The systematics and biogeography of Australian Hydroptilidae (Trichoptera)

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DECLARATION

This thesis contains no material which has been accepted for the award of any other degree or diploma in any University and, to the best of my belief, contains no material previously published or written by any other persons, except where due reference is made in the text. Upon the award of the Doctor of Philosophy Degree, I consent to this thesis being made available for photocopying and loan.

17 March 1986

To the memory of my father,

Keith Woodroffe.

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ABSTRACT

An analysis of the systematics and biogeography of the Australian Hydroptilidae (Trichoptera) is presented, based on a core of descriptions of 101 species revised from the works of Mosely (8 spp.), Neboiss (6) and the author, Wells (87). Collections have been expanded and large samples are now available for many species. This has enabled further association of females, reassessment of diagnoses, more precise delineation of distributions, and accumulation of significant data on general biology. Twelve genera in the sub-family Hydroptilinae are recognized, but no Ptilocolepinae. Of 6 tribes of Hydroptilini, only the Orthotrichiini and Hydroptilini are represented, with 1 and 10 genera respectively; the remaining genus, Maydenoptila, is unplaced.

New information has led to revisions of several supra-specific taxa, particularly in the course of including details of the cuticular morphology of the antennal flagellum. As revealed by light and scanning electron microscopy, antennal features show patterns characteristic of genera, and also specific differences. Their value in taxonomy is shown, and their possible significance in the evolution of the family, discussed.

The Australian hydroptilid fauna is characterized:- Its composition is found to be restricted: nine of the hydroptiline genera are in the Oxyethira group, and with the New Zealand-New Caledonian Paroxyethira, they form the entire group: Hydroptila, sole member of the Hydroptila group, is present, but the Agraylea group is absent. Many of the Oxyethira group genera are endemic, and most have long-legged larvae of the kind purported to feed on filamentous green algae. Of all genera, the orthotrichiine *Orthotrichia*, is the most speciose. It is more diverse in Australia than elsewhere in the world, and appears to occupy a different niche from that reported from the northern hemisphere. Immatures of most Hydroptilidae are conservative in form at the genus level, but one endemic, *Maydenoptila*, shows a range of larval and case forms.

Generic relationships in the *Oxyethira* group are analysed by 3 cladistic methods, applied to data on adults; *Hydroptila* is used as the out-group. The resultant cladograms are compared, and tested against data on larval characters. Arguments are advanced in favour of the cladogram derived by the Weighted Invariant Step Strategy (the WISS method). This method produced a cladogram in which *Paroxyethira* is the first off-shoot of a lineage that later spilt to form a clade consisting of *Oxyethira* and the *Hellyethira* complex of genera, and its sister clade in which *Acanthotrichia* is the sister group of *Tricholeiochiton* and *Orphninotrichia*. Data on distributions are substituted for taxa to derive area cladograms which are compared and examined for congruence with those derived for other plant and animal groups.

These studies lead to a perception of the Australian Hydroptilidae as comprised of one relatively primitive endemic genus, *Maydenoptila*, of almost certain Gondwanan origins, and a majority of genera in a highly derived sector of the family, the *Oxyethira* group, tribe Hydroptilini, which is probably Gondwanan too, although an older Pangaean origin cannot be discounted. It is suggested that the *Oxyethira* group evolved as long-legged, filamentous alga feeders, in warm, slow or still waters, and subsequently radiated to occupy cooler, faster waters.

Concerning the 2 remaining genera:- The origins of Australian *Hydroptila* are unclear, while *Orthotrichia* probably first reached

Australia from the north as the Australian and Sunda plates met in the Miocene. Orthotrichia has since diversified in lotic habitats. Dispersals between Australia and New Guinea and SE Asia have probably occurred quite frequently since the Miocene, and are invoked to account for present distributions of Tricholeiochiton, Oxyethira (Dampfitrichia), and some Orthotrichia and Hydroptila.

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Dr. A. Neboiss, Museum of Victoria, introduced me to micro-caddis flies and, with his enthusiasm for furthering knowledge of the Australian Trichoptera, catalysed my interest in the group. In addition, he collected a large proportion of the material upon which the thesis is based.

Many other people contributed specimens, either collected specially or taken in the course of other projects. Mr. M.J. Tyler (Department of Zoology, University of Adelaide) and his colleagues often put out a light for caddis-flies whilst on frog-collecting trips in N Australia; Dr. J.E. Bishop persuaded me not to neglect immatures, and patiently collected many species in the north-west.

Regular survey work by several groups produced valuable material and information. Much of this, from the rivers of N and E Victoria, was collected by members of the Survey Department, Museum of Victoria, (most of whom have now moved on to other employment). Emergence trap material, collected by Mr. A.J. Sharley in the Alligator Rivers region, Northern Territory, was made available to me by Dr. M. Malipatil, Northern Territory Museum of Arts and Sciences; Dr. R. Pearson provided immatures of several north-eastern species.

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ABBREVIATIONS USED ON PLATES

ach	accessory hooks
ae	aedeagus
aem	anal epimeron
artr	articular rod
ast	anal sclerite
ava	anterior ventral apotome
b.ap	basal apodeme
cer	cerci
cf	caudal filaments
con.st	conical structure
cox	coxa
dpl	dorsal plate
dpr.inf	dorsal process of inferior appendage
es	episternite
fe	femur
inf.app	inferior appendage (numbers suggest homologies)
inf.app.1	ventral lobe of inferior appendage
inf.app.2	dorsal lobe of inferior appendage
jl	jugal lobe
lab	labrum
la.pr	lateral process
lat.dpl	lateral arm of dorsal plate
lat.l.IX	lateral lobe of segment nine
lat.scl	lateral sclerotization
lds	left dorsal spine
l.sc.s	left sclerotized spine
man	mandible
med.dpl	median section of dorsal plate
med.sp	median spine
mes.pr	mesal process
mes.scl	mesal sclerotization
mes.sc	mesoscutellum
met.sc	metascutellum
oem	oral epimeron
ost	oral sclerite
pen	penicillus
pes	pre-episternite
pms	postmental sclerite
pos	post-segmental plate
prs	pre-segmental plate
pr	paramere
pva	posterior ventral apotome
rds	right dorsal spine
r.sc.s	right scleritized spine
sap.sp	sub-apical spine
sau	sensillum auricillicum
sc	sensillum coeloconica
scl."b"	sclerite "b"
sen	sensilla
set.lb	setose lobe
sg.s	strong spines
sl	setal lobes
sp	sensillum placodeum
ss	sinuous setae
st.pl	setose plate
st.pr	styliform processes
st.sp	stout spine
sub.g	sub-genital plate
sub.pr	sub-apical process
tar	tarsus
tc	tarsal claw
tib	tibia
tpr	tibial process
tr	trochanter
trich	trichobothria
tl	titillator
T-st	T-shaped structure
vh	vestitural hair
v.scl	ventral sclerotization
VII	abdominal segment seven
VIII	abdominal segment eight
IX	abdominal segment nine
X	abdominal segment ten

Scale bars in millimetres.

1. INTRODUCTION

Neboiss' 1983 checklist of Australian Trichoptera records 405 species in 24 families, including 96 species in the micro- or purse-caddis fly family, Hydroptilidae. More recently Neboiss (1984) comments on the high representation of this family in Australia: 29% of species are in Hydroptilidae, 21% in Leptoceridae, 11% in Hydrobiosidae, and fewer in all others. Yet prior to the studies reported here, little was known of the Australian micro-caddis fauna: only 14 species having been described. Future detailed studies of many other families will undoubtedly reduce the high proportional representation of hydroptilids, but never-the-less, the family is now shown to be relatively rich in species. (See Appendix 2 for checklist of species).

Hydroptilidae are a world-wide group which Marshall (1979) considers probably shows the greatest ecological, morphological, and behavioural diversity within the whole of the Trichoptera. She discusses the affinities of the family: a member of the super-family Rhyacophiloidea, it shares a close relationship with the saddle-case makers, Glossosomatidae, and is considered to be an early offshoot of the line leading to the tube-case makers, Limnephiloidea.

Although hydroptilids share the case-making habit, onset of building is delayed until the final instar: alone in the Trichoptera, hydroptilids show a curious "hypermetamorphosis". Thus, larvae of the first 4 instars, which are of short duration, are small, spidery, and free-living, but at the moult to the 5th or final instar case-building is initiated. Generally the case is carried around and extended as the larva feeds and swells to extraordinary proportions; then prior to pupation it becomes attached to the substrate. The final larval stage is more prolonged than earlier instars; pupal and adult stages are usually of short duration. Adults are small (2-7 mm in body length), and are not known to feed.

Although Marshall (1979) accepted Ross' (1956) division of Hydroptilidae into 2 sub-families, Ptilocolepinae and Hydroptilinae, some doubt has been expressed recently on the validity of including Ptilocolepinae (Malicky, Weaver pers. comm.). The 2 genera involved, <u>Palaeagapetus</u> and <u>Ptilocolepus</u>, certainly show close affinities with Glossosomatidae, while the other sub-family, Hydroptilinae, forms a distinct, clearly defined unit. The Ptilocolepinae occurs in the Nearctic and Palearctic; only the Hydroptilinae, which is world-wide in distribution, is found in Australia.

The first mention of Hydroptilidae from Australia, in a report by Ulmer (1908), is of a larva from Western Australia, ascribed to "<u>Hydroptila</u>? sp.?" No further information was available until 1934 when Mosely described 7 species in 3 genera - 2 endemic, 1 widespread - from adult males in the British Museum (Natural History). These same descriptions and that of 1 further species were included in Mosely and Kimmins' (1953) comprehensive "Trichoptera (caddisflies) of Australia and New Zealand".

During the 1960's and early 1970's, E.J. Riek and A. Neboiss accumulated hydroptilids in the collections of C.S.I.R.O., Canberra (now in Australian National Insect Collection), and National Museum of Victoria (now Museum of Victoria), respectively. Riek (1970) published figures of an unidentified larva and case, and Neboiss (1977) included descriptions of 7 species in his review of the taxonomy and biogeography of Tasmanian caddisflies. Neboiss also erected 4 new genera but subsequently 2 of these have been synonymised (Wells 1979a&b); one was later reinstated as a subgenus (Kelley 1984).

This thesis is based mainly on descriptions of 87 new species, for all of which the primary types are adult males; but for many species, descriptions of females, antennal features, immatures, cases, and notes on general biology are also included. All species names have been published in the papers of Wells 1978, 1979a&b, 1980, 1981, 1982, 1983, 1985b).

A study of the Australian Hydroptilidae in isolation from the world fauna would be artificial and could lead to spurious conclusions. Therefore, the broader systematic and biogeographical relationships of taxa occurring in Australia are examined.
Marshall (1979) recognised 6 tribes (rather than sub-families as suggested by Flint (1970)) in the Hydroptilinae, but several genera, including the Australian *Orphninotrichia* Mosely, were left as *incertae sedis*. Twelve genera are currently recognised in the Australian Hydroptilidae, of which all but 2 are in the tribe Hydroptilini. The exceptions are *Orthotrichia* Eaton, in the tribe Orthotrichiini, and *Maydenoptila* Neboiss, which is not assigned to a tribe.

Relationships within the family as a whole are outside the scope of this thesis, which is essentially a study of a regional, albeit a continental, fauna. However, since tribal representation in Australia is so restricted, it is of value to consider the affinities within the tribe Hydroptilini, to which most Australian genera belong.

In this thesis several cladistic methods are used to determine phylogenetic relationships. Hypotheses of relationships, derived by different approaches, are examined for congruence and tested against data on immature stages and distributions. For the determination of biogeographical relationships I have adopted the analytical approach advocated by Platnick and Nelson (1978).

The value of information on larval stages for the elucidation of relationships in the Trichoptera is a contentious issue (Schmid 1979, Wiggins 1981, Wiggins et al 1985). Wiggins and Mackay (1978) maintain that in the Trichoptera the genus is both a morphotype and an ecotype. If so, one can expect to recognise distinct differences between larvae at the generic level and in Chapter 10 I have evaluated the contribution of data on immatures to the recognition of genera, and also to the understanding of relationships.

The impression gained from the literature is that immature hydroptilids are very conservative. For example, Marshall (1979) says "the cases of the Hydroptilidae are very distinct for each genus and provide very useful key characters". Yet few studies are available that would enable us to assess intrageneric variability in immatures. In this present study the extent of such variability is illustrated for several genera.

Diagnostic characters for hydroptilids are described in detail in Marshall's work (1979) and I have mostly followed her terminology. Thus, descriptions of basic morphology are kept to a minimum and are elaborated only when new characters are introduced.

A new suite of characters introduced by Wells (1984a), and expanded in this work (Chapter 4), is derived from cuticular morphology of the antennal flagellum as revealed by light and scanning electron microscopy. The possible evolutionary significance of variation in form and arrangement of antennal hair and sensilla is discussed.

Little information is available on ecology of Hydroptilidae. Most of the generalisations repeated in the literature are derived from Nielsen's (1948) study on the life cycles of one species in each of 5 genera from northern Europe. In the present study, much information has been gleaned while collecting immatures of Australian species; more detailed studies have been made on 3 species, in 3 genera.

Thus this thesis centres upon a component of a continental fauna, members of a single family in a "relatively small order of stream-frequenting insects" (Riek 1970). I believe that as a small and discrete group, with aquatic larvae and adults with limited vagility and generally restricted life activities, this family offers potential for testing evolutionary and biogeographical hypotheses. Some questions are answered by this study, many more are raised.

2. MATERIALS AND METHODS

2.1 Introduction

The major parts of this study were carried out consecutively: studies on adults preceded work on immature stages; scanning electron microscope investigations on antennae were prompted by observations on antennae during preparation of species descriptions; phylogenetic and biogeographical analyses were dependent on morphological data from larvae, pupae and adults.

Initially a small amount of adult hydroptilid material was obtained on loan from the Australian National Insect Collection and considerably more from the Museum of Victoria. As the work progressed, more and more specimens were accumulated, thanks particularly to extensive light-trapping by colleagues. Valuable collections of immatures resulted from regular sampling of rivers by members of the Survey Department, Museum of Victoria, and by other groups conducting surveys on freshwater systems.

Collecting aquatic stages of Hydroptilidae is a tedious and often exasperating task, seldom undertaken by anyone not particularly interested in the group. With the aid of grants from the Australian Research Grants Scheme and the University of Adelaide, I was able to make numerous field trips throughout eastern, southern and southwestern Australia, and Tasmania, during which extensive collections were made. Several samples of northwestern species were provided by colleagues.

In total, many thousands of adults, larvae and pupae were examined. In addition, to gain an understanding of the family as a whole, representatives of non-Australian genera were studied, including adults in the National Museum of Natural History, Washington, D.C.; the

British Museum (Natural History), London (including Mosely's types for Australian species); and the collection of F. Schmid, Biosystematics Institute, Ottawa; and the collection of larvae of G.B. Wiggins, Royal Ontario Museum, Toronto.

2.2 Material examined and depositories

All types examined are listed and known distributions are given. Most of the material, including my own, is now in the Museum of Victoria, which houses the most comprehensive collection of Australian Trichoptera and is thus the most appropriate depository for Australian hydroptilids.

Depositories are abbreviated as follows:

ANIC	Australian National Insect Collection, C.S.I.R.O., Canberra;
BMNH	British Museum (Natural History);
NMV	Museum of Victoria, (formerly National Museum of Victoria);
NTM	Northern Territory Museum of Art and Sciences;
UHZIM	Universität Hamburg Zoologisches Institüt und Zoologisches Museum, Hamburg;
WAM	Western Australian Museum.

2.3 Methods: Field collecting of adults and immatures

Adults were collected at lights, by hand-netting, or by rearing immatures. A variety of light traps was used. Most commonly an incandescent mercury vapour lamp, run from a portable 240v generator, was hung above a white sheet, from which insects were picked selectively, or allowed to fall into a tray of 70% ethanol.

Alternatively a small black light was operated from a car battery or from disposable dry cells, with insects collected as before; or a small trap of the New Jersey type, fitted with a 0.45A globe and a fan, was set to run over night.

Hand-netting consisted of sweeping in riparian or emergent vegetation, and was especially successful for species in several genera now known to be seldom attracted to light.

Rearing of immatures was only possible with local species, which were kept in glass tanks with aerated water. Adults were collected from the fine nylon mesh tank-covers, using an aspirator.

Adults were stored in 70-80% ethanol.

Immatures were generally hand-picked from stones, rocks, algae, logs or submerged macrophytes. Early instar larvae were collected in a plankton net towed downstream from rocks that were kicked or scraped. In searching for immatures, every recognised microhabitat at each sampling site was thoroughly investigated, with varying success. The immatures of some species whose imagines were taken at lights were particularly elusive. It is likely that they occupy an unusual micro-habitat that was not sampled.

Regular sampling by various methods, including use of artificial substrates by the Museum of Victoria Survey Department, yielded valuable information on a number of species.

Early in the study all larval material was fixed and stored in 70-80% ethanol. More recently I used the method recommended by Wiggins (1977) in which specimens are fixed in Kahles Fixative, and then rinsed in water and transferred to 80% ethanol after 24-48 hours. This results in far better preservation of colour.

2.4 Methods: Association of males, females and immatures

The surest method of associating life-history stages is by rearing eggs to adults. Unfortunately it was rarely possible to do this, given distances travelled when collecting material, and the time and economic constraints on field work. Thus, only a few local species could be associated by rearing. A method used to obtain eggs for rearing was to aspirate adults at a light, or from a sweep net, to anaesthetise them with CO_2, sort, and allow females to recover in glass vials half covered with aluminium foil and containing a piece of damp filter paper. As females recovered, they would often deposit eggs. Eggs were kept flooded with water, and newly hatched larvae were transferred to shallow dishes of water containing green filamentous algae. Otherwise, immatures were associated by examination of fifth (final) instar larvae and comparison of pharate adults, case form and larval exuviae. The latter are retained within the pupal case. For most species, females were associated with males by examining features such as wing venation in specimens taken from a number of localities, and where immature stages were available, by examination of pharate adults.

2.5 Methods: Preparation of specimens for study; drawing methods

(a) Adults

Specimens were generally prepared as temporary mounts for microscopic study as follows:-

(i) Both right hand wings were removed, brushed free of hair using a pair of fine camel hair brushes, and mounted in 70% ethanol. It was often necessary to reduce light intensity considerably in order to see the veins clearly. Adjustment of the condenser, or drying, was often necessary for clear resolution.

(ii) The remainder of the specimen was heated for 15-30 minutes in a 50:50 mixture of 70% ethanol and 4% KOH, in a water bath, washed in water and mounted in alcohol; or, more recently specimens were cleared directly in Lacto-phenol, without prior maceration.

(iii) Following treatment all specimens were stored in glycerol or glycerated alcohol.

(b) Immatures

Larvae and pupae were generally prepared as temporary mounts but more permanent preparations of some species were made using Polyvinyl-lactophenol containing lignin pink. Use of lactophenol as a direct clearing agent was more successful than maceration with alcoholic KOH as the latter method often hopelessly collapses the abdomens of larvae.

Larvae were dissected by slicing off the top of the head to obtain a clear view of the labrum and mandibles. For this a slither of razor blade held in a pin vice was used to cut the larva, which was held upon polyporus pith.

(c) Drawing

All drawings were made using drawing attachments on Wild M20 and M3 microscopes.

2.6 Methods: S.E.M. studies of antennae

Whilst preparing descriptions of adults, by light microscopy, I noticed differences in form and arrangement of cuticular features on the antennae, and included these in diagnoses. Discrete differences were observed between supra-specific groups which are not visible in figures of hydroptilid antennae, such as those of Guinard (1879) or Ulmer (1951). Higher magnification and finer detail was required for analysis of these variations, and for this I used the scanning electron microscope.

(a) Selection of material for study

Specimens for study were selected from spirit collections. Usually, adults with slightly denuded antennae were chosen, since when the vestiture is intact it almost completely obscures underlying cuticular sensory structures. In each genus as many species as possible and, when enough material was available, 2 males and 2 females of each species, were prepared for viewing (see Appendix 1).

(b) Preparation of specimens for examination

Wings and legs were removed to facilitate glueing to stubs, and so that they would not obscure viewing of antennae.

Initially, specimens were critical point dried from amyl acetate. However, it was simpler and more efficient to take specimens through a graded series of ethanol-xylol, followed by air drying over silica gel. Dried specimens were mounted on stubs or rivets, ventral side uppermost, using silver dag, and kept dry both before and after coating.

Charging problems were encountered with material prepared in either way. To overcome this, mounted specimens were treated twice with Osmium Tetroxide vapour by placing them in a sealed container with 10% Osmium Tetroxide (1-2 ml) in a shallow dish for 36-48 hours, then dried again before coating. This treatment was repeated on coated specimens which were then recoated.

Two sputter-coatings of carbon (20 nm) and gold palladium (25 nm) were applied.

Specimens were viewed with an Etec Siemens Autoscan, using an accelerating voltage at 20 kv, or rarely 10 kv. Antennae of specimens were scanned, and the types, positions, and abundance of clothing hair and sensilla were recorded and photographed.

(c) Identification of sensilla types

The terminology applied to insect sensilla is variable and more recently a structure-function approach (see Altner 1977, Zacharuk 1980) has begun to replace the more commonly used morphotype classification (see Callahan 1979). Slifer (1960) developed a simple test for identification of chemosensilla. Using her method, aqueous crystal violet (4%) is applied to antennae of freshly preserved insects and any dendrite endings exposed through pores in the sensillum are stained blue. She recognised 2 distinct forms of chemosensilla: uniporous with a single terminal pore, and multiporous with many pores scattered over the surface. Electrophysiological tests (Schneider and Steinbrecht 1968) have shown these to have different chemosensory functions, namely gustatory and olfactory respectively.

Slifer's test was applied to some of the hydroptilids examined, but for most sensilla functions were inferred by analogy with known functions of similar structures in other insects. In the same way, names applied to sensilla in this study are only tentative, and are derived from comparisons with similar structures in other insects.

2.7 Phylogenetic analyses

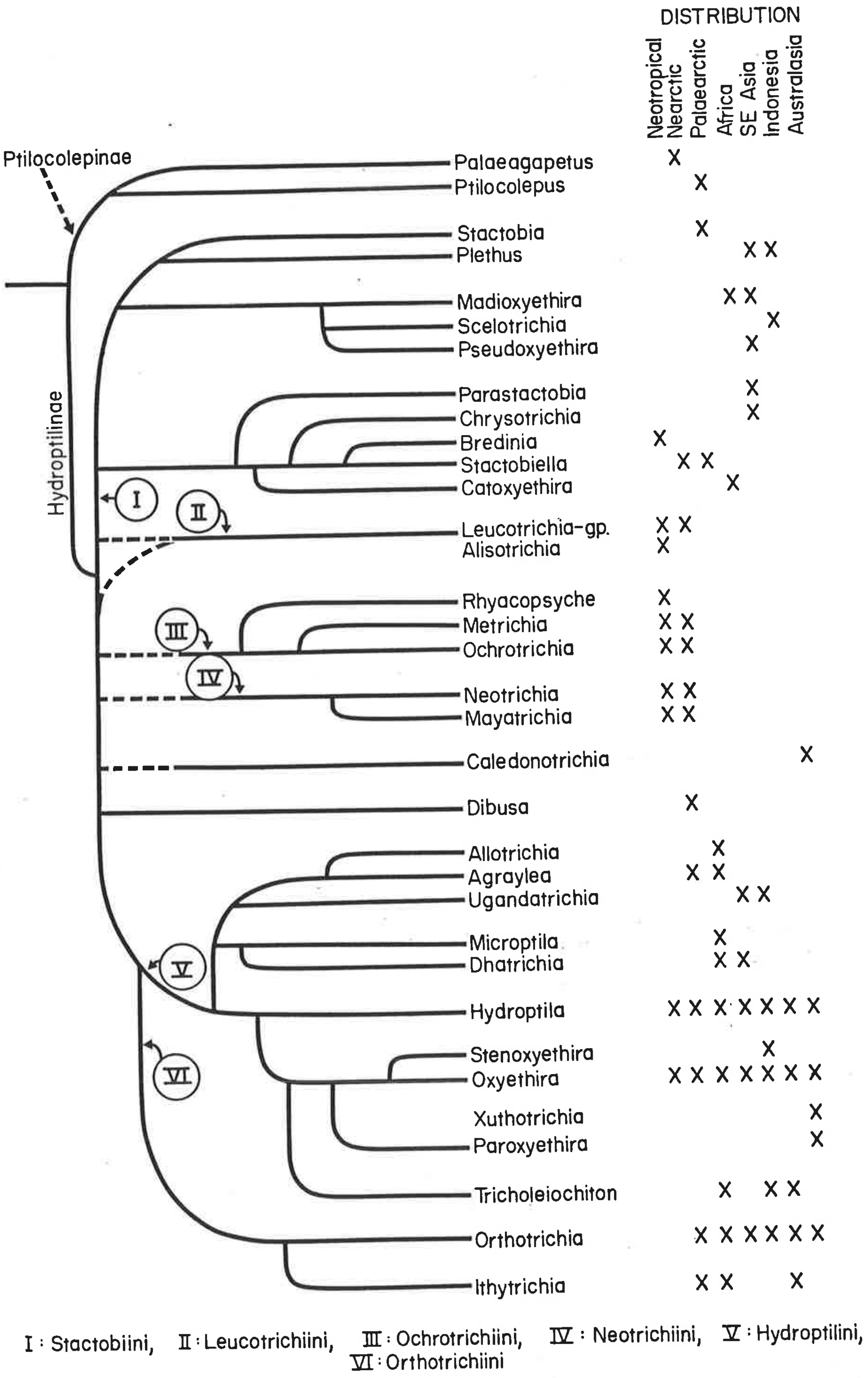
2.7.1 Introduction

(a) Current hypotheses of relationships

Marshall's phylogeny of the Hydroptilidae, (Fig. 2.1, from Marshall 1979), includes 4 genera that occur in the Australian fauna: Orthotrichia in the tribe Orthotrichiini, and Hydroptila, Oxyethira and Xuthotrichia (sensu Mosely) in the Hydroptilini, although at the time of her publication no Australian Orthotrichia or Oxyethira were known. Marshall was uncertain of the affinities of Orphninotrichia and left it as incertae sedis. The Orthotrichiini and Hydroptilini she perceived as the most highly derived tribes in the more apomorphic sub-family, Hydroptilinae.

In addition to her analysis of generic relationships, Marshall proposed a number of species groups within several larger genera. Possible relationships between species groups were suggested, but not clearly defined. Known Australasian Hydroptila were placed in a "losida-group", "which may have some affinity with the SE Asian members of the occulta-group ..." (Marshall 1979). Five sub-groups were recognised within Orthotrichia, including a "kokodana-group" accommodating "two distinct species from Papua New Guinea characterized by the simplicity of the male genitalia". All Australian species (and many more New Guinean species (Wells 1984b)) are placed in this group, within which a number of sub-sets are defined (Wells 1979b).

Kelley's (1984) systematic review of Oxyethira has superceded Marshall's work on that genus. He recognises sub-genera in Oxyethira, 2 of which occur in Australia: sub-genus Trichoglene, the earliest offshoot of the lineage, which is Australasian with 5 Australian, 1 New Zealand and 1 New Caledonian species (Kelley pers. comm.); and a more



	Neotropical	Nearctic	Palaearctic	Africa	SE Asia	Indonesia	Australasia
Palaeagapetus		X					
Ptilocolepus			X				
Stactobia			X				
Plethus					X	X	
Madioxyethira				X	X		
Scelotrichia						X	
Pseudoxyethira					X		
Parastactobia					X		
Chrysotrichia					X		
Bredinia	X						
Stactobiella		X	X				
Catoxyethira				X			
Leucotrichia-gp.	X	X					
Alisotrichia	X						
Rhyacopsyche	X						
Metrichia	X	X					
Ochrotrichia	X	X					
Neotrichia	X	X					
Mayatrichia	X	X					
Caledonotrichia							X
Dibusa		X					
Allotrichia			X				
Agraylea		X	X				
Ugandatrichia				X	X		
Microptila			X				
Dhatrichia			X	X			
Hydroptila	X	X	X	X	X	X	X
Stenoxyethira					X		
Oxyethira	X	X	X	X	X	X	X
Xuthotrichia							X
Paroxyethira							X
Tricholeiochiton			X		X	X	
Orthotrichia		X	X	X	X	X	X
Ithytrichia		X	X			X	

Figure 2.1. Marshall's (1979) phylogeny for the hydroptilid genera.

highly derived sub-genus, *Dampfitrichia*, found in the Neotropics, Palaeartic, SE Asia, Western Pacific and N Australia.

In several reviews of genera, I speculate on the affinities of Australian taxa. Using male genital synapomorphies, a close sister-group relationship was postulated between *Maydenoptila* and the New Caledonian *Caledonotrichia* Sykora (Wells 1983), which Marshall had tentatively placed near the North American *Dibusa* Ross, as an early offshoot of the line leading to Orthotrichiini and Hydroptilini. I also commented on what I perceived to be similarities between *Maydenoptila*/*Caledonotrichia* and *Dibusa* and the South American *Nothotrichia* Flint.

Similarities in genitalic features were noted in *Orphninotrichia* and the West African *Dhatrichia* Mosely, although differences in spur count and the presence of a jugal lobe in *Dhatrichia* were emphasized (Wells 1980). Subsequently *Orphninotrichia* was recognized as a member of the *Oxyethira* group, in the tribe Hydroptilini (Wells 1985a) rather than of the *Agraylea* group to which *Dhatrichia* is assigned.

The *Oxyethira* group is defined as "a more heterogeneous group [c/f the 2 other Hydroptilini groups - the *Agraylea* and *Hydroptila* groups] with respect to adult features, each genus possessing very distinct genitalia, but it is characterised by the relatively uniform appearance of the larvae" (Marshall 1979). As envisaged by Marshall, this group included *Oxyethira*, *Stenoxyethira* (now sunk in *Oxyethira* (Kelley 1984)), *Xuthotrichia* (*sensu* Mosely), *Paroxyethira* Mosely, and *Tricholeiochiton* Kloet and Hincks. *Xuthotrichia* has now been split (Wells 1979a), with all but the type species being transferred to *Hellyethira*, and several new genera have been added to what I refer to as the "*Hellyethira* complex" of genera (Wells 1983). On the basis of aedeagal structure, I considered this complex to stand apart from Paroxyethira and Tricholeiochiton (Wells 1979a), although Marshall placed Xuthotrichia as the sister group of Paroxyethira. At the same time, I placed the Hellyethira complex with Oxyethira, the most primitive members of which (sub-genus Trichoglene) share the state "aedeagus-without-titillator". However, Kelley (1984) considers this to be a derived state in Oxyethira.

It is apposite then, to re-examine the affinities of members of the Australian Hydroptilidae, which are now relatively well known as both immatures and adults. As mentioned in Chapter 1, the Australian hydroptilid fauna is relatively restricted, being represented by only 2 tribes - Orthotrichiini and Hydroptilini - and 1 unplaced genus, Maydenoptila. Furthermore, 9 of the 12 genera present are within one lineage, the Oxyethira group in the Hydroptilini, and together with the New Zealand/New Caledonian Paroxyethira these comprise the entire Oxyethira group as it is known. Thus, I have been able to analyse the relationships of most Australian genera, review the affinities of Maydenoptila and re-appraise the relationships of Australian Hydroptila and Orthotrichia.

(b) Phylogenetic analyses.

> "... starting merely with the initial grand assumption that life has a phylogenetic history. All we seek is a methodological strategy to recapture, as nearly as possible, that history."
>
> (Eldredge 1979, in Cracraft and Eldredge, p. 167).

The phylogenetic approach to systematics, as advocated by Hennig (1966) and clarified by Wiley (1976), has been followed in this study in preference to the alternative methods of evolutionary systematics or phenetics. Accordingly, taxa are clustered on the basis of the sharing of derived characters (apomorphies), which is assumed to provide evidence of common ancestry. Hypothetical ancestors are postulated in which particular apomorphisms, or sets of apomorphisms, arose, ie. contrary to the methodology of evolutionary taxonomy, no known taxon is postulated to be the direct ancestor of any other taxon of the same rank. Nor are taxa ranked as they are by evolutionary taxonomists, only order of branching is indicated (Hull 1979).

Disadvantages are inherent in all 3 methods of phylogenetic analysis:- The phenetic method computes indices of similarity based indiscriminately on character states that are either primitive or derived; yet sharing of primitive states does not provide evidence for relative recency of common ancestry. The evolutionary method results in untestable hypotheses of ancestor-descendent relationships (Wiley 1975); and according to Dobzhansky _et al_ (1977), the phylogenetic method is likely "to obscure the evolutionary and ecological significance of taxa".

The chief difficulty in applying the phylogenetic method lies in recognition of the polarities of character states, although numerical methods are available which obviate the necessity of designating polarities _a priori_, e.g. that of Lundberg (1972).

In designating polarity we are essentially formulating hypotheses about the direction of evolutionary change in transformation series. A variety of rules have been developed (for discussion of criteria see Stevens (1980)), but it is generally agreed that the most reliable means for determining polarity is by "out-group" comparison (Watrous and Wheeler 1981). Character states that occur in out-groups as well as in some members of the taxon in question are considered to be relatively primitive, while those that only occur in some members of the taxon in question are regarded as relatively derived. Difficulties arise in resolving conflicts in occurrence of character states due to homoplasy (parallelism, convergence, or reversal) and these can only be settled by examination of other character states in the taxon involved, and by choice of the dendrogram (cladogram) which gives the minimum number of conflicts. Another problem is that in order to use out-group comparisons, out-groups must already have been established.

Hennig's method can only be applied to the analysis of relationships within holophyletic groups (in the sense of Ashlock (1971)), which are defined as including all known descendents of a particular ancestor (Arnold 1981). For the purpose of this work, the Oxyethira group in the Hydroptilini is regarded as holophyletic. Two genera are precluded from the formal analysis by the requirement for holophyly. Maydenoptila, although of uncertain affinities, is certainly not in the Oxyethira group and probably not in the Hydroptilini. Orthotrichia is in the Orthotrichiini, which, according to Marshall's (1979) phylogeny, is the sister group of the Hydroptilini. Hydroptila, as the sole member of the Hydroptila group, is the sister group of the Oxyethira group and is thus used as the out-group.

Numerical methods, including computer algorithms, have been developed to facilitate handling of data on character states in phylogenetic analyses. Some require a coding of data according to polarity. Two such methods are employed here: that of Kluge and Farris (1969) as outlined by Wiley (1981), and another, the Weighted Invariant Step Strategy (WISS), outlined by Farris et al. (1970).

2.7.2 Character state analysis

Out-group comparison appears to provide the strongest criteria for determining polarity (Watrous and Wheeler 1981), and has generally been employed in this study. For the main part, Hydroptila (as the Hydroptila group) is used as the out-group of the Oxyethira group. The monophyly of the Hydroptila group is based upon a number of autapomorphies - no out-group is expected to exhibit primitive states of all characters. Where autapomorphies are recognized in Hydroptila, a more distant out-group is employed. As so little work is available on the Hydroptilidae, other than formal taxonomic descriptions, it is difficult to find reasoned arguments for polarities of character states. Nielsen's (1948, 1980) studies were useful in some instances.

Character states are designated 0 = primitive, and 1,2,3 = derived, although consecutive numbering does not necessarily indicate a sequence of transformation states. For completeness, information is included on the New Zealand/New Caledonian, Paroxyethira, the only Oxyethira group genus not found in Australia. Separate tables of genera, characters, and character states are drawn up for adults and immatures but phylogenetic analyses are performed on data from adults only. The resultant phylogenies are then tested by reference to data on immatures.

2.7.3 Phylogenetic analyses

The data set available for analysis is small, and amenable to a simple Hennigian approach. Hypotheses of monophyly of taxa are erected on the basis of synapomorphies (sharing of derived character states). Where conflicts arise, the cladogram with the fewest changes is favoured (ie. the principle of parsimony is applied (Wiley 1981)).

As a means of cross-checking hypotheses, several numerical methods are also applied. Each uses the same coded data and depends upon a knowledge of out-groups. Based upon the same data set, all resultant cladograms should be congruent (Wiley 1981), but as will be seen in this thesis, in practice they may not be congruent.

The Wagner algorithm of Kluge and Farris (1969, as detailed by Wiley 1981) proceeds as follows:-

An ancestor or sister group is specified and the distance of each taxon from the ancestor is computed.

The 2 taxa closest to the ancestor are chosen and together with the ancestor are used to compute the character states of a hypothetical ancestor (the median).

The sequence is repeated until all taxa are connected via hypothetical ancestral taxa.

This method, although useful as a test of others, is intuitively unsatisfactory since, like many other numerical methods, it is "strongly influenced by the number of unique characters possessed by a terminal or inclusive group" (Schuh and Polhemus 1980).

I favour the WISS method (Farris *et al.* 1970) which clusters taxa on the basis of sharing of derived *steps*, thus eliminating the above problem. (Taxon A may show state [1] of a character while taxon B shows state [2] of the same character, the ancestral state of which was [0]. Since they share the step leading from [0] to [1], they form a cluster).

Most of the data used in the phylogenetic analyses are taken from Chapter 3 and from Wells (1984a). Additional information on non-Australian taxa is taken mainly from Marshall's (1979) review, rather than primary sources, although these have been consulted where necessary.

2.8 Biogeographic analysis

Explanation of present distributions of taxa in the Australian Hydroptilidae must rely upon the methods of analytical biogeography. Fossil Trichoptera are known from the Upper Permian and Triassic in Australia but do not include hydroptilids. Thus, inferences about the past history of the fauna must be derived from considerations of relationships of taxa, past geological and geographical events, and data on present ranges and general biology.

Following the methods of Platnick and Nelson (1978) and Rosen (1978), no prior assumptions are made concerning dispersal, centres of origin, or vicariance. Distributions of taxa are plotted and distributions in common (= generalised tracks) are recognised. The relationships of taxa in these areas, as determined by phylogenetic methods (Chapter 6) and the geological and geographical histories of the areas are considered. Disjunct taxa pose problems which may often be resolved by examination of the biology of the group. For example, high vagility, perhaps coupled with broad ecological tolerance, may explain the disjunct distribution of a particular taxon. A possible outline of the past history of the Australian Hydroptilidae is offered: centres of origin and pathways for dispersal are suggested. Brundin's (1966) formula for recognising a centre of origin - that the most primitive forms are found in earliest occupied areas - is preferred to that of Darlington (1970), which is its antithesis. Wulff's (1943) premise that a centre of origin is the region of greatest species diversity is also taken into account.

Nothing is known of the dispersive abilities of hydroptilids. Aquatic stages, especially early larvae, probably disperse freely within a given watershed, and as a result of chance events - e.g. floods; transport by birds; or fusion of rivers or streams - even between systems. However, they are unlikely to traverse long distances. The adults are small and are relatively weak fliers, but could easily be transported for considerable distances in air currents. Wise (1983) lists numerous insects that were collected in nets on ships in the south Pacific Ocean, and although no Trichoptera were recognised, many small insects of similar sizes were taken.

Mackerras (1970) identified a number of distinct elements in the Australian fauna: an Archaic Element "consisting of primitive animals that have evidently survived with little change since Palaeozoic or early Mesozoic times"; a Southern Element with origins in Gondwanaland and which in the insects "represents a rather, though not extremely, early level in the evolution of most orders in which it has been recognised" and has a characteristic pattern of distribution in the Southern Hemisphere; an Older Northern Element "relatively primitive ... related to the southern ... but usually distinguishable from it taxonomically as well as in distribution"; a Younger Northern Element which "forms the most highly evolved and often the most conspicuous element in almost every order of insects"; and Recent Elements, including insects readily dispersed in aerial plankton or by man.

In the Australian Trichoptera, Ross (1967) recognised only 3 distinct groups. These are a group derived "moderately recently" from "progenitors in south-east Asia, arriving via New Guinea"; a Gondwanan group; and a group "known only from Australia or from Australia and New Zealand, whose close affinities and origin are difficult to determine".

The first 2 categories correspond to Mackerras' Younger Northern Elements and Southern Elements; the third fits none of Mackerras' categories and should probably be considered an autocthonous element (see Keast 1981 and Barlow 1981) of uncertain affinities and origins.

Ross (1967) postulated that the Trichoptera arose in cool montane streams in the late Triassic and that by the early Cretaceous "progenitors of most present day families had come into existence". He maintained that considerable radiation had occurred by the late Cretaceous, resulting in the evolution of "most of our older sub-families, tribes, and genera"; subsequently, "great diversification into modern genera continued through early Cenozoic". He envisaged "an old and continuing temperate fauna stretching across the north ..." and a similar belt in the south, each of which sporadically gave rise to groups that penetrated the tropics and intermingled.

A recent appraisal of the biogeography of Australia by Keast (1981) is in general accord with the ideas of Mackerras, although based on a more detailed background of historical events. Current ideas of the geological history of the Australian continent have been reviewed by Crook (1981) and Powell et al. (1981) and the Tertiary palaeogeography and evolution of the Australian climate by Kemp (1981). The Australian plate, including Tasmania and the southern edge of New Guinea, drifted free from Antarctica about 60-53 my BP (million years before present), some considerable time after the detachment of New Zealand and New Caledonia (about 80-60 my BP) and the separation of Africa and Greater India (about 135 my BP). These land masses, together with South America and Antarctica, which are thought to have begun to separate at about 29.3 my BP (Crook 1981), formed the large southern land mass of Gondwanaland. Little is known of the climate of this land before the

Tertiary but there is no evidence of ice-caps in Antarctica in the Palaeocene, when the northward moving Australian continent appears to have experienced a cool to warm temperate climate with high rainfall.

Another event which probably had a significant effect on the evolution of Australian Trichoptera was the tectonic movement which gave rise to the Eastern Highlands, thought to have coincided roughly with the breakup of Gondwanaland (Nix 1981).

Throughout the Tertiary, as Australia drifted slowly northward, the climate cooled. In the Eocene, conditions appear to have been reasonably equable, as indicated by widespread rainforest. Temperatures and rainfall decreased during the Oligocene, until in the Miocene central Australia was dry enough to support grasslands. At about 15 my BP the northern edge of the Australian plate converged with the southern margin of Sundaland, bringing about close contact with SE Asia.

In summary, the following picture emerges:- When Australia separated from the remnants of Gondwanaland in the late Cretaceous it shared a widespread southern trichopteran fauna which included many present day genera. Temperatures were moderate, and rainfall was high. Subsequently, the climate became cooler and drier. Orogenic activity in the east strongly modified the topography, providing a cooler, wetter eastern range.

Workers on aquatic groups, eg. Illies (1965) and Edmunds (1975, 1982), have postulated that the Eastern Highlands provided a refuge for cool-adapted forms as the climate of Australia warmed. It is conceivable though, that a more important role of the Eastern Highlands was in providing abundant freshwater courses as aridity became widespread, rather than a cool refuge.

3. RESULTS: SYSTEMATIC REVIEW OF THE AUSTRALIAN HYDROPTILIDAE

3.1 Introduction

In this section descriptions of adults and larvae from my papers on Australian Hydroptilidae (Wells 1978, 1979a, 1979b, 1980, 1981, 1982, 1983, 1985a&b) are ordered and revised. Diagnoses are given for the 2 tribes in the Subfamily Hydroptilinae, the Hydroptilini and Orthotrichiini, in which most Australian hydroptilids are placed; *Maydenoptila* Neboiss is unplaced. Two of Marshall's 3 generic groups within the Hydroptilini, the *Hydroptila* and *Oxyethira* groups, occur in Australia; the *Oxyethira* group is redefined. Generic keys are provided for adults and for known cased larvae. Genera are reviewed, and for some, keys to species are provided. Detailed information on antennal features is from Wells (1984a), and further unpublished studies. Information on general biology and distributions is included.

Kelley (1984) has revised the status of several Australian taxa, and his rearrangements are discussed in the section on the genus *Oxyethira*.

3.2 Keys to genera of Australian Hydroptilidae

(a) Key to adults

1 Ocelli present.. 3

Ocelli absent... 2

2 (1) Spur formula 0,2,4 (Pls 1-8) .... Hydroptila Dalman

Spur formula 0,3,4 (Pls 55-82) .... Orthotrichia Eaton

3 (1) Spur formula 0,2,4 (Pls 42-48) .... Orphninotrichia Mosely

Spur formula 0,3,4, rarely 1,3,4 4

4 (3) Forewing with jugal lobe; antennal segments with scattered clothing hair (Pls 49-54) .... Maydenoptila Neboiss

Forewing without jugal lobe; antennal segments each with basal whorl of clothing hair.. 5

5 (4) Wings strongly acuminate, forewing without fork 1 6

Wings acuminate, forewing with forks 1 and 2 7

6 (5) Male with abdominal segment IX retracted into VIII, aedeagus with or without spiral titillator (Pls 27-35) .. Oxyethira Eaton

Male with abdominal segment IX protruded; aedeagus with spiral titillator (Pl. 36) .... Acanthotrichia Wells

7 (5) Male without spiral titillator on aedeagus 8

Male with spiral titillator on aedeagus (Pls 37-41)

.... Tricholeiochiton Kloet and Hincks

8 (7) Male with inferior appendages discrete, consisting of one or more lobes or spines 9

Male with inferior appendages reduced, partly or completely fused (Pls 21-23) .... Acritoptila Wells

9 (8) Male with lobose inferior appendages. 10

Male with inferior appendages modified to form sclerotised spines (Pl. 9A,B) .... Xuthotrichia Mosely

10 (9) Male with median setose plate on sternite IX (Pls 24; 25C-F)

.... Austratrichia Wells

Male without median setose plate on sternite IX 11

11(10) Male with an unpaired medial structure above inferior appendages; without parameres (Pls 25A-D; 26) .... Mulgravia Wells

Male without unpaired medial structure above inferior appendages; parameres present (Pls 10-20) .... Hellyethira Neboiss

(b) Key to cased mature larvae*

1 Mid and hind limbs less than twice length of fore limbs 2

Mid and hind limbs at least twice length of fore limbs 5

2(1) Body slightly compressed laterally; abdominal segments enlarging gradually from I to IV or V; abdominal segment I without sclerotized ring; antenna with terminal sensillum discrete. Case of "purse" form, materials variable 3

Body slightly compressed dorso-ventrally; abdominal segment II swollen to form paired lateral "horns"; abdominal segment I usually encircled by median sclerotized ring; antenna with terminal segment fused. Case of "wheat seed" shape, built of secretion only (Pls 109-115) .... Orthotrichia Eaton

3(2) Claws on anal prolegs simple, without accessory hooks. Case shape and materials variable (Pls 102F-H; 103-108) .... Maydenoptila Neboiss

Claws on anal prolegs with 2 or more accessory hooks 4

4(3) Ecdysial sutures on head indistinct; pre-episternite on propleuron free; tergite on abdominal segment IX only. Case ovoid, bean or kidney shaped, incorporating sand grains and/or algal filaments (Pls 83-87) .... Hydroptila Dalman

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*Larvae of Acritoptila Wells, and Hellyethira Neboiss indistinguishable; those of Xuthotrichia Mosely, Mulgravia Wells, Austratrichia Wells, and Acanthotrichia Wells are unknown.

Ecdysial sutures on head distinct; pre-episternite fused on all thoracic pleura; tergites on abdominal segments I and IX. Case almost rectangular in profile with rounded ends and slight mid-lateral concavities; constructed of secretion with small amounts of sand and/or algal cells or filaments (Pls 99-102A-E) .... <u>Orphninotrichia</u> Mosely

5(1) Thoracic nota short, broad, only slightly constricted postero-laterally; abdominal segment I short, but considerably wider than metathorax 6

Thoracic nota elongate, saddle-shaped; abdominal segment I of same size as metathorax (Pls 88-94) .... <u>Acritoptila</u> Wells, <u>Hellyethira</u> Neboiss

6(5) Mid and hind limbs 4x length of fore limbs; mid and hind tibiae greatly exceeding length of other leg segments. Case almost rectangular in profile, with ends and lateral margins slightly convex; constructed of secretion only (Pls 97; 98) .... <u>Tricholeiochiton</u> Kloet & Hincks

Mid and hind limbs 2x length of fore limbs; all leg segments about equal in length. Case flask-shaped in profile, constructed of secretion only (Pls 95E-I; 96) .. <u>Oxyethira</u> Eaton

3.3 Tribe Hydroptilini Stephens

Hydroptilidae Stephens, 1836: 151.

Type-genus: Hydroptila Dalman, 1819; Marshall, 1979: 191-193.

Marshall (1979) says of this tribe "owing to the diversity of the group ... it is difficult to give a precise diagnosis ...". She considers that members are united by "a number of basic affinities .. . These include features of the adult thorax and the male genitalia, and also the fundamental association of the larvae with green filamentous algae in more slowly moving bodies of water." I am unable to refine her diagnosis further at this stage but such a variable group may later require splitting.

3.3.1 The Hydroptila group

Marshall, 1979: 192.

A monotypic group, containing only Hydroptila. Marshall (1979) says in her diagnosis that the adults "exhibit generalised but distinctive patterns of genitalia which vary slightly between species-groups; the larvae are basically typical of the hypothetical generalised hydroptilid but are adapted for feeding on filamentous algae on more-or-less exposed substrates in moderate to fast flowing water. The genus is distinguished by the specialized cephalic (post-occipital) scent-caps of the males and the absence of ocelli in both sexes." On the basis of my studies, this diagnosis can be further refined.

The Hydroptila group is recognised by tentorium reduced medially; ocelli absent, antennal hair in basal whorl on each flagellar segment; spur formula 0,2,4; fore wing with jugal lobe and R_2 and R_3 sharing footstalk in adults. In the larva submental sclerites paired; dorsal head sutures fused; legs subequal; no trichobothria on fore femora and trochanters; accessory hooks on anal claws; caudal gills.

Genus Hydroptila Dalman

Hydroptila Dalman, 1819: 125; Ulmer, 1907: 222; Nielsen, 1948: 62-76; Mosely & Kimmins, 1953: 505; Lepneva, 1964, (English translation, 1970: 264-365); Wiggins, 1977: 132-133; Marshall, 1979: 200-203; Wells, 1978: 745-762.

Type-species: Hydroptila tineoides Dalman, by monotypy.

Marshall (1979) reviewed the genus Hydroptila, which she viewed as "the most successful genus of the Hydroptilidae with over 150 species and with an almost world-wide distribution ...". On the basis of male and female genitalic features, Marshall proposed 13 species groups, placing the 3 then known Australian species with others from the Solomon Islands and New Guinea, in a "losida-group". She suggested that the affinities of this group may be with some SE Asian members of the occulta-group. However, Marshall figures the occulta-group with a paramere, lacking in Australian species. The genitalia in Australian Hydroptila more closely resemble her figure for the Palaearctic "sparsa-group".

Nine Australian species are now known from adult males, and females of 8 and immature stages of 7 of these have been associated (Wells 1978, 1985a). Adult males can be distinguished with ease; females with more difficulty, using genitalic features. All males have what is probably a basic (= primitive?) form of genitalia with well developed inferior appendages and dorsal and subgenital plates (see Marshall's (1979, p.146) figure of generalized hydroptilid genitalia). Detailed figures of adults of H. robusta Wells are given to show diagnostic features of the genus; a key to males and females of Australian species is given.

Larvae of several northern hemisphere species of Hydroptila have been described and these appear to be conservative morphologically. For larvae of 10 Illinois species, Ross (1944) could only find differences in colour and patterns of markings.

Similarly, final instar larvae of robusta Wells, scamandra Neboiss, incertula Mosely, losida Mosely, obscura Wells, and calcara Wells are almost indistinguishable without cases and/or pharate adults, but those of acinacis Wells are distinctive. Detailed figures are given of the mature larva of scamandra, a common species; acinacis is figured for comparison, and all cases are illustrated. A key is given to cased, 5th instar larvae, although the only reliable way of identifying most larvae in this genus is by association with pharate adults or by rearing.

Nielsen (1948) described an early larva of Hydroptila as similar in appearance to larvae of the Holarctic genus Agraylea Curtis, but with 3 caudal filaments or gills; he does not figure it. Early larvae of several Australian species have been collected and that of losida is figured. All have caudal filaments.

Pupal characteristics of Hydroptila are illustrated in figures for scamandra. Pupae are indistinguishable on the basis of these characters, but cases may be recognized, and well developed pupae (pharate adults) are readily identified by their genitalia.

Diagnosis

Adults (modified from Wells 1978 and Marshall 1979)

Length of forewing, 2-4 mm. Spurs 0,2,4. Ocelli absent. Post-occipital lobes, or caps, on head; scent organs may be present beneath caps in male. Tentorium reduced medially. Antennae 28-35-segmented in male, 23-27 in female; segments generally dark except for band of 3 pale segments at about $^2/3$ length; segments each with basal whorl of fimbriate hair and numerous placoid sensilla in male. Mesoscutellum subtriangular with convex anterior margin; metascutellum pentagonal to triangular, anterior margin strongly convex. Sternal glands present on abdominal segment V.

Male. Genitalia:- Sternite VII often with ventral process; segment VIII rarely with ventral process; segment IX fused, annular, sometimes with antero-lateral apodemes and often with postero-lateral processes. Inferior appendages distinct, usually simple, straight and elongate, sometimes modified. Tergite X forming a variable "dorsal plate". Subgenital appendages (= "parameres", "lateral penis sheaths", "intermediate appendages") variable. Subgenital plate simple, broad, slightly emarginate in sparsa- and consimilis-groups but absent or inconspicuous in others; bilobed process apparently absent (but may be incorporated into subgenital plate). Aedeagus with well developed spiral "titillator".

Female. Genitalia with simple oviscapt. Generally with sternite VIII forming sclerotized shield, sometimes with median glandular region or "ventral plate".

Fully grown larva (modified from Nielsen 1948: 62-76; Lepneva 1964, (English translation, 1970: 364-365); Marshall 1979: 200-201).

Body (Pl. 83B) slightly compressed laterally; legs short, subequal; abdomen distended, segments gradually enlarging from I to IV, then decreasing, segment I larger than metathorax, curvature of abdomen slight. Sclerotized parts generally pale; cuticle of head and thoracic nota densely covered with minute spinules.

Head (Pl. 84A) elongate, sides sub-parallel, ecdysial sutures indistinct; post-mental sclerites paired (Pl. 84D). (Marshall (1979) says "fused, although a faint median line may sometimes be detected", but in her figure they are paired, as I have seen them in Australian species). Labrum (Pl. 84C) short, anterior margin of sclerite deeply indented, lateral lobes slightly asymmetrical, generally with brushes of fine hair on antero-ventral membranes; setae less than or equal to length of labrum; tormae short and rounded. Mandibles (Pl. 84B) asymmetrical, stout, only lightly sclerotized: left with broad upper blade above dense bristle-like penicillus, lower blade narrower; right terminating in several rounded denticles. Antenna (Pl. 83E) with terminal sensillum about half as long as basal section, seta far longer than antenna.

Thorax (Pls 83B; 84A). All nota stout, almost rectangular in lateral view; median sutures distinct; prothorax with antero-lateral margins slightly rounded, meso- and metanota only partly covering dorsa of segments. Oral and paired anal sclerites on prothoracic venter only (Pl. 84E); pre-episternite free on propleuron only (Pl. 83B,C).

Legs (Pl. 83B,C). Segments shortening distally; tarsal claws about as long as tarsi; fore tibia with distal ventral process well developed and bearing specialized setae; inner femoral and trochantal setae smooth.

Abdominal segments II to VI with broad dorsal chloride epithelia (Pl. 83D). Tergite on segment IX only (Pl. 85A), anterior and lateral margins shallowly concave, posterior margin broadly rounded, all setae slender, inner setae on distal margin greatly exceeding length of tergite. Segment X broadly rectangular; anal prolegs postero-lateral (Pl. 85A); claws on prolegs stout, generally with 3 accessory hooks (Pl. 85B). Three filamentous caudal gills (Pl. 85A).

<u>Pupa</u>. Labrum (Pl. 85E) rounded anteriorly, sides straight or curved; anterior margin with one, rarely 2 pairs of rudimentary setae. Mandibles (Pl. 85D) long, slender, fine serrations on inner distal margin; a pair of latero-basal setae present. Hook plates (Pl. 85C) with presegmental plates forming narrow flaps bearing 5-8 broad spinules; postsegmental plates more-or-less rounded with several short, broad spinules.

<u>Case</u> (Pls 83A; 87A-E) laterally compressed, bean to kidney shaped in profile, consisting of 2 equal valves made of secretion covered with fine sand grains, algal filaments, or both, and often incorporating other detritus. Nielsen (1948) gives a detailed description of the process of case construction, which he says involves repeated opening and closing of the ventral seam of a small cockle-shell-shaped initial

structure for addition of new material to the ends and ventral side of each valve. At pupation, cases are attached closely to the substrate (generally the sides of a rock or stone) at both ends of the ventral side; they are not modified prior to pupation.

Early larva. The 2nd instar larva of *Hydroptila losida* (Pl. 86) looks similar to early *Agraylea multipunctata* (Nielsen 1948), although the lateral body setae are shorter, their length scarcely exceeding the width of the thorax. Coronal suture and posterior sections of fronto-clypeal sutures distinct; tergites of body difficult to discern; tibial processes of forelimbs poorly developed; anal prolegs long, discrete; claws elongate, slender and curved; caudal setae about half length of body; 3 caudal filaments.

Biology. Immatures of Australian *Hydroptila* are collected from flowing water where green filamentous alga is growing. Larvae are found amongst algae or on upper surfaces and sides of rocks or cobbles, often in riffles amongst tufts of algae; pupae are found on all sides of the rocks.

Distribution. Cosmopolitan, excluding polar regions and New Zealand. Widespread in Australia, ranging throughout the mainland and Tasmania, with the highly tolerant *H. losida* occurring from N Queensland, south and westwards to SW Western Australia, in both brackish and fresh waters. Species diversity is greatest along the Great Dividing Range of E Australia, where distributions frequently overlap.

Key to adults of Australian *Hydroptila* Dalman

1. Males 2
   Females 10

2(1) Dorsal plate distinctly trilobed 3
   Dorsal plate in form of single lobe or with median lobe almost twice length of overlying lateral lobes 7

3(2) Inferior appendages with 1 or 2 sclerotized teeth subapically .. 4
   Inferior appendages without sclerotized teeth (Pl. 7G,H) .... *incertula* Mosely

4(3) Inferior appendages with single sclerotized subapical tooth 5
   Inferior appendages with paired sclerotized subapical teeth (Pl. 5F,G) .... *losida* Mosely

5(4) Aedeagus with twisted, strap-like subapical process (Pl. 3A-C) .... *scamandra* Neboiss
   Aedeagus simple, without subapical process 6

6(5) Aedeagus strongly sinuous above a sharp, subapical bend. Inferior appendages stout, deflected laterally towards apices (Pl. 1E-G) .... *robusta* Wells
   Aedeagus slightly sinuous distally. Inferior appendages thin, straight (Pl. 2C,D) .... *tasmanica* Mosely

7(2) Dorsal plate with apico-lateral margins extended into slender, sharply inflected spines 8

Dorsal plate excised apically, apico-lateral margins not inflected 9

8(7) Aedeagus straight with short, stout, hook-like subapical spur (Pl. 4C-E) .... *calcara* Wells

Aedeagus sinuous, with thin, straight spur inserted at right-angles, further from apex than in *calcara* (Pl. 5 A-C) .... *acinacis* Wells

9(7) Aedeagus simple, straight, without subapical process. Without setose lobe at base of inferior appendage (Pl. 6D-F) .... *obscura* Wells

Aedeagus with sinuous subapical process. A rounded setose lobe at base of inferior appendage (Pl. 7C-E) .... *sinuosa* Wells

10(1) Sternite VIII rounded or produced apically 11

Sternite VIII with apico-mesal concavity (Pl. 8A,B) .... *incertula* Mosely

11(10) Sternite VIII triangular 12

Sternite VIII broadly rounded apically or produced apico-mesally into rounded lobe 14

12(11) Sternite VIII without lateral triangular sclerotizations 13

Sternite VIII with pair of small lateral triangular sclerotizations; tergite VIII deeply and widely excavated (Pl. 5H,I) .... losida Mosely

13(12) Sternite VIII with small rounded mesal sclerotization or gland (Pl. 2A,B) .... robusta Wells

Sternite VIII without mesal sclerotization or gland (Pl. 2E,F) .... tasmanica Mosely

14(11) Sternite VIII broadly rounded apically 15

Sternite VIII produced apico-mesally into small rounded lobe bearing setae (Pl. 6G,H) .... obscura Wells

15(14) Sternite VIII without Y-shaped mesal sclerotization or gland .. 16

Sternite VIII with Y-shaped mesal sclerotization or gland (Pl. 3F,G) .... scamandra Neboiss

16(15) Apex of sternite VIII broad, rounded, with row of 8 strong, evenly distributed marginal setae; tergite VIII with deep V- or U-shaped excision (Pl. 4F,G) .... calcara Wells

Apex of sternite VIII narrower than in calcara, rounded, 6 of the 8 marginal setae clustered mesally; tergite VIII deeply excised, sides of excision stepped (Pl. 5D,E) ... acinacis Wells

Key to cased, mature larvae of Australian *Hydroptila* Dalman*

1 Case constructed mainly or entirely of filaments of green algae 2

Case constructed entirely of sand or sand and a little detritus, often with small amounts of filamentous green algae incorporated 3

2(1) Case ovoid, neatly constructed of filamentous green algae (usually *Spirogyra* sp.) (Pl. 87C) .... *obscura* Wells

Case bean-shaped to ovoid, untidy, built mainly of filamentous green algae, often with some sand incorporated (rarely sand only) (Pl. 87D) .... *losida* Mosely

3(1) Larva elongate, thoracic nota incompletely covering dorsa of segments, head prognathous, segments of fore leg longer than wide 4

Larva short, thoracic nota completely covering dorsa of segments, mouth ventrally placed, segments of fore leg generally wider than long (Pl. 87F) .... *acinacis* Wells

4(3) Case bean-shaped, valves generally widest in middle, narrower at each end 5

Case more elongate to ovoid, valves generally slightly constricted before each end, slightly dilated at ends 6

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*Immatures of *sinuosa* Wells and *tasmanica* Mosely unknown.

5(4) Case with sand grains tightly and neatly incorporated, seldom much detritus. Larva pale fawn to dark brown, postero-lateral margins on thoracic nota black (Pl. 83A,B) .... <u>scamandra</u> Neboiss

Case with sand grains more sparsely incorporated, some detritus. Larva with dark brown sclerotized parts, postero-lateral margins of thoracic nota black (Pl. 87B) .... <u>calcara</u> Wells

6(4) Case neatly constructed of tightly-packed, fine sand grains. Larva with dark brown sclerotized parts, postero-lateral margin of thoracic nota black (Pl. 87A) .... <u>robusta</u> Wells

Case more roughly constructed of sparser sand grains, commonly with detritus incorporated. Larva pale fawn, postero-lateral margins on thoracic nota black (Pl. 87E) .... <u>incertula</u> Mosely

Hydroptila robusta Wells

(Pls 1; 2A,B; 87A)

Hydroptila robusta Wells, 1978: 747-49.

Holotype ♂, paratypes, 10♂, 11♀, Victoria, Millgrove, Yarra River, 24.ii.1976, Neboiss, NMV.

Adults (modified after Wells 1978)

Small, dark grey-brown with mottled wings and short, stout antennae. Anterior wing with r-m slightly beyond M_2-M_{3+4} fork, A_3 present; posterior wing with r-m at M_{1+2}-M_{3+4} fork; a single anal vein present (Pl. 1A). Closely resembling tasmanica, but distinguished in male by strongly sinuous aedeagus with sharp subapical bend, and stout inferior appendages, and in female by shallow apical excavation of sternite VIII.

Male. Length of anterior wing, 2.3 mm. Head (Pl. 1B) densely hairy on frons, scattered hairs on vertex; pair of posterior brush-like scent-organs beneath large erectile setose caps; short medial suture between scent organs. Antennae (Pl. 1D) 28-29-segmented, bicoloured: proximal 26 segments dark, followed by 3 light and 9 dark segments. 1st segment elongate, swollen; 2nd elongate; 3rd very short; terminal segment conical; intermediate segments short, cylindrical, with basal whorls of fimbriate hair and scattered placoid sensilla. Genitalia (Pl. 1E-G):- Abdominal segment IX short, without lateral processes. Dorsal plate trilobed: lateral arms long, somewhat divergent, apices obliquely truncate, laterally angled; median lobe short, membranous, triangular. Subgenital plate rounded laterally in basal half, tapered to subacute apex, 2 stout setae on midline, one behind other. Aedeagus short, slender, strongly sinuous above sharp subapical bend. Inferior appendages long, stout, tapered from base to rounded apex, deflected to side at tip; 1 heavily sclerotized subapical tooth, a group of lateral peg-like setae.

Female. Length of anterior wing, 2.5 mm. Head (Pl. 1H) differs from male in wider separation of dorsal setose caps, absence of scent organs and presence of dense hair flanking short medial suture. Antennae (Pl. 1I) shorter than in male, similar in form but without placoid sensilla, 22-segmented, bicoloured: proximal 11 segments dark, followed by 4 light and 7 dark segments. Genitalia (Pl. 2A,B):- Abdominal segment VIII heavily sclerotized. Sternite VIII with small ovoid mesal sclerotization; apex produced, triangular, tip rounded, 4 strong marginal setae on each side. Tergite VIII with excavated apical margin, 4 strong setae on each side. Segments IX and X fused, 2 stout cerci at apex.

Fully grown larva (Pl.87A). Sclerotized parts generally dark brown, thoracic nota with dark postero-lateral margins.

Pupa. No distinguishing features.

Case (Pl. 87A). Neatly constructed from fine sand; elongate-ovoid in profile, slightly narrower than in scamandra. Length of pupal case, 3.0-3.8 mm.

Biology. Final instar larvae and pupae have been picked from rocks and stones in flowing water. H. robusta is indistinguishable from scamandra in the field and occurs sympatrically in some habitats in north-central and E Victoria; it is not known whether they share the same micro-habitat. Despite regular and extensive sampling in these areas by survey teams from the Museum of Victoria, records are few, with adults taken only from November to March, the larger samples in February and March. Few immatures have been collected; larvae, pupae and empty cases were taken in December in the Yarra valley.

Distribution. Central and E Victoria.

Hydroptila tasmanica Mosely

(Pl. 2C-F)

Hydroptila tasmanica Mosely, 1934: 147-9; Mosely & Kimmins, 1953: 509-10; Neboiss, 1977: 40-1; Wells, 1978: 749-51.

Holotype ♂, paratype ♂, Tasmania, Wilmot, 9.i.1917, BMNH; paratypes 1♂, 1♀, same data, ANIC.

Adults (modified after Wells 1978)

New descriptions were given by Wells (1978) as the original figures omitted important features; *tasmanica* is distinguished from *robusta* by the acuminate wings, neuration and details of male and female genitalia.

Anterior wing: r-m at M_2-M_{3+4} fork, A_3 absent; jugal lobe present, although omitted from Mosely's figures; posterior wing with oblique crossvein between Cu_2 and A.

Male. Length of anterior wing, 3 mm. Genitalia (Pl. 2C,D):- Lateral arms of dorsal plate more divergent than in *robusta* (a small, triangular median lobe is present but was omitted from original figures): subgenital plate narrower, acuminate apically, paired mesal setae not on midline; aedeagus only slightly sinuous, without sharp subapical bend; inferior appendages thinner, cylindrical.

Female. (In poor condition: head damaged and antennae missing.) Length of anterior wing, 3 mm. Genitalia (Pl. 2E,F):- Differ from robusta as follows: sternite VIII with 10 strong marginal setae, without ovoid sclerotization; tergite VIII broadly and deeply excised apically, excision flanked by lobes, 2 strong setae on each side.

Immatures and habitat unknown.

Distribution. Tasmania.

Hydroptila scamandra Neboiss

(Pls 3A-G; 83; 84; 85A-E; 119C,D)

Hydroptila scamandra Neboiss, 1977: 41; Wells, 1978: 751-52.

Holotype ♂, paratype ♂, Tasmania, Upper Scamander, Scamander River, 9.ix.1972, NMV; homeotype ♀, Tasmania, Evandale, 1.iii.1967, ANIC.

Adults (modified after Wells 1978)

Often associated with other Hydroptila, but male is distinguished by its small size, dark colour, short, stout antennae, long strap-like subapical process on aedeagus; and female by heavily sclerotized abdominal segment VIII with ventral sclerotization.

Head as in robusta; wings of same shape. Anterior wing with r-m slightly beyond M_2-M_{3+4} fork; posterior wing with r-m at M_{2+3}-M_{3+4} fork.

Male. Length of anterior wing, 2.5 mm. Antennae (Pl. 3D) 28-segmented, bicoloured: proximal 17 segments dark, followed by 2 whitish and 9 dark segments; 1st 2 segments elongate; terminal segment conical; intermediate segments quadrate with scattered round placoid sensilla (Pl. 122E). Genitalia (Pl. 3A-C):- Abdominal segment IX short, lateral margins extended into membranous leaf-like processes, rounded apically. Dorsal plate trilobed; lateral arms convergent, rounded apically and overlapping a membranous median lobe which is almost equal in length to the lateral arms and truncate at apex. Subgenital plate slightly shorter than dorsal plate, broad at base and tapered to narrow, rounded apex; pair of stout setae near base. Aedeagus with strap-like subapical process. Inferior appendages with narrow trunk, broadly dilated posteriorly in lateral view; one heavily sclerotized subapical tooth, 5 lateral peg-like setae.

Female. Length of anterior wing 2.7 mm. Antennae (Pl. 3E) short, 23-segmented, not noticeably bicoloured; segments elongate cylindrical; few placoid sensilla (Pl. 122F). Genitalia (Pl. 3F,G):- Abdominal segment VIII heavily sclerotized: sternite with Y-shaped ventral sclerotization; apex broadly rounded, 10 strong marginal setae; tergite excavated posteriorly, mesal lobe and row of 6 strong setae offset from apical margin.

The genitalia of this species show considerable variability, some of which may be an artefact caused by preservation.

In some males inferior appendages, subgenital plate and dorsal plate are about equal in length; in others inferior appendages are about equal to subgenital plate but half to two-thirds as long as dorsal plate. Apex of subgenital plate may be rounded, truncate or excavated. Subapical process of aedeagus may be longer than, equal to, or shorter than aedeagus. In females variation occurs in number of strong setae on apical margin of tergite VIII (from 6 to 8), and in shape of the apex of sternite VIII, which may be broadly concave or broadly rounded.

Fully grown larva (Pls 83; 84; 85A,B). Sclerotized parts pale honey to brown, with dark brown to black postero-lateral markings on thoracic nota. Lengths of head and femur exceed their widths.

Pupa (Pl. 85C-E). Labrum broadly rounded; 1 pair of vestigial setae on anterior margin and 1 pair of long latero-basal setae.

Case (Pl. 83A). Ovoid to bean-shaped valves covered entirely with sand grains and occasional particles of detritus. Length of pupal case, 2.8-3.5 mm.

Biology. Immatures are collected in flowing water on rocks, often amongst filamentous green algae. Larvae are usually on upper surfaces, often in riffles on downstream edges of cobbles or rocks; pupae are attached to sides or undersurfaces of rocks or cobbles, generally in crevices if on exposed surfaces. Numerous adults are often taken at lights; adult collections are dated October to March, those of mature larvae and pupae, July to April.

Distribution. Eastern Australia; Tasmania; Fleurieu Peninsula, S Australia.

Hydroptila calcara Wells

(Pls 4; 87B)

Hydroptila calcara Wells, 1978: 753-55.

Holotype ♂, paratypes 10♂, 11♀, New South Wales, MacLaughlin River, nr Ando, 20.xi.1965, NMV.

Adults (modified after Wells 1978)

Small, grey-brown; head as in robusta, antennae long, thin. Wings (Pl. 4A) with scattered, erect black hairs; apices brown, upturned, acute; anterior wing with r-m beyond M_2-M_{3+4} fork; posterior wing with r-m anterior to M_{1+2}-M_{3+4} fork; A_2 present.

Male. Length of anterior wing, 2.4 mm. Antennae (Pl. 4B) 33-34-segmented, segments elongate, cylindrical; scattered placoid sensilla (as in acinacis (Pl. 119B)) on all but 1st, 2nd and last. Genitalia (Pl. 4C-E):- Abdominal segment IX short, lateral processes as in scamandra. Dorsal plate trilobed: lateral lobes short, overlying broad, membranous median lobe of almost twice their length; median lobe broadly truncate apically, lateral margins produced to form long recurved processes. Subgenital plate equal in length to dorsal plate, broad based, narrowing posteriorly, lateral margins folded; 2 stout mesal setae at base. Aedeagus slender with short, stout subapical spur. Inferior appendages large, obliquely truncate in ventral view, clavate in lateral view; one heavily sclerotized subapical tooth.

Female. Length of anterior wing, 2.4 mm. Antennae 23-segmented, shape as in male, few placoid sensilla. Genitalia (Pl. 4F,G):- Segment VIII long. Sternite VIII broad posteriorly, apex rounded; 8 strong marginal setae. Tergite VIII with deep V- or U-shaped excision; 4 strong setae on each side and 4 at base of excision, which is sometimes broader than shown.

Fully grown larva. Sclerotized parts generally dark tan, distal margins of thoracic nota black; head longer than wide.

Pupa. Labrum broadly rounded with pair of short anterior marginal setae and pair of elongate basal setae.

Case (Pl. 87B). Slightly more rounded than in other Australian *Hydroptila*; sand grains sparse. Length of pupal case, 2.8-3.4 mm.

Biology. Immatures found on undersides of stones in slow flowing water. Records for adults range from November to April, but the only sample of final instar larvae and pupae available is dated December. Collections from all localities are small, which suggests that it is not abundant.

Distribution. E New South Wales; central Victoria; Fleurieu Peninsula, S Australia.

Hydroptila acinacis Wells

(Pls 5A-E; 87F,G; 119B)

Hydroptila acinacis Wells, 1978: 755-56.

Holotype ♂, paratypes 10♂, 11♀, Victoria, Koornalla, Traralgon Creek, 26.ii.1974, NMV.

Adults (modified after Wells 1978)

Small dark-brown to reddish-brown, closely resembling calcara, but distinguished in male by the sharp right-angled spine on aedeagus, and shorter, more sharply recurved lateral processes on apex of dorsal plate. Females have a narrower apex on sternite VIII. In posterior wing r-m arises at M_2-M_{3+4} fork.

Male. Length of anterior wing, 2.4 mm. Antennae 33-35-segmented, bicoloured: proximal 22-24 segments dark, followed by 4 light and 9 dark segments; sensilla (Pl. 119B) as in calcara. Genitalia (Pl. 5A-C):- Differ from calcara as follows: processes on apex of dorsal plate shorter, more sharply recurved, finely serrate; subgenital plate shorter than dorsal plate, margins not folded, produced into finger-like process posteriorly; aedeagus sinuous, with sharp spine inserted at right angles further from apex than corresponding spur in calcara; inferior appendages tapered apically in ventral view.

Female. Length of anterior wing, 2.5 mm. Distinguished from calcara with difficulty as follows: apex of sternite VIII narrower, produced further, 6 of the 8 strong marginal setae clustered mesally; tergite VIII deeply excised, sides of excision stepped, without row of 4 setae at base (Pl. 5D,E).

Fully grown larva. Distinctive amongst Australian *Hydroptila* in that the larva (Pl. 87F) is more compact; head rounded, about as long as wide, mouth more ventral; thoracic nota overlapping completely to cover dorsa of thoracic segments; forelimb (Pl. 87G) stout, tibia and femur almost triangular in lateral view. Sclerites pale to dark brown.

Pupa. Indistinguishable from *calcara*.

Case. Sometimes similar to that of *calcara*; with sparse sand grains, with tightly packed covering of sand, or rarely almost entirely built of algal filaments. Length of pupal case, 3.8-4.1 mm.

Biology. In flowing water. Adults collected from November to May - generally in small numbers.

Distribution. Tasmania; Otway Ranges and north-central Victoria; Jindabyne, New South Wales.

Hydroptila losida Mosely

(Pls 5F-I; 86; 87D)

Hydroptila losida Mosely, 1953: 505; Wells, 1978: 756-57.
Holotype ♂, paratype ♂, Queensland, Eidsvold, ANIC.

Adults (modified after Mosely 1953, Wells 1978)

Large, pale fawn-brown, with cream hairs on head, and mottled wings with dark brown tips and scattered patches of erect black hair.

Male. Distinguished by paired sclerotised teeth on inferior appendages. Length of anterior wing, 2.2-3.5 mm. Antennae 30-31-segmented; with numerous placoid sensilla. Genitalia (Pl.5F,G):- Abdominal segment IX retracted into VIII; lateral processes acuminate apically. Dorsal plate trilobed; lateral lobes longer than median lobe, apices obliquely truncate; median lobe rounded apically. Sub-genital plate tapered distally, apex truncate to slightly concave. Aedeagus usually appears to be bifid with sheath widely separated distally. However, in fresh material the sheath is closely adpressed to the aedeagus. Inferior appendages cylindrical with paired sclerotised teeth; without stout peg-like setae.

Female. Length of anterior wing, 3.2 mm. Head as in robusta; wings as in male (Mosely and Kimmins 1953). Antennae stout, 24-26-segmented, bicoloured: proximal 13-15 segments dark, followed by 4 light and 7 dark segments; few placoid sensilla. Genitalia (Pl. 5H,I):- Recognized by pair of triangular lateral sclerotizations on sternite VIII. Segment VIII lightly sclerotized: sternite produced at apex, triangular, with 4 strong marginal setae on each side; tergite deeply and broadly excised, 4 strong setae on each side of excision.

Fully grown larva. Usually larger than other species; sclerotized regions pale honey-coloured; dark posterior margins on thoracic nota. Indistinguishable from scamandra except for less prominent upper accessory hook on anal claw.

Pupa. Labrum with 2 pairs of vestigial anterior marginal setae and 2 pairs of basal setae.

Case (Pl. 87D). Usually constructed from green filamentous algae, occasionally with some sand incorporated; rarely sand only. Cases rather untidy, generally elongate-ovoid, sides straight to slightly concave. Length of pupal case, 3.3-5.6 mm.

Early larva (Pl. 86). Details as in generic diagnosis.

Biology. Immatures in moderate to slow flowing water, brackish to fresh, on stones and rocks, generally amongst green filamentous algae. This is one of the more tolerant and widespread forms. In Queensland and S Australia adults of *losida* have been taken almost throughout the year: in warmer areas it is probably multivoltine. Despite extensive collecting in Victoria, few samples have been taken, and all are from localities to the NE and W of Melbourne, from December to March; in cooler, wetter areas there may be only one generation per year. Until further information is available, W Australian data, with collections only in October and November, are probably best interpreted as reflecting activities of collectors.

Distribution. Australia-wide, excepting Tasmania and NW Western Australia; New Caledonia (Wells, unpublished data).

Hydroptila obscura Wells

(Pls 6; 85F; 87C; 118D)

Hydroptila obscura Wells, 1978: 578-79.

Holotype ♂, paratypes 5♂, Queensland, Palmer River, 20.vi.1971, ANIC; paratype 1♀, Queensland, Broken River, Eungella National Park, 27.v.1971, ANIC.

Adults (modified after Wells 1978)

Although similar to other Australian species in general appearance, *obscura* is unique as follows: antennae stout in the basal half, thinner distally (Pl. 6B,C); anterior wing lacking M_1 and therefore fork 3 (Pl. 6A). Genitalia are also distinctive.

Male. Length of anterior wing, 2.0 mm. Antennae (Pl. 6B,C) 32-segmented; scattered placoid sensilla on all but 1st, 2nd and last segments, large sensory pit on each segment (Plate 118D). Genitalia (Pl. 6D-F):- Abdominal segment VIII covered with dense hair obscuring genitalia. Segment IX retracted into VIII; lateral processes as in *scamandra*. Dorsal plate distinct from that of *robusta*, *tasmanica*, *scamandra* and *losida* in being a single, long, membranous lobe; broad basally, tapered to narrow neck and dilated towards notched apex. Subgenital plate broad at base, tapered to long, narrow, finger-like process; pair of stout mesal setae at base. Aedeagus simple, slender; small apical notch. Inferior appendages expanded laterally at c. $^{2}/3$ their length, then constricted towards apices; 2 stout, peg-like setae on ventral, non-sclerotized wart in position of sclerotized tooth in other Australian species.

Female. Length of anterior wing, 2.3 mm. Antennae 27-segmented with few placoid sensilla. Genitalia (Pl. 6G,H):- Abdominal segment VIII sclerotized: sternite with Y-shaped ventral sclerotization anterior to ovoid mesal sclerotization, apical margin produced into median lobe bearing 4 strong setae; tergite with 2 lateral excavations in apical margin, pair of strong setae on each side.

Fully grown larva. Indistinguishable from scamandra and losida.

Pupa. Labrum with 1 pair of rudimentary anterior marginal setae, 2 pairs of basal setae. Postsegmental hook plates more rounded than in scamandra (Pl. 85F)

Case (Pl. 87C). Highly distinctive, constructed of regularly placed filaments of green algae (generally Spirogyra sp.); elongate ovoid. Length of pupal case, 3.3-4.1 mm.

Biology. Collected from rivers and streams with growths of filamentous algae; larvae and pupae are found on rocks and cobbles, amongst the algae. Adults taken from April to June in N Queensland, October in N New South Wales.

Distribution. NE Queensland to NE New South Wales.

Hydroptila sinuosa Wells

(Pl. 7A-E)

Hydroptila sinuosa Wells, 1978: 759-61.

Holotype ♂, paratype ♂, Queensland, Little Mulgrave River,
28.vi.1971, ANIC.

Adults (modified after Wells 1978)

Males red-brown with mottled vestiture and scattered erect black hairs on wings. H. sinuosa is unique amongst Australian species in having long lateral processes and prominent ventral setose lobes on segment IX, and a densely hairy subgenital plate. In posterior wing, M_{1+2} arises from r-m and R_1 is present (Pl. 7A), a situation also seen in incertula (Pl. 7F), but incertula does not share other features listed. Similar ventral setose lobes occur in H. bispina Kimmins from New Guinea (Kimmins 1962) and H. triloba Kimmins from Guadalcanal (Kimmins 1957), but in incertula, bispina and triloba the dorsal plate is trilobed, while in sinuosa it is simple. Descriptions of wings of bispina and triloba are not available.

Male. Length of anterior wing, 2.2 mm. Head as in robusta. Antennae (Pl. 7B) short, stout, 23-segmented; basal segment swollen; last segment conical; intermediate segments quadrate with scattered placoid sensilla. Genitalia (Pl. 7C-E):- Abdominal segment IX elongate; lateral processes long, membranous with rounded apices; pair of ventral setose lobes anterior to inferior appendages. Dorsal plate a single membranous lobe, narrowing towards excised apex. Subgenital plate hirsute, narrow at base, rounded medially and tapered to apex. Aedeagus slender with long sinuous process extending beyond apex. Inferior appendages small, folded posteriorly in ventral view, spatulate in lateral view, with one sclerotized tooth and group of lateral peg-like setae.

Female, immatures and habitat unknown.

Distribution. NE Queensland.

