. Gnathos central element long, spatulate. Valva (Fig. 50) ca. 245 µm long, reaching well beyond tegumen, strongly curved; medial edge smoothly excavated and ending in triangular projection; pectinifer consisting of 12 broad, blunt elements; dorsal surface towards apex with long setae. Juxta consisting of paired plate-like sclerites. Aedeagus (Fig. 51, 65) ca. 455 µm long; a spine-like process projecting from apex on right in ventral view; vesica with ca. 20 rather large cornuti, the 2 apical ones with very broad bases; sclerotized tube supporting cathrema very long, 2/3 length of aedeagus.

Female genitalia (Fig. 76, 89–91). Total length ca. 640 µm. T9 with ca. 10–11 setae on each side. Apophyses posteriores slightly longer than anteriores; apophyses anteriores curved inwards. Segment 7 produced laterally into 2 small evaginations either side of apophyses anteriores. Lateral sclerites of vestibulum broad, their apices associated with a pair of roughened irregular sclerotizations in centre of vestibulum. Ductus bursae strongly folded. Ductus spermathecae with ca. 3–4 poorly defined convolutions. Corpus bursae rounded; a field of concentrically arranged pectinations in posterior ½ on one side; signum a pair of concentric ovals of fence-like spines.

Larva. Appearing translucent whitish or yellowish in mine, becoming dull purplish white on vacating. Head as in Fig. 107; length of head ca. 345 µm; width ca. 270 µm. Thorax: prothoracic sternite (Fig. 112) narrow, I-shaped. Chaetotaxy and spinosity: T2 with 10 pairs of setae (L3 absent); otherwise as described for subgenus *Casanovula*. Anal rods slightly forked posteriorly.

Biology. Host plants: *Eucalyptus pilularis* Smith, *E. carnea* R. Baker, *E. acmenoides* Schauer and probably *E. saligna* Smith (see below) (Myrtaceae). Egg: on upperside of leaf. Mine (Fig. 119): commences as a tight spiral around the egg, causing a raised red-brown spot on the leaf about 3–5 mm in diameter; later broadens into a more or less contorted linear gallery with black frass leaving narrow clear margins; exit-hole on leaf underside, a crescentic hole. Often several mines to a leaf. Cocoon: reddish brown. Occupied mines were collected on 17 and 20 July 1995, and 21 Dec 1996, and have also been recorded in January, March, April, June and August (Moore 1966).

Diagnosis. The male of *P.* (*M.*) *scotodes* resembles those of *P.* (*M.*) *funeralis* (Meyrick), *P.* (*M.*) *libera* (Meyrick) and *P.* (*M.*) 119. It can be distinguished from all of these by its black head-tuft. The brown and yellow wing pattern of the female is distinctive amongst known species (although the females of *P.* (*M.*) *funeralis* and *P.* (*M.*) *libera* are unknown). The unusual larval mine of *P.* (*M.*) *scotodes* appears to be diagnostic.

Distribution. N.S.W, Southern Queensland.

DNA barcode. RMNH.INS.23548, Genbank KC292483.

Derivation. The specific name (an adjective) is derived from the Greek *skotodes*, meaning either 'dark' or 'dizzy'. It refers both to the blackish coloration of the adult male moth, and to the habit of the young larva, which mines in tight circles.

Remarks. The two female paratypes reared from mines on *Eucalyptus carnea* collected near Brisbane have a sparser scattering of brown scales on the yellow ground colour than the females reared from *E. pilularis*. However, no other differences have been observed between specimens from these two host-plants, and the mines also appear to be identical.

This species was first collected by K.M. Moore, who described and illustrated the mine (Moore 1966: figs 15, 15A). There are specimens in the ANIC (here designated paratypes) reared by him in the 1950's. The host-plant is indicated on the labels only by a rearing number; mines from his herbarium with the corresponding number are all in leaves of *Eucalyptus acmenoides*. He also recorded mines on *E. saligna,* but no specimens reared from this host-plant have been located. Moore referred to this species as '*Nepticula* sp. 3' and regarded it as related to *N. gilva* Meyrick. He was probably misled by the wing-pattern of the female of *P.* (*M.*) *scotodes*, which bears some resemblance to that of *P.* (*P.*) *gilva*: he would not have seen the type specimen of *P.* (*P.*) *gilva* in the BMNH. The two species are not closely related and belong to different subgenera of *Pectinivalva*.

***Pectinivalva* (*Menurella*) *acmenae* Hoare, sp. n.**

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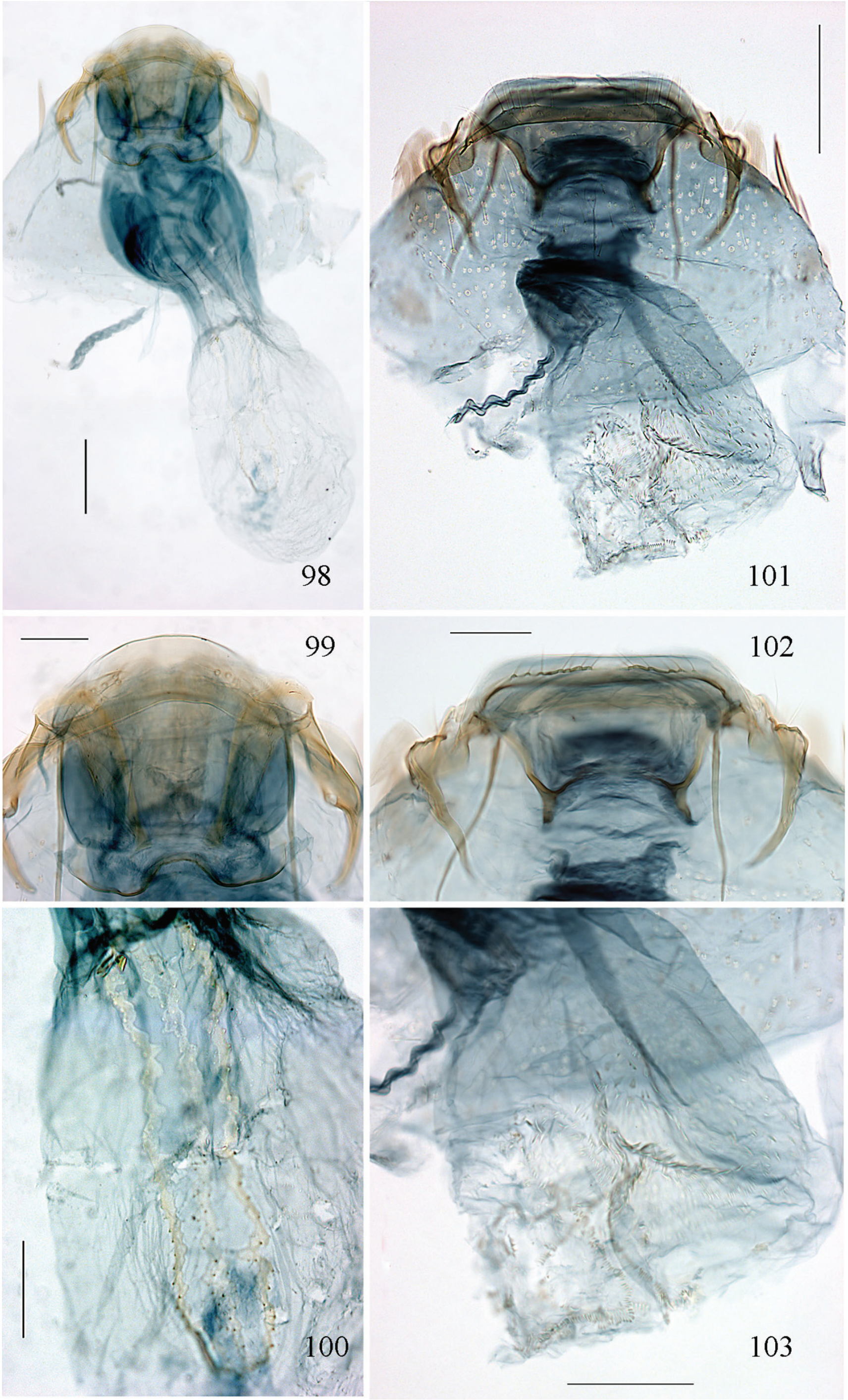
http://species-id.net/wiki/Pectinivalva_acmenae

Material examined. Holotype. ♂, 35.37S, 150.16E, 1 km SE of East Lynne, Kioloa State Forest, N.S.W., *Acmena smithii*, emg. 12.x.1995, R.J.B. Hoare. Paratypes. 3♂, 3♀, same data as holotype, emg. 10–21.x.1995; 2♂, 36.19S, 150.03E, Mt Dromedary, N.S.W., emg. 22, 24.x.1995, R.J.B. Hoare, E.S. Nielsen and M.J. Matthews, genitalia slides 10213, 11242 (ANIC); 2♂, 28.42S,153.37E, Broken Head NR, N.S.W., 13.vii.2000, emg. 15–18.viii.2000, *Acmena smithii*, R.J.B. Hoare, C. van den Berg, bred in NL, slide EJvN3541 (RMNH).

Description. Male (Fig. 12). Wingspan 4.5–5.5 mm. Head: frontal tuft ferruginous; collar inconspicuous, consisting of white, grey-tipped scales; eyecaps anteriorly white, posteriorly shining grey with bluish reflections; antennae shining dark grey, whitish beneath, ca. 35 segments. Thorax, tegulae and forewing uniform shining dark grey with strong blue reflections; an inconspicuous tornal spot consisting of a few white scales; cilia dark grey. Hindwing unmodified, pale grey; cilia pale grey. Under-



Figures 98–103. *Pectinivalva* (*Menurella*) spp., female genitalia, ventral view. **98–100** *P.* (*M.*) *xenadelpha*, holotype, slide EJvN3738 **101–103** *P.* (*M.*) *tribulatrix*, paratype, slide EJvN3963. Scales 100 µm, 50 µm (99, 100, 102).

side: forewing grey with faint brassy reflections; hindwing grey. Abdomen shining dark grey; anal tuft inconspicuous, dark grey.

Female (Fig. 13). Wingspan 5.2–5.6 mm. Similar to male, but antenna with 23–25 segments, and forewing rather broader. Wing venation as in Fig. 36. Abdominal tip not as broad and 'square' as in females of other *Pectinivalva* spp.

Male genitalia (Figs 52–54, 66). Capsule ca. 425 µm long, forming a narrow triangle. Anterior edge of vinculum excavated in a half-oblong. Tegumen rounded, with ventral extensions on each side overlapping lateral arms of gnathos. Uncus rectangular, bilobed, lobes slightly produced, with 3 setae on each. Gnathos central element long, reaching just beyond uncus, ending in small swelling. Valva (Fig. 53) ca. 210 µm long, squarish, more rounded caudally and produced into a short point at exterior corner of apex; apical ½ with numerous spine-like setae on dorsal surface; pectinifer consisting of ca. 18 spine-like elements. Long sublateral processes present. Juxta a weak subcircular plate. Aedeagus (Figs 54, 66) ca. 510 µm long, a curved spine arising towards apex on left, a shorter spine to right of this one, a third spine in line with second and anterior to it. Vesica basally with cathrema surrounded by a field of many broad, short cornuti; a separate field of ca. 9 long narrow cornuti above opening of ejaculatory duct.

Female genitalia (Fig. 77, 92–94). Total length ca. 760 µm. T9 prominent, with a group of 5–6 setae on each side. Apophyses anteriores rather narrow, curved inwards; apophyses posteriores narrow, straight, approximately equal in length to anteriores. Lateral sclerotizations of vestibulum strongly developed, forked, the bifurcations diverging widely, anterior pair blunt, posterior pair pointed. Ductus spermathecae with 4½ convolutions. Posterior part of corpus broad, folded, without markings; anterior part rounded, with rows of inconspicuous pectinations; signum consisting of broken linear sclerotization surrounded by oval sclerotized ring with blunt dentitions.

Larva. Green. Length of head ca. 440 µm; width ca. 350 µm. Thorax: prothoracic sternite in shape of Y with expanded base (Fig. 113); an additional small roundish sclerite on each side of this and antero-dorsal to SV and V group of setae. Chaetotaxy and spinosity: T2 with 11 pairs of setae (L3 present); otherwise as described for subgenus *Casanovula*. Anal rods distinctly forked posteriorly.

Biology. Host plant: *Syzygium smithii* (Poir.) Nied. (Myrtaceae) (formerly *Acmena smithii*), common lilly pilly. Egg: almost invariably on upperside, usually near leaf margin. Mine (Fig. 120): a long, very narrow contorted gallery, filled with brown frass apart from irregular crenulations along mine edge; exit-hole on underside, a semicircular hole. Cocoon: reddish brown. Occupied mines were collected on 30 July and 3 August.

Diagnosis. This is the one of three known species of *Pectinivalva* in which the forewings have a bluish lustre but no transverse fascia. The others are *P. xenadelpha* and *P. quintiniae*, both described and diagnosed below. There is an undescribed Australian species of *Stigmella* which sometimes occurs together with *P.* (*M.*) *acmenae*, and in which the forewings are similarly unicolorous dark blue; however, the *Stigmella* species is distinctly larger (wingspan 6–8 mm), and has a collar consisting of white lamellate scales; its larva is a leaf-miner on *Baloghia inophylla* (G. Forster) P. Green (Euphorbiaceae).

Distribution. New South Wales. Vacated mines probably of this species were seen abundantly along the coast near Manley, Sydney.

DNA barcode. RMNH.INS.23541, Genbank KC292474.

Derivation. The specific name is derived from the former host-plant genus, and is a noun in the genitive. Because the moth is referred to under this manuscript name in the first author's unpublished thesis, we have chosen to retain it for consistency, in spite of the change in classification of the host-plant.

Remarks. The host-plant genus of *P.* (*M.*) *acmenae*, *Syzygium*, is not closely related to other myrtaceous hosts from which *Pectinivalva* species have been reared in Australia, and belongs to the tribe Syzygieae (Wilson et al. 2005, Biffin et al. 2006). Vacated mines on *Syzygium ingens* (F.Muell. ex C.Moore) Craven & Biffin (= *Acmena brachyandra*) in Lamington National Park have tentatively been identified as this species (Appendix 2 and online Appendix 3).

***Pectinivalva* (*Menurella*) *xenadelpha* Van Nieukerken & Hoare, sp. n.**

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http://species-id.net/wiki/Pectinivalva_xenadelpha

Material examined. Holotype. ♀, INDONESIA (Kalim. Timur), Pasir distr.: Gunung Lumut Prot. For., Gunung Lumut, ridge SW of summit, 18–20.xi.2005, 50M LD864441, 950 m, leafmines, undisturbed *Acmena* dominated low forest, on *Acmena acuminatissima* (Blume) Merr. & L.M. Perry, emg. 15.xii.2005, RMNH/EvN no 2005185–1, E.J. van Nieukerken, genitalia slide EvN 3738 (MZB).

Additional material: leafmines, larvae, same locality (RMNH).

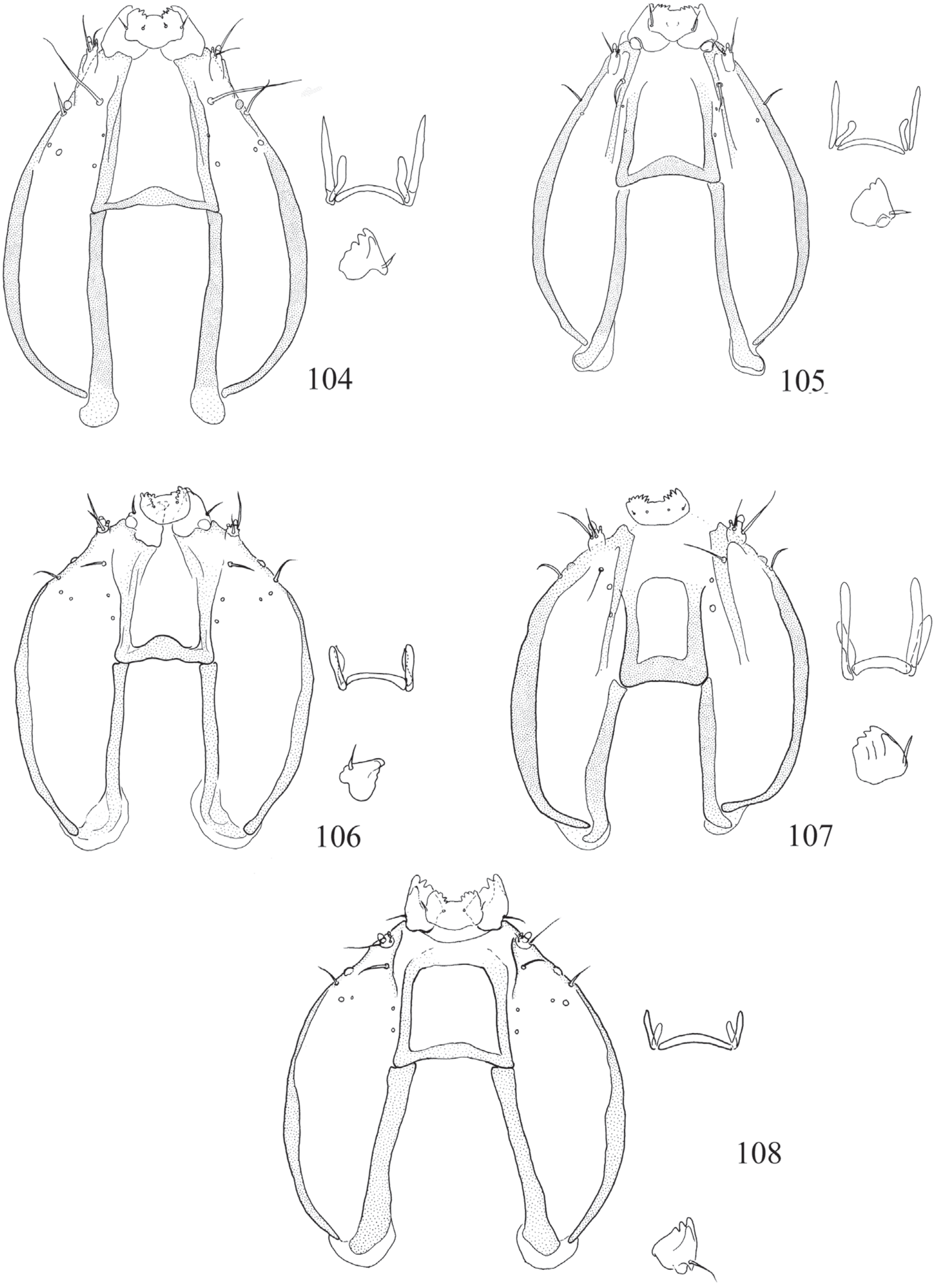
Description. Male. Unknown.

Female (Fig. 14, 129). Wingspan 4.0 mm. Head: frontal tuft pale ferruginous; collar inconspicuous, white; eyecaps anteriorly white, posteriorly shining grey with bluish reflections; antennae shining dark grey, 24 segments. Thorax, tegulae and forewing uniform shining dark grey with weak blue reflections; cilia dark grey. Hindwing pale grey; cilia pale grey. Underside: forewing grey with faint brassy reflections; hindwing grey. Abdomen shining dark grey, abdominal tip as in *acmenae*.

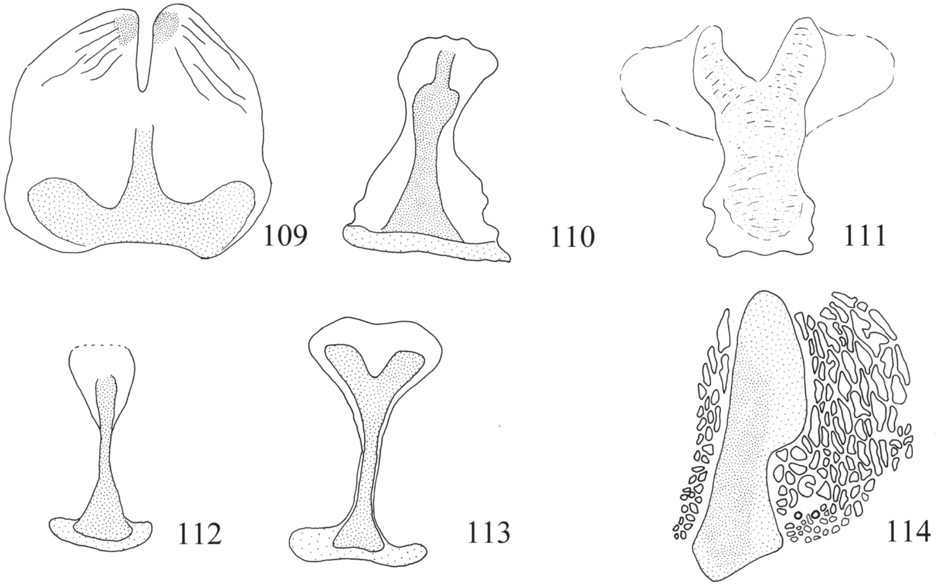
Female genitalia (Figs 98–100). Total length ca. 770 µm. T9 prominent, with a group of 5 setae on each side. Apophyses anteriores rather narrow, curved inwards; apophyses posteriores narrow, straight, longer than anteriores. Lateral sclerotizations of vestibulum strongly developed, but not forked. Ductus spermathecae with ca 6 close set convolutions. Posterior part of corpus normal, slightly folded, without markings; anterior part rounded, with rows of inconspicuous pectinations; signum consisting of broken linear sclerotization surrounded by oval sclerotized ring with blunt dentitions.

Larva. Not preserved.

Biology. Host-plant: *Syzygium acuminatissimum* (Blume) A. DC. (Myrtaceae) (formerly *Acmena acuminatissima*), very closely related to the Australian *S. smithii* (Biffin et al. 2006), a widespread species in the mountains of south Asia, from India and China



Figures 104–108. *Pectinivalva* spp., larval heads, dorsal view (head capsule to left, tentorium above right, mandible below right). **104** *P.* (*P.*) 138 **105** *P.* (*Casanovula*) *brevipalpa* **106** *P.* (*C.*) *minotaurus* **107** *P.* (*M.*) *scotodes* **108** *P.* (*M.*) *quintiniae*.



Figures 109–114. *Pectinivalva* spp., larval prothoracic sclerites. **109–113** Prosternites: **109** *P.* (*P.*) 138 **110** *P.* (*Casanovula*) *brevipalpa* **111** *P.* (*C.*) *minotaurus* **112** *P.* (*Menurella*) *scotodes* **113** *P.* (*M.*) *acmenae*. **114** *P.* (*P.*) 5, dorsal sclerite, showing surrounding reticulate cuticle; rings indicate positions of setae D1 and XD1.

to New Guinea and the Pacific islands (Chen and Craven 2007). Egg: almost invariably on upperside, almost always on or near midrib. Mine (Fig. 123): a long, very narrow contorted gallery, first half very narrow, running from midrib to leaf margin, or sometimes along midrib, filled with blackish frass, second half much wider, much contorted, often zigzagging, frass compact, black, leaving narrow clear margins; exit-hole on underside, a semicircular hole. Cocoon: ochreous. Occupied mines were collected on 18 and 20 November; they occurred together with abundant mines of a *Heliozela* species.

Diagnosis. Very similar externally to *P.* (*M.*) *acmenae* from Australia, but lacks the pale tornal spot of that species. In the genitalia, the lateral sclerites of the vestibulum are not forked (as they are in *acmenae*), and the apophyses posteriores are distinctly longer than the apophyses anteriores (same length in *acmenae*).

Distribution. Borneo, East Kalimantan: Gunung Lumut.

Derivation. The species name (a noun in apposition) derives from the Greek *xenos* (stranger, foreigner) and *adelpha* (sister) and refers to the close relationship to *acmenae* as well as the great geographical distance between this and other known *Pectinivalva* species.

DNA barcode. RMNH.INS.23738 (holotype), Genbank KC292487 and RMNH.INS.11968 (larva), genbank KC292486, both identical.

Remarks. We choose to describe this species here, even on the basis of a single female, to be able to record the genus from outside Australia. The detailed knowledge of its life history and three DNA markers (including CO1 barcode) will make future association with males straightforward.