Hydroptila incertula Mosely

(Pls 7F-H; 8A,B; 87E; 120A,B)

Hydroptila incertula Mosely, 1934: 145-7; Mosely and Kimmins, 1953: 507-9; Wells, 1978: 760-61.

Holotype ♂, Queensland, Brisbane, BMNH.

Adults

When I reviewed Australian *Hydroptila* (Wells 1978), *incertula* was only known from the holotype, which is in poor condition. Several minor additions were made to the diagnosis, viz., presence of jugal lobe and A_3 on anterior wing, and comments were made on the likely affinities of the species. As a result of recent collecting in N Queensland, further specimens are now available, and a female is here described; *incertula* has also been recorded from New Guinea (Wells 1984b), and Vanuatu (Kelley pers. comm.).

Male (modified after Mosely 1934, Wells 1978). Length of anterior wing, 2.5mm. Antennae 29-segmented; segments with numerous round and rosetted placoid sensilla (Pl. 120A) and *s. coeloconica* (Pl. 120B).

Genitalia (Pl. 7G,H):- Similar to *sinuosa* but without lateral processes or ventral setose lobes on segment IX; dorsal plate trilobed; aedeagus simple, slender, twisted towards apex.

Female. Length of anterior wing, 2.0-2.6 mm. Antennae 24-segmented. Genitalia (Pl. 8A,B):- Sternite VIII with broadly V-shaped apical excision and highly distinctive rugose mesal gland.

Fully grown larva. Indistinguishable from *scamandra*, *losida* or *obscura*.

Pupa. Labrum with 1 pair of anterior marginal setae, 2 pairs of basal setae; presegmental hook-plates with fewer spinules than in other species.

Case (Pl. 87E). Elongate ovoid; valves composed of a ragged mixture of algal filaments, sand and detritus. Length of pupal case, 3.0-3.5 mm.

Biology. Immatures on edges of rocks and cobbles in flowing water.

Distribution. SE Queensland; NW Western Australia; Vanuatu (Kelley pers. comm.); SE New Guinea (Wells 1984b).

3.2.2 The Oxyethira group

Marshall, 1979: 192.

The diagnosis of this group is redefined as follows:-

Adults distinguished by tentorial arms reduced medially; antennal hair in a basal whorl on each flagellar segment; ocelli present, 3; spur formula, 0,3,4 or rarely 0,2,4; wings without jugal lobe; venation variable; female terminalia a modified oviscapt. Larvae have fused submental sclerites; distinct dorsal head sutures, rarely fused; mid and hind legs usually elongate, rarely all legs subequal; trichobothria on fore femora and trochanters; accessory hooks on anal claws; no caudal gills.

Genus Xuthotrichia Mosely

Xuthotrichia Mosely, 1934: 139-40; Mosely & Kimmins, 1953: 518-19; Marshall, 1979: 209-10; Wells, 1979a: 312-13.

Type-species: Xuthotrichia ochracea Mosely, by original designation.

Xuthotrichia Mosely was erected for "four Australian species bearing a close resemblance to one another in the shape, neuration and colouration of the wings" (Mosely 1934). However, in gross features of the male genitalia at least two of these species are strikingly different from the type, Xuthotrichia ochracea Mosely, although they have much in common with a large group of new species which otherwise agree with Mosely's generic diagnosis.

Most hydroptilid genera are based on tibial spur count, presence or absence of ocelli, wing shape and neuration, number and relative sizes of antennal segments, and size of segments of maxillary palpi. Genitalic features are seldom considered. Nor, indeed, are presence or absence of dorsal setose warts on the head, shapes of meso- and metascutellae, although these are conservative at this level.

After considerable deliberation I split Xuthotrichia using male genitalic features. One of the divergent species referred to above, Xuthotrichia simplex Mosely, was described by Neboiss (1977) as Hellyethira vallecula, and thus Hellyethira was already established with Hellyethira simplex (Mosely), as the type-species. To this I transferred 2 more of Mosely's species, now H. eskensis (Mosely) and H. fimbriata (Mosely), so leaving Mosely's type-species X. ochracea alone in Xuthotrichia (Wells 1979a).

Diagnosis

Adults (modified after Marshall 1979, Wells 1979)

Male. Length of forewing, 3 mm. Spurs, 0,3,4. Ocelli 3. Post-occipital lobes small, widely separated, without associated scent organs; tentorial arms reduced to fine strands medially. Antennae long, thin, c. 41-segmented in male; segments each with basal whorl of fimbriate hair; basal segment short and rounded, only slightly longer than others. Mesoscutellum subtriangular, anterior margin convex; metascutellum rounded. Wings mottled, fawn-brown to bronze; lanceolate, apices acute; apical forks 1 & 2 in anterior wing; no apical forks in posterior wing. Abdominal segment IX of male deeply excised dorsally and ventrally, posterolateral margins produced beyond dorsal plate into bract-like lobes. Inferior appendages reduced, spiny. Slender mesal process on abdominal sternite VII.

Female, immatures and habitat unknown.

Distribution. Tully, and Brisbane, Queensland; Traralgon, Victoria.

Xuthotrichia ochracea Mosely

(Pl. 9A,B)

Xuthotrichia ochracea Mosely, 1934: 140-1; Mosely & Kimmins, 1953: 520-1; Wells, 1979a: 312-13.

Holotype ♂, Queensland, Brisbane, 30.ix.1920, Tillyard, BMNH.

Adults (modified after Mosely 1934, Wells 1979a)

Male. Length of anterior wing, 3.0 mm. Genitalia (Pl. 9A,B):- Segment IX deeply excised dorsally and ventrally, lateral margins extended posteriorly to form large bracteose lobes with short setae on outer surfaces; inferior appendages reduced, spiny, heavily sclerotized; dorsal plate small, indistinct, shorter than lateral lobes of segment IX.

Female, immatures and habitat unknown.

Distribution. See generic diagnosis.

Genus Hellyethira Neboiss

Hellyethira Neboiss, 1977: 42; Wells, 1979a: 312-329; 1983: 632-34.

Type-species: Xuthotrichia simplex Mosely, by original designation.

Since my review of Hellyethira (Wells 1979a), 2 further species have been described (Wells 1983) bringing the total to 18, while Neboiss (1982) described the female of H. litua Wells. Within this genus a number of pairs of sister species are recognized, based on genitalic features, e.g. H. eskensis Mosely and H. sentisa Wells, H. cubitans Wells and H. exserta Wells, and several distinct lineages are apparent; yet endeavours to demarcate species groups are foiled by the gradualistic nature of changes in character states from species to species within the lineages.

The male genitalia are of the basic hydroptilid form with a full complement of parts, and species are easily distinguished by genitalic differences. It is more difficult to generalize about the female terminalia, which are rather variable, although basically in the form of a short modified oviscapt.

The larva illustrated in Riek (1970), previously believed to be Xuthotrichia, is probably a species of Hellyethira: the case is characteristically envelope or purse-like and the larva itself has elongate mid and hindlimbs, with all segments about equal in length. However, no reliable characters have been found which separate immatures of Hellyethira and Acritoptila, and while known larvae of Australian Acritoptila can be distinguished, this is not so for all New Caledonian species (Wells, unpublished data).

Detailed figures of adults of H. simplex (Mosely) illustrate diagnostic features of the genus. Immatures of 10 of the 18 species of Hellyethira are described, and keys to males and cased mature larvae are provided. Mature larvae are close morphologically but often have recognizable colour patterns; many cases are readily recognized but a few are inseparable; no distinguishing pupal characters have been found.

Generic features of mature larvae and pupae are represented in figures for H. simplex, while illustrations of other species show distinctive colour markings and cases. A key to cased mature larvae is given.

Early instar larvae have been collected for simplex (Pl. 90A) and several other unidentified species. They closely resemble early Oxyethira as illustrated by Nielsen (1948) but have more elongate caudal setae.

Notes are given below on the mode of case construction in simplex.

Diagnosis

Adults (modified from Wells 1979a)

Length of forewing, 1.8-3.8 mm. Spurs, 0,3,4. Ocelli 3. Post-occipital lobes on head small, widely separated, without associated scent organs; anterior tentorial arms reduced to fine strands medially. Antennae long, thin, generally pale in proximal $^2/_3$, dark distally; 35-42-segmented in male, 25-31 in female; basal segment short and rounded, only slightly longer than others; s. placodea (Pl. 120D) and auricillica (Pl. 121A) common on all but 2 basal segments and terminal segment of males (Pl. 124A), rare on female antennae (Pl. 124B). Mesoscutellum sub-triangular with convex anterior margin, metascutellum rounded. Wings mottled, fawn/brown, lanceolate, apices acute; apical forks 1 & 2 in anterior wing, fork 2 only rarely present in posterior wing. Sternal glands present on abdominal segment V. Abdominal segment IX of male widely excised ventrally; inferior appendages lobose, wholly or partly membranous; paired parameres present below subgenital plate. Female genitalia a short modified oviscapt; variable in form; without obvious glandular structures.

Fully grown larva (Pl. 88B). Body showing strong lateral compression; abdomen with segments I and II each scarcely larger than metathorax, forming narrow "waist"; segments III to VIII greatly distended, with "back" of segment VIII overhanging segment IX, abdomen strongly curved; limbs long, slender, with mid and hindlimbs 2.5-3.0 times length of forelimbs; all segments of mid and hindlimbs about equal in length.

Head (Pl. 89A) ovoid in dorsal and lateral views, sutures usually distinct; postmental sclerites (Pl. 89D) fused to form crescentic or triangular plate; anterior ventral apotome broad and shallow. Labrum (Pl. 89C) small, sclerite symmetrical, slightly tapered anteriorly, lower membranes tipped with brushes of hair; setae slender, longest almost 2x length of sclerite; tormae short, stout. Antenna, (Pl. 89B); with apical sensillum about ½ length of basal segment, seta far longer than antenna. Mandibles (Pl. 88E) asymmetrical: left with small denticle on inner distal margin, broad upper and lower cutting blades and dense bristle-like penicillus between blades; right with small denticle on inner distal margin.

Thorax (Pls 88B; 89A,E). Nota saddle-shaped in dorsal view, lateral margins excised posteriorly; median and paired anal sclerites on pro- and mesothorax, anal sclerites fused to mesonotum, oral sclerite only on metathorax. Pre-episternite free on propleuron only (Pl. 88B,D). Mid and hindlimbs (Pl. 88B) with femur, tibia and tarsus sub-equal in length, tarsal claws close to ½ length of tarsi; inner ventral femoral and trochantal hairs on forelimb slender, ciliate (trichobothria) (Pl. 88C).

Abdominal segments III to VIII with round dorsal chloride epithelia; tergites on segments I and IX; tergite IX trapezoidal with median pair of setae on anal margin far longer than tergite. Anal prolegs (Pls 88B, 89G) protruding postero-laterally; claw (Pl. 89F) with four accessory hooks; no caudal filaments.

Pupa. Labrum (Pl. 90B) broadly rounded, 2 pairs of vestigial anterior marginal setae, one pair of basal setae. Mandibles (Pl. 90C) slender, inner distal margins finely serrate; pair of setae baso-laterally. Hook plates (Pl. 90D): presegmental plates form broadly rounded flanges with marginal and scattered spinules; postsegmental plates rounded, with spinules evenly distributed.

Case (eg. Pl. 88A). Laterally compressed with 2 equal valves; always far larger than larva; from rectangular to "bonbon" shaped; materials vary from secretion only to secretion covered with fine sand, sometimes incorporating algal filaments. Early cases are square to rectangular and constructed the width of the final case (cf. Hydroptila); subsequent increases in size are made at both open ends. At pupation, cases are attached to the substrate at 1-4 corners, usually by attachment discs at the end of ligaments; ends are sealed.

Early larva (Pl. 90A). Resembles *Oxyethira* Eaton (Nielsen 1948) by having short forelimbs and elongate mid and hindlimbs, at least 2x length of forelimbs. Tibial process of forelimb well developed. Head more elongate than in *Hydroptila* or *Maydenoptila* and more rounded posteriorly, ecdysial sutures fused. Tergites of body difficult to discern, lateral body setae shorter than width of body, caudal setae longer than body. Anal prolegs fused, claws short, only slightly curved. No caudal filaments. Sclerites of body covered entirely by tiny spinules.

Biology. Various species are found in still and flowing water, fresh to slightly brackish; generally on rocks and cobbles, on submerged macrophytes, or amongst filamentous green algae. Frequently several species have been taken at the same light or from the same body of water; immatures of several species have often been found on the same rock or cobble.

Distribution. Throughout mainland Australia and Tasmania, with some widespread and presumably tolerant species and others with localised distributions; one Australian species is also known from New Caledonia (Wells, unpublished data).

Key to males of Hellyethira Neboiss

1 Parameres more-or-less symmetrical 2

Parameres distinctly asymmetrical 14

2(1) Parameres intersecting medially. Dorsal plate with stout apicolateral spines or apicoventral "ruff" of weak, pale spines 3

Parameres widely separated or converging apically, never intersecting. Dorsal plate without spines or spines subapical 5

3(2) Inferior appendages divided distally into 4 lobes, dorsal lobe obscured in ventral view. Dorsal plate flared or tapered distally 4

Inferior appendages trilobed: ventral lobe hairy, membranous, other 2 smooth, sclerotized. Dorsal plate rounded apically (Pl. 14E,F) .... sentisa Wells

4(2) Dorsal plate expanded distally, 3 pairs of dark spines apicolaterally (Pl. 14A,B) .... eskensis (Mosely)

Dorsal plate tapered, triangular in dorsal view, median "ruff" of weak spines apicoventrally (Pl. 15A,B) .... veruta Wells

5(2) Inferior appendages with finger-like basal lobes 6

Inferior appendages without finger-like basal lobes 7

6(5) Segment IX with U-shaped excavation. Inferior appendages long and curved with small basal lobes. Subgenital plate shorter than dorsal plate (Pl. 11A-C) .... basilobata Wells

Segment IX squarely excavated. Inferior appendages with long basal lobe and bract-like median lobe. Subgenital plate longer than dorsal plate, lateral margins rolled ventrally (Pl. 11D,E) .... allynensis Wells

7(5) Inferior appendages almost cylindrical, curved and tapered slightly, with or without dorsal processes 8

Inferior appendages stout, dissected distally into 2 or 3 lobes 10

8(7) Inferior appendages simple, without dorsal processes. Parameres bilobed: one lobe spiny, other membranous, finger-like 9

Inferior appendages each with simple ventral lobe and plate-like dorsal process. Parameres straight, spiny (Pl. 10A,B) .... simplex (Mosely)

9(8) Aedeagus swollen basally and apically, constricted and twisted medially. Spiny lobes of parameres inturned at apices (Pl. 12A-C) .... cubitans Wells

Aedeagus narrow basally, slightly dilated distally, not twisted medially. Spiny lobe of parameres tapered, apices acuminate (Pl. 12D-F) .... exserta Wells

10(7) Dorsal plate adorned by spines or membranous spinules 11

Dorsal plate simple membranous, without spines or spinules (Pl. 13B,C) .... dentata Wells

11(10) Dorsal plate without subapical, collar-like constriction 12

Dorsal plate with subapical, collar-like constriction, from which arises a pair of horn-like processes (Pl. 17A,B) .... cornuta Wells

12(11) Dorsal plate entirely membranous; spinules, if present, not sclerotized 13

Dorsal plate with paired sclerotized spines subapically (Pl. 20A-C) .... vernoni Wells

13(12) Dorsal plate with prominent membranous bract-like lateral processes (Pl. 20-E,F) .... ramosa Wells

Dorsal plate without lateral processes; lateral margins fimbriate (Mosely 1934, Figs 13-15) . fimbriata (Mosely)

14(1) Left paramere stout, more-or-less hammer-shaped. Lateral lobes of inferior appendages tipped by inturned setae 15

Left paramere not hammer-shaped. Lateral lobes of inferior appendages without apical setae 17

15(14) Right paramere without subapical ring of hair. Inferior appendages asymmetrical, left bilobed distally 16

Right paramere with heavily sclerotized tip and ring of hair subapically. Inferior appendages asymmetrical, both 3-lobed (Pl. 18A-C) .... <u>malleoforma</u> Wells

16(15) Inferior appendages both bilobed. Right paramere tapered and sinuous (Pl. 19E,F) .... <u>litua</u> Wells

Inferior appendages completely asymmetrical: right divided distally into many indistinct lobes, left bilobed. Right paramere terminating in beak-like spine (Pl. 19A,B) .... <u>multilobata</u> Wells

17(14) Left paramere with apex enveloped in balloon-like membrane, a blunt arm subapically; right paramere stout, curved, spiny. Inferior appendages bilobed, inner lobe long, slender, outer lobe stout (Pl. 16C,D) .... <u>pulvina</u> Wells

Both parameres stout, spiny. Inferior appendages bilobed distally, both lobes stout (Pl. 16A,B) .... <u>loripes</u> Wells

Key to cased larvae of Hellyethira Neboiss*

1 Case of secretion only 2

Case with sand, algae, or detritus incorporated 6

2(1) Case with distinct dorsal and ventral seams, in profile with 1 axis of symmetry 3

Case without distinct dorsal and ventral seams, in profile with 2 axes of symmetry 4

3(2) Case always a simple secretion purse, without accessory structure (Pl. 91G) .... cubitans Wells

Case occasionally indistinguishable from that of cubitans but usually with broad shield surrounding purse case, case protruding through a median dorsal slit (Pl. 91I,J)............. .... exserta Wells

4(2) Larva with heavily sclerotized pronotum, other thoracic nota with dark posterior bands (Pl. 88B) ...... simplex (Mosely)

Larva with pronotum usually pale, with or without dark bands posteriorly 5

5(4) Larva with all thoracic nota pale (Pl.93F) .... litua Wells

Larva with thoracic nota pale except for narrow pigmented bands (Pl. 93D) .... malleoforma Wells

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*Immatures of sentisa Wells, ramosa Wells, fimbriata (Mosely), pulvina Wells, loripes Wells and veruta Wells unknown.

6(1) Case with distinct dorsal and ventral seams, only 1 axis of symmetry in profile 7

Case without distinct dorsal and ventral seams, 2 axes of symmetry in profile (except cornuta, which may show slight tapering at each end and rounding of upper angles) 8

7(6) Ventral margin of case straight to slightly convex, dorsal margin rounded at ends, with median notch or concavity (Pl. 91E) .... allynensis Wells

Ventral margin of case strongly convex, dorsal margin straight to broadly and shallowly concave (Pl. 91A) .... basilobata Wells

8(6) Larva with posterior half of head darkly pigmented, anterior section pale 9

Larva with scattered dark spots on head 10

9(8) Thoracic nota with extensive darkly pigmented areas; case of sand, algae and other detritus, roughly accreted (Pl. 92C,D) .... vernoni Wells

Thoracic nota pale, with narrow darkly pigmented bands; case of fine sand grains, neatly arranged (Pl. 93A,B) .... cornuta Wells

10(8) Spots large and few; case mainly of sand grains (Pl. 92E,F) .... eskensis (Mosely)

Spots smaller and more numerous than in eskensis; case mainly of diatoms and detritus, little sand incorporated (Pl. 92A,B) .... ramosa Wells

Hellyethira simplex (Mosely)

(Pls 9C-F; 10; 88; 89; 90; 116E,F; 120D; 124A,B)

Xuthotrichia simplex Mosely, 1934: 45; Mosely & Kimmins, 1953: 521-23;
by original designation.
Holotype ♂, Queensland, Warwick, October, BMNH.
Hellyethira vallecula Neboiss, 1977: 42-43.
Hellyethira simplex (Mosely), Wells, 1979a.

Adults (modified after Wells 1979a)

Male. Length of anterior wing, 2.7-3.8 mm. Antennae (Pls 9D; 116E,F; 120D; 124A) 40-segmented. Genitalia (Pl. 10A,B):- Sternite IX deeply and widely excavated. Dorsal plate with scattered membranous spinules. Subgenital plate membranous, excised apically. Parameres stout, straight. Inferior appendages symmetrical, ventral lobes membranous and setose, dorsal lobes meeting medially, apices rolled. (On dissection, these dorsal structures are seen to be part of the inferior appendages. They were described by Mosely (1934) as the "lower penis cover in the form of two horizontal plates with the apices rolled over, joined at the centre by a membrane"). Aedeagus narrow and twisted apically, swollen medially by dense, closely adpressed papillae, narrowed basally; spiral process wrapped around central canal. Mesal process on sternite VII long, slender with small acute basal spine.

Female. Length of anterior wing, 2.3-3.5 mm. Antennae (Pl. 124B), 30-31-segmented. Genitalia (Pl. 10C) distinguished by paired setose apico-lateral lobes on sternite VIII .

Fully grown larva (Pl. 88B). Head pale cream-fawn with median darkly sclerotized area on frontoclypeus; prothorax tan-brown with darker bands on anterior and posterior margins; meso- and metanota pale with small dark markings antero-laterally and dark band posteriorly; forelimbs pale, mid and hindlimbs with dark areas proximally on all segments except coxae; abdomen green in living animals, white in preserved specimens.

Head (Pl. 89A) with all ecdysial sutures distinct. Forelimb (Pl. 88C) with strongly recurved distal elements; tarsal claw subtended by single slender seta about ½ length of claw; tarsus with small blade-like seta and small comb on inner ventral margin; tibial process elongate, tipped by pair of flat setae and small comb. Tarsal claw of mid and hindlimbs thin, similar to forelimb (Pl. 88C).

Pupa. Labrum and hook plates as in Pl. 90B,D.

Case (Pl. 88A). Built of secretion only; more or less rectangular, occasionally with long sides slightly convex or notched medially; ends rounded, with no obvious dorsal or ventral side; size highly variable, length usually 3 times width. Length of pupal case, 4.6-6.2 mm.

Early larva. All early instars are similar to the 4th (Pl. 90A).

Biology. Generally found amongst filamentous green algae or on rocks and stones in streams and fresh still waters; the spidery, early larvae are found clambering amongst algae; pupae are usually on sides or under surfaces of rocks or submerged timber.

Adults have been raised from eggs laid in the laboratory. Eggs are laid in groups and development proceeds immediately. Larvae hatch within 3 weeks at 18-20°C. The duration of each early instar is from 3-6 days. During the 1st and 2nd instars the larva feeds on periphyton, but subsequent stages bite into algal filaments and suck out the contents. The 5th instar is completed in 3-4 weeks; the pupal stage takes about 3 weeks.

Records of adults are dated from April to December in Queensland, January to March in Tasmania, August to April in Victoria, September to February in South Australia and October to April in New South Wales; many samples contain large numbers of specimens. It is a common spring/summer species in temperate Australia, although abundant South Australian records show that mature larvae and pupae are present throughout the year.

Distribution. E Queensland; E New South Wales; Victoria; Tasmania; S South Australia.

Hellyethira basilobata Wells

(Pls 11A-C; 91A-D)

Hellyethira basilobata Wells, 1979a: 316-17.

Holotype ♂, paratype ♂, Victoria, Yarra River, below Upper Yarra Dam, 28.ii.1976, NMV; 2♂ paratypes, Victoria, 12 km SE Merrijig, Howqua River, 30.xi.1971, NMV.

Adults (modified after Wells 1979a)

Male. Resembles simplex in general appearance and colouration. Length of anterior wing, 2.8 mm; fork 2 absent in posterior wing. Antennae long, thin, 39-segmented. Genitalia (Pl. 11A-C):- Sternite IX deeply and roundly excavated. Dorsal plate broad, a short membranous process on each side; apex truncate. Subgenital plate broad, shorter than dorsal plate. Parameres long, finger-like, with apical setae. Inferior appendages large, membranous, setose, curving towards midline, with small basal lobe.

Female. Unknown.

Fully mature larva (Pl. 91B). Readily distinguished from most congeners by form of mid and hind tarsal claws.

Head, thoracic nota, pleura and limbs pale tan-brown; metanotum with darker bands on anterior and posterior margins; abdomen white in preserved specimens. Head more elongate and narrower than simplex, ecdysial sutures indistinct; submental sclerite fused, crescentic; anterior ventral apotome fused to parietal sclerite. Labral setae (Pl. 91C) shorter and stouter than simplex. Forelimb with tarsal claw subtended by a slender seta about ½ tarsal length; tarsus without brush on inner margin; tibial process short with curved, blade-like setae and simple brush. Mid and hind tarsal claws subtended by 3 setae about 2/3 length of claw (Pl. 91D).

Pupa. Indistinguishable from simplex.

Case (Pl. 91A). Two equal valves covered completely with fine sand grains; dorsal side concave in profile, ends rounded. Pupal case attached by 2 to 4 corners on undersides of rocks; length, 3-4 mm.

Biology. Larvae and pupae found on undersides of stones and rocks in moderately fast flowing streams and rivers. Adults taken from November to March; records of mature larvae scattered throughout the year.

Distribution. Otway Ranges, E and north-central Victoria; Tasmania.

Hellyethira allynensis Wells

(Pls 11D,E; 91E,F)

Hellyethira allynensis Wells, 1979a: 316-17.

Holotype ♂, paratype ♂, New South Wales, Upper Allyn River, 8.i.1958, ANIC.

Adults (modified after Wells 1979a)

Although close to *basilobata*, the male of *allynensis* is readily distinguished by its longer basal lobe and additional bract-like lobe on inferior appendages.

Male. Length of anterior wing, 2.1 mm. Antennae 36-segmented. Genitalia (Pl. 11D,E):- Sternite IX squarely excavated. Dorsal plate broad, truncate apically. Subgenital plate longer than dorsal plate, broad, lateral margins rolled ventrally. Parameres finger-like, longer than in *basilobata*, with long, sharp, inwardly directed apical setae. Aedeagus with long, slender, sclerotized terminal portion.

Female. Unknown.

Fully grown larva. Larvae of allynensis have not been collected, however, their prepupae and cast larval exuviae closely resemble basilobata in colour and form.

Pupa. As in simplex except for presegmental hook-plates with medial, not marginal spinules (Pl. 91F).

Case. Highly distinctive (Pl. 91E), of fine sand grains, with clear dorsal and ventral margins; ends broadly rounded, a deep median notch or concavity in upper margin. Length of pupal case, 3.0-4.0 mm.

Biology. The 2 streams from which pupae have been collected are small, slow tributaries with muddy bottoms.

Distribution. NE New South Wales; E and south-central Victoria.

Hellyethira cubitans Wells

(Pls 12A-C; 91G)

Hellyethira cubitans Wells, 1979a: 317-18.

Holotype ♂, paratypes 4♂, Queensland, Palmer River, 20.vi.1971, ANIC.

Adults (modified after Wells 1979a)

Male. Small with shorter antennae than most species, distinguished from basilobata and allynensis by bilobed parameres and very short segment IX. Aedeagus distinctive, with bulbous base, dilated apex, and median section narrow and sharply twisted. Mesal spine on abdominal segment VII short, acute. Length of anterior wing, 2.0 mm; fork 2 absent in posterior wing. Antennae 31-segmented. Genitalia (Pl. 12A-C):- Segment IX with sternite short, excavated; tergite reduced to short posterolateral lobes. Dorsal plate broad, membranous, with small, median apical sclerotization. Subgenital plate shorter than dorsal plate. Parameres bilobed; ventral lobes similar to parameres of basilobata, but stouter; dorsal lobes stout, sclerotized, apices inturned. Inferior appendages large, setose.

Females and larvae unknown.

Pupa. Indistinguishable from simplex.

Case (Pl. 91G). Two equal secretion valves; upper margin broadly concave in profile, ends rounded. Pupal case attached at one end by stalked disc; length, 2.6-3.7 mm.

Biology. Found in rivers and creeks that are quite slow flowing in the dry season, but probably flooded and swift in the rainy season. Records are scattered throughout the year: whenever light-trap collections are made they include small numbers of cubitans.

Distribution. NW Western Australia; N Northern Territory; NE Queensland.

Hellyethira exserta Wells

(Pls 12D-H; 91H-J)

Hellyethira exserta Wells, 1979a: 318-19.

Holotype ♂, paratyes 1♂, 2♀, New South Wales, Boonoo Boonoo River, 5 km upstream from falls, 11.x.1973, NMV; 4♂, 3♀, paratypes, Victoria, Yea River, 6 km NE Glenburn, 17.xi.1976, NMV; 4♂, 3♀, same data, ANIC.

Adults (modified after Wells 1979a)

Male. Length of anterior wing, 2.1 mm. Antennae 35-segmented. Distinguished from *cubitans* by: aedeagus slender, more typical of the genus; apices of dorsal lobes of parameres acuminate, apex of dorsal plate rounded and apices of posterolateral lobes of segment IX sclerotized (Pl. 12D-F).

Female. Length of anterior wing, 2.0 mm. Antennae 25-segmented. Genitalia (Pl. 12G,H):- Terminalia narrow. Segment VIII short: sternite concave apically with scattered marginal setae; tergite widely excised apically, few strong setae on lateral margins of excision. Segment X truncate apically.

Fully grown larva (Pl. 91H). Closely similar to *simplex*: body generally pale tan with darker median patch on head, dark band towards posterior margin of pronotum, dark markings posteriorly on mesonotum, postero-laterally on metanotum, and proximally on leg segments. Forelimb with blade-like seta in place of comb on tibial process.

Case (Pl. 91I,J). Basically a secretion purse with distinct dorsal and ventral margins; ends dilated with some slight fluting on upper margins. Pupal case attached at each end of ventral margin. A broadly rounded secretion shield may surround pupal case, its margins attached to substrate; upper seam of purse protrudes through a median slit (Pl. 91J). Some cases lack this outer shield. Length of pupal case (basic purse), 3.1-3.6 mm.

Biology. Final instar larvae and pupae occur on rocks and stones along the quieter, slower margins of rivers, often amongst growths of chain diatoms. In some samples all or most cases lack the outer shield; in other samples, the reverse is true. Specimens taken from slow edges of streams generally have shields, while they tend to be absent from cases taken from faster parts of water courses. Shielded pupal cases often carry surface growths of algae or fungi and appear rather worn, as if they have persisted for some time. The shielded case may belong to an over-wintering generation, the other to a summer generation.

Adults collected September to March, larvae December to February.

Distribution. NE New South Wales; SE and central Victoria; Tasmania; Kangaroo Island, S Australia.

Hellyethira dentata Wells

(Pl. 13A-C)

Hellyethira dentata Wells, 1979a: 319-20.

Holotype ♂, paratype ♂, Western Australia, Mitchell Plateau, Camp Creek, 31.i.1978, WAM.

Adults (modified after Wells 1979a)

Small, black and yellow, wings with somewhat atypical neuration (Pl. 13A), genitalia showing a combination of the symmetry found in exserta with inferior appendages closer to those of asymmetrical species such as malleoforma or multilobata.

Male. Length of anterior wing, 1.8 mm. Antennae 32-segmented, proximal half yellow, distal half black. Genitalia (Pl. 13B,C):- Sternite IX with deep V-shaped excavation. Dorsal plate broad, rounded apically. Subgenital plate slightly shorter than dorsal plate. Parameres stout basally, tapered and turned inwards posteriorly. Inferior appendages 3-lobed: ventral lobe membranous, tapered; median lobe sclerotized; dorsal lobe finger-like with apical seta. Aedeagus with strongly twisted sclerotized terminal portion.

Female and immatures unknown.

Distribution. NW Western Australia.

Hellyethira _vernoni_ Wells

(Pls 20A-D; 92C,D)

Hellyethira _vernoni_ Wells, 1983: 632-633.

Holotype ♂, allotype ♀, Queensland, Crystal Creek, nr turnoff to Mt Spec, 17.iv.1979, NMV; paratypes, Queensland: 1♂, 1♀, same locality as holotype, 2.v.1979, NMV; 4♂, 5♀, Leichardt Ck on Bruce Hwy north of Townsville, 12.iv.1979, NMV; 1♂, 3♀, Alice River on Harvey Range Road, 9.v.1979, NMV.

Adults (modified after Wells 1983)

Vestiture mottled, fawn-cream; antennae dark coloured in distal half.

Male. Length of anterior wing, 2.1-2.5 mm. Antennae 31-36-segmented. Genitalia (Pl. 20A-C):- Dorsal plate rectangular with pair of prominent sclerotized hooks dorsally. Aedeagus simple, twisted and sclerotized apically. Subgenital plate broadly rounded, membranous. Paired parameres present, resembling those of _H_. _dentata_ (Wells 1979a) in being broadly angled inwards in ventral view. Ventral to these are paired styliform processes, stout sclerotized processes and the broad setose lobes of the inferior appendages. These can probably all be homologised with the ventral processes of the genitalia of _dentata_; _vernoni_ is characterized by the paired dorsal spines.

Female. Length of anterior wing, 2.0-2.3 mm. Antennae 28-segmented. Genitalia (Pl. 20D):- In general form resembling those of _H_. _malleoforma_ Wells: segment VIII darkly sclerotized and with ventral apico-mesal notch.

Fully grown larva (Pl. 20D). Head black with white around eyes as in cornuta; thoracic nota mottled black and white; limbs with black areas proximally.

Case (Pl. 92C). More-or-less rectangular, valves covered completely with untidy mixture of algal threads, sand, bark, fungal spores and other detritus; pupal case with 2 to 4 points of attachment; length, 3.3-3.6 mm.

Biology. Larvae and pupae occur on rocks in flowing water; adults collected year-round (A.J. Sharley, pers. comm.).

Distribution. N Queensland; N Northern Territory; N Western Australia.

Hellyethira ramosa Wells

(Pls 20E,F; 15D; 92A,B)

Hellyethira ramosa Wells, 1983: 632-634.

Holotype ♂, paratypes, 4♂, 2♀, Northern Territory, Goanna Lagoon, 1 km W of Jabiru off Arnhem Highway, 27.vi.1979, 30.viii.1979, NMV.

Adults (modified after Wells 1983)

Medium sized, with mottled fawn-brown vestiture; closest in general form to *vernoni* or *dentata*.

Male. Anterior wing length, 1.5-2.2 mm. Antennae 37-segmented. Genitalia (Pl. 20E,F):- Sternite IX shallowly concave apically.

Dorsal plate broad-based, tapered slightly towards roughly crenate apex, paired membranous bract-like lobes laterally. Aedeagus twisted apically. Subgenital plate not visible. Inferior appendages broad, covered with short setae; ventral lobes produced apico-mesally to form slender styliform processes. Paired stout sclerotized parameres lie above inferior appendages; protruding laterally to these are paired styliform processes.

Female. Anterior wing length, 2.3-2.4 mm. Antennae 27-segmented. Genitalia (Pl. 15D):- Female distinguished from that of vernoni only by small mid-ventral cluster of setae on segment VIII.

Fully grown larva (Pl. 92B). Similar to simplex, distinguished by markings. Body generally pale: small scattered black spots on head; a band of spots on pronotum; antero- and postero-lateral markings on meso- and metanota; limbs with black spot proximally on coxa, dark areas proximally on other segments.

Pupa. Indistinguishable from simplex.

Case (Pl. 92A). Rectangular in profile, ends straight; made of secretion with strands of chain diatom and small particles of detritus incorporated, giving rough, untidy appearance. Length of pupal case, 3.5-4.0 mm.

Biology. Larvae and pupae netted from lagoons in March and April; adults emerge throughout year (A.J. Sharley, pers. comm.).

Distribution. NE Northern Territory; NW Western Australia.

Hellyethira eskensis (Mosely)

(Pls 14A-D; 92E,F)

Xuthotrichia eskensis Mosely, 1934: 141; Mosely & Kimmins, 1953: 525-6.

Hellyethira eskensis (Mosely), Wells, 1979a: 321-22.

Holotype ♂, Queensland, Esk, 9.vii.1916, BMNH.

Adults (modified after Mosely 1934, Wells 1979a)

This and the following 2 species, H. sentisa Wells and H. veruta Wells, are closely similar and differ from others in having long, curved parameres, which intersect medially, and stout thorny spines postero-laterally on the dorsal plate. H. eskensis is from NE and sentisa from NW Australia; females indistinguishable. Fork 2 absent from posterior wings.

Male. Length of anterior wing, 3.0 mm. Antennae 34-segmented. Genitalia (Pl. 14A,B):- Sternite IX deeply concave apically. Dorsal plate expanded - "flared" - distally, 3 pairs of dark spines apicolaterally. Aedeagus twisted apically. Inferior appendages irregularly trilobed, all lobes pale. Subgenital plate shorter than dorsal plate. Parameres long, slender, curved about each other medially.

Female. Length of anterior wing, 2.4 mm. Antennae, 28-segmented. Genitalia (Pl. 14D):- Terminalia narrow, lightly sclerotized. Segment VIII with scattered setae: sternite with short median notch in apical margin; tergite broadly excavated apically, row of stout setae offset from margin.

Fully grown larva (Pl. 92F). Distinguished by spotted appearance and rectangular sand case.

Body pale, head with paired black spots mid-dorsally and 4 on posterior margin; pro- and metathorax with darkened areas posteriorly; antero-lateral markings on mesothorax; limb segments dark proximally. Labial setae stout as in *malleoforma*; rounded blade-like process on fore tarsus in place of combs of *simplex*.

Pupa. Indistinguishable from *simplex*.

Case (Pl. 92E). Valves rectangular, covered entirely with coarse sand. Pupal case generally attached on one side to stone or log, on other to short detached length of plant material, slightly longer than case; length, 3.5-4.0 mm.

Biology. Immatures in shallow, sandy-bottomed rivers at times of moderate flow. Numerous adults taken in April/May and October/November; larvae collected during regular surveying are dated May, June, October; pupae, May and August.

Distribution. NE New South Wales; E Queensland.

Hellyethira sentisa Wells

(Pl. 14E,F)

Hellyethira sentisa Wells, 1979a: 321-22.

Holotype ♂, paratypes 3♂, 2♀, Western Australia, Millstream H.S., 21°35'S, 117°04'E, 21.v.1971, ANIC.

Adults (modified after Wells 1979a)

Males differ from those of eskensis as follows: dorsal plate narrowly rounded apically; inferior appendages distinctly trilobed with membranous, setose ventral lobe and two stout, sclerotized dorsal lobes; antennae shorter.

Male. Length of anterior wing, 2.5 mm. Antennae 34-segmented. Genitalia (Pl. 14E,F):- Dorsal plate membranous, apex rounded, lateral margins sclerotized, rolled ventrally; paired, stout thorn-like processes on apicolateral margins. Subgenital plate shorter than dorsal plate, rounded apically. Parameres long, slender, sclerotized, crossing in midline and overlapping at apices. Inferior appendages trilobed: ventral branch densely hairy, lobose, tapered at apex; median and dorsal branches stout, sclerotized, curved inwards.

Female. Length of anterior wing, 2.4 mm. Antennae 25-segmented. Genitalia indistiguishable from eskensis.

Immatures and habitat unknown.

Distribution. N Western Australia; April, October.

Hellyethira veruta Wells

(Pl. 15A-C)

Hellyethira veruta Wells, 1985b: 97-99.

Holotype ♂, Magela Creek, S. of Georgetown Billabong, N.T., 11.vii.1983, A.J. Sharley, NTM I.56. Paratypes: 3♂, 4♀, (including allotype NTM I.60), with holotype, NTM I.57-63; 16♂, 10♀, same locality as holotype, A.J. Sharley, 1.vii.1983, NTM I.64-89; 1♀, 27.vi.1983, NTM I.90, 4♀, 29.vi.1983, NTM I.91-94, Georgetown Billabong, nr Jabiru, N.T., A.J. Sharley; 1♀, 30.iii.1983, NTM I.95, 1♀, 22.iii.1983, NTM I.96, Corndorl Billabong, nr Jabiru, A.J. Sharley.

Adults (modified after Wells 1985b)

Medium sized, with mottled cream-fawn vestiture. Closely similar to eskensis and sentisa; male with inferior appendages more like those of eskensis; dorsal plate quite distinct.

Male. Length of anterior wing, 1.5-1.7 mm. Antennae 30-segmented. Genitalia (Pl. 15A,B):- Symmetrical. Inferior appendages multilobed, ventral-most lobe elongate, slender, bifid distally; second lobe also slender and elongate; upper lobe plate-like in ventral view, apicolateral angles attenuated. Dorsal plate membranous, with median serrate "ruff". Parameres slender, curved, intersecting medially. No subgenital plate visible.

Female. Length of anterior wing, 1.6-2.1 mm. Genitalia (Pl. 15C):- Sternite VII slightly bilobed apicomesally, each lobe tipped by paired setae.

Immatures unknown.

Habitat. Stream with sandy substrate, no macrophytes.

Distribution. NE Northern Territory.

Hellyethira loripes Wells

(Pl. 16A,B)

Hellyethira loripes Wells, 1979a: 322-23.

Holotype ♂, Western Australia, Mitchell Plateau, Camp Creek, 30.i.1978, WAM. Paratypes, Western Australia, 1♂, same data as holotype; 1♂, Mitchell Plateau, 29.i.1978, WAM; 1♂, Mitchell Plateau, Camp Creek, light trap, 31.i.1978, WAM.

Adults (modified after Wells 1979a)

In general appearance and colour *loripes* resembles *dentata*, but in males inferior appendages are slightly, and parameres distinctly, asymmetrical. Fork 2 absent from posterior wing.

Male. Length of anterior wing, 1.9 mm. Antennae 33-segmented; 18 proximal segments light, followed by 8 dark and 7 light. Genitalia (Pl. 16A,B):- Sternite IX long, excavated; genitalic structures almost completely contained within excavation. Dorsal plate short, shallowly concave at apex. Subgenital plate small, indistinct. Parameres stout; right longer, more curved than left. Inferior appendages bilobed, outer lobe with hair on small protuberance. Aedeagus with subapical constriction.

Female, immatures and habitat unknown.

Distribution. NW Western Australia.

Hellyethira pulvina Wells

(Pl. 16C,D)

Hellyethira pulvina Wells, 1979: 323-24.

Holotype ♂, paratypes 2♂, Western Australia, Mitchell Plateau, Camp Creek, 31.i.1978, WAM.

Adults (modified after Wells 1979a)

In general appearance almost indistinguishable from loripes.

Male. Length of anterior wing, 2.0 mm. Antennae 37-segmented: 4 terminal segments light, rest dark. Genitalia (Pl. 16C,D):- Sternite IX with V-shaped excavation. Dorsal plate broad with narrow median flap below. Subgenital plate wide. Parameres unequal: left paramere curved, with twisted, sclerotised apex surrounded by balloon-like membrane above sclerotised arm; right paramere straight, stout spiny. Inferior appendages trilobed: ventral lobe long, finger-like with paired apical hairs; dorsal lobe small, hairy; lateral lobe larger than in loripes, stout, on outer margin a median protuberance tipped with long hair. Aedeagus similar to that of simplex but with distal constriction.

Female, immatures and habitat unknown.

Distribution. Mitchell Plateau, N Western Australia: January.

Hellyethira cornuta Wells

(Pls 17A-D; 93A,B)

Hellyethira cornuta Wells, 1979a: 324-25.

Holotype ♂, paratypes 3♂, 4♀, Queensland, Little Mulgrave River, 28.vi.1971, ANIC; paratypes 6♂, Queensland, 40 km W Tully, 31.v.1971, ANIC.

Adults (modified after Wells 1979a)

In contrast to the two preceding species, parameres of cornuta are symmetrical, and inferior appendages show slight asymmetry. Crossvein r-m arises anterior to fork in M in both wings. Fork 2 is absent in posterior wing.

Male. Length of anterior wing, 2.4 mm. Antennae 35-36-segmented, uniformly dark brown. Genitalia (Pl. 17A,B):- Dorsal plate broad, membranous, constricted into subapical yoke, flared posteriorly; 2 sinuous horn-like processes arise at yoke, project beyond apex. Subgenital plate shorter than dorsal plate. Inferior appendages distinctly bilobed distally; right appendage with sclerotized tooth on inner margin of lateral lobe. Parameres symmetrical, slender, recurved.

Female. Length of anterior wing, 2.2 mm. Antennae 26-segmented. Genitalia (Pl. 17C,D):- Segment VIII short; sternite with rounded mesal lobe bearing cluster of strong setae; tergite with rounded lateral lobes. Segments IX and X fused, stout.

Fully grown larva (Pl. 93B). Similar to simplex but head jet black except for clear-cut pale surrounds to eyes; markings on thoracic nota and legs as in simplex, but darker.

Pupa. Indistinguishable from simplex.

Case (Pl. 93A). Subrectangular, with ends oblique and upper angles slightly rounded; covered with fine sand grains. Length of pupal case, 3.0-3.5 mm.

Biology. Immatures on rocks and cobbles in flowing water.

Distribution. NE Queensland.

Hellyethira malleoforma Wells

(Pls 18A-E; 93C,D)

Hellyethira malleoforma Wells, 1979a: 325-26.

Holotype ♂, South Australia, Uraidla, farm dam, 28.xi.1975, ANIC.

Paratypes, collected with holotype, 5♂, 5♀, NMV, 5♂, 5♀, ANIC, 5♂, 5♀, BMNH.

Adults (modified after Wells 1979a)

Males closely resemble those of cornuta, but parameres and inferior appendages asymmetrical. Crossvein r-m arises at foot of fork in M in both wings; fork 2 absent in posterior wing.

Male. Length of anterior wing, 2.7 mm. Antennae 37-40-segmented, colour uniform. Genitalia (Pl. 18A-C):- Sternite IX deeply excavated. Dorsal plate broad at apex, with small median excision. Subgenital plate membranous, equal in length to dorsal plate, apex rounded. Parameres unequal: left stout, hammer-shaped; right spiny,

almost straight, with sharp heavily sclerotized apex encircled by tuft of dense short hair. Inferior appendages asymmetrical, broad, setose basally, dissected distally to form 3 distinct lobes. Aedeagus sinuous, sclerotized apically, membranous and dilated proximally.
Female. Length of anterior wing, 2.8 mm. Antennae 29-segmented. Genitalia (Pl. 18D,E):- Abdominal segment VII broad. Segment VIII narrow, barrel-shaped, often heavily sclerotized ventrally; sternite with small indistinct median lobe; apical margin of tergite rounded. Segments IX and X distinct.

Fully grown larva (Pl. 93D). Frequently occurs in association with *simplex* from which it is distinguished with difficulty by its paler colour, particularly of the pronotum, which is similar in colour and markings to other thoracic nota.

Head and thoracic nota cream, nota with broken dark brown bands anteriorly and posteriorly; dark areas proximally on coxae, tibiae and tarsi. Setae of labrum subequal; comb on fore-tibia broader than in *simplex*.

Pupa. Indistinguishable from *simplex*.

Case (Pl. 93C). Elongate, rectangular, secretion only, generally narrower than *simplex* - length to breadth about 4:1. Length of pupal case, 4.6-6.0 mm.

Biology. Immatures are found on stems of macrophytes in lentic waters and slow streams (Pl. 128B). Large samples occasionally taken at lights; collecting dates for adults include May and November in

SW Western Australia, mainly October to April in Victoria, New South Wales and South Australia. Mature larvae and pupae collected in December, January, May and August in South Australia, and late October in N New South Wales.

Distribution. H. malleoforma is less common but even more widespread than simplex, although collecting records may be somewhat misleading, most light-trapping having been restricted to flowing waters. Localities range from S Queensland throughout New South Wales and Victoria into South Australia in coastal and inland areas; it is common in SW Western Australia. Known also from New Caledonia (Wells, unpublished data).

Hellyethira multilobata Wells

(Pl. 19A-D)

Hellyethira multilobata Wells, 1979a: 326-8.

Holotype ♂, paratypes 10♂, 7♀, Victoria, Lake Purrumbete,
23.ii.1970, ANIC.

Adults (modified after Wells 1979a)

Males distinguished from malleoforma, with difficulty, by form of inferior appendages and right paramere (Pl. 19B). Female readily recognized by heavily sclerotized, triangular median lobe on sternite VIII (Pl. 19D). Crossvein r-m anterior to fork in M in both wings. Fork 2 absent in posterior wing.

Male. Length of anterior wing, 2.9 mm. Antennae 39-40-segmented. Genitalia (Pl. 19A-B):- Dorsal plate without small median excision in apical margin. Parameres: left stouter than in malleoforma; right long, slender, curved sharply to right, ending in beak-like spine with minute serrations at base. Inferior appendages more asymmetrical than in malleoforma: left terminating in 2 short distinct lobes, right dissected into several ill-defined lobes of varying size.

Female. Length of anterior wing, 2.5 mm. Antennae 28-segmented. Genitalia (Pl. 19C,D):- Terminalia broad. Segment VIII short: sternite trilobed, mesal lobe heavily sclerotized, triangular, bearing cluster of strong setae; tergite shallowly excavated apically. Sternite IX lobulate.

Immatures and habitat unknown.

Distribution. E New South Wales; Tasmania; Victoria; Fleurieu Peninsula, Kangaroo Island, S Australia..

Hellyethira litua Wells

(Pls 19E,F; 8C,D; 93E-G)

Hellyethira litua Wells, 1979a: 127-8; Neboiss, 1982: 281-2.
Holotype ♂, paratype ♂, Western Australia, Jandakot, 15.i.1973, ANIC.

Adults (modified after Wells 1979a, Neboiss 1982)

Form of inferior appendages and parameres separates litua from malleoforma and multilobata.

Male. Length of anterior wing, 3.1-3.4 mm. Antennae 39-segmented. Genitalia (Pl. 19E,F):- Dorsal plate broad, rectangular. Parameres: left paramere similar to malleoforma, but apical portion longer and tapered; right paramere long, slender and sinous. Subgenital plate shorter than dorsal plate. Inferior appendages bilobed; small, non-sclerotized tooth on inner margin of dorsal lobe of right appendage. Female (after Neboiss 1982). Length of anterior wing, 3.3 mm. Antennae 29-30-segmented. Genitalia (Pl. 8C,D):- Sternite VIII deeply excised mid-ventrally, median finger-like lobe in excision.

Fully grown larva (Pl. 93F). No particularly distinctive features. Body pale honey; legs tan, small dark areas proximally on coxae; mid and hind tarsal claws elongate, slender, 3/4 length of tarsus (Pl. 93G).

Case (Pl. 93E). Length about 4x width; more-or-less rectangular but slightly constricted towards each end. Length of pupal case, 4-5 mm.

Biology. Cases found beneath logs in a slow flowing, muddy-bottomed stream (Pl. 125A); numerous adults taken beside still and flowing waters. All records but one are dated November to early January but they probably reflect collectors' activities. The one sample of immatures available (final instar larvae and pupae) was taken in September.

Distribution. SW Western Australia.

Hellyethira fimbriata (Mosely)

Xuthotrichia fimbriata Mosely, 1934: 142-5; Mosely & Kimmins, 1953: 523-5.

Hellyethira fimbriata (Mosely), Wells, 1979a: 320.

Holotype ♂, New South Wales, Heathcote, 26.viii.1916, BMNH.

When I reveiwed *Xuthotrichia* and *Hellyethira* (1979a) I transferred *fimbriata* from *Xuthotrichia* to *Hellyethira*. It now seems more likely that the closest affinities of this species lie with species in the recently diagnosed genus *Acritoptila* Wells (1982: 262). However, until further specimens are collected it is probably safer to leave it in *Hellyethira*. The single male known has been examined.

Genus *Acritoptila* Wells

Acritoptila Wells, 1982: 262.

Type-species: *Acritoptila globosa* Wells, by original designation.

Three Australian species were placed in *Acritoptila*, diagnosed by Wells (1982) for a group which shares most features of *Hellyethira*, but has distinctive male genitalia; 6 further species are now known from New Caledonia (Kelley pers. comm.). Males, females and immatures are known for 2 Australian species: male genitalia are highly specialized; the female terminalia form a short, modified oviscapt; immatures are indistinguishable from those of *Hellyethira*.

Diagnosis

Adults (modified after Wells 1982)

Distinguished from Austratrichia and Mulgravia by general form of male genitalia: segment IX short, broad; sternite shallowly excavated apically; inferior appendages partially or wholly fused ; parameres long, spiny. Long slender mesal process on sternite VII. Length of anterior wing, 1.6-2.7 mm. Antennae 22-40-segmented in male, 22-23 in female; segments of male with few large, smooth, ovoid s. placodea and flattened s. auricillica; in female few rounded s. placodea.

Fully grown larva (Pl. 94A). Body strongly compressed laterally: abdominal segment I about size of metathorax, II-V gradually enlarging, V-IX decreasing in size; VIII overhanging IX dorsally as in Hellyethira; segment I lightly sclerotized.

Head rounded in dorsal and lateral view; ecdysial lines distinct; postmental sclerites fused, anterior ventral apotome broadly triangular, posterior ventral apotome small, triangular. Labrum short with ventral membranes asymmetrical, sclerite slightly narrower anteriorly than posteriorly; setae slender and no longer than labrum; tormae short, stout. Mandibles asymmetrical, more-or-less triangular, left with long cutting blades, and an inner penicillus; right simple. Antenna with terminal sensillum about ½ length of basal section, seta 3x length of antenna.

Thorax (Pl. 94A). Nota saddle-shaped, pronotum completely covering prothorax, small anterior membranous areas on meso- and metathorax. Prothoracic venter almost entirely covered by the large oral and paired anal sclerites, all 3 sclerites present on meso- and metathorax. Pre-episternite free on propleuron, fused on other pleura. Limbs similar to <u>Hellyethira</u>, but mid and hind limbs shorter relative to forelimbs, in ratio 1:2:2, fore:mid:hind. Forelimb with disto-ventral tibial process well developed, spines and small anterior comb apically; tarsal claws same length as tarsi; inner ventral femoral and trochantal setae long, slender, ciliate. Mid and hind limbs with all segments subequal, tarsal claws shorter than tarsi.

Abdominal segments II- VIII with circular dorsal chloride epithelia. Tergite on segment IX lightly sclerotized, poorly defined, setae slender. Anal prolegs short, stout, projecting laterally, with 2-3 accessory hooks on claw (PL. 94D). No caudal filaments.

<u>Pupa</u>. Labrum broadly rounded, 1 pair of minute setae anteriorly, a longer pair baso-laterally. Mandibles slender, fine serrations on inner distal margins. Hook plates: presegmental plates broadly rounded, spinules scattered, deflected posteriorly; postsegmental plates small, rounded, a few scattered spinules directed anteriorly.

<u>Case</u> (Pl. 94B,C,E). Laterally compressed "purse case", rectangular to subrectangular in profile, constructed of secretion only, on which a considerable amount of alga and/or fungus accumulates. Construction appears similar to <u>Hellyethira</u>; early case built the width of pupal case, with subsequent additions made to ends only.

At pupation, cases are attached beneath stones or logs by 2 to 4 stalked holdfasts.

<u>Biology</u>. Immature stages of 2 species have been collected from a slow, sandy-bottomed river.

Distribution. Australia and New Caledonia; 2 species in SW Western Australia and a third near Gympie, S Queensland.

Acritoptila globosa Wells

(Pls 21A-D; 23C; 94A-D)

Acritoptila globosa Wells, 1982: 264-265.

Holotype ♂, paratypes 11♂, 11♀, Western Australia, Harvey River, near Harvey Falls, 15km E of Harvey, 21.xi.1978, NMV.

Adults (modified after Wells 1982)

Medium-sized, almost uniformly grey.

Male. Length of anterior wing, 1.9-2.3 mm. Antennae 27-28-segmented; segments light proximally, darker in distal half, 2 terminal segments pale. Genitalia (Pl. 21A,B; 23C):- Dorsal plate broad, membranous, with sclerotized lateral margins; apical margin with notch on either side of midline. Aedeagus twisted towards apex. Subgenital plate rounded apically. Parameres sclerotized, laterally placed, bifid: ventral spine strongly twisted; dorsal spine rod-like. Inferior appendages fused to form rounded, berry-like structure with paired apical setae and small sclerotized ventral processes.

Female. Length of anterior wing, 1.6-2.0 mm. Antennae 22-23-segmented. Genitalia (Pl. 21C,D):- Segment VIII sclerotized, sternite more-or-less triangular, apex with small notch and lobe.

Fully mature larva (Pl. 94A). Distinguished from *margaretae* by colour: head and prothorax pale anteriorly, dark posteriorly, meso- and metathorax with dark antero-lateral and posterior areas, dark areas proximally on leg segments.

Pupa. No distinguishing features.

Case (Pl. 94B,C). Dorsal and ventral seams distinct, ventral slightly longer than dorsal, ends rounded. Pupal case rounded at one end, slightly tapered at other; attached at 2 or 4 corners; length, 2.1-2.8 mm.

Biology. Immature stages found beneath stones and logs in sandy to muddy-bottomed rivers and streams of moderate flow.

Distribution. SW Western Australia.

Acritoptila hamatus Wells

(Pls 21E,F; 22A)

Acritoptila hamatus Wells, 1982: 264-265.

Holotype ♂, Queensland, Mothar Mountain, 12 km SE of Gympie, 29.x.1980, NMV. Paratype ♂, Queensland, Coondoo Creek, 30 km NE Gympie, Toolara State Forest, 27.x.1980, NMV.

Adults (modified after Wells 1982)

Medium-sized, mottled with grey-cream.

Male. Length of anterior wing, 2.4 mm. Antennae 40-segmented; distal half dark coloured. Genitalia (Pls 21E,F; 22A):- Segment IX short, stout; lateral margins produced posteriorly to form bracteose lobes, obliquely truncate in lateral view. Dorsal plate broad-based, membranous and truncate apico-mesally, small sclerotized mid-dorsal process and curved jet-black spines postero-laterally. Aedeagus partially enveloped in membranous sheath. Subgenital plate almost triangular. Inferior appendages forming broad band with pair of wide peg-like median processes, above which are found paired sclerotized lobes and styliform processes, an arrangement reminiscent of some Oxyethira species. A pair of lightly sclerotized parameres flanks dorsal plate.

Female, immatures and habitat unknown.

Distribution. N E Queensland.

Acritoptila margaretae Wells

(Pls 22B,C; 23A,B; 94E)

Acritoptila margaretae Wells, 1982: 265-267.

Holotype ♂, paratypes 1♂, 10♀, Western Australia, Harvey River below Harvey Falls, 15.xi.1980, NMV.

Adults (modified after Wells 1982)

Medium-sized, wings pale fawn with black spots.

Male. Anterior wing length, 2.7 mm. Antennae 36-segmented. Genitalia (Pls 22B,C; 23A):- Sternite IX deeply rounded anteriorly, produced ventro-laterally to form tapered bracteose lateral lobes.

Dorsal plate tapered posteriorly, deeply cleft apically, wrapped ventrally as a sheath around aedeagus; apico-medial margins of sheath heavily sclerotized. Aedeagus slender, backed distally by membranous sheath, apex hooked. Subgenital plate narrow and rounded, with paired apico-lateral setae. Inferior appendages similar to those of globosa but slightly separated distally.

Female. Anterior wing length, 2.2-2.4 mm. Antennae 27-segmented. Genitalia (Pl. 23B):- Sternite VIII deeply divided apico-mesally to form 2 rounded lobes; slender median process arising at anterior margin of sternite and extending slightly beyond apex; tergite VIII shallowly concave at apex.

Fully grown larva. Distinguished from globosa by uniform tan-brown colour and stouter thoracic segments.

Pupa. No distinguishing features.

Case (Pl. 94E). Rectangular in profile, no distinct dorsal and ventral seams. Pupal case attached at 2 or 4 corners; length, 2.8-3.2 mm.

Biology. Immature stages on stones and logs in sandy or muddy-bottomed streams of moderate flow.

Distribution. SW Western Australia.

Genus Austratrichia Wells

Austratrichia Wells, 1982: 259.

Type-species: Austratrichia neboissi Wells, by monotypy.

Similar to Hellyethira in many respects, yet, like Xuthotrichia its male genitalia are quite distinctive, particularly the postero-ventral plate on sternite IX and the several ventral membranous plates below the aedeagus. Immatures unknown.

Diagnosis

Adults (modified after Wells 1982)

Length of forewing, 2.6-2.8 mm. Spurs 0,3,4. Ocelli 3. Post-occipital lobes small, widely separated, without associated scent organs. Antennae long, thin, 35-38-segmented in male, 28 in female: basal segment short and rounded, only slightly longer than subsequent segments, terminal segment conical, intermediate segments elongate-cylindrical, with basal whorl of fimbriate hairs; placoid sensilla on all but 2 basal, and the terminal segment in male. Mesoscutellum almost triangular, anterior margin convex; metascutellum rounded. Wings lanceolate, apices acute; anterior wing without jugal lobe; apical forks 1 and 2 in anterior wing, no apical forks in posterior wing. Sternal glands on abdominal segment V. Abdominal segment IX of male with short lateral lobes; a membranous, setose plate occupies a deeply rounded postero-ventral excavation. Aedeagus without titillator, similar to that of Hellyethira. Inferior appendages lobose, discrete, overlain by broad, membranous plate lying below subgenital plate. Long, slender mesal process on sternite VII. Female terminalia forming short, modified oviscapt.

Immatures and habitat unknown.

Distribution. NE New South Wales; central Victoria; Fleurieu Peninsula, Kangaroo Island, S South Australia.

Austratrichia neboissi Wells

(Pls 24; 25E-F)

Austratrichia neboissi Wells, 1982: 260-262.

Holotype ♂, paratype ♀, Victoria: Mitta Mitta River-Snowy Creek junction, 3.xi.1976, NMV. Paratypes, Victoria: 1♂, 1♀, Millgrove, Yarra River, 24.ii.1976, NMV; 1♂, Yarra River, 2 km N Wonga Park, 23.ii.1976, NMV.

Adults (modified after Wells 1982)

Medium sized, slender, with long thin antennae; vestiture mottled, brown-fawn. Comprehensive diagrams are given to show diagnostic features of the genus (Pls 24; 25C-F).

Male. Length of anterior wing, 2.7-2.8 mm. Antennae (Pl. 25E) 35-38-segmented, pale proximally, darker distally but 3 terminal segments light. Genitalia (Pl. 24A-C):- Dorsal plate broad-based, narrower and rounded posteriorly with small membranous teeth towards apex and paired sclerotized subapical spines dorsally. Aedeagus curved and upturned apically. Subgenital plate rounded. A broad, membranous plate below subgenital plate, its lateral margins folded and sclerotized. Inferior appendages stout, lobose, discrete.

Female. Length of anterior wing, 2.6 mm. Antennae 28-segmented. Genitalia (Pl. 24D,E):- Terminalia short, stout: segment VIII with short lateral lobes and slender setose mesal lobe.

Immatures and habitat unknown.

Distribution. As for genus.

Genus Mulgravia Wells

Mulgravia Wells, 1982: 262; 1983: 647-48.
Type-species: Mulgravia coronata Wells, by monotypy.

Erected to accommodate a single aberrant male with many features in common with Xuthotrichia, Hellyethira and Austratrichia, yet unique in the form of its male genitalia. A second species is now referred to the genus (Wells 1983). Immatures and habitat unknown.

Diagnosis

Adults (modified after Wells 1982)

Distinguished from Austratrichia by general form of male genitalia: segment IX short, with short lateral lobes, sternite shallowly excavated; aedeagus without titillator, ringed with sclerotized spines; inferior appendages lobose, discrete, overlain by median sclerotized process and paired plate-like lateral processes.

Long slender mesal process on sternite VIII. Length of anterior wing, 2.5-2.8 mm. Antennae 35-44-segmented.

Distribution. The more northerly parts of the Great Dividing Range, E Australia.

Mulgravia coronata Wells

(Pl. 25A-D)

Mulgravia coronata Wells, 1982: 262-263.

Holotype ♂, paratype ♂, Queensland, Little Mulgrave River, 28.vi.1971, ANIC.

Adults (modified after Wells 1982)

Male. Length of anterior wing, 2.7 mm. Antennae long, slender, 35-segmented. Genitalia (Pl. 25A-D):- Tergite IX short, sternite concave apically. Dorsal plate broad, apex truncate. Subgenital plate rounded apically. Sclerotized lateral processes, plate-like in ventral view, in lateral view almost bilobed distally, with acute apices. A sclerotized T-shaped structure below subgenital plate. Inferior appendages discrete, stout, pale.

Female, immatures and habitat unknown.

Distribution. NE Queensland.

Mulgravia carteri Wells

(Pl. 26A-C)

Mulgravia carteri Wells, 1983: 647-648.

Holotype ♂, paratypes 12♂, 26♀, New South Wales, Clarence River, at Yates Crossing, 26.x.1981, NMV.

Adults (modified after Wells 1982)

Wings mottled fawn/brown; distal $^1/3$ of antennae dark.

Male. Length of forewing, 2.5-2.8 mm. Antennae 40-44-segmented. Genitalia (Pl. 26B,C):- Segment IX deeply excised medially. Dorsal plate broad, membranous, with apico-mesal notch covered with tiny spinules. Subgenital plate broad. Lightly sclerotized lateral processes, plate-like in ventral view. A sclerotized conical structure below subgenital plate, between lobes of inferior appendages. Aedeagus twisted apically, with ring of sclerotized spines at about $^2/3$ its length, and with membranous process bordered by numerous large spinules attached to distal sector.

Female. Length of anterior wing, 2.6-3.1 mm. Antennae 30-segmented. Genitalia (Pl. 26A):- Terminalia in form of short oviscapt: sternite VIII with swollen mesal area covered with short setae; segments IX and X fused.

Immatures and micro-habitat unknown; adults taken at lights beside shallow, cobbly streams of moderate flow (eg. Pl. 127A).

Distribution. NE New South Wales.

Genus *Oxyethira* Eaton

Oxyethira Eaton, 1873: 143-144; Ulmer, 1907: 226, and 1909: 36; Betten, 1934: 161; Nielsen, 1948: 76-95; Lepneva, 1964, (English translation, 1970: 373-388); Wiggins, 1977: 146-147; Marshall, 1979: 203-207; Wells, 1981: 104-112; Kelley, 1984: 435-463.

Type-species: *Hydroptila costalis* Curtis *sensu* Eaton, by original designation.

The cosmopolitan genus *Oxyethira* was reviewed by Marshall (1979) and Australian species were examined by Wells (1981); Kelley (1984) has subsequently revised the genus thoroughly.

Similarities between *Oxyethira*, *Stenoxyethira* Kimmins and *Gnathotrichia* Ulmer were discussed by Marshall, who synonymised *Gnathotrichia* with *Stenoxyethira*. After consideration of new Australian species, I recognised *Gnathotrichia* and *Stenoxyethira* as separate genera (Wells 1981). However, Kelley (1984) has now incorporated both in *Oxyethira*, in the subgenus *Dampfitrichia* Mosely.

In view of his comprehensive study of world *Oxyethira*, Kelley is in a strong position to make such rearrangements. He postulates an ancestral male with the following characteristics:- Acute apico-mesal process on sternite VII. Segment VIII synsclerotised, forming a cylinder of length greater than diameter. Segment IX completely, or almost completely, retracted within segment VIII "such that only the posteroventral tip protrudes"; venter "pointed or broadly rounded anteriorly ... rather than mesally truncate or excised"; dorsum reduced to a narrow band. Inferior appendages small, fused to venter IX at its caudal end; a "pair of short, membranous processes with one or more short setae at the tip ... associated with the interior mesal surface of the inferior appendages. A sclerotised ovoid or U-shaped subgenital plate ventrad of aedeagus." Titillator on aedeagus.

In the female, Kelley recognises the following as features of the original ancestor:- Loss of lateral connection between tergum and sternum VIII; tergum with apodemes. Tergum IX poorly sclerotised or lost; apodemes lost.

Kelley characterises the considerable divergence in these features shown at subgenus and species group levels by groups within Oxyethira. Future examination of immatures, found to be highly conservative in all known species, but presently unknown for many other species, will test Kelley's groupings. His phylogeny assumes a number of homoplaseous events, including repeated loss of titillator on aedeagus, and presents some challenging biogeographical puzzles.

According to Kelley (1984), 2 subgenera occur in Australia: Dampfitrichia and Trichoglene Neboiss. Subg. Dampfitrichia is found in N Australia, and also in SE Asia, Sri Lanka and the Neotropics: Subg. Trichoglene is a distinctive Australasian lineage which occurs in E and S Australia and has 1 species in New Zealand and 1 in New Caledonia (Kelley pers. comm.).

Immatures of Oxyethira were described in detail by Nielsen (1948) whose study has formed the basis of subsequent diagnoses. The relatively few descriptions of larvae and pupae available indicate extreme conservatism in form. Mature larvae and pupae are readily recognized by the characteristic flask-shaped case.

Five Australian species are known in Subg. Trichoglene. Two are very similar and seem to be closely related to the New Zealand O. albiceps; they are east to south-central in distribution. The other

3 species include 2 from SW Western Australia and 1 from Tasmania, all quite distinctive. Four species are known in Subg. *Dampfitrichia*.

Detailed figures are given for all stages of *O. columba* to illustrate diagnostic features.

Diagnosis

Adults (modified from Marshall 1979, and Wells 1981)

Length of anterior wing, 1.7-3.5 mm. Spurs, 0,3,4. Ocelli 3. Post occipital lobes widely separated, ovoid, without associated scent organs; anterior tentorial arms reduced medially. Antennae slender, segments with basal whorl of frimbriate hair, males with many *s. auricillica*, few *placodea* (Pl. 124C,D). Meso-scutellum with anterior margin convex, meta-scutellum convexly subtriangular. Sternal glands present on abdominal segment V.

Male. Genitalia:- Sternite VII with short, acute ventral process; segment VIII with sternite and tergite more-or-less fused, apical margins excised, that of tergite with dorsal or lateral processes, the latter sometimes armed with stout spines; segment IX mostly withdrawn into VIII, its upper half generally much shorter than lower, often reduced to transverse band; lateral margins of IX sometimes produced or with variously formed spiniform processes, ventral margin generally excised; tergite X (dorsal plate) obscure, membranous; inferior appendages represented by 2 sclerotized plates attached to segment IX, fused basally; subgenital plate present, membranous, with bilobed ventral process, tipped with setae; aedeagus long, slender, with or without spiniform titillator arising at midlength.

Female. Genitalia:- Modified oviscapt; sternite VI with short, acute ventral process; segment VII with tergite and sternite more-or-less fused, ventral apical margin sometimes excised; tergite VIII reduced to narrow arched band, centre of its apical margin produced as spatulate lobe; sternite VIII forming short "subgenital plate"; tergite IX either free or fused to VIII, short and hood-like; tergite X forming short, broad plate carrying two short slender cerci; details of internal vaginal structures obscure but apparently with an upper and lower lobe, the latter with a conspicuous baso-ventral process directed caudad.

<u>Fully grown larva</u> (modified after Nielsen 1948: 76-95, and others).

Body (Pl. 95F) strongly compressed laterally; limbs slender, with mid and hindlegs 1½-2x length of forelegs; abdomen distended, with segment I shorter but wider than metathorax, size increasing to segment IV, decreasing beyond VI, abdomen arched dorsally but almost straight ventrally from I to VII or VIII, terminal segments strongly depressed.

Head (Pl. 96A) ovoid in dorsal view; ecdysial sutures distinct; postmental sclerites fused (Pl. 96C), anterior ventral apotome crescentic, with distinct transverse ridge, posterior ventral apotome present. Labrum (Pl. 95H) symmetrical, sclerite with strongly convex lateral margins and deep median excavation; setae slender, longest about length of sclerite; tormae short, slender, inflected. Antenna (Pl. 96B) long, apical sensillum fused to basal segment, seta about 2x length of antenna. Mandibles (Pl. 95G) asymmetrical: left with projecting blades bearing small teeth and median brush; blades of right poorly defined, small denticles apically.

Thoracic nota (Pls 95F, 96A) broad, slightly constricted posteriorly, lateral margins of meso- and metanota shallowly concave. Median and paired anal sclerites on all venters, anal sclerites fused on meso- and metathorax (Pl. 96C). Pleura with plates fused except free anal epimeron on propleuron (Pl. 95I). Mid- and hindlimbs almost 2x length of forelimbs, segments subequal, tarsal claws shorter than tarsi. On forelimbs, tibial process well developed, inner ventral femoral and trochantal setae slender, ciliate.

Abdomen with circular dorsal chloride epithelia on segments II to VII; tergite on segment IX lightly sclerotized (Pl. 96E). Anal prolegs (Pl. 96D) short, stout; claws with 2-4 accessory hooks. No caudal filaments.

Pupa. Labrum short, rounded (Pl. 96G); anterior marginal setae usually absent or rudimentary; posterior marginal setae present; median setae very small or absent. Mandibles as in Hydroptila. Presegmental hook plates narrow, elongate with several broad spinules; postsegmental plates rounded (Pl. 96F).

Case (Pl. 95E). Highly distinctive amongst Hydroptilidae: laterally compressed, flask shaped in profile, with distinct anterior and posterior ends. Anterior end developed in the initial stage of case making, subsequent increments added to posterior end only (see Nielsen 1948). Pupal case attached at all 4 "corners" by stalked discs.

Early stage larvae. Not known for any Australian species. Nielsen (1948) described early Oxyethira flavicornis (Pictet) (as costalis (Curtis)) which closely resembles Hellyethira simplex (Pl. 90A). It has short lateral abdominal setae and a pair of caudal setae far longer than body; mid and hindlimbs 2x length of forelimbs; no caudal gills.

Biology. Larvae in lotic and lentic waters, on rocks and macrophytes and amongst algae; habitat variable. Immatures of Australian species are often difficult to locate in streams beside which adults are abundant.

Distribution. Cosmopolitan (excluding polar regions). *Oxyethira* is absent from central Australia. Subg. *Trichoglene* occurs throughout wetter peripheral parts of the continent, but is not found in the north-west; *Dampfitrichia* occurs in the far north.

Key to males of Australian *Oxyethira* Eaton

1 Venter of segment IX pointed anteriorly. Aedeagus with distal recurved process .... (*Trichoglene*) Neboiss .. 2

Venter of segment IX rounded anteriorly. Aedeagus without distal process .... (*Dampfitrichia*) Mosely .. 6

2(1) Inferior appendages without median membranous plate, each with small setate dorsal process 3

Inferior appendages separated by median membranous plate with 1 or 2 pairs of setae apically; or plate present, inferior appendages reduced to small, paired median process 4

3(2) Inferior appendages triangular, apices subacute (Pl. 29A,B).......
.... *triangulata* Wells
Inferior appendages broad-based, narrower apically;
apices truncate (Pls 27E,F; 28A,C) .... *columba* (Neboiss)

4(2) Dorsal and subgenital plates far longer than other
genitalic structures 5
Dorsal plate shorter other genitalic structures
(Pl. 31A,B) .... *retracta* Wells

5(4) Inferior appendages widely separated, as long as
mid-ventral membranous plate (Pl. 30D) .... *brevis* Wells
Inferior appendages reduced, fused basally, shorter
than mid-ventral membranous plate (Pl. 30A,B) .... *mienica* Wells

6(1) Row or patch of long black setae apically or
subapically on sternite VIII 7
Without long black setae on sternite VIII 8

7(6) Segment VIII subtriangular; apical margin of sternite deeply
concave with row of long black setae (Pl. 34C–E)
.... *plumosa* (Wells)
Segment VIII subrectangular; apical margin of sternite shallowly
concave, with patch of long black setae (Pl. 33B,D) ....
.... *artuvillosus* (Wells)

8(6) Sternite VIII with apical margin excised. Dorsal plate rounded apically. Aedeagus not strongly constricted medially (Pl. 35A,B) .... warramunga Wells

Sternite VIII with apical margin rounded. Dorsal plate subacute apically. Aedeagus strongly constricted medially (Pl. 32E,F) .... incana Ulmer

Subgenus Trichoglene Neboiss 1977

Type-species: Trichoglene columba Neboiss, 1977: 43-44.
Oxyethira columba (Neboiss), Wells 1981: 106-108.

Kelley (1984) erected this subgenus to accomodate several Australasian species characterised by "fusion of the subgenital processes to the posterolateral processes of segment IX as well as a reduction or loss of the titillator". He erroneously specified Hydroptila albiceps (McLachlan) as the type-species, and also erred in giving the author in parenthesis and not specifying the correct nomenclature which is Oxyethira albiceps (McLachlan) (Eaton 1873). Oxyethira columba (Neboiss) is rightly the type-species.

According to Kelley, Trichoglene is the most primitive of all subgenera in that it lacks "any modification of segment VIII".

Oxyethira columba (Neboiss)

(Pls 27; 28; 95E-I; 96; 124C,D)

Trichoglene columba Neboiss, 1977: 43-44.

Oxyethira columba (Neboiss), synonymised, Wells 1981: 106-108.

Holotype ♂, paratypes 20♂, 4♀, Tasmania, Dove River, Cradle Mountain National Park, 14.xii.1974, NMV.

Wells (1981) gave new figures drawn from type material and expanded descriptions of O. columba.

Adults (modified after Wells 1981)

Male. Length of anterior wing, 1.7-2.8 mm. Antennae (Pl. 124C) 30-33-segmented. Genitalia (Pls 27E,F; 28A,C):- Tergite VIII truncate apically, sternite slightly concave with short lateral lobes. Segment IX retracted into VIII, paired sclerotized lobes dorsolaterally. Dorsal plate membranous. Aedeagus slender, becoming dilated and membranous at apex, a curved sclerotized spine arises within membranous area. Subgenital plate rounded, shorter than dorsal plate, with paired lateral styliform processes. Inferior appendages sclerotized, peg-like, joined basally by a narrow bridge; apices broadly rounded or truncate; small setose lobes posteriorly.

Female. Length of anterior wing, 1.7-2.5 mm. Antennae 28-30-segmented. Genitalia (Pl. 28B):- Terminalia short, segment VIII broad, IX and X narrow; sternite IX appears to form 2 plates.

Fully grown larva (Pl. 95F). I can find no characters that separate the larvae of Australian Oxyethira.

Pupa. As for genus.

Case (Pl. 95E). As for genus. Length of pupal case, 2.7-3.5 mm.

Biology. Immatures generally on undersurfaces of rocks and cobbles in flowing or still waters where green filamentous alga is growing.

Distribution. E Australia; Tasmania; Fleurieu Peninsula, Kangaroo Island, S Australia.

Oxyethira triangulata Wells

(Pl. 29A-C)

Oxyethira triangulata Wells, 1981: 107-108.

Holotype ♂, paratypes 10♂, 11♀, Queensland, Crystal Creek, nr turnoff to Mt Spec, 2.v.1979, NMV. Paratypes, 11♂, 11♀, Queensland, Mt Spec, Little Crystal Creek, 29.v.1971, ANIC.

Adults (modified after Wells 1981)

Slightly stouter than *columba*, antennae shorter.

Male. Length of anterior wing, 1.7-2.1 mm. Antennae 25-26-segmented. Genitalia (Pl. 29A,B):- Distinguished from *columba* by triangular inferior appendages, joined basally by a broad band and widely separated apically.

Female. Length of anterior wing, 1.6-2.0 mm. Antennae 22-segmented. Genitalia (Pl. 29C):- Terminalia stout. Segment IX broadly rounded, sternite a single plate.

Immatures indistinguishable from columba. Length of pupal case, 2.1-2.4 mm.

Biology. Immatures on rocks in flowing water.

Distribution. NE Queensland.

Oxyethira mienica Wells

(Pl. 30A-C)

Oxyethira mienica Wells, 1981: 108-110.

Holotype ♂, paratypes 8♂, 6♀, Tasmania, Ouse River, 5 miles W of Miena, 28.ii.1967, ANIC. Paratypes 2♂, collected with holotype, NMV.

Adults (modified after Wells 1981)

Small and pale, probably faded.

Male. Length of anterior wing, 2.3 mm. Antennae 32-segmented. Genitalia (Pl. 30A,B):- Segment VIII produced into postero-lateral lobes. Segment IX withdrawn into VIII, paired sclerotized lobes postero-laterally. The series of plates found dorsally are difficult to interpret: there appears to be a short upper plate; a longer median plate with divergent lateral lobes, its inner margins sclerotized; and ventrally another longer membranous plate. Aedeagus sclerotized proximally, with membranous swelling beyond strongly curved apical spine. Subgenital plate long, with paired lateral styliform processes. Inferior appendages reduced to small sclerotized structures mesally on a short, median membranous plate.

Female. Length of anterior wing, 2.3 mm. Antennae 26-segmented. Genitalia (Pl. 30C):- Terminalia stout. Sternite IX broadly rounded with tapered lateral lobes.

Immatures and habitat unknown.

Distribution. Central Tasmania.

Oxyethira retracta Wells

(Pl. 31A-C)

Oxyethira retracta Wells, 1981: 110-112.

Holotype ♂, paratypes 1♂, 8♀, Western Australia, Serpentine River, Serpentine Falls, 20.xi.1978, NMV. Paratypes, Western Australia: 9♂, 5♀, Cape Leeuwin National Park Spring, 25.xi.78, NMV; 1♂, 5♀, Harvey River, nr Harvey Falls, 15 km E of Harvey, 21.xi.1978, NMV; 1♂, 5♀, Margaret River Rapids Crossing, 25 km S of Bussleton, 22.xi.1978, NMV.

Adults (modified after Wells 1981)

Small; vestiture mottled, grey-brown.

Male. Length of anterior wing, 2.2 mm. Antennae 38-segmented. Genitalia (Pl. 31A,B):- Terminalia short and truncate, segments VIII and IX quite discrete. Inferior appendages and sternite IX fused to form wide ventral plate, roundly excised apico-medially, heavily sclerotized apico-laterally. Dorsal plate short, membranous, bounded laterally by sclerotized lobes of segment IX. Aedeagus dilated and membranous apically, with curved spine. A membranous plate in front of aedeagus is probably the subgenital plate; paired styliform processes present.

Female. Length of anterior wing, 2.2 mm. Antennae 27-segmented. Genitalia (Pl. 31C):- Segment VIII broad, IX and X slender, barrel-shaped.

Immatures indistinguishable from columba. Length of pupal case, 2.3-2.8 mm.

Habitat. Adults taken beside lotic and lentic waters; immature stages from rocks, and netted in flowing water.

Distribution. SW Western Australia.

Oxyethira brevis Wells

(Pls 30D,E)

Oxyethira brevis Wells, 1981: 109-110.

Holotype ♂, paratypes 4♂, 7♀, Western Australia, Cape Leeuwin National Park Spring, 25.xi.1978, NMV.

Adults (modified after Wells 1981)

Small; vestiture grey. Closely similar to the Tasmanian mienica.

Male. Length of anterior wing, 2.3 mm. Antennae 27-segmented: proximal segments light, 7 terminal segments dark. Genitalia

(Pl. 30D):- Segment VIII with short postero-lateral lobes. Dorsal plate broad, long and membranous. Aedeagus sclerotized, twisted distally, apical spine strongly curved. Subgenital plate as long as dorsal plate, with short, paired styliform processes. Heavily sclerotized bilobed processes on each side of median membranous plate are interpreted as inferior appendages fused basally to lateral processes of segment IX.

Female. Length of anterior wing, 2.9 mm. Antennae 22-segmented: 6 terminal segments dark. Genitalia (Pl. 30E):- Terminalia short, stout. Segment IX broadly rounded mesally, with balloon-like lateral lobes, sclerotized on outer sides.

Immatures unknown.

Habitat. Adults collected at light beside a spring-fed pool, so this may be a lentic species.

Distribution. SW Western Australia.

Subgenus Dampfitrichia Mosely

Type-species: Dampfitrichia ulmeri Mosely, 1937 (monobasic): Kelley 1984.

More widespread than Subg. Trichoglene. Characterised by "Veins R_4 and R_5 of forewing fused"; and in male, "Subgenital processes with sclerotised bridge subdistally" (Kelley 1984). Other features include pre-apical spur of mid-tibia small or absent; venter VII with or without apicomesal process".

Kelley (1984) recognises 2-3 groups within Dampfitrichia. In his check list of species and his diagrammatic representation of the phylogeny of Oxyethira he gives 3 species groups, Ulmeri, Pallida and Minima, however he mentions and defines only the Ulmeri and Pallida groups in his systematic coverage.

In Kelley's check list, 1 Australian species is placed in the Ulmeri group, and 2 in the Minima group; a 4th species is now known in the Minima group (Wells 1985b).

Oxyethira incana Ulmer

(Pl. 32A-F)

Oxyethira incana Ulmer, 1906: 102.

Holotype ♀, Java, UHZIM.

Stenoxyethira excisa Kimmins 1951; synonymised Kelley 1984: 436, 439.

Gnathotrichia isabellina Ulmer 1951; synonymised Kelley 1984: 436, 439.

Gnathotrichia australiensis Wells 1981; synonymised Kelley 1984: 436, 439.

For the present, Kelley's (1984) rearrangements must stand. However, I believe there is some confusion as to the true nature of *O. incana*. The male which Ulmer (1951) figures as *O. incana*, from Java, bears little resemblance to the male of *O. isabellina* which he figures in the same work, and females of *O. isabellina* in my collection are more distinctive than that figured by Ulmer (1951).

Adults (modified after Wells 1981)

Mottled fawn to red-brown, with red-brown upturned tips on wings.

Male. Length of anterior wing, 2.2 mm. Antennae 26-segmented. Genitalia (Pl. 32E,F):- Kimmins' interpretation of genitalic structures is adopted. Sternite VIII rounded towards shallowly excised apex; tergite produced posteriorly and deeply excised to form slender lateral processes. Dorsal plate membranous, broad-based, apex triangular. Segment IX concealed within VIII. Subgenital plate wide at base, tapered and deeply excised posteriorly. A heavily sclerotized, forked structure below the subgenital plate described by Kimmins (1951) as "a minute transparent process bearing a few hairs" is probably derived from inferior appendages.

Female. Length of anterior wing, 2.5-3 mm. Antennae 22-segmented. Genitalia:- Segment VIII long and conical. Sternite IX small, quadrate; dark brown anteriorly.

Larva. As for genus (Ulmer 1957).

Pupa and habitat unknown.

Distribution. NE Queensland; Burma; Indonesia; Papua New Guinea.

Oxyethira artuvillosus (Wells)

(Pls 33; 34A,B)

Stenoxyethira artuvillosus Wells, 1981: 114-116.

Oxyethira artuvillosus (Wells), Kelley 1984: 436, 438.

Holotype ♂, paratypes 4♂, 7♀, Western Australia, Mitchell Plateau, Camp Creek at Crusher, 15.ii.1979, WAM. Paratypes, Western Australia, 4♂, 6♀, collected with holotype, ANIC; 2♂, 2♀, Mitchell Plateau, same locality, 18.ii.1979, NMV; 1♂, 3♀, Mitchell Plateau, Camp Creek, 13.vi.1978, WAM.

Adults (modified after Wells 1981)

Minute, with pale golden-brown vestiture; wings mottled, with distinctive dark-brown tips. Male with long dark-brown fringes on hind tibiae.

Male. Length of anterior wing, 1.7 mm. Antennae 31-segmented: basal segment swollen, 3rd shorter than 2nd, terminal segment conical. Genitalia (Pl. 33B-D):- Segment VIII broad, almost rectangular in dorsal or ventral view, tergite widely excised, sternite widely and shallowly excised apically, with median brush of long, stout setae. Segment IX almost completely concealed. Dorsal plate broad, membranous. Aedeagus broad based, rod-like distally, with ventral sclerotized spine; apex swollen and membranous. Kimmins interpreted the ventral plate as a lower sclerotized extension of segment IX, above which is a "subgenital plate" possibly representing the fused inferior appendages. Alternatively, the lower plate may be derived from the inferior appendages. Two distinctive areas of jet black androconia on tergite VI (Pl. 33B).

Female. Length of anterior wing, 1.3 mm. Antennae 21-segmented: basal 7 light, followed by 2 dark, 4 light, 5 dark and 3 light segments. Genitalia (Pl. 34A,B):- Terminalia difficult to interpret. Segment VIII unusually long, with paired setose ridges subapically on tergite; sternite with sclerotized apical band.

Immatures and habitat unknown.

Distribution. NW Western Australia.

Oxyethira plumosa (Wells)

(Pl. 34C-E)

Stenoxyethira plumosa Wells, 1980: 116-117.

Oxyethira plumosa (Wells), Kelley 1984: 436, 438.

Holotype ♂, North Queensland, Mulgrave River, 29.iv.1979, NMV.

Adult (modified after Wells 1981)

Small, vestiture cream to grey; wings mottled, tips black; hind tibiae with long dark grey fringes.

Male. Length of anterior wing, 3.2 mm. Antennae 35-segmented. Genitalia (Pl. 34C-E):- Segment VIII broad-based, tapered posteriorly, sternite and tergite excised apically, row of stout setae towards apical margin of sternite. Segment IX almost completely concealed within VIII. Dorsal plate membranous, sub-quadrate. Aedeagus membranous with sclerotized rod lying along its length and twisted subapically.

Upper or "subgenital" plate reduced to small median lobe bearing paired setae; lower plate similar to that of artuvillosus. An area of jet black androconia medially on tergite VI; lateral tufts of long black hair on abdominal segments III and IV.

Female, immatures and habitat unknown.

Distribution. NE Queensland.

Oxyethira warramunga Wells

(Pl. 35A-C)

Oxyethira warramunga Wells, 1985b: 99-101.

Holotype ♂, Georgetown Billabong, nr Jabiru, 21.vii.1983, A.J. Sharley. Paratypes, 1♂, 3♀, (including allotype, NTM I.107), 21.vii.1983, NTM I.106-109, 3♀, 27.vi.1983, NTM I.110-112, 1♂, 4♀, 3.vii.1983, NTM I.113-116, 1♂, 1♀, 15.vii.1983, NTM I.117-118, 1♂, 19.vii.1983, NTM I.119, 1♀, 29.vi.1983, NTM I.120, 1♂, 27.vii.1983, NTM I.121; 1♀, 3.vii.1983, NTM I.122, 1♀, 29.vii.1983, NTM I.123, Magela Creek, S. of Georgetown Billabong, N.T., A.J. Sharley; 1♂, Corndorl Billabong, nr Jabiru, 23.vii.1983, A.J. Sharley, NTM I.124.

Adults (modified after Wells 1985b)

Minute, with mottled vestiture; spur formula, 0,2,4.

Male. Length of anterior wing, 1.1-1.5 mm. Antennae 26-segmented. Genitalia (Pl. 35A-B):- Segment VIII broad, rounded sternite, widely and shallowly excised apico-mesally; tergite with broad, deep mesal concavity. Dorsal plate membranous, rounded, broad basally, narrower distally. Aedeagus stout, without titillator. Inferior appendages discrete distally, fused at base. Paired lobes dorsal to inferior appendages may represent subgenital plate.

Female. Length of anterior wing, 1.4-2.0 mm. Antennae 20-segmented; stapes about 2x length of pedicel. Genitalia (Pl. 35C):- Sternite VIII triangular, apex with narrow sclerotised band; tergite shallowly concave apically.

Immatures and habitat unknown.

Distribution. NE Northern Territory.

Genus Acanthotrichia Wells

Acanthotrichia Wells, 1982: 269-270.

Type-species: Acanthotrichia bilamina Wells, by monotypy.

This genus is distinct in the Australian fauna. It is placed in the Oxyethira group, Tribe Hydroptilini, within which it groups with Tricholeiochiton and Paroxyethira with which it shares several features including aedeagus with spiral titillator and form of larval case.

The female of A. bilamina is here figured and described for the first time. A small amount of information on larvae has been derived from exuviae taken from pupal cases.

Diagnosis

Adults (modified after Wells 1982)

Spurs, 0,3,4. Ocelli, 3. Post-occipital lobes large, ovoid, without associated scent organs. Antennae 35-segmented in male, basal segment longer than others, terminal segment conical, shorter than others; basal ring of hair on all but 1st and last segments; s. placodea present, but no auricillica. Mesoscutellum diamond-shaped; metascutellum rounded. Wings narrow, apices acute: anterior wing without jugal lobe, only fork 2 present; posterior wing without apical forks. Abdominal segment VIII of male broad, IX and X narrow, genitalia generally flat with dorsal and subgenital plates forming valves; aedeagus broad with spiral titillator; parameres present. Female terminalia in form of short, modified oviscapt.

Fully grown larva. Body probably laterally compressed; ecdysial sutures of head distinct, ventral apotomes similar to Hellyethira (Pl. 95B); antenna with distinct terminal sensillum, slightly more than ½ length of basal section (Pl. 95D); left mandible a slender cutting structure, right somewhat stouter. Thoracic nota similar to Hellyethira; 3 ventral sclerites on prothorax. Circular chloride epithelia on abdominal segments; anal claw with 1 slender, 2 stout accessory hooks (Pl. 95C).

Pupa. Labrum rounded, 2 short anterior marginal setae, pair of long basal setae. Presegmental hook plates flanged, with several marginal spinules; postsegmental hook plates broadly flanged, with marginal and scattered spinules. Mandibles long, slender, inner distal margins finely serrate as in Hydroptila.

Case (Pl. 95A). Secretion only, subrectangular, dorsal margin and ends convex, ventral margin slightly concave; pupal case attached at 2 or 3 corners; length, 3.0-3.6 mm.

Biology. Pupae and cases on rocks and cobbles in riffles, in fast flowing streams.

Distribution. A single species, widespread from E Victoria to N Queensland, along the Great Dividing Range.

Acanthotrichia bilamina Wells

(Pls 35D-G; 36; 95A-D; 123C,D)

Acanthotrichia bilamina Wells, 1982: 268-269.

Holotype ♂, paratype ♂, Victoria, Genoa River, near Wangarabell, 18.iii.1977, NMV. Paratypes, 8♂, Queensland, Yabba Creek, 10 km W of Imbil, 26.x.80, NMV.

Adults (modified after Wells 1982)

Medium-sized, red-brown. Comprehensive figures (Pls 35D-G; 36) show characteristic features of genus.

Male. Length of anterior wing, 2.3 mm. Antennae (Pls 35E; 123C) 35-segmented. Genitalia (Pl. 36B-D):- Segment IX narrow, with areas of long setae laterally and pair of short sclerotized lobes medially on posterior margin of sternite. Dorsal plate large, membranous, rounded. Aedeagus stout with strong, sclerotized, curved spine arising medially and extending slightly beyond bulbous apex; a fine titillator wrapped about base. Subgenital plate as large as dorsal plate, lightly sclerotized towards margins, shallowly concave apically, with paired short apico-lateral setae. Inferior appendages short, almost cylindrical, with row of hair on inner margins; small mesal lobes basally.

Female. Length of anterior wing, 2.0-2.3 mm. Antennae (Pl. 123D) 27-segmented. Genitalia (Pl. 35G):- Segment VIII short, stout, sternite divided medially by possible glandular structure.

Fully grown larva. Known only from larval exuviae (Pl. 95A-D). Head pale, pronotum dark-brown, meso- and metanota pale, each with dark posterior band.

Pupa, case, habitat and distribution as for genus.

Genus Tricholeiochiton Kloet & Hincks

Leiochiton Guinard, 1879: 139.

Type species: Leiochiton fagesii Guinard, by monotypy. [Preoccupied by Leiochiton Curtis, 1831, in Coleoptera].

Tricholeiochiton Kloet & Hincks, 1944: 97. [Replacement name for Leiochiton Guinard.]

Synagotrichia Ulmer, 1951: 81. Type-species: Synagotrichia fortensis Ulmer, by monotypy. [Synonymized by Marshall, 1979.]

Lepneva 1964, (English translation 1970: 388-391); Marshall 1979: 210-212.

Marshall (1979) reviewed *Tricholeiochiton*. In doing so, she transferred a third species to the genus and also remarked on "the unique larva" of *T. fagesii*. Since this review, *Tricholeiochiton* has been recognized from N Australia (Wells 1982; 1985b). While males of one of the 5 Australian species show close similarity to those of the Oriental and Palaearctic species, the other 4 are more divergent, although their females are similar to that of *fagesii*.

In her review of hydroptilid genera, Marshall (1979) gave the first detailed descriptions of the larva, pupa and case of *Tricholeiochiton*, based on the work of Lepneva (1964) and her own studies of material in the British Museum (Natural History). Immatures share many features with *Hellyethira* but the final larva is unique in having the tibia exceedingly long in the hind, and especially middle legs. Several highly distinctive early instar larvae collected in plankton nets in NE Australian rivers are possibly *Tricholeiochiton*, although no positive identification has yet been possible. These tiny, spidery larvae have extraordinarily elongate anal claws on the prolegs but in other respects resemble *Oxyethira* and *Hellyethira*. The rectangular secretion case of *Tricholeiochiton* is indistinguishable from that of some species of *Hellyethira*.

Detailed figures of *T. fidelis* Wells are given to illustrate the diagnostic features of the genus. Amongst Australian species immature stages of only *T. fidelis* have been identified and these are also illustrated.

Diagnosis

Adults (modified from Marshall 1979: 210-211; Wells 1982: 253)

Length of forewing, 1.7-3.3 mm. Spurs, 0,3,4. Ocelli 3. Head without post-occipital lobes; anterior tentorial arms reduced to fine strands medially; maxillary palpi with segment 5 only slightly longer than 3 or 4, 3 almost equal to 4. Antennae (Pl. 123A,B) 26-37-segmented in male, 23-24 in female; basal segment swollen, terminal segment short and conical, intermediate segments elongate-cylindrical with basal whorl of fimbriate hair; placoid sensilla on segments in male, no auricillica. Mesoscutellum almost triangular, anterior margin convex; metascutellum pentagonal. Wings long, acuminate; neuration variable; anterior wing without jugal lobe. Sternal glands on abdominal segment V. Male terminalia generally short and broad; segment IX almost triangular in lateral view; aedeagus slender, dilated and bilobed apically, titillator present. Female genitalia variable but generally with broad collar-like segment VIII, interrupted mid-ventrally by a stout lobe.

Fully grown larva (modified from Lepneva 1964, (English translation 1970: 388-391); Marshall 1979: 210-212).

Body (Pl. 97A) strongly compressed laterally. Legs slender: mid and hind legs 3-4x length of forelegs; tibiae far longer than other segments, mid tibiae longer than hind. Abdomen distended, segment I slightly larger than metathorax, segments enlarging from I to IV, decreasing gradually to IX; abdomen curved.

Head (Pl. 98A) elongate, rounded anteriorly, sides parallel; ecdysial lines distinct; postmental sclerites fused, anterior ventral apotome broadly crescentic, a small triangular posterior apotome present

(Pl. 98C). Labrum (Pl. 97D) symmetrical, broad and shallow, lateral margins strongly convex, 3 pairs of setae, much longer than sclerite. Mandibles (Pl. 97E) slender, asymmetrical: left with narrow upper blade; lower blade broad, slightly serrate with median penicillus; right tapered with notch on inner margin. Antenna (Pl. 98B) with terminal sensillum discrete, ½ length of basal section; seta more than 2x length of antenna.

Thorax (Pls 97A; 98A,C). Nota broad, almost rectangular in lateral view, but with lateral margins of meso- and metanota slightly concave; ecdysial sutures distinct, with notch on mesonotum. Oral and paired anal sclerites on all venters (Marshall (1979) says 3 on prothorax only), anal sclerites of mesothorax fused to margins of tergite; small round sclerite below oral sclerite on prothorax; pre-episternite and anal epimeron fused on all pleura. Forelegs short, tibiae with elongate disto-ventral process bearing apical spines and small comb; inner ventral femoral and trochantal setae long, slender, ciliate.

Abdomen (Pls 97A; 98D) with circular dorsal chloride epithelia on segments II or III-VIII; tergite on segment IX only: more-or-less rectangular, lightly sclerotized, setae slender, inner anal-margin setae extending well beyond end of body. Anal prolegs (Pl. 98D) protrude postero-laterally; claws slender, 2-5 accessory hooks (Pl. 98E). No caudal filaments.

<u>Pupa</u>. Mandibles as in <u>Hydroptila</u>. Labrum rounded (on the one pupa available I was unable to see whether any setae are present). Hook plates: pre- and postsegmental plates broad, spinules scattered.

Case (Pl. 97B). Laterally compressed, subrectangular in profile, margins slightly convex; constructed of secretion only. Pupal case attached by stalked discs at each end on one side. Case construction appears similar to *Hellyethira*, in which a wide initial structure is extended at each end. Length of pupal case, 4.0-4.4 mm.

Biology. Larvae in slow-flowing creeks, lakes and lagoons.

Distribution. West Palaearctic; SE Asia (Burma, Indonesia); N Australia.

Key to adults of Australian *Tricholeiochiton* Koet & Hincks

1. Male 2
   Female 5

2(1) Sternite IX concave apically 3
   Sternite IX produced postero-medially into 2 divergent
   lobes (Pls 39E,F; 40A) .... *bifurca* Wells

3(2) Subgenital plate cleft to form 2 lobes 4
   Subgenital plate undivided, rounded, with central
   sclerotized prominence (Pls 37E,F; 38A) .... *fidelis* Wells

4(3) Dorsal plate trilobed 5
   Dorsal plate undivided, almost square (Pls 40D,E; 41A) ....
   .... *edmondsi* Wells

5(4) Aedeagus with short, dark subapical spine (Pl. 41C,D) .... jabirella Wells

Aedeagus without spine (Pl. 39A,B) .... tridens Wells

6(1) Segment VIII collar-like, interrupted ventrally by glandular region 7

Segment VIII not collar-like, without ventral glandular region . 9

7(6) "Collar" of segment VIII slightly tapered posteriorly; glandular region forming lobe projecting over sternite IX 8

"Collar" of segment VIII cylindrical, greatly exceeding width of anterior part of segment IX; glandular region not projecting (Pl. 39C,D) .... tridens Wells

8(7) Glandular region on sternite VIII, smooth, tapered posteriorly, apex excised, margins of excision overlapping (Pl. 40B,C) .... bifurca Wells

Glandular region on sternite VIII rough, tapered posteriorly, apex with a deep V-shaped excision (Pl. 41B) .... edmondsi Wells

9(6) Apical margin of sternite VIII slightly trilobed; labial palpi with terminal segment enlarged, densely covered with sensilla (Pl. 38C,D) .... fidelis Wells

Apical margin of sternite VIII concave; labial palpi unmodified (Pl. 41E) .... jabirella Wells

Tricholeiochiton fidelis Wells

(Pls 37; 38A-D; 97; 98)

Tricholeiochiton fidelis Wells, 1982: 253-256.

Holotype ♂, paratypes 4♂, 4♀, N Queensland, Alice River on Hervey Range Road, 9.v.1979, NMV. Paratypes, 2♂, 5♀, N Queensland, Ross River at Apex Park nr Townsville, 26.iv.1979, NMV.

Adults (modified after Wells 1982)

Fawn-brown, with upturned, dark-brown wing tips: forks 1 and 2 present in anterior wing, no forks in posterior wing. Remarkably close to the Indian T. lacustris Kimmins (Kimmins 1951) from which it is distinguished by slight differences in neuration and shape of subgenital plate. Comprehensive diagrams are given to show features characteristic of the genus (Pls 37; 38A-D).

Male. Length of anterior wing, 2.0-2.5 mm. Antennae (Pl. 37B) 32-segmented, proximal segments pale, 8 distal segments dark. Genitalia (Pls 37E,F, 38A):- Segment IX considerably smaller than VII and VIII, retracted into VIII; sternite with deep U-shaped apico-mesal excavation, lateral lobes sclerotized apically. Dorsal plate membranous, trilobed: median lobe broad, roughly rounded apically, lateral lobe produced downwards. Subgenital plate rounded, with raised and heavily sclerotized median section. Inferior appendages shorter than lateral lobes of segment IX, membranous, united basally. Mesal process on sternite VII extending posteriorly beyond margin of sternite, apex dentate.

Female. Length of anterior wing, 3.0-3.3 mm. Antennae 24-segmented. Labial palpi (Pl. 38B) with segment three 4x times length of 1 or 2, ventral surface covered in small peg sensilla. Genitalia (Pl. 38C,D):- Sternite IX sclerotized, shallowly trisected distally, tergite shallowly concave apically.

Fully grown larva (Pl. 97A). See generic diagnosis: the larva of *fidelis* agrees exactly with Lepneva's (1970) description of *fagesii*.

Pupa. As for genus.

Case (Pl. 97B). Mature case usually "bon-bon" shaped in profile. Length of pupal case, 4.0-4.4 mm.

Biology. Immatures netted from lagoons; probably live amongst macrophytes or filamentous algae. Adults collected year round (A.J. Sharley, pers. comm.).

Distribution. NW Australia.

Tricholeiochiton tridens Wells

(Pls 38E,F; 39A-D; Pl. 123A,B)

Tricholeiochiton tridens Wells, 1982: 256.

Holotype ♂, paratypes 11♂, 12♀, Western Australia, Mitchell Plateau, 30.i.1978, NMV.

Adults (modified after Wells 1982)

Stout, uniformly dark grey when fresh, fading to grey-brown in spirit. Wings (Pl. 38F) differ from *fidelis* in having anterior wing with long-foot stalk on fork 1, and part of Cu_1 visible; fork 2 present in posterior wing.

Male. Length of anterior wing, 1.7-2.5 mm. Antennae (Pl. 123A) 26-segmented. Genitalia (Pls 38E; 39A,B):- Tergite IX short medially, produced into lateral lobes; sternite short, shallowly rounded. Dorsal plate membranous, trilobed: lateral lobes rounded apically with small outer subapical hooks; median lobe narrow, truncate apically. Subgenital plate deeply excised medially to form 2 lobes with darkly sclerotized areas on inner distal margins. Inferior appendages membranous, curved, cyclindrical, each with small sclerotized apical tooth. Short, blunt, mesal spine on sternite VII.

Female. Length of anterior wing, 2.0-2.5 mm. Antennae (Pl. 123B) 23-segmented. Labial palpi without specialized sensilla. Genitalia (Pl. 39C,D):- Segment VIII collar-like, short and broad, greatly exceeding width of segment IX, with long setae around margin of "collar"; a median area marked by sclerotized bands. Segments IX and X narrow.

Immatures and habitat unknown.

Distribution. N Western Australia; NE Northern Territory.

Tricholeiochiton bifurca Wells

(Pls 39E,F; 40A-C)

Tricholeiochiton bifurca Wells, 1982: 256-259.

Holotype ♂, paratypes 1♂, 2♀, Western Australia, Mitchell Plateau, Camp Creek, 31.i.1978, NMV. Paratypes, Western Australia: 1♂, 3♀, Mitchell Plateau, Lone Dingo Creek, tributary of Mitchell River, 17.ii.1979, NMV; 2♂, 4♀, Mitchell Plateau, 30.i.1978, NMV.

Adults (modified after Wells 1982)

Occurs with *T. tridens*, from which it is almost indistinguishable in general appearance; wings similar to *tridens*.

Male. Length of anterior wing, 1.9-2.4 mm. Antennae 27-segmented. Genitalia (Pls 39E,F; 40A):- Segment IX with short lateral lobes, sternite produced postero-medially to form pair of divergent lobes. Dorsal plate short, rounded apically. Subgenital plate slightly concave apically, with paired apico-lateral sclerotized regions. Inferior appendages short and broad.

Female. Length of anterior wing, 2.0-3.2 mm. Antennae 24-25-segmented. Labial palpi without specialized sensilla. Genitalia (Pl. 40B,C):- Segment VIII collar-like (narrower than *tridens*), with semi-triangular sclerotized plate mid-ventrally, excised medially.

Immatures and *habitat* unknown.

Distribution. N Western Australia, NE Northern Territory.

Tricholeiochiton edmondsi Wells

(Pls 40D,E; 41A,B)

Tricholeiochiton edmondsi Wells, 1982: 258-259.

Holotype ♂, paratypes 2♀, Western Australia, Stonewall Creek, 2.ii.1978, NMV. Paratypes, Western Australia: 3♀, Fine Springs Creek, 2.ii.1978, NMV; 2♀, Stonewall Creek, 4.ii.1978, NMV.

Adults (modified after Wells 1982)

Similar to tridens and bifurca, but male genitalia intermediate: dorsal plate, tergite IX and inferior appendages of male resemble bifurca; subgenital plate more like that of tridens.

Male. Length of anterior wing, 2.2 mm. Antennae 25-segmented. Genitalia (Pls 41A,B):- Segment IX short, broad; sternite produced posteriorly into blunt lateral lobes. Dorsal plate membranous, sub-quadrate. Subgenital plate bilobed, lobes divergent, tapered towards sclerotized apices. Inferior appendages stout, with apical and subapical sclerotizations.

Female. Length of anterior wing, 2.3-2.5 mm. Antennae 21-segmented. Labial palpi without specialized sensilla. Genitalia (Pl. 40D,E):- Similar to bifurca in dorsal view; in ventral view the median sclerotized plate is wider, its lobes divergent and tapered.

Immatures and habitat unknown.

Distribution. NW Australia.

Tricholeiochiton jabirella Wells

(Pl. 41C-E)

Tricholeiochiton jabirella Wells, 1985b: 99-100.

Holotype ♂, Corndorl Billabong, nr Jabiru, N.T., 20.iii.1983, A.J. Sharley, NTM I.97. Paratypes: 1♂, 1♀, (allotype), with holotype, NTM I.98,99; 1♂, 12.iii.1983, NTM I.100, 1♂, 16.iii.1983, NTM I.101, 2♂, 18.iii.1983, NTM I.101,102, Corndorl Billabong, nr Jabiru, N.T.; 1♂, Georgetown Billabong, nr Jabiru, N.T., A.J. Sharley, NTM I.104, 7.iii.1983.

Adults (modified after Wells 1985b)

Medium sized; wings mottled, tips upturned, R_2 and R_3 arise independently in anterior wing. Males most closely resembles fidelis, but are distinguished by the spine on aedeagus, broader inferior appendages, and bilobed subgenital plate.

Male. Length of anterior wing 2.2-2.5 mm. Antennae 32-segmented. Genitalia (Pl. 41C,D):- Segment X short, sternite with broad, deep, median excavation, lateral lobes sclerotised distally. Dorsal plate trilobed, membranous; central lobe subquadrate. Subgenital plate membranous, broad, narrowly cleft apicomesally. Inferior appendages stout, slightly extended apicomesally to form rounded, sclerotized lobes. Aedeagus with black spine arising subapically, projecting slightly beyond apex.

Female. Length of anterior wing, 2.5 mm. Antennae 22-segmented. Genitalia (Pl. 41E):- Segment VIII simple, collar-like.

Immatures unknown.

Habitat. Billabongs.

Distribution. NE Northern Territory.

Genus Orphninotrichia Mosely

Orphninotrichia Mosely, 1934: 138-139; Mosely & Kimmins, 1953: 510-511; Neboiss, 1977: 39-40; Marshall, 1979: 220-221; Wells, 1980: 628-635; Wells, 1983: 645-647.

Type-species: Orphninotrichia maculata Mosely, by monotypy.

The endemic genus Orphninotrichia is known from 9 species (Mosely 1934; Neboiss 1977; Wells 1980, 1983) all showing close similarities in adult features and with inseparable immatures.

All basic structures can generally be identified in the male genitalia but are often reduced, fused or otherwise modified. Female terminalia are more elongate than in Hellyethira but shorter than in Maydenoptila Neboiss; a large gland is always present on sternite VIII.

Larvae and cases are distinctive and readily recognized. Larvae share several features with the Oxyethira group, tribe Hydroptilini, but have sub-equal legs such as are seen in Hydroptila, probably as a secondary adaptation to a torrenticolous habitat. Cases are distinguished by their shape from all others in the Hydroptilidae (see Pl. 99B-D). Mode of case construction is similar to Hellyethira.

Diagnosis

Adults (modified after Marshall 1979, and Wells 1980)

Length of forewing, 2.2-4.0 mm. Spurs 0,2,4. Ocelli 3. Post-occipital lobes widely separated, without associated scent organs; tentorium incomplete. Antennae slender, uniformly dark grey to black; 22-30-segmented in male, 19-20 in female; hair fimbriate, in basal whorl on each segment; males with numerous placoid sensilla (Pl. 120C). Mesoscutellum subtriangular with convex anterior margin; metascutellum rounded.

Wings black with small white or golden spot midway on anal margin; lanceolate, apices acute; only apical fork 2 in anterior wing, 2 and 5 present in posterior wing. Sternal gland on abdominal segment V. Male with abdominal segment IX withdrawn into VIII, tergite deeply excavated; aedeagus similar to Tricholeiochiton, elongate, slender, dilated and bilobed apically, with spiniform titillator arising midway. Female terminalia with segmentation distinct; median ventral sclerite or gland on segment VIII.

Fully grown larva (Pl. 99A). Body slightly compressed laterally; legs short, subequal; abdomen distended, with segment I smaller than metathorax, II to III successively larger, IV-VI equal, subsequent segments decreasing in size; abdomen strongly arched at beginning of instar, scarcely curved at end. Sclerotized parts of body dark brown-black, covered with fine spinules; abdomen green in living specimens, white in those in spirit.

Head (Pl. 100D) rounded anteriorly, posterior margin truncate; ecdysial lines distinct; post-mental sclerites fused (Pl. 100E) forming broadly crescentic plate anterior to subtriangular anterior ventral apotome; posterior ventral apotome, small. Antenna (Pl. 100C) with discrete terminal sensillum as long as basal section, seta more than 2x length of antenna. Labrum (Pl. 100F) short, with stout, inflected tormae; setae stout, all shorter than sclerite; 3 pits present; sclerite excised apico-mesally, line of small papillae in excision; brushes on ventral membranes short, narrow. Mandibles (Pl. 101A) stout, asymmetrical, heavily sclerotized: left with broad upper and lower blades and several rounded apical denticles, penicillus between blades; right without penicillus, with several rounded apical denticles.

Thorax (Pls 99A; 100D; 101B): nota completely covering segments dorsally, segments broad anteriorly, slightly constricted posteriorly; sutures distinct on all nota, notched posteriorly on mesonotum; abundant short setae on anterior margins of nota. Well developed oral sclerites on all thoracic segments, anal sclerite on mesothorax only. Pre-episternite fused on all pleura, anal epimeron free on propleuron (Pl. 100B) as in <u>Oxyethira</u>.

Limbs (Pls 99A; 100A) short, subequal, segments decreasing in length distally. Forelimb (Pl. 100A) with tarsal claw longer than tarsus, subtended by fine seta; tarsus bearing short, mid-ventral blade-like seta; tibial process elongate with paired, blade-like apical setae and well developed comb on distal margin; inner ventral femoral and trochantal setae elongate, ciliate.

Abdomen (Pls 99A; 101C) with distinct tergites on segments I and IX and often faint, slender plates between elongate mid-dorsal setae on other segments; round dorsal chloride epithelia on segments II to VIII; tergite IX subrectangular, setae slender, pale, median anal marginal setae elongate. Anal prolegs (Pl. 101C) short, stout, protruding postero-laterally; anal claw (Pl. 101D) stout, 4 accessory hooks; no caudal filaments.

Pupa. Labrum (Pl. 102A) broadly rounded, 2 pairs of short basal setae only. Mandibles (Pl. 102B) elongate, with serrate inner distal margins and paired baso-lateral setae. Hook plates (Pl. 102C,D): presegmental plates broad flanges with posteriorly directed, broad marginal spinules; postsegmental plates broadly rounded with few to many small scattered spinules.

Case (Pl. 99B-D). Two equal valves - elongate, straight-sided, with rounded ends and shallow median concavity on each side; constructed of secretion incorporating some strands of filamentous algae and sometimes sand grains. The case is carried flat to the substrate, larva twisting in thoracic region. Early cases developed on twisted algal filaments and built the width of the final case (Pl. 99B). Subsequent additions to ends only, thus obviating need to open dorsal or ventral seams. At pupation, case is attached to substrate by stalked discs, usually on each side of one end, so that case hangs vertically.

Early larva (Pl. 101E). Distinctive, with all setae shorter than width of body; sclerites covered with tiny spinules. Head rounded anterolaterally, truncate posteriorly; dorsal ecdysial sutures distinct. Tergites clearly visible. Thoracic nota with rows of setae anteriorly. Anal prolegs partially fused, free distally, claws slender; no caudal filaments. Early larvae more like those of Stactobia (see Lepneva 1964) than Agraylea or Oxyethira (Nielsen 1948), perhaps reflecting adaptation to similar habitats.

Biology. The records show that adults have often been collected from waterfalls and I have usually collected immatures stages from natural or artificial falls. Larvae live and feed on the faces of falls amongst algae and mosses, and walk across or up the rock, cases held flat against the fall. Pupal cases generally hang vertically on open surfaces or in cracks and crevices, often clustered in large numbers. A few specimens are found downstream but larvae are most abundant on falls. Adults are diurnal and can be seen "scurrying" back and forth on rocks and vegetation; generally only small numbers are taken at lights. A typical locality for Orphninotrichia is shown in Pl. 126A.

Distribution. E and SE Australia along the Great Dividing Range; Victorian Alps; Tasmania; Fleurieu Peninsula, S Australia.

Key to males of Orphninotrichia Mosely

1. Sternite VIII almost truncate, or produced apically to form 1 or 2 distinct lobes, never concave 2

   Sternite VIII concave apically, with small sclerotized papillae (or androconia) in concavity 7

2(1) Sternite VIII cleft apico-mesally 3

   Sternite VIII produced to form rounded or triangular apical margin 6

3(2) Inferior appendages distinctly bilobed, outer lobe heavily sclerotized apically 4

   Inferior appendages irregular, but not bilobed 5

4(3) Apico-mesal lobes of sternite VIII rounded apically, apices not widely divergent (Pl. 44A,B) .... regia Wells

   Apico-mesal lobes of sternite VIII tapered to acute and widely divergent apices (Pl. 47A,B) .... justini Wells

5(3) Inferior appendages obliquely truncate at apices (Pls 42E,F; 43A) .... maculata Mosely

   Inferior appendages rounded at apices (Pl. 47C,D) .... benambrica Wells

6(2) Inferior appendages united basally, divided distally, or united throughout their length to form a broad plate 7

Inferior appendages discrete, columnar; apices rounded to truncate (Pl. 43D,E) .... <u>acta</u> Neboiss

7(6) Inferior appendages united basally, distal lobes widely separated, rounded and heavily sclerotized apically (Pl. 45A,B) .... <u>media</u> Wells

Inferior appendages united throughout their length to form broad plate with sclerotized apicolateral angles (Pl. 48C,D) .... <u>subulata</u> Wells

8(1) Androconia lining apico-mesal concavity of sternite VIII numerous (Pl. 45C,D) .... <u>papillata</u> Wells

Androconia in small median groups in apico-mesal concavity of sternite VIII (Pl. 46C,D) .... <u>silicis</u> Wells

Orphninotrichia maculata Mosely

(Pls 42; 43A-C; 99-101; 102A-C)

Orphninotrichia maculata Mosely, 1934: 138-9; Mosely & Kimmins, 1953: 510-11; Neboiss, 1977: 39-40; Wells, 1980: 630-32.

Holotype ♂, New South Wales, Hornsby, 31.viii.1916, BMNH.

Adults (modified after Mosely 1934, Wells 1980)

Male. Length of anterior wing, 2.1-2.5 mm. Antennae (Pl. 42B) 28-30-segmented. Genitalia (Pls 42E,F; 43A):- Abdominal tergite IX with rounded apico-mesal excavation; in dorsal view lateral lobes broader at apex than medially. Sternite VIII bilobed apico-mesally. Inferior appendages undivided, fused basally, discrete distally; apices obliquely truncate.

Female. Length of anterior wing, 2.5-3.4 mm. Antennae 23-segmented. Genitalia (Pl. 43B):- Terminal abdominal segment heavily sclerotized anteriorly; irregularly shaped ventral sclerotization, or gland, on sternite VIII.

Fully grown larva, pupa, case and early larva (Pls 99-101; 102A-C) as for genus.

Biology. Larvae of all instars and pupae amongst blue-green algae, green filamentous algae and mosses on faces of falls (e.g. Pl. 126A). Adults collected October to May. Observations in S Australia suggest that maculata is multivoltine, with populations increasing in size through summer. Development proceeds immediately in eggs deposited under laboratory conditions, with hatching after 6-8 days. Larvae feed upon periphyton.

Distribution. S Queensland; E New South Wales; Victoria; Fleurieu Peninsula, S Australia; SW Tasmania.

Orphninotrichia acta Neboiss

(Pl. 43C-E)

Orphninotrichia acta Neboiss, 1977: 40; Wells, 1980: 632.
Holotype ♂, paratypes 12♂, 1♀ (allotype) Tasmania, Ulverstone, 4 km NW waterfalls, 18.xi.1972, NMV, T4997.

Adults (modified after Wells 1980)

Closely resemble *maculata*.

Male. Length of anterior wing,, 3.0-3.5 mm. Antennae 29-31-segmented. Lateral lobes of tergite IX straight-sided, not expanded apically. Genitalia (Pl. 43D,E):- Sternite IX with apex broadly rounded, not bilobed.

Female. Distinguished from *maculata* only by narrower segment VIII (Pl. 43C). Length of anterior wing, 3.5 mm. Antennae 20-segmented.

Immatures unknown.

Distribution. Tasmania; November, January.

Orphninotrichia regia Wells

(Pl. 44)

Orphninotrichia regia Wells, 1980: 632-33.

Holotype ♂, Victoria, Kinglake, 29.xi.1955, NMV. Paratypes 9♂,14♀,(including allotype), collected with holotype; 1♂, 2♀, Snobs Creek Falls, 15.xii.1955, NMV; 1♂, Snobs Creek Falls, 24.i.1956, NMV.

Adults (modified after Wells 1980)

Smaller than maculata, uniformly reddish-brown, antennae shorter.

Male. Length of anterior wing, 2 mm. Antennae 25-segmented. Genitalia (Pl. 44A,B):- Sternite VIII densely hairy, obscuring genitalia; apical margin sclerotized, produced posteriorly into 2 median lobes. Lateral lobes of segment IX tapered posteriorly, rounded apically, with small inner ventral lobes. Dorsal plate triangular. No subgenital plate visible. Inferior appendages broad-based, bilobed distally: inner lobes finger-like, pale, tipped with setae; outer lobes rounded and heavily sclerotized apically.

Female. Length of anterior wing, 2.4 mm. Antennae 20-segmented. Genitalia (Pl. 44C):- Sternite VIII widely excavated apically; small lateral lobes bearing rows of setae; ventral sclerotization mesally. Segments IX and X membranous.

Immatures unknown.

Biology. Two of the samples of this poorly known species are from a waterfall, so it is likely that like other members of the genus, it occurs most commonly on falls.

Distribution. Victorian Alps.

Orphninotrichia media Wells

(Pl. 45A,B)

Orphninotrichia media Wells, 1980: 632-634.

Holotype ♂, Victoria, Porepunkah, 27.i.1957, NMV.

Adults (modified after Wells 1980)

At first sight *O. media* closely resembles *regia*; only after treatment with potassium hydroxide was it recognized as a distinct species.

Male. Length of anterior wing, 1.9 mm. Antennae 22-segmented. Genitalia (Pl. 45A,B):- Sternite VIII densely hairy, tapered posteriorly to form apico-mesal lobe. Segment IX short, lateral lobes cylindrical, apices rounded, each with small inner sclerotized tooth. Dorsal plate straight-sided basally, tapered towards rounded apex. Subgenital plate membranous with median notch and a pair of setae apically. Inferior appendages united at base; smaller inner lobes tipped by setae, outer lobes rounded and sclerotized apically.

Female and immatures unknown.

Distribution. Victorian Alps.

Orphninotrichia justini Wells

(Pls 47A,B: 48A)

Orphninotrichia justini Wells, 1983: 645-646.

Holotype ♂, Victoria, Stevensons Falls, Upper Gellibrand River, 20.i.1982, NMV. Paratypes 15♂, 7♀ (including allotype), with holotype, NMV.

Adults (modified after Wells 1983)

Similar to *O. regia* in form of inferior appendages of male and terminalia of female.

Male. Length of anterior wing, 2.0-2.3 mm. Antennae 23-27-segmented. Genitalia (Pl. 47A,B):- Apex of sternite VIII bilobed; tips of lobes acuminate, divergent. Dorso-lateral lobes of segment IX widest at about $^2/3$ length in dorsal view, tapered towards rounded apices. Inferior appendages bilobed: outer lobe with apex heavily sclerotized; inner lobe membranous, with sub-apical seta.

Female. Length of anterior wing, 2.0-2.5 mm. Antennae 18-21-segmented. Genitalia (Pl. 48A):- Sternite VIII with large, heavily sclerotized, irregularly shaped mesal gland; terminal segment sclerotized except for pale apical margin.

Immatures. Indistinguishable from maculata, although cases occasionally have more sand attached to them. Length of pupal case, 2.3-4.0 mm.

Biology. As for maculata.

Distribution. Otway Ranges, Victoria.

Orphninotrichia benambrica Wells

(Pls 47C,D; 48B; 102D; 120C)

Orphninotrichia benambrica Wells, 1983: 646-647.

Holotype ♂, Victoria, Benambra Creek, 25 km NE Benambra at granite falls, 17.i.1982, NMV. Paratypes 15♂, 15♀ (including allotype), with holotype, NMV.

Adults (modified after Wells 1983)

Distinguished from maculata by rounded inferior appendages of male; in females, penultimate segment of the abdomen is more elongate.

Male. Length of anterior wing, 2.4-3.0 mm. Antennae (Pl. 120C) 30-31-segmented. Genitalia (Pl. 47C,D):- Sternite VIII almost square, apical margin irregular, shallowly notched medially. Dorso-lateral lobes of segment IX stout, in dorsal view truncate apically. Inferior appendages discrete, strongly curved towards mid-line.

Female. Length of anterior wing, 2.7-3.2 mm. Antennae 21-22-segmented. Genitalia (Pl. 48B):- Terminalia elongate:

sternite VIII shorter than broad, occupied by large glandular structure; sternite IX pale and membranous anteriorly, darker posteriorly; all but apico-lateral margins of terminal segment dark.

Immatures as in *maculata*, except pupal hook plates (Pl. 102D). Length of pupal case, 2.7-4.0 mm.

Biology. Immature stages from faces of small cascades along gently sloping granitic falls, and from amongst blue-green and filamentous green algae and mosses on the falls. Adults swept from riparian vegetation (mainly *Leptospermum* sp.).

Distribution. NE Victoria.

Orphninotrichia papillata Wells

(Pls 45C,D; 46A,B)

Orphninotrichia papillata Wells, 1980: 634-635.

Holotype ♂, Victoria, Tawonga, 28.i.1957, NMV. Paratype, ♀ (allotype), with holotype, NMV.

Adults (modified after Wells 1980)

Small, red-brown caddisflies, probably discoloured due to preservation; male readily distinguished by row of black papillae or androconia on apical margin of sternite VIII, female by large black apico-mesal sclerotization on sternite VIII.

Male. Length of anterior wing, 2.2 mm. Antennae 25-segmented. Genitalia (Pl. 45C,D):- Apical margin of sternite VIII with broad, shallow concavity bordered by small black papillae. Tergite IX dissected to form discrete, stout lateral lobes: broad basally, bilobed distally; inner lobe with sclerotized apico-lateral tooth, outer lobe narrower. Dorsal plate broad, rounded apically. Subgenital plate not visible. Inferior apendages pale, irregularly shaped, discrete; each with small lateral lobe near base.

Female. Length of anterior wing, 2.4 mm. Antennae 19-segmented. Genitalia (Pl. 46A,B):- Sternite VIII heavily sclerotized, reduced to large, rounded mid-ventral lobe; tergite short, broad. Segments IX and X membranous.

Immatures unknown.

Distribution. Victorian Alps, January.

Orphninotrichia silicis Wells
(Pl. 46C,D)

Orphninotrichia silicis Wells, 1980: 635-636.

Holotype ♂, North Queensland, Tinaroo Lake Road, Stream at M4, 6.viii.1972, NMV.

Adult.

Jet black.

Male. Length of anterior wing, 2.5 mm. Antennae damaged. Genitalia (Pl. 46C,D):- Apical margin of sternite VIII with narrow, shallow concavity with median group of small black androconia or papillae. In dorsal view, distinguished from papillata mainly by long narrow dorsal plate. Sternite IX with pair of blunt median lobes. Inferior appendages slender, discrete, sclerotized.

Female and immatures unknown.

Distribution. Atherton Tableland, NE Queensland.

Orphninotrichia subulata Wells

(Pl. 48C,D; 102E)

Orphninotrichia subulata Wells, 1983: 646-647.

Holotype ♂, New South Wales, Undercliffe Falls, 12 km E of Liston, 24.x.1981, NMV.

Adults (modified after Wells 1983)

Distinctive in having inferior appendages fused to form broad plate.

Male. Length of anterior wing, 1.6 mm. Antennae damaged. Genitalia (Pl. 48C,D):- Sternite VIII pear-shaped, hairy, entirely concealing segment IX in ventral view. Dorso-lateral lobes of tergite IX short and slender. Inferior appendages fused medially to form subrectangular plate with sclerotized apico-lateral angles.

Female. Unknown.

Immatures. Indistinguishable from *maculata* except pupal hook plates (Pl. 102E). Length of pupal case, 2.0-3.8 mm.

Biology. Immatures from the near-vertical face of falls, amongst moss and algae.

Distribution. NE New South Wales.

3.3 *Incertae sedis*

At present *Maydenoptila* Neboiss is not placed in any tribe. It shares features of its specialised male genitalia with *Caledonotrichia* Sykora (New Caledonia), and in addition, similarities between these genera and *Dibusa* Ross (North America) and *Nothotrichia* Flint (South America) can be recognised. Like Marshall (1979), who was unable to place *Caledonotrichia*, *Dibusa* and *Nothotrichia*, I am unable to find any synapomorphies which unite these genera.

Genus *Maydenoptila* Neboiss

Maydenoptila Neboiss, 1977: 44; Wells, 1980: 635-645; Wells, 1983: 637-645.

Type-species: *Maydenoptila cuneola* Neboiss, by original designation.

Eight species are referred to *Maydenoptila* (Neboiss 1977; Wells 1980, 1983); larvae are known for only four. Two distinct species groups are recognizable, based upon wing venation. In all other respects, adults of all species but *M. pseudorupina* show remarkable uniformity, especially in the highly specialised form of their male genitalia. In contrast, the larvae are more divergent in general features than any other genus in the Australian Hydroptilidae.

Wells (1983) noted close similarities between adults of *Maydenoptila* and *Caledonotrichia* and suggested possible relationships between these and *Dibusa* and *Nothotrichia*. The larva of the only known species of *Dibusa*, and of 1 species of *Caledonotrichia*, have been described (Wiggins 1977; Marshall 1979) and in general appearance these are similar to larvae of *Maydenoptila*. However, in at least one character, generally considered to be conservative, they differ:- In *Dibusa* the thoracic pleurites are fused on all segments; in *Caledonotrichia* the pre-episternite is free on all segments, the epimeron of each apparently fused; and in *Maydenoptila* the pre-episternite of the propleuron is free, while being fused on the other 2 pleurites. Considering the close similarity of adults of *Maydenoptila* and *Caledonotrichia* (see Wells 1983) this raises doubts about the reliability of this character at the generic level. Curiously, both *Dibusa angata* Ross and *M. cuneola* Neboiss feed upon, and construct their cases of, red algae, and are the only hydroptilids known to do so.

Marshall (1979) found it difficult to homologise the genitalic features of *Caledonotrichia* with structures of other hydroptilids. Neboiss (1977) interpreted the similar genitalia of *Maydenoptila* as consisting of the rudiments of superior appendages - the small dorso-lateral protuberances on the apico-lateral margin of tergite IX - and inferior appendages - the ventral bilobed structures. A diagnostic feature of Hydroptilidae is lack of superior appendages, yet close examination of Nothotrichia illiesi Flint reveals that, like Dibusa angata, it has elongate-cylindrical, dorso-lateral structures, referred to by Ross (1944) as "cerci". If these are superior appendages, reduced to rudiments in Maydenoptila and Caledonotrichia, then their presence represents retention of another primitive feature in the 4 genera. Alternatively, but less likely, these structures are apomorphous.

Detailed figures of adults of the type-species, Maydenoptila cuneola, are given to show diagnostic features of the genus; immature stages are characterized in illustrations of M. rupina, for which more material is available, including early-stage larvae.

Diagnosis

Adults (modified after Wells 1980)

Length of forewing, 2-4 mm. Spurs 0,3,4, or 1,3,4. Ocelli 3. Post-occipital lobes large, without associated scent organs; tentorium complete, well developed. Antennae long, slender; 28-42-segmented in male, 33 in female; hair scattered, simple in male (Pl. 116A,B; 122A), fimbriate in female (Pl. 122B); male antennae with few placoid sensilla and s. auricillica (Pl. 121C), 2 basal segments enlarged, terminal segment longer than penultimate, intermediate segments cylindrical to flask-shaped. Mesoscutellum large, subtriangular, anterior margin convex; metascutellum more-or-less pentagonal. Wings broadly lanceolate: anterior wing with small rounded jugal lobe, forks 1, 2 and 3 present; posterior wing with forks

2, 3 and 5, fringe moderately long, less than twice greatest width of wing. Sternal glands on segment V. Male with broad abdominal segment IX to which stout bilobed inferior appendages hinge apico-laterally; mesal process on sternite VII. Terminalia of female extensible into long slender ovipositor.

Fully grown larva (Pl. 103A).

Body slightly compressed laterally; legs sub-equal; abdomen distended, segments gradually enlarged from I to IV, then decreasing subsequently; segment I usually slightly larger than metathorax, curvature of abdomen slight.

Head (Pl. 104A) ovoid to round in dorsal view; coronal and posterior section of fronto-clypeal suture distinct; ventral sutures fused, except in M. pseudorupina where all sutures are distinct. Postmental sclerites fused to form broadly crescentic or triangular plate (Pl. 104C); pseudorupina has a broadly crescentic anterior ventral apotome (Pl. 108G). Labrum (Pls 104D; 107A,E) variable: tormae slender to stout, inflected; setae slender, always shorter than sclerite, 3 pits present. Mandibles (Pls 103C; 106C; 108A,F) asymmetrical, heavily sclerotized, varying from stout grinding structures with many rounded denticles to fine cutting blades; penicillus on both mandibles, on left only, or absent. Antenna (Pl. 103E) with small discrete apical sensillum, seta less than 2x length of antenna.

Thorax (Pls 103A; 104A,B): all nota stout, almost rectangular in lateral view; median sutures distinct, small median to posterior notch on each suture; meso- and metanota only partially covering dorsa of segments. Prothorax with oral and paired anal ventral sclerites

(Pl. 104B); paired anal sclerites only on mesothorax; only paired anal sclerites on prothorax of pseudorupina. Pre-episternite of propleuron free (Pl. 103D), fused on other pleura.

Legs (Pl. 103A,D) short, length of segments decreasing distally; tarsal claws about as long as tarsi; distal segments of forelimbs variable; tibial processes generally short; inner ventral setae on femur and trochanter short and smooth.

Abdomen with round dorsal chloride epithelia (Pls 103A; 106E) on segments II to VIII; generally only segment IX with tergite (Pl. 104E), however, baynesi has tergites on all segments (Pl. 106A,E; Ulmer, 1908). Tergite IX (Pl. 104E) rounded posteriorly, anterior and lateral margins irregular in shape; setae all fine, median anal marginal setae 1½ to 5x length of tergite. Anal prolegs (Pls 104E; 106E) short, protruding postero-laterally; claws (Pl. 104F) stout, simple, strongly curved. No caudal filaments.

Pupa. Labrum (Pls 102F; 107F) broad, margins rounded or somewhat angular, generally constricted towards base; 1-2 pairs of anterior marginal setae of variable length; 2 pairs of basal setae, inner pair short, outer at least length of labrum. Mandibles (Pl. 102G) slender, inner distal margins serrate; paired setae at base. Hook plates (Pls 102H, 107B, 108B) varied: postsegmental lobes rounded with scattered spinules, presegmental plates flanged with marginal spinules, or broadly rounded with scattered spinules.

Case (Pls 103B; 106B; 107C; 108C,D). Generally 2 more-or-less ovoid valves, joined on long sides; usually constructed of algae or sand grains; laterally compressed, carried vertically. Prior to pupation, cases are attached closely to substrate, usually at each end of ventral side and ends are sealed. Construction appears similar to that of Hydroptila: increments added ventrally and to each end of small cockle-shaped early case.

In pseudorupina (Pl. 108C,D) case is constructed of secretion only and has a small constriction towards each end of dorsal seam; pupal case tapered at one end only.

Early larva (Pl. 105). Typically hydroptiline, with legs short and sub-equal; head broadly rounded anteriorly, flattened posteriorly; coronal and distal portions of fronto-clypeal suture distinct. Thoracic and abdominal tergites distinct. Lateral body setae slightly longer than width of body, caudal setae longer, but less than ½ length of body. Anal prolegs discrete, about length of abdominal segments; claw slender, about length of proleg; no caudal filaments.

Biology. Just as the larval morphology varies, so do habitats for this genus although it is always in fresh, flowing water. M. rupina, baynesi and pseudorupina, at least, appear to be univoltine. Adults of baynesi and rupina are diurnal and both show similar frenzied activity, running up and down, to and fro, on riparian vegetation and rocks. I observed similar behaviour in 3 species of the sister group, Caledonotrichia (Wells, unpublished data).

Distribution. Along the Great Dividing Range; on Fleurieu Peninsula and Kangaroo Island, S Australia; Tasmania; SW Western Australia.

Key to males of Maydenoptila Neboiss

1. Both wings with foot-stalk on fork 2 only $^{2}/3$ length of foot-stalk on fork 3 2

   Both wings with foot-stalk on fork 2 longer than foot-stalk on fork 3 by almost $^{1}/3$ 5

2(1) Dorsal lobe of inferior appendages with inwardly directed apical tooth 3

   Dorsal lobe of inferior appendages with subapical tooth on inner surface (Pls 49E,F; 50A) .... cuneola Neboiss

3(2) Inferior appendages with 2 well developed lobes. Aedeagus simple, without processes 4

   Inferior appendages with ventral lobe reduced to swelling at base of dorsal lobe. Aedeagus in form of 2 sclerotized rods with titillator adpressed distally (Pl. 51A,B) .... explicata Wells

4(3) Ventral lobe of inferior appendages square to rectangular 5

   Ventral lobe of inferior appendages cylindrical (Pl. 51C,D) .... commista Wells

5(4) Dorsal lobe of inferior appendages narrow, cylindrical, with apico-mesal spine (Pl. 51E,F) .... kurandica Wells

   Dorsal lobe of inferior appendages sub-rectangular, with apico-lateral angle produced into small spine (Pl. 54C,D) .... antennifera Wells

6(1) Both branches of inferior appendages membranous, lobose 7

Ventral branch of inferior appendages membranous, lobose; dorsal branch sickle-shaped, sclerotized (Pl. 53B,C) .... pseudorupina Wells

7(6) Spine on dorsal branch of inferior appendages subapical on ventral surface (Pl. 52B-E) .... rupina Neboiss

Spine on dorsal branch of inferior appendages on apico-lateral angle (Pl. 54A,B) .... baynesi Wells

Key to cased larvae of Maydenoptila Neboiss*

1 Larva with abdominal segments I-VIII membranous, tergite on segment IX only 2

Larva with tergites on all abdominal segments (Pl. 106A) .... baynesi Wells

2(1) Case of secretion or sand grains; body sclerites dark brown 3

Case of strands of red algae; body sclerites pale fawn, with dark posterior markings on thoracic nota (Pl. 107C) .... cuneola Neboiss

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*Larvae of commista Wells, explicata Wells, kurandica Wells and antennifera Wells unknown.

3(2) Case of sand grains: valves ovoid to bean-shaped in profile (Pl. 103B) .... rupina Neboiss

Case of secretion only, valves in profile broadly rounded at ends beyond shallow dorsal constrictions (Pl. 108C,D) .... pseudorupina Wells

Maydenoptila cuneola Neboiss

(Pls 49; 50; 107C-F; 116A,B; 122A,B)

Maydenoptila cuneola Neboiss, 1977: 44-45; Wells, 1980: 637-639.

Holotype ♂, Tasmania, Wedge River, 17.ii.1971, NMV,T5067. Paratypes (including allotype), 9♂, 4♀, with holotype, NMV,T5068-T5080; 1♂, 2♀, Tasmania, Wedge River, 30 miles W of Maydena, 25.ii.1967, ANIC.

Adults (modified after Neboiss 1977, Wells 1980)

Both wings with short foot-stalks on fork 2 (Pl. 49D).

Male. Length of anterior wing, 3.5-4.0 mm. Antennae (Pl. 122A) 40-41-segmented. Genitalia (Pls 49E,F; 50A):- Sternite IX shield-shaped, posterior margin shallowly concave. Ventral lobe of inferior appendages triangular, dorsal lobe narrower, rounded, with ventral sclerotized spine, small setose subgenital process (= plate?) present.

Female. Length of anterior wing, 4.0 mm. Antennae (Pl. 122B) 34-36-segmented. Genitalia (Pl. 50B):- Sternite VII with 4 long setae on apical margin.

Fully grown larva. Body pale cream, dark markings on margins of pronotum, proximally on coxae.

Head slightly broader posteriorly than rupina; frontoclypeal sutures distinct behind eyes. Labrum (Pl. 107E): sclerite symmetrical, almost rectangular; tormae stout, inflected; only 2 pairs of setae visible, others may be present but obscured by the 6 highly specialized rosettes of setae on apical margin. Mandibles (Pl. 108A) stout, chisel-like; without penicillus.

Prothorax with pale midventral sclerite, attached to paired anal sclerites; mesothorax with fused anal sclerites forming posterior bar; no sclerites visible on metathorax.

Forelimb (Pl. 107D). Tarsal claw slender, curved, longer than tarsus, subtended by slender curved seta; tibial process apico-ventral, poorly developed, with pair of slender setae only.

Abdomen as in rupina.

Case (Pl. 107C). Highly distinctive, of branches of freshwater red alga, Batrachospermum sp. (identified by H.B.S. Womersley, pers. comm.). Case typically hydroptiline; at pupation attached closely to algal thallus or upper surfaces of stones or rocks. Even when mature, larva does not fully occupy case. Length of pupal case, 4.0-5.3 mm.

Pupa. Labrum (Pl. 107F) broadly rounded, constricted basally; 4 pairs of setae, outer pairs longer than inner. Hook plates (Pl. 108B): presegmental plates broadly rounded with scattered and marginal spinules; postsegmental plates round, covered with anteriorly directed spinules.

Biology. Amongst tufts of Batrachospermum in flowing waters. Appears to feed upon the alga and its curiously modified mouthparts and tarsal claws are probably specialized for handling and feeding it. Final instar larvae from November to February; adults December to April.

Distribution. SW Tasmania; E Gippsland, the Grampians, and central Victoria.

Maydenoptila explicata Wells

(Pl. 51A,B)

Maydenoptila explicata Wells, 1980: 639-641.

Holotype, ♂, Tasmania, Gordon River, 1 km above First Split, 11.i.1977, NMV. Paratypes, Tasmania, 7♂, with holotype, NMV; 1♂, Gordon River, 1/2 km above Sprent River junction, 13.i.1977, NMV; 2♂, Gordon River, a creek $^1/2$ km below Second Split, 12.i.1977, NMV; 1♂, Russell Falls National Park, 23.ii.67, NMV.

Adults (modified after Wells 1980)

Wings of cuneola-form, with short foot-stalks on fork 2. In general appearance, male genitalia similar to those of cuneola but aedeagus more like that of rupina.

Male. Length of anterior wing, 2.9-3.5 mm. Antennae 38-segmented. Genitalia (Pl. 51A,B):- Terminal abdominal segments short, stout. Sternite IX broadly concave apically with median row of 4 short setae on subapical tubercles. Dorsal plate narrow, rounded. Aedeagus of 2 curved rods to which a stout titillator is adpressed distally. No subgenital structure. Inferior appendages dilated ventrally at base to form small ventral lobes; posterior lobes cylindrical with rounded apices and inner sclerotized apical teeth.

Female and immatures unknown.

Distribution. W Tasmania; January-February.

Maydenoptila commista Wells
(Pl. 51C,D)

Maydenoptila commista Wells, 1980: 640-641.

Holotype ♂, Victoria, Dee River, 2 km NW of Millgrove, 24.ii.1976, NMV. Paratype, 1♂, with holotype, NMV.

Adults (modified after Wells 1980)

Similar to rupina in general appearance, but closer to cuneola in neuration and form of aedeagus; ventral lobe of inferior appendages more pronounced than in explicata.

Male. Length of anterior wing, 2.6 mm. Antennae 33-segmented. Genitalia (Pl. 51C,D):- Dorsal plate short, almost rectangular. Aedeagus as in cuneola. Inferior appendages with large, swollen, dorsal lobes tipped by sclerotized hook; ventral lobes poorly developed, irregular. Mesal process of sternite VII long, slender, blunt apically.

Female and immatures unknown.

Distribution. Central Victoria.

Maydenoptila kurandica Wells

(Pl. 51E,F)

Maydenoptila kurandica Wells, 1980: 640-642.

Holotype, ♂, Queensland, stream 3 miles E of Kuranda, 7.viii.1972, NMV.

Adults (modified after Wells 1980)

Male. Dark grey. Length of anterior wing, 3.0 mm. Antennae 36-segmented. Genitalia (Pl. 51E,F):- Dorsal plate long, rounded apically. Aedeagus simple, proximal $^2/3$ enclosed in membranous sheath; tip narrowed, sclerotized. Subgenital structure similar to cuneola. Inferior appendages with large, almost rectangular ventral lobe; narrow dorsal lobe with elongate apical tooth. Mesal process of sternite VII short, acute.

Female and immatures unknown.

Distribution. NE Queensland.

Maydenoptila rupina Neboiss

(Pls 52; 53A; 102F-H; 103; 104; 105; 121C)

Maydenoptila rupina Neboiss, 1977: 45; Wells, 1980: 642-643.
Holotype ♂, Tasmania, Guide River Falls nr Ridgely, 18.xi.1972, NMV, T5081. Paratypes, Tasmania, 20♂, 9♀ (including allotype), with holotype, NMV, T5082–T5110; 3♂, Scamander River, Upper Scamander, 19.xi.1972, NMV, T5111–T5113.

Adults (modified after Neboiss 1977, Wells 1980)

Male. Length of anterior wing, 2.1-3.0 mm. Wings with long foot-stalks on fork 2 (Pl. 52A). Antennae 27–28-segmented. Genitalia (Pl. 52B-E):- Sternite IX shallowly concave apically. Inferior appendages bilobed; both lobes stout, membranous; dorsal lobe with ventral subapical spine. Aedeagus with spine extending distally from a median constriction; small apical hook.

Female. Length of anterior wing, 2.2-3.1 mm. Antennae 25-segmented. Genitalia (Pl. 53A):- Sternite VIII with 4 long setae subapically.

Fully grown larva (Pl. 103A). Sclerotized parts dark brown; abdomen green, white in preserved specimens.

Head (Pl. 104A) almost ovoid in dorsal view. Labrum (Pl. 104D): sclerite deep; shallow apico-mesal concavity; 6 pairs of setae, all shorter than labrum; short regular brushes of fine setae apically on ventral membranes. Mandibles (Pl. 103C) stout grinding structures with numerous rounded denticles.

Forelimb (Pl. 103D): tarsal claw slender, curved, subtended by a short seta; tarsus with paired apico-ventral blade-like setae and small comb; tibia with well developed ventral process, bearing paired blade-like setae and small comb apically.

Abdomen (Pls 103A; 104E) with tergite on segment IX only.

Case (Pl. 103B). Typically hydroptiline; 2 valves covered by sand grains and a few algal filaments; ventral margin almost straight, dorsal convex. Early case of algal filaments. Length of pupal case, 2.7-5.0 mm.

Pupa. Labrum (Pl. 102F): 4 pairs of setae, anterior margin setae vestigial, outer basal setae slightly longer than labrum, inner pair short. Hook plates (Pl. 102H): presegmental plates broad with posteriorly directed marginal spinules only; postsegmental plates rounded with spinules directed anteriorly.

Early larva (Pl. 105). See diagnosis.

Biology. First and second instar larvae appear in mid-winter (July) in a S Australian stream (see Pl. 127B); pupae present by early spring (September); adults emerge in single spring 'flush' over 3-4 weeks in October. During this period adults engage in frenzied activity, running to and fro on vegetation. No egg-laying has been observed in the field, but adults have been induced to lay in captivity. Unlike eggs of Hellyethira simplex and Orphninotrichia maculata those of rupina did not develop immediately. M. rupina is strictly univoltine in this habitat where the stream is usually dry from mid-November to April. Possibly the eggs undergo diapause.

Larvae of all instars collected from amongst tufts of the chain diatom Melosira on rocks and stones in flowing water. The guts of 5th instar larvae contain Melosira and small quantities of several other non-filamentous diatoms.

Few adult records: 2 dated February, all others September to November. Adults are not attracted to lights.

Distribution. Central Victoria; Tasmania; Fleurieu Peninsula, Kangaroo Island, S Australia.

Maydenoptila baynesi Wells

(Pls 54A,B; 106; 107A,B)

Maydenoptila baynesi Wells, 1983: 630-631.

Holotype ♂, Western Australia, Marrinup Brook on Pinjarra-Dwellingup Rd at railway crossing, 9.ix.1980, Wells, NMV. Paratypes, 17♂, 1♀ (allotype) collected with holotype, NMV.

Adults (modified after Wells 1983)

Similar to rupina in general appearance and venation.

Male. Length of anterior wing, 2.1-2.8 mm. Antennae 35-segmented. Genitalia (Pl. 54A,B):- Dorsal plate narrow, tapered distally. Aedeagus slender, hooked apically; thin short rod closely adpressed. No subgenital structure visible. Inferior appendages bilobed: ventral lobe slender, membranous, almost 2x length of club-shaped dorsal lobe which has small apical protuberance tipped with heavily sclerotized tooth.

Female. Indistinguishable from that of rupina. Length of anterior wing, 2.6 mm. Antennae 29-segmented.

Fully grown larva (Pl. 106A). A larva figured by Ulmer (1908, pp 38-40), and referred to "Hydroptila? sp.?" is probably baynesi.

Characterised by tergites on all abdominal segments; sclerotized parts dark brown to black, pale ring around eyes, abdomen orange, white in preserved material.

Head almost square in dorsal view, coronal suture only. Labrum (Pl. 107A) similar to rupina but with straight row of apico-mesal papillae. Mandibles (Pl. 106A) tapered apically with sharp cutting blades; penicillus between blades on each mandible.

Forelimb (Pl. 106D) short, stout; tarsal claw stout, curved, subtended by a short, broad seta; pair of apico-ventral setae on tarsus; tibial process poorly developed, tipped by paired spatulate setae.

Abdomen (Pl. 106A,E) with small lateral humps on segment IV; size of tergites varies, tergite IX covers most of dorsum of segment. Anal prolegs with heavily sclerotized plates.

Case (Pl. 106B). Similar to rupina; straight-sided to convex. Length of pupal case, 3.5-4.0 mm.

Pupa. Labrum as in cuneola (Pl. 107F): broadly rounded with 4 pairs of setae, outer pairs longer than inner. Hook plates: presegmental plates broad but not hooked as in rupina, spinules scattered; postsegmental plates broadly rounded, spinules scattered.

Biology. Larvae on faces of short falls and bedrock in swift streams and rivers (eg. Pl. 125B); pupae in crevices on upper surfaces of boulders and basement rocks. Although some filamentous algae was growing on rocks in some localities, larvae appeared to be "grazing" on periphyton on rock surfaces.

Adults, final instar larvae and pupae collected in September, final instar larvae in August and September; empty cases only in November. Adults diurnal.

Distribution. SW Western Australia.

Maydenoptila antennifera Wells

(Pl. 54C,D)

Maydenoptila antennifera Wells, 1983: 630-632.

Holotype ♂, New South Wales, Wiangaree State Forest, via Kyogle, 18.xi.1974, NMV. Paratype ♂, collected with holotype, NMV.

Adults (modified after Wells 1983)

Brown; wings of *cuneola*-form with short foot-stalk on fork 2 in both wings; antennae reaching to tips of forewings, longer than in other species.

Male. Length of anterior wing, 3.5-3.7 mm. Antennae 49-50-segmented. Genitalia (Pl. 54C,D):- Dorsal plate slightly tapered, rounded posteriorly. Aedeagus simple as in *cuneola*. Subgenital process ovoid distally. Inferior appendages bilobed, both lobes broad: width and length of ventral lobe almost equal; dorsal lobe more-or-less rectangular, small spur apico-laterally. Small ventral spur apico-mesally on sternite VII.

Female and immatures unknown.

Distribution. NE New South Wales.

Maydenoptila pseudorupina Wells

(Pls 53B-D; 108C-G)

Maydenoptila pseudorupina Wells, 1980: 643-645.

Holotype, ♂, Brodribb River, Sardine Creek Track, 39 km N of Orbost, 16.xii.1976, NMV. Paratypes, Victoria: 1♂, 11♀ (including allotype), collected with holotype, NMV; 10♂, 10♀, Albert River, nr Hiawatha, 3.xi.77, NMV.

Adults (modified after Wells 1980)

Large, grey to red-brown; distinguished by spur formula, 1,3,4.

Male. Length of anterior wing, 3.0 mm. Antennae 32-33-segmented. Genitalia (Pl. 53B,C):- Segment IX narrower than in preceding species: tergite deeply excavated, sternite truncate apically with median setose process similar to subgenital structures of cuneola and kurandica. Dorsal plate narrow, rounded. Aedeagus 3-pronged apically. Inferior appendages bilobed: ventral lobe broad, membranous; dorsal lobe sclerotized, sickle-shaped.

Female. Length of anterior wing, 3.0 mm. Antennae 26-27-segmented. Genitalia (Pl. 53D):- Closely similar to cuneola and rupina, but with many apical setae on sternite VIII.

Fully grown larva. Sclerotized parts dark brown, abdomen white in preserved material.

Head almost circular in dorsal view, posterior margin shallowly concave. All ecdysial sutures distinct; postmental sclerites fused; anterior ventral apotome present (Pl. 108G); no posterior ventral apotome. Labrum long, as in rupina but without apical concavity. Mandibles (Pl. 108F) tapered towards apices, with several sharp apical denticles; fine, bristly penicillus on each mandible. Anal sclerites on prothoracic venter only.

Forelimb (Pl. 108E). Tarsal claw stout, strongly curved, subtended by broad, short seta; several spurs apico-ventrally on tarsus; tibial process moderately developed, with pair of blade-like setae apically and 1 on distal margin. Mid and hind tarsal claws strongly curved, no basal setae.

Abdomen as in rupina. Anal prolegs with strongly curved claw subtended by short spur-like seta.

Case (Pl. 108C,D). Two equal secretion valves; laterally compressed, with distinct dorsal and ventral sides; constriction towards each end of dorsal seam beyond which larval case is open. Mature larva fully occupies case; head and thorax protrude anteriorly, terminal abdominal segment protrudes posteriorly. Case shows some resemblance to those of Orthotrichia, especially in the way that it is extended posteriorly (Pl. 108D) at pupation, but it lacks dorsal ribs. Construction is of basic form found in other *Maydenoptila* and in *Hydroptila* as can be seen from "growth rings" in Pl. 108D. Pupal case attached along base, ends sealed; length, 2.7-3.6 mm.

Pupa. Labrum as in *cuneola*: 1 pair of vestigial anterior marginal setae; 2 pairs of basal setae, outer pair as long as labrum. Hook plates: both sets broadly rounded, spinules scattered.

Biology. Larvae and pupae on rocks and stones in flowing water; often numerous pupal cases are found close-pressed and aligned with the current.

Adults, final instar larvae and pupae from October-December, abundant empty cases from October to January. Probably univoltine, with brief spring emergence.

Distribution. SE Queensland; Otway Ranges and central Victoria.

3.5 *Tribe Orthotrichiini Nielsen*

Orthotrichiinae Nielsen, 1948: 186.
Type-genus: *Orthotrichia* Eaton, 1873.
Orthotrichiini Nielsen, Marshall, 1979: 212-213.
Type-genus: *Orthotrichia* Eaton, 1873.

Marshall (1979) proposed that *Orthotrichia* and *Ichthytrichia* be united in a tribe, the Orthotrichiini in the subfamily Hydroptilinae, rather than in a subfamily of their own. Her diagnosis, given almost unchanged below, shows clear differences between the two genera. Only Orthotrichia occurs in Australia.

Adults (after Marshall 1979)

Forewing length 2-4 mm; tentorium complete; ocelli 3 or 0; post-occipital lobes unmodified; thoracic nota variable; mesonotum without transverse suture; spur formula 0,3,4; abdominal sternite V with typical setate process; genitalia basically a simple oviscapt, modified in Orthotrichia; genitalia very characteristic for each genus, highly asymmetrical in Orthotrichia; aedeagus with spiral titillator.

Larva. Both Orthotrichia and Ichthytrichia have very distinct and specialized larval stages. Their characteristic features, on the basis of which Nielsen (1948) grouped the genera together, are as follows. Labium broad and flat; mandibles flattened, tapering; general form of the ventral apotome and "postmental sclerites"; the thoracic sternites; the comb-like setae of the fore-coxae; the circle of "rings" on abdominal segment I and the single median caudal filament from segment X. The cases of the larvae of each genus are also very characteristic, neither being of the typical "purse-type".

Pupa. Typically hydroptiloid, with, according to Marshall (1979), long, untoothed mandibles. However, mandibles of Australian Orthotrichia pupae are short and stout in comparison with those of members of the Hydroptilini, or Maydenoptila.

Genus Orthotrichia Eaton

Orthotrichia Eaton, 1873: 141; McLachlan, 1880: 518; Nielsen, 1948: 95-114; Lepneva 1964, (English translation, 1970: 391-399); Wiggins, 1977: 144-145; Marshall, 1979: 144-145; Wells, 1979b: 585-622.

Type-species: Hydroptila augustella McLachlan, by original designation.

Orthotrichia is widespread and occurs in the Holarctic region, Africa, SE Asia to New Guinea (Marshall 1979) and Australia (Wells 1979b). Thirty-five species are known from Australia (Wells 1979b, 1983, 1985b). Marshall gives a figure of "approximately 40" for the rest of the world and splits the genus (without Australian members) into four main species groups based on the form of male genitalia.

I have grouped Australian species on the same basis: three of my groups are distinct from Marshall's. The fourth, the adornata group, probably belongs with her kokodana group, which contains "two distinct species from Papua New Guinea characterized by the simplicity of the male genitalia".

Immatures of the European Orthotrichia tetensii Kolbe were described in detail by Nielsen (1948) and the characteristic larva and "wheat seed" case of several other species have been described (e.g. Ross 1944, Wiggins 1977). However little information is available on the extent of interspecific variation.

Mature larvae, cases and pupae of 11 Australian species have been identified, and although interspecific differences in colour and markings can be recognized in larvae and in ribbing and shape of cases, no clear differences are discernible between most species or even species groups. However, immature stages known for 2 species in the *aberrans* group are highly distinctive.

Ulmer (1957) figured and described larvae and cases of several *Orthotrichia* from Indonesia (as *Orthotrichia* sp., *Orthotrichiella ranauana* Ulmer, and *Baliotrichia literalis* Ulmer (the latter 2 are now synonymised with *Orthotrichia* (Marshall 1979)). In addition he showed features of an unusual larva, pupa and case designated "Hydroptilid B", from Central Java. The hook plates of that pupa differ from any others described in the Hydroptilidae. They do, however, closely resemble those of *aberrans* Wells; cases are also similar.

No detailed life history study has been made for any Australian *Orthotrichia* but it is apparent from general field data that northern hemisphere and Australian species differ considerably. Throughout the literature on European and North American species, *Orthotrichia* is described as living on macrophytes in lentic waters: "in lakes and ponds" (Ross 1944); "inhabitants of submerged phanerogamic vegetation ...", "almost exclusively associated with lakes and large ponds" (Nielsen 1948); "in submerged beds of aquatic plants along lake margins or in slowly flowing sections of rivers" (Wiggins 1977); and "in plant thickets in sluggish to still water" (Marshall 1979). Only Lepneva (1970) says "stagnant and running waters". Yet on all but one occasion, I have collected larvae of Australian species from flowing waters, generally beneath rocks and cobbles.

Another puzzle is that northern hemisphere species are reported to feed on green filamentous algae. However, on only one occasion have I collected larvae of a species, *atraseta* Wells, from amongst filamentous green algae, upon which it was probably feeding (5th instar larvae were abundant amongst algae on rocks). Even this species is usually on undersurfaces of rocks in areas where little or no green filamentous alga is growing. Most species appear to feed on aufwuchs on rocks. On many occasions, though, I have collected both *atraseta* and *tortuosa* Wells from amongst insect egg masses upon which they were "grazing", as shown by one or several larvae being surrounded by damaged eggs, or gaps in the egg masses.

Burton and McRae (1972) and Disney (1973) reported observations of *Orthotrichia* larvae feeding on *Simulium* larvae, but Marshall (1979) suggested improbably that the *Simulium* were mistaken for algal filaments.

Amongst many Hydroptilidae that feed on filamentous green algae, *Orthotrichia* is the only genus that has a tooth-like process on the labrum. Nielsen (1948) viewed this structure as an extreme specialization for algal feeding. If that is so, then the "tooth" may be seen as a structure which pre-adapted the genus for the predatory niche of feeding on insect eggs and larvae. The alternative is that algal feeding is the secondary niche for *Orthotrichia*. Further support for this proposition lies in the fact that in the more highly specialized algal feeders of the tribe Hydroptilini fore-limbs are strongly modified for grasping filaments of algae, an adaptation unknown in *Orthotrichia*.

Males are readily recognized by features of their highly specialized and often strongly asymmetrical genitalia, but females are more difficult to identify; they have been associated for only 16 Australian species. Detailed figures of adults of *O. adornata* Wells are provided to illustrate diagnostic features of the genus; male and female genitalia and sometimes wings of other species are drawn; and a key to males of Australian species is supplied.

Immatures of O. bishopi Wells are figured in detail, and unusual features of some other species are included. As larvae of relatively few Australian species are known, no key is provided.

Diagnosis

Adults (modified after Marshall 1979, and Wells 1979b)

Length of forewing, 1.3-4.0 mm; wings markedly attenuate. Post occipital lobes prominent, subspherical, not modified as scent organs; ocelli absent; tentorium complete; antennae (Pl. 122C,D) of 20-40 segments, segments with scattered hair, in males numerous placoid sensilla; antennal segments generally dark, two pale bands distally. Mesoscutellum triangular, metascutellum characteristically rectangular; spur formula 0,3,4; sternal glands present on abdominal segment V. Female terminalia generally forming a modified oviscapt; segment VIII fused or sclerotized, often forming collar-like structure, segments IX and X membranous. Male genitalia characteristically asymmetrical; sternites VI and VII variously with ventral processes or tufts of setae; segment VIII unmodified; segment IX fused, often with asymmetrical posterolateral processes; inferior appendages usually small and fused medially, but well developed; subgenital plate indistinct or absent; bilobed process present; tergite X generally forming large asymmetrical dorsal plate, ventrally concave, often with laterally directed dorsal spines; beneath dorsal plate is a variously shaped slender, asymmetrical sclerite usually with 2 asymmetrical processes, one long and slender, lying diagonally beneath dorsal plate, alongside aedeagus (= paramere (Wells, 1979b)); aedeagus very long and slender with distinct proximal and distal halves near junction of which arises a slender, spiral titillator.

Fully grown larva (modified after Nielsen 1948: 95-114, Wells 1985a: 26-32, and others).

Body (Pls 109A, 110A) slightly depressed dorso-ventrally; legs short, sub-equal; abdomen greatly distended beyond segment I, segment II with pair of lateral "humps"; sclerotized parts generally dark.

Head (Pls 109A, 110A,D): ecdysial sutures distinct, submental sclerites fused, anterior and posterior ventral apotomes triangular. Labrum (Pl. 110B) asymmetrical, with tooth-shaped median process. Mandibles (Pl. 110E) asymmetrical, slender, acute apically: dorsal blade of left with rounded denticles and fine penicillus; right notched on inner edge. Antenna (Pl. 110C) slender, curved, a simple undivided sensillum; basal seta about 2x length of antenna.

Thorax (Pls 109A, 110A, 111A) usually heavily sclerotized; stout, paired nota completely covering segments dorsally; pre-episternite free on propleuron, produced into long horn-like structure (Pl. 109D); paired anal sclerites present on all thoracic venters, fused on prothorax. Forelimb (Pl. 109D) with relatively simple distal elements: tibia without distinct ventral process or modified setae; coxa with comb-like rows of setae; ventral femoral and trochantal setae simple, smooth.

Abdomen (Pl. 110A) with complete whorl of small sclerites on segment I, dorsal chloride epithelia on segments III-VIII; tergite on segment IX only (Pl. 111B), rectangular to rounded, generally with 1 or more pairs of stout black setae; rarely 3 caudal filaments; anal prolegs of mature larva positioned ventrally; claw simple, rounded (Pl. 111C). (Pairs of setae on tergite IX are numbered I-VI to facilitate comparisons between species.)

Case (Pl. 109B,C). Described by Marshall (1979) as "wheat seed" shape, case is highly distinctive: generally ribbed dorsally, flattened ventrally, greatest diameter medially, tapered towards slit-like anterior and posterior ends. Pupal cases attached to substrate at one or both ends by sessile or stalked discs; prior to pupation one end is partially sealed, other extended to cone shape.

Several Australian species can be distinguished by a combination of case and larval features, others are indistinguishable.

Early stage larva. Nielsen (1948) described and figured an early larva of the European *Orthotrichia* *tetensii* which closely resembles *Hydroptila losida* (Pl. 86), although lacking dorsal ecdysial sutures, oral margin setae on thoracic nota, and caudal filaments. Early larvae have been collected which are probably *atraseta*; they do have caudal filaments.

Biology. Nielsen (1948) and Marshall (1977) say *Orthotrichia* occurs on aquatic vegetation in lakes. Immatures of most Australian species have been collected from flowing water, in all but one instance from rocks or cobbles, usually on their lower surfaces.

Distribution. Australian *Orthotrichia* are generally limited to peripheral areas of the continent: NW Western Australia; N Northern Territory; N Queensland; along the Great Dividing Range of E Australia; E and central Victoria, Otway Ranges and Grampians; Tasmania; and Fleurieu Peninsula, S Australia. Several species are from the more central Murray-Darling river system but none from the third of the continent lying SW of a line drawn between Adelaide and Broome.