***Pectinivalva* (*Menurella*) *quintiniae* Hoare & Van Nieukerken, sp. n.**

urn:lsid:zoobank.org:act:0D0B16C5-745C-433A-9571-169793F72486
http://species-id.net/wiki/Pectinivalva_quintiniae

Material examined. Holotype. ♂, Tullawalal, Lamington National Park, Qld, [UTM: 56J NP188794], la. 19.viii.2004, 900–940 m, [rainforest], emg. 25.ix.-6.x.2004, *Quintinia verdonii*, E.J. van Nieukerken, R.J.B. Hoare, RMNH/EvN no. 2004100, genitalia slide 18720 (ANIC) (= EJvN 3960). Paratypes. 2♂, 6♀, same data as holotype, genitalia slides ♂: EvN 3736, ♀: EvN 3961, 3993 (ANIC, RMNH); 2♀, 28.28S,153.07E, Bar Mountain, Border Ranges Nat. Pk, N.S.W., emg. 21–23.viii.2000, *Quintinia verdonii*, C. van den Berg, R.J.B. Hoare (ANIC, RMNH).

Additional material: leafmines from same localities.

Description. Male (Fig. 15). Wingspan 4.7–4.8 mm. Head: frontal tuft ferruginous; collar inconspicuous, consisting of shining pale grey scales; eyecaps basally white, exteriorly shining grey with violet reflections; antennae shining dark grey, whitish beneath, ca. 35–38 segments. Thorax, tegulae and forewing uniform shining fuscous with strong blue to violet reflections; cilia greyish fuscous. Hindwing unmodified, grey; cilia grey. Underside: forewing dark greyish fuscous; hindwing grey. Abdomen shining dark greyish fuscous; anal tuft inconspicuous, fuscous.

Female (Figs 16, 128). Wingspan 5.0–5.8 mm. Similar to male, but antenna with ca. 27 segments, and forewing rather broader.

Male genitalia (Figs 55–57, 67–69). Capsule ca. 425–465 μm long, ovoid. Anterior edge of vinculum rounded, without excavation. Tegumen rounded, without ventral extensions. Uncus rectangular, bilobed, lobes strongly produced, with ca. 6 setae on each. Gnathos central element long, reaching just beyond uncus, tapering apically. Valva (Fig. 56) ca. 305–320 μm long, rounded caudally; apically fringed with numerous spine-like setae on dorsal surface; pectinifer absent, but apex of valva thickened and well-sclerotized. Long sublateral processes present. Juxta a subrectangular plate. Aedeagus (Figs 57, 69) ca. 455–480 μm long, a curved spine arising towards apex on left. Vesica basally with many broad, short cornuti, grading into field of much larger longer cornuti towards apex.

Female genitalia (Fig. 78, 79, 95–97). Total length ca. 950 μm. T9 produced on each side into prominent anal papillae, each with a group of 5–6 setae. Apophyses anteriores moderately narrow, curved inwards; apophyses posteriores narrow, straight, distinctly shorter than anteriores. Lateral sclerotizations of vestibulum strongly developed, thick, not forked but with outer tooth-like process at ca. ½ length. Ductus spermathecae with 2½ convolutions. Posterior part of corpus broad, folded, without markings; anterior part rounded, with faint pectinations; signum consisting of broken linear sclerotization surrounded by oval sclerotized ring with blunt dentitions; an elongate band of scobination opposite signum.

Larva. Green. Head as in Fig. 108; length of head ca. 410 μm; width ca. 450 μm. Thorax: prothoracic sternite hourglass-shaped; no additional sclerites. Chaetotaxy and spinosity: T2 with 11 pairs of setae (L3 present); otherwise as described for subgenus *Casanovula*. Anal rods not forked posteriorly.

Biology. Host plant: *Quintinia verdonii* F. Muell. (Paracryphiaceae). Egg: on either side of leaf. Mine (Fig. 122): a long, meandering gallery, central line of blackish frass taking up most of mine width except near end where gallery broadens and frass takes up only ½ width; exit-hole on underside, a semicircular to oval hole. Cocoon: reddish brown. Occupied mines have been collected on 13 July and 19 August.

Diagnosis. Superficially very similar to *Pectinivalva* (*Menurella*) *acmenae*, but lacking the pale tornal forewing spot of that species.

Distribution. Northern N.S.W. (Border Ranges National Park); Southern Queensland, (Lamington National Park).

DNA barcode. RMNH.INS.23736, Genbank KC292482, RMNH.INS.23960 (holotype), Genbank KC292481 and RMNH.INS.23961, Genbank KC292480, with one variable nucleotide.

Derivation. The specific name (a noun in the genitive) is derived from the host-plant genus.

Remarks. Currently this is the only species of *Pectinivalva* known from a host-plant that does not belong to Myrtaceae. *Quintinia* was formerly placed in Escalloniaceae, but is now assigned to the small family Paracryphiaceae (e.g., Winkworth et al. 2008).

Pectinivalva (*Menurella*) *tribulatrix* Van Nieukerken & Hoare, sp. n.

urn:lsid:zoobank.org:act:A3AF88EF-778D-4D82-B333-24DC81DEE3EA
http://species-id.net/wiki/Pectinivalva_tribulatrix

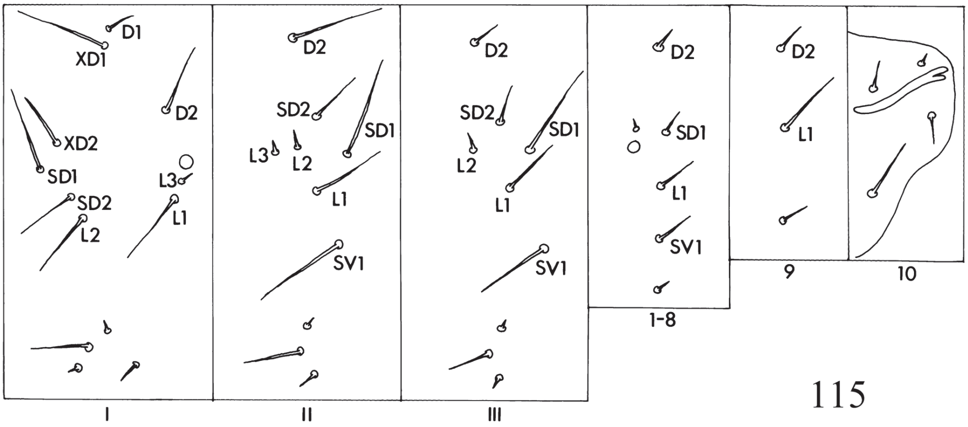
Material examined. Holotype. ♂, Cape Tribulation, Queensland, [UTM: 55K CC365219], la. 23.vii.2004, [coastal rainforest], emg. 8.ix.2004, *Rhodomyrtus macrocarpa*, E.J. van Nieukerken, RMNH/EvN no 2004017, genitalia slide 18721 (ANIC) (= EvN 3962). Paratype. ♀, same data as holotype, genitalia slide EvN 3963 (RMNH).

Additional material: many leafmines from type locality, and 2 km south.

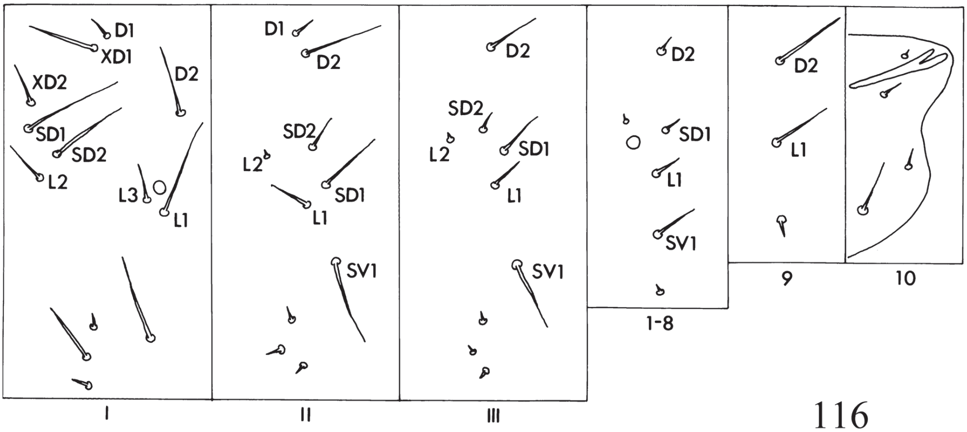
Description. Male (Fig. 17). Wingspan 3.5 mm, forewing length 1.5 mm. Head: frontal tuft yellow to ferruginous, collar white; eyecaps basally white, exteriorly grey; antennae grey, 25 segments. Thorax and forewing entirely shining grey fuscous, cilia-line indistinct. Hindwing basally wide, grey, with androconial pocket in basal half; cilia grey. Underside: forewing and hindwing dark brown. Abdomen grey brown, with small white anal tufts.

Female (Fig. 18). Wingspan 3.2 mm, forewing length 1.4 mm. Head: as male, but eyecaps shining white, no grey, antennae with 17 segments. Coloration as male, but hindwing narrower, grey. Abdomen shining dark grey, wide blunt abdominal tip.

Male genitalia (Figs 70–72). Capsule ca. 235 µm long, ovoid. Anterior edge of vinculum with shallow excavation. Tegumen rounded, without ventral extensions. Uncus triangular, slightly indented in middle, lobes with ca. 3–4 setae on each. Gnathos central element long, not reaching beyond uncus, parallel edges, rounded tip. Valva



115

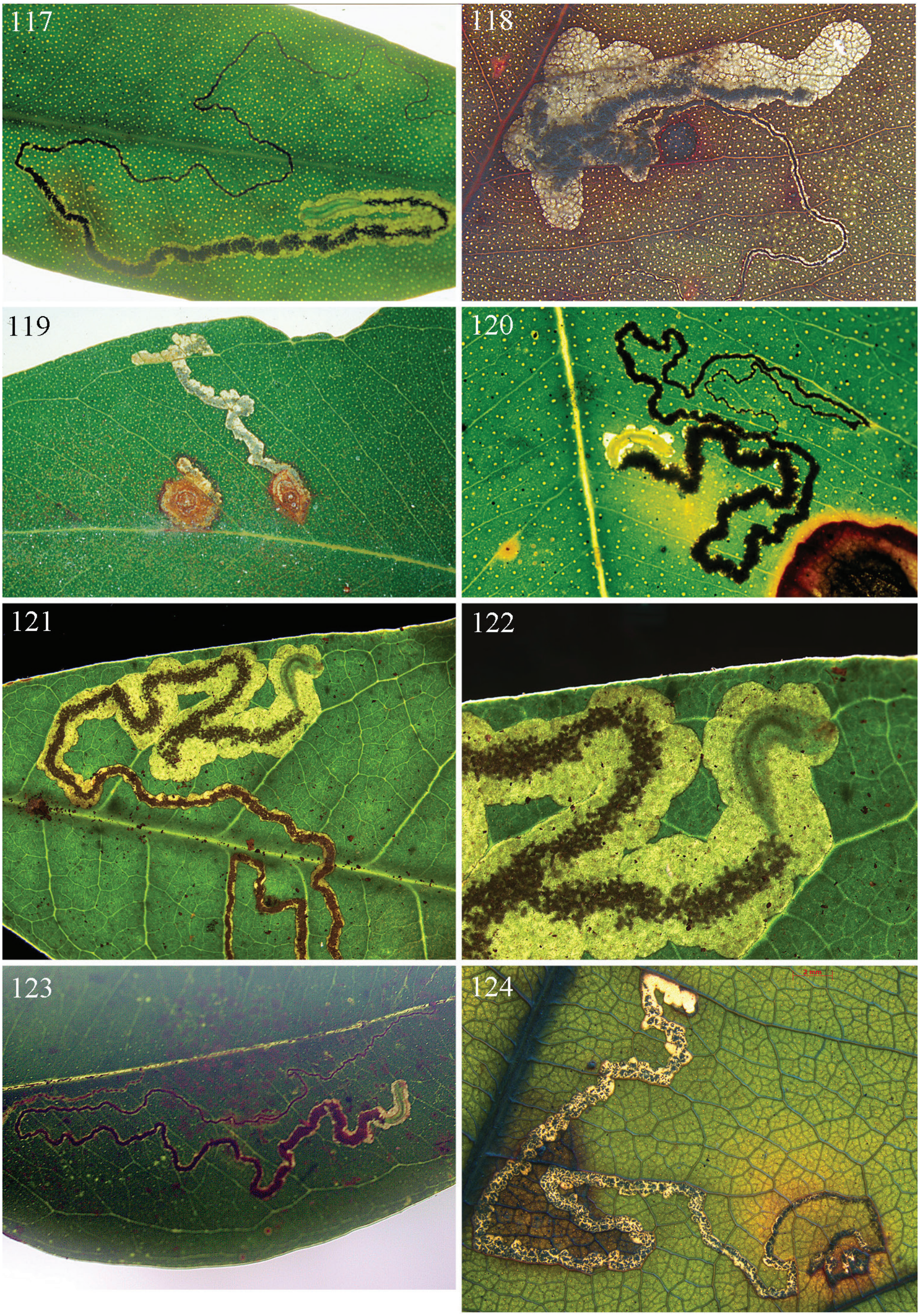


116

Figures 115, 116. *Pectinivalva* spp., larval chaetotaxy. **115** *P.* (*P.*) 138 **116** *P.* (*Casanovula*) *brevipalpa*.

ca. 190 µm long, reaching well beyond tegumen, strongly curved; medial edge slightly excavated and ending in obtuse angle; pectinifer consisting of 15–16 broad, blunt elements; dorsal surface towards apex with long setae. Sublateral processes short. Juxta not visible. Aedeagus (Fig. 72) ca. 280 µm long; tubelike sclerite associated with cathrema ca 2/3 aedeagus length, anteriorly bilobed; vesica otherwise with a few small cornuti.

Female genitalia (Fig. 101–103). Total length ca. 335 µm. T9 produced on each side into prominent anal papillae, each with a group of 7 setae. Apophyses anteriores moderately narrow, curved inwards; apophyses posteriores narrow, straight, longer than anteriores. Lateral sclerotizations of vestibulum strongly developed, forked, the bifurcations diverging widely. Ductus spermathecae with 6 convolutions. Corpus small, about as long as wide, folded, covered with many pectinations; signum of concentric bands of fence-like spinules, indistinct.



Figures 117–124. *Pectinivalva* spp., larval leaf-mines. **117** *P.* (*Casanovula*) *brevipalpa* on *Tristaniopsis collina* **118** *P.* (*C.*) *minotaurus* vacated mine on *Lophostemon confertus* **119** *P.* (*Menurella*) *scotodes* on *Eucalyptus pilularis* **120** *P.* (*M.*) *acmenae* on *Syzygium smithii* **121, 122** *P.* (*M.*) *quintiniae* on *Quintinia verdonii* **123** *P.* (*M.*) *xenadelpha* on *Syzygium acuminatissimum* **124** *P.* (*M.*) *tribulatrix* vacated mine on *Rhodomyrtus macrocarpa*.

Figures 125–129. 125, 126. *Pectinivalva* (*Casanovula*) and *P.* (*Menurella*) spp., cocoon, pupa, live adults. **125** *P.* (*C.*) *minotaurus* cocoon **126** *P.* (*C.*) *minotaurus* male pupa (pharate adult), ventral view **127** *P.* (*C.*) *minotaurus* male pupa (pharate adult), dorsal view **128** *P.* (*M.*) *quintiniae* live adult male **129** *P.* (*M.*) *xenadelpha*, female holotype, live.

Larva. Green. Fieldnotes state that it feeds with dorsum upwards, which may be incorrect. Larva not preserved.

Biology. Host-plant: *Rhodomyrtus macrocarpa* Benth., finger cherry (Myrtaceae). Many mines and three larvae were collected on the ca. 20 cm long leaves of seedling shrubs. Egg: on either side of leaf. Mine (Fig. 124): a narrow, long gallery, either completely meandering, or partly straight and following a major vein; frass black, broken and dispersed over total gallery width, not leaving clear margins; edges of gallery not straight, irregular; exit-hole on underside, a semicircular to oval hole. Cocoon reddish brown. Occupied mines have been collected on 22 July.

Diagnosis. One of the smallest *Pectinivalva* species we know, recognised by unmarked greyish fuscous wings, grey edged scape in male and androconial pocket on male hindwing.

Distribution. Northern Queensland, Cape Tribulation.

DNA barcode. RMNH.INS.23962 (holotype), Genbank KC292484 and RMNH.INS.23963, Genbank KC292485, identical.

Derivation. The species name is a noun in apposition, from the Latin *tribulare*, to press: hence *tribulatio*, distress, trouble, *tribulatrix*, one who causes trouble. It refers partly to the type locality (Cape Tribulation), and partly to difficulties the authors encountered in identifying the hostplant.

Remarks. This species stands out from its relatives amongst the 'derived' species of *Menurella* (those with broad tooth-like pectinifer elements) in its hostplant *Rhodomyrtus*, which belongs to the tribe Myrteae; other members of this group feed on Eucalypteae.

Keys to the subgenera of Nepticulidae known from Australia

The keys presented here are only intended for the identification of nepticulid specimens taken in Australia, and will not necessarily work for material captured elsewhere. They are based on the extensive collection of Nepticulidae in ANIC, with associated larval material. Although the keys should work for all Australian nepticulids so far known, it should be noted that our knowledge of the fauna is still very incomplete and there may possibly be species which will key out incorrectly or not at all.

Key to adults, based on external characters and wing venation

1	Forewing with vein 1+2A unthickened	**2**
–	Forewing with vein 1+2A thickened	**7**
2	Forewing with apical suffusion of pale bluish or silver scales	***Roscidotoga***
–	Forewing without apical suffusion of pale bluish or silver scales	**3**
3	Vein R2+3 of forewing present	***Pectinivalva* (*Pectinivalva*)**
–	Vein R2+3 of forewing absent	**4**
4	Forewing without bluish or purplish lustre	***Pectinivalva* (*Menurella*) (part)**
–	Forewing with bluish or purplish lustre	**5**
5	Forewing with transverse fascia	***Pectinivalva* (*Casanovula*) (part)**
–	Forewing without transverse fascia	**6**
6	Forewing lustre bluish	***Pectinivalva* (*Menurella*)**[1]
–	Forewing lustre purplish	***Pectinivalva* (*Casanovula*)**[2]
7	Collar consisting of lamellate scales	**8**
–	Collar consisting of piliform scales	**9**
8	Vein Cu of forewing absent; closed cell present (vestigial)	***Acalyptris***
–	Vein Cu of forewing present; closed cell absent	***Stigmella***

9 Vein M of hindwing 2-branched; male hindwing underside with raised androconia .... ***Trifurcula* (*Glaucolepis*)**
– Vein M of hindwing 1-branched; male hindwing underside without raised scales .... ***Ectoedemia* (*Fomoria*)**

[1] Two species of *P.* (*Menurella*) key out here: *P.* (*M.*) *acmenae* and *P.* (*M.*) *quintiniae*.

[2] One undescribed species of *P.* (*Casanovula*) lacks a fascia and keys out here.

Key to adults, based on male genitalia

1 Gnathos present, not reduced **2**
– Gnathos strongly reduced or absent .... ***Roscidotoga***
2 Gnathos with 1 central element **3**
– Gnathos with 2 central elements .... ***Stigmella* (part)**
3 Uncus dorsally with 2 well-defined tufts of setae **4**
– Uncus without well-defined tufts of setae **6**
4 Uncus pointed, undivided .... ***Pectinivalva* (*Pectinivalva*)**
– Uncus bifid **5**
5 Cathrema associated with a smooth tubular sclerotization .... ***Pectinivalva* (*Menurella*)**
– Cathrema without associated sclerites, or sclerites not forming a smooth tube .... ***Pectinivalva* (*Casanovula*)**
6 Transverse bar of transtilla membranous or absent 7
– Transverse bar of transtilla present **8**
7 Valvae widely separated at base; aedeagus with carinate processes .. ***Acalyptris***
– Valvae close basally; aedeagus lacking carinae........ ***Trifurcula* (*Glaucolepis*)**
8 Valvae widely separated at base; vinculum with posterior membranous extension; aedeagus with carinae .... ***Ectoedemia* (*Fomoria*)**
– Valvae close basally; vinculum unmodified; aedeagus lacking carinae... ***Stigmella***[3]

[3] One undescribed *Stigmella* species from South Australia, which has a gnathos with a single central element, keys out here.

Key to adults, based on female genitalia

1 Signum present **2**
– Signum absent 7
2 One signum, not reticulate **3**
– Two reticulate signa **5**
3 Signum a pair of concentric ovals of fence-like pectinations .... ***Pectinivalva* (*Menurella*) (part)**
– Signum a toothed band **4**

4 Lateral sclerites of vestibulum forked or with exterior tooth at ½; signum small, rounded ... ***Pectinivalva* (*Menurella*)**[4]

– Lateral sclerites (if present) not forked, no exterior tooth at ½; signum long, narrow ... ***Pectinivalva* (*Pectinivalva*)**

5 Margins of signa crenulate ... **Acalyptris**

– Margins of signa smooth ... 6

6 Vestibulum with complex sclerotizations ... ***Ectoedemia* (*Fomoria*)**

– Vestibulum without sclerotizations ... ***Trifurcula* (*Glaucolepis*)**[5]

7 Apophyses anteriores expanded basally; corpus bursae weakly sclerotized, with diverticulum ... ***Roscidotoga***

– Apophyses normal; corpus bursae well or moderately sclerotized; no diverticulum ... **8**

8 Vestibulum with lateral sclerites ... ***Pectinivalva* (*Casanovula*)**

– Vestibulum without lateral sclerites ... ***Stigmella***

[4] Two species of *P.* (*Menurella*) key out here: *P.* (*M.*) *acmenae* and *P.* (*M.*) *quintiniae*.

[5] No females of *Trifurcula* have yet been captured in Australia, and the distinction used here is based on Holarctic members of the genus (see Johansson et al. 1990).

Key to the larvae

1 Antenna 3-segmented ... **2**

– Antenna 2- or 1-segmented ... **3**

2 Cuticle spinose, with smooth texture; mesothorax with 2 D setae ... ***Roscidotoga***

– Cuticle without spines, sculptured; mesothorax with 1 D seta ... ***Pectinivalva* (*Pectinivalva*)**

3 Antenna 2-segmented ... **4**

– Antenna 1-segmented ... **5**

4 Hostplant *Lophostemon*, *Tristaniopsis*, or *Melaleuca* ... ***Pectinivalva* (*Casanovula*)**[6]

– Hostplant another myrtaceous genus, or *Quintinia* ... ***Pectinivalva* (*Menurella*)**[6]

5 Sensilla of antenna arranged in a cross ... ***Stigmella***

– Sensilla not arranged in a cross ... 6

6 Mesothorax with 1 D seta ... ***Ectoedemia* (*Fomoria*)**

– Mesothorax with 2 D setae ... **7**

7 Labial palpus 2-segmented ... ***Acalyptris***

– Labial palpus 3-segmented ... ***Trifurcula* (*Glaucolepis*)**[7]

[6] No constant morphological differences have been found between larvae of *P.* (*Casanovula*) and those of *P.* (*Menurella*).

[7] No larva of *Trifurcula* has been found in Australia, and the distinction used here is based on the description of European species in Johansson et al. (1990).

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Appendix 1. Characters and states for cladistic analysis

All characters were treated as unordered. Figure numbers are given only as exemplars of character states and not all illustrations of each state are necessarily indicated.

1 Shape of male antenna: (0) flagellum of even width throughout; (1) basal flagellar segments expanded and flattened (Figs 24, 25, 29, 30).

2 Sexual colour dimorphism: (0) not pronounced; (1) pronounced (Figs 10, 11).

(3) Forewing pattern of male: (0) more or less unicolorous (Fig. 4); (1) dark with a pale costal streak (Hoare et al. 1997: fig. 1); (2) dark with a pair of opposite pale spots or a pale fascia; (3) metallic with a shining fascia (Fig. 6, 8); (4) metallic with silver spots (Hoare 2000a: figs 1–3).

(4) Androconial scales of male forewing: (0) absent; (1) present as a long dorsal fringe (Hoare et al. 1997: fig. 20).

(5) Forewing venation: (0) R2+3 present (Figs 31, 32); (1) R2+3 absent (Figs 33–36).

(6) Shape of male hindwing: (0) more or less lanceolate (Fig. 33); (1) strongly expanded at base (Figs 31, 35).

(7) Androconial pocket of male hindwing: (0) absent; (1) present (Figs 31, 35).

(8) Male genitalia — anterior extension of vinculum: (0) rounded or smoothly concave (Fig. 39); (1) H-shaped (Fig. 46).

(9) Male genitalia — uncus: (0) undivided (Fig. 39); (1) bifid (Figs 43, 46).
Notiopostega atrata has a weakly developed uncus which is very slightly indented apically (Davis 1989: fig. 274): this species has been scored '?' for this character.