Key to males of Australian *Orthotrichia* Eaton

1\. Tergite VIII with 1-2 pairs of stout, dark, spiny setae mesally or on posterior margin, extending posteriorly to overlie dorsal plate (*gracilis* group) 4
Tergite VIII without stout, dark, spiny setae; with or without lateral groups of slender, dark setae 2

2(1) Inferior appendages large and wide, together about equal in length and width to dorsal plate (*morula* group) 14
Inferior appendages together always shorter and narrower than dorsal plate 3

3(2) Aedeagus twisted in distal half; dorsal plate stout, irregularly lobed; often stout mesal lobe on segment VIII, partly obscuring genitalia (*aberrans* group) 15
Aedeagus straight in distal half; dorsal plate generally longer than wide; never with mesal lobe on sternite VIII (*adornata* group) 20

4(1) Tergite VIII with pair of spiny, dark setae 5
Tergite VIII with 2 pairs of spiny, dark setae 13

5(4) Dorsal process of inferior appendages a single lobe, lying on right side, arching towards left, bearing 2 setae 6
Dorsal process of inferior appendages always medial, more-or-less divided, generally symmetrical 9

6(5) Inferior appendages short, length no more than 2x breadth; dorsal process smoothly rounded or angled posteriorly beyond basal "heel" 7

Inferior appendages elongate, more than 3x as long as wide; dorsal process anteriorly directed beyond basal "heel" which projects posteriorly (Pl. 72C,D) .... *exiqua* Wells

7(6) Inferior appendages united or fused at bases 8

Inferior appendages widely separated at bases, apices convergent (Pl. 82B,C) .... *attenuata* Wells

8(7) Inferior appendages stout throughout length, apices truncate (Pl. 71A,B) .... *kholoensis* Wells

Inferior appendages broad based, tapered to attenuate apices (Pl. 71C,D) .... *paranga* Wells

9(5) Dorsal process of inferior appendages short, obscured by inferior appendages; paramere simple, spiny without apical hook 10

Dorsal process of inferior appendages divided into pair of elongate, swollen lobes projecting beyond apices of inferior appendages; paramere strongly hooked at apex (Pl. 69C,D) .... *gracilis* Wells

10(9) Paired spiny setae on tergite VIII widely separated 11

Paired spiny setae on tergite VIII both medial (Pl. 73C,D) .... *bellicosa* Wells

11(10) Paramere straight, spiny, without elaborations 12

Paramere corkscrew-like in distal third (Pl. 70D,E) tortuosa Wells

12(11) Inferior appendages strongly asymmetrical (Pl. 73A,B) tyleri Wells

Inferior appendages symmetrical (Pl. 72A,B) .... stipa Wells

13(4) Dorsal process of inferior appendages symmetrical, bilobed; pairs of spiny setae laterally placed on tergite VIII; left dorsal spine on dorsal plate attenuate apically (Pl. 74A,B) .... capillata Wells

Dorsal process of inferior appendages highly asymmetrical, undivided; pairs of spiny setae medial on tergite VIII; left dorsal spine on dorsal plate rounded apically (Pl. 81D,E) .... yabbaca Wells

14(2) Inferior appendages united briefly at bases, widely separated posteriorly. Dorsal plate simple; left dorsal spine only, diverging from dorsal plate (Pl. 69A,B) .... alveata Wells

Inferior appendages almost completely united. Dorsal plate folded; right dorsal spine only, diverging from dorsal plate (Pl. 68A,B) .... morula Wells

15(3) Broad mesal lobe on sternite VIII obscuring genitalia 16

Without broad mesal lobe on sternite VIII 19

16(15) Mesal lobe on sternite VIII with scattered, stout, black setae along length of ventral surface of lobe or distally on lobe 17

Mesal lobe on sternite VIII with stout, black setae in broad apical fan or short, subapical row 18

17(16) Inferior appendages in form of short, stout lobes; dorsal process projecting posteriorly beyond their apices (Pl. 74C,D) .... aberrans Wells

Inferior appendages united basally, with elongate, distal lobes projecting beyond apices of lobes of dorsal process (Pl. 75B,C) .... conferta Wells

18(16) Mesal lobe of sternite VIII with row of 4 stout, black setae subapically (Pl. 76B,C) .... pectinella Wells

Mesal lobe of sternite VIII with dense brush of stout, black setae apically (Pl. 77A,B)) .... flabella Wells

19(15) Inferior appendages in form of slender, widely-separated, hairy lobes. An extraordinary process lies above inferior appendages, brush of slender hair on its inner distal surface (Pl. 78A,B) .... muscari Wells

Inferior appendages in form of stout lobes, slightly tapered distally. Without process seen in flabella, but characterized by stout divergent lateral lobes on sternite IX (Pl. 79A,B) .... divaricata Wells

20(3) Clavate mesal lobe on abdominal sternite VII, with scattered stout blunt setae 21

No such mesal lobe on abdominal sternite VII 30

21(20) Without groups of slender, black setae laterally on segment VIII 22

With groups of slender black setae laterally on segment VIII (Pl. 58A,B) .... <u>atraseta</u> Wells

22(21) Inferior appendages symmetrical 23

Inferior appendages highly asymmetrical (Pl. 62B,C) .... <u>scutata</u> Wells

23(22) Dorsal process of inferior appendages divided into discrete lobes, projecting beyond inferior appendages 24

Dorsal process of inferior appendages scarcely divided, short, generally obscured by inferior appendages 28

24(23) Right dorsal spines lying obliquely across dorsal plate, left may also be angled across plate 25

Only left dorsal spine angled across dorsal plate, right spine absent (Pl. 57A,B) .... <u>zonata</u> (Neboiss)

25(24) Right and left dorsal spines angled across dorsal plate 26

Only right dorsal spine angled across dorsal plate, left lying along lateral margin 27

26(25) Right dorsal spine densely hairy. Lobes of dorsal process of inferior appendages slender, with apical setae (Pl. 56A-C) .... *adornata* Wells

Right dorsal spine smooth, not hairy. Lobes of dorsal process of inferior appendages stout, setae subapical (Pl. 63B,C) .... *turrita* Wells

27(25) Left dorsal spine with rounded apical process. Dorsal plate with small rounded subapical spine (Pl. 60C,D) .... *orbostensis* Wells

Left dorsal spine slender, simple, without apical process. Dorsal plate without subapical spine as in *orbostensis* (Pl. 80A,B) .... *dilgri* Wells

28(23) Paramere divided apically. Dorsal plate with small median anterior spine 29

Paramere undivided apically, with apical twist. Dorsal plate without small median anterior spine (Pl. 59C,D) .... *bishopi* Wells

29(28) Left dorsal spine with sclerotized tooth-like structure apically (Pl. 61A,B) .... *rostrata* Wells

Left dorsal spine without apical tooth, with median process wrapped across dorsal plate (Pl. 59A,B) .... *armata* Wells

30(20) Dorsal plate with lateral spines or other ornamentation 31

Dorsal plate without lateral spines or other ornamentation (Pl. 67A,B) .... inornata Wells

31(30) Inferior appendages symmetrical 32

Inferior appendages highly asymmetrical (Pl. 66A,B) .... aculeata Wells

32(31) Dorsal process of inferior appendages undivided, broad, and plate-like or small and obscured by inferior appendages 33

Dorsal process divided into 2 discrete, slender lobes (Pl. 67D,E) .... suteri Wells

33(32) Dorsal process of inferior appendages a small knob, almost obscured by inferior appendages 34

Dorsal process of inferior appendages a broad plate (Pl. 81A,B) .... velata Wells

34(33) Inferior appendages cylindrical; dorsal plate without subapical spine; antennal segments with broad bands or patches of s. auricillica (Pl. 65B,C) .... eurhinata Wells

Inferior appendages bulbous; dorsal plate with slender apical spine; antennal segments unmodified (Pl. 64A,B) ....bullata Wells

The adornata group

Sixteen of the 35 Australian species are in this group. Males are characterized by small inferior appendages, always shorter than the dorsal plate; tergite VIII without paired stout black spines. Wing venation is variable between species, in one instance within a species.

Adults of Orthotrichia adornata Wells are described in detail to represent the group.

Orthotrichia adornata Wells

(Pls 55; 56; 116C,D; 117A)

Orthotrichia adornata Wells, 1979b: 589-591.

Holotype ♂, paratypes 10♂, 11♀, Victoria, Millgrove, Yarra River, 24.ii.1976, NMV, T5817, T5860-5880.

Adults (modified after Wells 1979b)

Medium-sized; mottled grey-black. Antennae (Pl. 55B; 116C,D; 117A) banded, segments with scattered short hair; small placoid sensilla in male only; basal segment slightly longer than others, terminal segment rounded apically, others elongate cylindrical. Maxillary palpi with 5th segment longer than either 3rd or 4th. Thorax (Pl. 55C) with mesoscutellum triangular, metascutellum almost rectangular. Wings (Pl. 55D) lanceolate, apices acute. Forewing with R_3 arising from R_2 (in some specimens it is difficult to determine origin of R_3); forks 1-3 present, crossvein r-m distal to fork on M; crossveins between

M-Cu_1, Cu_1-Cu_2 and Cu_2-A_1. Posterior wing with fork 2, crossvein r-m distal to fork on M.

Male. Length of anterior wing, 3.1 mm. Antennae 30-32-segmented: basal 20 segments dark, followed by 3 light, 4 dark, 2 light, 3 dark. Genitalia (Pl. 56A-C):- Segment IX short, rectangular; left dorsal spine sharply curved medially, wrapped over dorsal plate and protruded ventrally beyond another sharp curve; right dorsal spine hairy, curved to left. Dorsal plate rounded apically, notched medially; right lateral margin folded ventrally. Paramere narrow, apex sharply hooked about aedeagus; basal spine slender, curved. Inferior appendages small, united basally, lateral margins oblique; dorsal process divided, each lobe with strong apical seta; basal apodeme long, narrow. Aedeagus slender, dilated towards notched apex; titillator wrapped about base. Mesal lobe of abdominal segment VII broad, covered with stout blunt setae.

Female. Length of anterior wing, 3.3 mm. Antennae 25-segmented, banded as in male. Genitalia (Pl. 55E,F):- Segment VIII dark, forming broad collar around terminalia, long dorsally, shorter and tapered ventrally with median excision; posterior margin ringed with strong, sinuous setae; short spine in mid-ventral cleft. Segments IX and X stout, X truncate apically.

Immatures and habitat unknown.

Distribution. North-central Victoria, and Otway Ranges; Tas.; SE NSW.

Orthotrichia zonata (Neboiss)

(Pl. 57A-D)

Targatrichia zonata Neboiss, 1977: 41; Wells, 1979b: 591-593.

Holotype ♂, paratypes 6♂, 13♀, Tasmania, Targa, St Patricks River, 22.ii.1971, NMV, T5013-T5032.

Adults (modified after Neboiss 1977, Wells 1979b)

Differs from adornata in details of male and female genitalia. Male. Length of anterior wing, 3.5-3.75 mm. Antennae 31-segmented. Genitalia (Pl. 57A,B):- Left dorsal spine divided, one branch extended posteriorly along lateral margin of dorsal plate, other curved across dorsal plate; right dorsal spine absent. Paramere without apical hook. Female. Length of anterior wing, 3.5-4.0 mm. Antennae 29-segmented. Genitalia (Pl. 57C,D):- Segment VIII less collar-like: sternite steeply dissected, side pockets at base of excision absent; tergite with dense fine hair posteriorly; sinuous setae offset from margins.

Immatures and habitat unknown.

Distribution. Tasmania; January to March.

Orthotrichia atraseta Wells

(Pls 58A-C; 112A)

Orthotrichia atraseta Wells, 1979b: 593-594.

Holotype ♂, Victoria, Millgrove, Yarra River, 24.ii.1976, NMV, T5818. Paratypes, Victoria: 3♂, 5♀ (including allotype), Mitta Mitta River, 15 km NNW Benambra, 15.ii.1978, NMV, T5881-T5888; 1♂, Koornalla, Traralgon Creek, 26.ii.1974, NMV, T5889.

Adults (modified after Wells 1979b)

Small, dark brown; males distinguished by groups of slender dark brown to black setae dorsally on tergite VIII.

Male. Length of anterior wing, 2.9 mm. Antennae 30-segmented, banded as in adornata. Genitalia (Pl. 58A,B):- Segments VIII and IX difficult to distinguish; 2 groups of fine, long dark setae on each side of tergite VIII. Dorsal plate narrow; left dorsal spine slender, curved across dorsal plate, right dorsal spine short, acute. Paramere almost straight. Inferior appendages truncate apically, united basally; dorsal process bilobed, obscured; basal apodeme thin, short.

Female. Length of anterior wing, 3.1 mm. Antennae 26-segmented, banded as in adornata. Genitalia (Pl. 58C):- Closely resembling adornata; large median sclerotization on sternite VIII; band of fine hair posteriorly on tergite VIII.

Fully grown larva. Head and thorax dark brown with some pale markings; head truncate posteriorly, tapered anterior to eyes. Tergite IX subrectangular, darkly sclerotized; anal marginal seta I slender and elongate, setae III and IV stout and black, subequal, V sclerotized, longer than III and IV. Anal prolegs with lateral sclerite ("b") irregular, longer than wide; articular rods elongate, both converging mid-ventrally (Pl. 112A).

Pupa. No distinctive features.

Case. Dark brown-black; 5 short dorsal ribs always in median position as in *tortuosa* (Pl. 113D). Pupal case usually attached at both ends; length, 3.2-3.8 mm.

Biology. Immature stages collected from several localities, including Upper Gellibrand River, Otway Ranges, where many final larvae were amongst dense green filamentous algae on rocks. At other localities final larvae were feeding on insect eggs (*Simulium*?) on undersides of rocks. Probably omnivorous.

Adults, January-March, i.e. mid to late summer; final instar larvae and pupae, January-February.

Distribution. The Alps, Otway Ranges and Grampians, Victoria; 1 female from Canberra may have been misidentified.

Orthotrichia armata Wells

(Pls 59A,B; 112B)

Orthotrichia armata Wells, 1979b: 594-595.

Holotype ♂, paratypes 4♂, Victoria, Snobs Creek, 24.i.1956, NMV, T5820, T5821-5823.

Adults (modified after Wells 1979b)

Males with sternite IX reduced to shield within VIII.

Male. Length of anterior wing, 2.4 mm. Antennae densely hairy, short, 25-segmented, banded as in *adornata*. Genitalia (Pl. 59A,B):- Sternite IX a median shield, tergite short; left dorsal spine broad basally, divided distally with slender branch curved across dorsal plate, short posterolateral branch, small ventral hook; left dorsal spine acute, lying obliquely across dorsal plate; small basal sclerotized tooth medially. Paramere rounded apically; a short, acute subapical process. Inferior appendages rounded, separated medially; dorsal process bilobed; basal apodeme long, slender.

Female unknown.

Fully grown larva, pupa indistinguishable from *atraseta*.

Case (Pl. 112B). Ribs short, situated anteriorly in pupal case; ends rounded.

Biology. Beneath rocks and stones in river of moderate flow.

Distribution. North-central Victoria.

Orthtrichia bishopi Wells

(Pls 59C,D; 60A,B; 109; 110; 111)

Orthotrichia bishopi Wells, 1979b: 595-596.

Holotype ♂, paratypes 5♂, 10♀, South Australia, Second Valley, Anacotilla Creek, 20.x.1976, ANIC. Paratypes, 3♂, 4♀, South Australia, Delamere, The Deep Creek, 1.ix.1976, NMV, T5890-5896.

Adults (modified after Wells 1979b)

Dark, with banded antennae. Females closely resembling adornata and atraseta; males closer to armata, with similar shield-shaped sternite IX; short, distinct tergite IX.

Male. Length of anterior wing, 2.4 mm. Antennae 28-segmented, banded as in adornata. Genitalia (Pl. 59C,D):- Left dorsal spine divided, posterolateral branch extended to apex of dorsal plate, lateral branch short, blunt; right dorsal spine broad, apex indented. Dorsal plate large, hood-like with narrow, sclerotized margin.. Paramere sharply twisted apically. Inferior appendages united, globose; dorsal process small, divided; basal apodeme short, narrow.

Female. Length of anterior wing, 2.6 mm. Antennae 26-segmented, banded as in adornata. Genitalia (Pl. 60A,B):- Differs from adornata in less distinct ventral margins of "collar"; dorsal margin more rounded; posterior portion of tergite VIII has fine hair as in zonata and atraseta.

Fully grown larva (Pls 109A; 110A). Head more-or-less ovoid in dorsal view; tan medially, pale laterally and along postero-dorsal margin; thorax dark tan with several lighter markings. Tergite IX (Pl. 111B) broadly rounded distally; median anal marginal seta I slender, elongate, only III stout and black, IV and V slender, longer than III and about ½ length of I. Anal prolegs widely separated in ventral view (Pl. 111G), to give broad, shallow, segment X.

Pupa. Pls 111D-F illustrate generic features.

Case (Pl. 109B,C). Dark brown-black; not markedly flattened; with 5 distinct dorsal ribs. Pupal case generally attached by stalked disc; length, 2.7-3.3 mm.

Biology. Small numbers on undersurfaces of rocks and stones in slow streams; adults taken in spring (September-October), final instar larvae, winter and spring (July-March).

Distribution. Fleurieu Peninsula, S Australia.

Orthotrichia orbostensis Wells

(Pl. 60C,D)

Orthotrichia orbostensis Wells, 1979b: 597-597.

Holotype ♂, Victoria, Brodribb River, Sardine Creek Track, 39 km N of Orbost, 16.xii.1977, NMV, T5824.

Adults (modified after Wells 1979b)

Dark-fawn, inferior appendages as in adornata and zonata; sternite IX shield-shaped.

Male. Length of anterior wing, 2.8 mm. Antennae 27-segmented, banded as in adornata. Genitalia (Pl. 60C,D):- Tergite IX fused with dorsal plate; left dorsal spine along lateral margin of dorsal plate, a broad outwardly directed flange posteriorly; right dorsal spine slender, curved across dorsal plate. Dorsal plate sheathing aedeagus, swollen basal section ventrally on right, plate tapered to apex, broad sclerotized subapical spine medially. Paramere straight spiny. Inferior appendages widely separated basally, convergent posteriorly; dorsal process divided, lobes widely divergent, basal apodeme long, slender.

Female, immatures and habitat unknown.

Distribution. Orbost, E Gippsland, Victoria.

Orthotrichia rostrata Wells

(Pl. 61A-D)

Orthotrichia rostrata Wells, 1979b: 598-599.

Holotype ♂, paratypes 2♂, 1♀, New South Wales Styx River,
12 km S of Ebor, 17.x.1973, NMV, T5825-T5828.

Adults (modified after Wells 1979b)

Resembles armata, particularly in small median dorsal spine and form of paramere; but sternite IX more elongate, without apicolateral lobes.

Male. Length of anterior wing, 2.3 mm. Antennae of all specimens damaged. Genitalia (Pl. 61A,B):- Tergite IX and dorsal plate fused; left dorsal spine enlarged and beak-like posteriorly; right dorsal spine offset from dorsal plate. Dorsal plate broad, rounded apically. Paramere swollen apically, with acute subapical process. Inferior appendages discrete but close-pressed, rounded, obscuring small dorsal process; basal apodeme long, slender.

Female. Length of anterior wing, 2.8 mm. Antennae short, 22-segmented, banded as in adornata. Genitalia (Pl. 61C,D):- Segment VIII not collar-like, short, broad anteriorly, tapered posteriorly; small mid-ventral lobe; row of sinuous setae on each side. Segment IX broad, short. Segment X rounded.

Immatures and habitat unknown. Pl. 128A is a photograph of the type locality, the moderately fast flowing Styx River. However, the precise microhabitat is not known.

Distribution. NE New South Wales.

Orthotrichia scutata Wells

(Pl. 62A-D)

Orthotrichia scutata Wells, 1979b: 559-560.

Holotype ♂, paratypes 1♂, 1♀, Western Australia, Spillway Creek, Ord River Dam, 20.ii.1977, WAM. Paratypes, Western Australia: 4♂, same data as holotype, ANIC; 1♂, Mitchell Plateau, Camp Creek, 13.vii.1978, WAM; 2♂, 1♀, Stonewall Creek, 4.ii.1978, NMV, T5897-5899.

Adults (modified after Wells 1979b)

Medium-sized, dark brown: forewings with R_{4+5} arising from R_3 (Pl. 62A).

Male. Length of anterior wing, 2.3 mm. Antennae 28-segmented. Genitalia (Pl. 62B,C):- Sternite IX deep, wide, shield-shaped, tergite and dorsal plate fused; left dorsal spine complex, branched; right dorsal spine broad, bract-like. Paramere sharply twisted below apex. Inferior appendages discrete, broad basally, narrower posteriorly; dorsal process more-or-less triangular, broad posteriorly; basal apodeme short, stout.

Female. Length of anterior wing, 2.6 mm. Antennae damaged. Genitalia (Pl. 62D):- Segment VIII short, collar-like, with small mid-ventral break; sinuous setae short, forming ring on posterior margin, broken only for short distance mid-ventrally.

Immatures and habitat unknown.

Distribution. N Western Australia, N Northern Territory.

Orthotrichia turrita Wells

(Pls 63A-C; 112C-F)

Orthotrichia turrita Wells, 1979b: 600-602.

Holotype ♂, Western Australia, Four Mile Creek, 20 km NE Lake Argyle Tourist Village, 2.ii.1978, WAM. Paratypes, Western Australia: 2♂, Mitchell Plateau, Camp Creek, 13.vii.1978, WAM; 1♂, same data, ANIC; 1♂, same data, NMV, T5900.

Adults (modified after Wells 1979b)

Unusual in forewing (Pl. 63A) resembling scutata except M_1 briefly intercepts R_5, and posterior wing with compressed venation as in inornata Wells (Pl. 66C). The situation seen in the forewing is probably a step towards further reduction in neuration as in inornata, where M_1 arises from R_5. O. inornata and several other species with reduced venation lack the stout mesal lobe on sternite VII, but it is present in turrita. The sinuous terminal portion of aedeagus and large dorsal process of inferior appendages distinguish this species.

Male. Length of anterior wing, 1.9 mm. Antennae 28-segmented, uniformly pale. Genitalia (Pl. 63B,C):- Sternite IX similar to rostrata, tergite short, fused with VIII, 4 short setae medially; dorsal spines simple, both lying across dorsal plate, left slender and curved, right broad for $^2/3$ length, tapered towards apex. Dorsal plate short, truncate apically. Paramere may be absent. Inferior appendages widely separated basally, convergent posteriorly; dorsal process large, arising on right and branching to left, stout setae offset from apices of lobes; basal apodeme long, stout.

Female unknown.

Fully grown larva. Body pale, cream-fawn with black markings on postero-lateral angles of thoracic nota. Head ovoid. Tergite IX broadly rounded; terminal segment of abdomen broad with pair of caudal filaments on anal prolegs (Pl. 112C); form and arrangement of setae on tergite IX as in capillata (Pl. 113F). Chloride epithelia in form of 4 irregular shaped "cells" (Pl. 112D).

Pupa. No distinctive features.

Case (Pl. 112E,F). Mature larval case pale fawn-brown, transparent; slightly compressed dorso-ventrally; 3 dorsal ribs along length of case, the 2 lateral ribs forming edges of folds, another short fold on ventral side of these. Mid-dorsal rib interrupted close to ends by small pore protected by crescentic shield arising on its inner side. Pupal case attached at both ends; length, 3.2-3.5 mm.

Biology. Final larvae and pupae found on undersides of rocks in riffles below a weir. It is difficult to reconcile the respiratory elaborations, ie. persistent caudal filaments and dorsal vents on case, with the flowing water habitat. Possibly flow in habitats of turrita ceases or becomes extremely sluggish periodically. Botosaneanu and Flint (1982) describe similar vents ("chimneys") in cases of an Ochrotrichia (Metrichia) from South America and comment on the similarities of those cases to others described for Dicaminus (or Dialus) by Muller (see Ulmer 1957), but they make no suggestion about the possible function of these structures.

Distribution. N Australia.

Orthotrichia bullata Wells

(Pl. 64A,B)

Orthotrichia bullata Wells, 1979b: 602-603.

Holotype ♂, paratypes 4♂, Queensland, Mossman Gorge, 16.vi.1971, ANIC. Paratype, 1♂, Queensland, Whitfield Range, Upper Freshwater Creek, 24.viii.1974, NMV.

Adults (modified after Wells 1979b)

Tiny; male with sternite IX broad anteriorly, rounded posteriorly. Neuration of wings variable: wings of male from N Western Australia similar to those of scutata while males from NE have compressed neuration as in inornata (Pl. 66C). No mesal lobe on sternite VII.

Male. Length of anterior wing, 1.9 mm. Antennae 26-28-segmented, banded: basal 11-13 segments pale, following 4 dark, then 2 light, 4 dark, and 5 light. Genitalia (Pl. 64A,B):- Sternite IX fused with dorsal plate; left and right dorsal spines stout, apices inturned. Dorsal plate rounded apically, sharp sclerotized subapical spine in position of sclerotized tooth of rostrata. Inferior appendages divided but together forming bulb-shaped structure; dorsal process small, divided apically; basal apodeme short, thin. Aedeagus with long titillator.

Female, immatures and habitat unknown.

Distribution. NE Queensland; Millstream Homestead, Western Australia.

Orthotrichia eurhinata Wells

(Pl. 65A-C)

Orthotrichia eurhinata Wells, 1985b: 101-102.

Holotype ♂, Georgetown Billabong, nr Jabiru, 17.vi.1983, A.J. Sharley, NTM I.125.

Adult (modified after Wells 1985b)

Male with distinctive antennae: segments of proximal $^1/3$ of flagellum stout, broader than long, subsequent segments becoming more elongate towards tip; proximal segments with whorls of hair on either side of broad band of *s*. *auricillica* (Pl. 65A), distal segments with incomplete bands or patches of *auricillica*.

Male. Length of anterior wing, 1.7 mm. Antennae 24-segmented; 4 terminal segments dark, preceeded by 1 pale, 4 dark, 2 pale, and 13 dark segments. Genitalia (Pl. 65B,C):- Right dorsal spine only, elongate, tapered and curved across dorsal plate. Dorsal plate rounded apically, wrapping around aedeagus; small blunt subapical process on dorsum. Inferior appendages small, discrete, symmetrical; dorsal process short, divided apically; basal apodeme elongate, slender. Paramere thin, curved.

Female, immatures and habitat unknown.

Distribution. NE Northern Territory.

Orthotrichia aculeata Wells

(Pls 64C; 66A,B)

Orthotrichia aculeata Wells, 1979b: 603-604.

Holotype ♂, paratypes 2♂, Western Australia, Spillway Creek, Ord River Dam, 2.ii.1978, WAM.

Adults (modified after Wells 1979b)

Male genitalia closely resemble bullata especially in arrangement of dorsal spines. Anterior wing (Pl. 64C) similar to that of turrita, but M_1 ill-defined beyond where it intercepts R_5: posterior wing similar to scutata.

Male. Length of anterior wing, 1.7 mm. Antennae damaged on all specimens. Genitalia (Pl. 66A,B):- Sternite IX short, tergite indistinguishable from dorsal plate; both dorsal spines present, left slender, heavily sclerotized, right broad, apex tapered, acute. Dorsal plate broad. Paramere acuminate apically. Inferior appendages asymmetrical, divided basally, overlapping distally; dorsal process obscured, setae stout, both protruding on left; basal apodeme long, slender.

Female, immatures and habitat unknown.

Distribution. N Western Australia; N Northern Territory.

Orthotrichia inornata Wells

(Pls 66C, 67A,B)

Orthotrichia inornata Wells, 1979b: 605-606.

Holotype ♂, Western Australia, Mitchell Plateau, 30.i.1978, WAM.

Paratypes, Western Australia: 4♂, Mitchell Plateau, 13.vii.1978, WAM; 1♂, Mitchell Plateau, Camp Creek, 20.vii.1978, ANIC; 2♂, Mitchell Plateau, Camp Creek at crusher site, 21.vii.1978, NMV, T5902-T5903; 2♂, Mitchell Plateau, Camp Creek, 13.vii.1978, ANIC; 1♂, Mitchell Plateau, Trib. Camp Creek, 19.vii.1978, WAM.

Adults (modified after Wells 1979b)

Tiny, brown; genitalia relatively simple, almost symmetrical; venation reduced in both wings (Pl. 66C); no mesal lobe on sternite VII. Male. Length of anterior wing, 1.7 mm. Antennae 24-segmented, banded with 12 basal segments dark, followed by 2 light and 9 dark; segments shorter than in other species. Genitalia (Pl. 67A,B):- sternite IX compressed, tergite fused with dorsal plate, no dorsal spines present. Dorsal plate broad, folded around aedeagus, with shallow V-shaped excavation in dorsal margin. Paramere either absent or not visible. Inferior appendages similar in form to orbostensis, dorsal process bilobed, lobes large and rounded; basal apodeme short, thin.

Female, immatures and habitat unknown.

Distribution. N Northern Territory; NW Western Australia.

Orthotrichia suteri Wells

(Pls 66D, 67C-E)

Orthotrichia suteri Wells, 1979b: 605-608.

Holotype ♂, paratypes 1♂, 2♀, Western Australia, Mitchell Plateau, Camp Creek, 13.vii.1978, WAM. Paratypes, Western Australia: 1♂, 1♀, collected with holotype, ANIC; 1♂, Mitchell Plateau, Camp Creek at crusher site, 21.vii.1978, NMV.

Adults (modified after Wells 1979b)

Minute, grey; genitalia quite typical in form, but general appearance atypical, with acuminate wings and short body. Neuration of forewing (Pl. 67C) can be interpreted as a further reduction on that of inornata; veins of the hindwing are difficult to distinguish but appear to be compressed.

Male. Length of anterior wing, 1.4 mm. Antennae 26-segmented, uniformly pale. Genitalia (Pl. 67D,E):- Sternite IX short, rectangular as in adornata, tergite fused with dorsal plate, sclerotized spine on right margin of dorsal plate and another mesally. Dorsal plate short, broad, folded ventrally. Paramere not seen. Inferior appendages discrete, lying obliquely; dorsal process bilobed, lobes long and widely divergent; basal apodeme short. Small rounded mesal lobe on sternite VII.

Female. Length of anterior wing, 1.3 mm. Antennae 20-segmented, uniformly pale. Genitalia (Pl. 66D):- Segment VIII not collar-like, no sinuous setae, large mesal spine with sclerotized margins on sternite. Tegment IX broadly rounded, with membranous lateral spines.

Immatures and habitat unknown.

Distribution. NW Western Australia.

Orthotrichia dilgri Wells

(Pl. 80A-C)

Orthotrichia dilgri Wells, 1983: 640-641.

Holotype ♂, paratypes 7♂, New South Wales, Dilgry River,
19 km NW of Rawdon Vale, 151°32'E 31°53'S, 18.ii.1980, NMV.

Adults (modified after Wells 1983)

Brown, but probably faded in alcohol; closest to armata in form of male genitalia.

Male. Length of anteror wing, 3.2 mm. Antennae both damaged on only specimen. Genitalia (Pl. 80A,B):- Dorsal plate strongly tapered posteriorly; left lateral spine simple, produced towards margin of plate, without lobe passing dorsally over plate as in armata; right spine lanceolate, slightly curved; small triangular median spine projects over tergite IX. Paramere curved, spiny. Inferior appendages slightly divided apico-mesally; dorsal process bilobed; basal apodeme slender. Mesal process bearing blunt setae on sternite VII.

Female. Length of anterior wing, 2.9 mm. Antennae 28-segmented, banded with basal 17 segments dark, followed by 2 light, 4 dark, 2 light, 3 dark. Genitalia (Pl. 80C):- Segment VIII tapered posteriorly, not forming usual collar, but with collar-like ring of sinuous setae interrupted mid-ventrally; small median glandular structure on anterior margin of sternite.

Immatures and habitat unknown.

Distribution. N E New South Wales.

Orthotrichia velata Wells

(Pls 80D; 81A,B; 113A)

Orthotrichia velata Wells, 1983: 641.

Holotype ♂, paratypes 18♂, 14♀, Queensland, Upper Ross River, below weir, 8.v.1979, NMV.

Adults (modified after Wells 1983)

Resemble inornata.

Male. Anterior wing length, 1.9-2.2 mm. Antennae 22-25-segmented, terminal 9 segments dark, preceded by 2 light and rest dark. Genitalia (Pl. 81A,B):- Dorsal plate forming broad, membranous sheath with mid-ventral V-shaped cleft, dorsal margin concave. Paramere not visible. Inferior appendages rounded, with rounded apico-mesal excision, apices heavily sclerotized; dorsal process symmetrical, divided apico-mesally into 2 more-or-less obliquely truncated lobes, each bearing stout seta; basal apodeme slender, curved. Short acute median spine on sternite VII.

Female. Anterior wing length, 2.2-2.4 mm. Antennae 23-segmented, with terminal 9 segments dark, preceded by 2 light and rest dark. Genitalia (Pl. 80D):- Segment VIII collar-like, but not tapered. Mid-ventral break in ring of straight setae occupied by probable glandular structure.

Fully grown larva. Readily distinguished by unusual spines on sclerites of anal prolegs (Pl. 113A).

Head, thorax, tergite IX and sclerites of anal prolegs tan-brown. Tergite IX broadly rounded with only setae I slender, elongate, II to V short, stout, darkly sclerotized. Anal prolegs with sclerite "b" rounded and bordered with stout spines (Pl. 113A).

Pupa. Presegmental hook-plates as in stipa with 5-6 marginal spinules.

Case. Mature larval case with ribs medial, occupying slightly more than $^1/3$ length. Pupal case rounded anteriorly; length, 1.8-2.5 mm.

Distribution. NE Queensland; N Northern Territory; NW Western Australia.

The morula group

This group differs from the adornata group in that inferior appendages of male are far larger and are approximately as long as dorsal plate. Segment IX broad anteriorly, rounded posteriorly; mesal lobe on sternite VII covered with stout, blunt setae. Wings as in adornata.

Orthotrichia morula Wells

(Pls 68; 113B)

Orthotrichia morula Wells, 1979b: 607-608.

Holotype ♂, paratypes 1♂, 5♀, Queensland, Mossman Gorge, 16.vi.1971, ANIC. Paratypes, Queensland: 1♂, Little Mulgrave River, 28.vi.1971, ANIC; 1♂, 9♀, The Boulders, W of Babinda, 29.vi.1971, ANIC; 1♂, 5♀, Crystal Cascades, near Cairns, 10.vi.1971, ANIC.

Adults (modified after Wells 1979b)

Male. Length of anterior wing, 2.4 mm. Antennae 29-segmented. Genitalia (Pl. 68A,B):- Segment IX narrowed posteriorly, only right dorsal spine present, simple, diverging from dorsal plate. Dorsal plate irregular, broad and short. Paramere spiny. Inferior appendages large, almost completely united, broad basally, constricted medially, apices tapered, divergent; dorsal process divided, lobes long, apices narrowed, strong setae subapical as in turrita; basal apodeme short, thin.

Female. Length of anterior wing, 2.2 mm. Antennae 24-segmented, banded as in adornata. Genitalia (Pl. 68C,D):- Terminalia broad. Segment VIII not collar-like, sternite with pale mesal knob surrounded by sclerotized sculpturing, pair of sinuous setae on each side; tergite short, truncate apically, without sinuous setae. Sternite IX with wide sclerotized plate, pair of rounded membranous lobes posteriorly, and slender lateral lobes.

Larvae unknown.

Pupa. Of usual form.

Case (Pl. 113B). Distinct from other Australian *Orthotrichia*. Rather than a ribbed "core" structure, case has paired, rounded, dorso-medial plates, each with small central "dimple". Anterior end of pupal case slightly tapered, almost truncate in lateral view. On pupation the case is attached at each end; length, 2.7-3.2 mm.

Biology. Pupae on undersides of rocks and cobbles in flowing water.

Distribution. NE Queensland.

Orthotrichia alveata Wells

(Pl. 69A,B)

Orthotrichia alveata Wells, 1979b: 609-610.
Holotype ♂, paratype ♂, Queensland, Mossman Gorge, 16.vi.1971, ANIC.

Adults (modified after Wells 1979b)

Similar to *morula*, but males readily distinguished by discrete, rounded inferior appendages and simple narrow dorsal plate.

Male. Length of anterior wing, 2.6 mm. Antennae 29-30-segmented, banded as in *adornata*. Genitalia (Pl. 69A,B):- Segment IX similar in shape to *morula*, one dorsal spine present, but on left. Paramere straight, spiny. Inferior appendages rounded: dorsal process divided, lobes swollen, with apical setae: basal apodeme long, narrow. Aedeagus with long titillator.

Female, immatures and habitat unknown.

Distribution. NE Queensland.

The gracilis group

Characterized by presence of paired, stout black spines on tergite VIII. As in adornata group, wing venation is variable and there are species with and without mesal lobe on sternite VII; however, again I feel that genitalia are more fundamental in this group.

Orthotrichia gracilis Wells

(Pls 69C,D; 70A,B; 122C,D)

Orthotrichia gracilis Wells, 1979b: 609-611.
Holotype ♂, paratypes 10♂, 11♀, New South Wales, Coraki,
10.i.1958, ANIC.

Adults (modified after Wells 1979b)

Wings as in adornata.

Male. Length of anterior wing, 1.8 mm. Antennae (Pl. 122C) 26-27-segmented, banded with 10-11 basal segments light, followed by 5 dark, 2 light, 4 dark, 2 light and 3 dark. Genitalia (Pl. 69C,D):- Posterior margin of sternite VIII excavated; paired stout black spines on tergite shorter than dorsal plate. Sternite IX more-or-less truncate posteriorly, tergite fused with dorsal plate; right dorsal spine slender, tapered, lying obliquely across dorsal plate. Dorsal plate broad and rounded posteriorly. Paramere stout, apex hooked around aedeagus. Inferior appendages small, rounded, hairy, discrete, each with sclerotized lobe posteriorly; dorsal process divided, lobes large, unequal, with apical setae; basal apodeme long, slender.

Female. Length of anterior wing, 1.9 mm. Antennae (Pl. 122D) 23-segmented. Genitalia (Pl. 70A,B):- Terminalia are narrower and more typical than in morula. Sternite VIII collar-like laterally, bearing sinuous setae, large sclerotized knob medially; tergite with fine hair posteriorly and laterally, few sinuous setae on posterolateral margins. Segment IX broad, with membranous acute processes laterally.

Fully grown larva. Indistinguishable from atraseta and armata; head tan, pale around eyes, thoracic nota dark, tergite IX and sclerites of prolegs dark.

Pupa. Indistiguishable from bishopi.

Case. Ribs short, medial in position. Length of pupal case, 2.3-3.0 mm.

Biology. On undersurfaces of rocks in flowing water.

Distribution. SE Queensland; NE New South Wales; the Murray-Darling river system.

Orthotrichia tortuosa Wells

(Pls 70C-E; 113C,D; 117B)

Orthotrichia tortuosa Wells, 1979b: 611-612.

Holotype ♂, paratypes 1♂, 13♀, Victoria, Genoa River near Wangarabell, 18.iii.1977, NMV. Paratypes, 1♂, 2♀, Victoria, Mitchell River near Tabberabbera, 30.xii.1975, NMV.

Adults (modified after Wells 1979b)

Male readily recognized by form of dorsal plate and by stout, twisted, left dorsal spine. Its unique feature, the corkscrew-like paramere, is more difficult to see. Wings as in adornata.

Male. Length of anterior wing, 2.5 mm. Antennae 29-segmented, uniformly pale. Genitalia (Pl. 70D,E):- Segment VIII similar to gracilis but shorter; stout spines almost as long as dorsal plate. Segment IX short; left dorsal spine stout, heavily sclerotized and twisted with small sclerotized spine at base, right dorsal spine broad-based, tapered posteriorly. Dorsal plate with basal bulge on right, narrowed posteriorly. Inferior appendages united basally, divided posteriorly, lateral margins oblique; dorsal process divided, but obscured; basal apodeme short.

Female. Length of anterior wing, 2.9 mm. Antennae 26-segmented, banded as in adornata. Genitalia (Pl.70C):- Sternite VIII with short sclerotized mesal spine between pair of sclerotized, hairy lobes. Sinuous setae in median rows towards lateral margins; tergite rounded posteriorly with complete row of sinuous setae marginally. Segments IX and X narrow.

Fully grown larva. Indistinguishable generally from atraseta, armata and gracilis; head pale, thorax dark, tergite IX and sclerites of prolegs black, 3 pairs of stout black spines on tergite IX (Pl. 113C).

Pupa. Indistinguishable from bishopi.

Case (Pl. 113D). Dark brown to black; broad medially, with 5 prominent mid-dorsal ribs, slightly shorter than in atraseta, armata and gracilis. Pupal case attached directly at posterior end, and by short stalk anteriorly; length, 2.3-3.0 mm.

Biology. Final instar larvae found on undersurfaces of rocks and cobbles, in flowing waters, often amongst insect egg masses (probably Simulium sp.).

Distribution. Carnarvon Gorge, Queensland; NE New South Wales; E Victoria.

Orthotrichia kholoensis Wells

(Pl. 71A,B)

Orthotrichia kholoensis Wells, 1979b: 612-614.

Holotype ♂, paratype ♂, Queensland, Brisbane River near Kholo, 9.iii.1973, NMV.

Adults (modified after Wells 1979b)

Minute; males resemble gracilis in genitalic features but lack mesal lobe on sternite VII; neuration as in inornata (Pl. 66C).

Male. Length of anterior wing, 1.6 mm. Antennae 24-segmented, uniformly pale. Genitalia (Pl. 71A,B):- Sternite VIII with deep V-shaped excavation; tergite with straight posterior margin, stout black spines longer than dorsal plate. Tergite IX distinct from dorsal plate, right dorsal spine broad and tapered slightly, left broad, rounded posteriorly. Dorsal plate rounded posteriorly. Paramere slender. Inferior appendages discrete, quadrate, apical margins sclerotized, rolled ventrally; dorsal process undivided, arising on right, curving inwards; basal apodeme long, thin.

Female, immatures and habitat unknown.

Distribution. SE and N Queensland; N Northern Territory.

Orthotrichia paranga Wells

(Pl. 71C,D)

Orthotrichia paranga Wells, 1979b: 613-614.

Holotype ♂, Western Australia, Ord Dam, 21.ii.1977, WAM. Paratypes, 1♂, Western Australia, Spillway Creek, Ord River Dam, 2.ii.1978, WAM; 1♂, same data, ANIC.

Adults (modified after Wells 1979b)

Male. Tiny, grey; appears to be the counterpart of the north-eastern kholoensis. Males differ only in having narrower, partly fused inferior appendages with undivided dorsal process slanted, not curved, towards midline, with basal heel. Small lateral knob posteriorly on right of tergite IX (Pl. 71 C,D).

Length of anterior wing, 1.8 mm. Antennae 25-segmented, banded as in *adornata*.

Female, *immatures* and *habitat* unknown.

Distribution. N Western Australia.

Orthotrichia stipa Wells

(Pls 72A,B; 113E)

Orthotrichia stipa Wells, 1979b: 614-616.

Holotype ♂, Western Australia, Mitchell Plateau, Camp Creek, 26.ii.1978, WAM. Paratypes, Western Australia: 1♂, Mitchell Plateau, Camp Creek, 20.vii.1978, ANIC: 2♂, Mitchell Plateau, Camp Creek at crusher site, 21.vii.1978, WAM: 1♂, Mitchell Plateau, Trib. Camp Creek, 19.vii.1978, NMV.

Adults (modified after Wells 1979b)

Closely resembling *kholoensis* and *paranga*, chief differences being in inferior appendages and their dorsal process. Anterior wing as in *inornata*, posterior wing as in *adornata*.

Male. Length of anterior wing, 1.7 mm. Antennae 24-segmented, uniformly pale. Small mesal lobe on sternite VII. Genitalia (Pl. 72A,B):- Stout black spines arise from prominences on posterior margin of tergite VIII. Segment IX ill-defined, both dorsal spines present, left broad, with scattered fine hair, right broad based, tapered posteriorly. Dorsal plate broad-based, narrower apically. Paramere spiny. Inferior appendages fused for $^{2}/3$ length, apices sclerotized; dorsal process small bilobed, obscured; basal apodeme long, slender.

Female. Unknown.

Fully grown larva. Head brown anteriorly, pale cream coloured distally, thoracic nota brown, tergite IX and sclerites of prolegs reddish-brown; head almost quadrate in dorsal view. Median anal marginal setae on tergite IX long, slender; seta IV stout and black, shorter than III; III and V slender, dark. Anal prolegs forming broad sclerotized region in ventral view.

Pupa. Presegmental plates broad with about 6 marginal spinules.

Case (Pl. 113E). Larval case pale, fawn to greyish, strongly flattened dorso-ventrally, with prominent ribs extending full length. Pupal case attached to substrate directly at each end; length, 2.0-2.3 mm.

Biology. Little known; collecting dates for adults are scattered throughout year.

Distribution. NW Western Australia.

Orthotrichia exiqua Wells

(Pl. 72C-E)

Orthotrichia exiqua Wells, 1979b: 615-616.

Holotype ♂, paratypes 2♂, Western Australia, Fine Spring Creek, on road between Lake Argyle Tourist Village and Duncan Highway, 23.ii.1977, WAM. Paratypes, Western Australia: 1♂, Mitchell Plateau, Camp Creek, 29.i.1978, ANIC; 6♂, Mitchell Plateau, Camp Creek, 20.vii.1978, NMV, T5906-T5911; 1♂, Mitchell Plateau, Camp Creek at crusher site, 21.vii.1978, ANIC; 2♂, Mitchell Plateau, Surveyor Pool, 17.vii.1978, WAM; 1♂, Mitchell Plateau, Trib. Camp Creek, 19.vii.1978, WAM.

Adults (modified after Wells 1979b)

Males mottled grey-cream, unique among Australian representatives of the genus in having cylindrical inferior appendages, similar in form to those of some species of Hellyethira. Although exiqua has "Orthotrichia-like" features, they are mostly extreme in development. Wings similar to those of inornata; mesal lobe on sternite VII absent. Male. Length of anterior wing, 1.7 mm. Antennae 23-segmented, banded as in adornata. Genitalia (Pl. 72C-E):- Segments VIII and IX clearly distinguished. Only left dorsal spine present as irregular structure on lateral margin of dorsal plate. Dorsal plate irregularly lobed. Paramere bifid apically. Inferior appendages heavily sclerotized, cylindrical; dorsal process large, undivided, sclerotized, arising on right and sloping to left, setae on raised bases either side of midline; basal apodeme long, slender.

Female, immatures and habitat unknown.

Distribution. N Western Australia; N Northern Territory; NE Queensland.

Orthotrichia tyleri Wells

(Pl. 73AB)

Orthotrichia tyleri Wells, 1979b: 17-618.

Holotype ♂, paratypes 5♂, Western Australia, Mitchell Plateau, Camp Creek, 20.vii.1978, WAM. Paratypes, Western Australia: 1♂, Mitchell Plateau, Camp Creek, 13.vii.1978, WAM, 4♂, Mitchell Plateau, Camp Creek at crusher site, 21.vii.1978, ANIC; 4♂, Mitchell Plateau, Trib. Camp Creek, 19.vii.1978, NMV, T5849-T5852.

Adults (modified after Wells 1979b)

Medium-sized, mottled grey-cream, readily distinguished by widely positioned stout black spines dorsally. Wings as in adornata; no lobe on sternite VII.

Male. Length of anterior wing, 1.8 mm. Antennae 23-segmented, banding faint but as in adornata. Genitalia (Pl. 73A,B):- Sternite VIII deeply excised as in scutata; tergite broad, rounded posteriorly with stout black spines antero-laterally. Tergite IX fused with dorsal plate; right dorsal spine obscured by tergite VIII, left broad, hairy, with a posterior branch; broad sclerotized spine mesally. Dorsal plate narrow, folded ventrally, rounded apically. Paramere narrow, spiny. Inferior appendages completely asymmetrical; dorsal process short, obscured; basal apodeme long, narrow.

Female, immatures and habitat unknown.

Distribution. N Western Australia; N Northern Territory; July-November.

Orthotrichia bellicosa Wells

(Pl. 73C,D)

Orthotrichia bellicosa Wells, 1979b: 617-618.

Holotype ♂, Western Australia, Mitchell Plateau, Camp Creek, 31.i.1978, WAM. Paratypes, Western Australia: 4♂, Mitchell Plateau, Camp Creek, 13.vii.1978, WAM; 6♂, Mitchell Plateau, Camp Creek, 20.vii.1978, ANIC; 2♂, Mitchell Plateau, Trib. Camp Creek, 19.vii.1978, NMV, T5853-T5854.

Adults (modified after Wells 1979b)

Stout black spines on tergite VIII of male close-set, medial, not marginal. Wings of *scutata* form; no lobe on sternite VII but triangular area of setae delineated.

Male. Length of anterior wing, 1.8 mm. Antennae 23-segmented, banded as in *adornata*. Genitalia (Pl. 73C,D):- Tergite VIII broad, rectangular, sternite difficult to distinguish from IX. Tergite IX with both dorsal spines: left small, irregular; right broad basally, tapering posteriorly. Dorsal plate broad and folded ventrally at base, narrower posteriorly. Paramere spiny, obscured. Inferior appendages broad, united at bases, lobed distally: ventral lobe membranous, hairy and rounded, dorsal lobe narrow, sclerotized; dorsal process small, divided; basal apodeme long, tapered.

Female, immatures and habitat unknown.

Distribution. NE Northern Territory; N Western Australia.

Orthotrichia capillata Wells

(Pls 74A,B; 113F)

Orthotrichia capillata Wells, 1979b: 619-620.

Holotype ♂, Queensland, Mossman Gorge, 16.vi.1971, ANIC. Paratypes, Queensland: 2♂, Carnarvon Gorge, 1.iv.1957, ANIC; 2♂, Brisbane River near Kholo, 9.iii.1978, NMV.

Adults (modified after Wells 1979b)

As in males of bellicosa, stout black spines on tergite VIII are mesal, not marginal, but in this species they are paired and situated towards lateral margins. In other respects capillata resembles gracilis.

Male. Length of anterior wing, 2.2 mm. Antennae 26-segmented, uniformly pale. Genitalia (Pl. 74A,B):- Sternites VIII and IX more-or-less rectangular. Tergite IX fused with dorsal plate; left dorsal spine broad and twisted at base, tapered to acuminate apex; right broad, tapered. Dorsal plate similar to inornata. Paramere spiny, short. Inferior appendages discrete, irregularly lobed, inner ventral margin heavily sclerotized; dorsal process divided, obscured; basal apodeme long, slender.

Female unknown.

Fully grown larva. Pale creamish-fawn, with black markings posterolaterally on pro- and mesonota, along posterior margin of metanotum, and on ridges of thoracic pleurites; tergite IX and sclerites of prolegs pale reddish-brown. Tergite IX rectangular with all setae but IV slender, pale; IV short, stout and black; III and V greatly exceeding IV in length. Anal prolegs as in atraseta, but pale (Pl. 113F).

Pupa. Presegmental hook-plates similar to stipa: broad flanges with 5-6 marginal spinules.

Case. Similar to stipa, pale brown, transparent, ribs extending full length of case. Pupal case attached at each end; length, 2.7-3.2 mm.

Biology. Final instar larvae and pupae found on undersurfaces of rocks and cobbles in moderate to fast flowing rivers.

Distribution. E Queensland; NE New South Wales.

Orthotrichia yabbaca Wells

(Pl. 81C-E)

Orthotrichia yabbaca Wells, 1983: 642-643.

Holotype ♂, paratypes 1♂, 1♀, Queensland, Yabba Creek, 10 km W of Imbil, 26.x.1980, NMV.

Adults (modified after Wells 1979b)

Medium sized; male with 2 pairs of mid-dorsal spiny setae on tergite VIII, similar to capillata.

Male. Length of anterior wing, 2.5 mm. Antennae 27-segmented. Genitalia (Pl. 81D,E):- Segment VIII with 2 pairs of strong setae mid-dorsally in more central position than in capillata; setae paler and not as stout as in capillata. Dorsal plate almost rectangular in dorsal view, wrapping ventrally to form sheath around aedeagus; left lateral spine broadly spatulate, right lanceolate. Paramere narrow, spiny. Aedeagus straight, with median, slender titillator. Inferior appendages deeply separated, rounded apically; dorsal process broad, asymmetrical; basal apodeme long, slender. Without lobe bearing blunt setae on sternite VII.

Female. Length of anterior wing, 2.0-2.6 mm. Antennae of both specimens damaged. Genitalia (Pl. 81C):- Terminalia narrow. Segment VIII collar-like, with large black lobe (probably opening of gland) anteriorly in mid-ventral cleft, as in gracilis; setae on posterior margin of "collar" short and straight, not sinuous.

Immatures and habitat unknown.

Distribution. SE Queensland.

Orthotrichia attenuata Wells

(Pl. 82A-C)

Orthotrichia attenuata Wells, 1983: 643.

Holotype ♂, paratypes 1♂, 1♀, New South Wales, Darling River, Burtundy Station, 120 km N Mildura, 31.iii.1981, NMV.

Adults (modified after Wells 1983)

Highly distinctive: male with unusually elongate aedeagus; female with highly attenuated terminalia. The elongate oviscapt of the female is reminiscent of that of Maydenoptila; it would be interesting to observe oviposition behaviour of these females.

Male. Length of anterior wing, 1.7-2.00 mm. Antennae 26-segmented. Genitalia (Pl. 82B,C):- Dorsal plate broad, rounded apically; right margin sheathing aedeagus; stout rounded spine on left margin. Paramere straight, elongate. Inferior appendages in form of hairy lobes, widely separated basally, apices convergent; dorsal process stout, asymmetrical; basal apodeme elongate, slender.

Female. Length of anterior wing, 2.2-2.4 mm. Antennae 23-segmented. Genitalia (Pl. 82A):- Segment VIII elongate, sternite produced apico-mesally into rounded lobe, row of sinuous setae aligned in typical position subapically; terminal segments greatly attenuated.

Immatures and habitat unknown.

Distribution. Inner Murray-Darling rivers system.

The aberrans group

A revised diagnosis is given for this group which I established, "with misgivings" (Wells 1979b), to accommodate a single "aberrant" species. Now, with discovery of 5 further species (Wells 1983), and of immature stages of 2, my misgivings are redirected: perhaps this unusual group should be given subgeneric status.

Adults are typically orthotrichine, but are large and characterized by stout genitalic structures. In male: aedeagus twisted; inferior appendages small relative to size of dorsal plate; no spiny black setae on tergite VIII; generally a broad mesal lobe extended posteriorly from sternite VIII, obscuring genitalia.

Pupae are strikingly different from those of other species groups: fronto-clypeus with forward projection overhanging mouthparts (Pl. 114D): hook-plates are stout, sclerotized hooks (Pl. 114C) rather than "plates" or flanges.

Mature larvae have characteristically orthotrichine features on head, thorax and limbs; the abdomen is extraordinarily swollen (Pl. 114B) and lacks whorl of tiny sclerites on segment I and chloride epithelia on segments II - VIII.

Ulmer (1909) figures the pupa, larva and case of a species, "Hydroptilid B", from Java, which has hook-plates of the form found in this group. His figures of the larva are insufficiently clear to compare with aberrans group larvae; the case could be similar to that of O. aberrans Wells.

Orthotrichia aberrans Wells

(Pls 74C,D; 75A; 114A-D; 118A,C; 119A)

Orthotrichia aberrans Wells, 1979b: 619, 621.

Holotype ♂, Victoria, Mitta Mitta River, 8 km NE Benambra, 5.ii.1974, NMV. Paratypes, 2♂, Victoria: Macalister-Barkly River Junction, Lyndon Flat, 6.xii.1977, NMV, T5858-T5859.

Adults (modified after Wells 1979b)

Grey-black, one of the largest Australian hydroptilids. Wings as in scutata.

Male. Length of anterior wing, 3.6 mm. Wings mottled grey-black, with 3 transverse bands. Antennae 26-27-segmented, banded with 14-15 basal segments black, followed by 1 white, 9 black, 3 white; a sensory pit or s. coeloconicum on each segment (Pl. 118C). Small, blunt mesal spine on sternite VI. Genitalia (Pl. 74C,D):- Sternite VIII with stout apico-mesal lobe covered with stout, blunt, black setae (in the original figure and description this was shown incorrectly as part of sternite IX). Sternite IX short, narrow with membranous posterolateral lobes. Tergite IX long, truncate posteriorly, broad sclerotized spine lying along left lateral margin, another projecting beyond right posterolateral margin. Dorsal plate irregular in shape, with membranous dorsal process. Paramere difficult to see, short, spiny. Aedeagus of normal form, stouter than in other species groups. Inferior appendages rounded laterally, separated mesally; dorsal process rounded, notched between setae but not clearly divided; basal apodeme short.

Female. Length of anterior wing, 2.7-4.7 mm. Antennae 25-segmented, with distal 3 segments dark, preceded by 2 light, 4 dark, 2 light and 13 dark segments. Genitalia (Pl. 75A):- Sternite VIII with collar-like band of sinuous setae sub-apically, interrupted mid-ventrally by glandular structure.

Fully grown larva (Pl. 114B). Highly distinctive amongst Australian Orthotrichia: when fully grown resembling a "honey-pot" ant in its extroardinary proportions. In features of head, thorax and legs, 5th instar larva resembles other Orthotrichia, but abdomen differs: no sclerites on abdominal segment I, or chloride epithelia on other segments.

Pupa. With highly distinctive hook-plates (Pl. 114C); an extraordinary projection of head region (Pl. 114D); mandibles of usual form.

Case (Pl. 114A,B). Two equal, unsculptured, transparent valves, ovoid in cross-section, rounded at ends. On the rare occasions that I have found these cases they have "appeared" on the underside of a rock after I have spent some time picking and scraping at its surface. I suspect that the thin secretion case is covered with sand grains or tiny pebbles prior to pupation, rather in the way Hydrobiosidae build pupal shelters, or as found in Hydroptila hirra (Botosaneanu and Greudicelli 1981). Absence of attachment discs on cases, suggests that some other means is used for attachment. Length of pupal case, 3.3-5.5 mm.

Early larva. The early larva figured (Pl. 114E) is determined from its labral tooth as Orthotrichia sp. Its specific identity is, as yet unknown, but this unusual larva taken from habitats of aberrans, has stout setae and lateral papillae on abdominal segments I to VIII, and may be early aberrans.

Biology. Adults taken mid to late summer. Females from several localities were dissected but none were found with mature ovarioles, although frequently female hydroptilids from light trap samples are extruding eggs. Probably accummulation of extensive food reserves in aberrans larva is connected with an unusually protracted adult life.

Distribution. Central Victoria; Barrington Tops area, E New South Wales.

Orthotrichia pectinella Wells

(Pl. 76A-C)

Orthotrichia pectinella Wells, 1983: 635-636.

Holotype ♂, Victoria, Warburton, Yarra River, 17.ii.1979, NMV.

Paratype ♂, Victoria, Bright, 25.i.1960, NMV;

1♂, Wellington-Carey River Junction, 15.ii.1977, NMV.

Adults (modified after Wells 1983)

Large, black; distinguished from aberrans only by detailed examination of male genitalia.

Male. Length of anterior wing, 3.5-3.8 mm. Antennae 27-28-segmented, with 17 basal segments dark, followed by 2 light, 9 dark segments. Genitalia (Pl. 76A-C):- Segment VIII broadly rounded, with stout apico-mesal ventral lobe with 4 stout black setae subapically. Segment IX only $^2/3$ width of VIII, well retracted into VIII. Dorsal plate folded around aedeagus, asymmetrical, with short lateral section tipped by broad sclerotized spine. Aedeagus stout, twisted; paramere stout, strongly curved, tapered apically. Inferior appendages short, rod-like, widely separated; dorsal process stout, shallowly divided.

Female, immatures and habitat unknown.

Distribution. Central Victoria, Otway Ranges; January-February.

Orthotrichia conferta Wells

(Pls 75B-D; 115)

Orthotrichia conferta Wells, 1983: 634-635.
Holotype ♂, paratype ♂, Victoria, Wellington River,
17 km N of Licola, 14.ii.1977, NMV.

Adults (modified after Wells 1983)

Mottled fawn-black wings; fawn hair on head. Distinguished from aberrans only by close examination of male genitalia.

Male. Length of anterior wing, 4.0 mm. Antennae 32-segmented, segments 18,19 pale, rest dark. Genitalia (Pl. 75B,C):- Segment VIII broad, bearing stout lobe tipped with blunt black setae. Segment IX only slightly narrower than VIII, tergite fused with broad-based dorsal plate. Dorsal plate bilobed: left lobe broad, obliquely truncate apically; right curved, spinous. Curved, blunt paramere associated with aedeagus. Inferior appendages fused basally, slender and widely divergent distally, tipped by paired setae; dorsal process swollen, shallowly divided apico-mesally.

Female. Length of anterior wing, 3.8 mm. Antennae 26-segmented, segments 16,17 pale, rest brown. Genitalia (Pl. 75D):- Arrangement of sinuous setae typically orthotrichine, but segment VIII is not divided midventrally.

Fully mature larva. From examination of prepupae and an immature larva, it appears that mature 5th instar larva conferta probably resemble aberrans (Pl. 114B).

Early fifth instar larva. An extra stage is inserted in the larval life of this species, illustrated in Pl. 115A. At this stage larva is minute (approximately 1 mm long; ratio head:thorax:abdomen = 1:1.1:3.4), although head, thoracic nota, legs, tergite IX and prolegs (Pl. 115D) are size of mature larva; body is strongly dorso-ventrally flattened, 3 caudal filaments or gills.

Case. Case of early 5th instar larva tiny, dorso-ventrally flattened, ovoid, with 2 unequal secretion valves (Pl. 115A), upper valve overhanging lower valve anteriorly. These valves are incorporated into dorso-medial section of the mature case (Pl. 115B). Length of early case, 0.85 mm; pupal case, 4 mm.

Pupa. Differs from aberrans in having only a short projection on head; 2 pairs of rudimentary oral margin setae on labrum (Pl. 115G). Hook-plates similar but tips of hooks undivided (Pl. 115F).

Biology. Adults taken November-March, and October-November in warmer areas, beside shallow, cobbly, streams of moderately fast flow, e.g. the Boyd River (Pl. 127A). Mature 5th instar larvae, pupae and empty cases found on undersurfaces of rocks and cobbles November, January, March; pupae November, March. Earlier stages netted, often after scraping, or wire-brushing, of rocks. Data from regular survey work suggest that the specialized early 5th instar larvae are an overwintering stage (found May-November). Possibly the small dorso-ventral case is attached to rocks or cobbles and the larva feeds minimally, or not at all, before water warms in spring when the final case is built.

Distribution. E Victoria; NE New South Wales; NE Queensland.

Orthotrichia flabella Wells

(Pl. 77A,B)

Orthotrichia flabella Wells, 1983: 637.

Holotype ♂, Victoria, McKenzie River, Princes Highway bridge, 25 km W Cann River, 27.i.1975, NMV.

Adults (modified after Wells 1983)

Large, dark-coloured.

Male. Anterior wing length, 4.0 mm. Antennae 29-segmented, banded with 17 dark, 3 light, 4 dark, 2 light and 3 dark segments. Genitalia (Pl. 77A,B):- Superficially indistinguishable from aberrans, but microscopic examination shows small lateral hook on left dorsal plate, pair of stout lateral spines on right. Inferior appendages short, inflected, apices sclerotized; dorsal process similar form to inferior appendages, setae subapical. Stout, posteriorly directed mesal lobe on sternite VIII, tipped with broad fan of dense black setae, tends to obscure genitalia.

Female, immatures and habitat unknown.

Distribution. E Victoria.

Orthotrichia muscari Wells

(Pl. 78A,B)

Orthotrichia muscari Wells, 1983: 638-639.

Holotype ♂, Queensland, Iron Range, Middle Claudie River, 2-9.x.1974, NMV.

Adults (modified after Wells 1983)

Resembling conferta.

Male. Anterior wing length, 3.5mm. Antennae damaged. Genitalia (Pl. 78A,B):- Segments VII & VIII broad; VII bearing short lobe covered with sharp black setae. Segment IX $^1/2$ width of VIII, retracted into VIII. Dorsal plate scarcely longer than inferior appendages, bilobed with left lobe rounded, right lobe tapered. Aedeagus slightly twisted, associated with fine, short paramere. Inferior appendages hairy; united basally, widely divergent distally; dorsal process deeply divided. An extraordinary structure protrudes from above inferior appendages: a curving rod, the tip of which bears a brush of setae on its inner side.

Female, immatures and habitat unknown.

Distribution. N Queensland.

Orthotrichia divaricata Wells

(Pl. 79A,B)

Orthotrichia divaricata Wells, 1983: 639-640.
Holotype ♂, Queensland, Upper Freshwater Creek, 24.viii.1974, NMV.

Adults (modified after Wells 1983)

Large, brown; resembling pectinella and muscari.

Male. Length of anterior wing, 4.9 mm. Antennae damaged. Genitalia (Pl. 79A,B):- Sternite VIII broadly rounded. Segment IX with stout, paired latero-ventral lobes. Dorsal plate highly irregular: left section elongate, with blunt apical spine; right section with broadly rounded posterior excavation. Aedeagus stout, twisted, no paramere visible. Inferior appendages discrete, broad-based, converging distally; dorsal process asymmetrical with pair of widely separated lobes, subapical setae. Small spine present on segment VII.

Female, immatures and habitat unknown.

Distribution. NE Queensland.

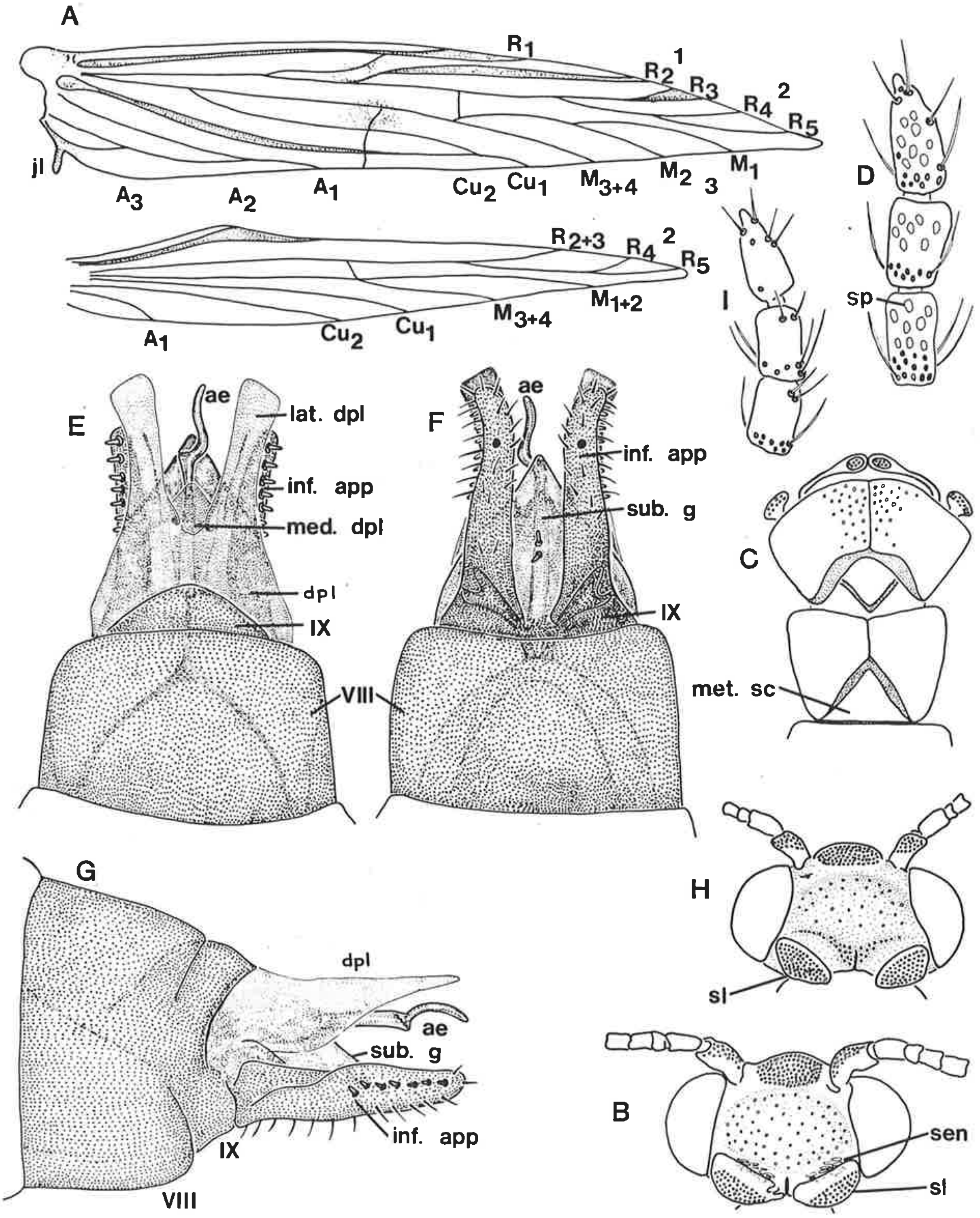


Plate 1A-I. *Hydroptila robusta* Wells. A-G, Male: A, wings; B, head, dorsal view; C, thorax, dorsal view; D, antenna, three terminal segments; E-G, genitalia, dorsal, ventral and lateral views.
H-I, Female: H, head, dorsal view; I, antenna, three terminal segments.

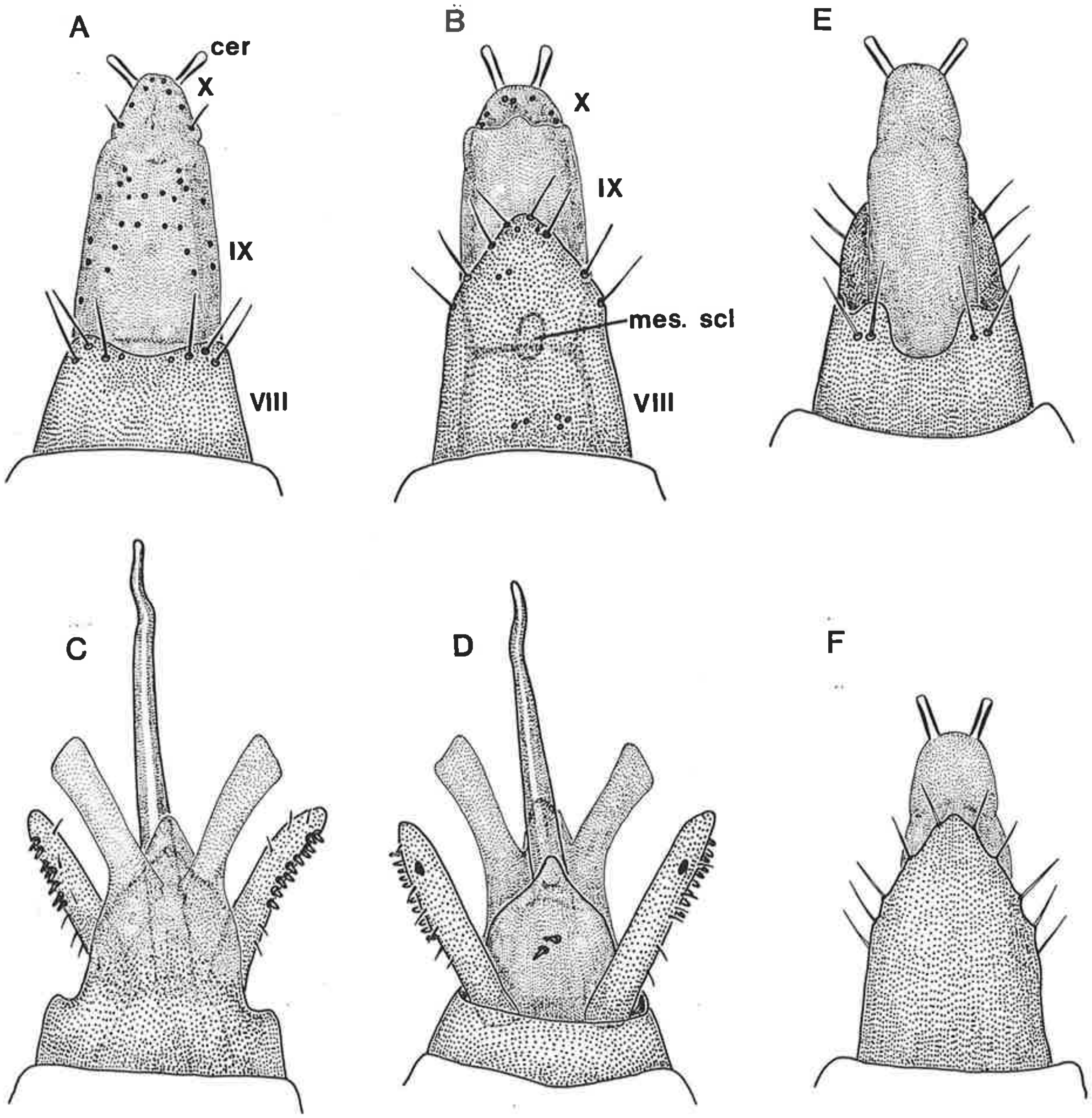


Plate 2A-F. A,B, *Hydroptila robusta* Wells, female genitalia, dorsal and ventral views.
C-F, *H. tasmanica* Mosely: C,D, male genitalia, dorsal and ventral views; E,F, female genitalia, dorsal and ventral views.

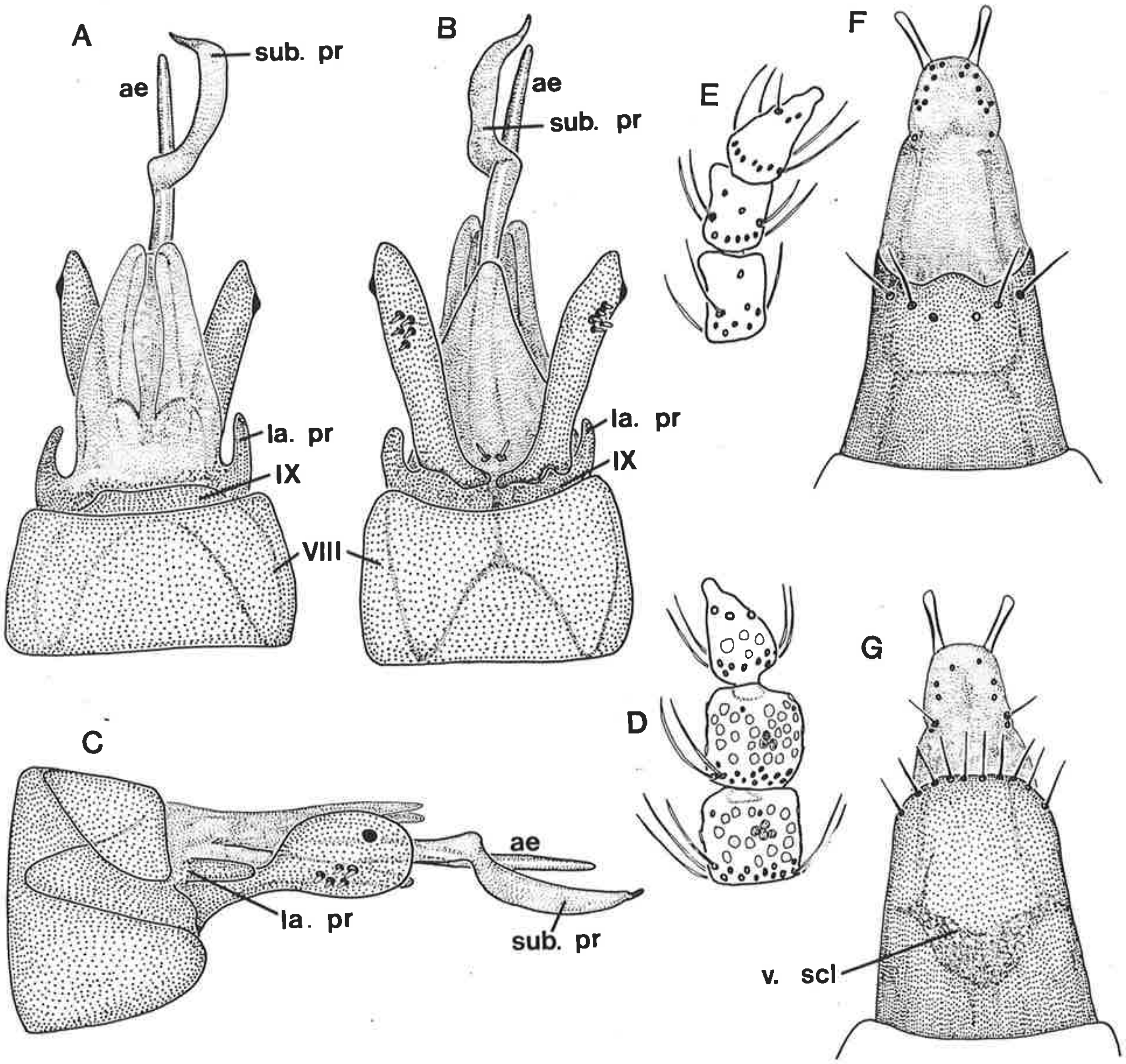


Plate 3A-G. Hydroptila scamandra Neboiss. A-D, Male:
A-C, genitalia, dorsal, ventral and lateral views; D, antenna, three terminal segments.
E-G, Female: E, antenna, three terminal segments;
F,G, genitalia, dorsal and ventral views.

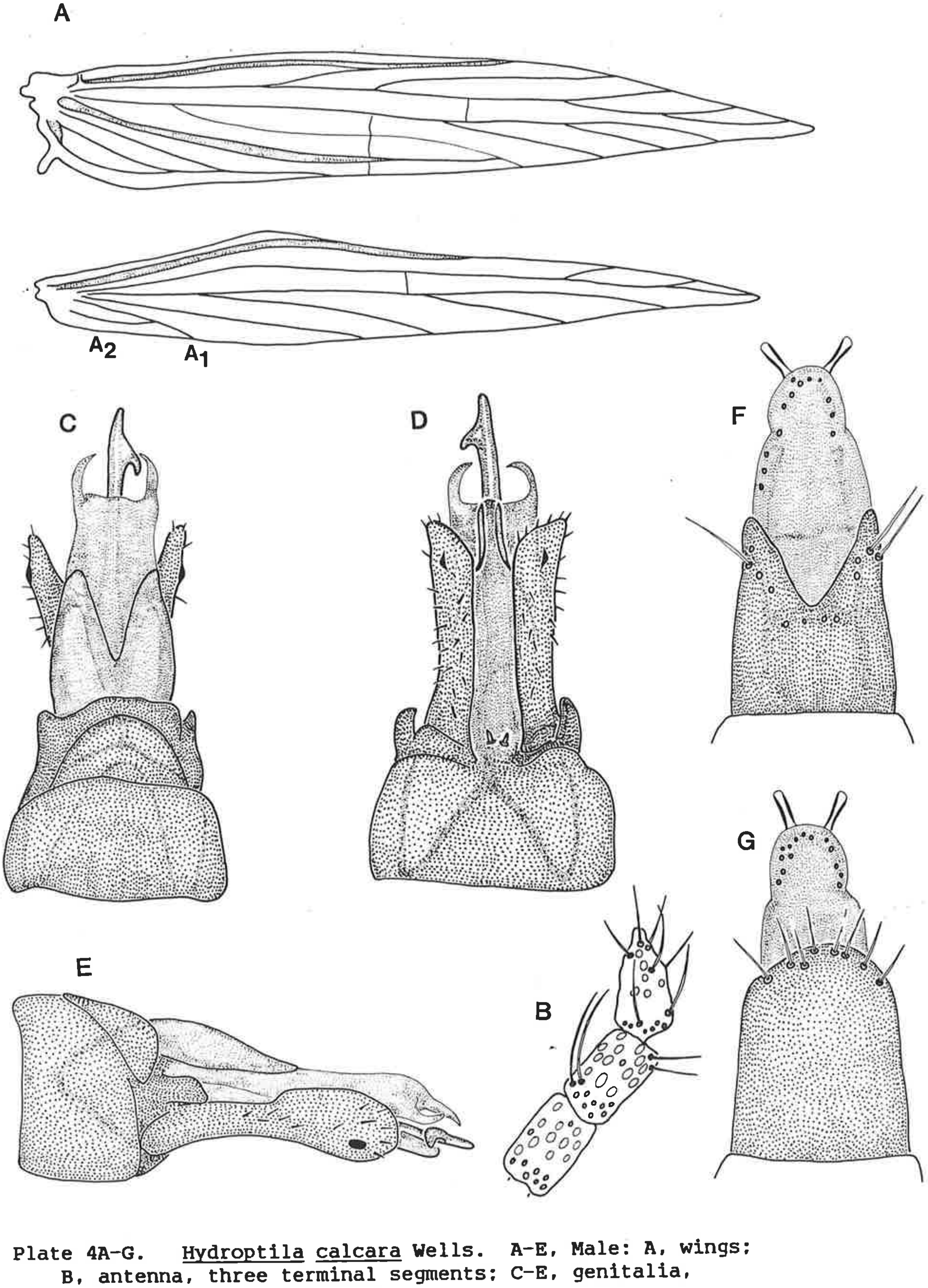


Plate 4A-G. Hydroptila calcara Wells. A-E, Male: A, wings; B, antenna, three terminal segments; C-E, genitalia, dorsal, ventral and lateral views.
F-G, Female genitalia, dorsal and ventral views.