(10) Male genitalia — uncus: (0) without well-defined tufts of setae; (1) a pair of well-defined tufts present (Figs 39, 43); (2) tufts present, arising from lobes on dorsal surface of uncus (Hoare et al. 1997: fig. 39).

(11) Male genitalia — central element of gnathos: (0) narrow (at least basally) or triangular (Fig. 39, 43, 46); (1) broad and cordate (Hoare et al. 1997: fig. 38).
The gnathos in *Notiopostega atrata* is reduced and takes the form of a narrow band. *Roscidotoga callicomae* lacks a gnathos. Both species are scored '?' for this character.

(12) Male genitalia — number of elements on pectinifer of valva: (0) 20 or more (Fig. 44, 47); (1) fewer than 20 (Fig. 50); (2) pectinifer strongly reduced or absent (Figs 40, 56).

(13) Male genitalia — shape of pectinifer elements: (0) peg- or spine-like (Figs 44, 53); (1) broad and tooth-like (Fig. 50).

(14) Male genitalia — sublateral processes of transtilla: (0) well-developed (Figs 40, 44); (1) strongly reduced (Hoare et al. 1997: fig. 38).

(15) Male genitalia — cathrema of aedeagus: (0) weakly developed, supported by 2 or 3 interconnected sclerites (Fig. 42) (1) moderately developed, supported by a smooth sclerotized tube (Fig. 51, 72); (2) moderately developed, with 1 short sclerite, or without associated sclerotizations (Fig. 48); (3) absent.
The structure of the cathrema and its associated sclerites in *Pectinivalva* is often obscured by cornuti and hard to observe in conventional slide preparations, and the character coding adopted here is somewhat provisional in nature. Further detailed studies, perhaps of everted vesicas, are desirable.

(16) Female genitalia — lateral sclerites of vestibulum: (0) absent (Fig. 73); (1) present, narrow (Fig. 74); (2) present, strongly developed (Fig. 78).
In *Pectinivalva acmenae*, the lateral sclerites are relatively narrow but have very strongly forked tips (Fig. 77): this species has been tentatively scored (2) for this character.

(17) Female genitalia — pectinations on corpus bursae: (0) extensive (Fig. 74); (1) restricted to a field on the posterior part of the corpus (Fig. 76); (2) very reduced or absent (Fig. 78).

(18) Female genitalia — form of signum: (0) well-sclerotized, sparsely toothed (Fig. 77); (1) well-sclerotized, continuously toothed (Hoare et al. 1997: fig. 73); (2) sclerotization reduced to parallel spinules (Fig. 76); (3) absent (Fig. 75).

(19) Female genitalia — shape of signum: (0) narrow, band-like (Fig. 73); (1) broad, oval (Fig. 76).

(20) Anterior edge of tergite 2 of abdomen: (0) continuously well sclerotized; (1) weakly sclerotized medially (Hoare 2000a: fig. 9).

(21) Larval antenna: (0) 3-segmented (Hoare 2000a: fig. 36); (1) 2-segmented; (2) 1-segmented.

(22) Shape of larval head: (0) anteriorly unmodified, more or less cordate (Fig. 106–108); (1) anteriorly elongate, more or less pyriform (Figs 104, 105).

(23) Posterior lobes of larval head: (0) continuously sclerotized (Hoare 2000a: fig. 29); (1) with sclerotization interrupted (Figs 104–108).

(24) Shape of prothoracic sternite of larva: (0) approximately as long as broad (Fig. 109); (1) much longer than broad (Figs 112, 113).
The larva of *Notiopostega atrata* lacks a prothoracic sternite, and this species has therefore been scored '?' for this character.

(25) Number of mesothoracic D setae of larva: (0) 2 pairs (Fig. 116); (1) 1 pair (Fig. 115).

(26) Spinosity of larval cuticle: (0) cuticle spiny; (1) cuticle lacking spines.

(27) Texture of larval cuticle: (0) smooth; (1) sculptured (Fig. 114).

(28) Exit-hole of larval mine: (0) a small slit or hole (Fig. 118), larva leaves mine to pupate; (1) a large slit, larva pupating in mine.

Data matrix

	0000	00000	11111	1111	12	22222	222
	1234	56789	01234	5678	90	12345	678
Notiopostega	0000	1000?	0?001	3023	?0	100?0	000
Enteucha acetosae	0030	10000	002?0	3023	?0	20000	000
Roscidotoga callicomae	0040	10000	0?2?0	2023	?0	00000	000
Pectinivalva acmenae	0000	10001	10100	1210	11	10110	000
P. brevipalpa	1030	10001	10000	0103	?1	11110	000
P. caenodora	0010	00000	21001	0101	01	?????	???
P. commoni	0000	00000	10000	0100	01	01101	110
P. minotaurus	1030	10011	10000	2103	?1	10110	000
P. mystaconota	0000	01100	102?0	0000	01	?????	???
P. scotodes	0101	11101	10110	1212	11	10110	000
P. quintiniae	0000	10001	102?0	1220	11	20110	000
P. 2	0000	11101	10100	1212	11	10110	000
P. 5	0000	00000	10000	0100	01	01101	110
P. 34	0010	00000	21001	0101	01	01101	110
P. 91	0020	10101	10110	1212	11	10111	000
P. 119	0101	11101	10110	1212	11	10010	000
P. 138	0000	01100	10000	0020	01	01101	110
P. 163	0000	01100	10000	0020	01	01101	110
P. 219	0030	10011	10000	2103	?1	?????	??1
P. 226	0030	10011	10000	2103	?1	10111	001

Appendix 2. Catalogue of hostplants of *Pectinivalva*

Myrtaceae

Lophostemoneae
Lophostemon ?confertus (R.Br.) Peter G.Wilson & J.T.Waterh.
  P. (C.) 113
Lophostemon confertus (R.Br.) Peter G.Wilson & J.T.Waterh.
  P. (C.) minotaurus, *P. (C.)* 41
Lophostemon suaveolens (Sol. ex Gaertn.) Peter G.Wilson & J.T.Waterh.
  P. (C.) minotaurus

Melaleuceae
Melaleuca citrina (Curtis) Dum.Cours (= *Callistemon citrinus*)
  P. (C.) 219
Melaleuca salicina Craven (= *Callistemon salignum*)
  P. (C.) A98
Melaleuca squarrosa Donn ex Sm.
  P. (C.) 226
Melaleuca viminalis (Sol. ex Gaertn.) Byrnes (= *Callistemon viminalis*)
  P (C.) sp EvN2004116
Melaleuca sp. (= *Callistemon* sp.)
  P. (C.) 174

Syncarpieae
Syncarpia glomulifera (Sm.) Nied.
  Pectinivalva sp. (RH198) (vacated mines only)

Eucalypteae
Angophora costata (Gaertn.) Britten
  P. (M.) Q1, *P. (M.)* 119
Angophora floribunda (Sm.) Sweet
  P. (M.) Q2, *P. (M.)* Angophora 1 (CvdB_Loc IV.21.sp1), *P. (M.)* Angophora 2 (CvdB_Loc IV.21.sp2)
Corymbia ficifolia (F.Muell.) K.D.Hill & L.A.S.Johnson
  P. (M.) 127
Corymbia maculata (Hook.) K.D. Hill & L.A.S. Johnson
  P. (M.) 29
Corymbia torelliana (F.Muell.) K.D.Hill & L.A.S.Johnson (=*Eucalyptus torelliana*)
  Pectinivalva sp. (RH114) (vacated mines only)
Eucalyptus acmenoides Schauer
  Pectinivalva sp. (RH158) (vacated mines only)

Eucalyptus blakelyi Maiden
 P. (M.) scotodes
Eucalyptus ?blakelyi Maiden
 P. (P.) 78
Eucalyptus bridgesiana R.T.Baker
 P. (M.) 91, *P. (M.)* 92, *P. (M.)* 123, *P. (P.)* 138, *P. (P.)* 148a, *P. (P.)* 163
Eucalyptus carnea R.T. Baker
 P. (M.) scotodes, *P. (P.)* 225
Eucalyptus cyanophylla Brooker
 P. (M.) 76
Eucalyptus cypellocarpa L.A.S. Johnson
 P. (P.) 89, *P. (P.)* 90
Eucalyptus ?delegatensis R.T. Baker
 P. (P.) commoni
Eucalyptus dives Schauer
 P. (M.) 91
Eucalyptus elata Dehnh.
 P. (P.) 100
Eucalyptus ?globoidea Blakely
 P. (P.) 153
Eucalyptus globulus Labill.
 P. (M.) Q3, *P. (M.)* 91, *P. (P.)* A87, *P. (P.)* 148a
Eucalyptus goniocalyx F.Muell. ex Miq.
 P. (P.) 148b
Eucalyptus grandis W. Hill
 P. (P.) 148a
Eucalyptus leptophylla F.Muell. ex Miq.
 P. (M.) 91
Eucalyptus macarthurii H.Deane & Maiden
 P. (P.) A87, *P. (M.)* 150
Eucalyptus mannifera Mudie
 P. (P.) 78, *P. (M.)* 151
Eucalyptus melliodora A.Cunn. ex Schauer
 P. (M.) 23, *P. (M.)* 136
Eucalyptus microcorys F. Muell.
 P. (M.) 23
Eucalyptus ?muelleriana A.W. Howitt
 P. (M.) 91
Eucalyptus nitida Hook. f.
 P. (M.) 227
Eucalyptus oleosa F.Muell. ex Miq.
 Pectinivalva sp. (RH169) (vacated mines only)

Eucalyptus pilularis Sm.
  P. (M.) scotodes, *P. (M.)* 91
Eucalyptus polyanthemos Schauer
  P. (M.) 21
Eucalyptus rubida H.Deane & Maiden
  P. (P.) 139
Eucalyptus saligna Sm.
  P. (M.) KM7
Eucalyptus ?saligna Sm.
  P. (P.) 5
Eucalyptus socialis F.Muell. ex Miq.
  Pectinivalva sp. (RH168) (vacated mines only)
Eucalyptus tereticornis Sm.
  P. (P.) 68
Eucalyptus viminalis Labill.
  P. (M.) 143, *P. (P.)* 78, *P. (P.)* 142

Leptospermeae
Leptospermum ?glaucescens S.Schauer
  P. (M.) 211
Leptospermum laevigatum (Gaertn.) F.Muell.
  P. (M.) A85
Leptospermum morrisonii
  P. (M.) 189
Leptospermum scoparium Joy Thomps.
  P. (M.) 216
Leptospermum trinervium (Sm.) Joy Thomps.
  P. (M.) 2, *P. (M.)* 175

Kanieae
Tristaniopsis collina Peter G. Wilson & Waterhouse
  P. (C.) brevipalpa

Syzygieae
Syzygium acuminatissimum (Blume) A. DC. (= *Acmena acuminatissima*)
  P. (M.) xenadelpha
Syzygium ingens (F.Muell. ex C.Moore) Craven & Biffin (= *Acmena brachyandra*)
  P. (M.) cf *acmenae* (EvN2004099) (vacated mines only)
Syzygium smithii (Poir.) Nied. (= *Acmena smithii*)
  P. (M.) acmenae

Myrteae
Gossia bidwillii (Benth.) N.Snow & Guymer (= *Austromyrtus bidwillii*)
    Pectinivalva sp. (RH46) (vacated mines only)
Pilidiostigma tropicum L.S.Sm.
    Pectinivalva sp. (RH106) (vacated mines only)
Rhodomyrtus macrocarpa Benth.
    P. (M.) tribulatrix

Paracryphiaceae

Quintinia verdonii F. Muell.
    P. (M.) quintiniae

Appendix 3

Specimen locality data of *Pectinivalva* Scoble (Lepidoptera: Nepticulidae) and outgroup taxa: examined specimens, DNA vouchers and host records. (doi: 10.3897/zookeys.278.4743.app) File format: Microsoft Excel (xls).

Explanation note: The records comprise all material studied, including rearing records of species that have not been treated and voucher specimens for DNA barcoding. We have treated specimens with a genitalia slide or other preparation and DNA vouchers as individual records for each species. Other records combine all adults from a single rearing or other single collection event. While compiling this datasheet, the authors no longer had direct access to the ANIC collection in Canberra, and in some cases our notes were not sufficient to enter all fields. This explains why for some slides 'sex unknown' is given, and uncertainties about exactly how many specimens were collected on a given date.

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Cockroaches of genus *Muzoa*: morphology of the male genital sclerites and description of one new species (Dictyoptera, Blattodea, Ectobiidae, Nyctiborinae)

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Abstract

The male genital sclerites of cockroaches of genus *Muzoa* Hebard, 1921 are described for first time and the new species *Muzoa curtalata* **sp. n.** is described and ilustrated. A dichotomous key to identify the species of genus *Muzoa* is given.

Keywords

Colombia, Dichotomous key, Male genital sclerites, *Muzoa curtalata* Vélez sp. n.

Introduction

The genus *Muzoa* is distributed in Central and South America (Beccaloni 2007). It was erected by Hebard (1921) according to: 1) Interocular space wide; 2) Cerci broad and heavy, subspatulate with the apex rather sharp; 3) Subgenital plate symmetrical; 4) Cephalic femora with ventro-cephalic margins armed with minute and well spaced spiniform hairs and 5) Symmetrical tarsal claws. The species *M. madida* Rehn, 1930 (Costa Rica) and *M. simplex* Hebard, 1921 (Colombia) have been grouped based on these characters exclusively.

The detailed study of the genital sclerites of cockroaches performed by McKittrick (1964) significantly influenced the Blattodea systematics. From that moment, it was common to find descriptions of genital sclerites, mostly male, in works dedicated to the description of new species, since the descriptions prior to the 60's were limited only to description the external morphology of the specimen, so that the genus *Muzoa* was not exception. Subsequently, new works appeared to supplement or correct the terminology proposed by McKittrick (Roth and Gurney 1969, Roth 1970, 1973) or in the worst case rejecting this and proposing a new terminology (Guthrie and Tindall 1968). Mizukubo and Hirashima (1987), Klass (1995) and Grandcolas (1996) studied the homologies of the different elements of the male genital sclerites. And so today, based on the detailed work developed by Klass (1995), the genital sclerites that were previously considered as a single unit is divided into several regions (e.g. genital sclerite R (right phallomere) composed of regions R1, R2,....R5), and these in turn are divided into subregions (e.g. R1d, R1v), thus modifying the initial nomenclature proposed by McKittrick.

Therefore, in this work the genus *Muzoa* is rediagnosed, now adding, morphological characters related to the male genital sclerites, and additionally, one new species is described for the genus.

Methods

Observations of external morphological characters were made with Leica MS5 and MZ16 stereomicroscopes (magnification 10–64× and 7–115×), equipped with an ocular graticule for measurements of lengths and ratios. Drawings were prepared with Digital Camera Leica EC3 attached to the compound scope. Based on the digital image, illustrations were made with an illustration software, in order to highlight features of taxonomic significance. The methods for dissecting male genitalia followed Gutiérrez (2001). The descriptions are based on male specimens.

The morphological terminology followed Torre-Bueno (Nichols 1989). Specific structures such as wings, sutures of head and genital sclerites were described in accordance with Crampton (1925), Klass (1995) and Roth (2003). The term R3c is named here for first time referring to sclerotized region of the genital sclerite R (see Klass 1995 to recognize the other sclerotized regions). R3c refers to the lower right corner of the sclerotized region R3 which projects as a short or long arm depending on the species.

The descriptions of the male genital sclerites were made based on the permanent slides (belonging to the holotypes) and fresh material preserved in glycerine. Illustrations were made based on fresh material.

The insect Collection codens are in accordance with Evenhuis (2012), as follows:

ANSP	USA, Pennsylvania, Philadelphia, Academy of Natural Sciences.
CIB	Colombia, Medellín, Centro de Investigaciones Biológicas.
MUJ	Colombia, Bogotá D.C., Pontificia Universidad Javeriana, Museo Javeriano de Historia Natural, Laboratorio de Entomología.

UNAB	Colombia, Bogotá D.C., Museo Entomológico de la Facultad de Agronomía, Universidad Nacional de Colombia.
USNM	USA, Washington D.C., National Museum of Natural History.

Taxonomy

Muzoa Hebard, 1921

http://species-id.net/wiki/Muzoa

Dichotomous key to the species of *Muzoa*

1 Cockroaches with tegmina and membranous wings well developed, completely covering the supra-anal plate (Figs 1, 2) **2**

– Cockroaches with tegmina and membranous wings shortened, reaching just the first abdominal tergite (Fig. 3). Lateral extension of L2a elongate and extended dorsally over the process "via" (Fig. 16); apex of the region R2 of the genital sclerite R (right phallomere), broad and truncated (Fig. 20) .... ***M. curtalata*** **Vélez sp. n. (Colombia)**

2 Head vertex convex (Fig. 4). Styli short, four times longer than wide. Process "via" slender, long and curved (Fig. 14). Lateral extension of L2a extending over the process "via" (Fig. 14). .... ***M. simplex*** **(Colombia)**

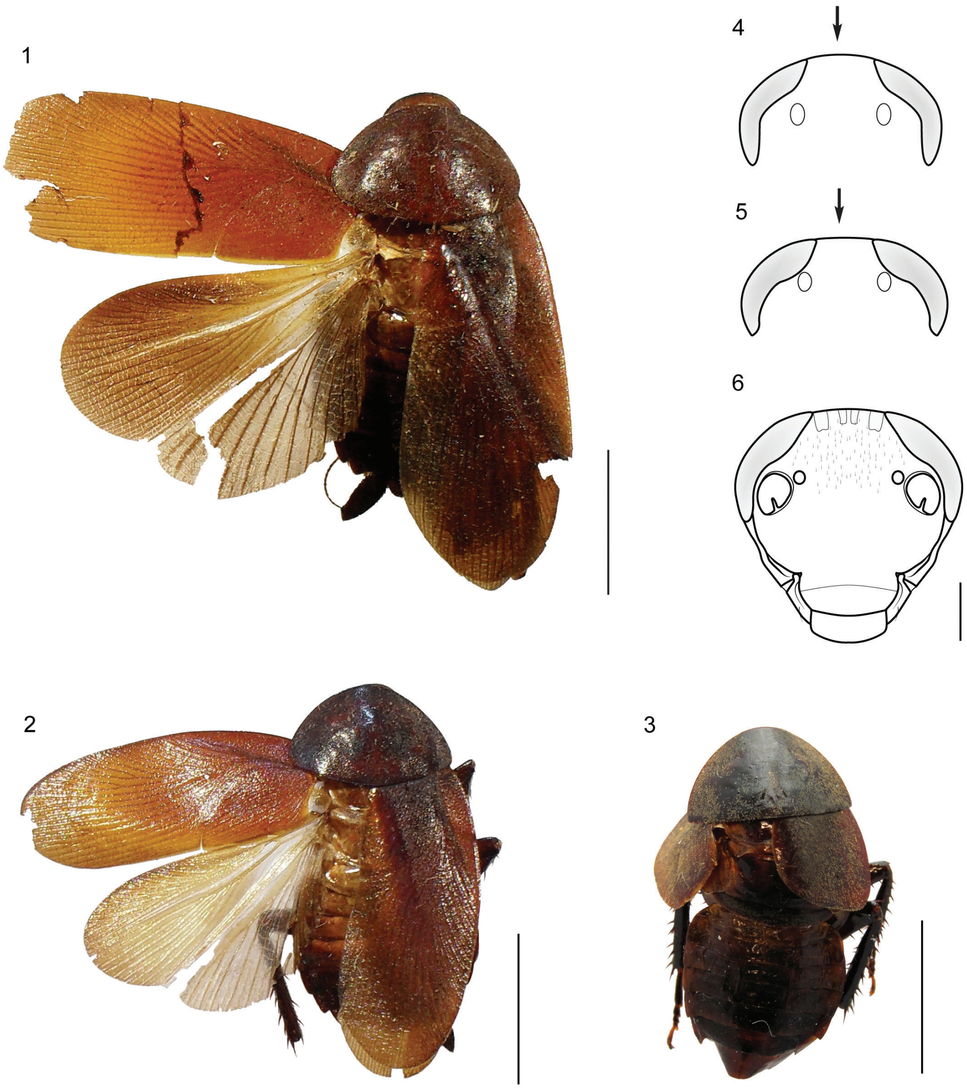
– Head vertex straight (Fig. 5). Styli long, five times longer than wide (Fig. 12). Process "via" short, thick and straight (Fig. 15). Lateral extension of L2a not extending over the process "via" (Fig. 15) ..... ***M. madida*** **(Colombia, Costa Rica)**

Remarks. Although the original descriptions of *M. madida* (Fig. 2) and *M. simplex* (Fig. 1) are extensive and detailed (see Hebard 1921 and Rehn 1930), these do not address the male genital sclerites, and in none other subsequent publication those structures have been described. Below are described and illustrated the male genital sclerites of these two species.

Redescription for the genus. Species of medium size (24–27 mm male, 20–26 mm female), with body dark brown. The legs and antennae are entirely brown. Pronotum and tegmina reddish brown.

Head triangular and with big reniform eyes, extending antero-laterally beyond to the antennal socket, eyes are not globose; intraocular distance of the same length than distance between ocellar fenestra; face globose; gena and pleurostoma undivided, at least externally, so that the subgenal suture only present in the inner margin of pleurostoma; subantenal suture ending next to the inferior margin of the eye; the face and gena bare. Antennae filiform and setosas along their length; the first flagellar segment of the same length that the pedicel.

Pronotum parabolic, with its cephalic margin convex and the caudal margin truncated. In either sex, both pairs of wings are developed surpassing slightly the apex of



Figures 1–6. 1–3 Habitus (dorsal) of the species of genus *Muzoa*. **1** *Muzoa simplex* Hebard, 1921, holotype male (ANSP) **2** *Muzoa madida* Rehn, 1930, holotype male (ANSP). **3** *Muzoa curtalata* sp. n., holotype male (MUJ). Scale bar 1 cm. **4–6** Heads (ventral) of the species of genus *Muzoa* **4** *M. simplex* **5** *M. madida* **6** *M. curtalata* sp. n. The arrow is indicating the shape of the vertex. Scale bar 1 mm.

the cercus, except in *Muzoa curtalata* sp. n. in which the males are brachypterous. Fore wings with the base of the remigium narrower than the base of vanal region (vannus) and the apex rounded; with discoidal sector longitudinal. Tegmina and pronotum densely covered with fine silky pubescence. Legs long and slender; cephalic coxa with a diagonal carina; antero-ventral margin of the front femur without spines heavy, only with short and heavy setae and with three terminal spines; postero-ventral margin of the hind femur with terminal spine; tarsomeres 1-4 with pulvilli, the first metatarsomere with its pulvilli covering only a 1/3 of its length; tarsal claws simple and symmetrical; arolium present.

Abdomen often convex and short; first tergite unspecialized. Supra-anal plate tranverse and with the caudal margin produced and bilobed (Figs 7, 8). Cerci long, thick and subspatulate, composed of 9 to 12 segments; last segment small and narrower than the remaining segments. Ventrally, right paraproct specialized and transverse, this is articulated directly with the lateral margin of the supra-anal plate throughout its right lateral margin. Male subgenital plate symmetric, with styles similarly shaped (Figs 11, 12). Internally, attached to this plate, is located the membranous pouch with genital sclerites L2, L3, and R (right phallomere).

Genital sclerites. The male genital sclerites of the species of the genus *Muzoa* are formed by sclerites L2 (Figs 14, 15), L3 (Figs 18, 19), and R (right phallomere) (Figs 21, 22).

Genital sclerite L2 thin and elongated. Sclerotized region L2a and process "via" separated but closely articulated (Articulation 10 (A10), see Klass 1995) (Figs 14, 15). Process "via" finger-shaped, slender and elongate except for *M. madida* in which it is shorter and thicker (Fig. 15). Region L2a is at least four times longer than process "via". Whole region is slightly sclerotized.

Hook "hla" of sclerite L3 with the typical shape observed in most Ectobiidae and Blaberidae species, with distal area narrow and elongated; in addition to the notch "45", the hook also exhibit groove "hge" along of its lower margin (Figs 17-19). In ventral view, basal area of hook "hla" longer than its apical area; left lateral margin of basal area, straight. Membranous tube of hook "hla" not covered by setae.

Genital sclerite R (right phallomere) formed by the sclerotized regions R1, R2, R3 and R4 (Figs 20–22). Region R1 as a large and bulky structure at the caudal region of sclerite R; subregion R1v broader than subregion R1d, which is a longitudinal narrow and elongated band, extending along the left lateral margin of R1; in species like *M. madida* and *M. simplex* this band does not reach the caudal margin of R1. Subregion R1d passing over the complex R1t+R2, surpassing its farthest right margin; its size varies among species. As in the other genera of Nyctiborinae, regions R1 and R3 articulated by the lower right corner of R3 and the upper right corner of R1. In all species of *Muzoa* the upper right corner of R1 (R1c) slightly projected (Figs 20–22). Subregion R1t is not fused with other areas of R1. Left arm of the complex R1t+R2 thicker than right arm, varying from apically rounded in *M. simplex* to pointed in *M. madida*. Complex R1t+R2 similar in size to region R3, located on its left margin, below the subregion R1d. Apex of R1t and R2 extending beyond caudal margin of R3.

Region R3 as a slightly sclerotized plate articulated by its lower right corner to R1c. This plate is longer than wide and its apex is rounded (Figs 20–22).

Region R4 as an elongated dorsal plate, covering R1 and R1t+R2 complex in part (Figs 20–22).

Table 1. Material examined.

Species	Country	Locality	Method of collecting	Date	Collector's names	Condition of specimen	Repository
Muzoa madida	Colombia	Chocó, Nuquí, Jurubida, Emberá community. Edge of primary forest.	Shannon-165W	23 Oct. 1995	R. Vélez	Male. Pinned	CIB. Used to illustrate the genital sclerites
Muzoa madida	Costa Rica	Limón, forest near La Emilia. In dense second growth forest, 304 m.		15 Sep. 1937	Rehn	Male. Pinned	ANSP. Holtype 5481
Muzoa madida	Costa Rica	Turrialba. 900 m.			Heyne, Berlin-Wilm	Male. Pinned	USNM.
Muzoa simplex	Colombia	Boyacá, Muzo		Sep. 1919	A. María	Male. Pinned	ANSP. Holotype 9295
Muzoa simplex	Colombia	Chocó, Nuquí, Jurubida, Emberá community. Edge of primary forest	Shannon-165W	23 Oct. 1995	R. Vélez	2 Male. Pinned	CIB. Used to illustrate the genital sclerites
Muzoa simplex	Colombia	Cundinamarca, Bogotá		Jan. 1934	Guevara	2 Male. Pinned	USNM.
Muzoa simplex	Colombia	Cundinamarca, Tibacuy, Ins. Pol. Cumaca. 4°21'N, 74°27'W, 1647 m.		14 Nov. 1993	Valderrama	Male. Pinned	UNAB.

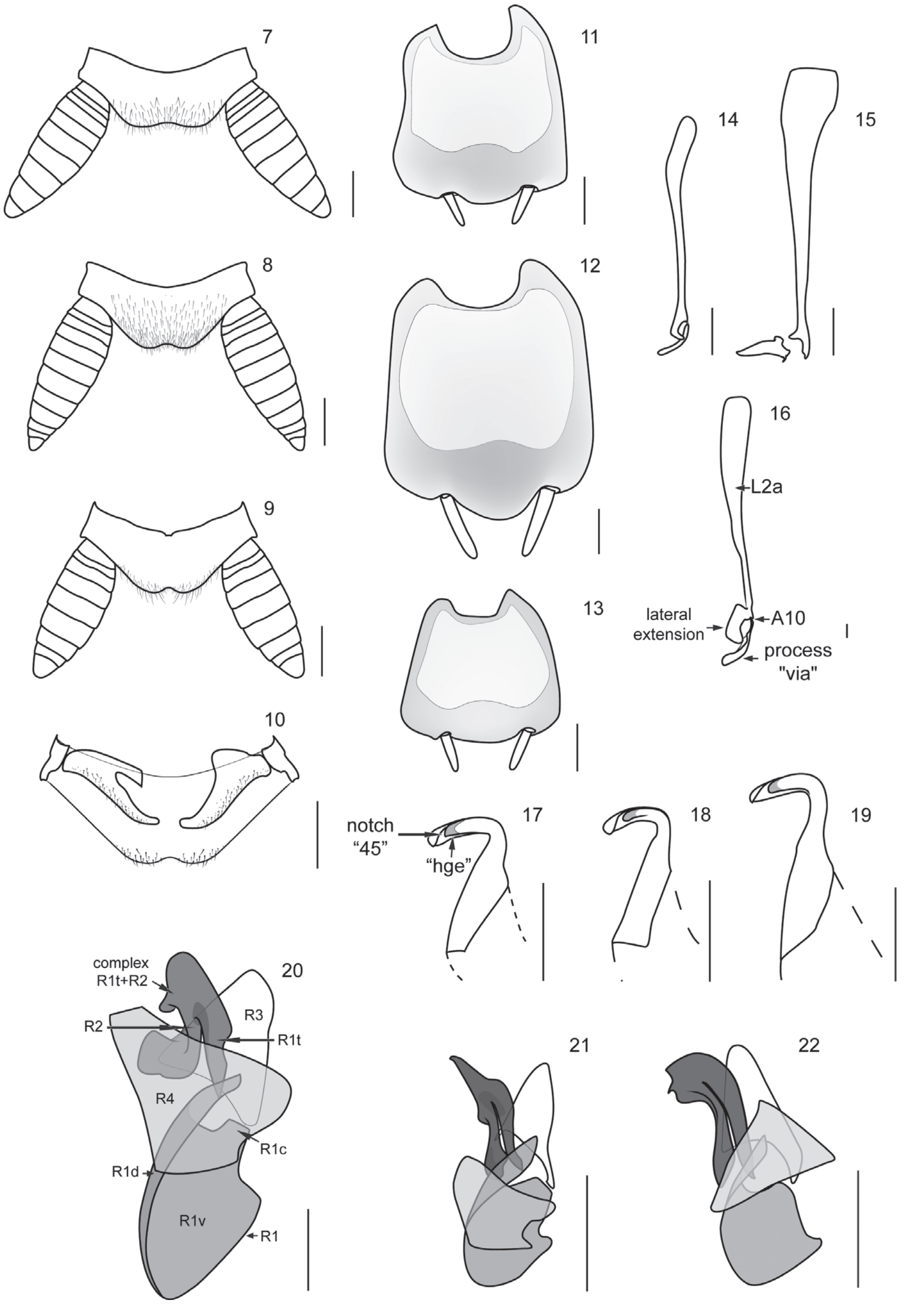
Muzoa curtalata Vélez, sp. n.

urn:lsid:zoobank.org:act:0B136466-60A0-44D8-8DF8-528FDE38D010
http://species-id.net/wiki/Muzoa_curtalata
Figures 3, 6, 9, 10, 13, 16, 17, 20

Type-locality. Colombia, Valle del Cauca, Tuluá, Juan María Céspedes botanical garden, 4.029214, -76.160409, 1100 m, E. Amat leg. 24–31 Aug 1996.

Type-specimen. Holotype male, pinned, with genitalia in a separate microvial. Original label: "Colombia. Valle. Mun. Tuluá. Jardín Botánico "Juan María Céspedes" 1100 m.s.n.m. E. Amat leg. 24–31 Ago 1996" MUJ – BLA - 025.

Differential diagnosis. This species belongs to the genus *Muzoa* by: 1) Pronotum parabolic, with the caudal margin truncated; 2) antero-ventral margin of the cephalic femur without spines; 3) tarsal claws simple and symmetrical; 4) first abdominal tergite unspecialized; 5) supra-anal plate tranverse, with caudal margin produced and bilobed; 6) cerci long, thick and subspatulate; 7) male subgenital plate symmetric, with styles similarly shaped; 8) genital sclerites: process "via", of the genital slcerite L2, finger-shaped and 9) hook "hla" of the genital sclerite L3, with groove "hge" along its lower margin. *M. curtalata* differs from *M. madida* and *M. simplex* for its brachypterous condition. *M. curtalata* is more closely related to *M. simplex* for having a long lateral extension of L2a, which covers part of the process "via" (Figs 14, 16), different to *M. madida*, in which the lateral extension is shorter and never covers part of the process "via" (Fig. 15).



Figures 7–22. Supra-anal plate (dorsal), subgenital plate (vental), and male genital sclerites of the species of genus *Muzoa. Muzoa simplex* Hebard, 1921: **7** Supra-anal plate **11** Subgenital plate **14** Median sclerite L2 (dorsal) **18** Hook "hla" of L3 (ventral) **21** Right sclerite R (dorsal). *Muzoa madida* Rehn, 1930: **8** Supra-anal plate **12** Subgenital plate **15** Median sclerite L2 (dorsal) **19** Hook "hla" of L3 (ventral) **22** Right sclerite R (dorsal). *Muzoa curtalata* sp. n. (Holotype): **9** Supra-anal plate **10** Supra-anal plate (ventral) with the paraprocts **13** Subgenital plate **16** Median sclerite L2 (dorsal) **17** Hook "hla" of L3 (ventral) **20** Right sclerite R (dorsal) (sclerotized regions R1 [subregions R1c, R1d, R1v, R1t], R2, R3, R4). Scale bar 1 mm.

Description. Species of medium size (19.8 mm), with body dark brown; legs and antennae entirely brown. Pronotum and tegmina reddish brown (Fig. 3).

Head triangular and with big reniform eyes, extending antero-laterally beyond the antennal sockets; intraocular distance equal to distance between ocellar fenestra (1.3 mm) and lesser than distance between antennal sockets (2.0 mm) (fig. 6); face globose; gena and pleurostoma undivided, at least externally, so that subgenal suture only present on the inner margin of pleurostoma; subantennal suture ending next to inferior margin of eye; face with many short setae on the frons, gena and remaining of face bare.

Pronotum parabolic, with cephalic margin convex and caudal margin truncated. Brachypterous. Fore wings coriaceous, lacking distinct veins; apex truncated, not surpassing the first abdominal tergite. Hind wings slightly developed, with reduced venation. Tegmina and pronotum covered densely with fine silky pubescence. Legs long and slender; cephalic coxa with a diagonal carina; antero-ventral margin of the front femur without spines heavy, only with short and thick setae, with three terminal spines; antero-ventral margin of middle and posterior femur with five and six spines correspondingly, postero-ventral margin with four and five spines respectively; tarsomeres 1-4 with pulvilli, first metatarsomere with its pulvilli covering only 1/3 of its length; tarsal claws simple and symmetrical; arolium present.

First abdominal tergite unspecialized. Supra-anal plate transverse, with caudal margin produced and bilobed (Fig. 9); cerci long, thick and subspatulate, composed of nine segments; last segment shorter and narrower than remaining segments (Fig. 9); ventrally, right paraproct transverse and claw-shaped (Fig. 10), articulated directly with the lateral margin of supra-anal plate through its right lateral margin. Subgenital plate symmetric, with styli similary shaped (Fig. 13). Internally, subject to this plate is located the membranous pouch with genital sclerites L2 (Fig. 16), L3 (Fig. 17), and R (right phallomere) (Fig. 20).

Genital sclerites. Genital sclerite L2 thin and elongated. Sclerotized region L2d and the process "via" separated but closely articulated (A10). Process "via" finger-shaped, slender and long (Fig. 16). Region L2a slightly sclerotized, at least four times length of "via", with a lateral extension extending over the process "via".

Hook "hla" of the genital sclerite L3 with distal area elongated; in addition to the notch "45", with the groove "hge" along its lower margin (Fig. 17). Basal area of "hla" longer than its apical area, left lateral margin of basal area straight.

Genital sclerite R (right phallomere) formed by sclerotized regions R1, R2, R3 and R4 (Fig. 20). Region R1 as a large and bulky structure at the caudal region of sclerite R; subregion R1v much wider than subregion R1d, which is a narrow and elongated band, extending along left lateral margin of R1; subregion R1d projected over the apex of R1t (Fig. 20). R1c slightly projected, articulated to the lower right corner of R3 (Fig. 20). Subregion R1t is not fused with other areas of R1. Both arms of the complex R1t+R2 have more or less the same length. Left arm of the complex R1t+R2 thick, irregularly shaped, projected towards the left. Complex R1t+R2, similar in size to region

R3, located on the left corner of the region R3, below the projection of R1d. Apex of R1t and R2 extended beyond the caudal margin of R3.

Region R3 as a nearly triangular, slightly sclerotized plate articulated by its lower right corner to R1c; apex of R3 rounded (Fig. 20).

Region R4 as a wide dorsal plate, covering R1 and R1t+R2 complex in part (Fig. 20).

Measurements (mm). Body length 19.8; pronotum maximum length × width 6.2 × 10.5; tegmen length × width 7.0 × 5.9; interocular width 1.3; interantennal sockets width 2.0.

Etymology. *curtus* (L) = short, *alatus* (L) = winged. The name refers to the short tegmina of this species.

Distribution. North of South America in the department of Valle del Cauca, Colombia.

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Special thanks to Jennifer C. Girón (UPRM-INVCOL) for their comments and corrections to this work. To Dr Jon K. Gelhaus and Sr Jason Weintraub (ANSP), to Sr Juan Zuluaga (CIB), to Dr Giovanny Fagua (MUJ) and Dr Floyd Shockley (USNM) for the loan of Nyctiborinae specimens. Visits to USNM collection was funded by the Franz Lab (University of Puerto Rico). Jessup and McHenry Awards made possible to visit ANSP collection.

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RESEARCH ARTICLE

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Four new species of *Unixenus* Jones, 1944 (Diplopoda, Penicillata, Polyxenida) from Australia

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Abstract

Unixenus carnarvonensis **sp. n.**, *U. corringlensis* **sp. n.**, *U. barrabaensis* **sp. n.** and *U. myallensis* **sp. n.** are described from Australia. A revised diagnosis of *U. karajinensis* and new details on the distribution of the species are given. A key is presented to 10 of all 11 currently known species of the genus.

Keywords

Diplopoda, Polyxenida, Polyxenidae, *Unixenus*, millipede, Australia

Introduction

Unixenus Jones, 1944 is a widespread genus in the family Polyxenidae in the single order Polyxenida within the millipede subclass Penicillata. The genus is characterised by the presence of a single generalised type I caudal bundle of trichomes (Condé and Nguyen Duy-Jacquemin 2008) with a linear arrangement of ornamental trichomes above, and antennal articles VII with 2 thick basiconic sensilla, 1 setiform sensillum between, and 1 coeloconic sensillum posteriorly. Barbate trichomes are arranged posteriorly on each tergite in 2 or more rows with trichomes arranged in 2 broad clusters laterally. Tarsus 2 has one small seta.

Seven species have been described in *Unixenus*. The type species *Unixenus padmanabhii* (Jones, 1937) from India, *U. broelemanni* (Condé & Jacquemin, 1962) from Madagascar, *U. vuillaumei* (Condé & Terver, 1963) from Ivory Coast and four Australian species

U. mjoebergi (Verhoeff, 1924), *U. attemsi* Nguyen Duy-Jacquemin & Condé, 1967, *U. karajinenis* Short & Huynh, 2011 and *U. corticolus* Short & Huynh, 2011. In this paper, four new species of *Unixenus* from Australia are described. A revised diagnosis together with an expanded distribution is given for the recently described species *U. karajinensis,* previously identified from just three locations in the Hamersley Ranges in the Pilbara, WA.

Methods

The specimens in this study came from the collections of the Australian Museum in Sydney, NSW and the Western Australian museum, Perth, WA. Specimens were examined using light microscopy. For light microscopy, specimens were cleared in 15% potassium hydroxide, heated in a water-bath for 2 minutes at 80°C, neutralised in 20% acetic acid for 2 minutes, rinsed in distilled water and dehydrated in a series of ethanol baths prior to staining with 1% Fast Green solution to increase contrast. The head and body were separated, the body cut open with a single latero-longitudinal incision and contents removed. After rinsing in 100% ethanol, stained specimens were transferred to 100% isopropanol, then to xylene and mounted on slides with DPX synthetic resin.

Specimen lengths were measured from head to telson with the caudal bundle of trichomes excluded. Adults were sexed when possible. Naming of the leg segments follows Manton (1956). Unless otherwise indicated, all millipedes referred to are adults (stadium VIII). Stadium VII specimens are referred to as subadult, and "immature" refers to any non-adult stadium. The trichomes in a transverse row on the telson dorsal to the caudal bundle are referred to as ornamental trichomes.

Abbreviations: AM = Australian Museum, Sydney, New South Wales; NSW = New South Wales; WA = Western Australia; WAM = Western Australian Museum, Perth; L = left; R = right.

Results

Subclass Penicillata Latreille, 1831
Order Polyxenida Verhoeff, 1934
Superfamily Polyxenoidea Lucas, 1840
Family Polyxenidae Lucas, 1840

Unixenus Jones, 1944

Monoxenus Jones, 1937: 138; Silvestri 1948: 216.
Unixenus Jones, 1944: 94; Nguyen Duy-Jacquemin and Condé 1967: 68.

Type species: *Unixenus padmanabhii* (Jones, 1937).

Unixenus carnarvonensis **Short & Huynh, sp. n.**

urn:lsid:zoobank.org:act:2FCC1AEE-BC97-4DB1-BCD2-04208BBA2C0D
http://species-id.net/wiki/Unixenus_carnarvonensis
Fig. 1A–K

Holotype. Female, Meedo Station, WA, site MO3, 25°39'13"S, 114°37'37"E, wet pitfall traps 22 August–11 October 1994, collected by P. West et al., WAM T71123. Specimen mounted on slide, deposited in WAM.

Paratypes. One male and 2 females, slightly damaged, Woodleigh Station, WA, site WO5, 26°11'45"S, 114°25'23"E, wet pitfall traps 22 August–10 October 1994, collected by M. Harvey et al., WAM T71120 (male), T127782 and T127783 (females). One female, same collection as holotype, WAM T127781. All paratypes mounted on slides, deposited in WAM.

Etymology. For Carnarvon region, the type locality; adjective. All specimens of this species identified to date were collected as part of the Carnarvon Survey carried out by WAM and the Department of Conservation and Land Management (now part of Department of Environment and Conservation).

Diagnosis. Antennal article VI with 3 basiconic sensilla, 1 coeloconic sensillum, no associated setiform sensillum; seta present on tarsus 1 of legs 2–13, elongate smooth sided setiform setae on leg segments, ornamental trichomes *b* with large insertion points.

Description. Measurements: Body length 2.8–3.3 mm with no differences between sexes, caudal bundle 0.3 mm.

No freshly collected specimens available. Specimens had been preserved in 70% ethanol. Body yellow brown in colour, trichomes largely missing.

Head with 8 ocelli each side: 4 dorsal, 4 lateral (1 anterior, 2 medial and 1 posterior). Vertex with anterior rows of trichomes arranged as typical for the genus *Unixenus*, with a gap to two posterior groups of trichomes arranged in 2 closely positioned straight oblique rows. Number of trichomes in posterior rows of vertex of head each side varies from 10–13 (anterior), 5–9 (posterior). Trichobothria equal in size, arranged in shape of isosceles triangle with greater width a–c (Fig. 1A).

The antennae with proportions of 8 articles and 4 sensitive cones typical of the genus. Article VI with 3 thick basiconic sensilla of equal length, coeloconic sensillum posterior to basiconic sensilla (Fig. 1C). Antennal segment VII typical of the genus with 1 coeloconic sensillum to the posterior followed anteriorly by 2 thick basiconic sensilla of similar height; 1 setiform sensillum between the basiconic sensilla (Fig. 1B). Clypeo-labrum with 10 setae along posterior margin; anterior margin of labrum with 5–6 rounded lamellar teeth each side of median cleft; surface covered with tiny spherical papillae, papillae reducing in size to the posterior margin and lacking tiny hairs (Fig. 1D). Gnathochilarium typical of the genus with lateral palp 2.5 × length of medial palp; lateral palp with 13–15 cylindrical sensilla, medial palp with 22 sensilla.

Collum with arrangement of trichomes on tergites similar to *U. mjoebergi*, with symmetrical pattern of trichomes each side of a broad median gap, with anterior and poste-

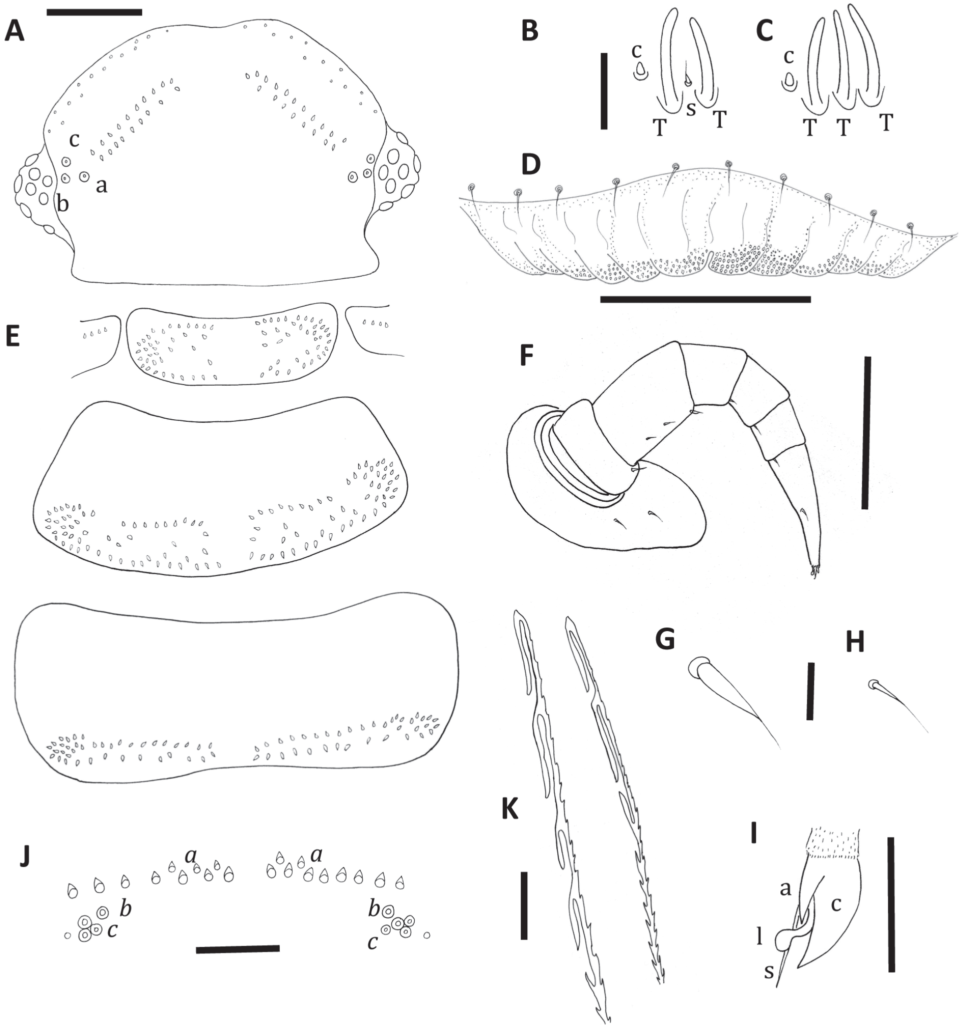

Figure 1. *Unixenus carnarvonensis* sp. n., adult female. **A** Head, dorsal view showing arrangement of ocelli, position of trichobothria (a, b and c) and trichome insertions **B** Details of sensilla on antennal article VII, sensillum type indicated as follows: coeloconic (**c**), setiform (**s**), thick basiconic (**T**) **C** Details of sensilla on antennal article VI **D** Clypeo-labrum **E** Collum, tergite 2 and tergite 10 showing pattern of trichome insertions **F** Left leg 3 showing chaetotaxy on leg segments **G** Details of seta on coxa, prefemur and femur **H** Details of seta on tarsus 2 **I** Anterior view of left telotarsus showing anterior spinous projection (**s**), claw (**c**) with anterior (**a**) process and lamella (**l**) **J** Pattern of ornamental trichome insertions **K** Detail of distal ends of hooked caudal trichomes, Scale bars: **A** and **E** (shared bar), **F** = 50 µm; **D** and **J** = 30 µm; **K** = 10 µm; **B** and **C** (shared bar) **G H, I** = 5 µm.

rior rows merging laterally to form rosettes of trichomes, and further trichomes scattered between these rows. Small lateral protuberances each with row of 4–6 forward facing trichomes (Fig. 1E). Tergites 2–9 with trichomes arranged on posterior half of the tergite with one distinct posterior row with a medial gap and ending with small clusters laterally. Further trichomes anterior to this row loosely arranged in two to three rows (Fig. 1E). Anterior trichomes directed towards head while remaining trichomes directed posteriorly. Tergite 10 with 2 rows of trichomes arranged along posterior edge with broad medial gap (Fig. 1E). Conical pleural projections along each side associated with tergites 2–10, each with a dense cluster of trichomes. Tergal trichomes barbate, same structure as *U. mjoebergi*.