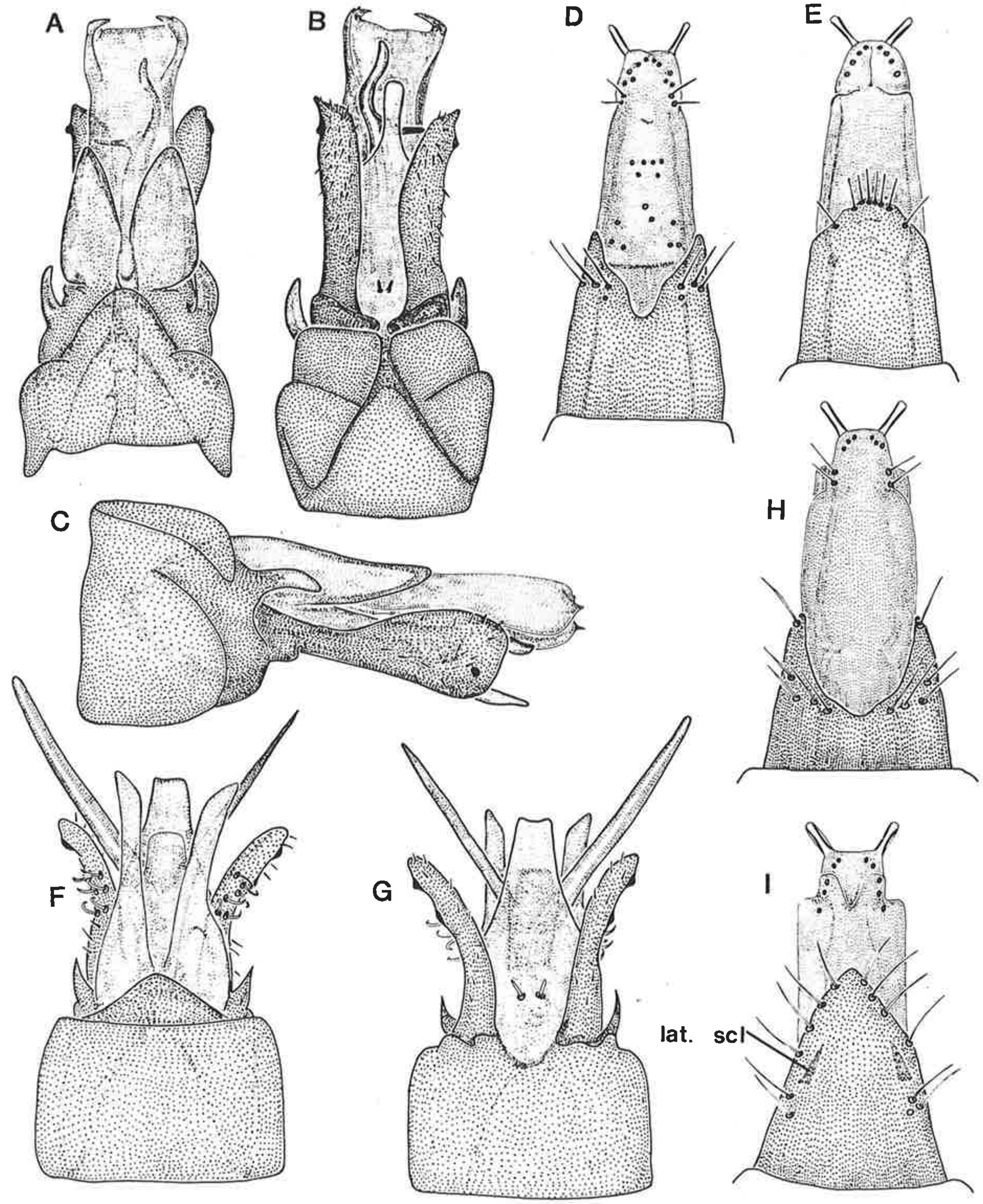


Plate 5A-I. A-E, *Hydroptila acinacis* Wells: A-C, male genitalia, dorsal, ventral and lateral views; D,E, female genitalia, dorsal and ventral views.
F-I, *H. losida* Mosely: F,G, male genitalia, dorsal and ventral views; H,I, female genitalia, dorsal and ventral views.

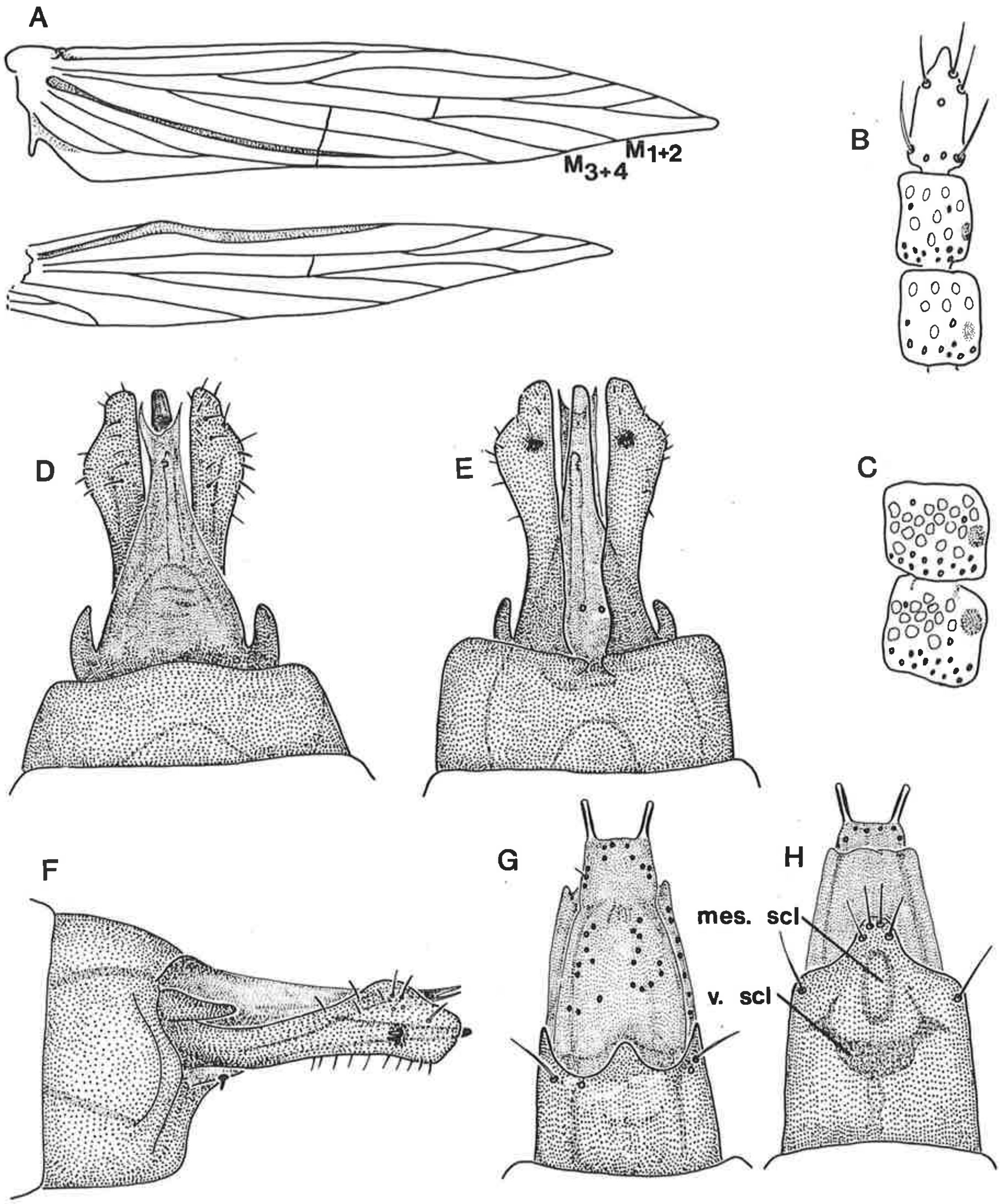


Plate 6A-H. Hydroptila obscura Wells. A-F, Male: A, wings; B, antenna, three terminal segments; C, antenna, two proximal segments; D-F, genitalia, dorsal, ventral and lateral views.
G,H, Female genitalia, dorsal and ventral views.

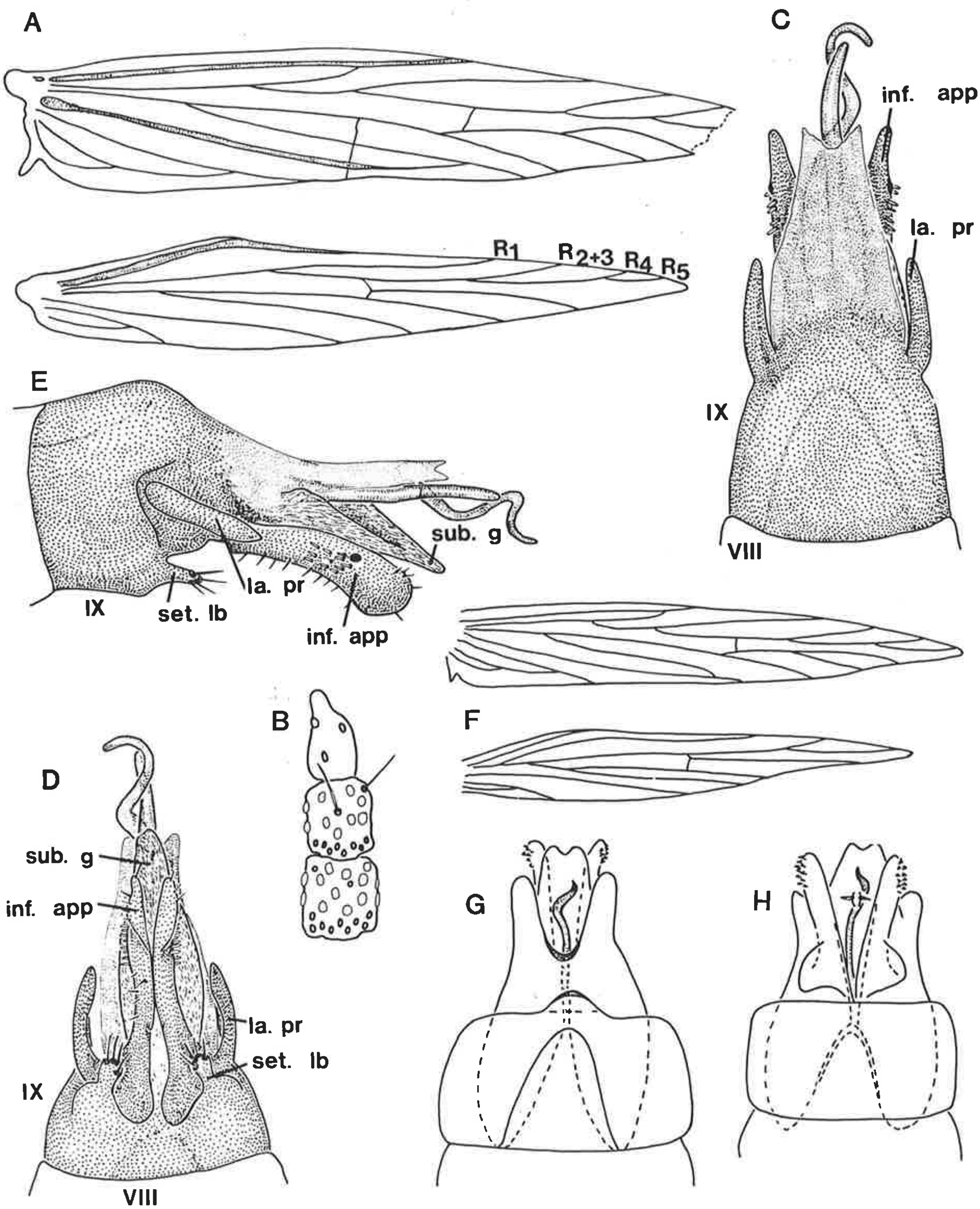


Plate 7A-H. A-E, *Hydroptila sinuosa* Wells, male: A, wings; B, antenna, three terminal segments; C-E, genitalia, dorsal, ventral and lateral views.
F-H, *H. incertula* Mosely, male: F, wings; G,H, genitalia, dorsal and ventral views.

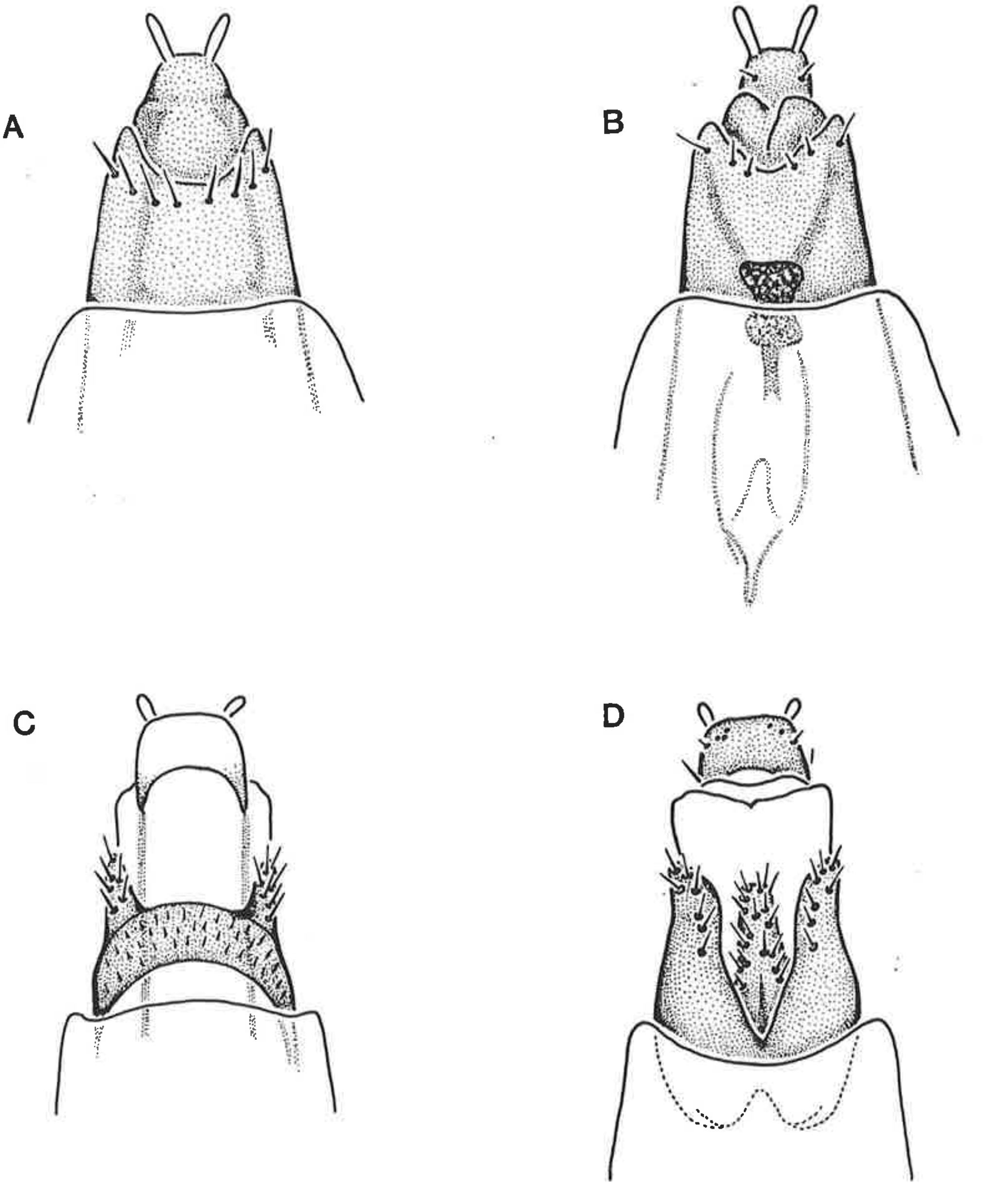


Plate 8A-D. A,B, *Hydroptila incertula* Mosely, female genitalia, dorsal and ventral views.
C,D, *Hellyethira litua* Wells, female genitalia, dorsal and ventral views.

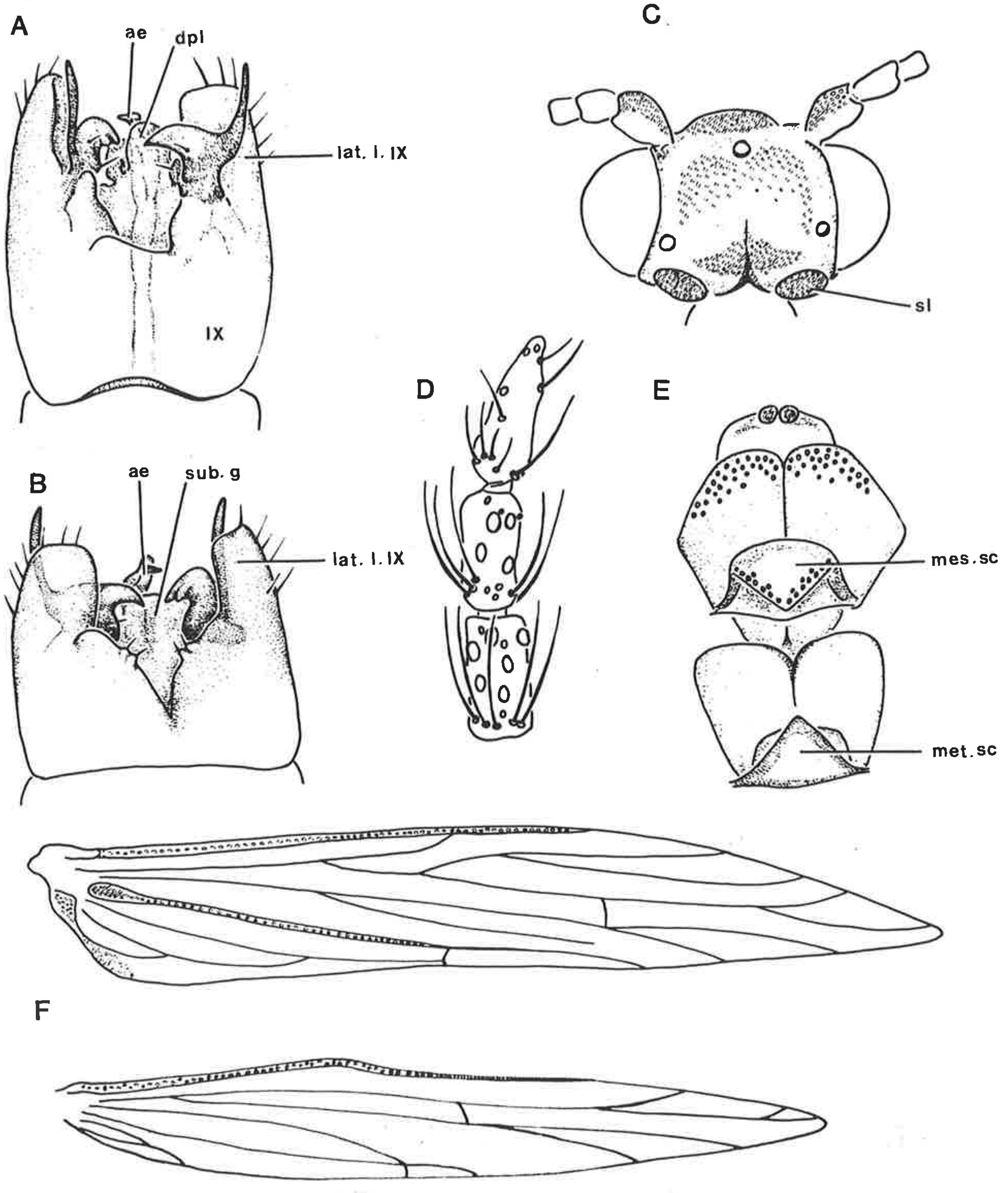
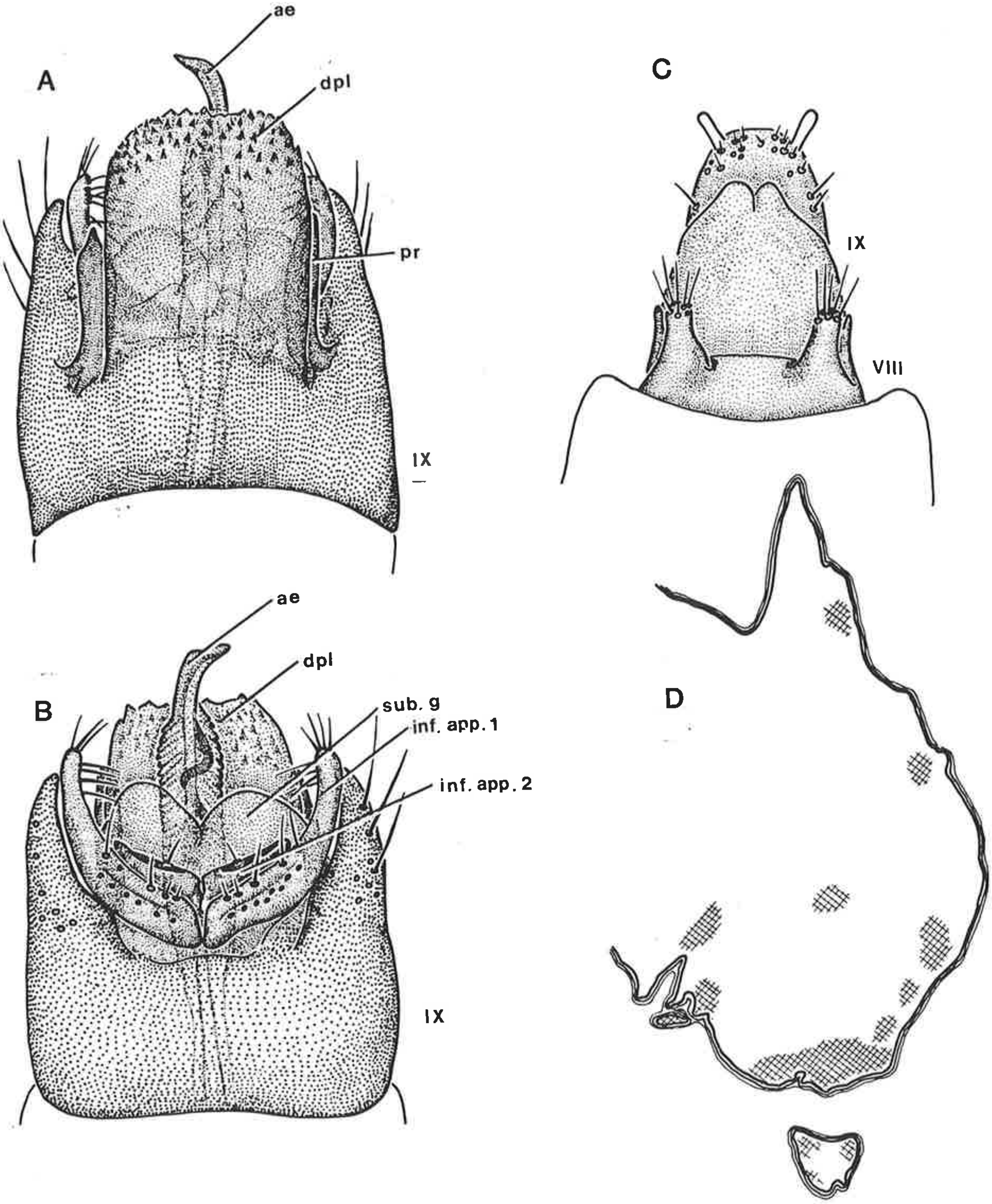


Plate 9A-F. A,B, *Xuthotrichia ochracea* Mosely, male genitalia: A, dorsal; B, ventral view. C-F, *Hellyethira simplex* (Mosely), male: C, head, dorsal view; D, antenna, three terminal segments; E, thorax, dorsal view; F, wings.



late 10A-D. *Hellyethira simplex* (Mosely): A,B, male genitalia dorsal and ventral views; C, female genitalia, ventral view; D, known distribution.

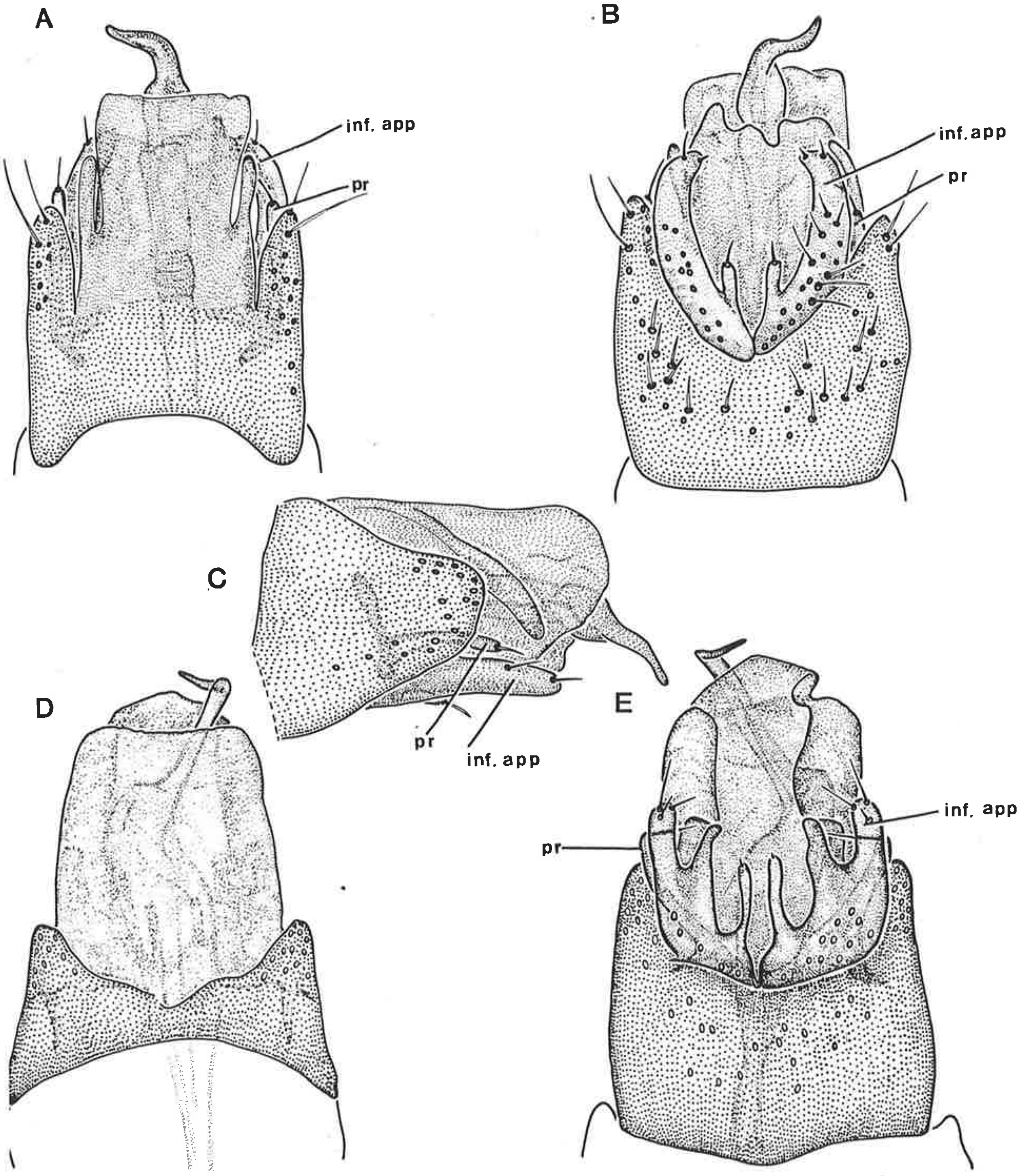


Plate 11A-E. A-C, Hellyethira basilobata Wells, male genitalia, dorsal, ventral and lateral views.
D,E, H. allynensis Wells, male genitalia, dorsal and ventral views.

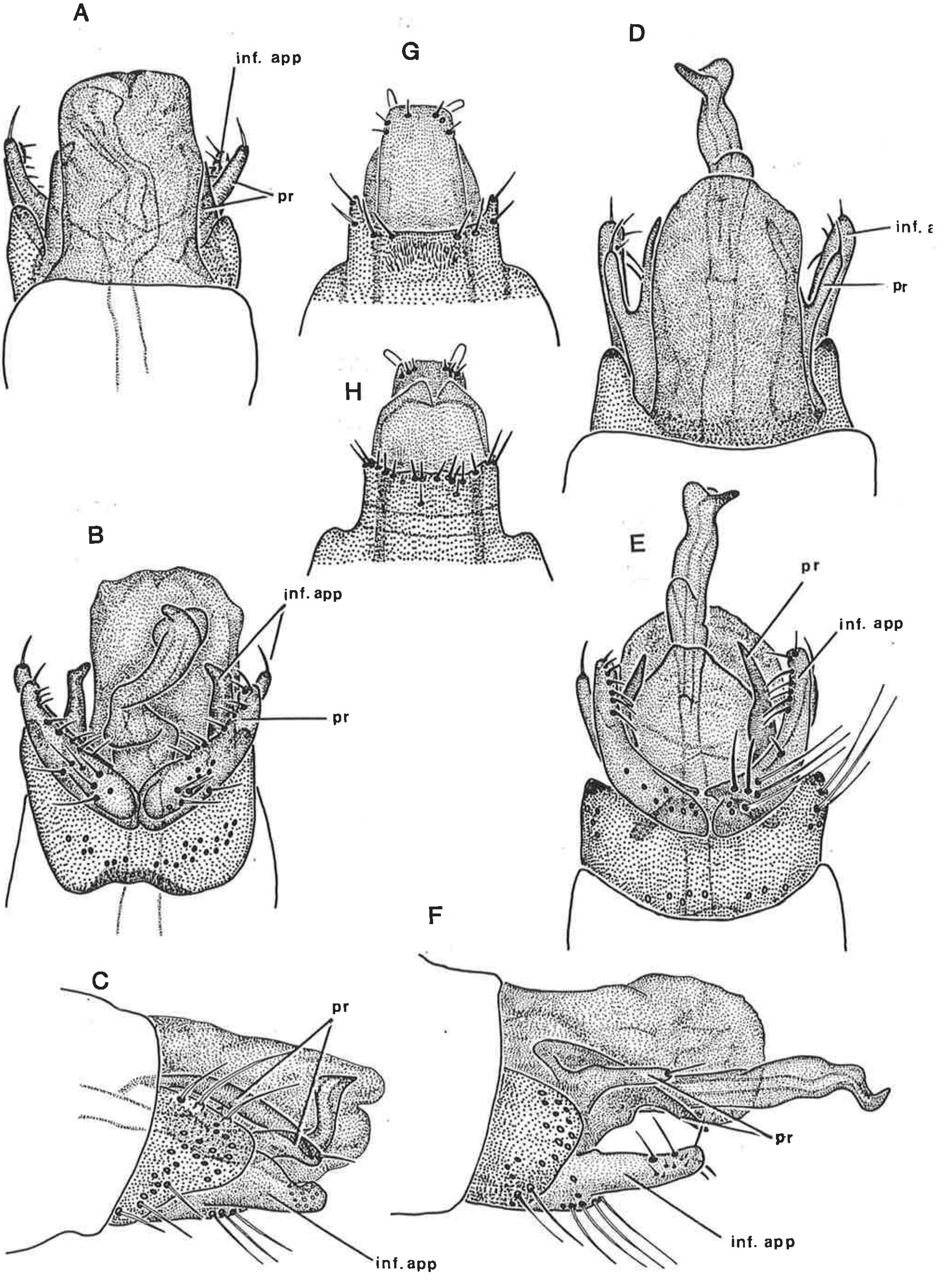


Plate 12A-H. A-C, <u>Hellyethira</u> <u>cubitans</u> Wells, male genitalia, dorsal, ventral, and lateral views.
D-H, <u>H</u>. <u>exserta</u> Wells: D-F, male genitalia, dorsal, ventral, and lateral views; G,H, female genitalia, dorsal and ventral views.

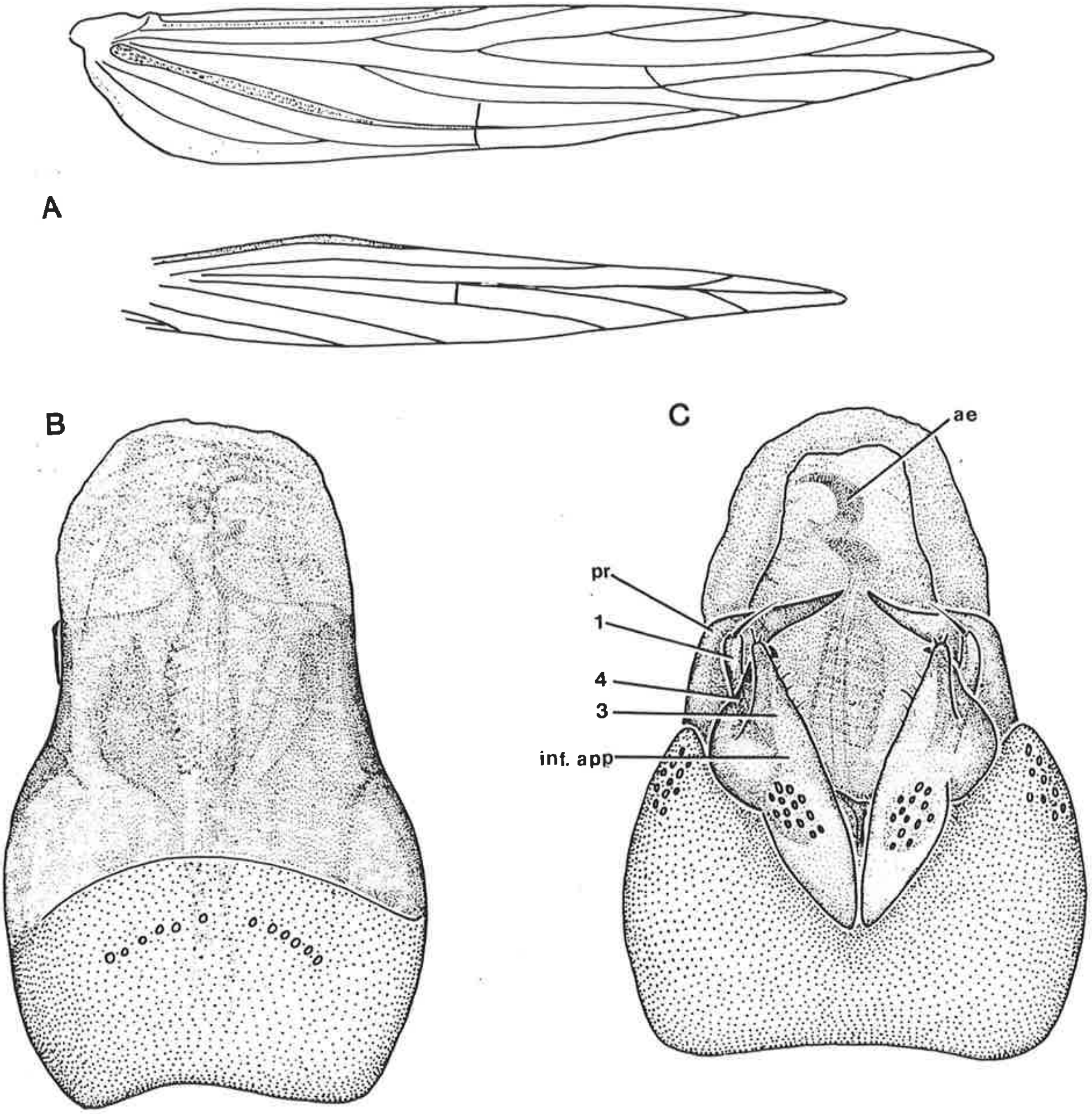


Plate 13A–C. *Hellyethira dentata* Wells, A, wings; B,C, male genitalia, dorsal and ventral views.

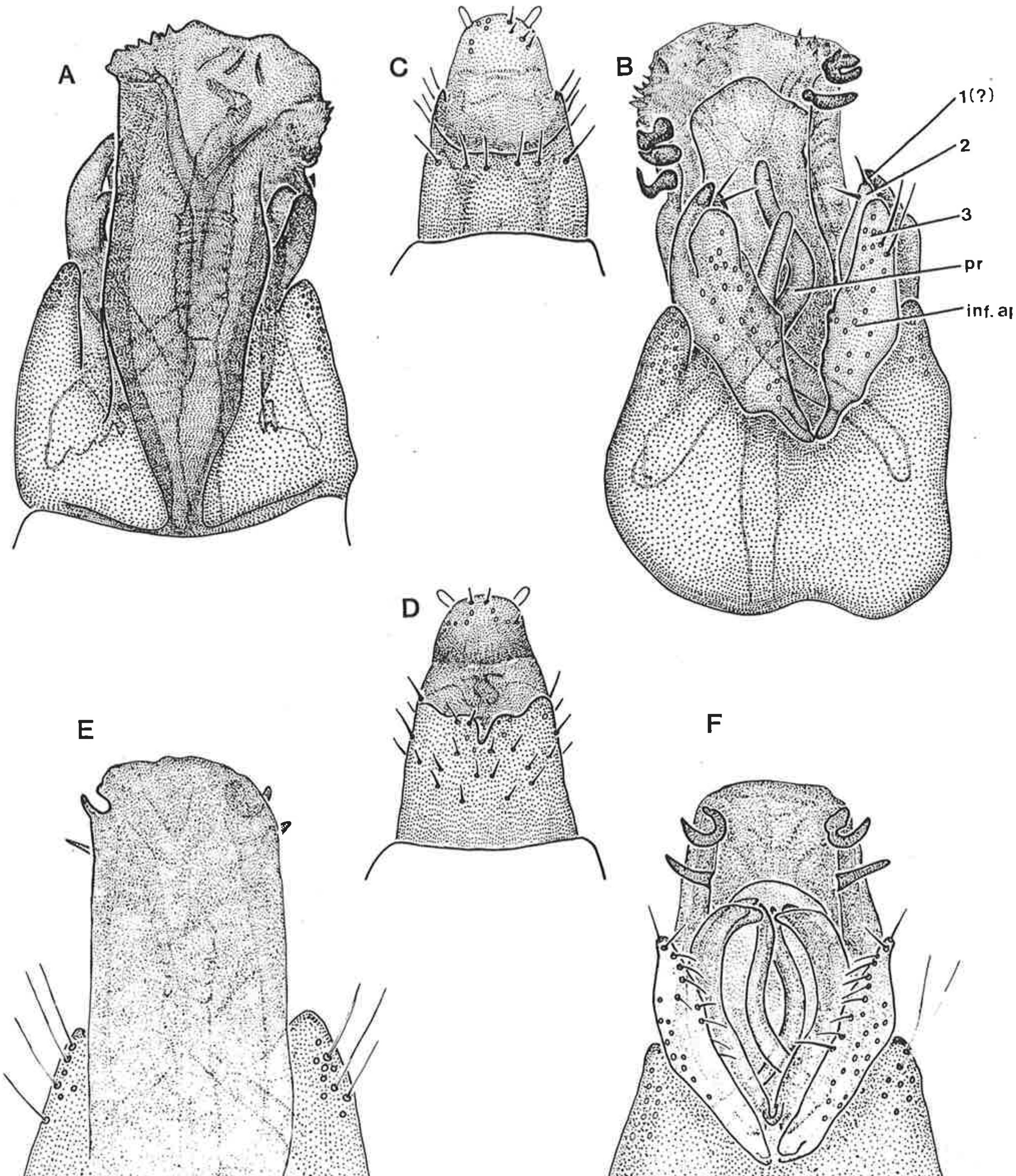


Plate 14A–F. A–D, <u>Hellyethira</u> <u>eskensis</u> (Mosely): A,B, male genitalia, dorsal and ventral views; C,D, female genitalia, dorsal and ventral views.
E,F, <u>H</u>. <u>sentisa</u> Wells, male genitalia, dorsal and ventral views.

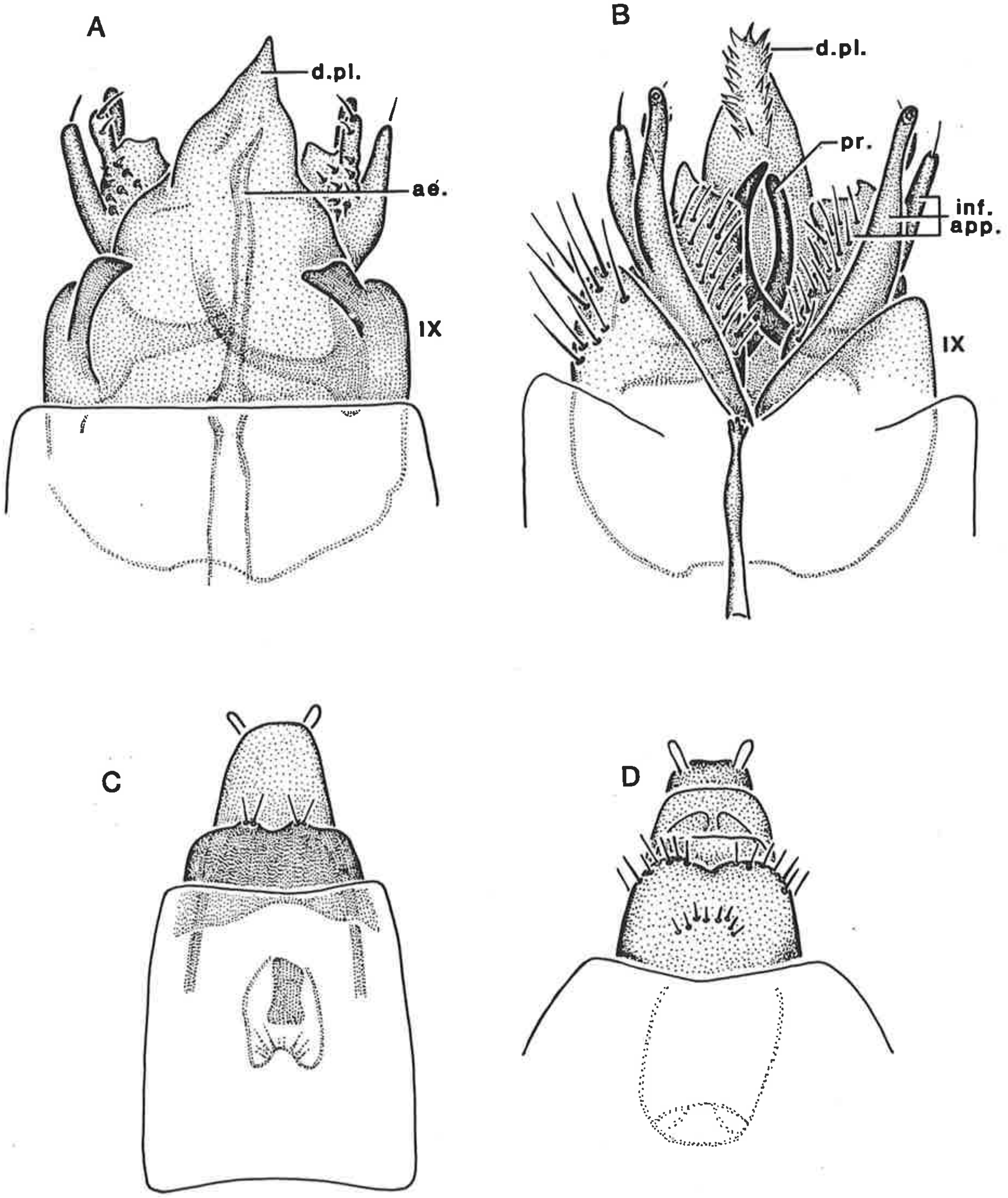


Plate 15A–D. A–C, Hellyethira veruta Wells: A,B, male genitalia, dorsal and ventral views; C, female genitalia, ventral view. D, H. ramosa Wells, female genitalia, ventral view.

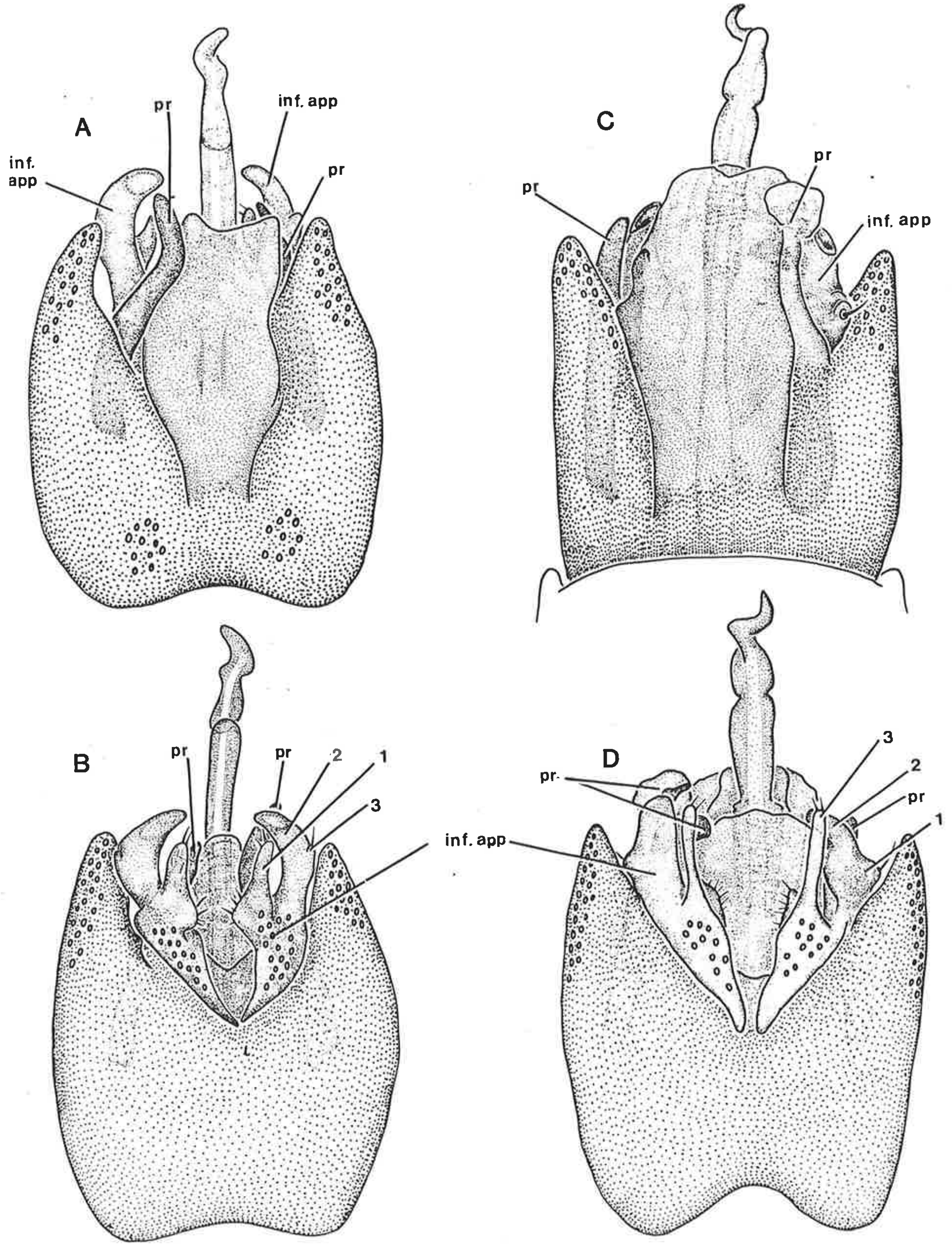


Plate 16 A–D. A,B, *Hellyethira loripes* Wells, male genitalia, dorsal and ventral views.
C,D, *H. pulvina* Wells, male genitalia, dorsal and ventral views.

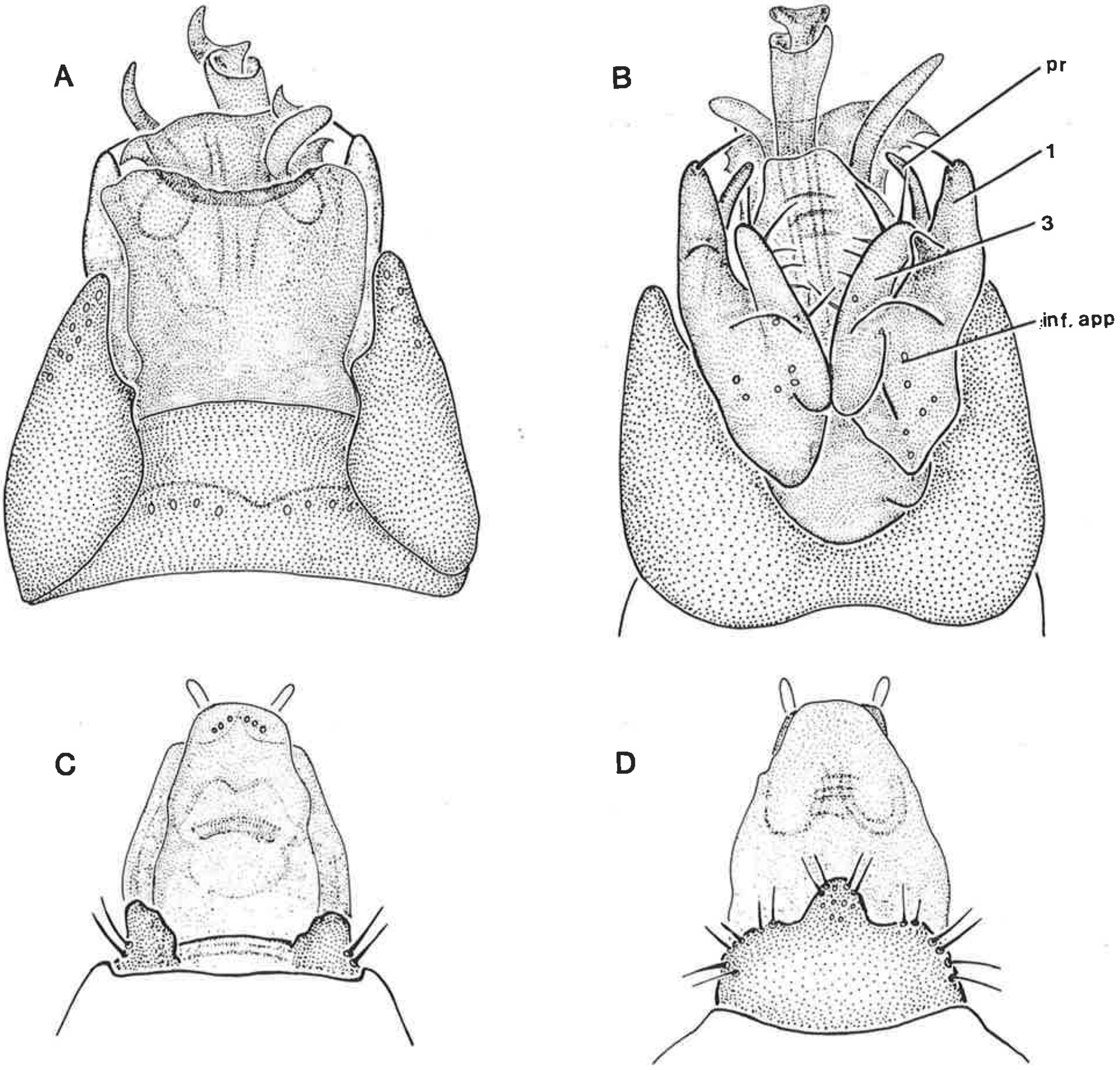


Plate 17A-D. <u>Hellyethira</u> <u>cornuta</u> Wells: A,B, male genitalia, dorsal and ventral views; C,D, female genitalia, dorsal and ventral views.

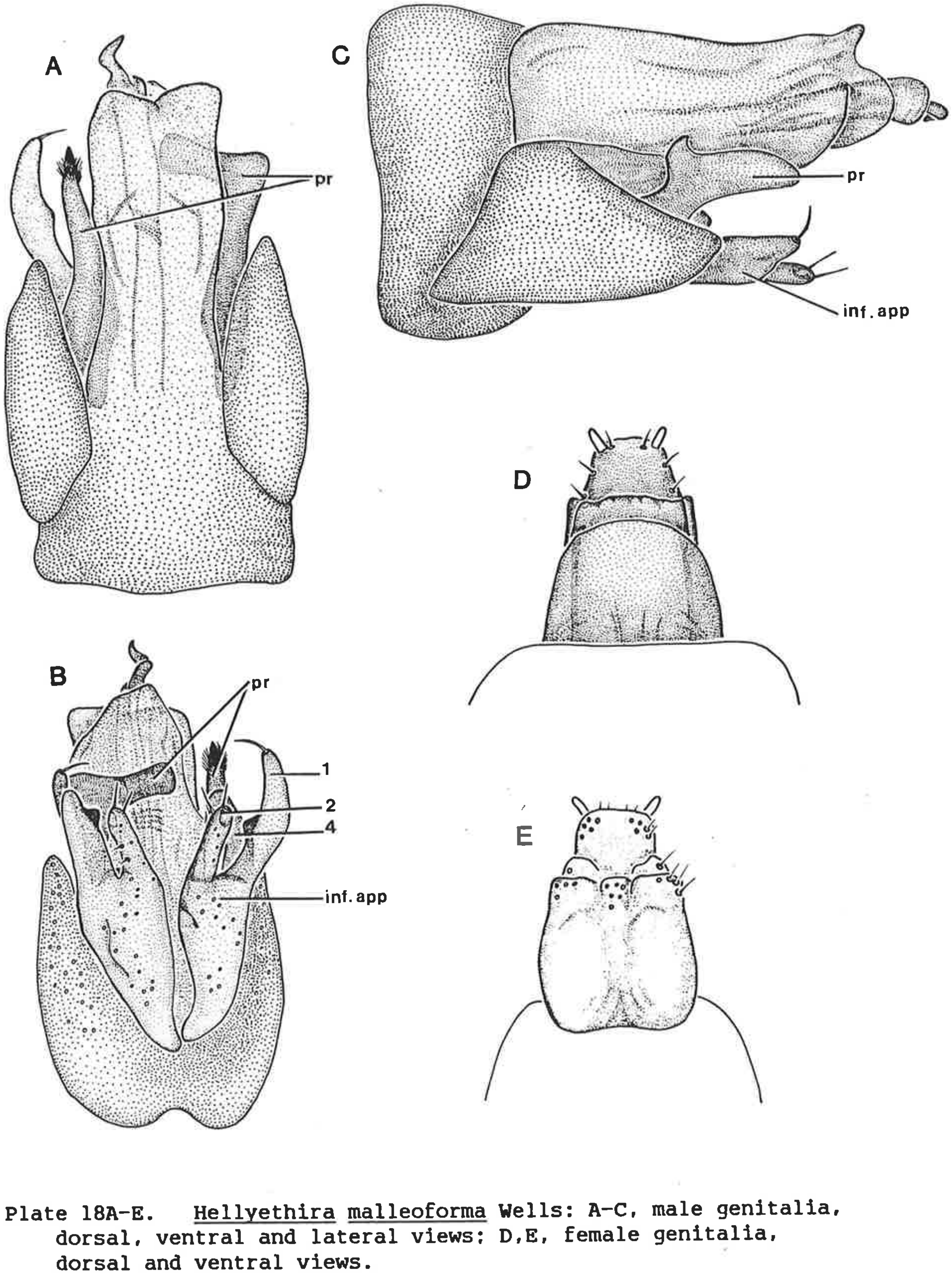


Plate 18A-E. *Hellyethira malleoforma* Wells: A-C, male genitalia, dorsal, ventral and lateral views; D,E, female genitalia, dorsal and ventral views.

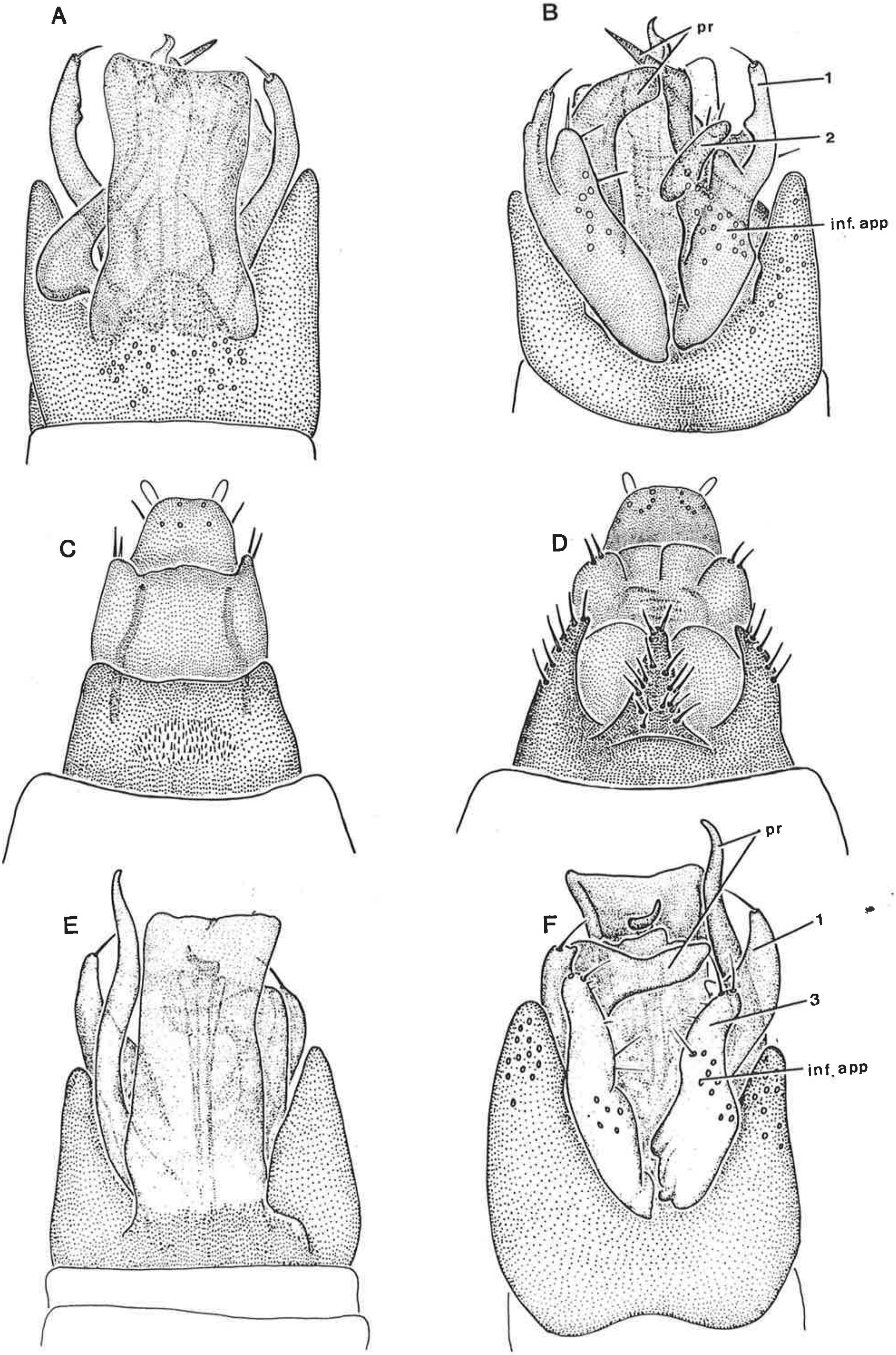


Plate 19A–F. A–D, *Hellyethira multilobata* Wells: A,B, male genitalia, dorsal and ventral views; C,D, female genitalia, dorsal and ventral views.
E,F, *H. litua* Wells, male genitalia, dorsal and ventral views.

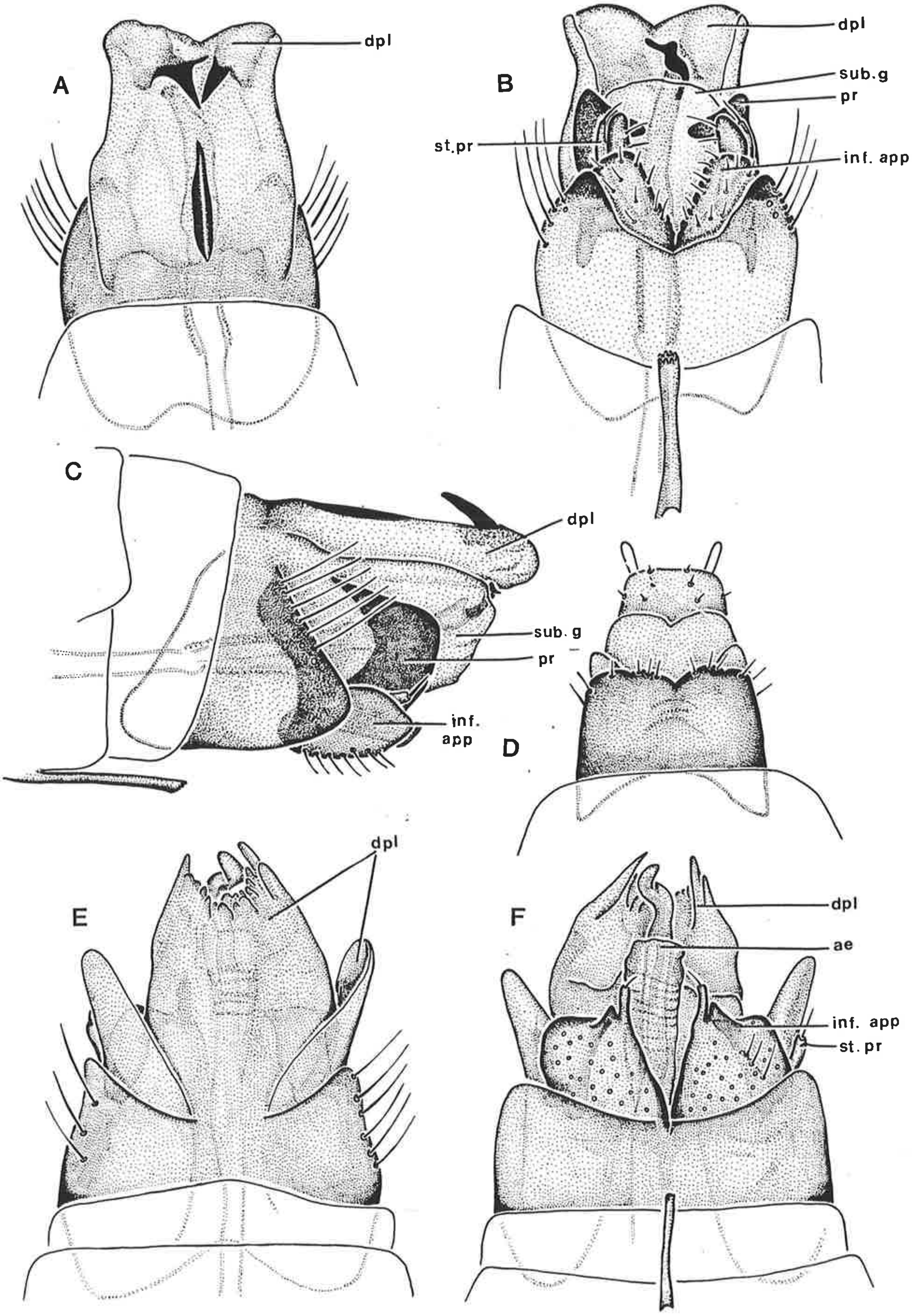


Plate 20A-F. A-D, *Hellyethira vernoni* Wells: A-C, male genitalia, dorsal, ventral and lateral views; D, female genitalia, ventral view.
E,F, *H. ramosa* Wells, male genitalia, dorsal and ventral views.

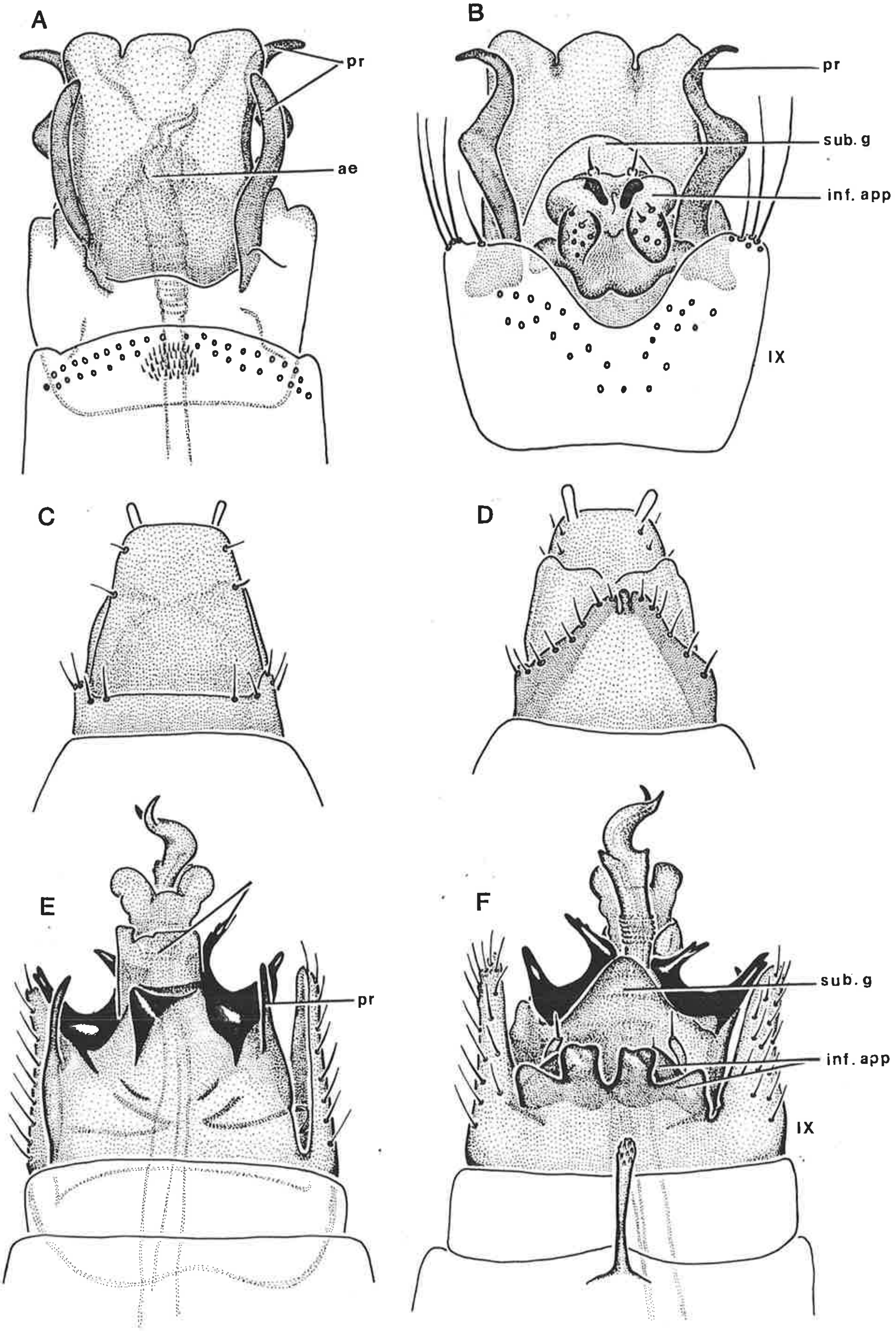


Plate 21A-F. A-D, _Acritoptila globosa_ Wells:
A,B, male genitalia, dorsal and ventral views;
C,D, female genitalia, dorsal and ventral views.
E,F, _A. hamatus_ Wells, male genitalia, dorsal
and ventral views.

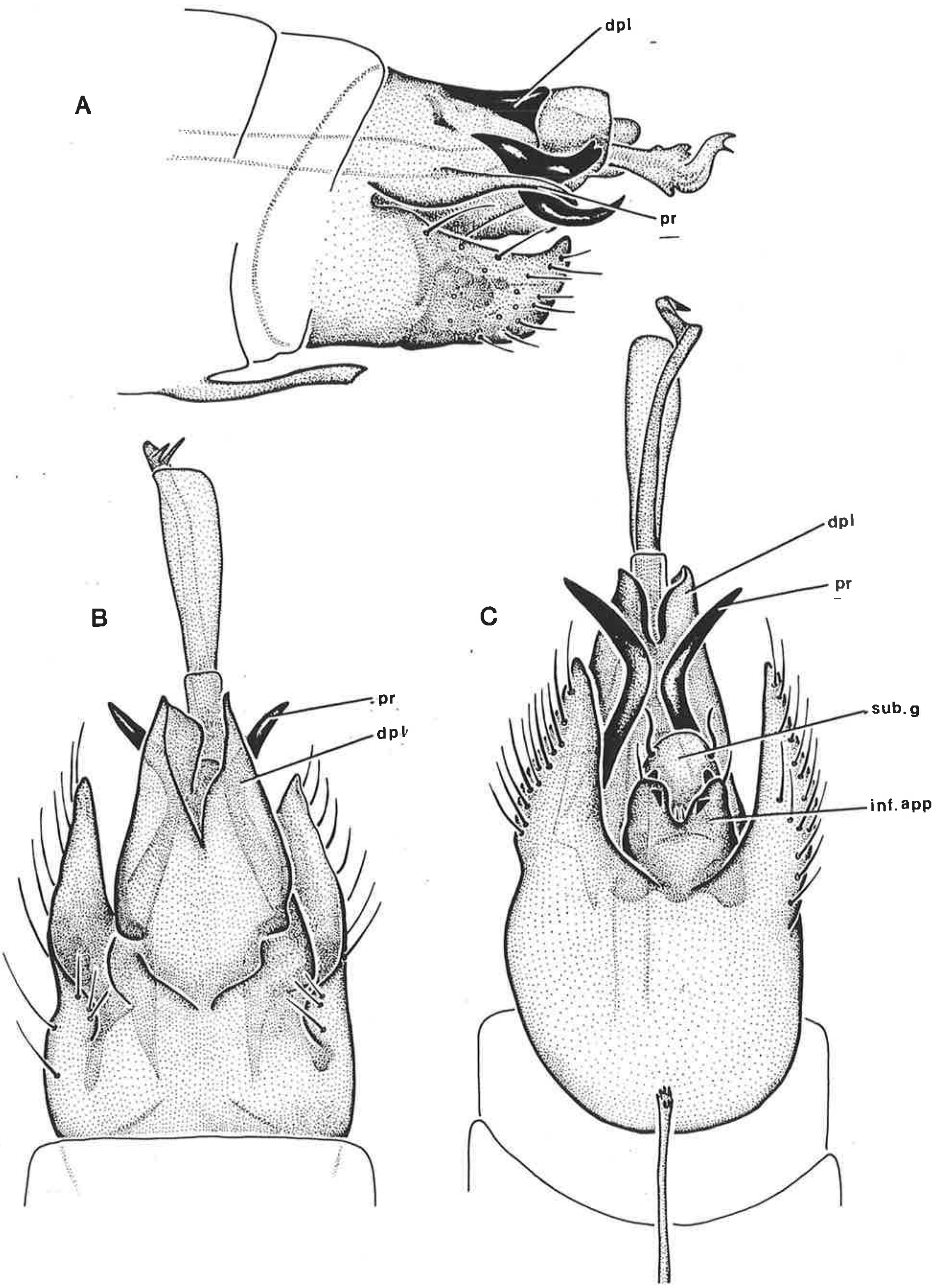


Plate 22A-C. A, Acritoptila hamatus Wells, male genitalia, lateral view.
B,C, A. margaretae Wells, male genitalia, dorsal and ventral views.

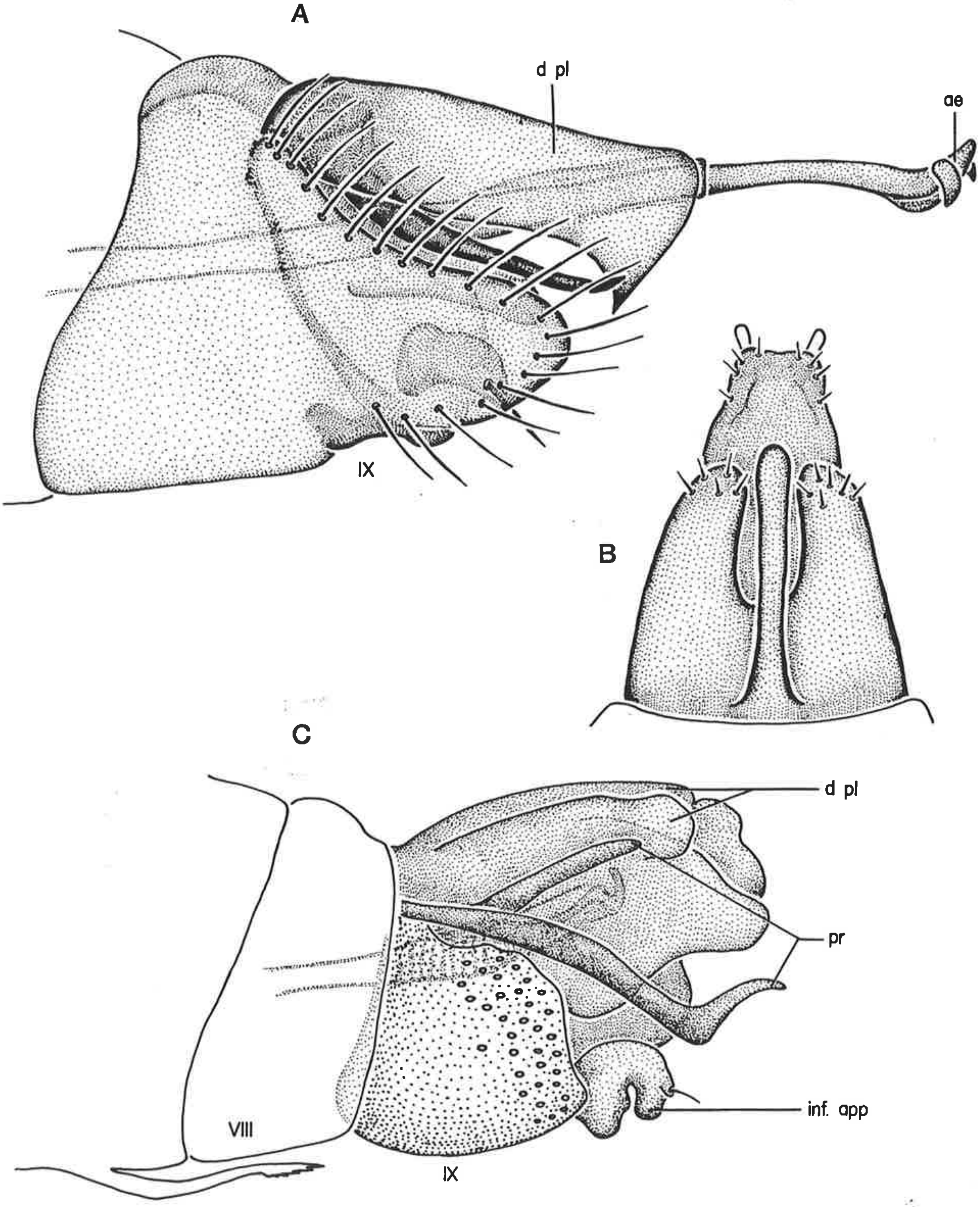


Plate 23A-C. A,B, *Acritoptila margaretae* Wells: A, male gennitalia, lateral view; B, female genitalia, ventral view. C, *A. globosa* Wells, male genitalia, lateral view.

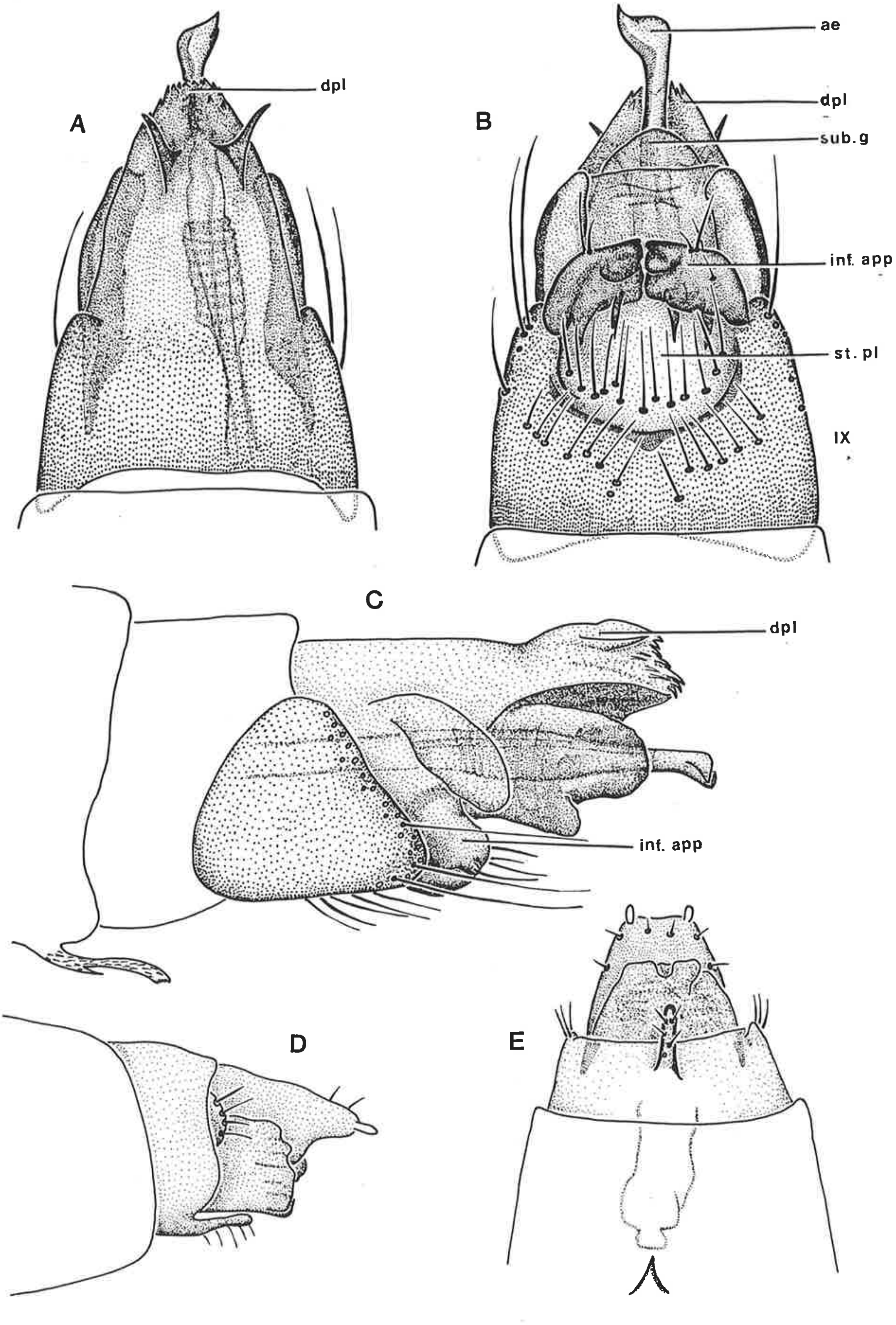


Plate 24A-E. *Austratrichia neboissi* Wells: A-C, male genitalia, dorsal, ventral and lateral views; D,E, female genitalia, lateral and ventral views.

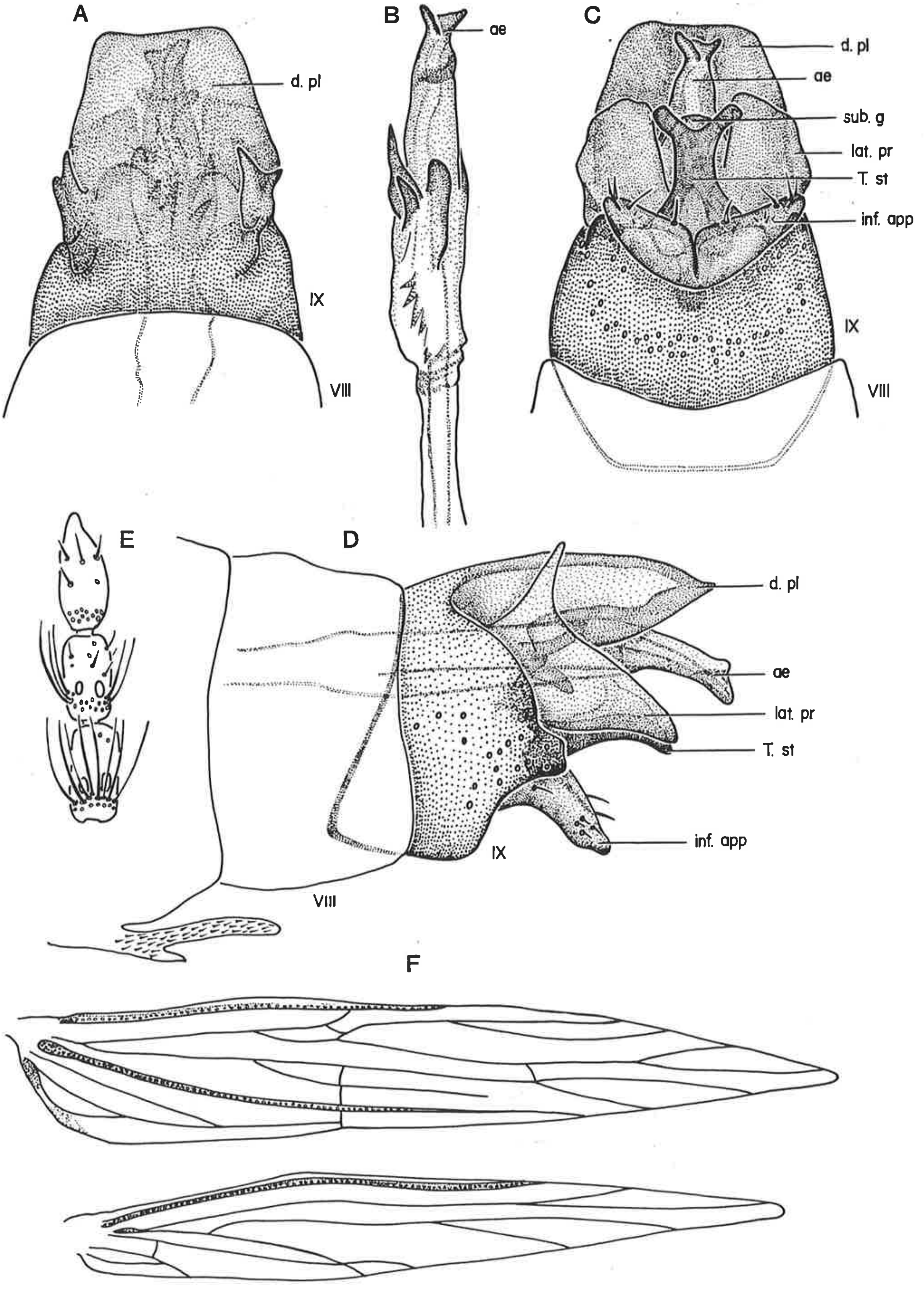


Plate 25A-F. A-D, *Mulgravia coronata* Wells, male genitalia: A,C,D, dorsal, ventral and lateral views: B, aedeagus. E,F, *Austratrichia neboissi* Wells, male: E, antenna, three terminal segments; F, wings.

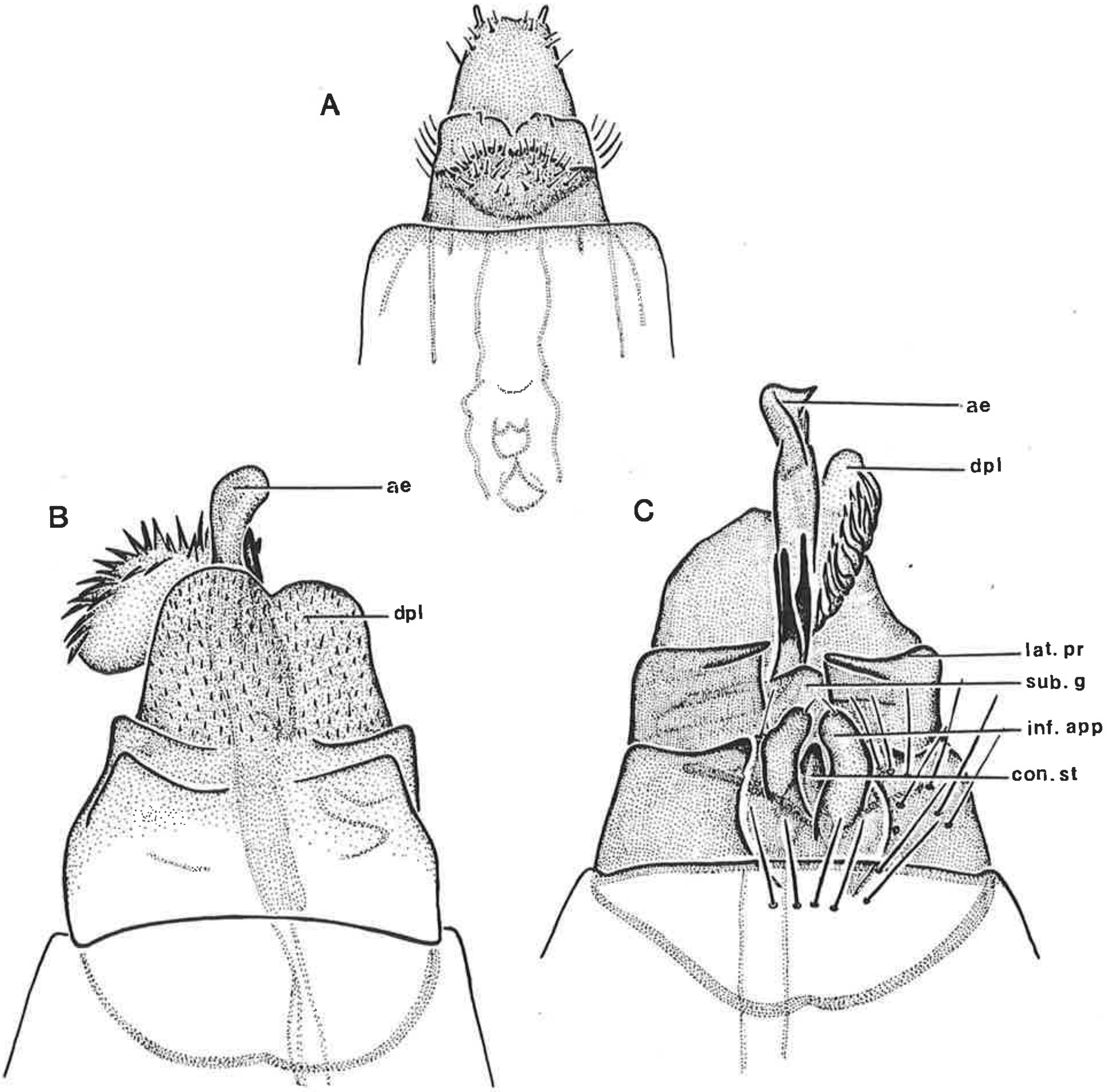


Plate 26A-C. *Mulgravia carteri* Wells: A, female genitalia, ventral view; B,C, male genitalia, dorsal and ventral views.

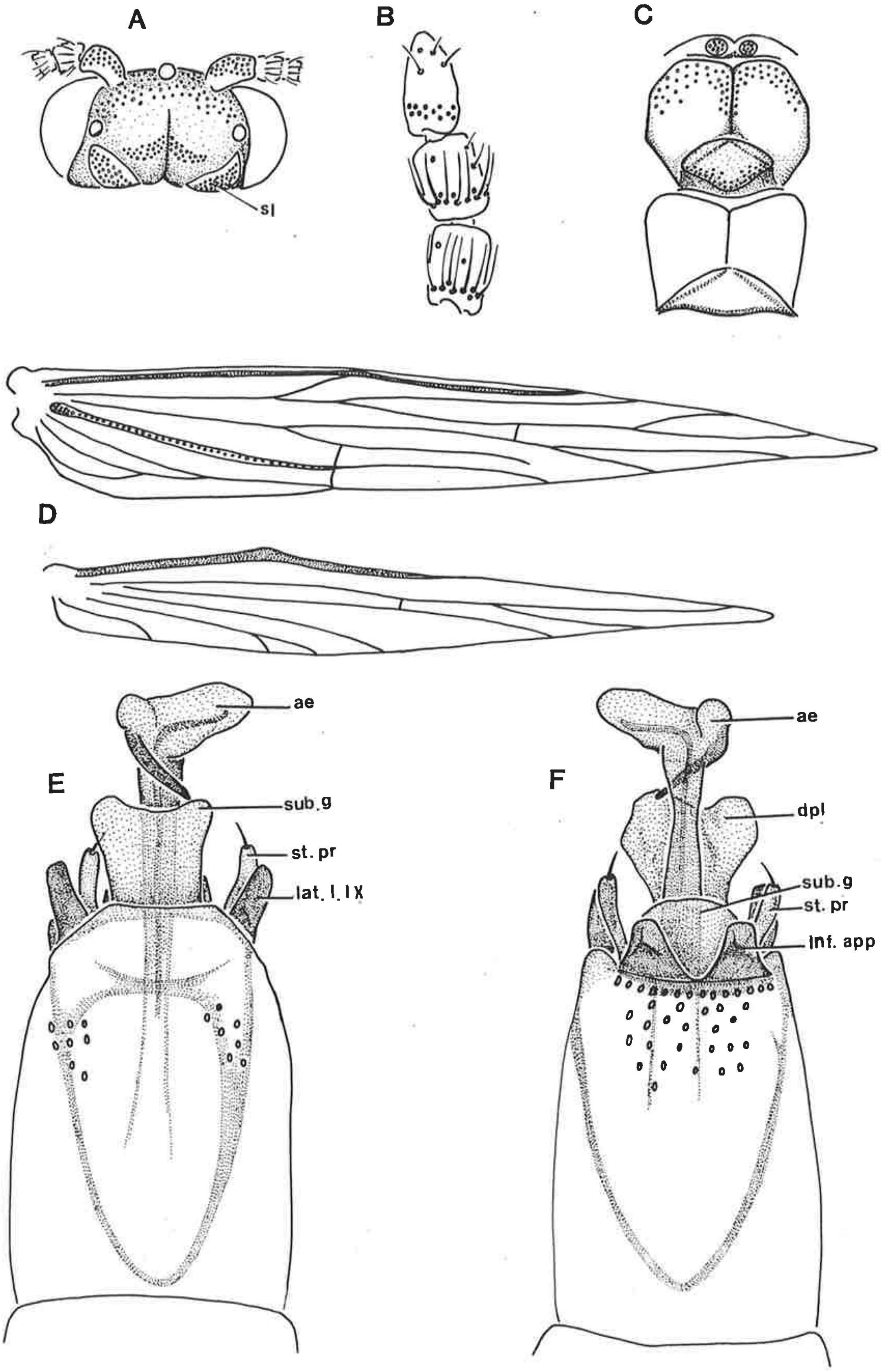


Plate 27A-F. Oxyethira columba (Neboiss), male, type locality: A, head, dorsal view; B, antenna, three terminal segments; C, thorax, dorsal view; D, wings; E,F, genitalia, dorsal and ventral views.

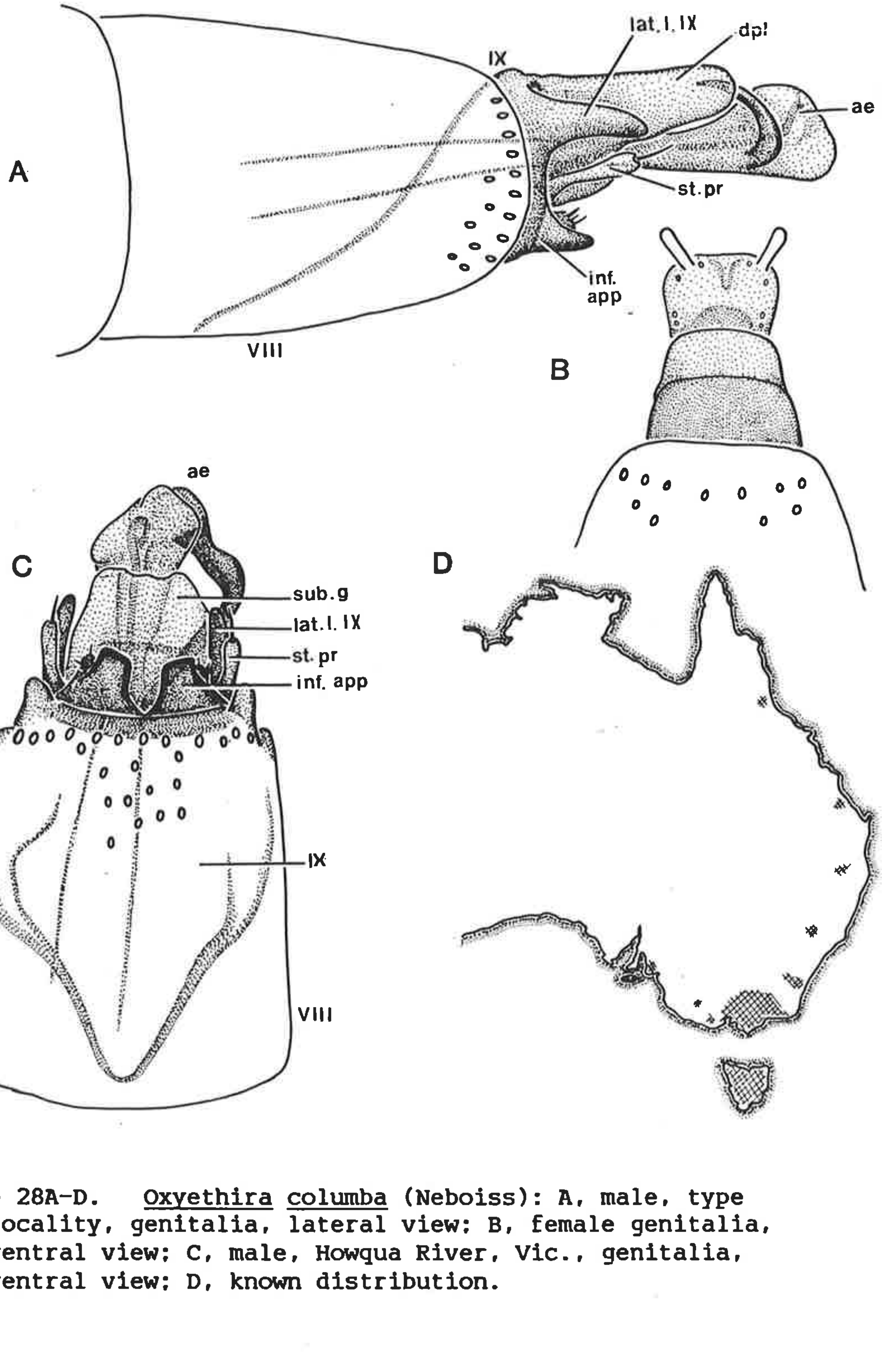


Plate 28A-D. *Oxyethira columba* (Neboiss): A, male, type locality, genitalia, lateral view; B, female genitalia, ventral view; C, male, Howqua River, Vic., genitalia, ventral view; D, known distribution.

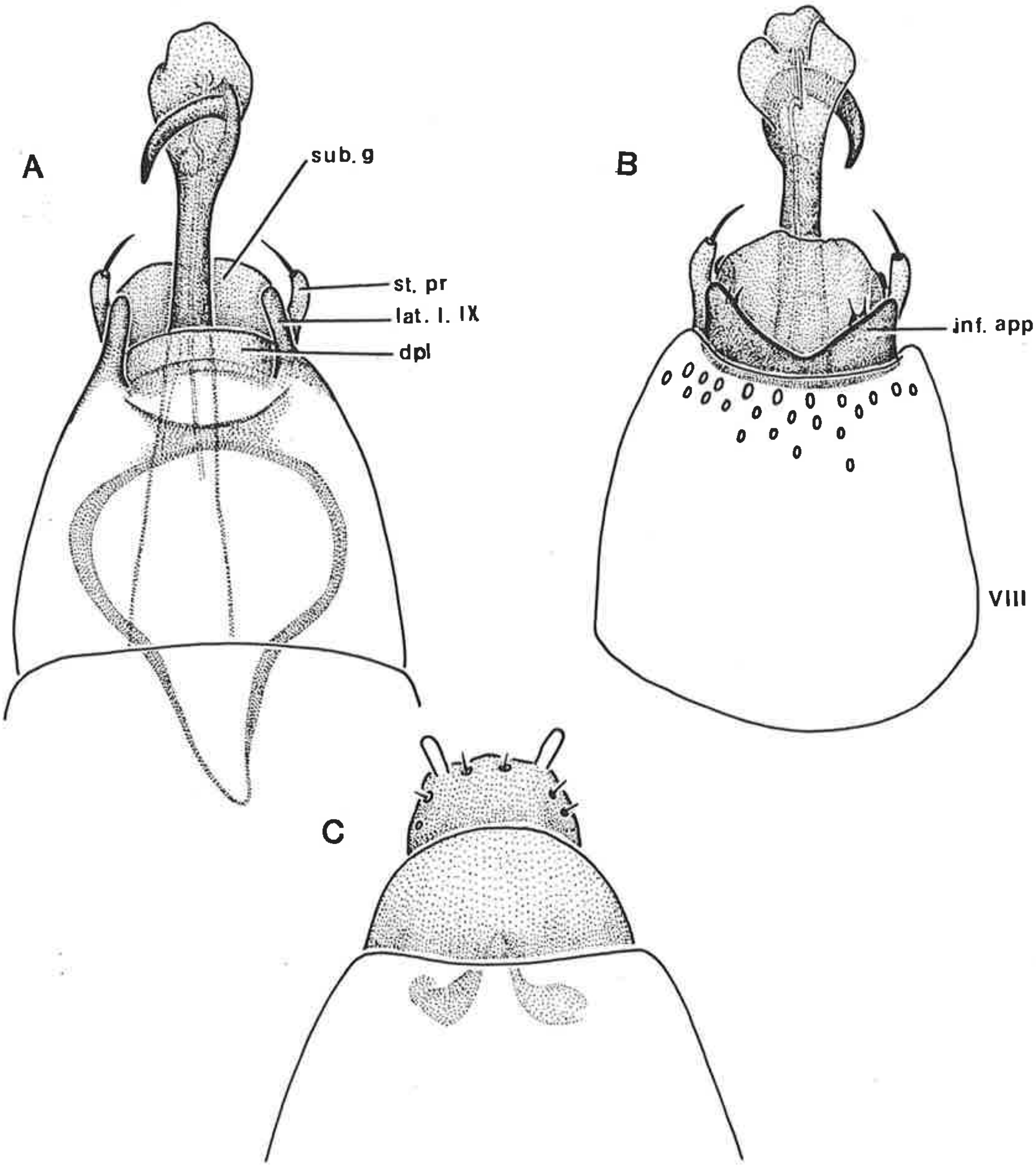


Plate 29A-C. Oxyethira triangulata Wells: A,B, male genitalia, dorsal and ventral views; C, female genitalia, ventral view.

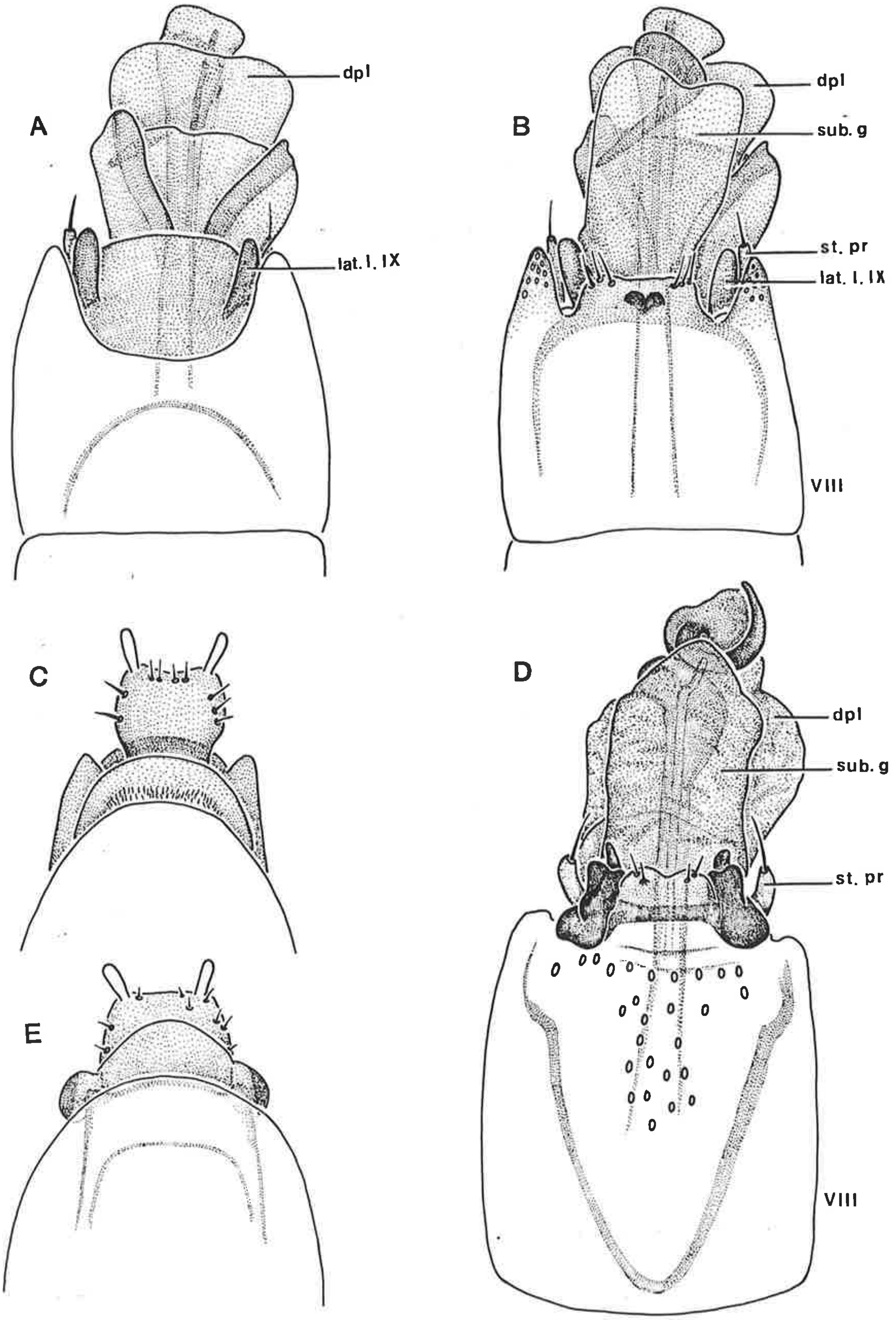


Plate 30A-E. A-C, *Oxyethira mienica* Wells: A,B, male genitalia, dorsal and ventral views; C, female genitalia, ventral view. D,E, *O. brevis* Wells: D, male genitalia, dorsal and ventral views; E, female genitalia, ventral view.

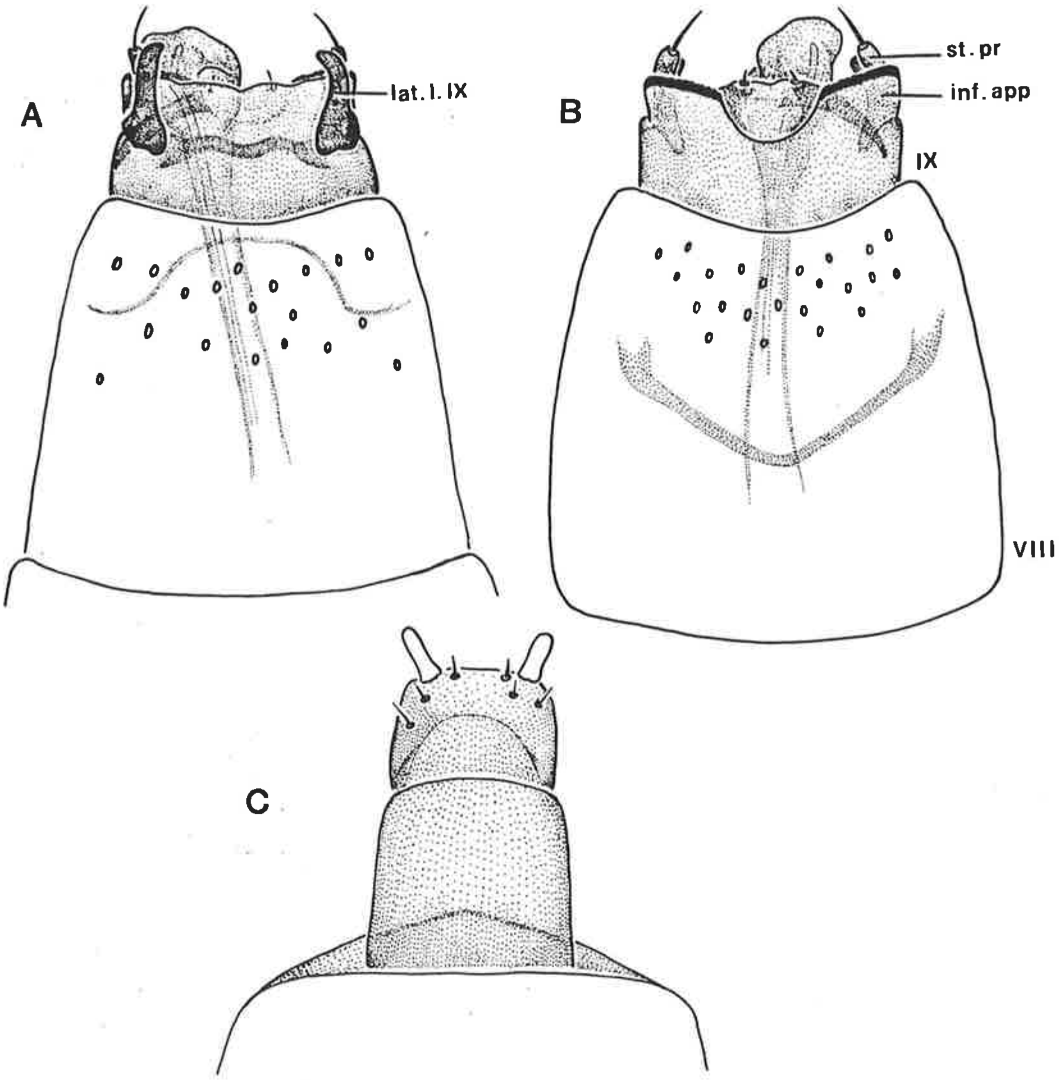


Plate 31A-C. A-C, *Oxyethira retracta* Wells: A,B, male genitalia, dorsal and ventral views; C, female genitalia, ventral view.

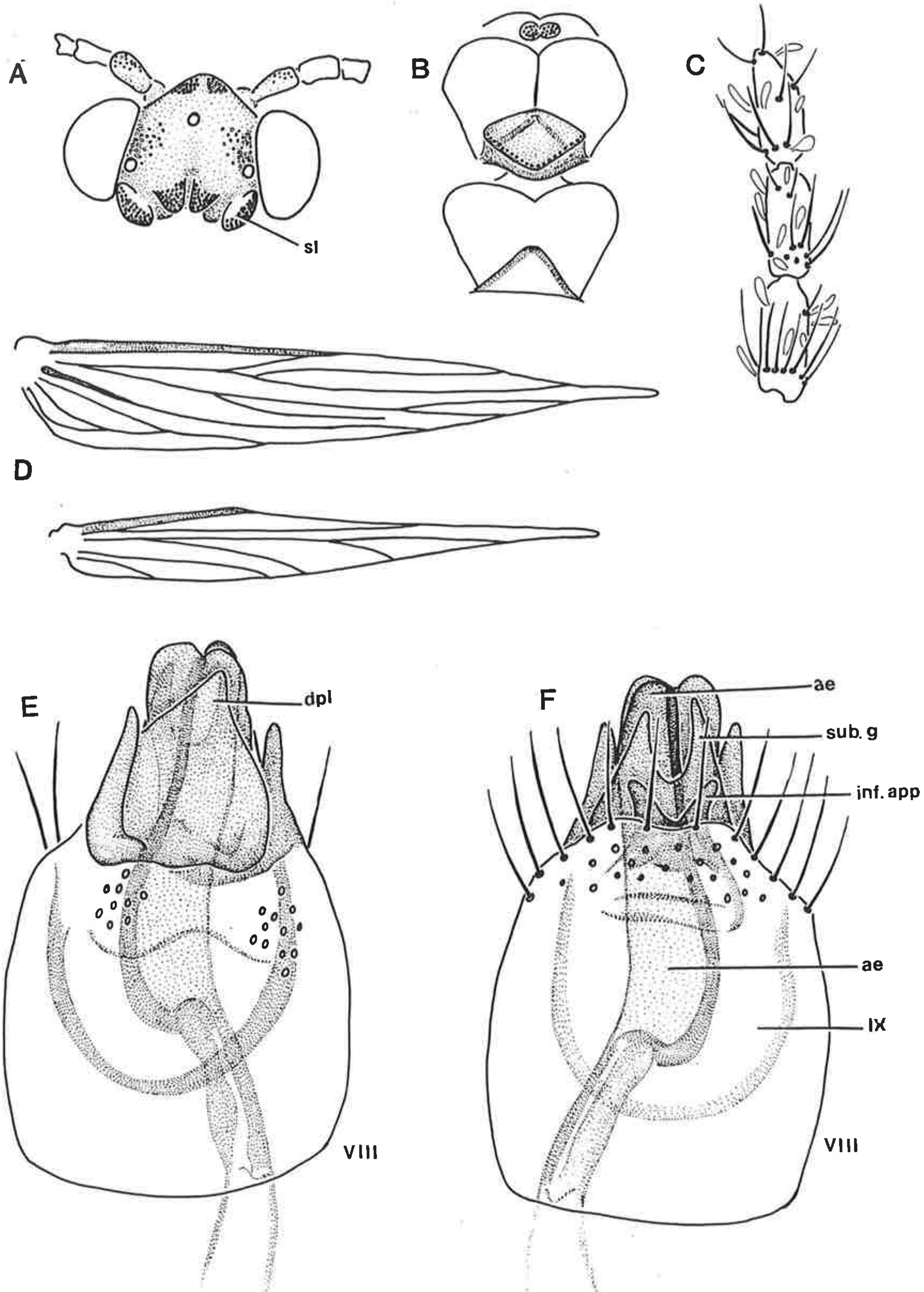


Plate 32A-F. Oxyethira incana Ulmer, male: A, head, dorsal view; B, thorax, dorsal view; C, antenna, three terminal segments; D, wings; E,F, genitalia, dorsal and ventral views.

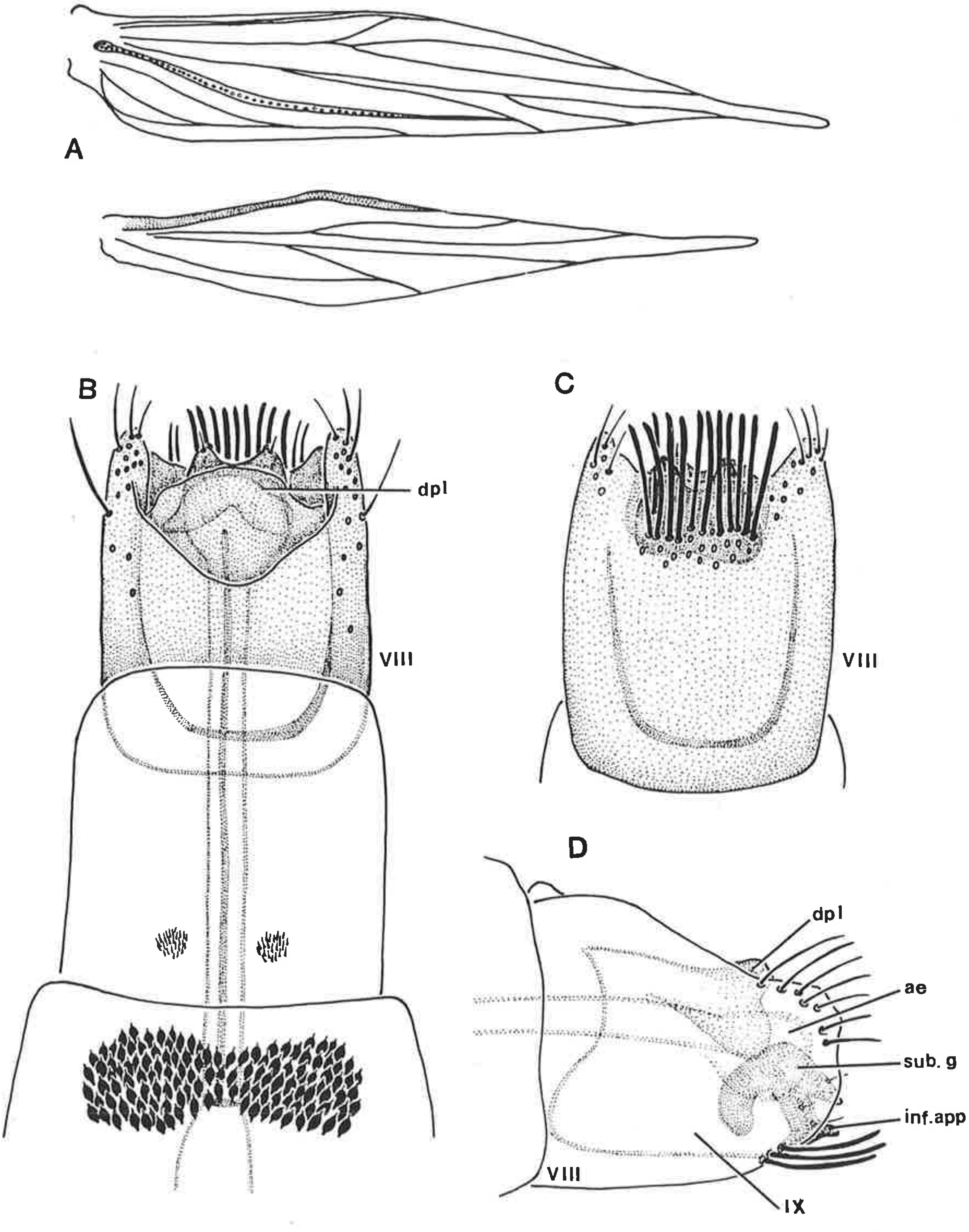


Plate 33A-D. *Oxyethira artuvillosus* (Wells), male: A, wings; B-D, genitalia, dorsal, ventral and lateral views.

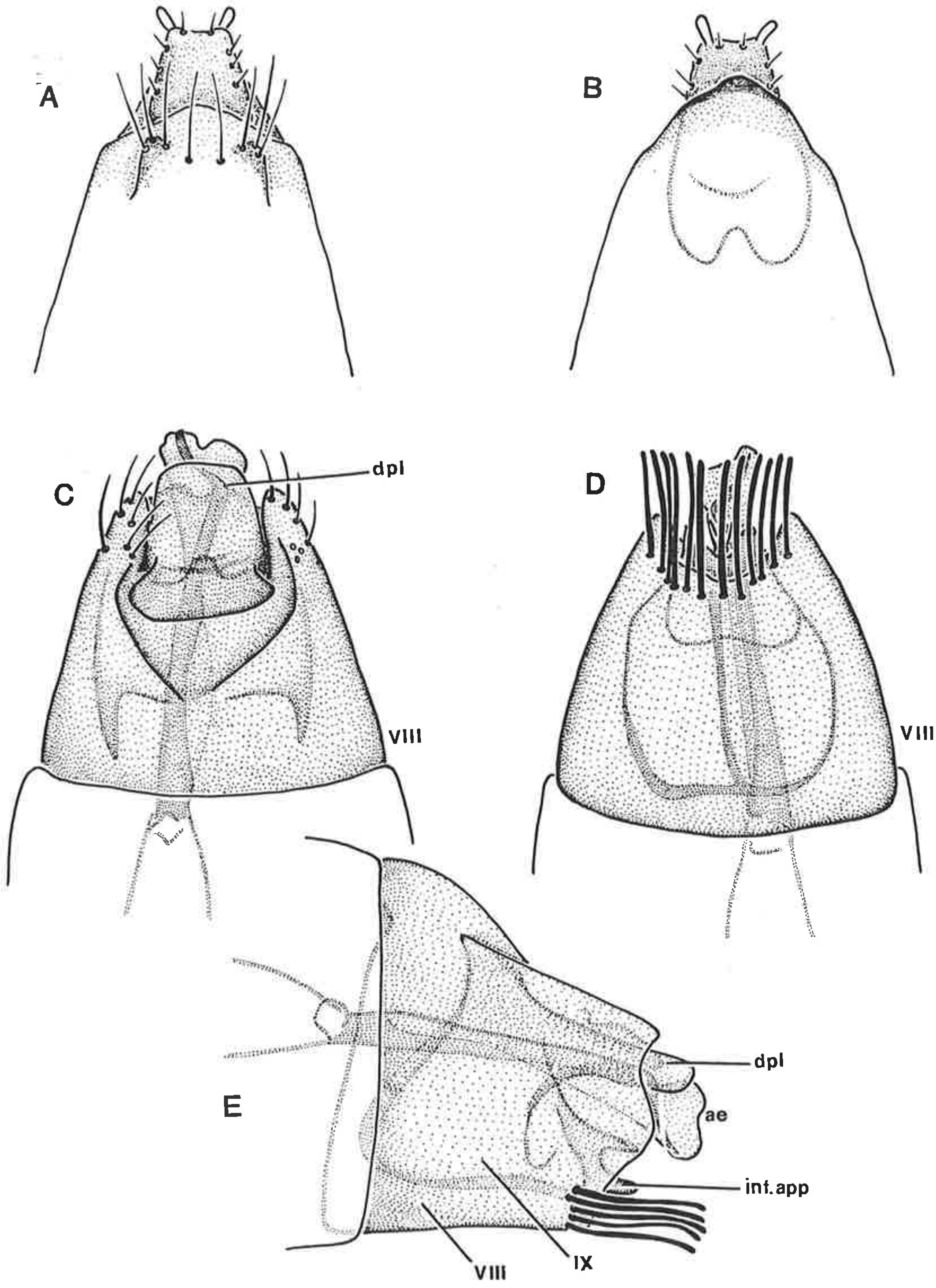


Plate 34A-E. A,B, *Oxyethira artuvillosus* (Wells), female genitalia, dorsal and ventral views.
C-E, *O. plumosa* (Wells), male genitalia, dorsal, ventral and lateral views.

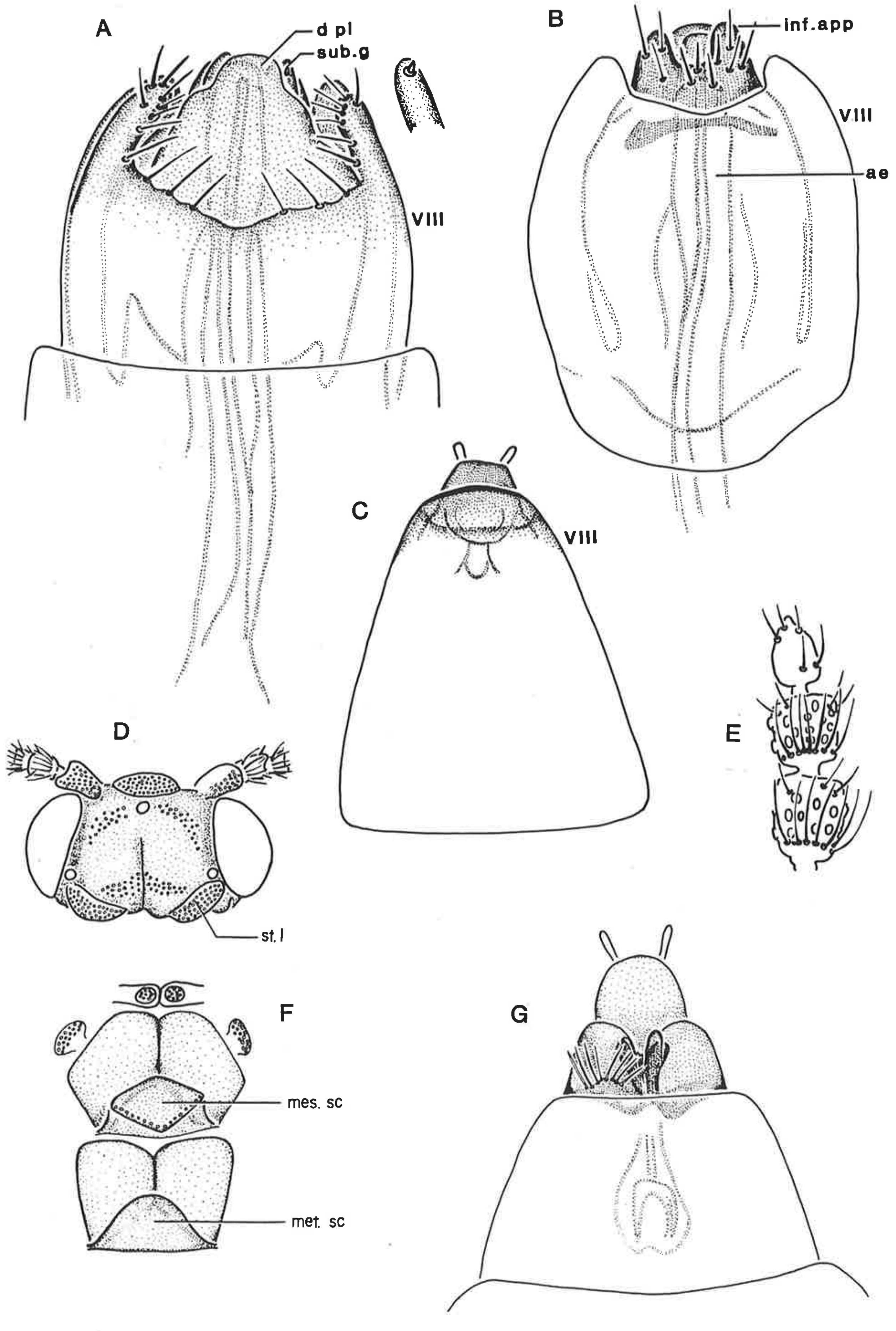


Plate 35A–G. A–C, <u>Oxyethira</u> <u>warramunga</u> Wells: A,B, male genitalia, dorsal and ventral views; C, female genitalia, ventral view
D–G, <u>Acanthotrichia</u> <u>bilamina</u> Wells: D, male antenna, three terminal segments; E, male head, dorsal view; F, male thorax, dorsal view, G, female genitalia, ventral view.

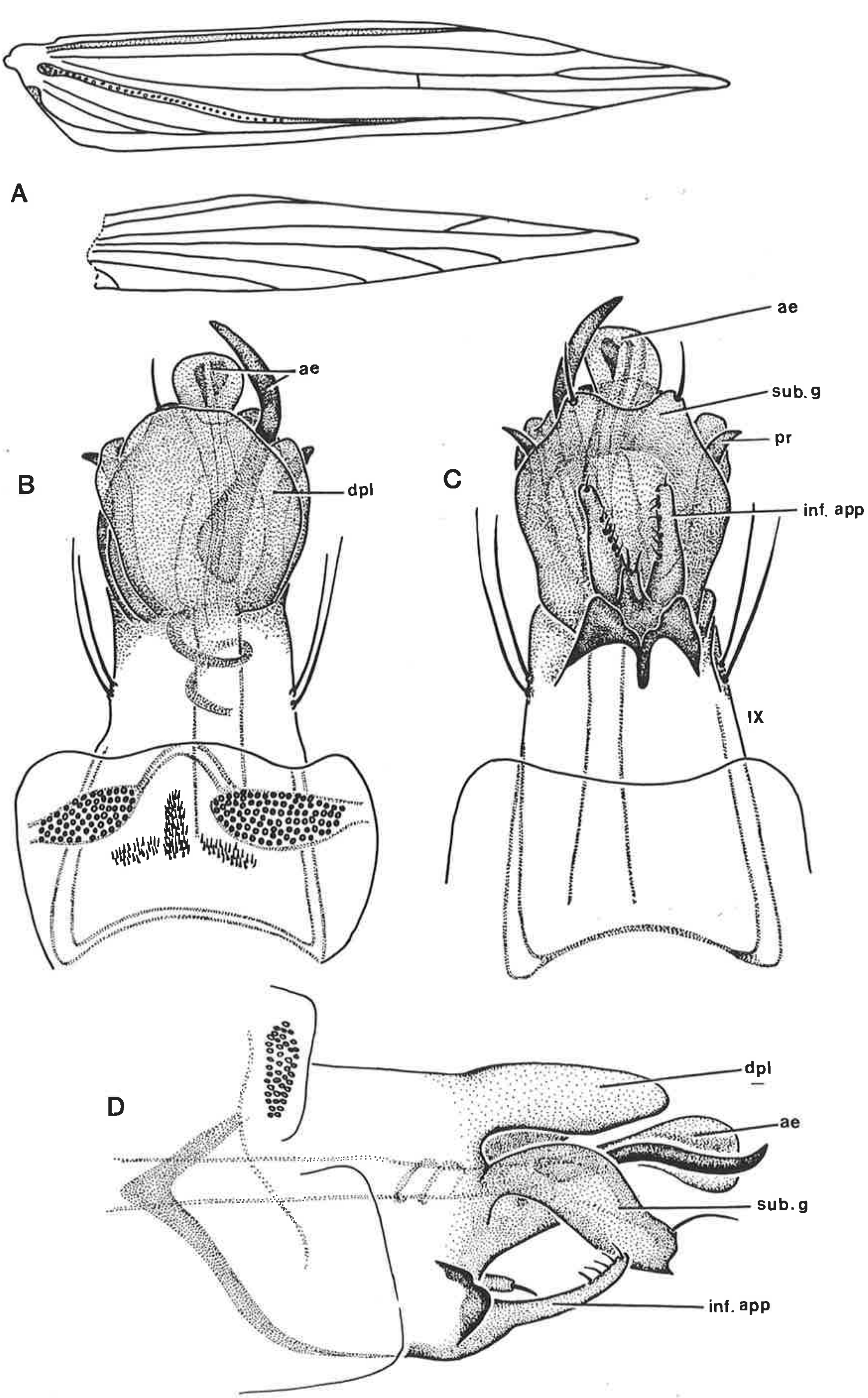


Plate 36A-D. *Acanthotrichia bilamina* Wells, male: A, wings; B-D, genitalia, dorsal, ventral and lateral views.

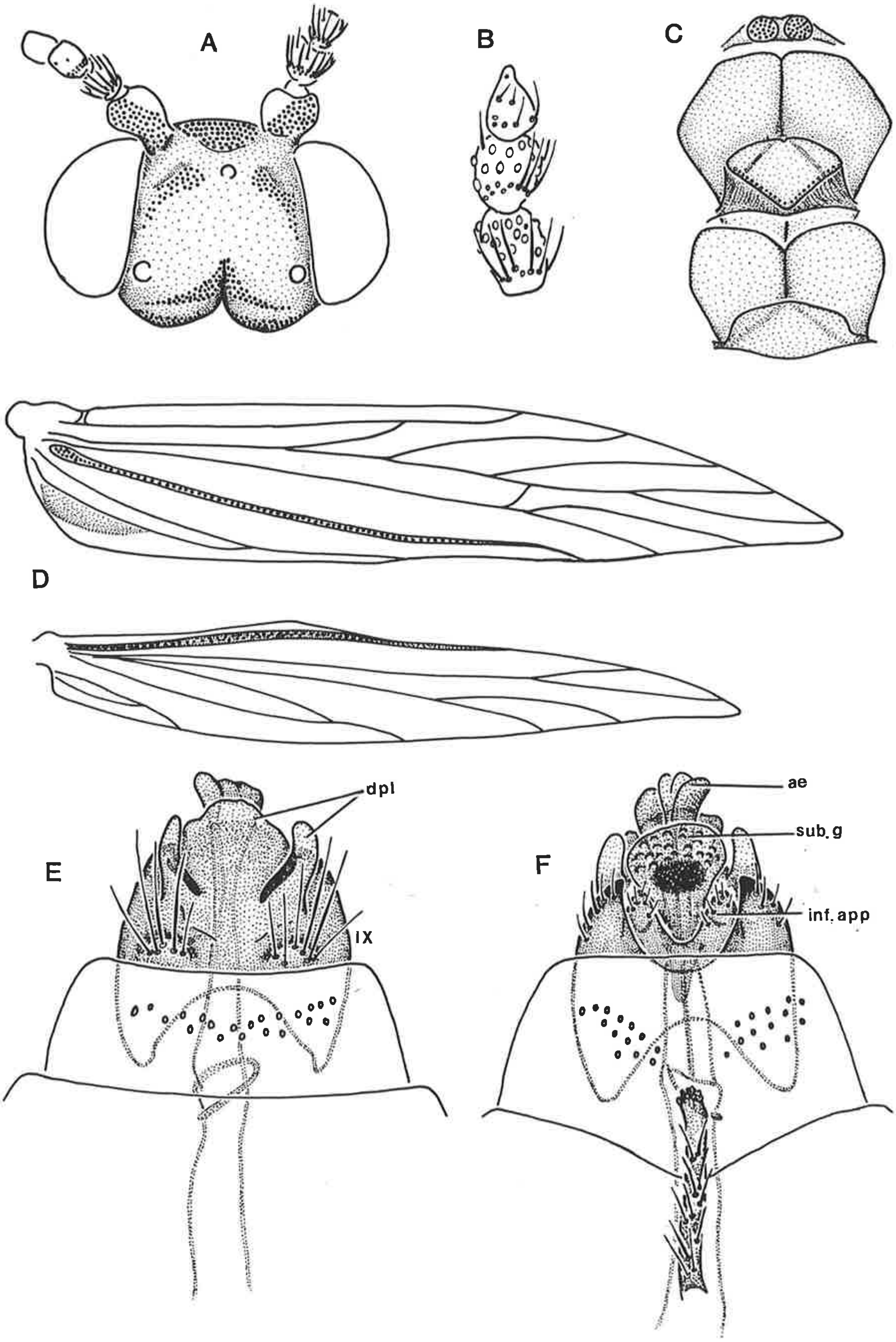


Plate 37A–F. *Tricholeiochiton fidelis* Wells, male: A, head, dorsal view; B, antenna, three terminal segments; C, thorax, dorsal view; D, wings; E,F, genitalia, dorsal and ventral views.

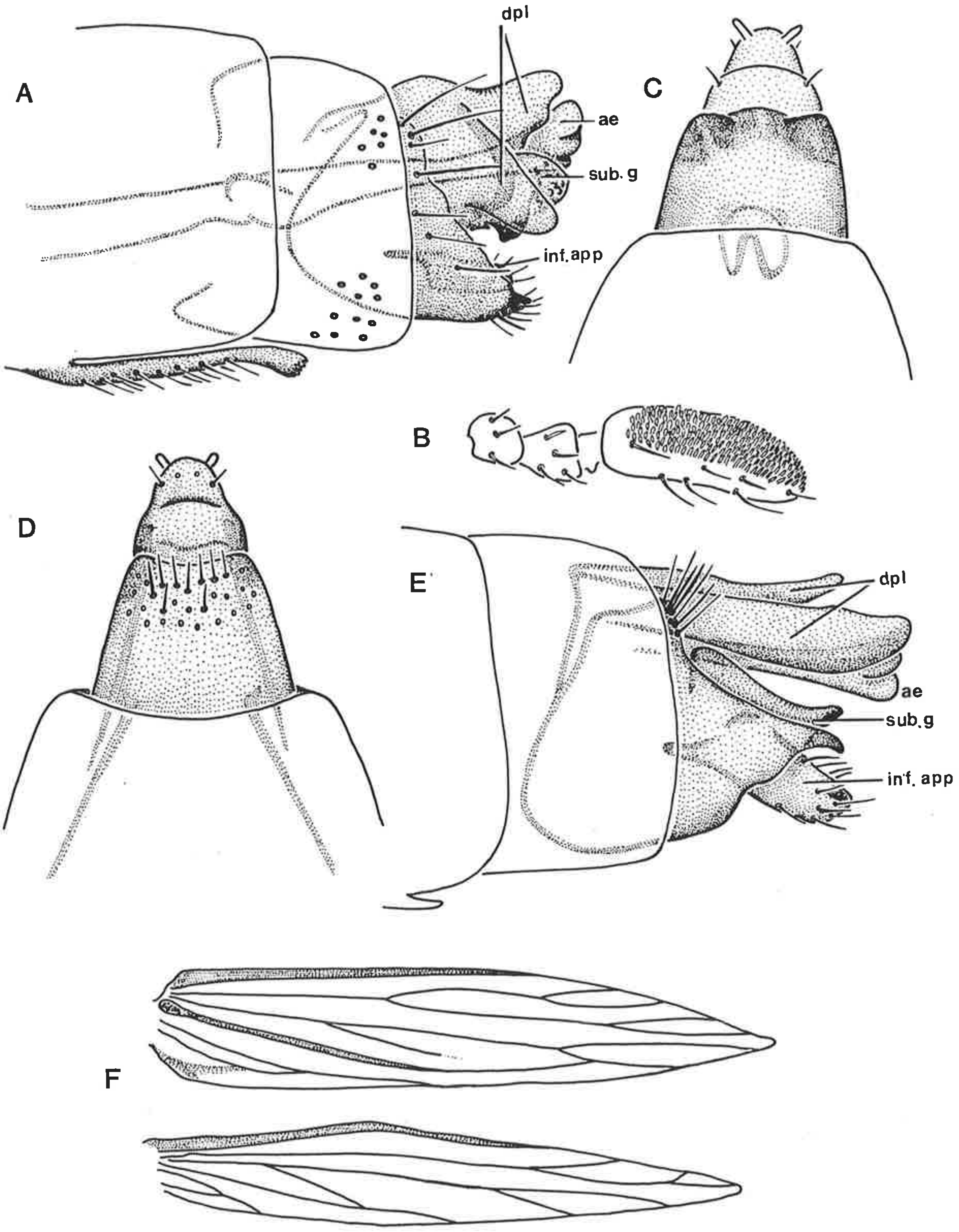


Plate 38A-F. A-D, Tricholeiochiton fidelis Wells: A, male genitalia, lateral view; B, female labial palp; C,D, female genitalia, ventral and dorsal views. E,F, T. tridens Wells, male: E, male genitalia, lateral view; F, wings.

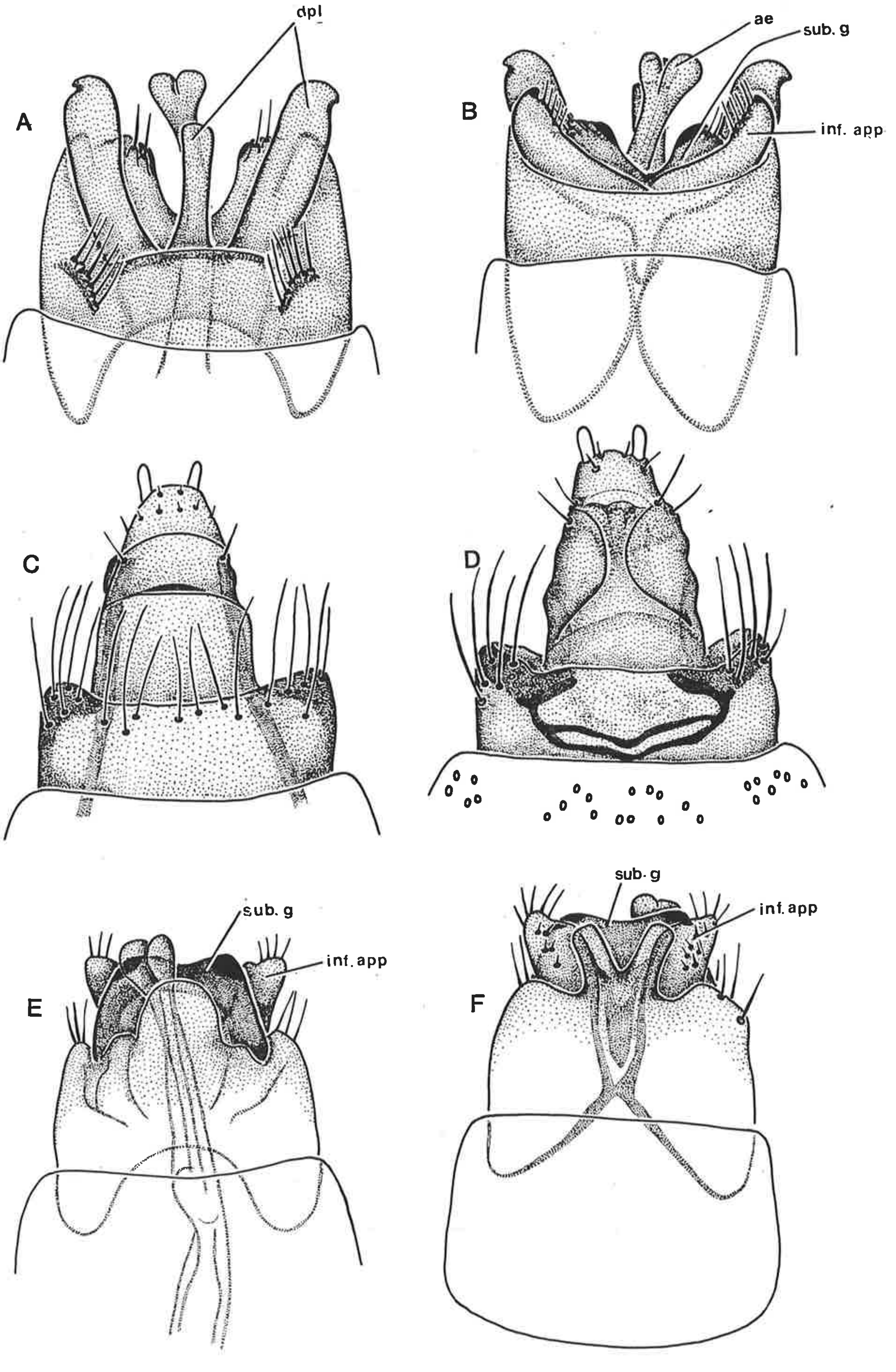


Plate 39A–F. A–D, *Tricholeiochiton tridens* Wells: A,B, male genitalia, dorsal and ventral views; C,D, female genitalia, dorsal and ventral views.
E,F, *T. bifurca* Wells, male genitalia, dorsal and ventral views.

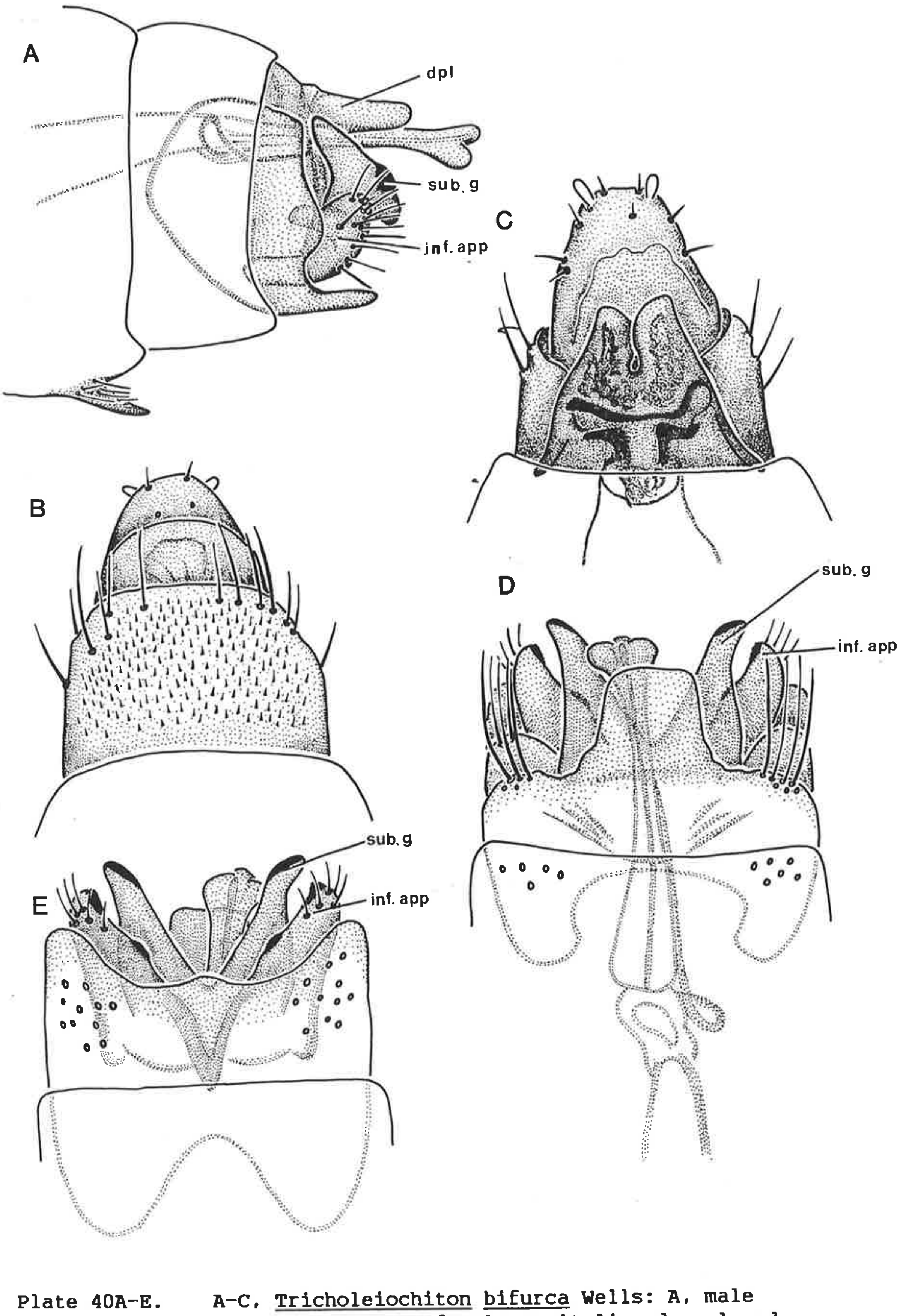


Plate 40A–E. A–C, *Tricholeiochiton bifurca* Wells: A, male genitalia, lateral view; B,C, female genitalia, dorsal and ventral views.
D,E, *T. edmondsi* Wells, male genitalia, dorsal and ventral views.

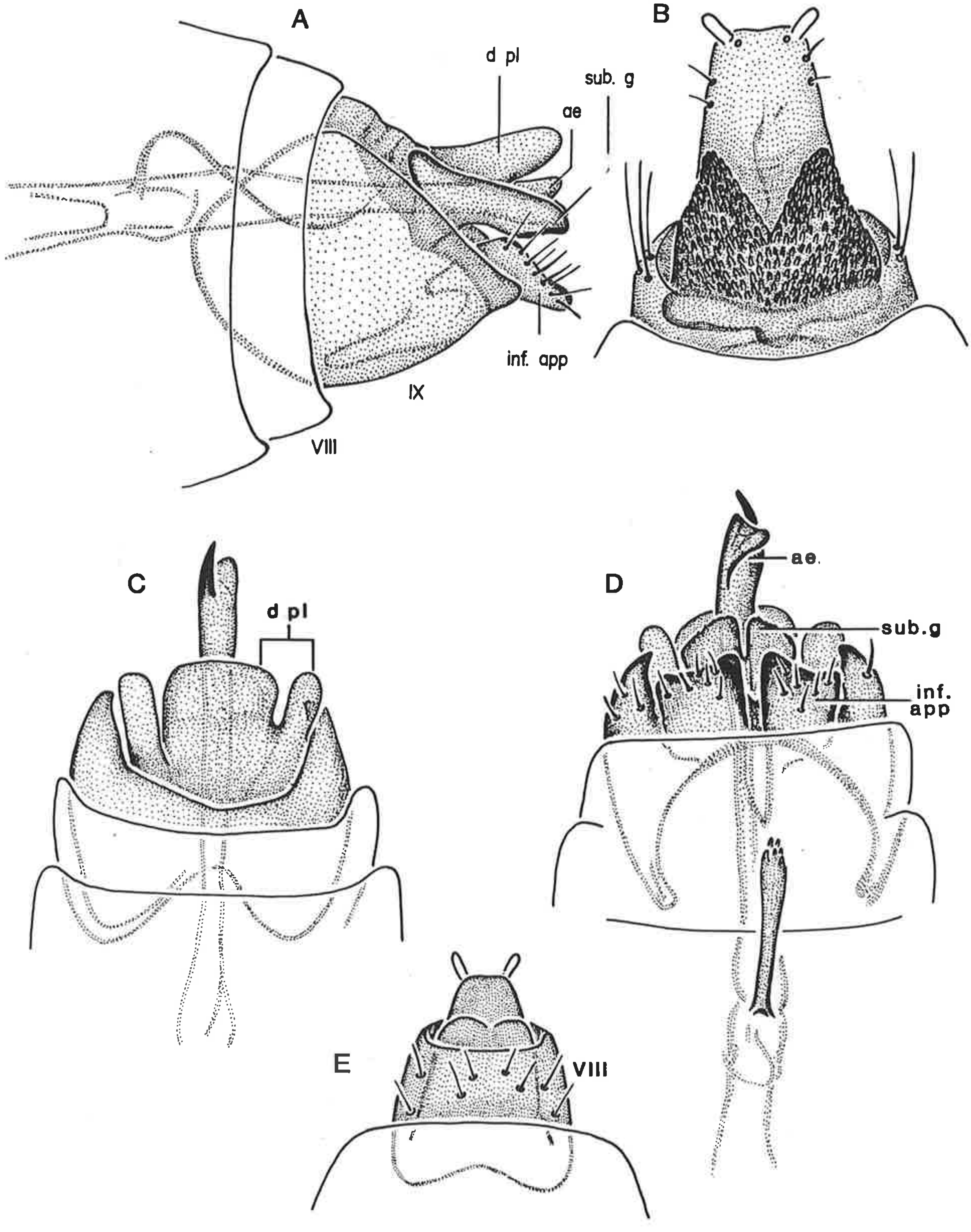


Plate 41A-E. A,B, *Tricholeiochiton edmondsi* Wells: A, male genitalia, lateral view; B, female genitalia, ventral view. C-E, *T. jabirella* Wells: C,D, male genitalia, dorsal and ventral views; E, female genitalia, ventral view.

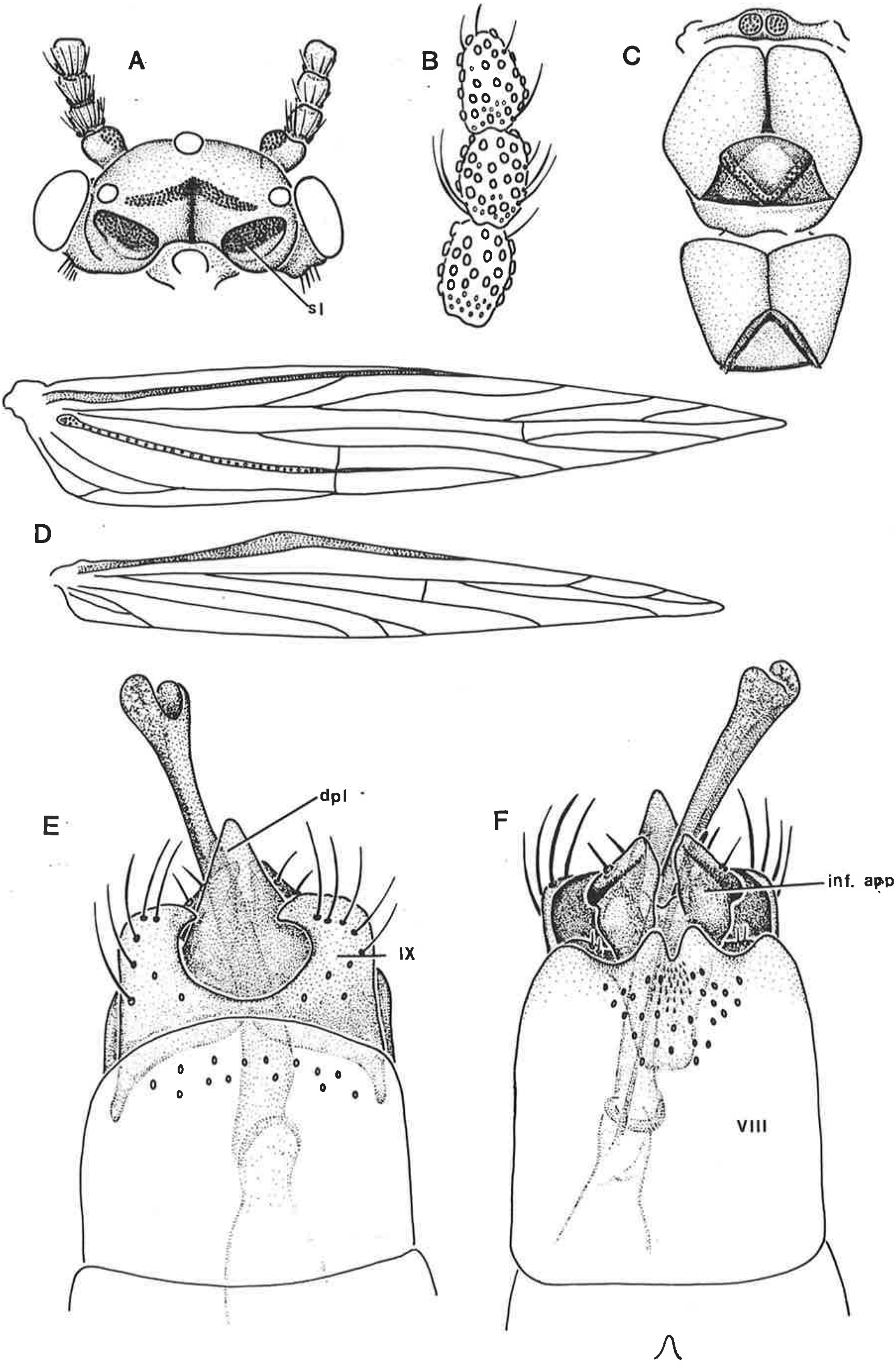


Plate 42A-F. *Orphninotrichia maculata* Mosely, male: A, head dorsal view; B, antenna, three terminal segments; C, thorax, dorsal view; D, wings; E,F, genitalia, dorsal and ventral views.

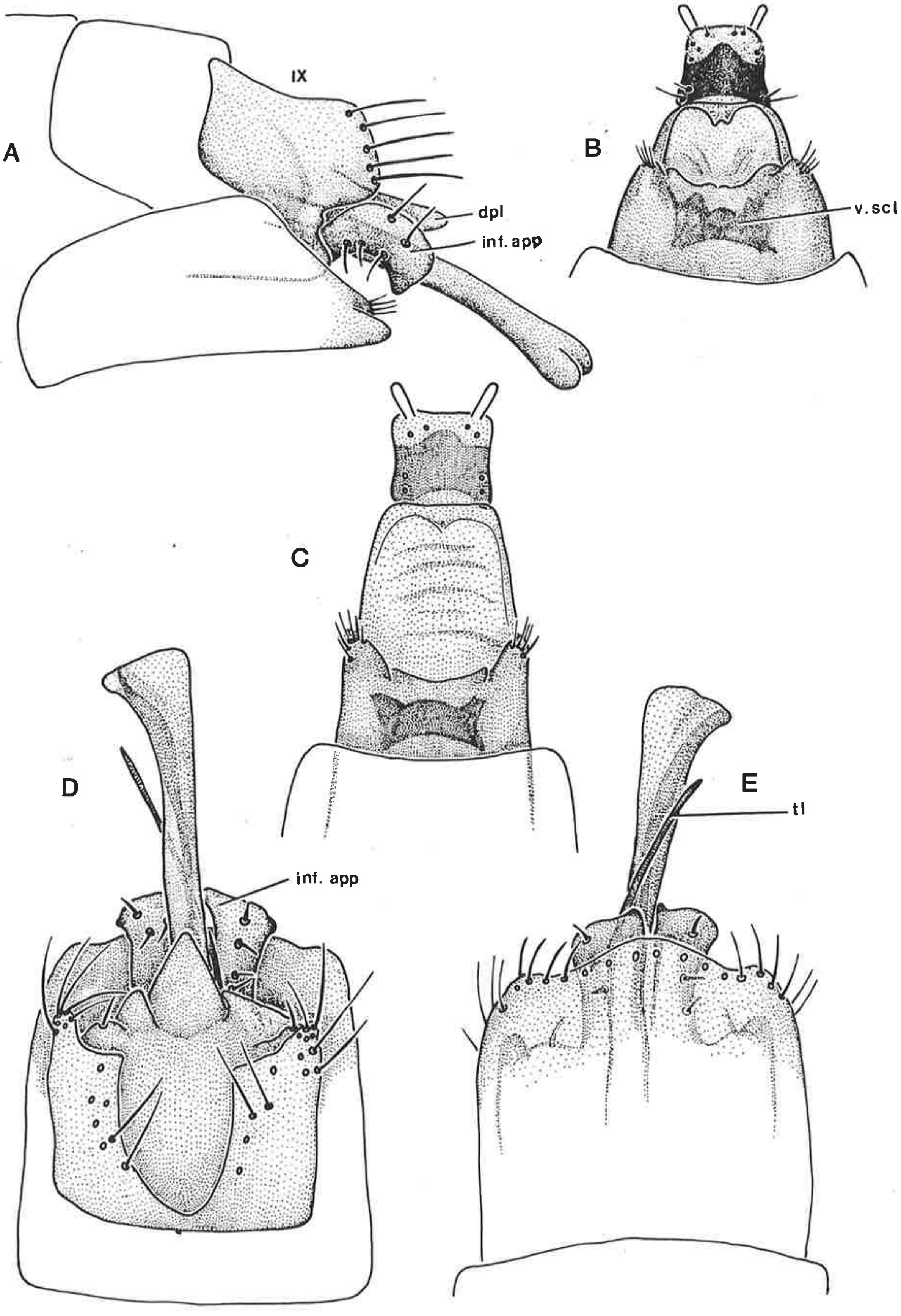


Plate 43A–E. A,B, *Orphninotrichia maculata* Mosely: A, male genitalia, lateral view; B, female genitalia, ventral view. C–E, *O. acta* Neboiss: C, female genitalia, ventral view; D,E, male genitalia, dorsal and ventral views.

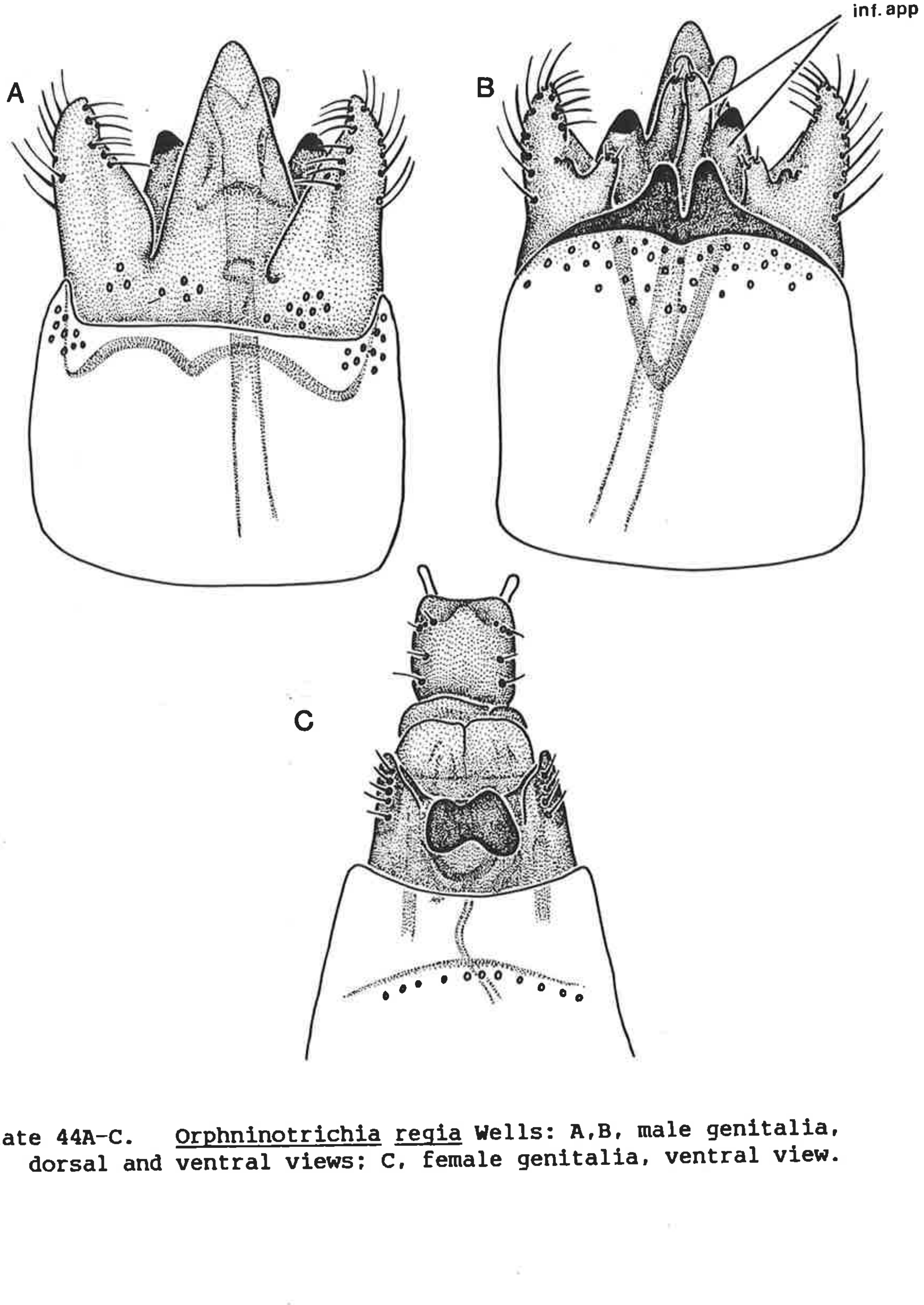


Plate 44A-C. *Orphninotrichia regia* Wells: A,B, male genitalia, dorsal and ventral views; C, female genitalia, ventral view.

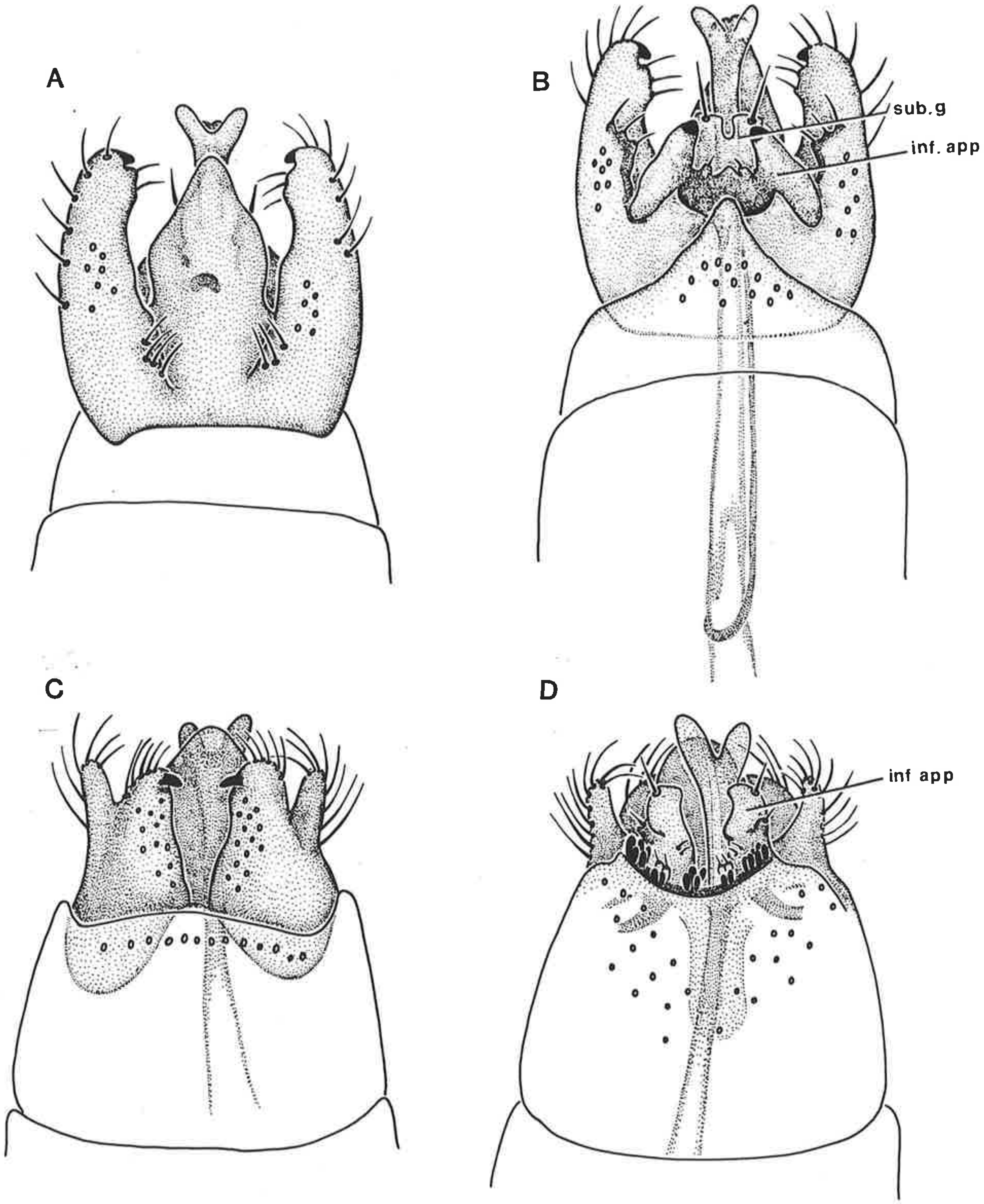


Plate 45A-D. A,B, <u>Orphninotrichia</u> <u>media</u> Wells, male genitalia, dorsal and ventral views.
C,D, <u>O</u>. <u>papillata</u> Wells, male genitalia, dorsal and ventral views.

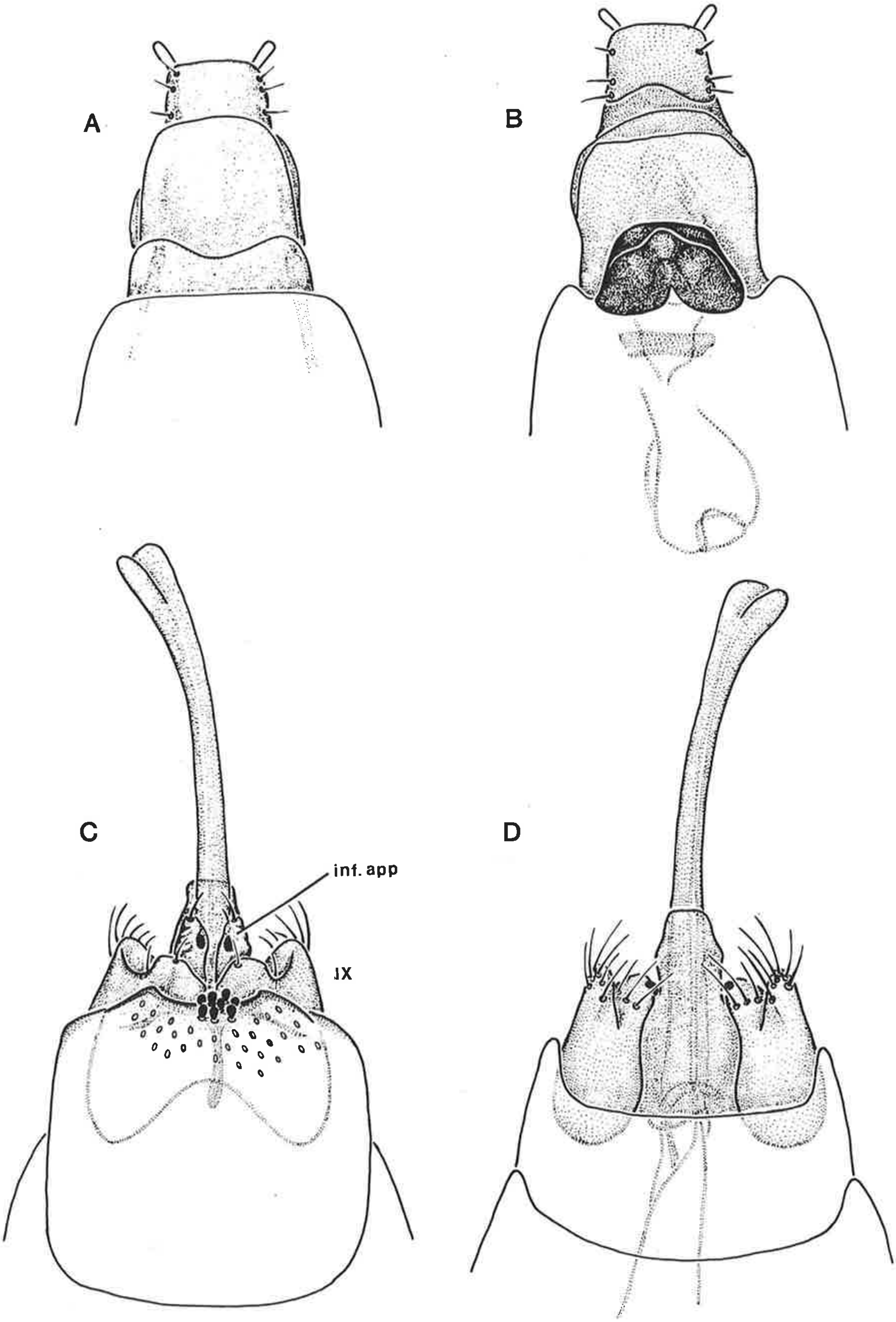


Plate 46A-D. A,B, Orphninotrichia papillata Wells, female genitalia, dorsal and ventral views.
C,D, O. silicis Wells, male genitalia, ventral and dorsal views.