Legs 1 and 2 without trochanter, leg 1 also lacks tarsus 1. Trochanters legs 3–13 lack setae. Chaetotaxy as follows: coxa 1, 1 seta, coxa 2, 2 setae, coxae 3–13, 2–3 setae; prefemur, postfemur, tarsus 2, legs 1–13 and tarsus 1, legs 2–13, with 1 seta; femur 1, 1 seta, femur 2, 1–2 setae, femur 3–13, 2–3 setae (Fig. 1F), setae distinctive elongate setiform (Fig 1G) with distal seta of femur longer, small setae on postfemur, tibia, tarsus 1 and tarsus 2 (Fig. 1H); telotarsus bearing slender anterior spinous projection longer than the claw which bears anterior process, presence of posterior process unable to be determined, lamella process present (Fig. 1I). Male coxal glands not visible due to damage.

Telson with ornamental trichome insertions arranged almost symmetrically with 6–10 trichomes *a*, 1*b*, and 3*c* each side of the midline (holotype has 4 trichomes *c* on right side). Large insertion points for trichomes *b* (Fig. 1J). A small indentation external to trichomes *c*, either side. Single caudal bundle typical of genus. Hooked caudal trichomes with 2–5 hooks on barbed stems, majority with distal facing barbs only along stem proximal to hooks (Fig. 1K), some with distal and proximal facing barbs.

Distribution. So far known only from two sites in the Carnarvon region of Western Australia (Fig. 5). Co-occurs with *U. mjoebergi*.

Remarks. This species is very similar to *U. mjoebergi* and cannot be separated without examination under high magnification.

Unixenus corringlensis **Short & Huynh, sp. n.**

urn:lsid:zoobank.org:act:FEA7C5BF-F58F-4DF4-8A25-506C6354C0B5
http://species-id.net/wiki/Unixenus_corringlensis
Fig. 2A–I

Holotype. Female, Corringle State Forest, NSW, 33°22'12"S, 147°15'00"E, 21–26 March 1996, collected by D. Smith, AM KS.119541. Specimen mounted on slides, deposited in AM.

Paratypes. 1 male, same collection as holotype, AM KS.119540. 1 female and 1 male subadult stadium VII, Severn State Forest, Atholwood Loop Rd. 29°04'28"S, 151°00'53"E, wet pitfall traps 22 November–13 December 2001, collected by L. Wilkie and H. Smith, AM KS.87406 (male), AM KS.119542 (female). 1 female adult, Newnes State Forest, Birds Rock Flora Reserve, 0.6 km from Sunnyside Ridge Rd., 33°19'43"S, 150°11'33"E, litter sampling 23 Feb 2006, collected by G.A. Milledge, J. Tarnawski and M. Beatson. AM KS.119543. All paratypes mounted on slides and deposited in AM.

Other material: 4 specimens (sex and stadia not determined), Severn State Forest, Atholwood Loop Rd. 29°04'28"S, 151°00'53"E, wet pitfall traps 22 November–13

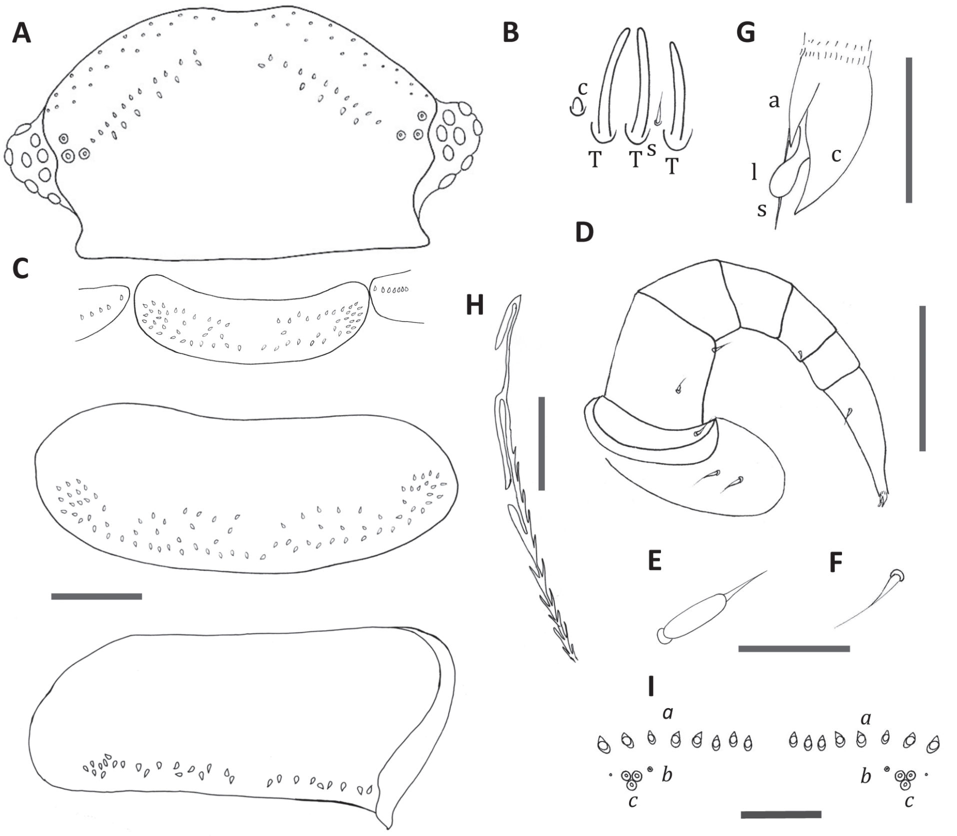

Figure 2. *Unixenus corringlensis* sp. n., adult female **A** Head, dorsal view showing arrangement of ocelli, position of trichobothria and trichome insertions **B** Details of sensilla on antennal article VI, sensillum type indicated as follows: coeloconic (**c**), setiform (**s**), thick basiconic (T) **C** Collum and tergite 2 (holotype), tergite 10 (paratype male) showing pattern of trichome insertions. Tergite 10 pattern partially obscured due to folding **D** Leg 3 showing chaetotaxy **E** Details of seta of coxa, prefemur and femur **F** Details of seta on tarsus 2 **G** Anterior view of telotarsus showing anterior spinous projection (**s**), claw (**c**) with anterior (**a**) process and lamella (l) **H** Hooked caudal trichome, distal section only **I** Pattern of ornamental trichome insertions. Scale bars: **A** and **C** (shared bar), **D** = 50 µm **B, E** and **F** (shared bar), **G** = 5 µm; **H** and I = 20 µm.

December 2001, collected by L. Wilkie and H. Smith. AM KS.87400, KS.87410, preserved in ethanol. 2 immature specimens, (sex and stadia not determined), Corringle State Forest, NSW, 33°22'12"S, 147°15'00"E, 21–26 March 1996, collected by D. Smith, AM KS.53604, preserved in ethanol.

1 male stadium VII, Newnes State Forest, Birds Rock Flora Reserve, 0.6km from Sunnyside Ridge Rd., 33°19'43"S, 150°11'33"E, litter sampling 23 Feb 2006, collected by G.A. Milledge, J. Tarnawski and M. Beatson, AM KS.119544, mounted on slide, poor quality.

Etymology. For Corringle State Forest, the type locality; adjective.

Diagnosis. Similar to *U. attemsi* with biarticulate setae on leg segments and proximal position of seta on tarsus 2. Differs from *U. attemsi* in being larger, having 2 setae on femur and 1 seta on tibia, maximum of 3 setae on coxa, broad gap between anterior rows of trichomes on vertex and posterior rows, and in arrangement of posterior rows.

Description. As for *U. carnarvonensis* sp. n., differing in the following details:

Measurements: Body length 2.3–2.5 mm with no differences between sexes, caudal bundle 0.3 mm.

No freshly collected specimens available. Specimens had been preserved in 70% ethanol. Body yellow brown in colour with tergal trichomes medium brown.

Number of trichomes in posterior rows of vertex of head each side varies 10–12 (anterior rows), 4–6 (posterior rows) (Fig. 2A). Antennal article VI with 3 thick basiconic sensilla, anterior sensillum shorter, coeloconic sensillum posterior to basiconic sensilla, setiform sensillum between basiconic sensilla 1 and 2 (Fig. 2B). Clypeo-labrum similar to *U. carnarvonensis* sp. n. with 10 setae along posterior margin and fine sandy granular surface, granules decreasing in size to the posterior. Differs from *U. carnarvonensis* sp. n. in having only 4 overlapping lamellar teeth each side of the median cleft. Lateral palp of gnathochilarium with 13 cylindrical sensilla, medial palp 20–21 sensilla.

Lateral protuberances of collum with 5–7 trichomes each. Tergites 2–9 with presence of median gap variable and narrow if present. Tergite 10 with median gap and reduced number of trichomes (Fig. 2C). Trichomes short barbate. Legs with similar chaetotaxy to *U. mjoebergi* with coxa 1, 1 seta, coxa 2, 2 setae, coxae 3–13, 2–3 setae; prefemur, tibia and tarsus 2, 1 seta; femur, 2 setae; trochanter, postfemur and tarsus 1 lack setae (Fig. 2D). Setae same as for *U. attemsi*, biarticulate with base lacking ridges and spines (Fig. 2E), seta on distal edge of femur with longer flagellum; setiform, tarsus 2 seta slightly longer and located more proximal than in *U. mjoebergi* (Fig. 2F); telotarsus bearing anterior spinous projection longer than the wide claw which bears anterior process, posterior process not visible, small thin lamella process (Fig. 2G). Last sternal plate with 2 setae. Male with 2 pairs coxal glands on leg pairs 8 and 9.

Telson with ornamental trichome insertions numbering 7–10*a*, 1*b*, and 3*c* each side of the midline (Fig. 2I). Trichome *b* insertion points small, typical of the genus. Hooked caudal trichomes with 2–4 hooks on barbed stems, distal facing barbs along stem proximal to hooks, most distal barb larger. Caudal trichomes with 2 hooks only in both holotype and paratype from Corringle State Forest (Fig. 2H).

Distribution. So far known only from State forest at two widely separated sites in mid NSW and one site in northern NSW (Fig. 5).

Unixenus barrabaensis Short & Huynh, sp. n.

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http://species-id.net/wiki/Unixenus_barrabaensis
Fig. 3A–I

Holotype. Female, Crown Reserve, Woods Reef, between road and Nangahrah Ck. NSW, 30°23'39"S, 150°44'08"E, pitfall traps 18 November–9 December 2001, col-

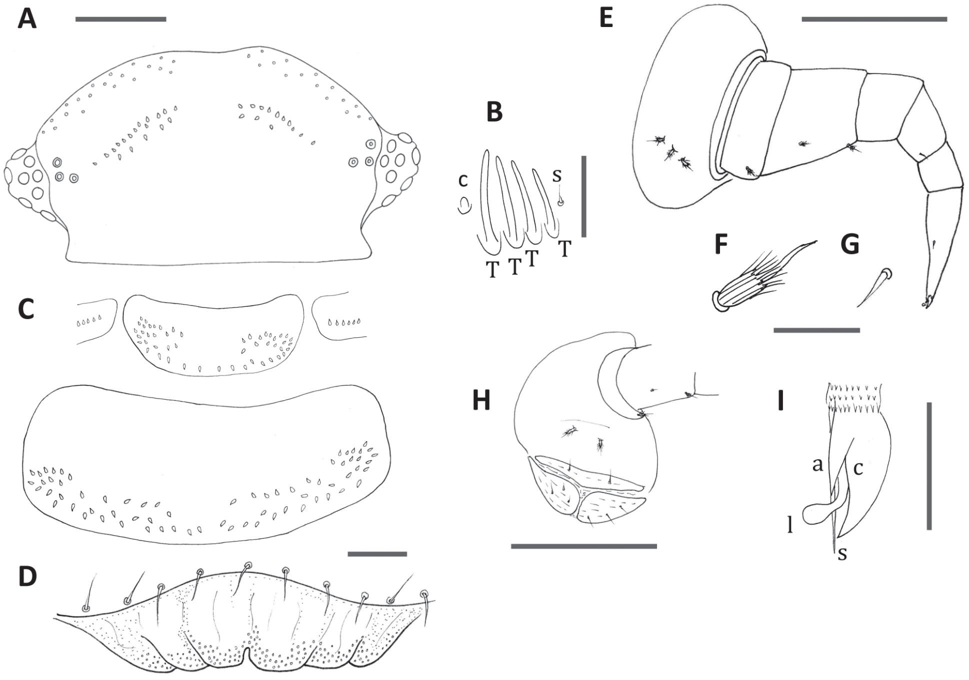

Figure 3. *Unixenus barrabaensis* sp. n., adult female **A** Head, dorsal view showing arrangement of ocelli, position of trichobothria and trichome insertions **B** Details of sensilla on antennal article VI, sensillum type indicated as follows: coeloconic (**c**), setiform (**s**), thick basiconic (**T**) **C** Collum and tergite 2 showing pattern of trichome insertions **D** Clypeo-labrum **E** Left leg 3 showing chaetotaxy on leg segments **F** Details of seta on coxa, prefemur and femur **G** Details of seta on tarsus 2 **H** Detail of coxa and vulva of left leg 2 **I** Anterior view of left telotarsus showing anterior spinous projection (**s**), claw (**c**) with anterior (**a**) process and lamella (**l**). Scale bars: **A** and **C** (shared bar), **E** and H = 50 µm; D = 10 µm **B** Fand G (shared bar) and I = 5 µm.

lected by H. Doherty and M. Elliot, AM KS.119545. Specimen mounted on slide, deposited in AM.

Paratypes. Male subadult stadium VII, same collection as holotype, AM KS.119546. Male subadult stadium VII Crown Reserve, 8.9 km along Bukkulla-Ashford Rd., NSW, 29°25'59"S, 151°04'18"E, pitfall traps 22 November–13 December 2001, collected by H. Doherty and M. Elliot, AM KS.119547. Female, stadium VII, Oaky Creek Nature Reserve, at base of E side of Melville Range, 31°06'31"S, 150°37'20"E, wet pitfall traps 17 November–8 December 2001, collected by L. Wilkie and H. Smith, AM KS.119548. Specimens mounted on slides, deposited in AM.

Etymology. For Barraba, town closest to type locality; adjective.

Diagnosis. Chaetotaxy similar to *U. mjoebergi* with leg setae being spiny, 2 setae on femur and 1 on tibia; differs from *U. mjoebergi* in having four basiconic sensilla on antennal article VI.

Description. As for *U. carnarvonensis* sp. n., differing in the following details:

Measurements: female adult, 1.94 mm, caudal bundle 0.3 mm; male subadult, Stadium VII, 1.6–2.1 mm. (n=3), caudal bundle 0.3 mm.

No freshly collected specimens available. Specimens had been preserved in 70% ethanol. Body yellow brown in colour with brown tergal trichomes.

Two rows of trichomes either side of posterior vertex of head with slightly larger medial gap than for *U. carnarvonensis* sp. n. Number of trichomes each side of posterior vertex varies 8–14 (anterior rows), 4–6 (posterior rows) (Fig. 3A). Antennal article VI with 4 thick basiconic sensilla, coeloconic sensillum posterior to basiconic sensilla, One setiform sensillum anterior to the basiconic sensilla (Fig. 3B). Clypeolabrum with 10 setae along posterior margin in holotype, 8–10 in subadult paratypes; anterior margin of labrum with 3–4 lamellar teeth each side of the median cleft; fine sandy granular surface, granules becoming smaller posteriorly (Fig. 3D). Lateral palp of gnathochilarium typical of the genus with 13 cylindrical sensilla.

Collum and tergites 2–9 with small median gap in posterior row of trichomes (Fig. 3C). Rows increasingly closer together in posterior tergites. Tergite 10 of holotype damaged so size of median gap unable to be determined. Leg chaetotaxy as follows: coxa 1, 1 seta, coxa 2, 2 setae, coxae 3–13, 2–3 setae; prefemur, tibia, tarsus 2, 1 seta; femur, 2 setae (Fig. 3E). Setae of the coxa, prefemur and distal edge femur with biarticulate setae similar to those for *U. mjoebergi* with longitudinal ridges on basal funicle, each ridge extending distally in a long, thin spine with the spines surrounding the base of the flagellum (Fig. 3F); seta of mid femur similar but smaller, tibia and tarsus 2 with setiform setae (Fig. 3G); telotarsus bearing anterior spinous projection longer than the claw which bears large anterior process ½ length of claw, no posterior process visible, short lamella process (Fig. 3I). Vulvae of adult female typical of genus, with numerous setae (Fig. 3H). Male with 2 pairs coxal glands on leg pairs 8 and 9.

Telson with ornamental trichome insertions numbering 6–8*a*, 1*b*, and 3*c* each side of the midline, arrangement typical for the genus, as illustrated for *U. corringlensis*. These trichomes barbate, long and straight. Hooked caudal trichomes with 1–3 hooks on barbed stems, majority with distal facing barbs only along stem proximal to hooks, very small number with distal and proximal facing barbs.

Distribution. So far known only from three forested sites in northern NSW, with a north-south range of ca 200 km (Fig. 5).

Unixenus myallensis Short & Huynh, sp. n.

urn:lsid:zoobank.org:act:1DB55177-48AA-48A3-AF88-4820D4706C7E
http://species-id.net/wiki/Unixenus_myallensis
Fig. 4A–K

Holotype. Female, Myall Lakes National Park, 3.8 km South of Mungo Brush campsite, NSW, 32°34'46"S, 152°17'27"E, ca 300–500 m, wet pitfall traps 14–24 May 1998, collected by L. Wilkie, AM KS.93670. Specimen mounted on slide, deposited in AM.

Paratypes. Male subadult stadium VII, same collection as holotype, AM KS.94096.

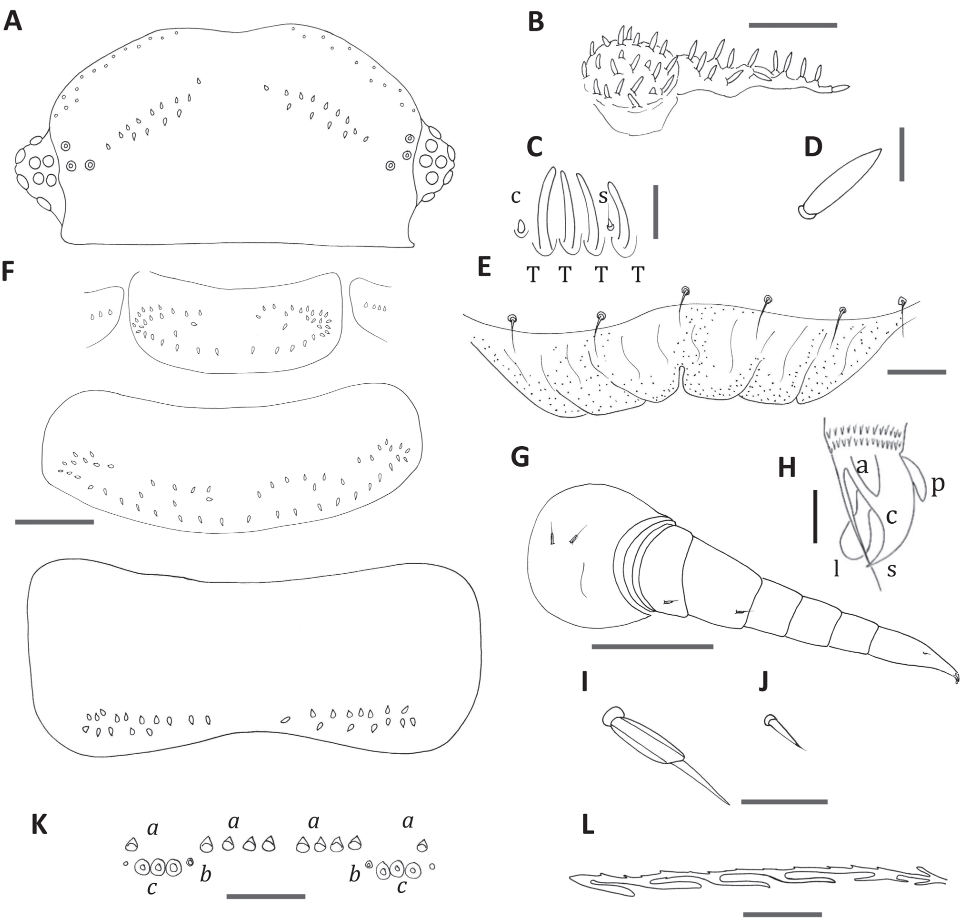

Figure 4. *Unixenus myallensis* sp. n., adult female **A** Head, dorsal view showing arrangement of ocelli, position of trichobothria and trichome insertions **B** Left palp of gnathochilarium **C** Details of sensilla on antennal article VI, sensillum type indicated as follows: coeloconic (**c**), setiform (**s**), thick basiconic (**T**) **D** Details of gnathochilarial sensillum **E** Clypeo-labrum **F** Collum, tergite 2 and tergite 10 showing pattern of trichome insertions **G** Left leg 3 showing chaetotaxy on leg segments **H** Anterior view of left telotarsus showing anterior spinous projection (**s**), claw (**c**) with anterior (**a**) and posterior (**p**) processes and lamella (**l**) **I** Details of seta on coxa, prefemur and femur **J** Details of seta on tarsus 2 **K** Pattern of ornamental trichome insertions **L** Hooked caudal trichome, distal section only. Scale bars: **A** and **F** (shared bar), **G** = 50 µm; **B** and **K** = 20 µm; **E** = 10 µm; **I** and **J** (shared bar) and **L** = 5 µm **C, D** and **H** = 2 µm.

Female, same site as holotype, wet pitfall traps 26 November 1997, collected by L. Wilkie, AM KS.93660. Male adult, Male subadult stadium VII, Female subadult stadium VII, Wyrrabalong National Park, NSW, 33°16'47"S, 151°32'40"E, wet pitfall traps 27 November 1997, collected by L. Wilkie, AM KS.93662, KS.119556, AM KS.93663. All paratypes mounted on slides, deposited in AM.

Other material: 1 immature stadium IV (6 pairs legs), same site as holotype, wet pitfall traps 14 May 1998 collected by L. Wilkie, KS.93665. 1 stadium VI, 10 pl, sex unknown, Wyrrabalong National Park, NSW, 33°16'48"S, 151°32'45"E, wet pitfall traps 27 November 1997, collected by L. Wilkie, AM KS.93659. 1 stadium V, 8 pl, 1 stadium IV, 6 pl, Wyrrabalong National Park, NSW, 33°16'47"S, 151°32'40"E, wet pitfall traps 27 November 1997, collected by L. Wilkie, AM KS.93661, AM KS.93666. Preserved in ethanol in AM.

Etymology. For Myall Lakes National Park, the type locality; adjective.

Diagnosis. Similar chaetotaxy to *U. attemsi* with 1 seta on femur and none on tibia, setae smooth biarticulate; differs from *U. attemsi* in having a gap between anterior and posterior vertex groups of trichomes, 4 basiconic sensilla on antennal article VI, gnathochilarium with short lateral palps (1.5 × diameter of medial palp) bearing 12–13 short rounded sensilla, ornamental trichome insertions *c* in row.

Description. As for *U. carnarvonensis*, differing in the following details:

Measurements: Body length 2.2–2.4 mm (n=3) with no differences between sexes. Caudal bundle 0.5 mm.

Colouration: No freshly collected specimens available. Specimens had been preserved in 70% ethanol. Body yellow brown in colour with black trichomes including caudal bundle dark brown – black.

Two rows of trichomes either side of posterior vertex of head with number of trichomes in rows varying from 7–11 trichomes each side anteriorly, 4–6 each side in posterior rows. (Fig. 4A). Antennal article VI with 4 thick basiconic sensilla, coeloconic sensillum posterior to the basiconic sensilla, setiform sensillum between basiconic sensilla 1 and 2 (Fig. 4C). Clypeo-labrum with 6–9 setae along the posterior margin; anterior margin of labrum with 3–5 square shaped lamellar teeth each side of median cleft; tiny granular structures over labrum (Fig. 4E).

Gnathochilarium with lateral palp 1.5 times length of medial palp. Lateral palp with 12–13 sensilla, medial palp 22 sensilla (Fig. 4B), sensilla fat, cylindrical and short (2/3 length of *U. attemsi* sensilla) (Fig. 4D).