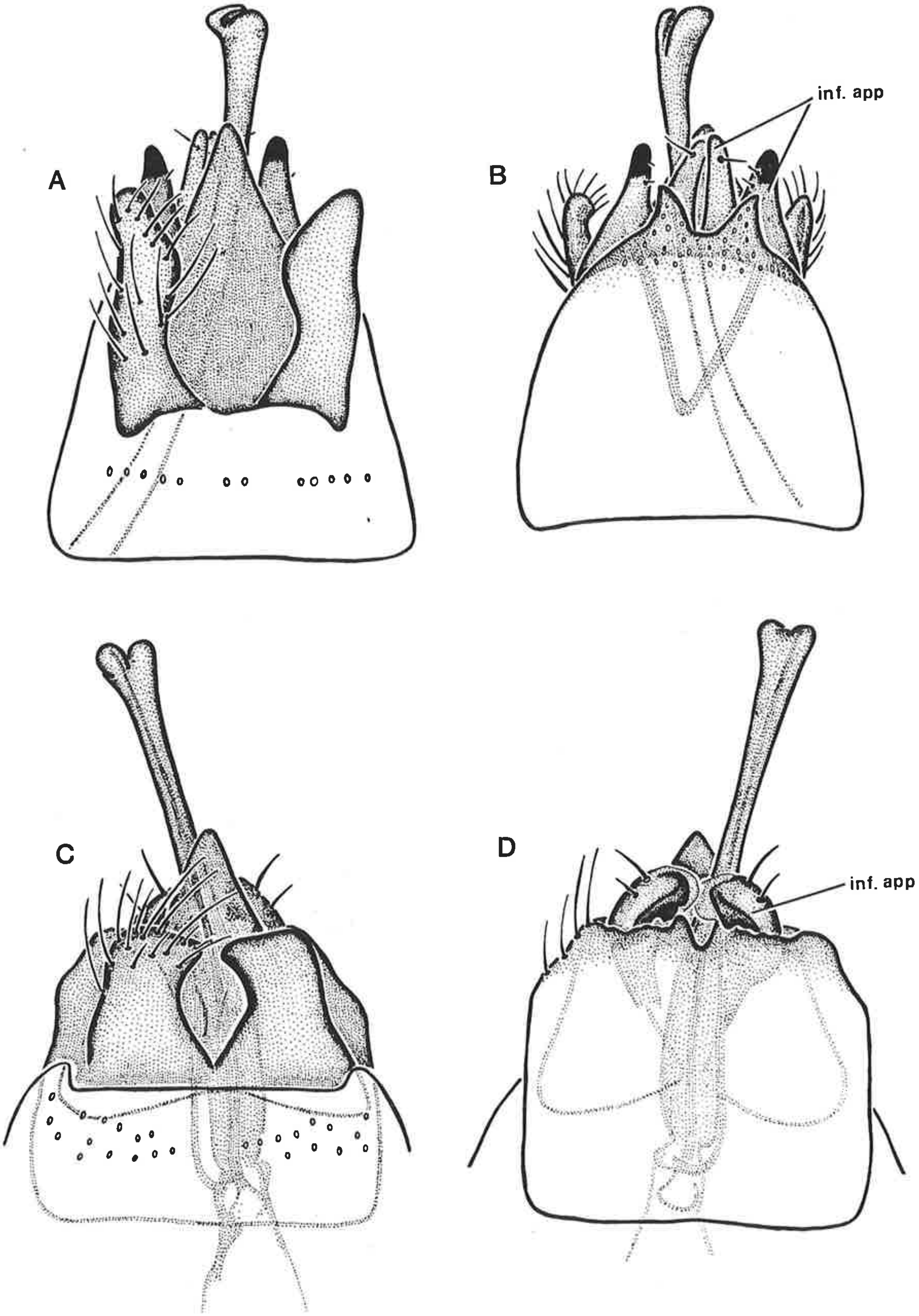


Plate 47A-D. A,B, Orphninotrichia justini Wells, male genitalia, dorsal and ventral views.
C,D, O. benambrica Wells, male genitalia, dorsal and ventral views.

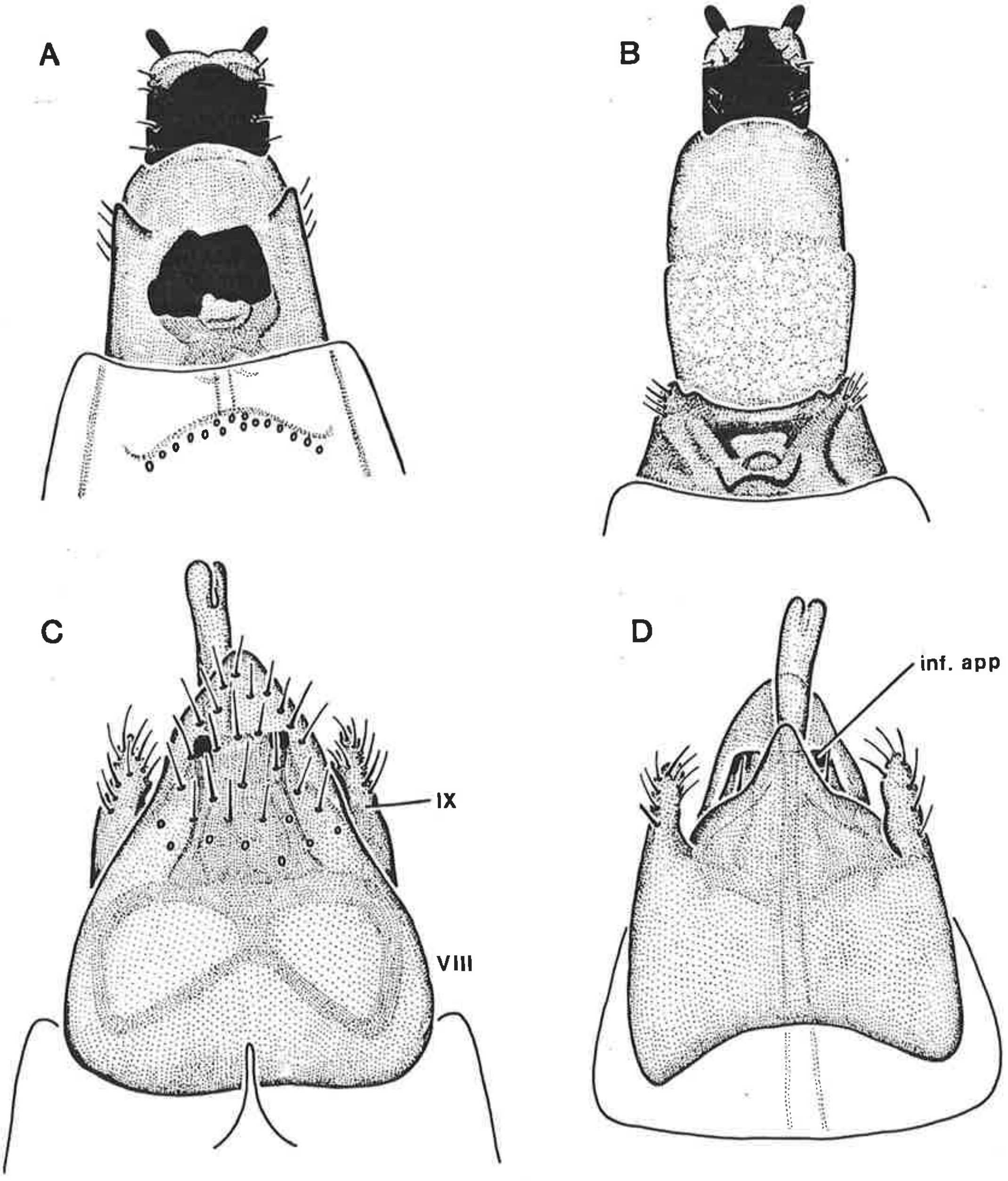


Plate 48A-D. A, <u>Orphninotrichia justini</u> Wells, female genitalia, ventral view.
B, <u>O</u>. <u>benambrica</u> Wells, female genitalia, ventral view.
C,D, <u>O</u>. <u>subulata</u> Wells, male genitalia, ventral and dorsal views.

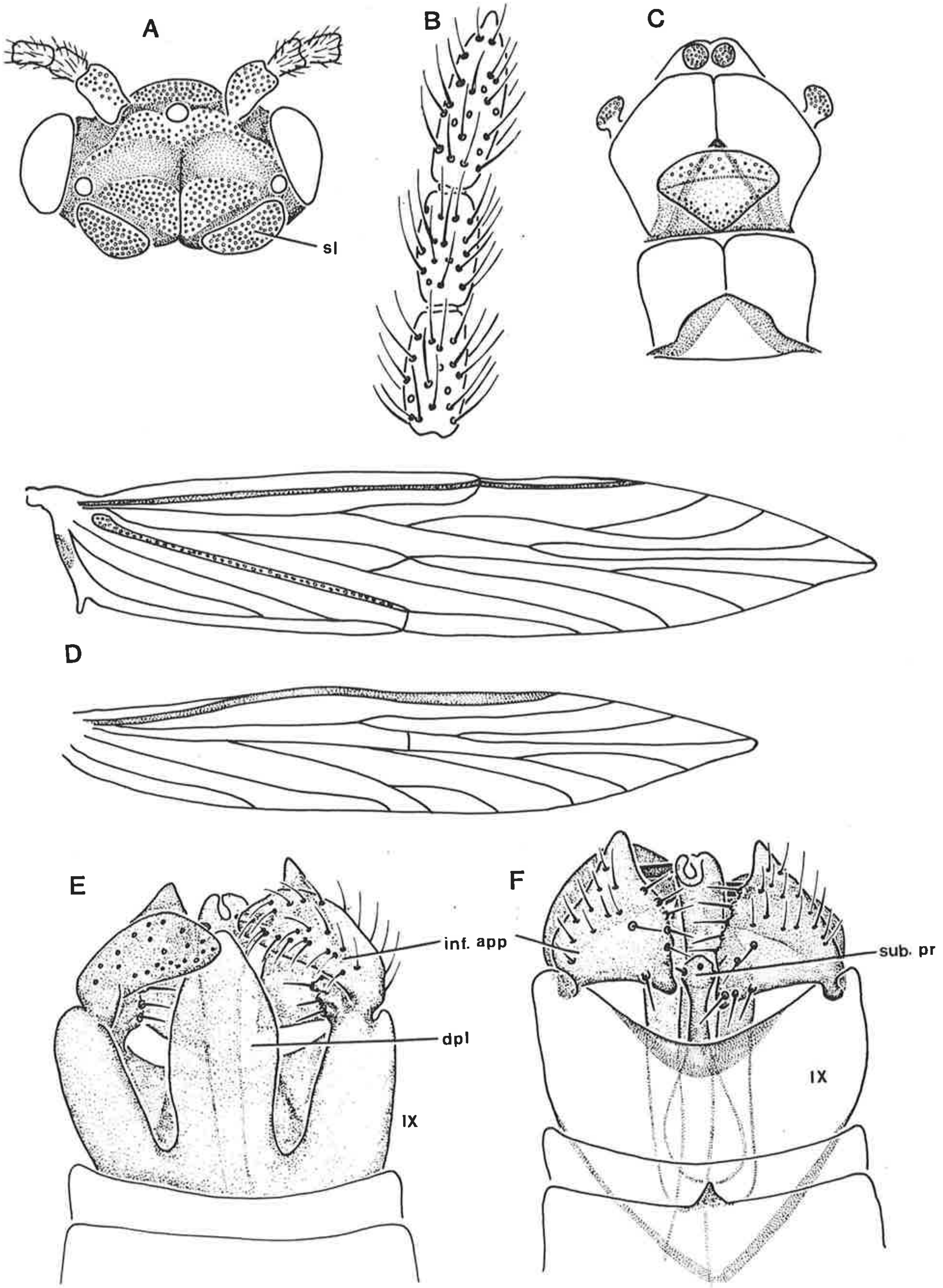


Plate 49A-F. Maydenoptila cuneola Neboiss, male:
A, head, dorsal view; B, antenna, three terminal segments; C, thorax, dorsal view; D, wings; E,F, genitalia, dorsal and ventral views.

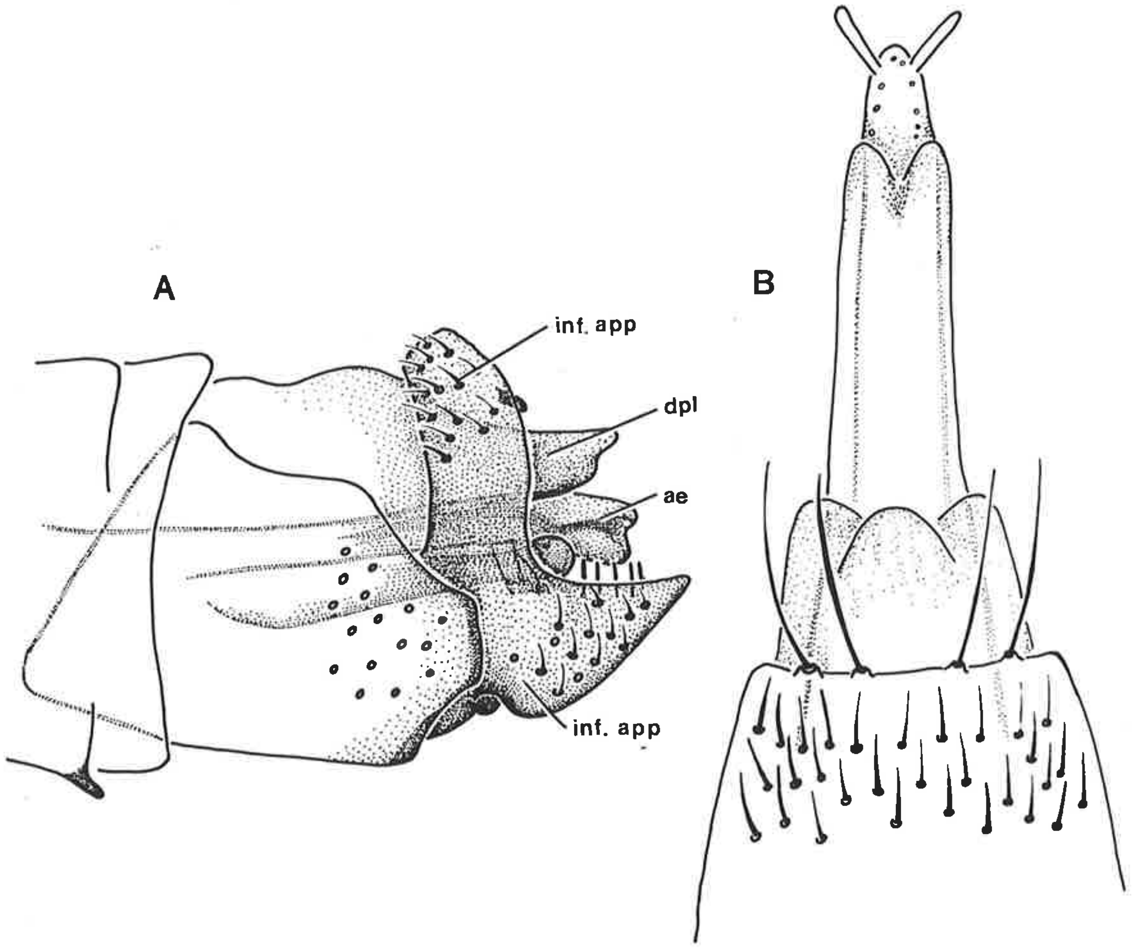


Plate 50A,B. *Maydenoptila cuneola* Neboiss: A, male genitalia, lateral view; B, female genitalia, ventral view.

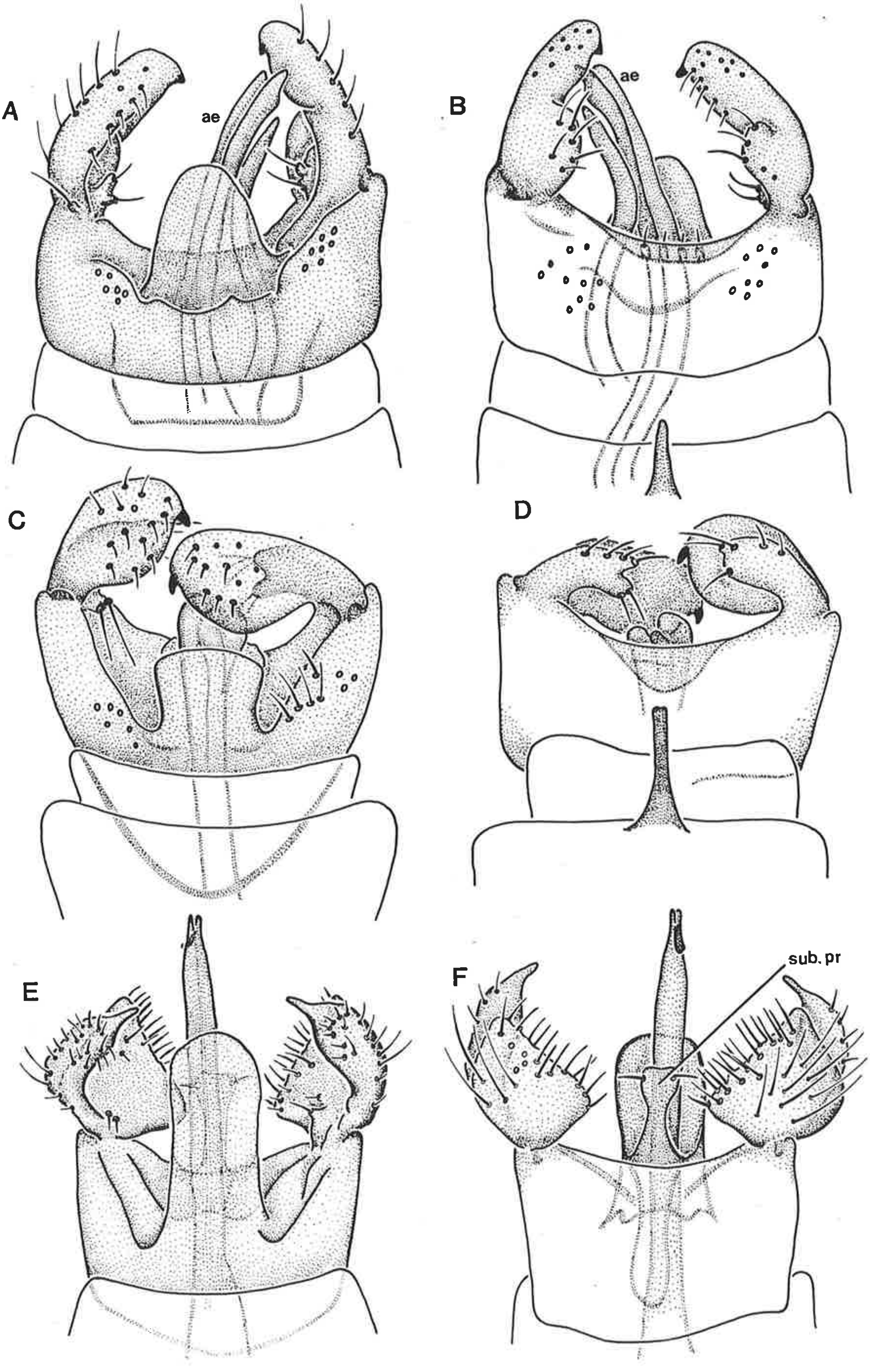


Plate 51A-F. A,B, *Maydenoptila explicata* Wells, male genitalia, dorsal and ventral views.
C,D, *M. commista* Wells, male genitalia, dorsal and ventral views.
E,F, *M. kurandica* Wells, male genitalia, dorsal and ventral views.

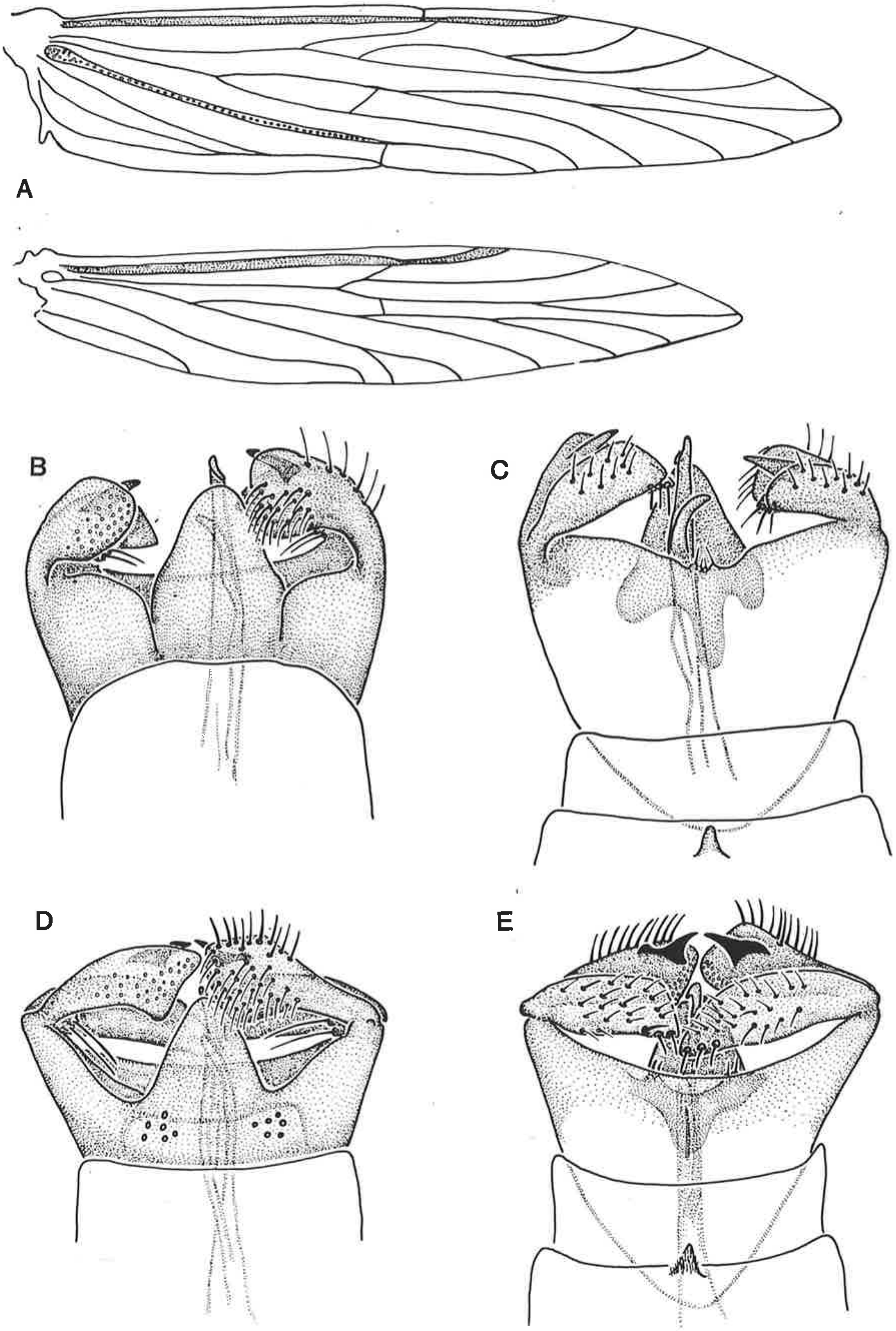


Plate 52A–E. *Maydenoptila rupina* Neboiss, male: A, wings; B,C, genitalia of specimen from type locality, dorsal and ventral views; D,E, genitalia of specimen from South Australia, dorsal and ventral views.

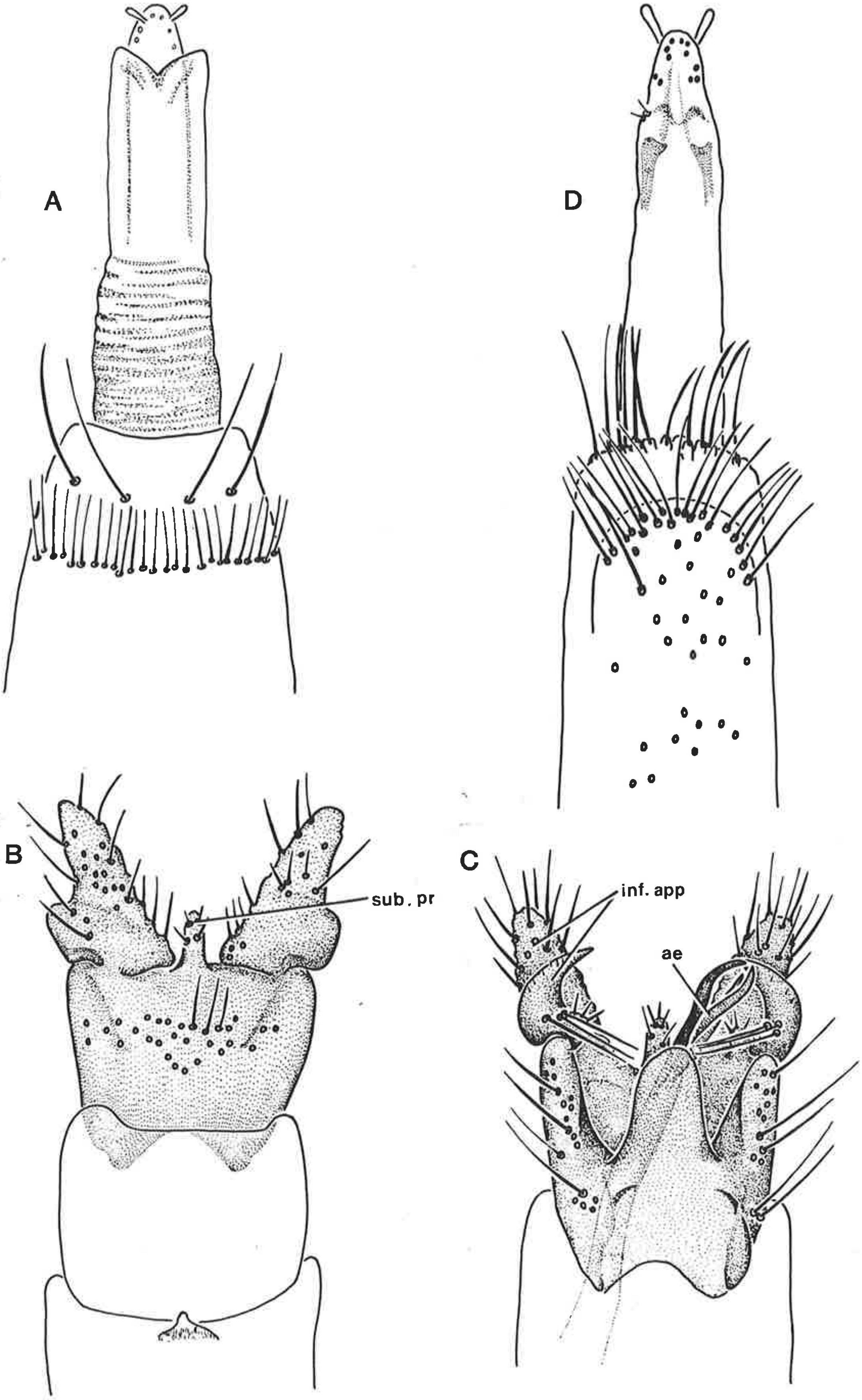


Plate 53A-D. A, Maydenoptila rupina Neboiss, female genitalia, ventral view. B-D, M. pseudorupina Wells: B,C, male genitalia, dorsal and ventral views; D, female genitalia, ventral view.

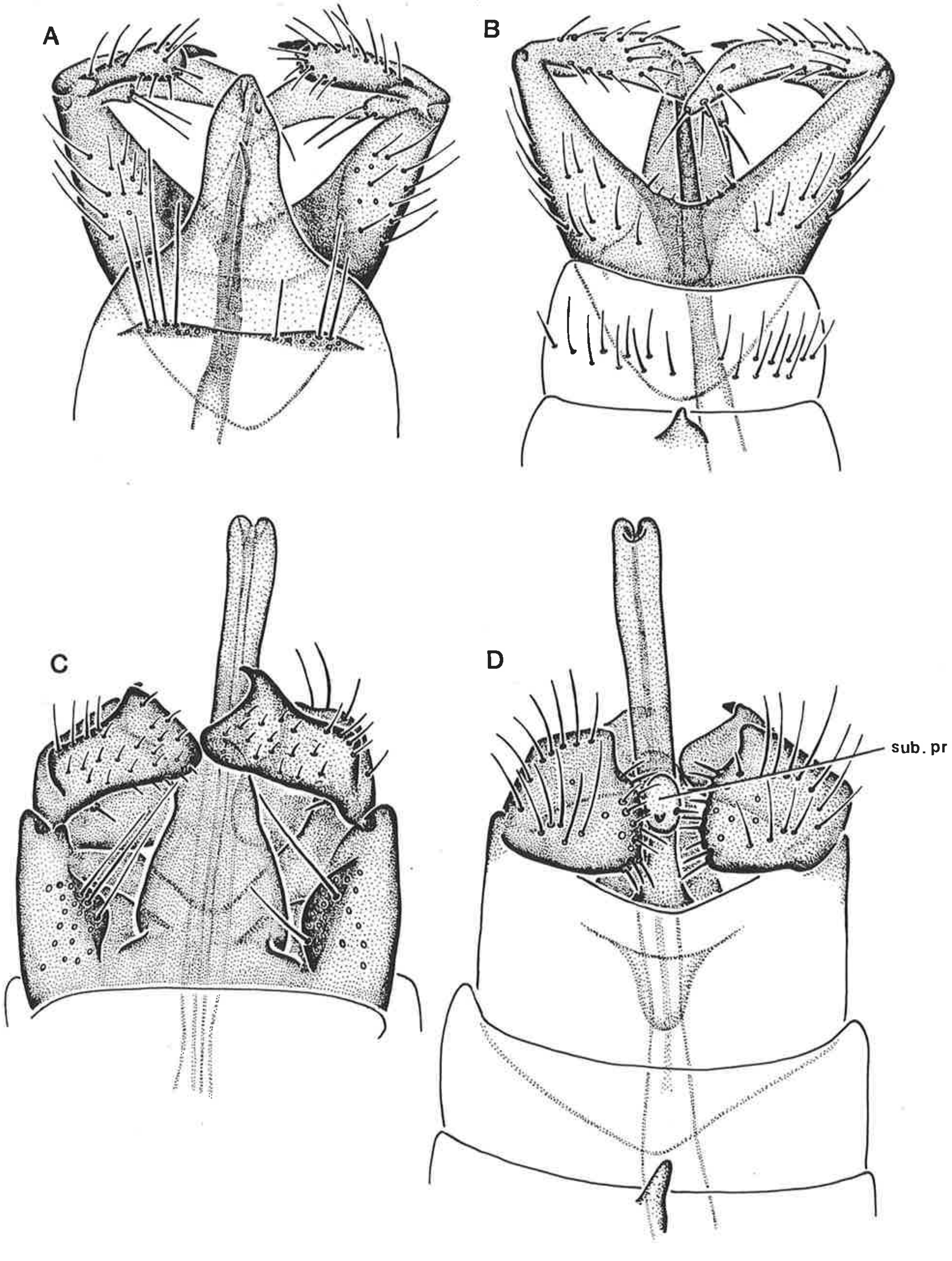


Plate 54A–D. A,B, Maydenoptila baynesi Wells, male genitalia, dorsal and ventral views.
C,D, M. antennifera Wells, male genitalia, dorsal and ventral views.

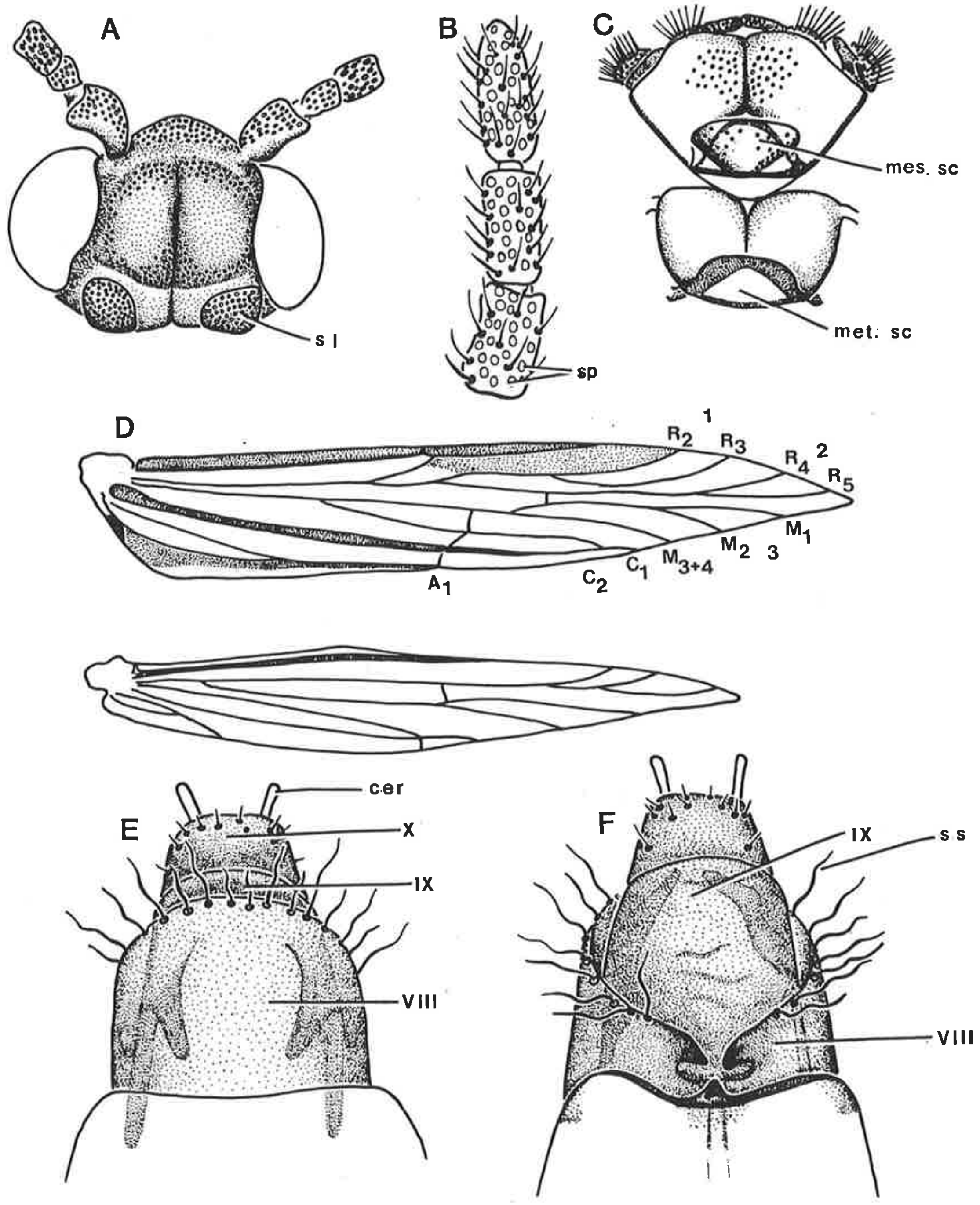


Plate 55A-F. *Orthotrichia adornata* Wells: A, male head, dorsal view; B, male antenna, three terminal segments; C, male thorax, dorsal view; D, male wings; E,F, female genitalia, dorsal and ventral views.

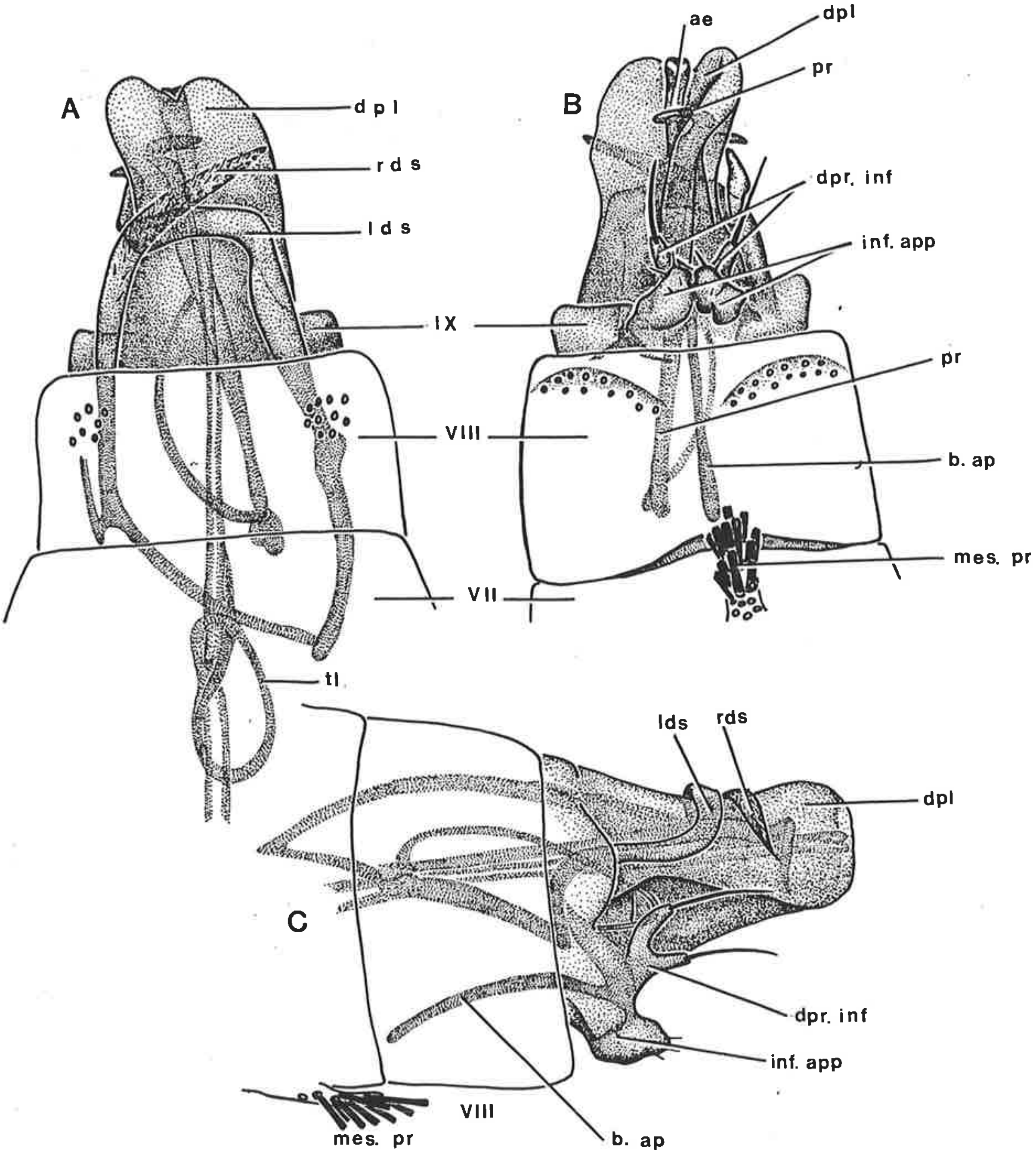


Plate 56A-C. Orthotrichia adornata Wells, male genitalia, dorsal, ventral and lateral views.

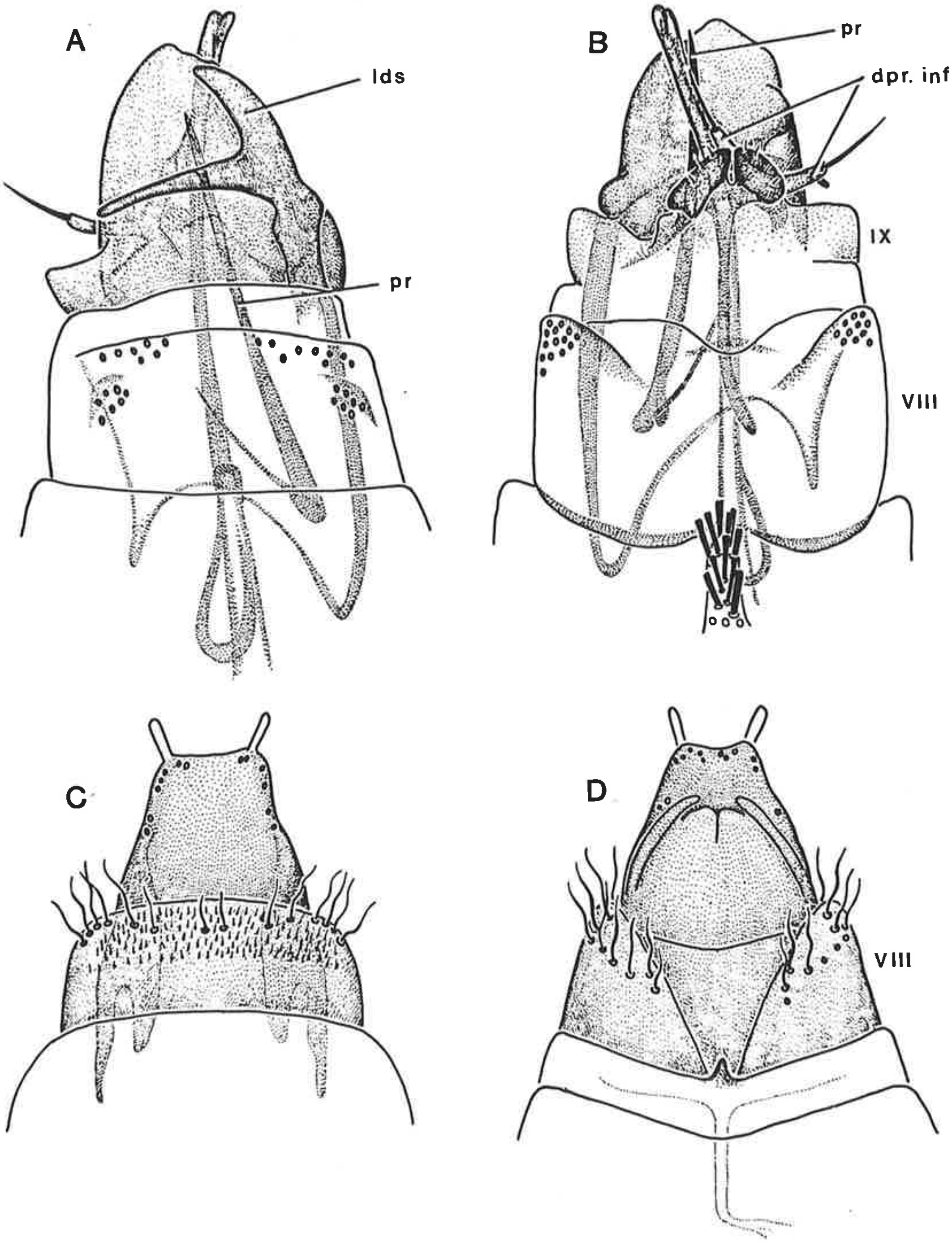


Plate 57A-D. Orthotrichia zonata (Neboiss): A,B, male genitalia, dorsal and ventral views; C,D, female genitalia, dorsal and ventral views.

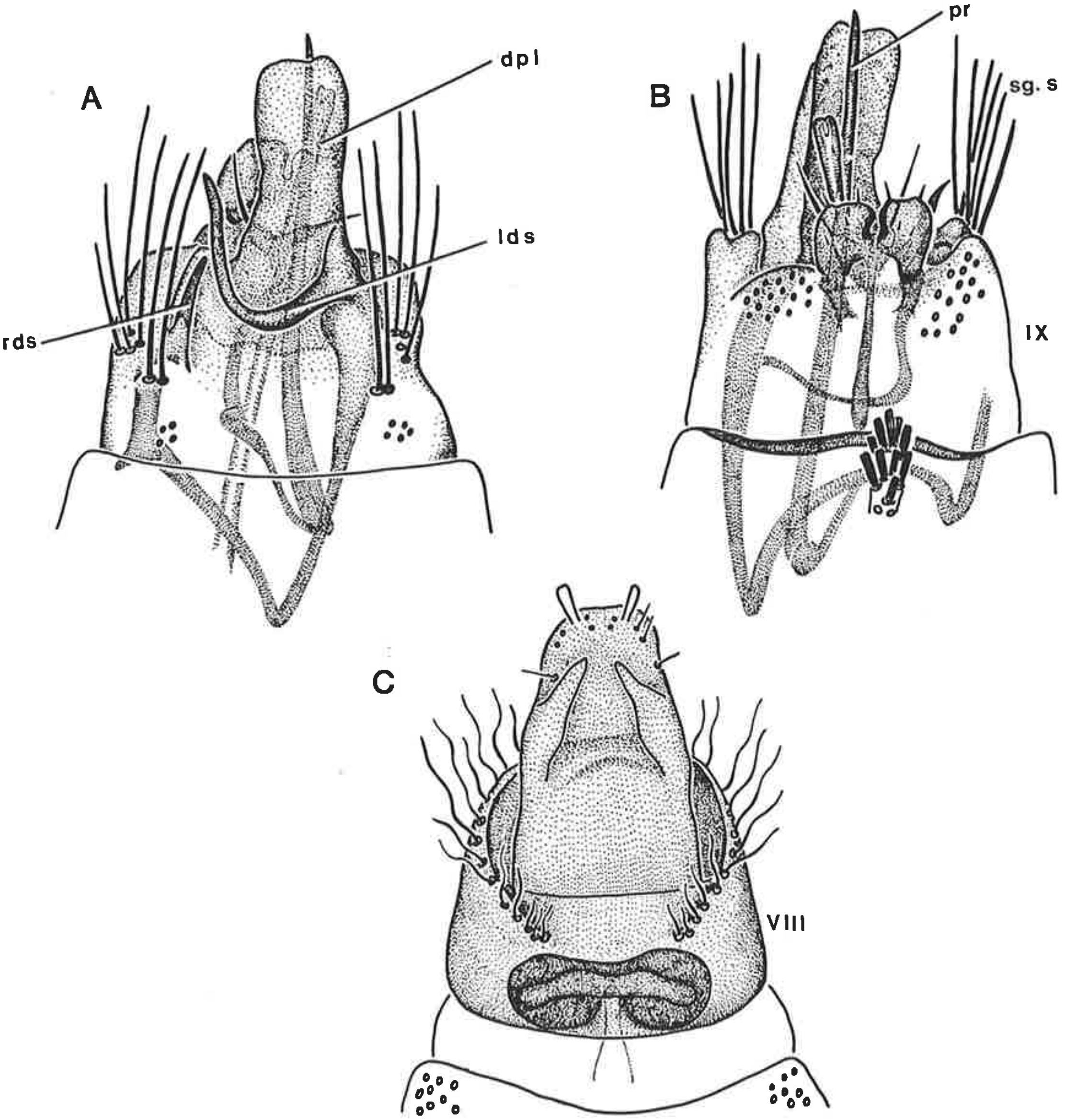


Plate 58A–C. *Orthotrichia atraseta* Wells: A,B, male genitalia, dorsal and ventral views; C, female genitalia, ventral view.

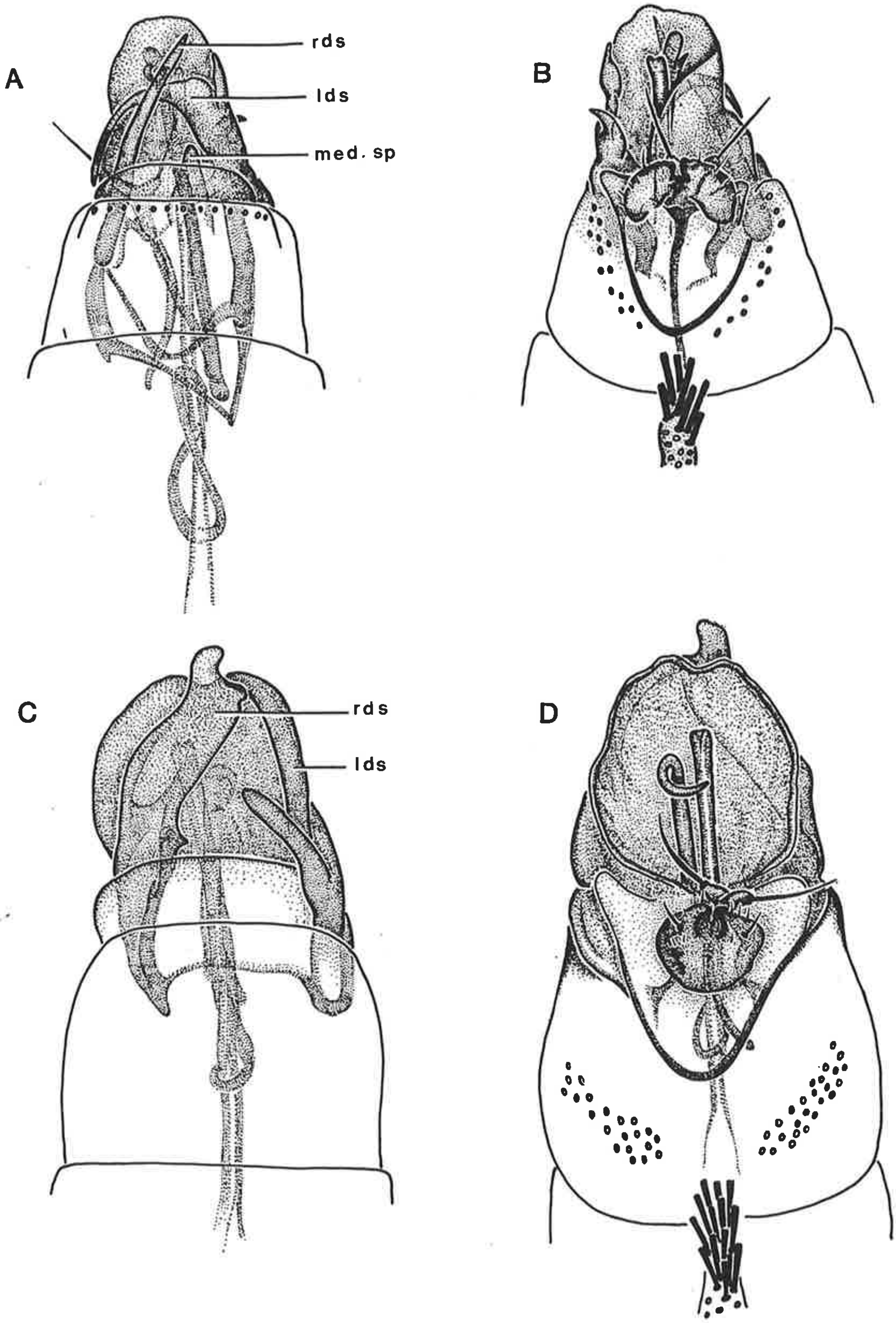


Plate 59A-D. A,B, *Orthotrichia armata* Wells, male genitalia, dorsal and ventral views.
C,D, *O. bishopi* Wells, male genitalia, dorsal and ventral views.

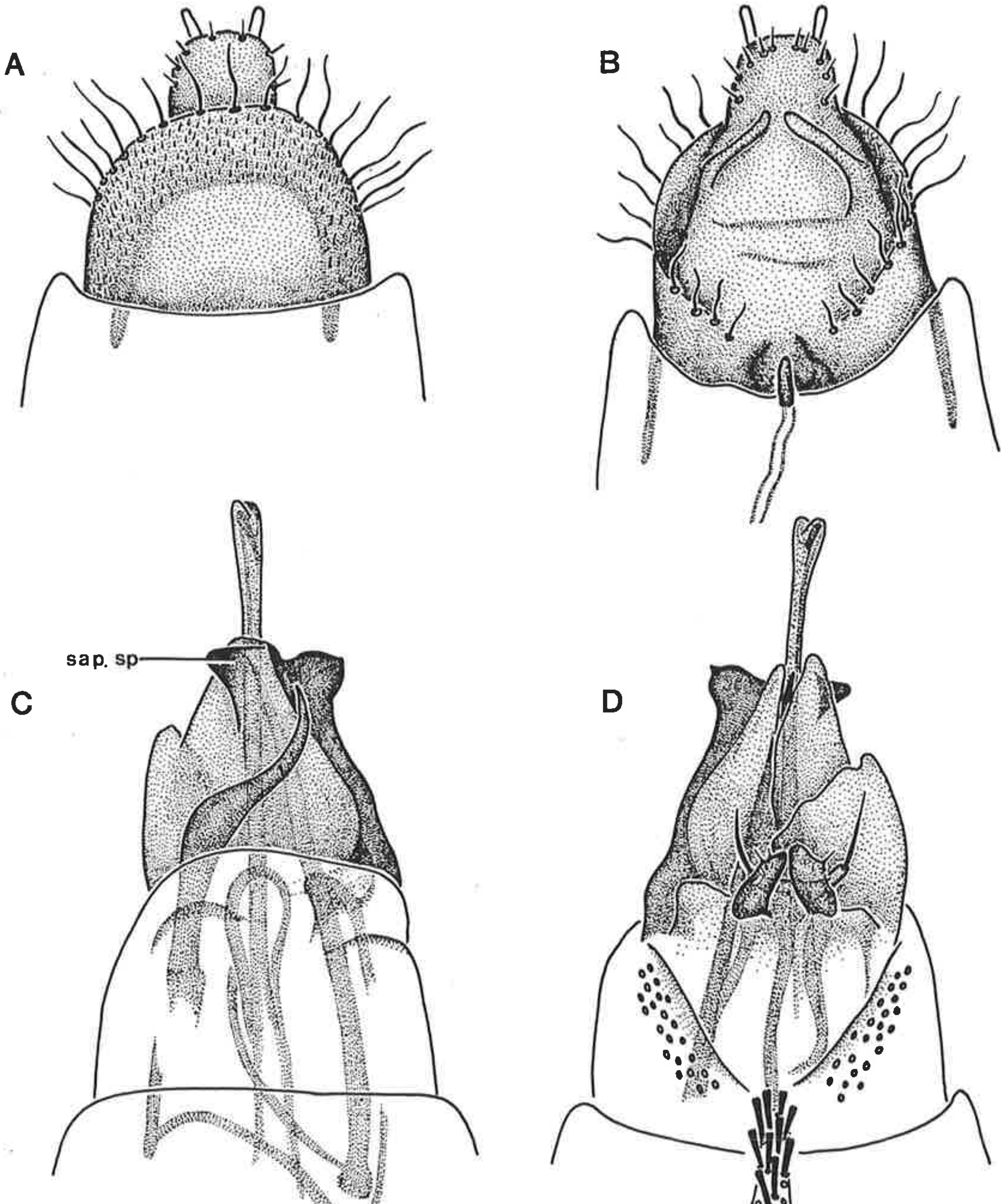


Plate 60A-D. A,B, <u>Orthotrichia</u> <u>bishopi</u> Wells, female genitalia, dorsal and ventral views.
C,D, <u>O</u>. <u>orbostensis</u> Wells, male genitalia dorsal and ventral views.

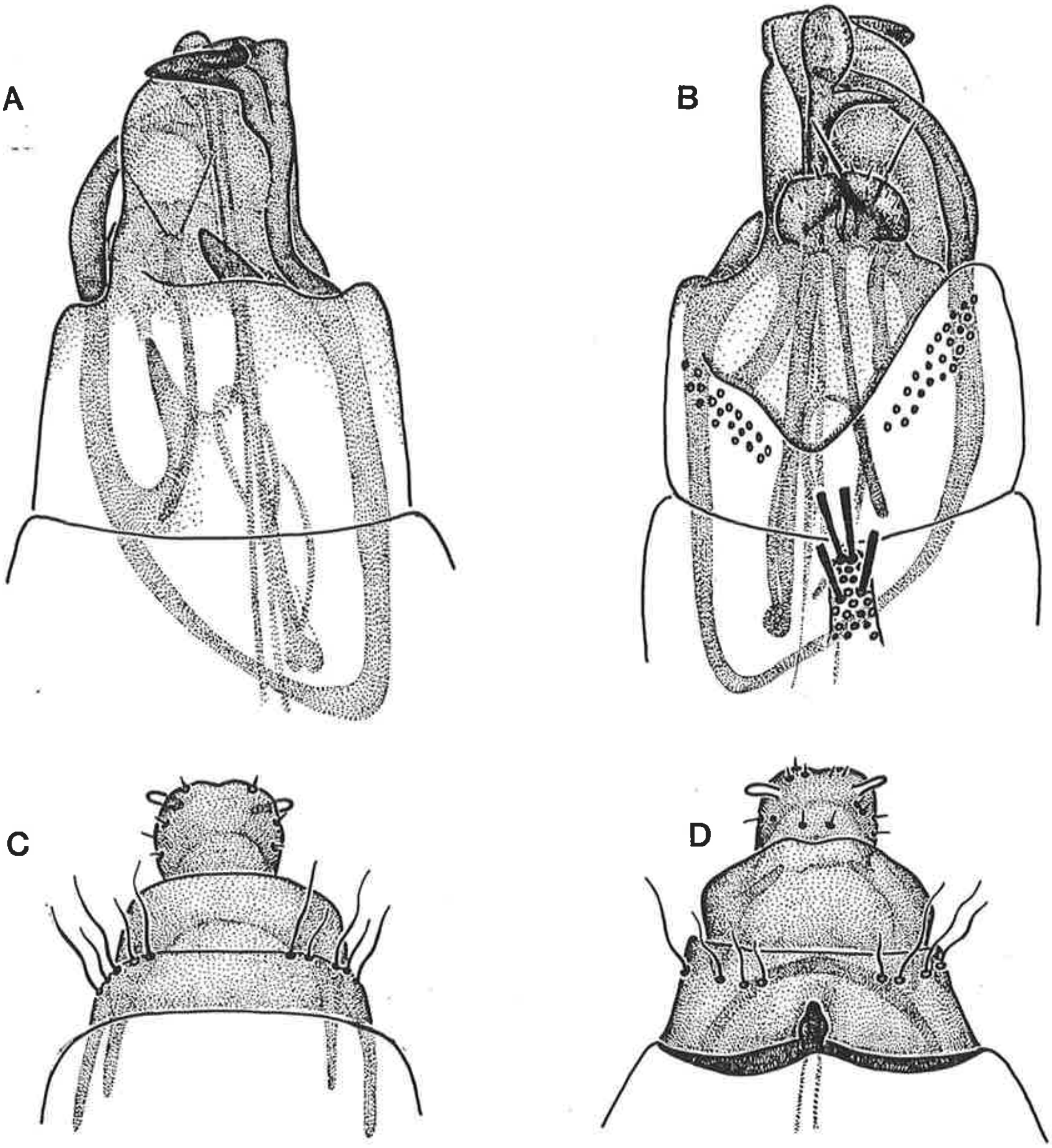


Plate 61A-D. *Orthotrichia rostrata* Wells: A,B, male genitalia, dorsal and ventral views; C,D, female genitalia, dorsal and ventral views.

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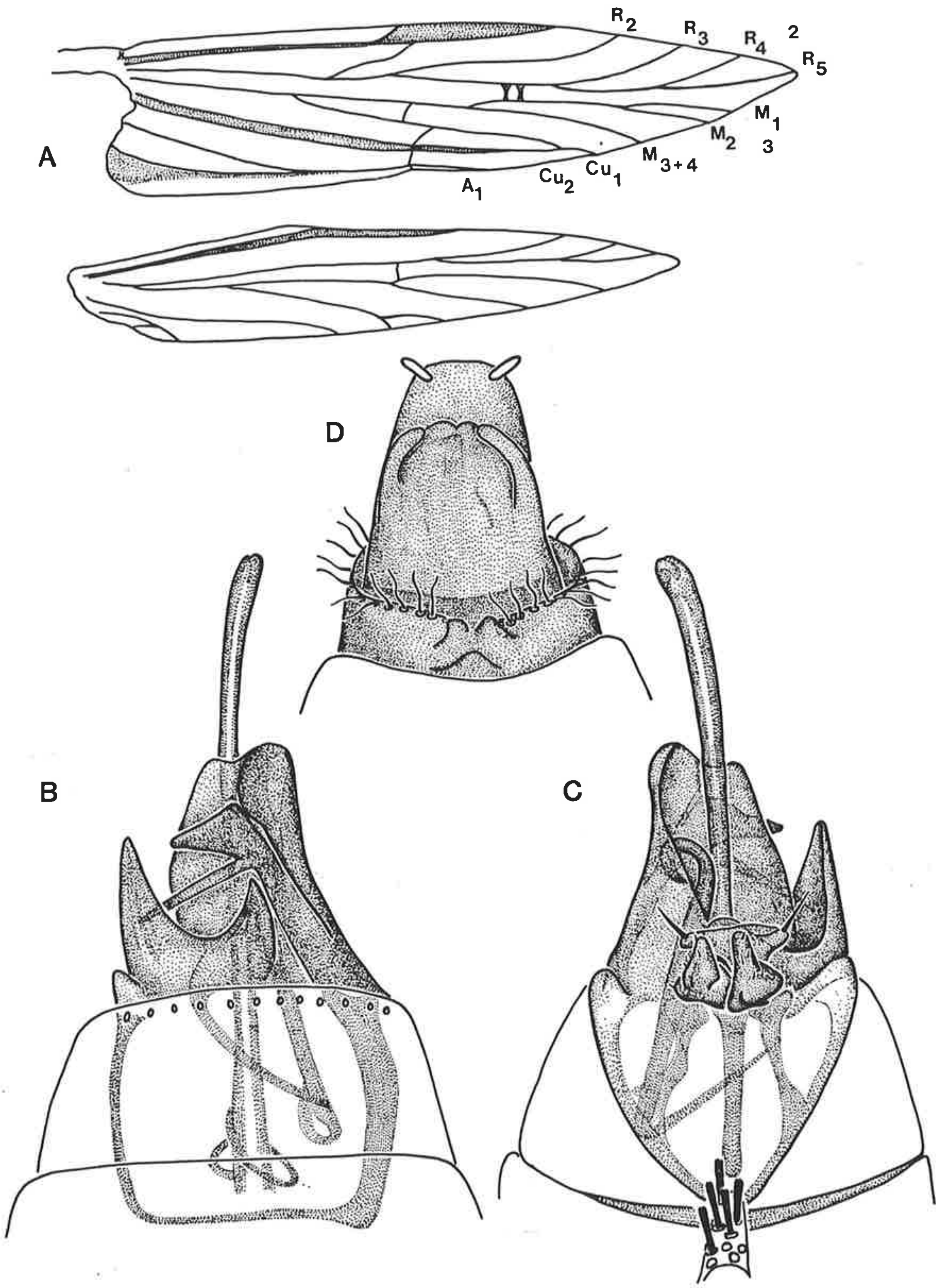


Plate 62A-D. Orthotrichia scutata Wells: A, male wings; B,C, male genitalia, dorsal and ventral views; D, female genitalia, ventral view.

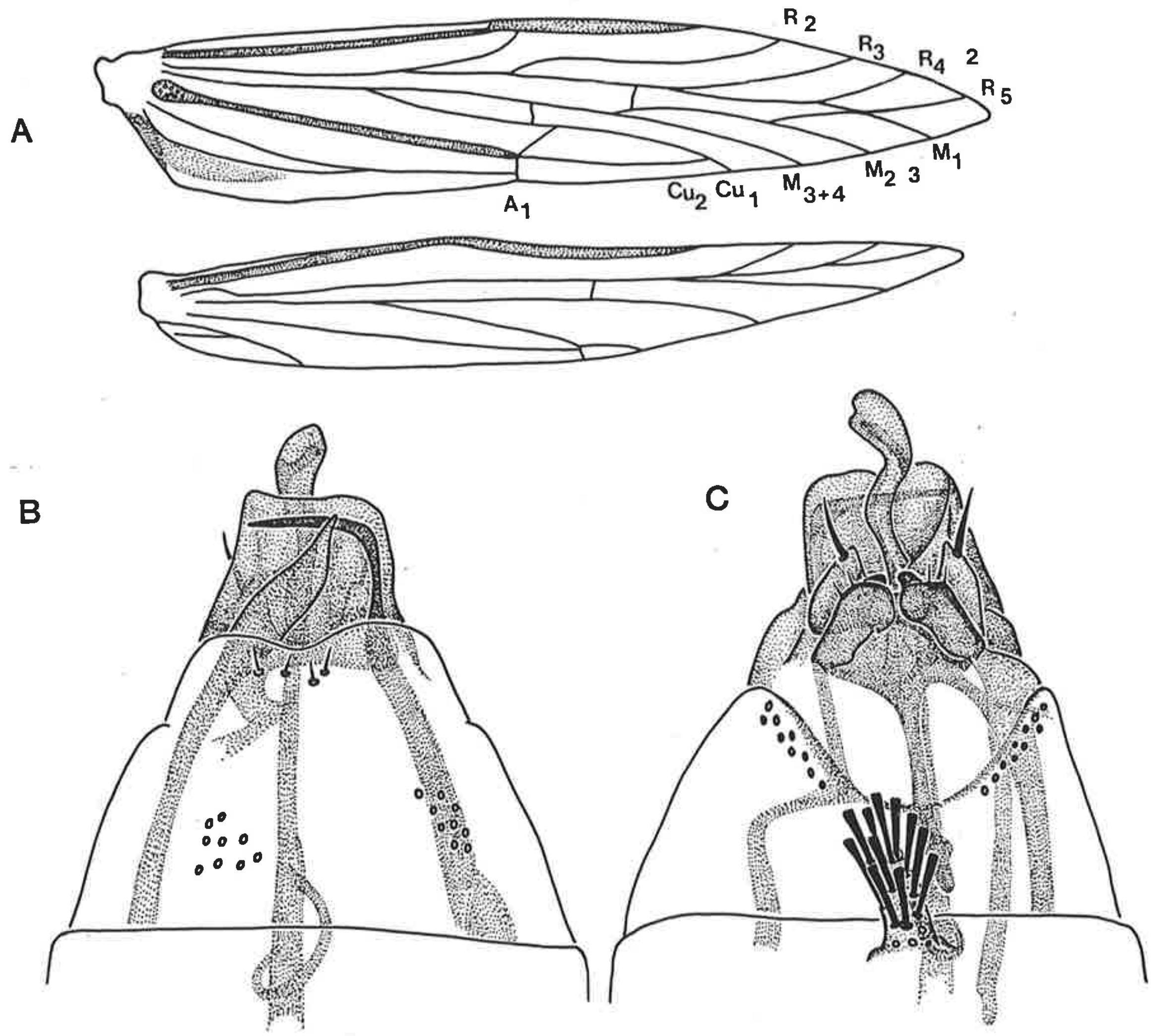


Plate 63A–C. *Orthotrichia turrita* Wells, male: A, wings; B,C, male genitalia, dorsal and ventral views.

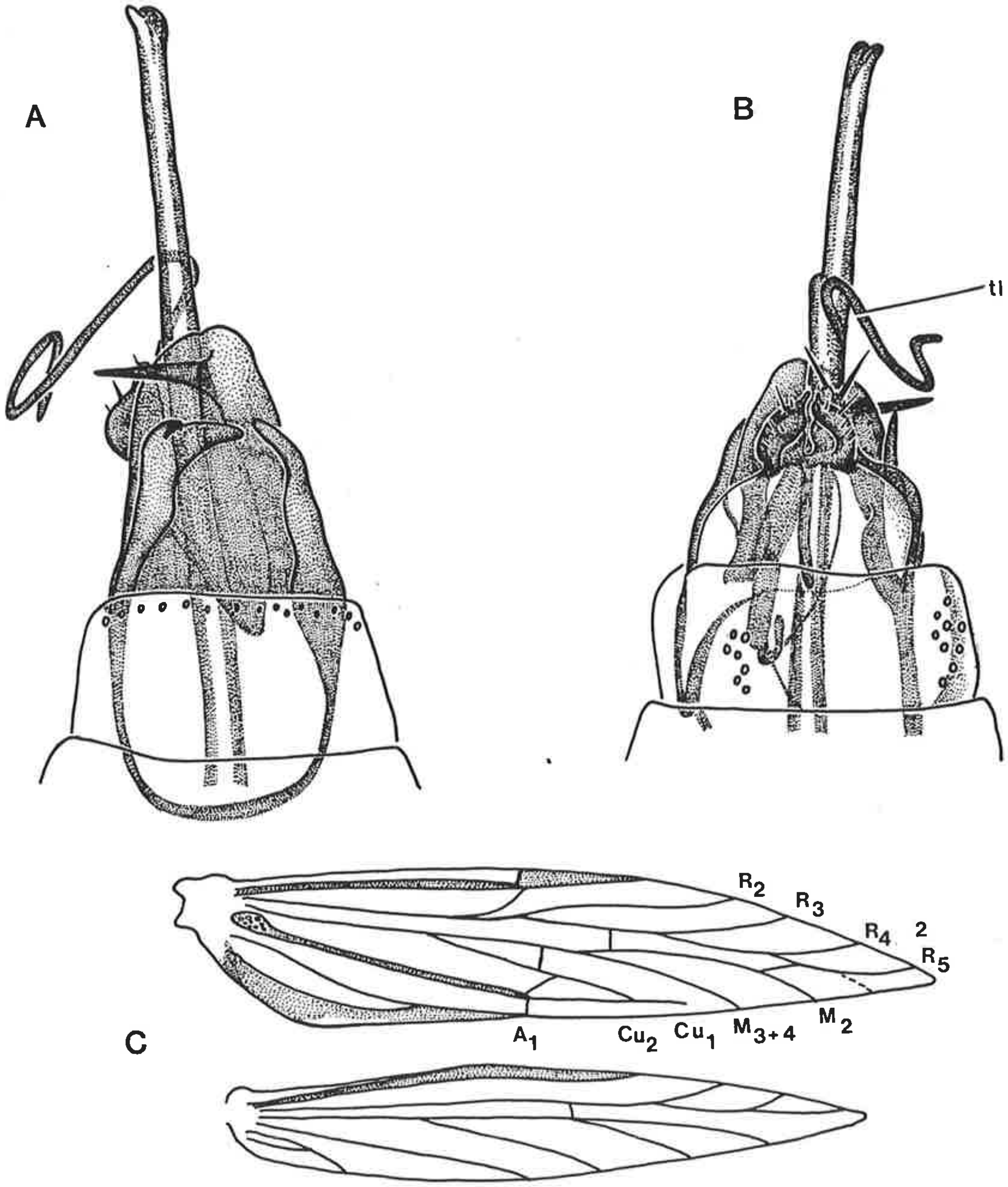


Plate 64A-C. A,B, *Orthotrichia bullata* Wells, male genitalia, dorsal and ventral views.
C, *O. aculaeta* Wells, male wings.

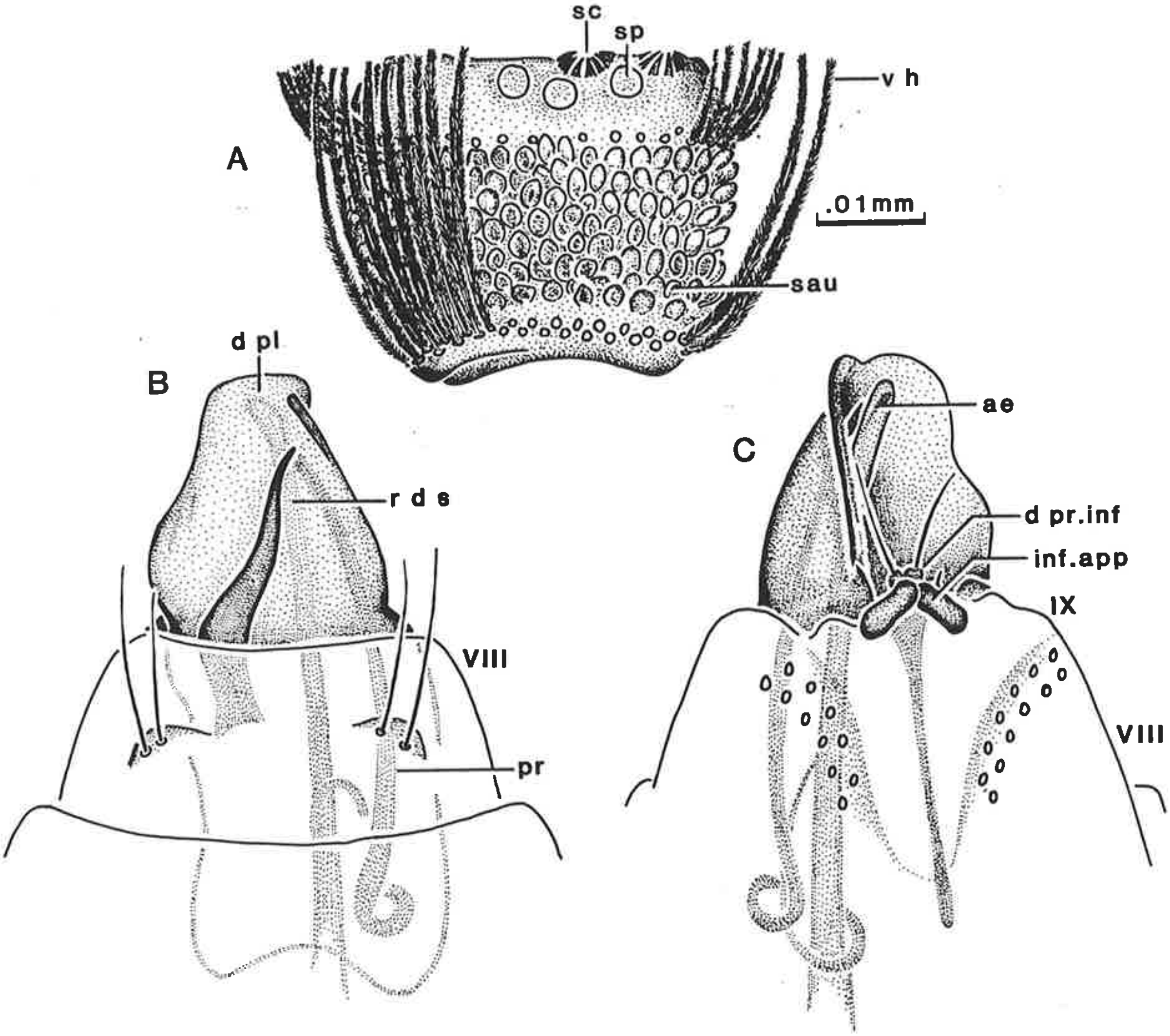


Plate 65A-C. Orthotrichia eurhinata Wells, male: A, antenna, flagellar segment; B,C, genitalia, dorsal and ventral views.

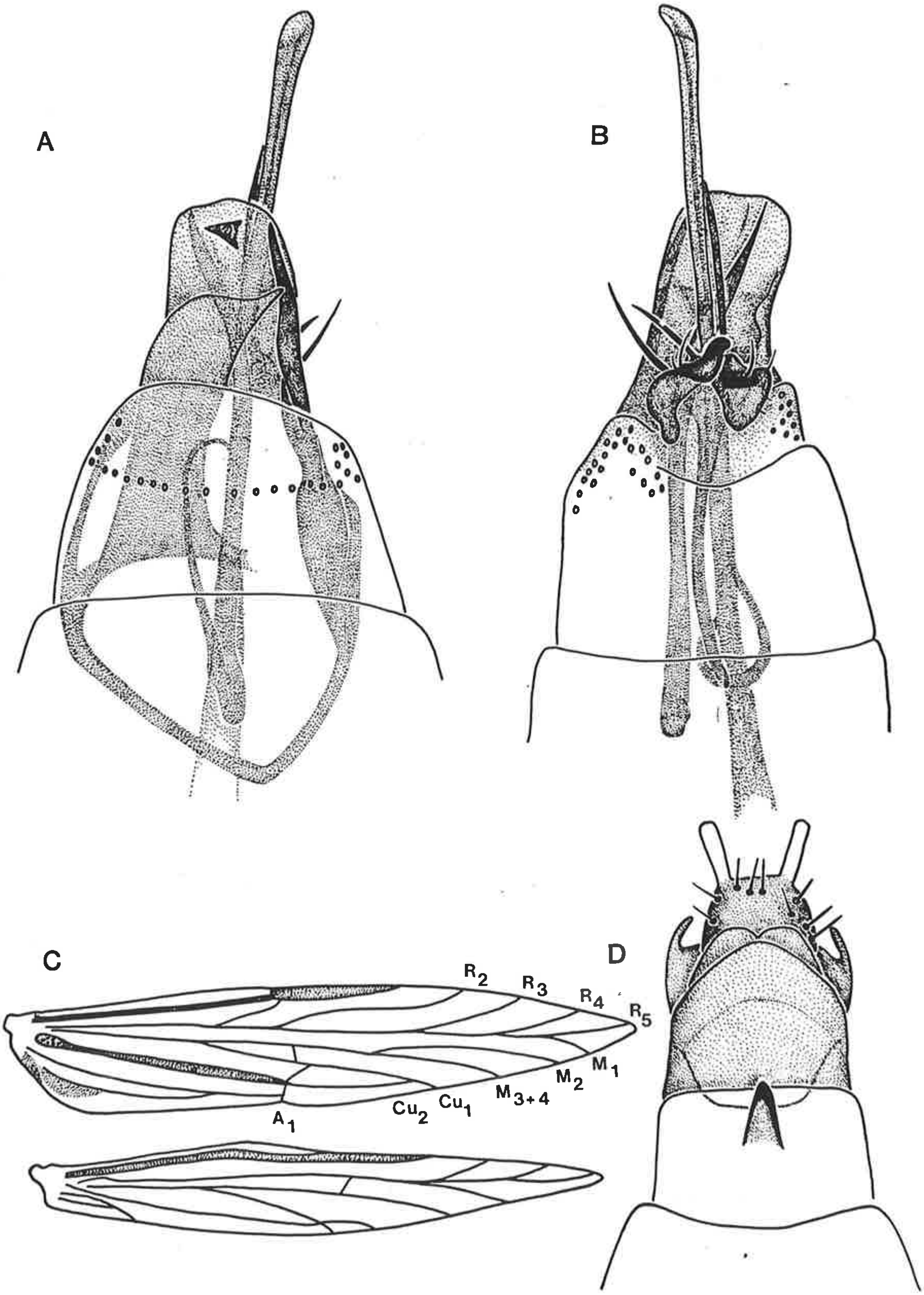


Plate 66A–D. A,B, *Orthotrichia aculeata* Wells, male genitalia, dorsal and ventral views.
C, *O. inornata* Wells, male wings.
D, *O. suteri* Wells, female genitalia, ventral view.

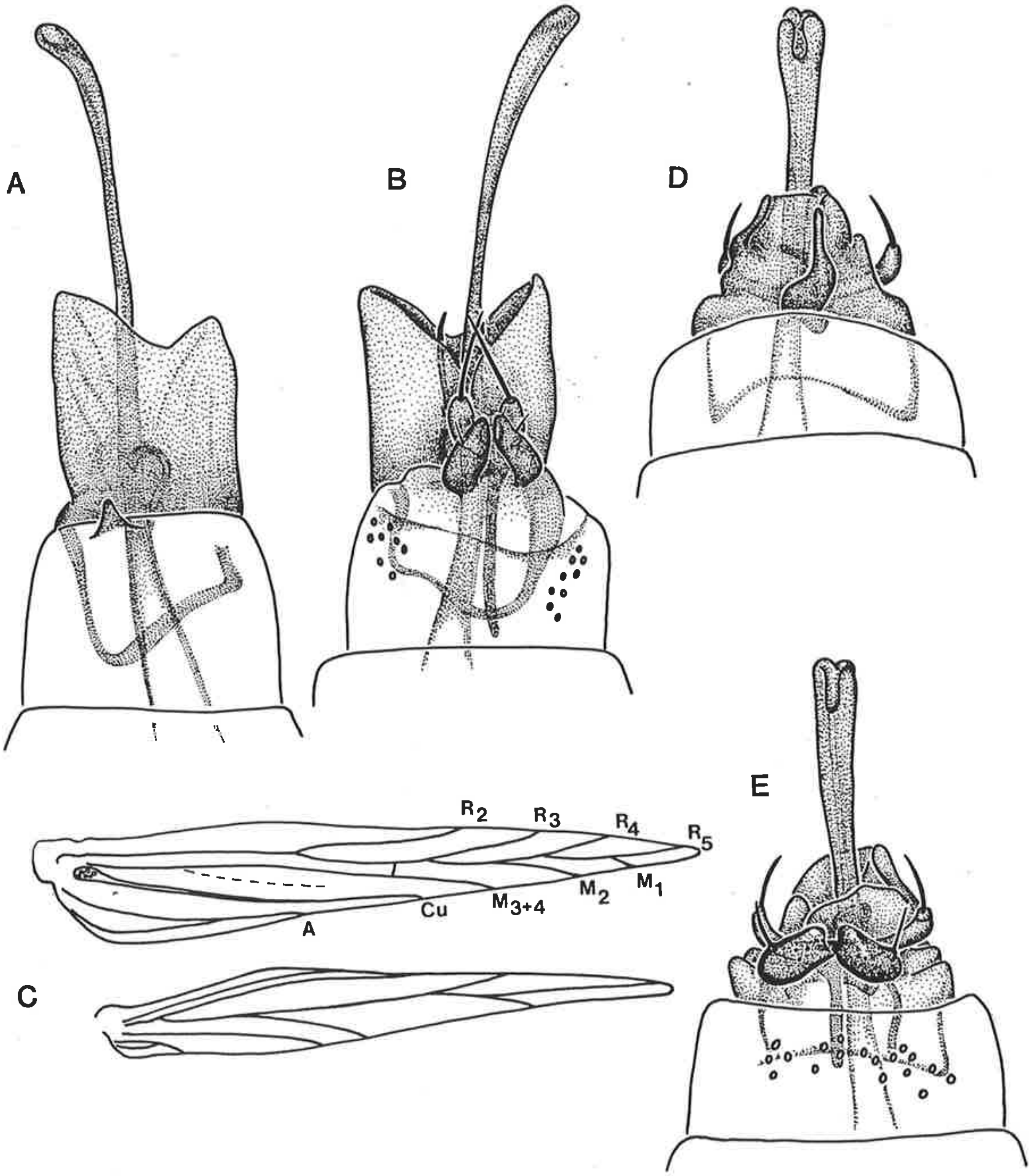


Plate 67A–D. A,B, *Orthotrichia inornata* Wells, male genitalia, dorsal and ventral views.
C–E, *O. suteri* Wells, male: C, wings; D,E, genitalia, dorsal and ventral views.

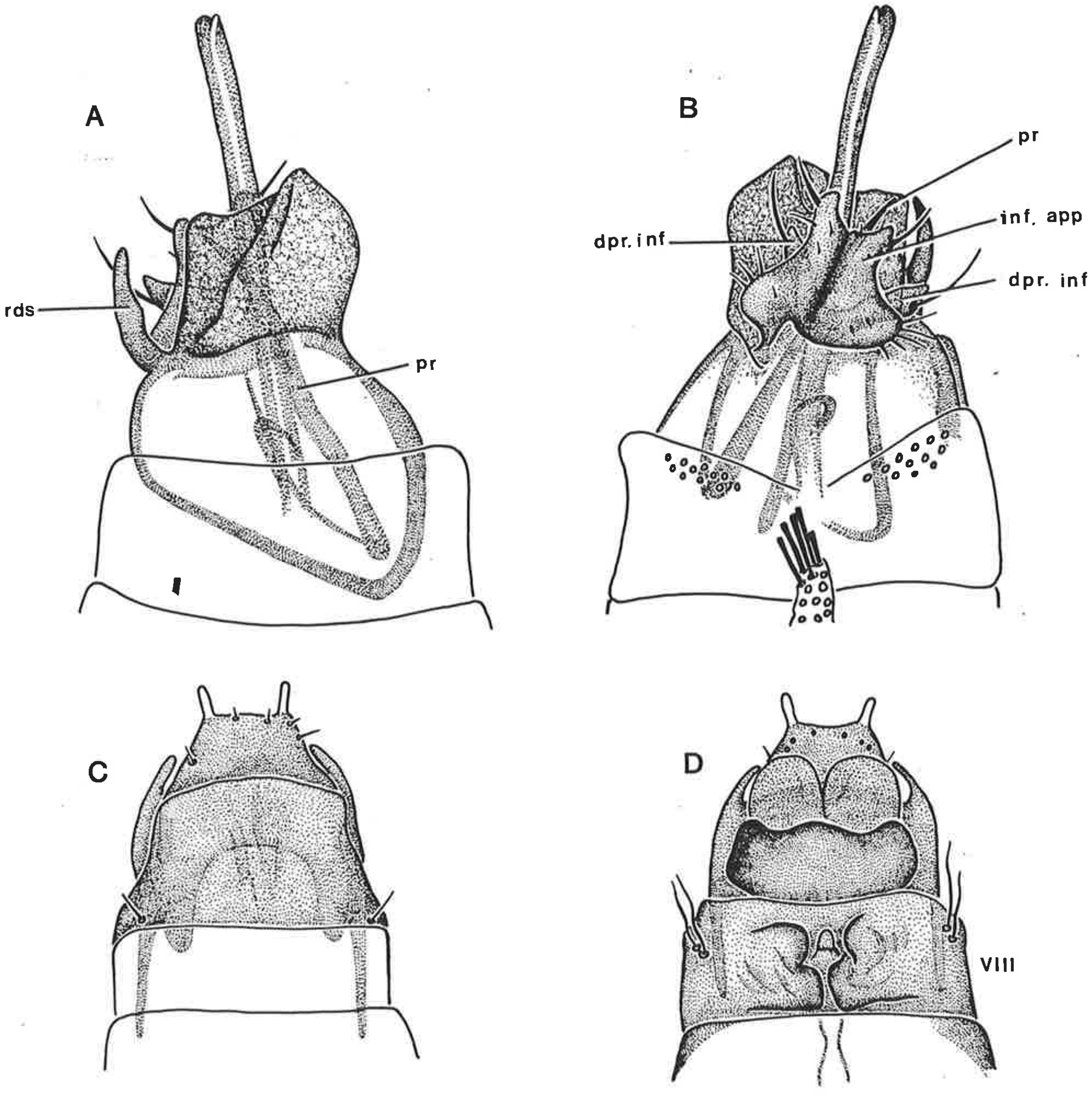


Plate 68A-D. *Orthotrichia morula* Wells: A,B, male genitalia, dorsal and ventral views; C,D, female genitalia, dorsal and ventral views.