Collum with two rows of trichomes sparsely arranged each side of a medial gap, rows merge laterally to form rosettes of trichomes, and with a small number (2 each side in holotype) of trichomes between the two rows. Lateral protuberances of collum with 3–4 trichomes each. Tergites 2–10 with trichomes arranged most commonly in 2 rows on posterior half of the tergite each side of a medial gap. Anterior row sinuous with small gap to lateral cluster. In posterior tergites the two rows are closer together and straighter (Fig. 4F). In some specimens tergites 2 and 3 have scattered trichomes between the anterior and posterior rows forming an intermediate 3rd row. Conical pleural projections along each side associated with tergites 2–10, each with dense cluster of short dark trichomes. Tergal trichomes of posterior tergites longer than those of anterior tergites.

Leg chaetotaxy as follows: coxa 1, one seta, coxa 2, 2 setae, coxae 3–13, 2–3 setae; prefemur, femur, 1 seta (Fig. 4G); setae biarticulate with glabrous funicle showing longitudinal ridging (Fig. 4I), tarsus 2 with small setiform seta (Fig. 4J), trochanter, postfemur, tibia and tarsus 1 lack setae, claw of telotarsus bearing posterior and anterior processes (Fig. 4H). Male with 2 pairs coxal glands on leg pairs 8 and 9.

Figure 5. Map of Australia with states New South Wales and Western Australia expanded to show distribution of five *Unixenus* species In Western Australia: *U. carnarvonensis* sp. n.: diamonds, type region shown as open diamond *U. karajinensis* Short and Huynh 2011: stars, type locality shown as open star. In New South Wales: *U. corringlensis* sp. n.: squares, squares, type locality shown as open square *U. barrabaensis* sp. n.: circles, type locality shown as open circle *U. myallensis* sp. n.: triangles, type locality shown as open triangle. Scale bar =1000 km.

Telson with ornamental trichome insertions numbering 5–6*a*, 1*b* and 3*c* each side of the midline, with *c* trichome insertions in straight line (Fig. 4K). Trichomes *b* and *c* black in colour. Hooked caudal trichomes with 1–6 hooks on barbed stems, majority with distal facing barbs only along stem proximal to hooks, with occasional double barbs with both distal and proximal facing projections (Fig. 4L).

Distribution. So far known only from two treed coastal sites in mid NSW, with a north-south range of ca 150 km (Fig. 5).

Unixenus karajinensis Short & Huynh, 2011

http://species-id.net/wiki/Unixenus karajinensis\according to Short et al 2013

Material examined. A number of collections of various stadia, in poor quality: Wittenoom WA, May 1973, EN Wahl, WAM T116466, T116467, T116469; Wittenoom, WA, from out of drain pipe in bath at night, also on floors in house, 10 October 1983, Mrs. M. McKay, WAM T116468; Tom Price Caravan park, Tom Price, WA, 22 December 1982, K. Campbell, WAM T116450; Tom Price Caravan park, Tom Price, WA, 2 December 1982, A. Davies, WAM T116470; Hamersley Station, WA, under house, 20 April, 1989, JS Bogle, T117557; Mt Stuart Station, 0.7 km W Urandy Bore (1: 100,000 map ref: 2153-283201), huge numbers on surface of ground (gibber slope) at night, 6 August 1985, large collection in very poor condition, A Baynes and TA Smith, WAM T117558. Selected specimens mounted on slides for identification, remainder in ethanol, all deposited in WAM.

Revised diagnosis. Differs from *U. mjoebergi* in longer and thinner tergal trichomes, 6 pairs of coxal glands in males on leg pairs 6–11, telotarsus with anterior spinous projection shorter than the claw, 5–9 ornamental trichomes *c* each side. Antennal articles VI and VII with distinctive notched appearance at the distal edge, article VI with setiform sensillum anterior to 3 basiconic sensilla. Number of setae on coxae 3–13 varies more widely from 1–6 in contrast to 2–3 in *U. mjoebergi*. The hooked caudal trichomes have double barbs proximal to the hooks. The last sternal plate has 2 setae.

Remarks. Examination of further specimens of *U. karajinenis* has confirmed that the original diagnosis for the species is in error in stating that the number of ornamental trichomes *c* is 8 each side (Short and Huynh 2011). Although the number is 8 each side in the majority of specimens examined, the number can vary from 5–9.

A number of the collections examined were from the two previous collection sites: the type locality Wittenoom and the nearby township of Tom Price. However the species has now been identified from two further locations in the Pilbara region of Western Australia, with one site being 200 km from the type locality indicating that its distribution is not as tightly restricted to the Hamersley Ranges as originally recorded (Fig. 5).

Collections were sent to WAM for identification after reports from 1972 of the millipedes reaching nuisance proportions in parts of the Pilbara, particularly the Hamersley Ranges area and the townships of Tom Price and Wittenoom (Koch 1985). Koch identified the species involved as *U. mjoebergi* and a study was done for the Western Australian Department of Agriculture (Burt 1984) to determine ways of reducing millipede numbers and swarming behaviour. However after recent examination of collections in WAM it appears that *U. karajinensis* also occurred in huge numbers and has been found associated with housing. It appears very likely to have been involved in swarming behaviour.

Discussion

The genus *Unixenus* is widespread and speciose. It is likely further species will be identified. The genus is not limited to Australia. Apart from *U. padmanabhii* in India, *U. vuillaumei* in Ivory Coast and *U. broelemanni* in Madagascar, specimens from two locations in Vietnam have been identified as *Unixenus* by Nguyen Duy-Jacquemin and Condé (1967), as well as two specimens from Vietnam retrieved from imported tropical fruit by the Australian Quarantine and Inspection Service and identified by the authors (QM collection QMS 25102, prepared as slides) as being in the genus *Unixenus*. Specimens from 3 locations in Papua New Guinea have been identified as 3 distinct species of *Unixenus* (Nguyen Duy-Jacquemin and Condé 1982, Condé and Nguyen Duy-Jacquemin 1984). The specimens are tiny juveniles (stadia II and III) and were identified as *Unixenus*, most probably from 3 undescribed species. Adult or subadult specimens will be required for complete identification.

Updated Key to described species of *Unixenus*

The type species from India, *U. padmanabhii* is not included as insufficient details are known.

Unfortunately the species in the genus *Unixenus* are very similar and reliable characters suitable for identification are only visible under high magnification, requiring preparation of slides. The key should be used with some caution as although it has been developed using characters that are consistent in the individuals examined for each species, there may be some variability in characters that has not been discernable due to the limited number of adult individuals available for examination.

1 Presence of setae without projecting spines on legs............ **2**
– Presence of setae with projecting spines on legs............ **6**
2 One seta only on femur, no setae on tibia of legs 6–13 .... **3**
– At least 2 setae on femur, 1 seta on tibia............ **5**
3 3 basiconic sensilla on antennal article VI **4**
– 4 basiconic sensilla on antennal article VI, to date found only in NSW, Australia .... ***U. myallensis* sp. n.**
4 Telotarsus with more than 2 processes on claw, to date found only in Australia .... ***U. attemsi***
– Telotarsus with 2 or less processes on claw, to date found only in Madagascar .... ***U. broelemanni***
5 No seta on tarsus 1 of legs 3–13, small or no median gap in posterior row of trichomes on tergite 2, setiform sensillum between basiconic sensilla 1 and 2 on antennal article VI, to date found only in NSW, Australia .... ***U. corringlensis* sp. n.**
– Seta present on tarsus 1 of legs 3–13, Median gap in posterior row of trichomes on tergite 2, no setiform sensillum between basiconic sensilla 1 and 2 on antennal article VI, to date found only in WA, Australia............ ***U. carnarvonensis* sp. n**
6 One seta only on femur, no setae on tibia 7
– At least 2 setae on femur, 1 seta on tibia **8**
7 4 basiconic sensilla on antennal article VI, 5 ornamental trichomes *c* to date found only in Australia .... ***U. corticolus* sp. n.**
– 3 basiconic sensilla on antennal article VI, 3 ornamental trichomes *c* to date found only in Ivory Coast, West Africa............ ***U. vuillaumei***
8 3 basiconic sensilla on antennal article VI **9**
– 4 basiconic sensilla on antennal article VI to date found only in NSW, Australia .... ***U. barrabaensis* sp. n.**
9 3 ornamental trichomes *c* per side, 2 pairs coxal glands to date found only in Australia .... ***U. mjoebergi***
– 5–9 (most commonly 8) ornamental trichomes *c,* 6 pairs coxal glands in male, to date found only in WA, Australia............ ***U. karajinensis***

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We thank Graham Milledge (AM) and Julianne Waldock (WAM) for loan of specimens and for help with registering specimens, and Dr Monique Nguyen Duy-Jacquemin for her support and advice. We also are grateful to the reviewers for their suggestions on improving the paper. Open access to this paper was supported by the Encyclopedia of Life (EOL) Open Access Support Project (EOASP).

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Appendix

The record of all *Unixenus* specimens examined for this publication are available (doi: 10.3897/zookeys.278.4765.app). File format: Comma-separated values files (CSV).

Citation: Short M, Huynh C (2013) Four new species of *Unixenus* Jones, 1944 (Diplopoda, Penicillata, Polyxenida) from Australia. ZooKeys 278: 75–90. doi: 10.3897/zookeys.278.4765.app

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RESEARCH ARTICLE

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A new species of the genus *Duvalius* sg. *Neoduvalius* from Montenegro with taxonomical remarks on the genus *Duvalius* (Coleoptera, Carabidae, Trechini)

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Abstract

Duvalius (sg. *Neoduvalius*) *gejzadunayi* **sp. n.** from Pećina u Dubokom potoku cave (Donje Biševo village near Rožaje, Montenegro), the first known representative of this subgenus from the territory of Montenegro is described, illustrated and compared with the related species of the subgenus *Neoduvalius* Müller, 1913. This new species is characterised by depigmented, medium sized body, totally reduced eyes, deep and complete frontal furrows, 3–4 pairs of discal setae in third elytral stria, as well as by the shape of aedeagus. Data on the distribution and the ecology of this remarkable species, as well as a check-list of the subgenus *Neoduvalius* are also provided. Recently described genera *Serboduvalius* Ćurčić, S. B. Pavićević & Ćurčić, B.P.M., 2001, *Rascioduvalius* Ćurčić, S. B. Brajković, Mitić & Ćurčić, B.P.M., 2003, *Javorella* Ćurčić, S. B. Brajković, Ćurčić, B.P.M. & Mitić, 2003 and *Curcicia* Ćurčić, S. B. & Brajković, 2003 are regarded as junior synonyms of the genus *Duvalius* Delarouzée.

Keywords

Duvalius (Neoduvalius) gejzadunayi sp. n., *Serboduvalius*, *Rascioduvalius*, *Javorella*, *Curcicia*, subterranean environment, Coleoptera, Carabidae, Trechinae, Duboki potok cave, Rožaje, Montenegro, Serbia, taxonomy, new synonymy

Introduction

The Dinaric mountain chain, and the Balkan peninsula as a whole, are an impressive hotspot of subterranean biodiversity (see, as examples, Pretner 1969, 1973, 1977, Bedek et al. 2006, Gottstein et al. 2002, Jalžić 1984, 1994, Jalžić et al. 2010). Despite the fact that the cave fauna of this region has systematically been studied for more than one and half centuries new taxa are frequently described. Intensive biospeleological research performed in the Dinaric karst region during last twenty years has led to the discovery of many new subterranean trechine taxa, species and also genera (Monguzzi 1993, Casale and Guéorguiev 1994, Casale and Jalžić 1999, Quéinnec 2008, Quéinnec and Pavićević 2008, Quéinnec et al. 2008, Lohaj and Jalžić 2009, Lohaj and Lakota 2010, Lakota et al. 2010, Casale et al. 2012, Lohaj and Mlejnek 2012).

During biospeleological research in the caves of the vicinity of Rožaje (Montenegro) undertaken by members of association Biospeleologica Slovaca (D. Čeplík, G. Dunay, J. Lakota and R. Lohaj) in 2009, a new species of the trechine genus *Duvalius* belonging to the sg. *Neoduvalius* was discovered. This new species is described below.

Material and methods

The morphological features of beetles were examined using Olympus SZ 60 and MBS 10 stereo-microscopes. Male and female genitalia were dissected, cleaned and mounted in Euparal® on transparent slides under the examined specimens. Macrophotographs were taken using a Canon 5D mark II camera. Photographs of genitalia were taken using microscope Leitz Ergolux with Nikon Colpix E4500 digital camera attached and were completed using Helicon Focus software program.

Measurements

TL	total body length (measured from the anterior margin of clypeus to the apex of elytra)
L	overall length, from apex of mandibles to apex of elytra, measured along the suture
HL	head length (measured from the anterior margin of the clypeus to the neck constriction)
HW	maximum width of head
HL/HW	ratio length of head/ maximum width of head
PL	pronotum length (measured along the median line)
PW	maximum width of pronotum, as greatest transverse distance

PL/PW	ratio length of pronotum/maximum width of pronotum
EL	elytral length (as linear distance measured along the suture from the elytral base to the apex)
EW	maximum width of elytra
EL/EW	ratio length of elytra/maximum width of elytra

Collections

HPM	collection of Hrvatski Prirodoslovni Muzej, Zagreb, Croatia (B. Jalžić)
NMP	collection of Národní Muzeum Praha, Czech republic
ZSM	collection of Zoologische Staatssammlung Munich, Germany
CAC	private collection of Achille Casale, Torino, Italy
CDC	private collection of Dávid Čeplík, Košice, Slovakia
CGD	private collection of Gejza Dunay, Kráľovce, Slovakia
CAG	private collection of Artur Gitzen, Neuhofen, Germany
CJL	private collection of Ján Lakota, Ružomberok, Slovakia
CRL	private collection of Roman Lohaj, Pezinok, Slovakia
CVZ	private collection of Vladimír Zieris, Pardubice, Czech republic
hw	handwritten
p	printed

Forward slash indicates separate labels

The following species have been also studied:

D. (Neoduvalius) eurydice (Schaufuss, 1881): 1♂ labelled: „Croatia (hw)/Coll. Geittner (p)“ (ZSM); 1♀ „05028 (p)/Raduć. (p) 25.VII. (hw)“ (ZSM); 1♂ „Croatia (p)/*eurydice* (hw)/Sammlung Dr.K.Daniel (p)“ (ZSM); 1♂ „Croatia (p)/Collection Strasser (p)“ (ZSM).

D. (Neoduvalius) guidononveilleri Janák & Moravec, P., 2008: 1♂ Paratype labelled: „Jugoslavija, Srbija, Divčibare–sedlo, 750-900 m, 20.5.1991, V.Zieris lgt.“ (CVZ).

D. (Neoduvalius) klimeschi (Winkler, 1914): 1♀ labelled: „Dinar Alpen Troglav–Geb. A.Winkler (p)/*Neoduv. troglavensis* Wkl. (hw)“ (ZSM).

D. (Neoduvalius) kodrici (Scheibel, 1938): 1♂1♀ labelled: „Pljesevica grupe NO Lika Cro, L.Weirather, Insbruck (p)/Höhle Nr. (p) 658 (hw) grundbuch, Weirather (p)/*Neoduvalius opermanni* Schbl. (hw)“ (ZSM, CAC)

D. (Neoduvalius) langhofferi (Csiki, 1913): 1♀ labelled: „Ogulin, Tamnica potok, Donje Dubrave, 22.06.2008, B. Jalžić (hw)“ (HPM); 1♀ „Tamnica potok, D.Dubrave, Kordun, 2.03.1985, leg. Jalžić (hw)“ (HPM); 1♀ „Kordun, Mateško selo, Mijatova jama, 15. trav. 1979, Rada“ (HPM); 1♀ „Kordun, Mateško selo, Mijatova jama“ (HPM).

D. (Neoduvalius) opermanni Scheibel, 1933: 2♂♂ labelled: „CROATIA, Ogulin, Slunj, Stara Kršlja, Dumenčića špilja cave, 21.5.2012 resp. 19.9.2012, J. Lakota, B. Jalžić lgt.“ (CJL, HMP).

D. (Neoduvalius) reitteri (Miller, 1881): 1♂ labelled: „Croatia Stava. (hw)/*Reitteri* Mil.. (hw)/Coll. Mihók (p)/*Neoduvalius reitteri* Mill. (hw) Det.Dr.Bokor E. (p)“ (ZSM); 1♀ „Senjsko Bilo Cro., Winkler (p)“ (ZSM); 1♂ „Senjsko Bilo Cro., Winkler (p)/*Anophthalmus reitteri* Mill. (hw)“ (ZSM); 1♂ „*A.Reitteri* Mit. Croatien (hw)“ (ZSM); 1♂ „Ostrovica Geb. 8.7.89 (hw)/*Reitteri* (hw)“ (ZSM); 1♂ „Mogorice (hw)/Croatia (hw)/Reitteri Mill. (hw)/ Sammlung Dr.K.Daniel (p)“ (ZSM); 1♀ „Croatien Likaer Grotten Reitter 79 (p)/Sammlung Müller (p) (ZSM); 8♂♂, 7♀♀: „Bosnia, 1.8.2009, Bosanski Petrovac, Dragišića pećina cave, individually, D.Čeplík, R. Lohaj lgt.“ (CDC, CRL); 6♂♂, 7♀♀: „Croatia, Lika, Gospić, Mogorić willage env., Pčelina špilja cave, 22.5.2012, individually, D.Čeplík, B. Jalžić, J. Lakota, R. Lohaj lgt.“ (HPM, CDC, CJL, CRL).

D. (Neoduvalius) schatzmayri (J. Müller, 1912): 1♀ labelled: „Mračna pećina Prolog Bos. Novak 17.8.89 (p)/*Neoduvalius schatzmayri* J. Müll. (hw) det. F. Stöcklein 1953 (p)“ (ZSM).

D. (Neoduvalius) starivlahi Guéorguiev, B.V., Čurčić, S.B. & Čurčić, B.P.M., 2000: 1♀ labelled: Serbia, Hadži Prodanova Pećina cave, Raščići, Ivanjica, Leg. B. Mitić, 29.05.2003“ (CRL), 1♂ the same data, but Leg. S. Čurčić, 28.05.2008 (CAG).

D. (Neoduvalius) styx (Apfelbeck, 1904): 1♂ labelled: „Mrzla pec. Plitvic. jez. (hw)/ Weir. VII.39 H.658 (hw)“ (ZSM).

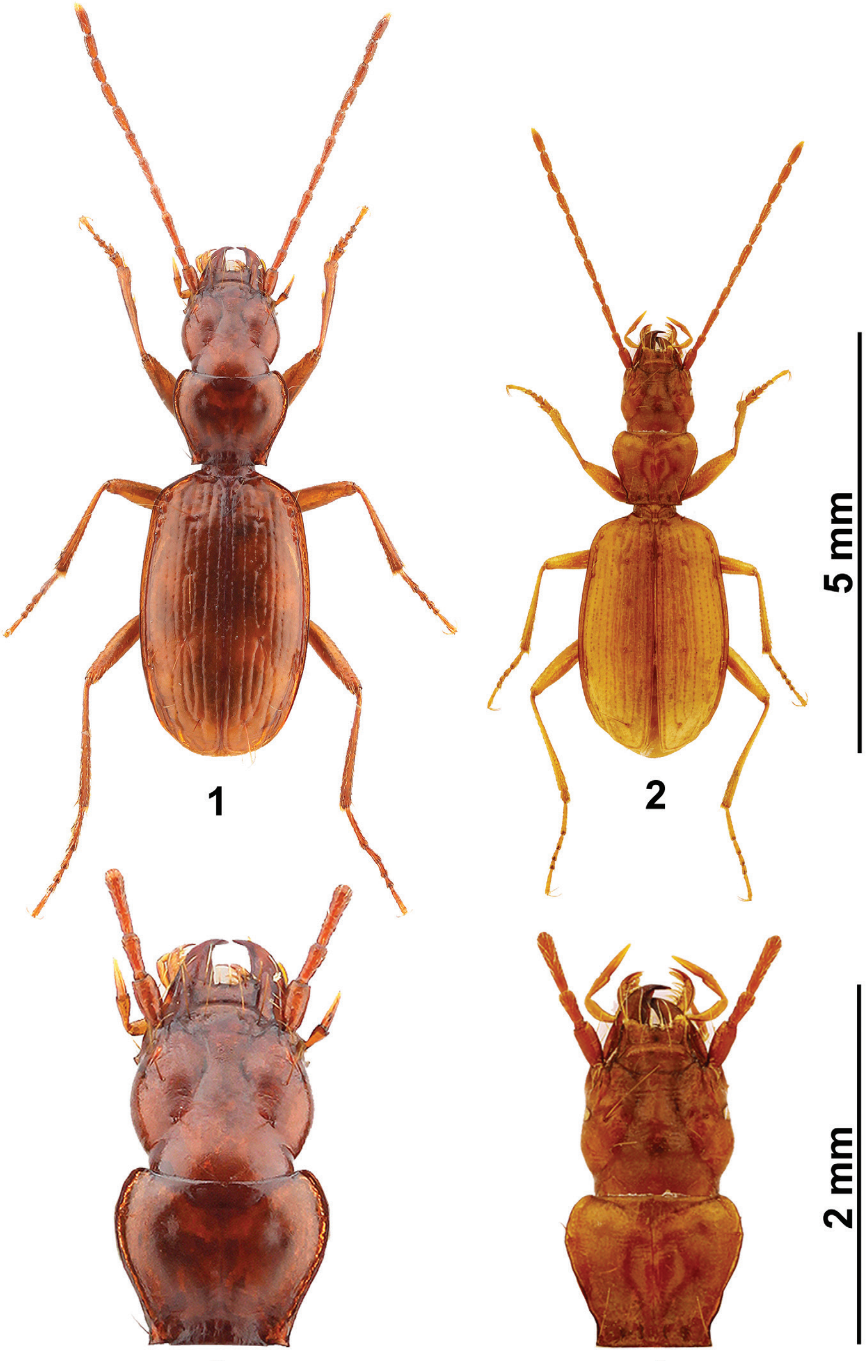
Result

Duvalius (Neoduvalius) gejzadunayi sp. n.

urn:lsid:zoobank.org:act:707EAD03-4EE3-4A13-9592-1178ADA5938C
http://species-id.net/wiki/Duvalius_gejzadunayi
Figs 1, 3, 5, 6, 7

Material examined. Holotype male labelled as follows: „MONTENEGRO, Rožaje, Donje Biševo, Pećina u Dubokom potoku cave, 17.4.–11.8. 2009 traps, R.Lohaj, D.Čeplík & G.Dunay lgt.“ (white label, printed) / „HOLOTYPUS *Duvalius (Neoduvalius) gejzadunayi* sp. n. R. Lohaj, D. Čeplík & J.Lakota det. 2011“ (red label, printed), (NMP). Paratypes: 6 ♂♂ 7 ♀♀, the same data as Holotype (CDC, CGD, CAG, CJL, CRL, CVZ). All paratypes are labelled with white, printed locality labels and with red printed labels „PARATYPUS *Duvalius (Neoduvalius) gejzadunayi* sp.nov. R. Lohaj, D.Čeplík & J.Lakota det. 2011“.

Diagnosis. A medium sized (L 5.5–6.3 mm), glabrous, depigmented, anophthalmous trechine species with the character states of the genus *Duvalius* Delarouzée, 1859 of subgenus *Neoduvalius* J. Müller, 1913 (Fig. 1). Colour reddish-brown, pronotum cordiform, transverse, head large and rounded, with deep, complete frontal



Figures 1–4. 1, 3 *Duvalius (Neoduvalius) gejzadunayi* sp. n., Holotype male, Duboki potok cave **2, 4** *Duvalius (Neoduvalius) starivlahi* Guéorguiev et al. 2000, Topotype male, Hadži Prodanova pećina cave **1, 2** habitus, dorsal view **3, 4** detail of head and pronotum.

furrows (Fig. 3), elytral stria 3 with 3–4 discal setigerous punctures. Close to *D. (Neoduvalius) starivlahi* Guéorguiev, Ćurčić, S.B. & Ćurčić, B.P.M, 2000, from which is distinguished by several different morphological features (see: Discussion).

Description. TL 5.2–6.0 mm (HT 5.3 mm). Colour reddish-brown, legs, antennae and palpi paler. Glabrous, shiny, head and pronotum with distinct isodiametric microsculpture, microsculpture of elytra with isodiametric and transverse meshes.

Head large, rounded, neck markedly distinct, HL 0.85- 0.97 mm (HT 0.87 mm), HW 1.05–1.22 mm (HT 1.08 mm), slightly narrower than pronotum, index HL/HW 0.79 - 0.81 (HT 0,80), glabrous, with distinct isodiametric microsculpture. Frontal furrows deep, complete, reaching neck constriction. Head with two pairs of long supraorbital setae, anterior pair behind middle of head length, posterior pair at hind part of head near the neck. Mandibles relatively long and slender, acutely pointed, the right one with tridentate basal teeth. Clypeus with 2 pairs of setae, labrum with three pairs. Eyes completely reduced, in some specimens present as a dark spot. Antennae long and slender, reaching almost half of elytral length, covered with dense decumbent pubescence, antennomere 3 longest, scape and antennomeres 5–10 nearly equally long.

Pronotum glabrous, slightly transverse, with maximum width in anterior fifth, PL 0.95–1.08 mm (HT 1.00 mm), PW 1.13–1.40 mm (HT 1.25 mm), index PL/PW 0.75–0.81 (HT 0.80), on base distinctly narrower than on anterior margin. Sides rounded, before hind angles sinuate, anterior angles rounded, obtuse, posterior sharply pointed. Lateral furrows well developed, deep, with two pairs of setae; anterolateral setae situated in the anterior fifth, basolateral pair before hind angles. Median furrow weakly marked, visible in middle of pronotum.

Elytra glabrous, elongate, almost parallel-sided, with maximum width in middle, EL 2.80–3.25 mm (HT 3.00 mm), EW 1.75–2.10 mm (HT 1.85 mm), index EL/EW 1.58–1.70 (HT 1.62), apically rounded. Shoulders well defined, forming obtuse angle, scutellum small, flat; single pair of basal scutellar setigerous pores present. Elytral striae 1–4 well developed, deep, striae 5 –7 vanished, reduced to rows of foveae. Elytral stria 3 with 3–4 discal setigerous punctures (formula 3 + 3, 3 + 4, 4 + 3 or 4 + 4) and pair of apical ones. Umbilicate series consists of 9 setae on both elytra, formula 4 humeral + 2 middle + 3 apical, humeral group of umbilicate pores aggregated. Ventrites 4–6 glabrous, each with pair of setae on their posterior margins, anal ventrite with pair of setae in males and females.

Legs long, slender, densely pubescent, protibiae with a deep longitudinal furrow on their dorsal side. First two tarsomeres of male protarsi distinctly dilated and toothed at their internal margins. Tarsal claws long and slender, pointed at apex.

Aedeagus (Figs 5, 6) 0.91–1.00 mm long (HT 0.97 mm), median lobe in lateral aspect regularly curved and moderately narrowed apically. Endophallus with copulatory piece widely bilobed both at base and apex, with a reduced bundle of scales in middle. Apex obtuse, widely rounded dorsaly. Parameres slender, length of parameres about half of length of aedeagus, each paramere with four thick apical setae.

Female genitalia: (Fig. 7): without peculiar features, apical segments of gonostyli elongated and slender, regularly curved, at apex pointed, with two dorsal and two ventral spines.

Figures 5–7. *Duvalius (Neoduvalius) gejzadunayi* sp. n., **5** aedeagus, left lateral aspect **6** aedeagus, dorsal aspect **7** female genitalia, ventral aspect

Etymology. Patronymic, dedicated to our dear friend Gejza Dunay (Kráľovce, Slovakia), member of our biospeleological expeditions on Balkans and one of the discoverers of this new species.

Distribution. So far known only from the type locality, Duboki potok cave near Rožaje, Montenegro.

Topographic location and ecology. Rožaje town is situated in the easternmost part of Montenegro and is surrounded by high rugged mountains exceeding 2000 m, notably Bjelasica Mts to the west, Hajla Mts and Suva planina Mts to the south and Mokra Gora Mts to the east. To the north is the more open Pešter Polje hill country.

Pećina u Dubokom Potoku cave is situated at 1180 m near the village of Dinje Biševo, 8km north of Rožaje, on the left side of a deep clough valley with the Duboki Potok (English = „deep creek") draining it. The Duboki Potok is one of the left-side confluents of Ibar river, which flows from this area to the Black Sea. The cave is inactive (without water course) with entrance of ca 1 × 1,5 m, followed by spacious hall with wet, black, clay-like humus floor, but deeper in the cave this changes to an ochre-brown sticky mud. The cave floor is littered throughout with stones, stalagmites and stalactites occur only in the furthest recesses of the cave. Total length of the cave is nearly 60 m. Type series of *Duvalius gejzadunayi* sp. n. was collected by traps baited with cheese and meat, placed in various parts of the cave.

Associated fauna

Araneae (det. A. Mock, Košice, Slovakia)
    Dysderidae sp.

Pseudoscorpionidea (det. R. Ozimec, Zagreb, Croatia)
    Neobisiidae:
        Neobisium (Blothrus) umbratile Beier, 1938

Diplopoda (det. A. Mock, Košice, Slovakia)
    Chordeumatidae:
        Melogona broelemenni (Verhoeff)

Collembola (det. Ľ. Kováč, Košice, Slovakia)
    Entomobryidae, Entomobryinae:
        Heteromurus nitidus (Templeton, 1835)
        Verhoeffiella media (Loksa et Bogojević, 1967)
    Entomobryidae, Tomocerinae:
        Tomocerus sp.
    Arrhopalitidae:
        Arrhopalites principalis Stach, 1945

Neelidae:
Megalothorax sp.

Coleoptera
Leiodidae:
Rozajella jovanvladimiri Ćurčić SB et al., 2007 (type locality)
Staphylinidae, Pselaphinae:
Bryaxis sp.

Discussion

Subgenus *Neoduvalius* includes 20 described species (see Check-list bellow), small to medium sized (4–9 mm), depigmented, glabrous, with large head, prominent temporae, strongly reduced or totally absent eyes and third elytral interval with 2–5 setigerous pores, distributed in subterranean habitats from Croatia (Mala Kapela, Lika and Plješevica) through Bosnia & Herzegovina and Serbia to Montenegro (Rožaje).

Duvalius gejzadunayi sp. n. is closely related to *D. starivlahi* Guéorguiev et al. 2000, described from Hadži-Prodanova pećina cave near Ivanjica, southwest Serbia. Both species are unique within subgenus *Neoduvalius*, characterised by peculiar combination of characters: (1) head with deep and complete frontal furrows, (2) elytral disc with 3–4 (exceptionally 5) setigerous pores. Complete frontal furrows are, except these two mentioned species, present only in *D. (N.) cvijici* Jeannel, which possess 2 elytral setigerous pores. Species with 3 elytral discal setae are shared also with *D. (N.) schatzmayri* Müller and *D. (N.)petraeus* Knirsch, but both species possess short, incomplete frontal furrows.

D. (N.) starivlahi and *D. (N.)gejzadunayi* sp. n. can be easily separated using the following key:

1(2) Head elongate, subglobose, frontal furrows very deep. Eyes reduced, composed of 8–20 ommatidia (Fig. 4). Aedeagus strongly arcuate, forming an angle of 90°, basal bulb large, apex from dorsal view sinuated and bent (see Guéorguiev et al. 2000). TL 5.1–5.7 mm. Serbia, Ivanjica.......................... .... ***D.* (*Neoduvalius*) *starivlahi* Guéorguiev et al. 2000**

2(1) Head rounded, frontal furrows shallower, eyes totally absent (Fig. 3). Aedeagus strongly elongate, apex from dorsal view widely rounded (Figs 5, 6). TL 5.2–6 mm. Montenegro, Rožaje .... ***D.* (*Neoduvalius*) *gejzadunayi* sp. n.**

Taxonomical notes on the genus *Duvalius*

During the period 2001–2003, four new Serbian genera: *Serboduvalius* Ćurčić SB et al., 2001 (based on *Serboduvalius dragacevensis* Ćurčić SB et al., 2001 and *D.* (*Neo-

duvalius) *starivlahi* Guéorguiev et al., 2000)); *Rascioduvalius* Ćurčić SB et al., 2003 (based on *D.* (*Neoduvalius*) *cvijici* Jeannel, 1923); *Javorella* Ćurčić SB et al., 2003 (based on *D.* (*Duvalius* s.str.) *suvoborensis* Pavićević and Popović, 2001) and *Curcicia* Ćurčić SB and Brajković, 2003, (based on *D.* (*Duvalius* s.str.) *bolei* Pretner, 1963) were erected based on species formerly included in the genus *Duvalius* s.l. (Ćurčić et al. 2001, Ćurčić et al. 2003a, 2003b, Ćurčić and Brajković 2003).

The aforementioned genera were based on morphological features that are present among many other species of various subgenera of *Duvalius* s.l., namely: flattened and reduced eyes (*Serboduvalius, Rascioduvalius, Javorella*); anophthalmy (*Curcicia*); presence of darkened eye border (*Serboduvalius, Rascioduvalius, Javorella*), presence of deep and complete frontal furrows (*Serboduvalius, Rascioduvalius, Javorella*), or incomplete frontal furrows (*Curcicia)*, convex or flat genae which are glabrous (*Serboduvalius, Javorella, Curcicia*); or finely pubescent (*Rascioduvalius*); first male tarsomere almost twice as long as wide or longer than wide (all genera); presence of 2 pairs of discal elytral setae (*Rascioduvalius, Javorella, Curcicia*); or 3 (rarely 2–4) pairs of discal elytral setae (*Serboduvalius*); specific position of humeral setae (all genera, note: humeral group of umbilical series in all these taxa is formed by 4 aggregated setae, as in all other *Duvalius* representatives); presence of longitudinal furrows on protibiae (*Serboduvalius, Rascioduvalius, Javorella*); absence of such furrow (*Curcicia*); specific shape of copulatory piece of median lobe of aedeagus (all genera).

Based on a thorough literature research in combination of specimen examination we conclude that the type species designated for genera *Serboduvalius, Rascioduvalius, Javorella* and *Curcicia* do not exhibit any autapomorphies or synapomorphies, respectively, which satisfactorily separate them from other representatives of *Duvalius* s.l. and warrant erection of new taxa. Therefore the following new synonyms are proposed:

Duvalius Delarouzée, 1859

= *Serboduvalius* Ćurčić, S. B., Pavićević & Ćurčić, B.P.M., 2001, **syn. nov.**

= *Rascioduvalius* Ćurčić, S. B., Brajković, Mitić & Ćurčić, B.P.M., 2003, **syn. nov.**

= *Javorella* Ćurčić, S. B. Brajković, Ćurčić, B.P.M., & Mitić, 2003, **syn. nov.**

= *Curcicia* Ćurčić S. B. & Brajković, 2003, **syn. nov.**

Check-list of the genus *Duvalius* sg. *Neoduvalius*.

Duvalius Delarouzée, 1859: 65 type species *Duvalius raymondi* Delarouzée, 1859, subgenus ***Neoduvalius*** Müller, J., 1913: 180 type species: *Anophthalmus Reitteri* L. Miller, 1881

Locality data given here is recorded in the language of the original text.

1 ***bradycephalus*** Jeannel, 1928: 549 (*Duvalius*, TL: Herzégovine)
= *hercegovinensis* Knirsch, 1926c: 62 (*Neoduvalius*, TL: »Herzegovina«)
Distribution: Bosnia & Herzegovina

2 ***cvijici cvijici*** Jeannel, 1923: 10 (*Duvalites*, TL: Murtenica planina, vers 1100m. d'alt., en forêt, comm. de Bela Rjeka, département d'Užice (Serbie occidentale))
Distribution: Serbia (Užice, Murtenica plateau)

cvijici stopicensis Jeannel, 1923: 11 (*Duvalites*, TL: grotte Stopića pećina, à Rožanstvo, département d'Užice (Serbie occidentale))
Distribution: Serbia (Užice, Zlatibor Mts)

3 ***cuniculinus*** Knirsch, 1929: 86 (*Neoduvalius*, TL: Crna-gora (Herc.)
Distribution: Bosnia & Herzegovina (Glavatićevo)

4 ***dragacevensis*** Ćurčić ,S.B., Pavičevć & Ćurčić, B.P.M., 2001: 53 (*Serboduvalius*, TL: Mala Pećina Cave, village Rti, near Kotraža, the Dragačevo Mts, southwestern Serbia)
Distribution: Serbia (Ivanjica, Dragaćevo Mts)
Note: This species was described based on set of 9 specimens (7 males, 2 females) collected in Mala pećina cave near willage Kotraža. This locality is situated ca 10 km from Hadži-Prodanova pećina cave, type locality for *D. (N.) starivlahi* Guéorguiev et al. Based on presented morphological differencies it is very probable that these two species are conspecific.

5 ***eurydice*** Schaufuss, 1881: 86 (*Anophthalmus*, TL: in cavernis Croatiae [=Špilja u Lici (=Špilje Like) (Bedek et al., 2006: 73)])
Distribution: Croatia (Lika)

6 ***gejzadunayi* sp. n.,** TL: Montenegro, Rožaje, Donje Biševo, Pećina u Dubokom potoku cave
Distribution: Montenegro (Rožaje)

7 ***guidononveilleri*** Janák & Moravec, P., 2008: 12 (*Duvalius*, TL: Jugoslavija, Srbija: Maljen, Divčibare-sedlo, 700-800m)
Distribution: Serbia (Maljen plateau)

8 ***humerosus*** Knirsch, 1926: 63 (*Neoduvalius*, TL: Prenj-planina in cca. 1400 m)
Distribution: Bosnia & Herzegovina (Prenj Mts)

9 ***klimeschi*** Winkler, 1914: 171 (*Trechus*, TL: Troglavgebiet (Dinarische Alpen) an der dalmatinisch-bosnischen Grenze in zirka 1500 Meter Höhe)
Distribution: (Croatia, Bosnia & Herzegovina)–Mt. Troglav

10 ***kodrici*** Scheibel, 1938: 221 (*Neoduvalius*, TL: Plitvička–Plješevica, Kočevlje (Gotschee))
Distribution: Croatia–Mala Kapela Mts, Plješevica Mts (Pretner 1973: 171)

11 ***langhofferi*** Csiki, 1913: 386 (*Anophthalmus*, TL: Croatia: in antro prope Josipdol a Dom [=Špilja u Mekoti (=Plandište jama) (Bedek et al., 2006: 73)])
Distribution: Croatia (Ogulin)

12 ***neumanni*** Müller, J., 1911 1 (*Trechus*, TL: Höhle „Dragišica" bei Petrovac (Bosnien) [=Dragišići pećina])
Distribution: Bosnia & Herzegovina (Bosanski Petrovac, Dragišići)

13 ***opermanni*** Scheibel, 1933: 241 (*Duvalius*, TL: Höhle nächst Rakovica in Kroatien [=Dumenčića špilja (Bedek et al., 2006: 21)])
Distribution: Croatia (Rakovica, Slunj)

14 ***petraeus*** Knirsch, 1927: 51 (*Neoduvalius*, TL: Muharnica-planina. Süd.-Bosn.)

Distribution: Bosnia & Herzegovina (Muharnica Mts)

15 ***reitteri*** Miller, 1881: 203 (*Anophthalmus*, TL: Grotte bei Mogorice, Südkroatien, im Likaner Reg. [=Pčelina špilja (Buljmize, Mogorić, Gospić) (Bedek et al., 2006: 46)])
= *acherontius* Schaufuss, 1881: 36 (*Anophthalmus*, TL: in cavernis Croatiae) synonymy in Heyden, 1883: 10
Distribution: Croatia (Lika), Bosnia & Herzegovina (Bosnia)

16 ***schatzmayri*** Müller, J., 1912: 297 (*Trechus*, TL: Höhle des Prologgebirges an der bosnisch-dalmatinischen Grenze [=Mračna pećina (Pretner 1973: 172)])
Distribution: Bosnia & Herzegovina/Croatia (Dalmatia): Prolog Mts

17 ***starivlahi*** Guéorguiev, B.V., Ćurčić, S.B. & Ćurčić, B.P.M., 2000: 227 (*Duvalius*, TL: Hadži-Prodanova Pećina Cave, v. Raščići, near Ivanjica, cca 650 m)
Distribution: Serbia (Ivanjica)

18 ***styx*** Apfelbeck, 1904: 139 (*Trechus*, TL: Bosnien, Höhle bei Vacar Vakuf (Zentral-Bosnien))
Distribution: Bosnia & Herzegovina (Mrkonjic Grad), Croatia (Mala Kapela Mts, Plitvicka jezera, Medvedjak) (Pretner 1973: 172)

19 ***vranensis*** Breit, 1904: 28 (*Trechus*, TL: Höhle des Vran-Gebirges in der Herzegovina [=Mijatova jama (Hauser, 2011: 117)])
Distribution: Bosnia & Herzegovina (Vran Mts)

20 ***zlatiborensis*** Ćurčić S. B., Brajković, Ćurčić, B. P. M., 2005: 65 (*Rascioduvalius*, TL: Markova (=Ršumska) Pećina cave, village of Gornji Ljubiš, Mt. Zlatibor, Western Serbia)
Distribution: Serbia (Užice, Zlatibor Mts)
Note: This species was described based on two females collected in Markova pećina cave, which is very close (ca 10 km) to Stopića pećina cave, type locality for *D. (N.) cvijici stopicensis* Jeannel and ca 2 km to Murtenica planina Mts., type locality for *D. (N.) cvijici cvijici* Jeannel. Based on presented morphological differencies it is very probable that all these taxa are conspecific, inhabiting both caves and MSS of the region of Zlatibor and Murtenica Mts.

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Several errors came to our attention after our manuscript was published, which we address here. First, we uploaded the wrong table for Appendix C, which was supposed to have verbose descriptions of material examined. We also neglected to provide complete repository names for the museum codens. We regret these errors and provide these data here in Table 1 and in an updated Appendix C.

At least one reader was confused about our observations of type specimens and the subsequent designation of *Evaniscus sulcigenis* Roman, 1917 as a junior subjective synonym of *Evaniscus rufithorax* Enderlein, 1905. We observed the type specimen of *E. sulcigenis* directly (specimen data in the corrected Appendix C below; see also Figs 1, 2) and neglected to include that declaration and the listing of *E. sulcigenis* as a junior subjective synonym in the taxonomic treatment of *E. rufithorax*.

Table 1. Specimen repositories from Mullins et al. 2012.

Coden	Repository name, address	Facilitator
AEIC	American Entomological Institute, Gainesville, FL, USA	David Wahl
BMNH	The Natural History Museum [formerly British Museum (Natural History)], London, UK	David Notton
NCSU	NCSU Insect Museum, North Carolina State University, Raleigh, NC, USA	Bob Blinn
HNHM	Hungarian Natural History Museum, Budapest, Hungary	Csősz Sándor
INPA	Instituto Nacional de Pesquisas da Amazoonia, Colecão Sistemática da Entomologia, Manaus, Amazonas, Brazil	Augusto Loureiro Henriques
MPEG	Museu Paraense Emilio Goeldi, Belém, Pará, Brazil	Orlando Tobias Silveira
ZMPA	Polish Academy of Science, Museum of the Institute of Zoology, Warsaw, Poland	Wioletta Tomaszewska
USNM	National Museum of Natural History [formerly United States National Museum], Washington, DC, USA	David Smith
NHRS	Naturhistoriska Riksmuseet, Stockholm, Sweden	Bert Viklund
ZMHB	Museum für Naturkunde der Humboldt-Universität, Berlin, Germany	Frank Koch
MZSP	Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil	Carlos Roberto Ferreira Brandão
MIUP	Universidad de Panamá, Museo de Invertebrados Graham B. Fairchild, Panama City, Panama	Diomedes Quintero
CAS	California Academy of Sciences, San Fransisco, CA, USA	Robert Zuparko
MZLU	Museum of Zoology, Lund University, Sweden	Roy Danielsson
UCDC	Bohart Museum, University of California, Davis, CA, USA	Steve Heydon
INHS	Illinois Natural History Survey, Champaign, IL, USA	Colin Favret (now Dmitry A. Dmitriev)
TAMU	Texas A & M University Insect Collection, College Station, TX, USA	Edward Riley
INBC	Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica	Carlos Víquez
IAVH	Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, Bogotá D.C., Colombia	Fernando Fernandez

Finally, a number of typos persisted in the manuscript despite our intention to properly vet the taxonomic treatments. We offer our corrections to help resolve any confusion:

Our database had two entries for each type specimen, and so the type data was listed twice in each treatment. This error has been fixed in the database.

Pseudevania is not a misspelling of *Evaniscus* but rather a junior objective synonym (Deans 2005). This error has been fixed in the database.

The type specimens for *Evaniscus marginata* (Cameron, 1887) and *Evaniscus tibialis* Szépligeti 1903 are not necessarily holoypes. Neither Cameron nor Szépligeti explicitly designate holotypes, nor did they list all specimens examined in their treatments of these species. Each type specimen is deposited at the taxonomist's home institution (BMNH for Cameron and HNHM for Szépligeti), and we are unaware of any other specimens that would have been available for observation at the time.

The repository for the holotype of *Evaniscus lansdownei* Mullins should be IAVH, not NCSU.

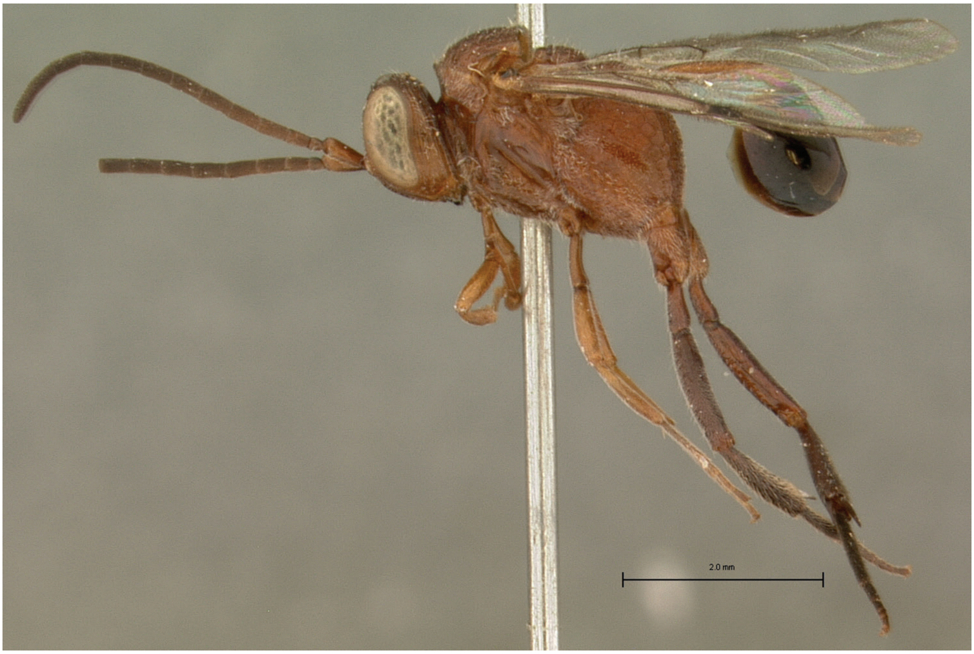

Figure 1. *Evaniscus sulcigenis* Roman, 1917. Lateral habitus (whole body) of holotype.

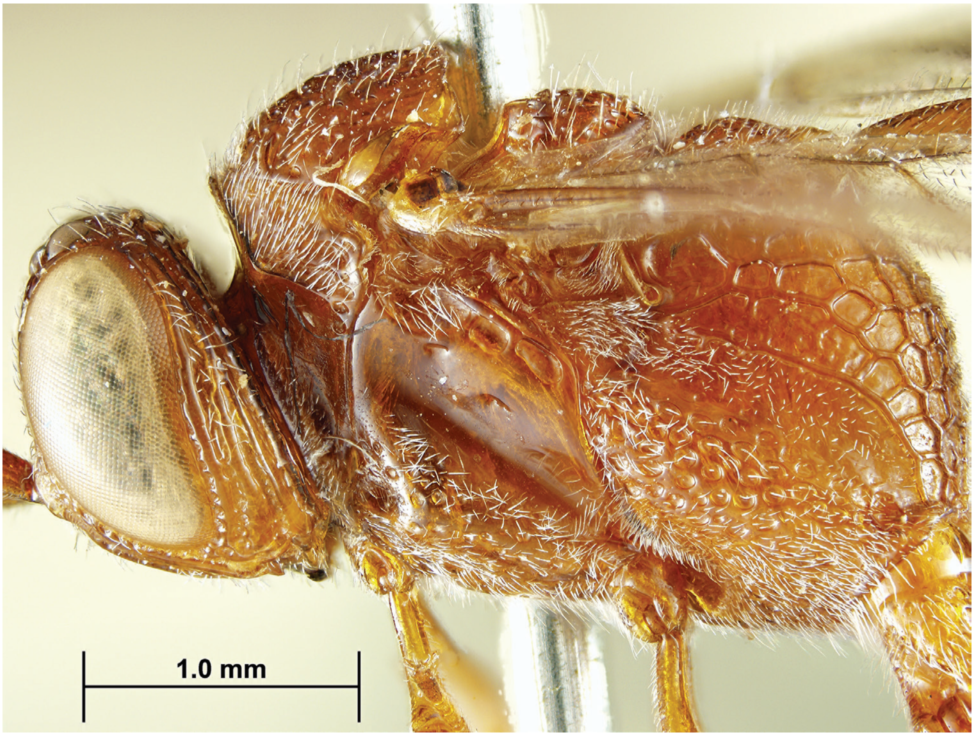

Figure 2. *Evaniscus sulcigenis* Roman, 1917. Lateral habitus (mesosma and head) of holotype.

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Appendix C

Verbose export of specimens examined.

Evaniscus lansdownei Mullins, 2012.

Identifier(s)	Repository	Sex	Collecting event
NCSU 33809	IAVH	male	COLOMBIA-AMAZONAS Mata Mata Sta., Tierra Firme Mar 8-12 2000 Sweep, Sharkey {HOLOTYPE}
NCSU 67242	INPA	male	BRASIL: Amazonas Balawa-u, 30Km NW of Parque Nacional Parima Tapirapecó -1.8069 -63.7844 14.ix.1995 Malaise LS Aquino col {PARATYPE}.

Evaniscus marginatus (Cameron, 1887).

Identifier(s)	Repository	Sex	Collecting event
NCSU 53033; DERV 052	INBC	male	Costa Rica: Prov. Guanacaste: Bosque N. Diriá, Retallano, Alred. Torre de Control de Incendio: 600-700m, 15.xi-16.xii.2001, I. Jimenez, Malaise L_N_238550_358650 #66658
NCSU 9894	TAMU	female	Mexico: Oaxaca, 9 miles ne. Mitla July 20, 1985 Jones, Schaffner
NCSU 9893	UCDC	male	Costa Rica: Guanacaste Prov. near Cañas, 19.VIII.1992 F. D. Parker, MT
NCSU 9892	AEIC	female	S. Rosa Park, Guan., C. Rica 22 Feb. 77 D. H. Janzen, riparian
NCSU 41748	USNM	female	ECUADOR: NAPO Res. Ethnica Waorani, 1km S. Onkone Gare Camp, Trans.Ent. 12 Jan. 1994 220m 00°39’10”S 076°26”W T.L. Erwin, et. al Insecticidal fogging of mostly bare green leaves, some with covering of lichenous or bryophytic plants in terre firme forest. At Trans. 10, Sta. 2 Project MAXUS Lot 562 USNM 2027843
NCSU 67240	MZSP	female	BRASIL Piauí Floriano -6.7651 -43.0257 05-12.xi.1992 Malaise Amarante, Brandão, Cancello, Moutinho & Ponte, col.
	BMNH	female	COSTA RICA: Guanacaste Pv. Sta. Rosa NP Sn. Emilio-8-C Janzen & Gauld 10-31.i.1987

Identifier(s)	Repository	Sex	Collecting event
	BMNH	female	COSTA RICA: Guanacaste Pv. Sta. Rosa NP Sn. Emilio-8-C Janzen & Gauld 2-23.iii.1986
	BMNH	female	COSTA RICA: Guanacaste Pv. Sta. Rosa NP Sn. Emilio-6-C Janzen & Gauld 13.vii-3.viii.85
	BMNH	female	COSTA RICA: Guanacaste Pv. Sta. Rosa NP Bosq. Hum-12-C Janzen & Gauld 29.xi.-20.xii.1986
NCSU 67241	MZSP	female	BRASIL Piauí Floriano -6.7651 -43.0257 05-12.xi.1992 Malaise Amarante, Brandão, Cancello, Moutinho & Ponte, col.

Evaniscus rafaeli Kawada, 2012.

Identifier(s)	Repository	Sex	Collecting event
NCSU 67243	INPA	female	BRASIL Amazonas Manaus Reserva [Florestal Adolpho] Ducke -2.9558 -59.9222 07-21.xi.1994 Arm. suspensa 20m, Torre JA Rafael & J Vidal col. {PARATYPE}
NCSU 67244	MZSP	female	BRASIL Amazonas Manaus Reserva [Florestal Adolpho] Ducke -2.9558 -59.9222 06-20.x.1994 Arm. suspensa 10m, Torre JA Rafael & J Vidal col. {PARATYPE}
NCSU 67245	INPA	female	BRASIL Amazonas Manaus Reserva [Florestal Adolpho] Ducke, 26 Km NE Manaus -2.9558 -59.9222 22.ix.1988 Arm. suspensa 21m JA Rafael col. {HOLOTYPE}
NCSU 67246	INPA	female	BRASIL Amazonas Manaus Reserva [Florestal Adolpho] Ducke, 26 Km NE Manaus -2.9558 -59.9222 06.x.1988 Arm. suspensa 15m JA Rafael col. {PARATYPE}

Evaniscus rufithorax Enderlein, 1905.

Identifier(s)	Repository	Sex	Collecting event
NCSU 41750	AEIC	male	Amazonas, Brazil 71°38'W, 4°33'S IX.1979 Alvarenga
DERV 010b	AEIC		Amazonas, Brazil 71°38'W, 4°33'S IX.1979 Alvarenga
NCSU 2400	AEIC	male	Sinop, M. Grosso 12°31'S, 55°37'W, Oct.1976 Brazil M. Alvarenga
NCSU 2399	AEIC	male	Sinop, M. Grosso 12°31'S, 55°37'W, Oct.1976 Brazil M. Alvarenga
NCSU 2398	AEIC	male	Sinop, M. Grosso 12°31'S, 55°37'W, Oct.1976 Brazil M. Alvarenga
NCSU 2397	AEIC	male	Sinop, M. Grosso 12°31'S, 55°37'W, Oct.1976 Brazil M. Alvarenga
NCSU 2396	AEIC	male	Sinop, M. Grosso 12°31'S, 55°37'W, X.1974 Brazil M. Alvarenga
NCSU 2395	AEIC	male	Sinop, M. Grosso 12°31'S, 55°37'W, X.1974 Brazil M. Alvarenga
NCSU 2394	INHS	male	Peru: Madre de Dios: Tambopata Preserve, 270m, 22-30-V-1995 S. Cameron, J. Whitfield, rainforest
NCSU 2393	INHS	male	Peru: Madre de Dios: Tambopata Preserve, 270m, 22-30-V-1995 S. Cameron, J. Whitfield, rainforest
NCSU 2392	INHS	male	Peru: Madre de Dios: Tambopata Preserve, 270m, 22-30-V-1995 S. Cameron, J. Whitfield, rainforest
NCSU 2391	INHS	male	Peru: Madre de Dios: Tambopata Preserve, 270m, 22-30-V-1995 S. Cameron, J. Whitfield, rainforest
NCSU 7000	AEIC	female	Napo & Coca Rivers, V.2-10-65 Ecuador, Luis Peña
NCSU 6999	AEIC	male	Napo & Coca Rivers, V.2-10-65 Ecuador, Luis Peña
NCSU 6998	AEIC	male	Napo & Coca Rivers, V.2-10-65 Ecuador, Luis Peña
NCSU 6997	AEIC	male	Napo & Coca Rivers, V.2-10-65 Ecuador, Luis Peña

NCSU 6996	AEIC	female	Napo & Coca Rivers, V.2-10-65 Ecuador, Luis Peña
NCSU 6995	AEIC	male	Napo & Coca Rivers, V.2-10-65 Ecuador, Luis Peña
NCSU 6994	AEIC	male	Napo & Coca Rivers, V.2-10-65 Ecuador, Luis Peña
NCSU 6993	AEIC	male	Coca & Napo Rivers, V.1-12.65 Ecuador Luis Peña
NCSU 6992	AEIC	female	Coca & Napo Rivers, V.1-12.65 Ecuador Luis Peña
NCSU 6991	AEIC	male	Cumbaratza (E) XI.21.70 Ecuador Luis E. Peña
NCSU 6990	AEIC	female	Coca Ecuador May 1965 Luis Peña
NCSU 6989	AEIC	male	Coca Ecuador May 1965 Luis Peña
NCSU 6988	AEIC	male	Coca Ecuador May 1965 Luis Peña
NCSU 6987	AEIC	male	Coca Ecuador May 1965 Luis Peña
NCSU 6986	AEIC	male	Coca Ecuador May 1965 Luis Peña
NCSU 6985	UCDC	male	Ecuador: Prov. Mor. Santiago, Miazal 50km se. Macas, 4-7.I.1993 300m M. & J. Wasbauer
NCSU 6984	UCDC	female	Ecuador: Prov. Mor. Santiago, Miazal 50km se. Macas, 4-7.I.1993 300m M. & J. Wasbauer
NCSU 6983	UCDC	male	Ecuador: Prov. Mor. Santiago, Miazal 50km se. Macas, 4-7.I.1993 300m M. & J. Wasbauer
NCSU 6982	UCDC	male	Ecuador: Prov. Mor. Santiago, Miazal 50km se. Macas, 4-7.I.1993 300m M. & J. Wasbauer
NCSU 6981	UCDC	female	Ecuador: Prov. Mor. Santiago, Miazal 50km se. Macas, 4-7.I.1993 300m M. & J. Wasbauer
NCSU 6980	UCDC	female	Ecuador: Prov. Mor. Santiago, Miazal 50km se. Macas, 4-7.I.1993 300m M. & J. Wasbauer
NCSU 6979	UCDC	male	Ecuador: Prov. Mor. Santiago, Miazal 50km se. Macas, 4-7.I.1993 300m M. & J. Wasbauer
NCSU 6978	USNM	male	Ecuador: Napo, Res. Ethnica Waorani, 1km S. Onkone Gare Camp, Trans. Ent. 30Jun 1995, 220m, 00°39' 10”S, 076°26'W, T. L. Erwin et al. insecticidal fogging of mostly bare green leaves, some with covering of lichenous or bryophytic plants in terre firma forest, At trans.8, Sta. 9 Project MAXUS Lot 1079
NCSU 6977	AEIC	female	Ecuador: Napo forest, E. Coca, March 6, 1983, Lars Huggert
NCSU 6976	AEIC	male	Ecuador: Napo forest, E. Coca, March 6, 1983, Lars Huggert
NCSU 6975	INHS	male	Ecuador: Orellana, Yasuni Biological Station, 3-7 VII-2000, S. Cameron, J. Whitfield
NCSU 6974	AEIC	male	Ecuador: Napo, S. Sacha, III.7.83, Lars Huggert
NCSU 6973	AEIC	male	Ecuador: Napo, Sacha, III.5.83, Lars Huggert
NCSU 6972	AEIC	male	Ecuador: Napo, P. Misahuelli, Feb. 20, 1983, Lars Huggert
NCSU 6971	AEIC	male	Ecuador: Napo, Tena, II.16.83, Lars Huggert
NCSU 6970	AEIC	male	Ecuador: Napo, Tena, II.16.83, Lars Huggert
NCSU 6969	AEIC	female	Ecuador: Napo, Sacha, III.7.83, Lars Huggert
NCSU 6968	AEIC	male	Amazonas, Brazil 71°38'W, 4°33'S IX.1979 Alvarenga
NCSU 6967	AEIC	female	Tucuruí, Pará I.1979 Brazil M. Alvarenga
NCSU 9891	AEIC	male	Avispas, Perú 30m nr. Marcapata Oct. 20-30, 1962 Luis Peña
NCSU 9890	AEIC	female	Avispas, Perú 30m nr. Marcapata Sept. 1962 Luis Peña
NCSU 9889	UCDC	male	Brazil: RO Fazenda Rancho Grande 62km s. Ariquemes, 12-22. XI.1991 E. M. Fischer
NCSU 9888	UCDC	male	Brazil: RO Fazenda Rancho Grande 62km s. Ariquemes, 12-22. XI.1991 E. M. Fischer
NCSU 9887	AEIC	male	Peru: Loreto Iquitos II.7.84 Lars Huggert
NCSU 9886	AEIC	male	Peru: Junin Satipo I-23-84 Lars Huggart
NCSU 18399	MZLU	male	Peru: Junin Satipo I-23-84 Lars Huggart

NCSU 18398	MZLU	female	Peru: Junin, Satipo 21-I-1984 leg. Lars Huggert
NCSU 41741	NCSU	male	COLOMBIA Putumayo PNN La Paya Bocana Mamansoya 0°6'S, 74°58'W, 330m Red 23.ix.2001 D. Campos, leg. M.2092
NCSU 41742	NCSU	male	COLOMBIA Putumayo PNN La Paya Bocana Mamansoya 0°6'S, 74°58'W, 330m Red 23.ix.2001 D. Campos, leg. M.2092
NCSU 33582	NCSU	male	COLOMBIA Putumayo PNN La Paya Cabana La Paya 0°2'S, 75°12'W, 330m Red. 25.ix.2001 D. Campos, leg. M.2083
NCSU 67257	INPA	male	BRASIL Amazonas S. Izadel. R. Negro, Maturaca 11-13.x.1990 Malaise JA Rafael col.
NCSU 67258	INPA	male	BRASIL Roraima Ilha de Maracá Rio Ura 3.2589 -60.9889 21-30.xi.1987 fogging JA Rafael & equipe col.
NCSU 67259	INPA	male	BRASIL Pará Alter do Chão 09-11.ix.1991 Malaise JA Rafael col.
NCSU 67260	INPA	male	BRASIL Rondônia Nova Mamoré Parque Estadual de Guajará Mirim, Rio Formoso, Terra firme -10.3239 -64.6578 22.x.1995 J Vidal & LS Aquino col.
NCSU 67261	INPA	male	BRASIL Amazonas Tabatinga 13-17.iv.1992 Malaise J Vidal & Lilian col.
NCSU 67262	INPA	male	BRASIL Amazonas Tabatinga 13-17.iv.1992 Malaise J Vidal & Lilian col.
NCSU 67263	INPA	male	BRASIL Amazonas Tabatinga 13-17.iv.1992 Malaise J Vidal & Lilian col.
NCSU 67264	INPA	male	BRASIL Amazonas Tabatinga 13-17.iv.1992 Malaise J Vidal & Lilian col.
NCSU 67265	INPA	female	BRASIL Amazonas Manaus ZF03 Km 23, Fazenda Estelo, Reserva 1208 (RLE) -2.3761 -59.8775 viii.1986 Malaise Bert Klein col.
NCSU 67266	INPA	female	BRASIL Amazonas Borba Rio Abacaxis, Paxiúba -4.4800 -58.5733 02-04.vi.2008 Malaise JA Rafael & equipe col.
NCSU 67267	INPA	male	BRASIL Amazonas Manaus Reserva [Florestal Adolpho] Ducke, Igarapé Acará, Rod[ovia] AM-010, Km 26 x.2001 Malaise JF Vidal
NCSU 67268	INPA	male	BRASIL Amazonas Manaus Reserva [Florestal Adolpho] Ducke, Igarapé Tinga -2.9560 -59.9223 iii.2003 Malaise, JMF Ribeiro
NCSU 67269	INPA	female	BRASIL Amazonas Manaus Reserva [Florestal Adolpho] Ducke, Igarapé Tinga -2.9560 -59.9223 iii.2003 Malaise, JMF Ribeiro
NCSU 67270	INPA	female	BRASIL Amazonas Manaus Reserva [Florestal Adolpho] Ducke, Igarapé Ipiranga -2.9560 -59.9223 iv.2003 Malaise JMF Ribeiro
NCSU 67271	INPA	male	BRASIL Amazonas Parque Nacional do Jaú, Rio Unini -1.7317 -61.9089 20-24.vi.1996 Malaise AL Henriques, JF Vidal & FL Oliveira col.
NCSU 67272	INPA	male	BRASIL Amazonas Manaus Reserva [Florestal Adolpho] Ducke, Igarapé Acará -2.9560 -59.9223 05.viii.1993 Malaise JF Vidal col.
NCSU 67273	INPA	male	BRASIL Maranhão Serra Esplanada 07.xii.2001 Malaise JA Rafael & equipe col.
NCSU 67274	CAS	male	PERU Monzon Valley Tingo Maria 23.ix.1954 EI Schlinger & ES Ross col.
NCSU 67275	CAS	male	PERU Madre de Dios Rio Tambopata Reserve, 20 air Km SW of Puerto Maldonato, 290m 01-26.xi.1982 ER Ross col.
NCSU 67276	CAS	female	PERU Monzon Valley Tingo Maria 02.ix.1954 EI Schlinger & ES Ross col.
NCSU 67277	MIUP	male	PERU Madre de Dios Est. Pakitza, Res. Manu 10.vi-06.vii.1993 R Cambra & T Amarilla
NCSU 67278	MIUP	male	PERU Madre de Dios Est. Pakitza, Res. Manu 10.vi-06.vii.1993 R Cambra & T Amarilla
NCSU 67279	INPA	female	BRAZIL Amazonas [Manaus] AM: 010. Km. 31 Embrapa, colheita de cacau 27.iii.1991 Shannon (isca de fruta) LP Albuquerque & JE Binda col.
NCSU 67287	MZSP	male	BRASIL Rondônia Porto Velho, Rio Madeira 11-19.v.2010 RR Silva & RM Feitosa Malaise

NCSU 67288	MZSP	male	BRASIL Rondônia Porto Velho, Rio Madeira 11-19.v.2010 RR Silva & RM Feitosa Malaise
NCSU 67289	MZSP	male	BRASIL Rondônia Porto Velho, Rio Madeira 11-19.v.2010 RR Silva & RM Feitosa Malaise
NCSU 67290	MZSP	male	BRASIL Rondônia Porto Velho, Rio Madeira 11-19.v.2010 Light Trap F. Albertoni
NCSU 67280	MPEG	male	BRASIL Pará Benevides PA 408 Km 06 -1.3608 -48.2267 23.vi.1981 flight trap LS Gorayeb col.
NCSU 67281	MPEG	male	BRASIL Pará Xingu Rio Xingu, Ilha Boa Vista, 600 m da trilha -2.2000 -51.0167 20-24.xi.2007 Malaise
NCSU 67282	MPEG	male	BRASIL Pará Xingu Rio Xingu, Bom Jardim -2.3742 -51.011 22.xi.2007
NCSU 67283	MPEG	male	BRASIL Pará Primavera Quaitipura, Fazenda Feitosa -0.9419 -47.1178 28-30.xi.1992 armadilha suspensa (4 m) J Dias col.
NCSU 67284	MPEG	male	BRASIL Pará Juruti estrada p/o Mutum -2.1520 -56.0870 30.xi.2008 Malaise(4)
NCSU 67285	MPEG	female	BRASIL Pará Altamira Rio Xingu, A1. Itapuama, S. Antonio -7.5450 -54.7120 19-23.viii.2008 Malaise (4) OT Oliveira, SS Silva, JO Dias col.
NCSU 67286	MPEG	female	BRASIL Pará Xingu área- [Santo] Antonio -7.5450-54.7120 06-11.xi.2007 Malaise(1)
	BMNH	male	Suriname: Marowijne River vii.1965 E.A.M. Gale Cambridge Exped. B.M. 1965-516 E. rufithorax Enderlein 1905 det. by M.Huben 1995 ID#0301.17 (male) BMNH
	BMNH	male	MAZARUNI: 2nd growth (Low Forest) 16.viii.1937 BRITISH GUIANA: Coll. Richards & Smart B.M. 1937-776 Evaniscus rufithorax Enderlein 1905 det.M. Huben 1995 ID# 0301.18 (male) BMNH
	BMNH	male	PERU: Loreto Pucallpa 12.vi.1962 J.M. Schunke B.M. 1962-491 Evaniscus, Huben 1992
	BMNH	male	PERU: Loreto Pucallpa 5.viii.1963 J.M. Schunke B.M. 1962-565
	BMNH	male	Forested eastern foothills of the Andes, 2000 ft. PERU: Tingo Maria 1 km. E. of town Malaise trap, dense woodland 13.viii.1971
	ZMHB	male	Bolivia Mapiri Staudinger, V.
	ZMHB	male	Bolivia Mapiri Staudinger, V.
	ZMHB	male	Peru Pachitea-Fluss Staudinger, V.
NCSU 36699	NCSU	female	COLOMBIA Putumayo PNN La Paya Cabana La Paya 0°2'S 75°12'W 330m Malaise 24-25.ix.2001 E. Lozano, leg. M.2074
	ZMPA	male	Bolivia Mapiri Staudinger, V.

Evaniscus sulcigenis Roman, 1917

Identifier(s)	**Repository**	**Sex**	**Collecting event**
NCSU 9895	NHRS	male	Manaos 1914. Bosque Municipal, nordwestlich der Stadt

Evaniscus tibialis Szépligeti, 1903

Identifier(s)	Repository	Sex	Collecting event
NCSU 9896	USNM	male	Tamana Caves, Trinidad B. W. I. 3-XII-66 J. Darlington I1d*, on rocks in tunnel to bat chamber
NCSU 41747	USNM	male	Tamana Caves, Trinidad B. W. I. 4-III-66 J. Darlington I1b*c*, on rocks in tunnel to bat chamber
NCSU 41746	USNM	male	Tamana Caves, Trinidad B. W. I. 24-III-66 J. Darlington I1e*, on rocks in tunnel to bat chamber
NCSU 41745	USNM	female	[no label, but based on specimen preparation and point type it appears to be from same series as NCSU 41746: Tamana Caves, Trinidad B. W. I. J. Darlington, on rocks in tunnel to bat chamber]
	HNHM	female	Merida Venezuela 539 135 Evaniscus tibialis Szepl. id.nr.015742 HNHM Hym. Coll. {labeled as”holotype”}
NCSU 67247	INPA	female	BRASIL Amazonas Manaus ZF-2 07-21.xi.1994 Arm. suspensa 1,5m, Torre JA Rafael & J Vidal col.
NCSU 67248	INPA	male	BRASIL Amazonas Manaus Reserva [Florestal Adolpho] Ducke, 26 Km NE Manaus -2.9558 -59.9222 08-10.viii.1981 arb. flight trap, 1-2m
NCSU 67249	INPA	female	BRASIL Amazonas Manaus Reserva [Florestal Adolpho] Ducke, Igarapé Tinga -2.9558 -59.9222 10-20.v.2004 Malaise AL Henriques col.
NCSU 67250	INPA	female	BRASIL Amazonas Novo Airão/Barcelos Parque Nacional do Jau, Rio Unini -1.7317 -61.9089 20-24.vi.1996 Malaise AL Henriques, J Vidal, FL Oliveira col.
NCSU 67251	INPA	male	BRASIL Amazonas Manaus ZF03 Km 23, Fazenda Estelo, Reserva 1112 (RLO) -2.4339 -59.8542 vii.1986 Malaise Bert Klein col.
NCSU 67252	INPA	male	BRASIL Amazonas Manaus ZF03 Km 23, Fazenda Estelo, Reserva 1112 (RLO) -2.3922 -59.8775 ix.1986 Malaise Bert Klein col.
NCSU 67253	INPA	female	BRASIL Amazonas Manaus ZF03 Km 23, Fazenda Estelo, Reserva 1208 (RCN) -2.3761 -59.8775 08-15.22.iv.1987 Malaise Bert Klein col.
NCSU 67256	MPEG	male	BRASIL Pará Altamira Bom Jardim -5.0010 -54.0880 07-10.viii.2008 Malaise(10)
	BMNH	male	4383 BRITISH GUYANA: Essequibo R., Moraballi Creek 18.x.1929 Oxf. Univ. Expedn. B.M. 1929-435 Evaniscus tibialis Szepligeti 1903 det. M. Huben 1995 ID# 0227.6
	BMNH	male	967 BRITISH GUYANA: Essequibo R., Moraballi Creek 27.viii.1929 Oxf. Univ. Expedn. B.M. 1929-485
NCSU 67254	INPA	male	Brazil: Pará São João do Pirabas, Japerica 16-18.xii.1992 armadilha 1.6m suspensa J Dias col.
NCSU 67255	INPA	male	Brazil: Amazonas: Manaus ZF03 Km 23, Fazenda Estelo, Reserva 1208 (RCN) 2°22’34”S, 59°52’39”W 08-15.iv.1987 Malaise Bert Klein col