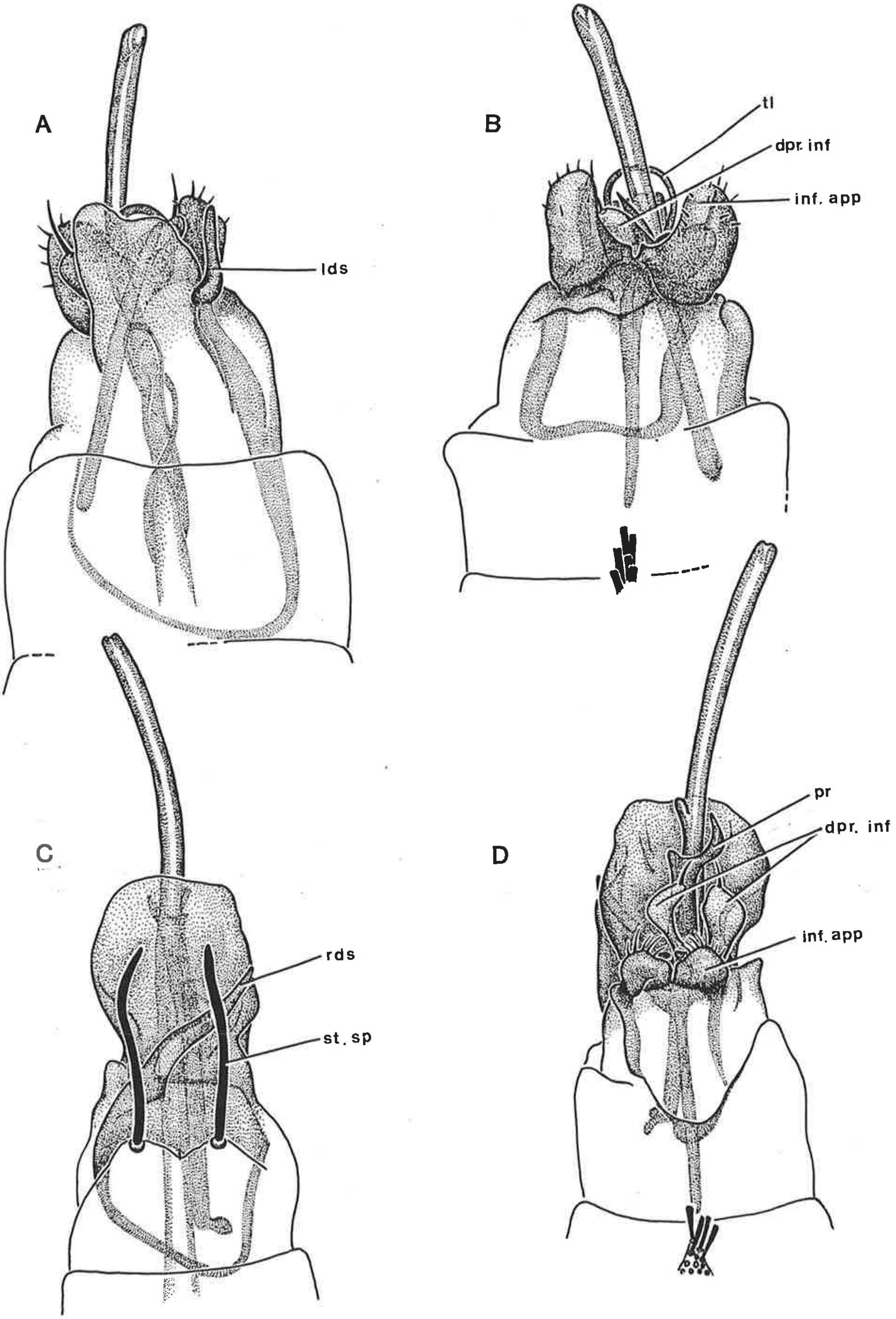


Plate 69A–D. A,B, *Orthotrichia alveata* Wells, male genitalia, dorsal and ventral views.
C,D, *O. gracilis* Wells, male genitalia, dorsal and ventral views.

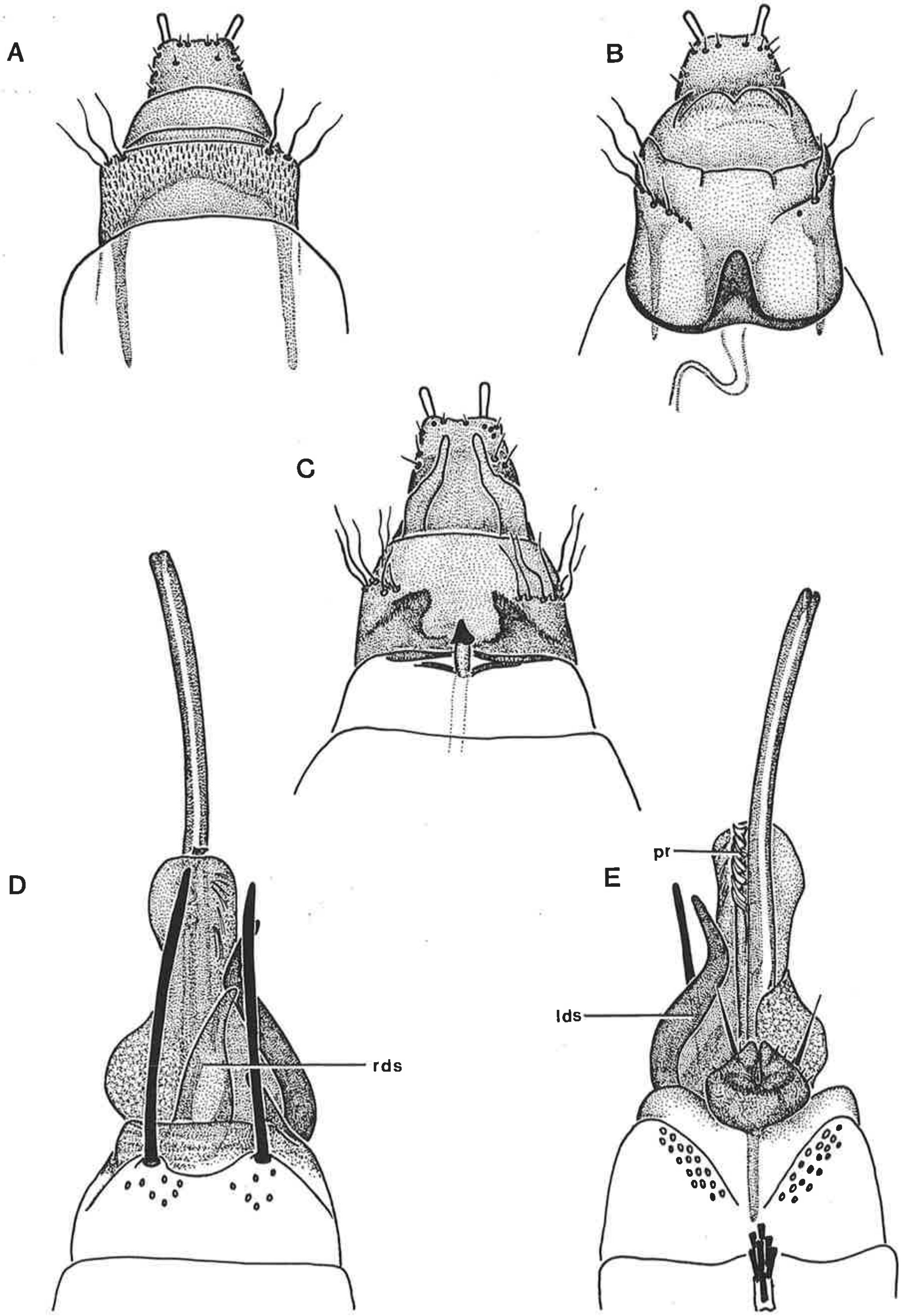


Plate 70A-E. A,B, Orthotrichia gracilis Wells, female genitalia, dorsal and ventral views.
C-E, O. tortuosa Wells: C, female genitalia, ventral view; D,E, male genitalia, dorsal and ventral views.

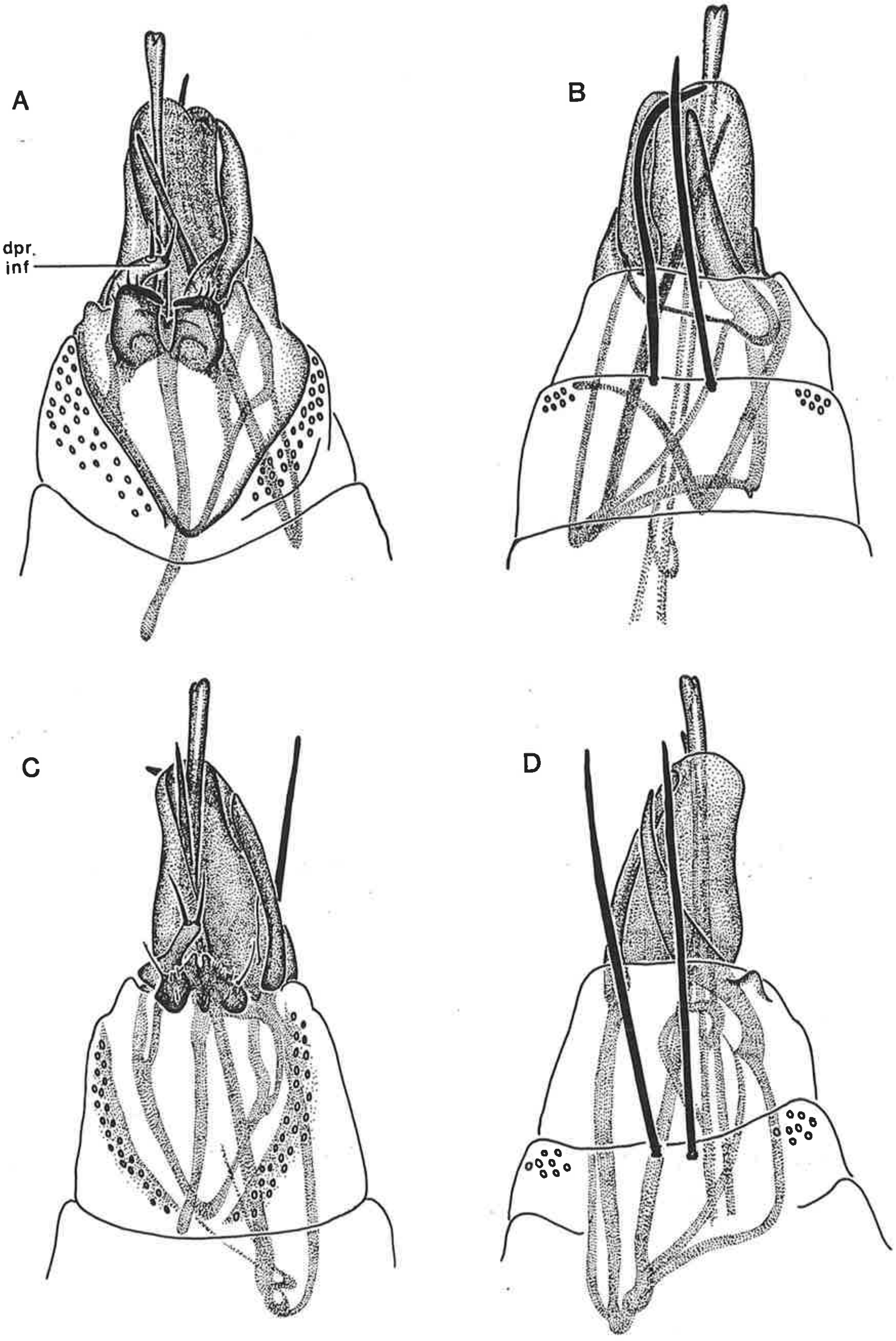


Plate 71A-D. A,B, <u>Orthotrichia</u> <u>kholoensis</u> Wells, male genitalia, dorsal and ventral views.
C,D, <u>O</u>. <u>paranga</u> Wells, male genitalia, dorsal and ventral views.

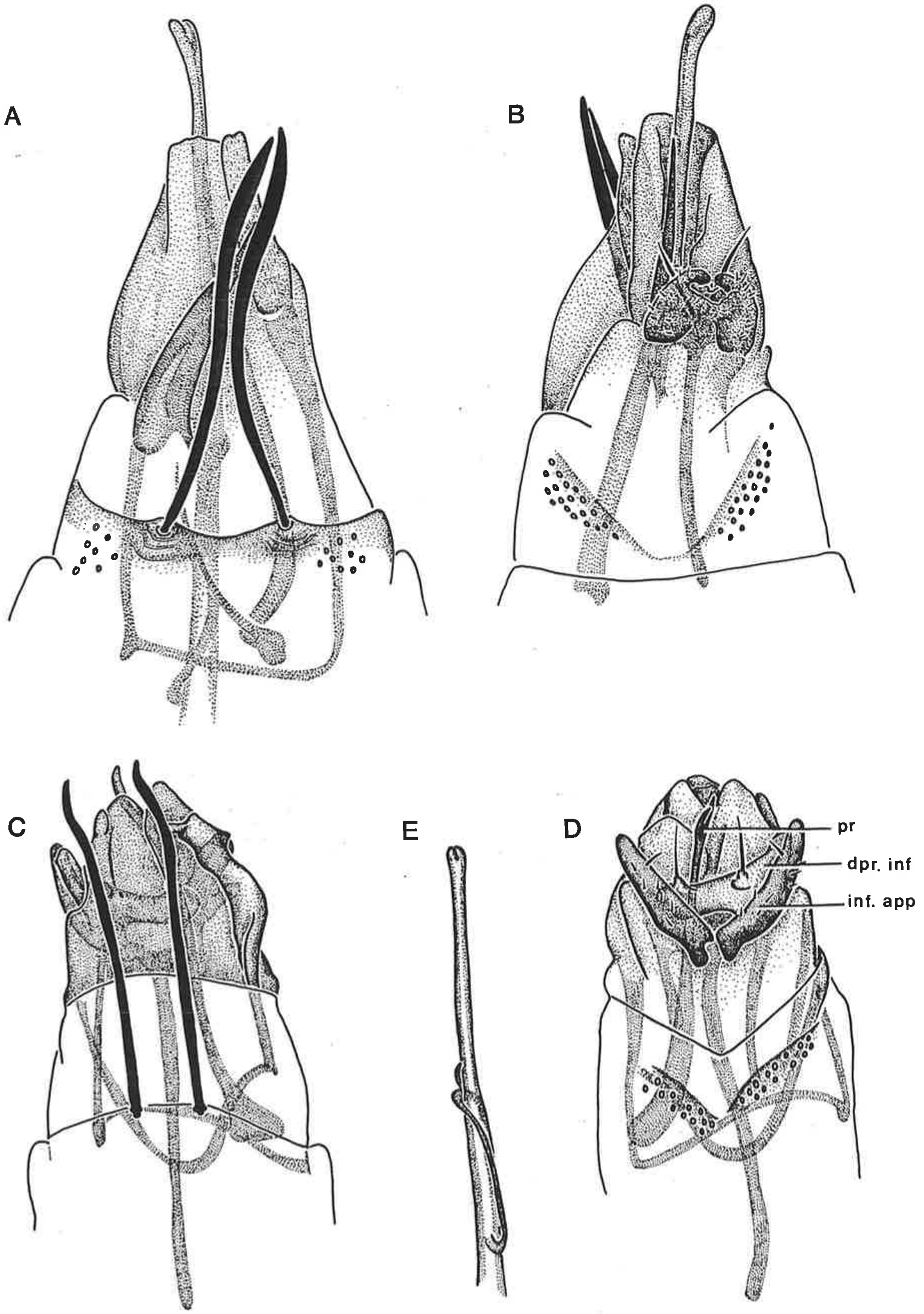


Plate 72A–D.   A,B, *Orthotrichia* *stipa* wells, male genitalia, dorsal and ventral views.
C–E, *O. exigua* Wells, male genitalia: C,D, dorsal and ventral views; E, aedeagus.

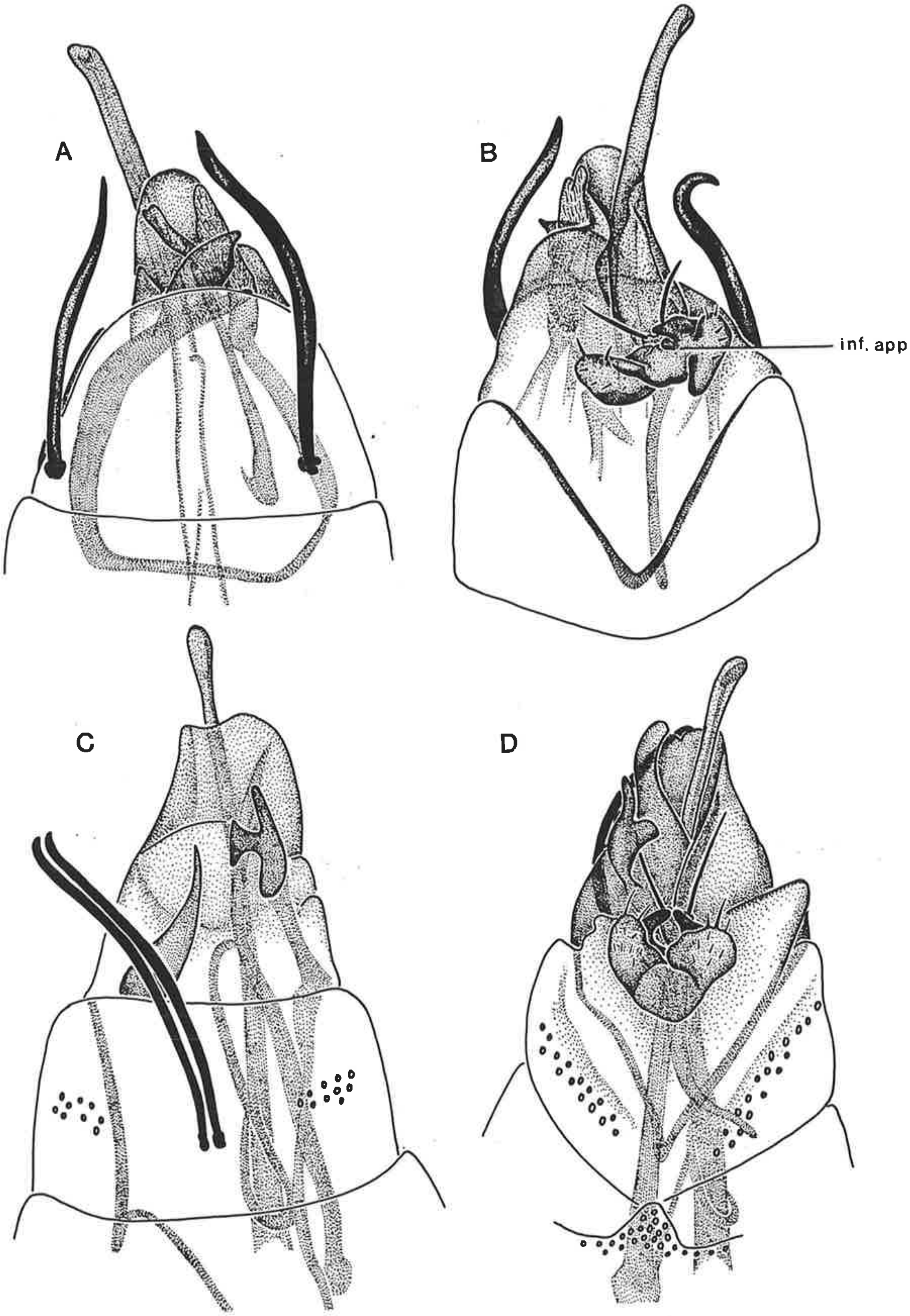


Plate 73A-D. A,B, Orthotrichia tyleri Wells, male genitalia, dorsal and ventral views.
C,D, O. bellicosa Wells, male genitalia, dorsal and ventral views.

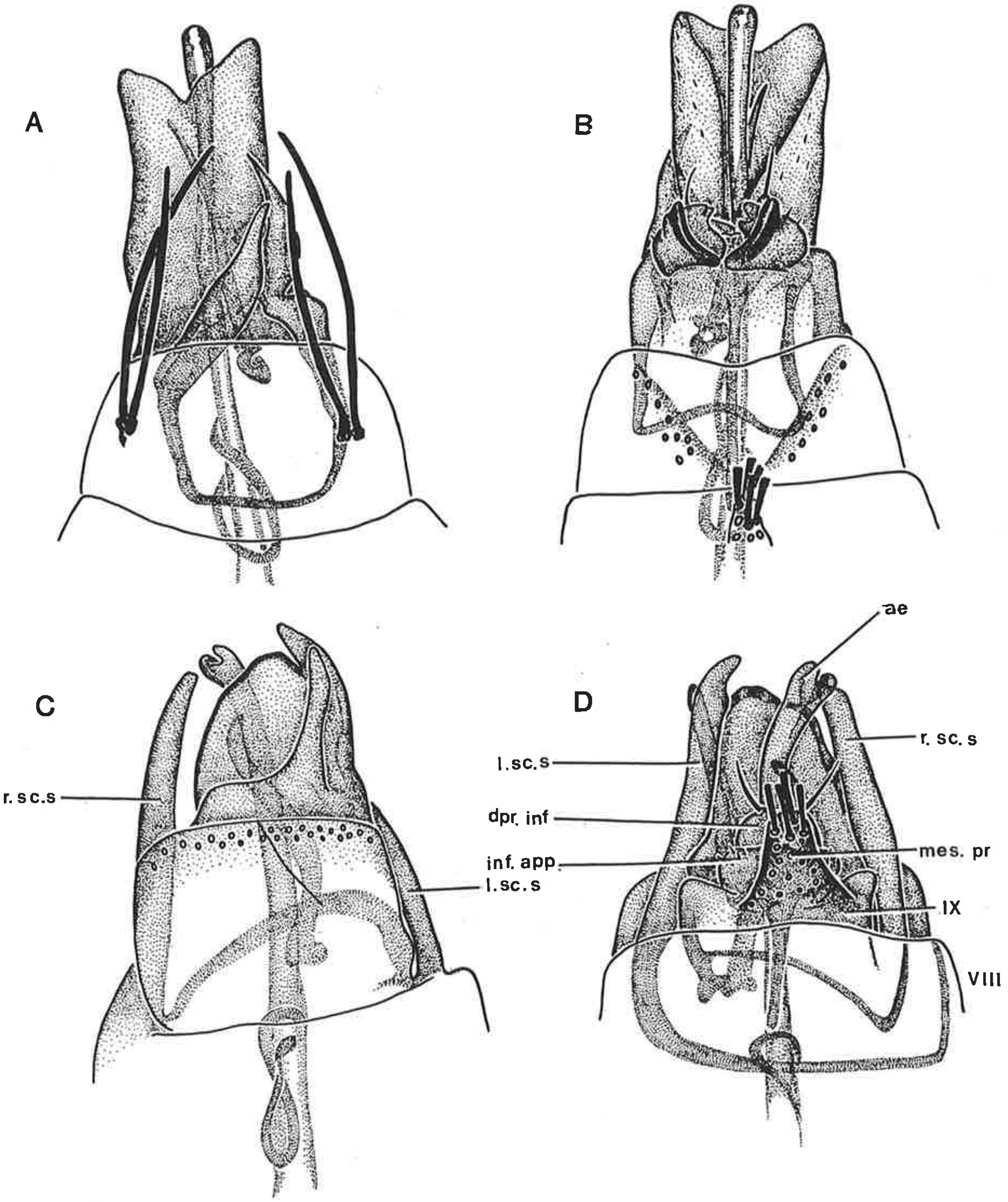


Plate 74 A-D. A,B, *Orthotrichia capillata* Wells, male genitalia, dorsal and ventral views.
C,D, *O. aberrans* Wells, male genitalia, dorsal and ventral views.

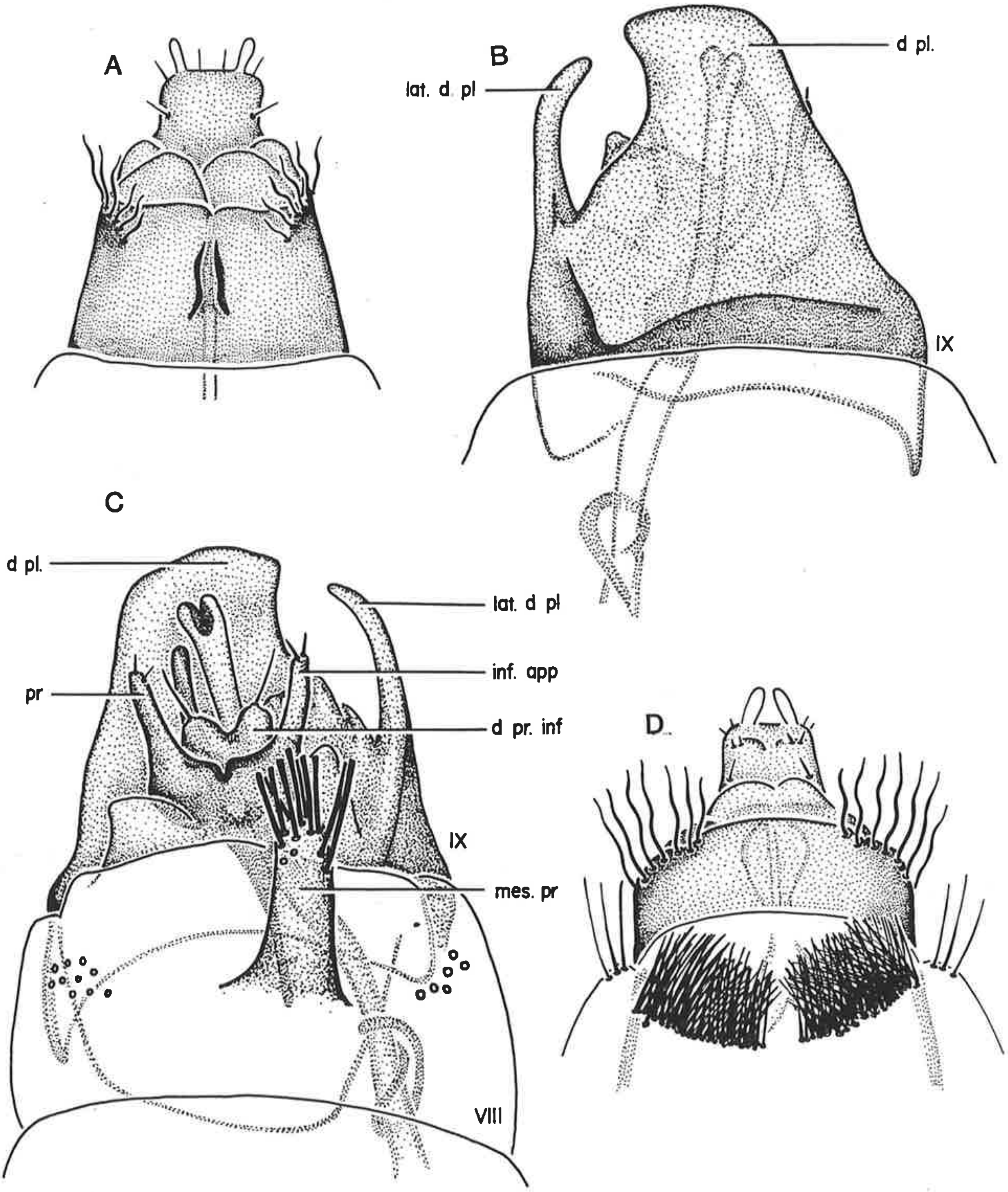


Plate 75A-D. A, *Orthotrichia aberrans* Wells, female genitalia, ventral view.
B-D, *O. conferta* Wells: B,C, male genitalia, dorsal and ventral views; D, female genitalia, ventral view.

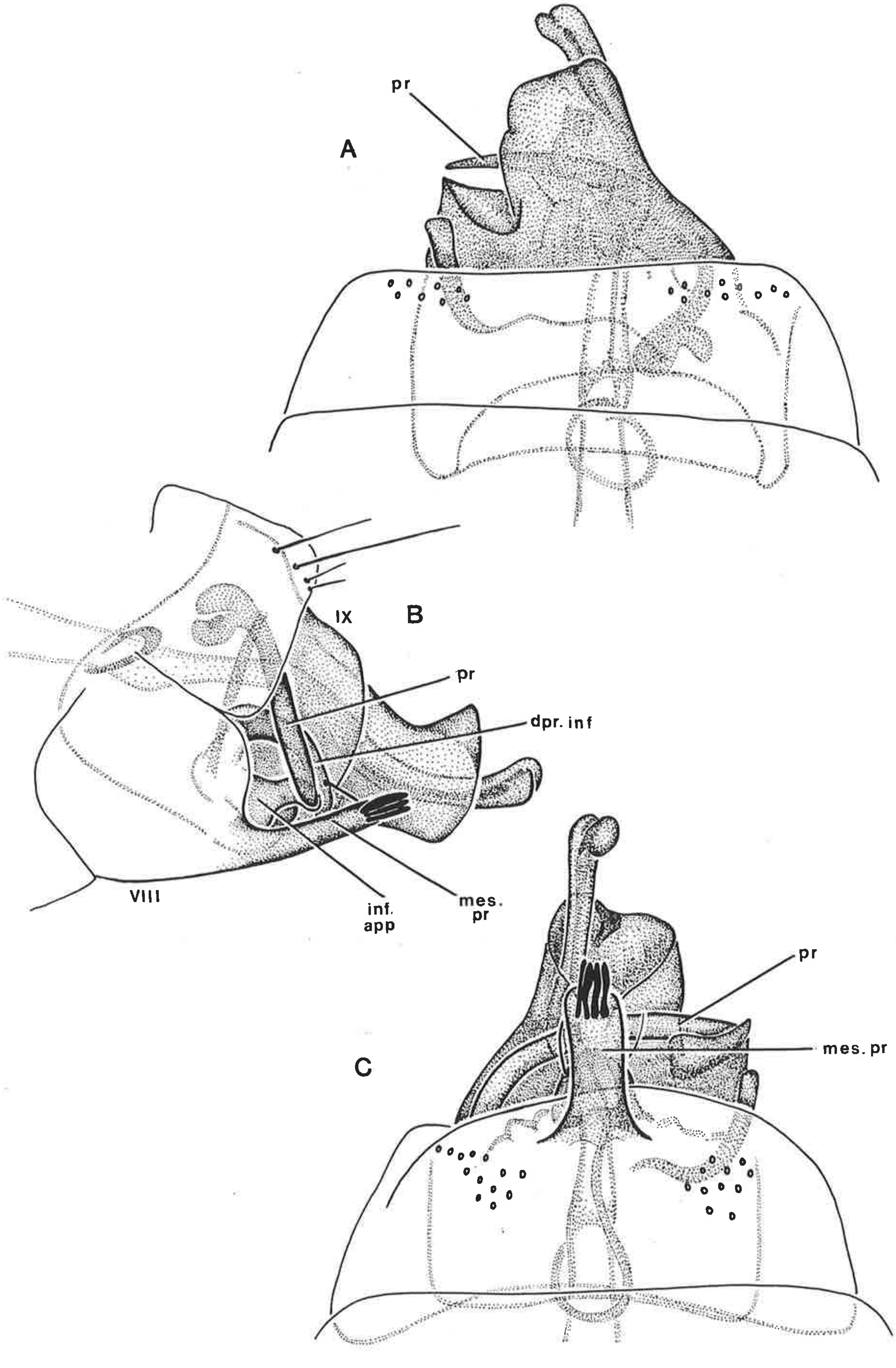


Plate 76A–C. *Orthotrichia pectinella* Wells, male genitalia, dorsal, lateral and ventral views.

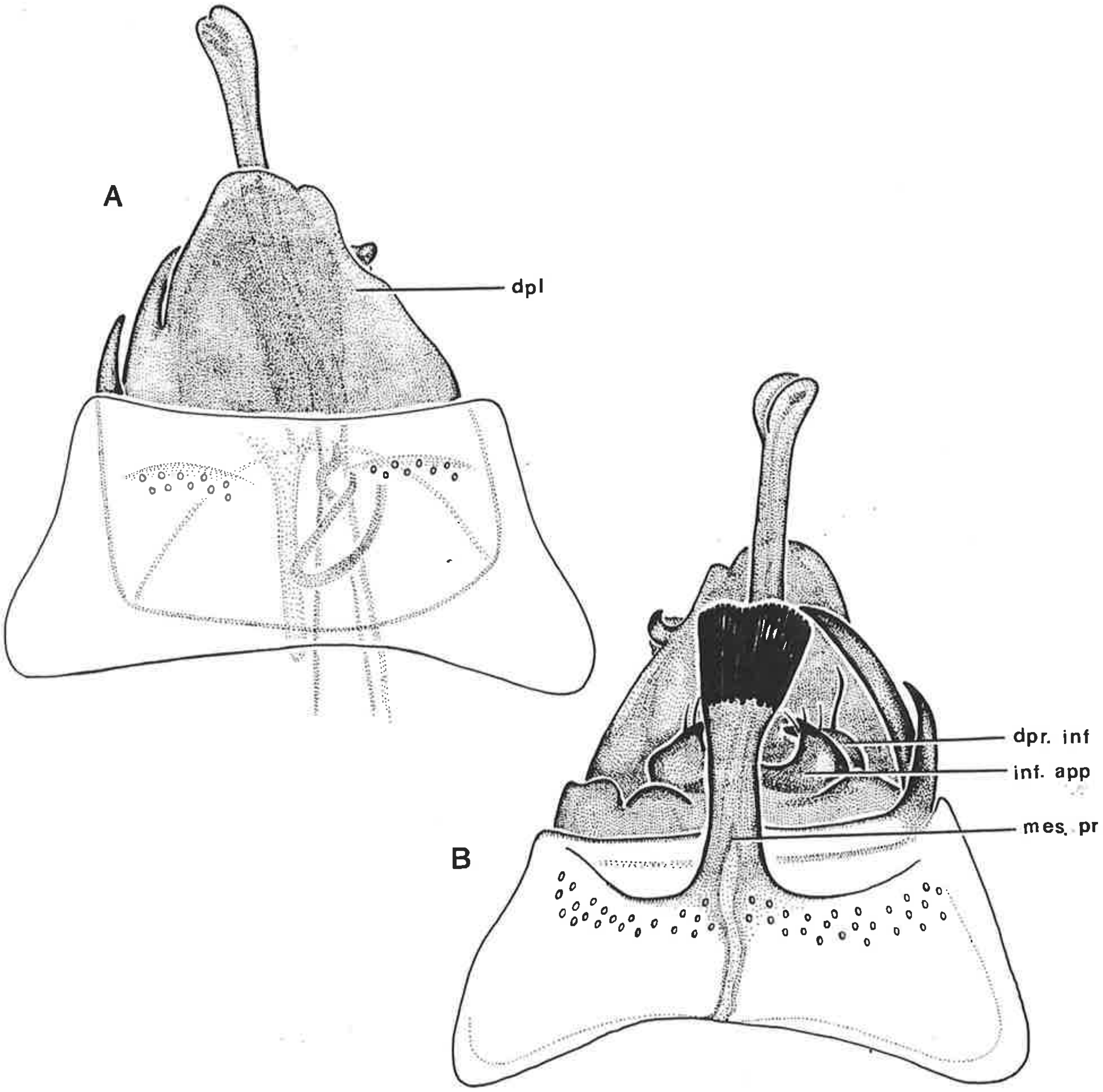


Plate 77A,B. *Orthotrichia* *flabella* Wells, male genitalia, dorsal and ventral views.

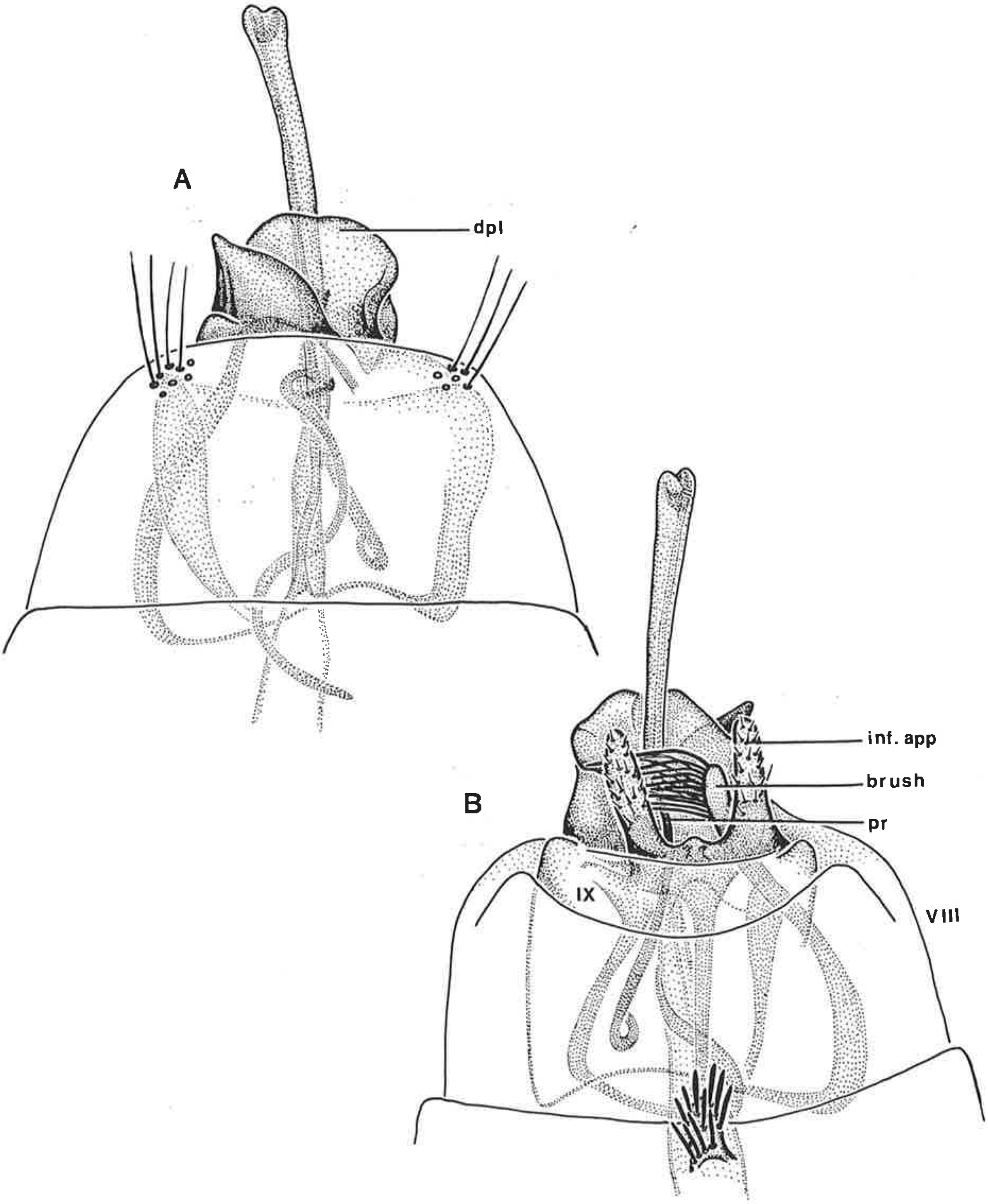


Plate 78A,B. *Orthotrichia* *muscari* Wells, dorsal and ventral views.

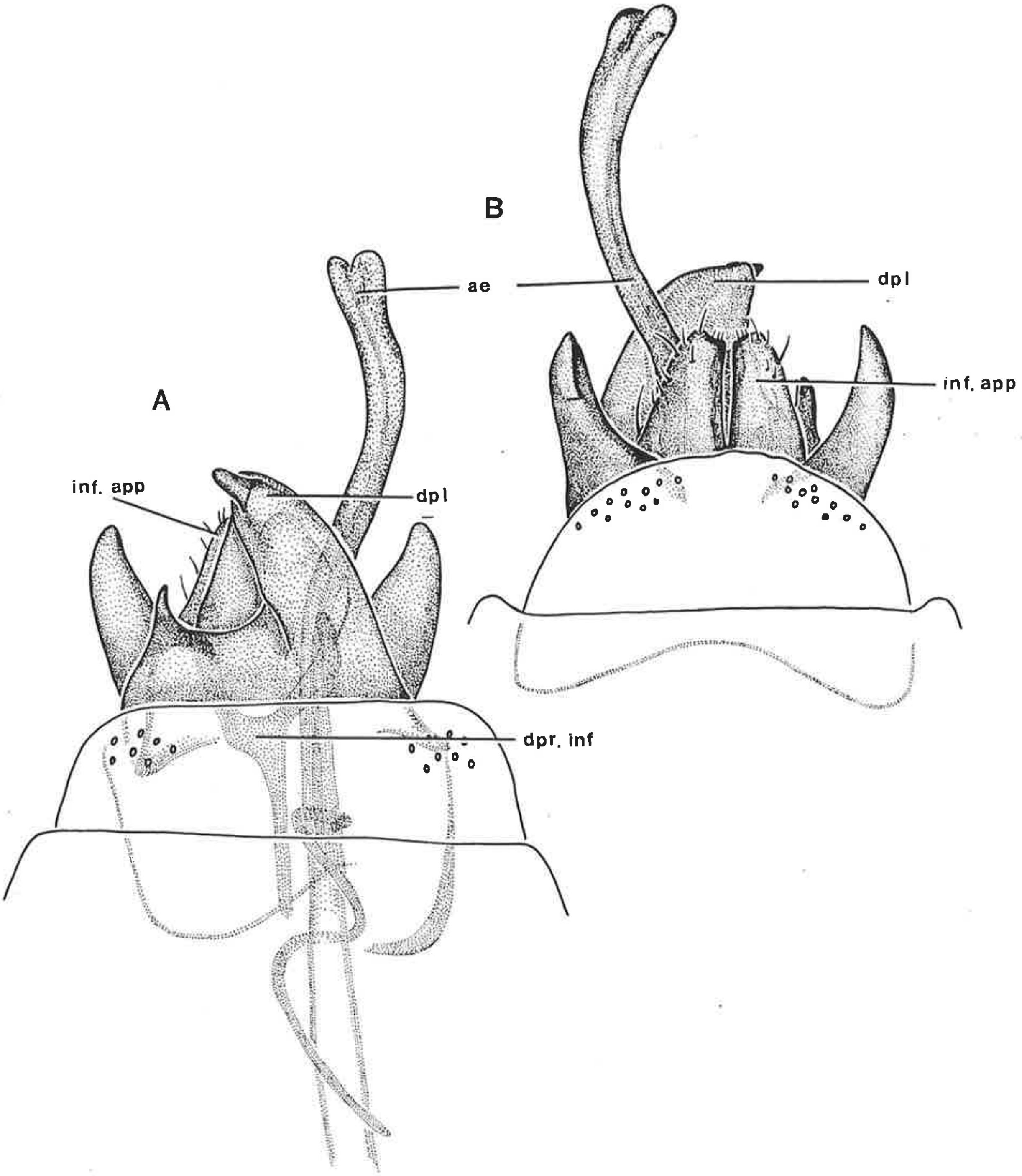


Plate 79A,B. Orthotrichia divaricata Wells, dorsal and ventral views.

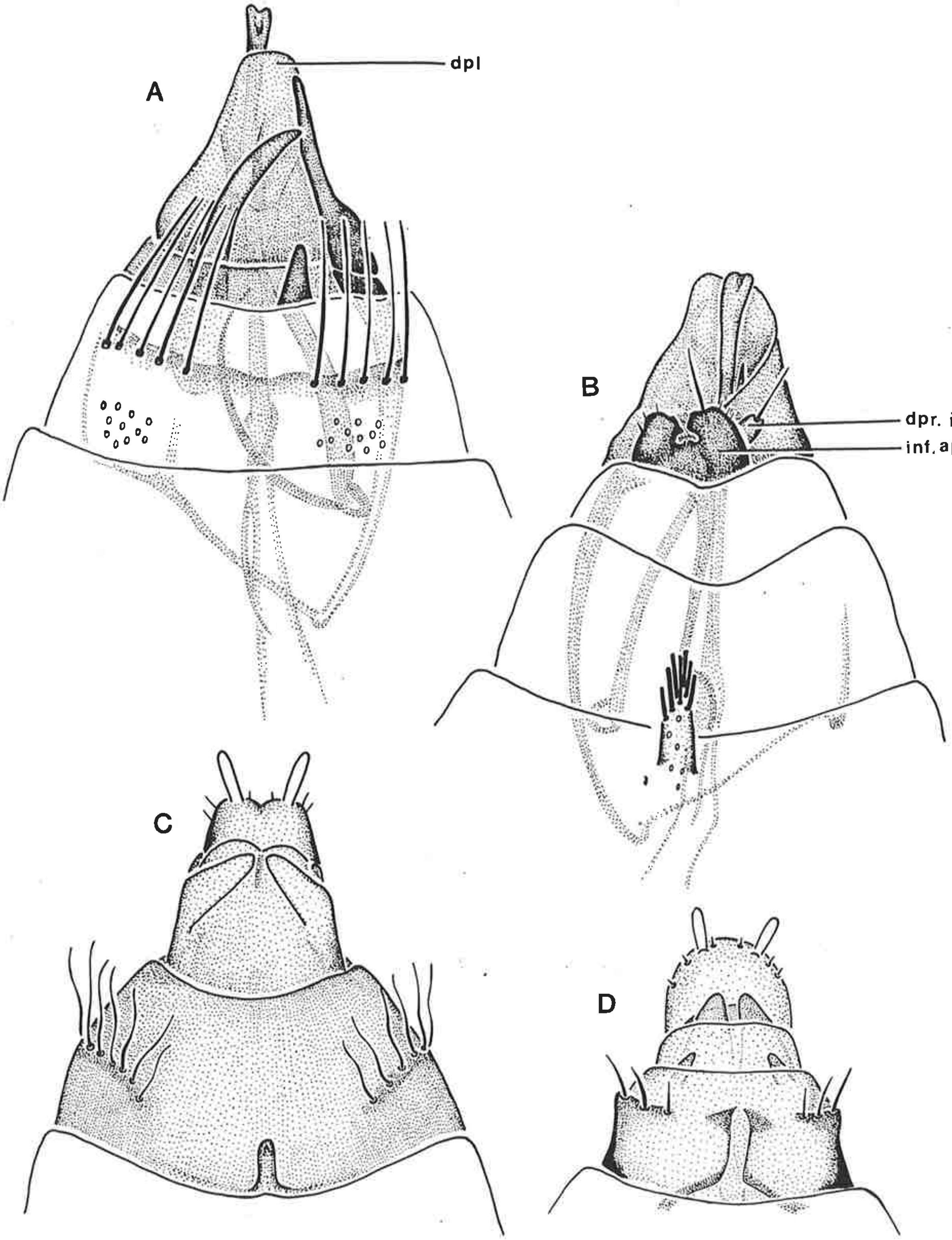


Plate 80A-D. A-C, *Orthotrichia dilgri* Wells:
A,B, male genitalia, dorsal and ventral views;
C, female genitalia, ventral view.
D, *O. velata* Wells, female genitalia, ventral view.

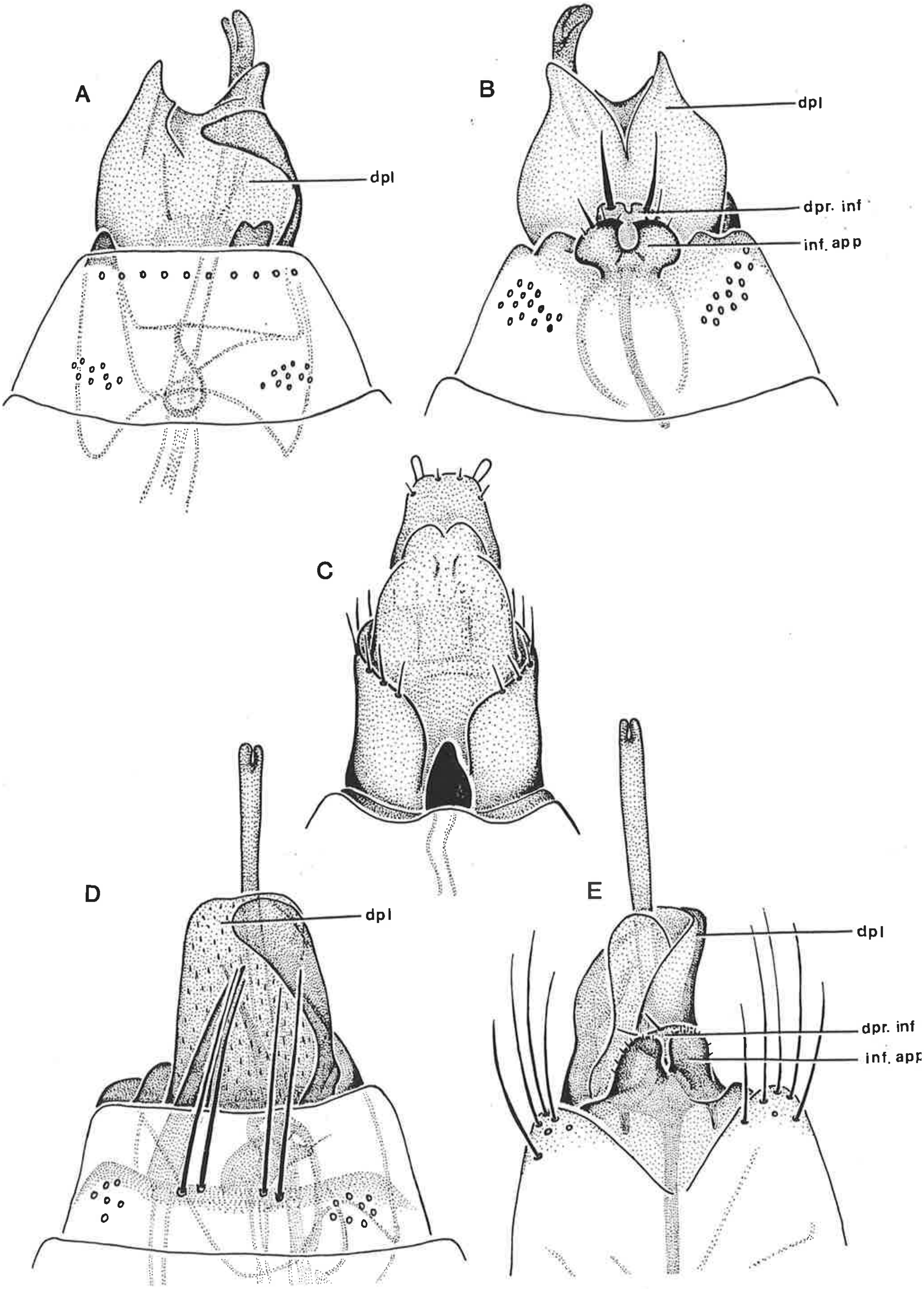


Plate 81A–E. A,B, *Orthotrichia* *velata* Wells, male genitalia, dorsal and ventral views.
C–E, *O.* *yabbaca* Wells: C, female genitalia, ventral view; D,E, male genitalia, dorsal and ventral views.

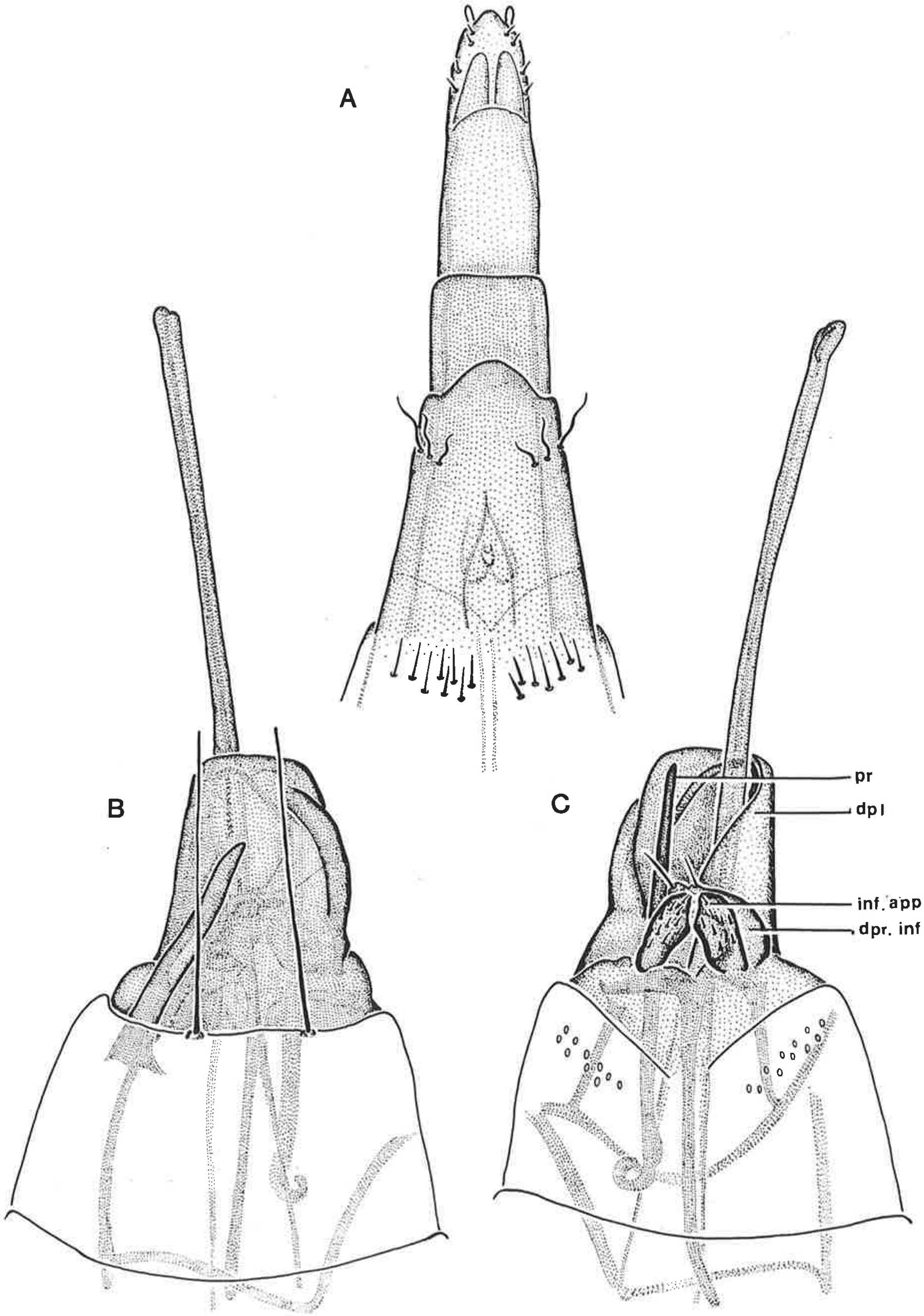


Plate 82A-C. *Orthotrichia attenuata* Wells: A, female genitalia, ventral view; B,C, male genitalia, dorsal and ventral views.

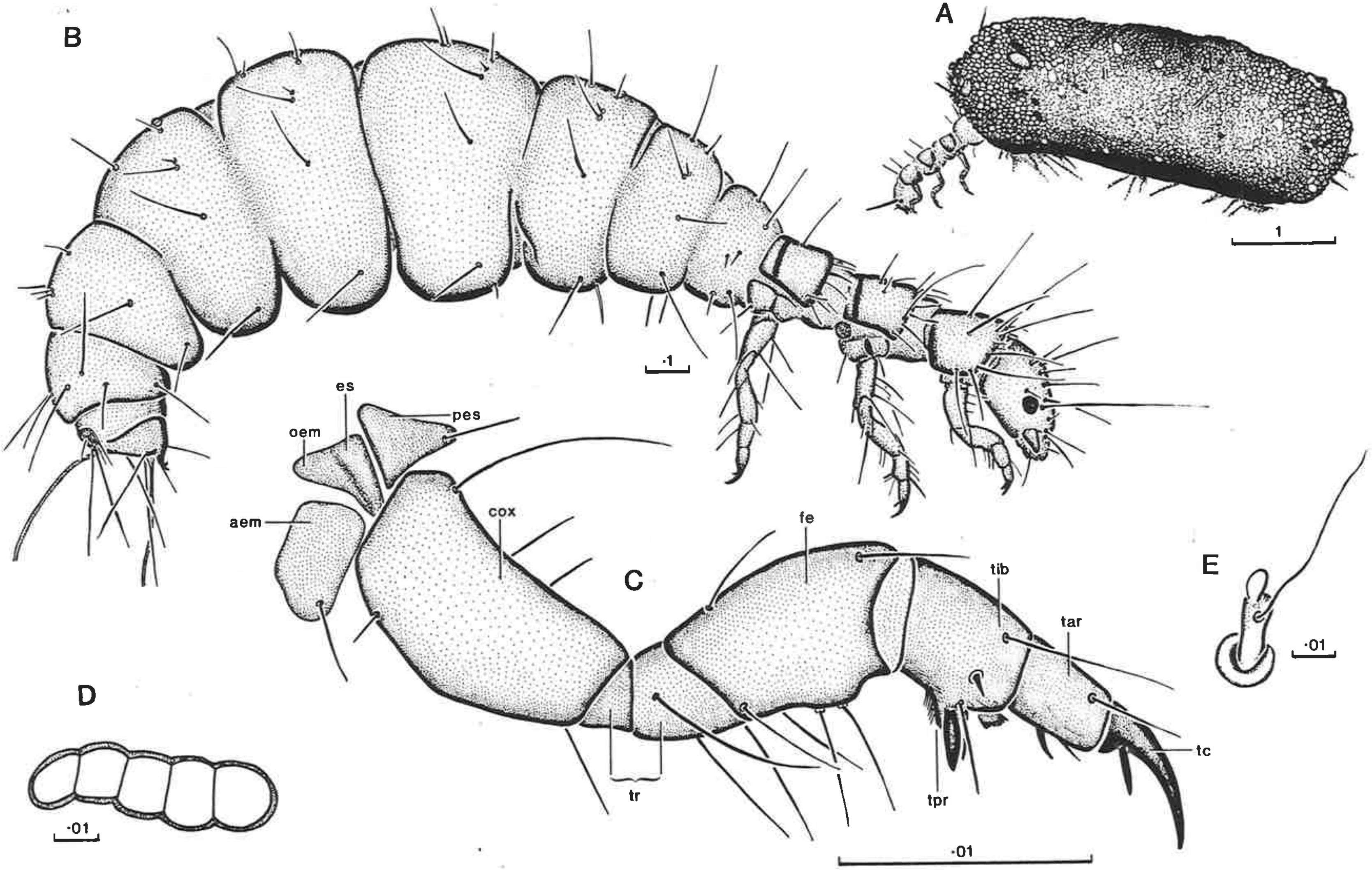


Plate 83A-E. *Hydroptila scamandra* Neboiss: A, mature larva in case; B, mature larva; C, forelimb and propleuron; D, dorsal chloride epithelia; E, antenna.

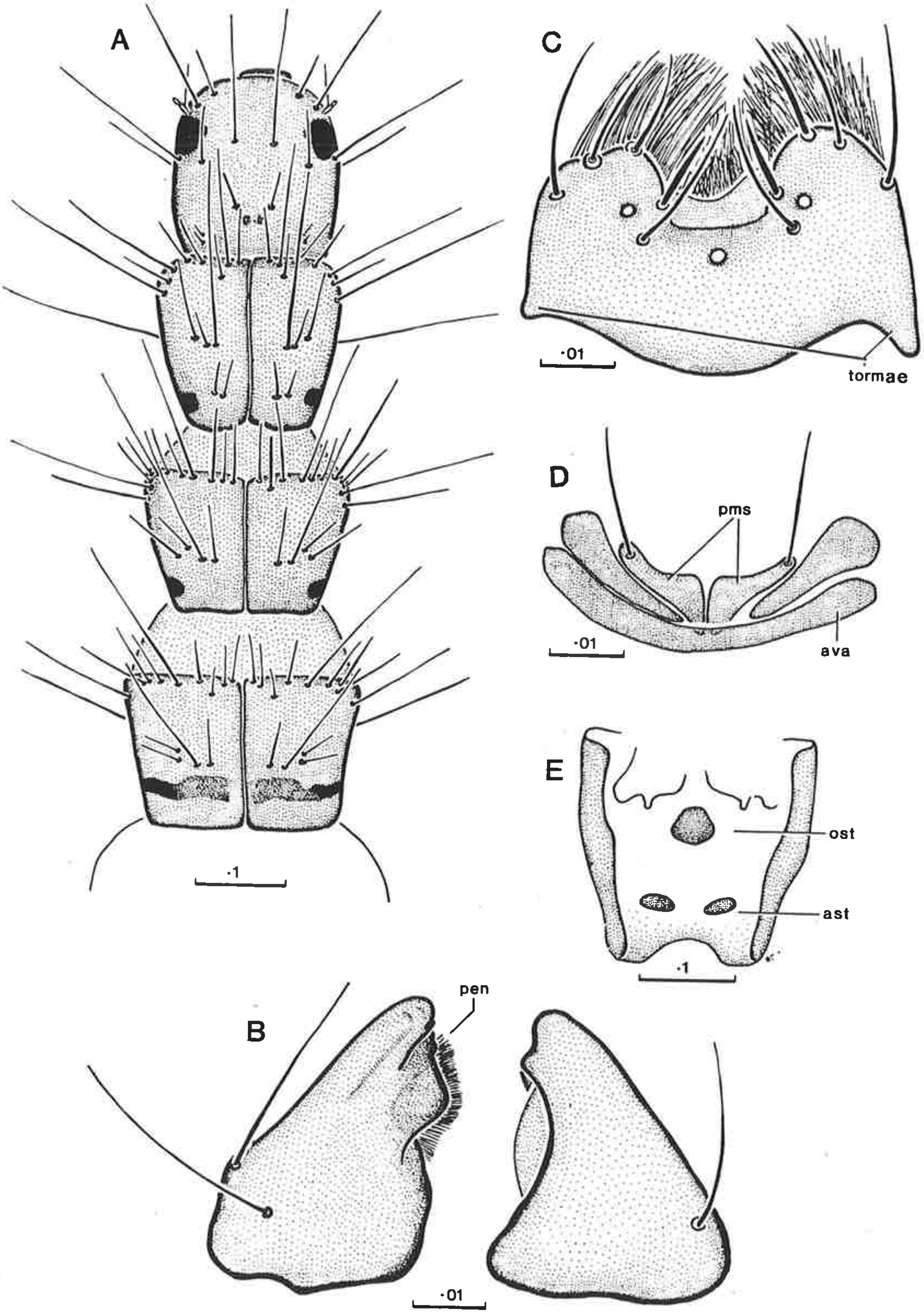


Plate 84A–E. *Hydroptila scamandra* Neboiss, mature larva: A, head and thorax; B, mandibles; C, labrum; D, ventral sclerites of head; E, prothorax, ventral view.

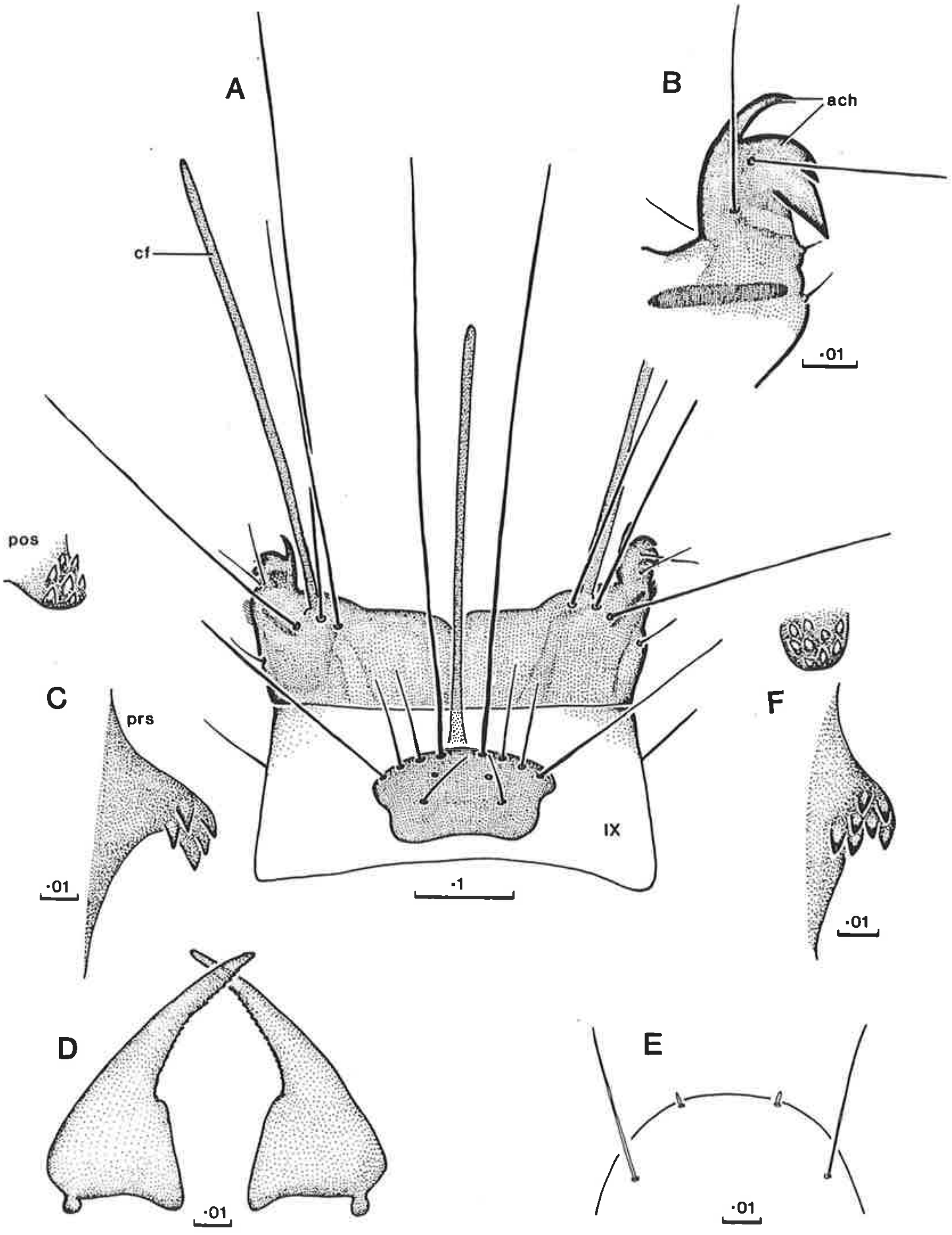


Plate 85A-F. A-E, *Hydroptila scamandra* Neboiss: A, segments IX and X, dorsal view; B, anal proleg, C, pupal hook plates; D, pupal mandibles; E, pupal labrum. F, *H. obscura* Wells, pupal hook plates.

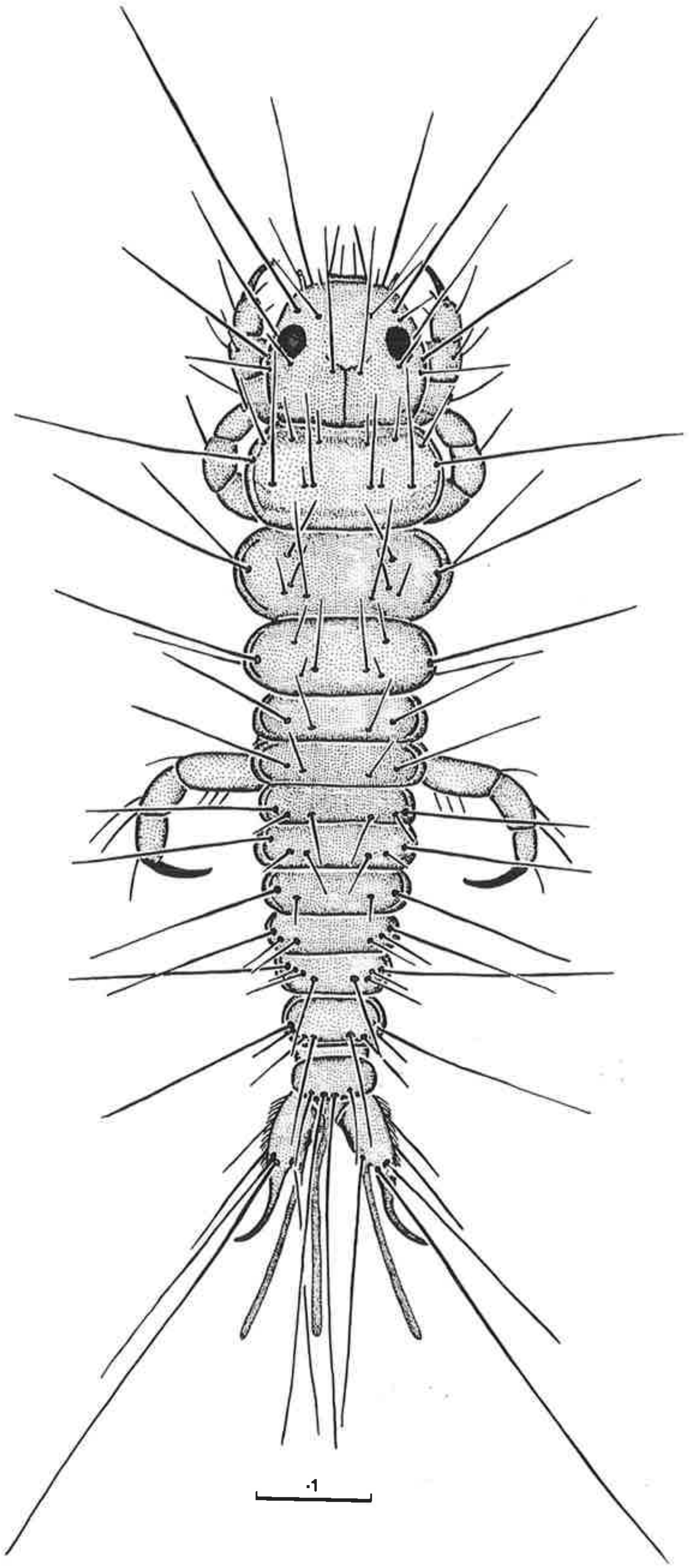


Plate 86. Hydroptila losida Mosely, second-instar larva.

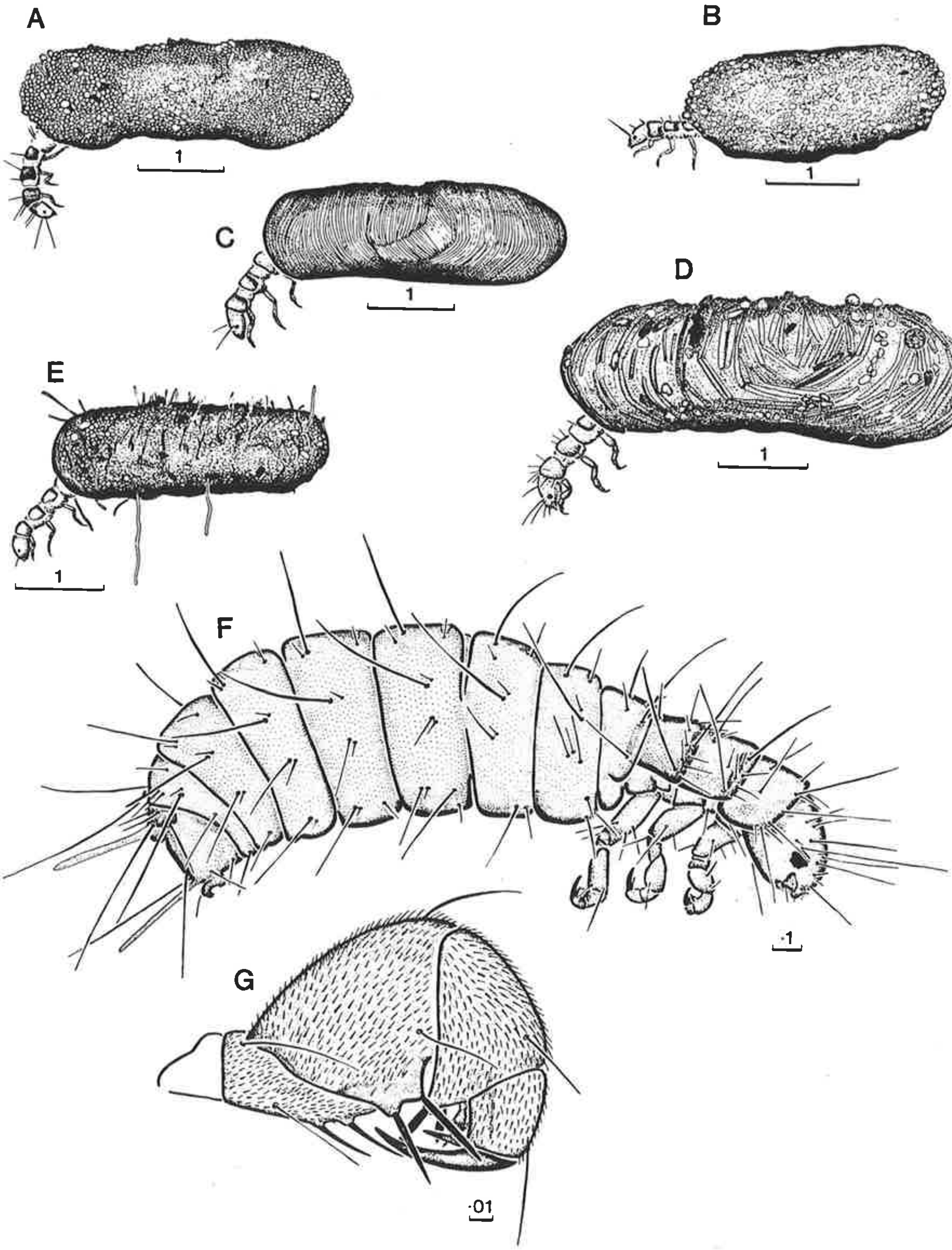


Plate 87A–G. A–E, *Hydroptila* cases: A, *robusta* Wells; B, calcara Wells; C, *obscura* Wells; D, *losida* Mosely; E, *incertula* Mosely.
F,G, *Hydroptila acinacis* Wells: F, mature larva; G, forelimb of mature larva.

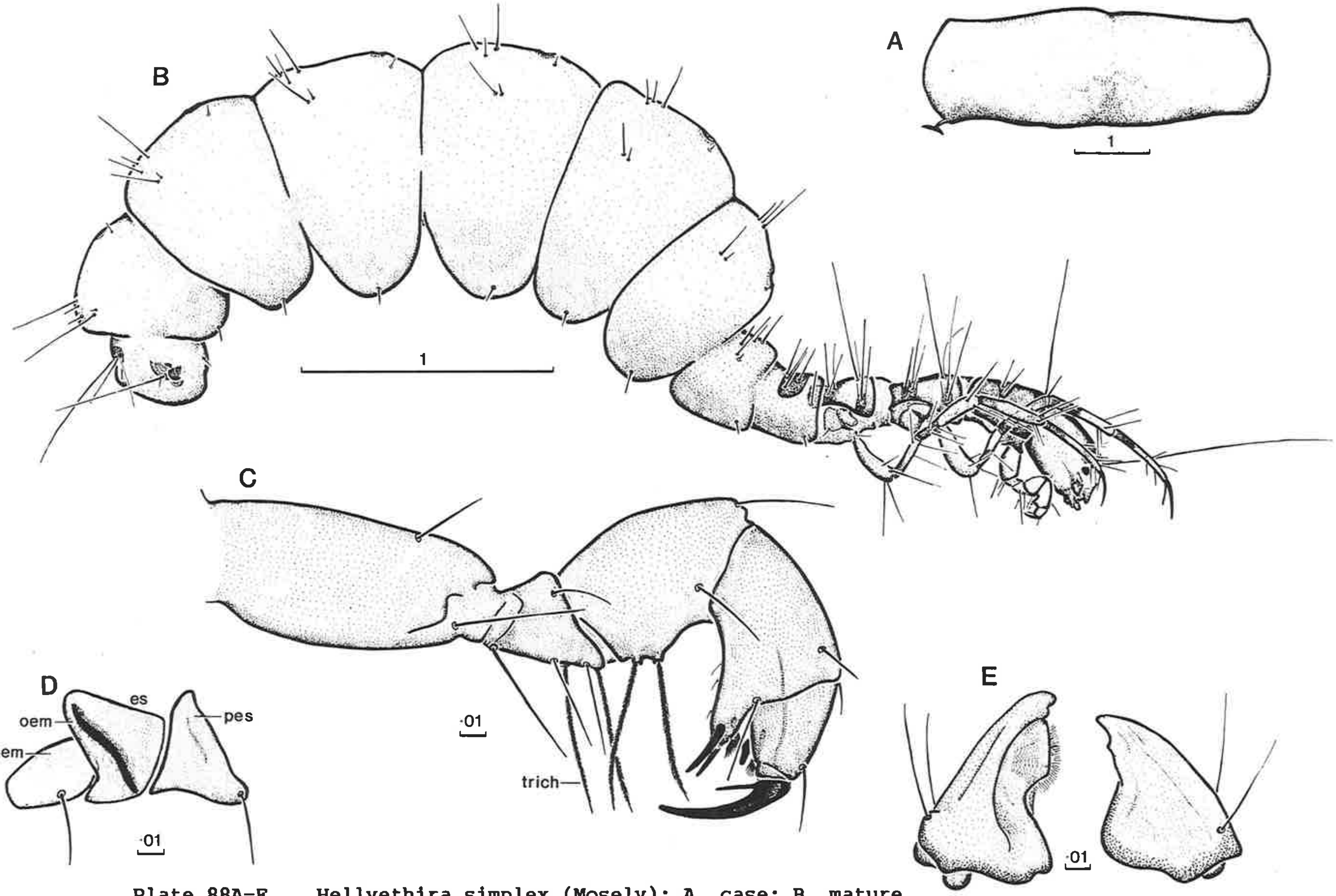


Plate 88A–E. <u>Hellyethira</u> <u>simplex</u> (Mosely): A, case; B, mature larva; C, forelimb; D, propleuron; E, mandibles.

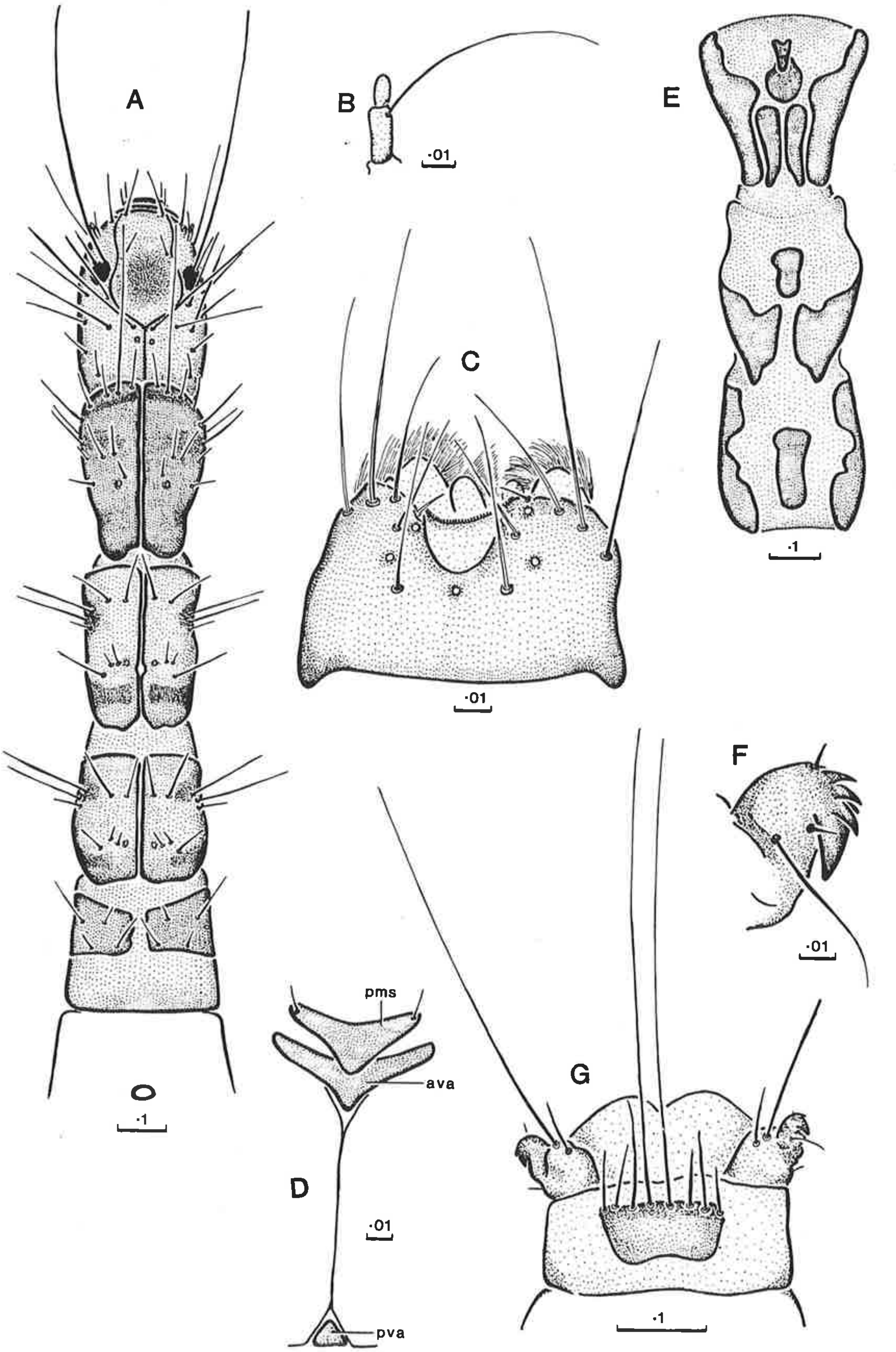


Plate 89A-G. *Hellyethira simplex* (Mosely), mature larva: A, head and thorax, dorsal view; B, antenna; C, labrum; D, ventral sclerites of head; E, ventral sclerites of thorax; F, anal proleg; G, segments IX and X, dorsal view.

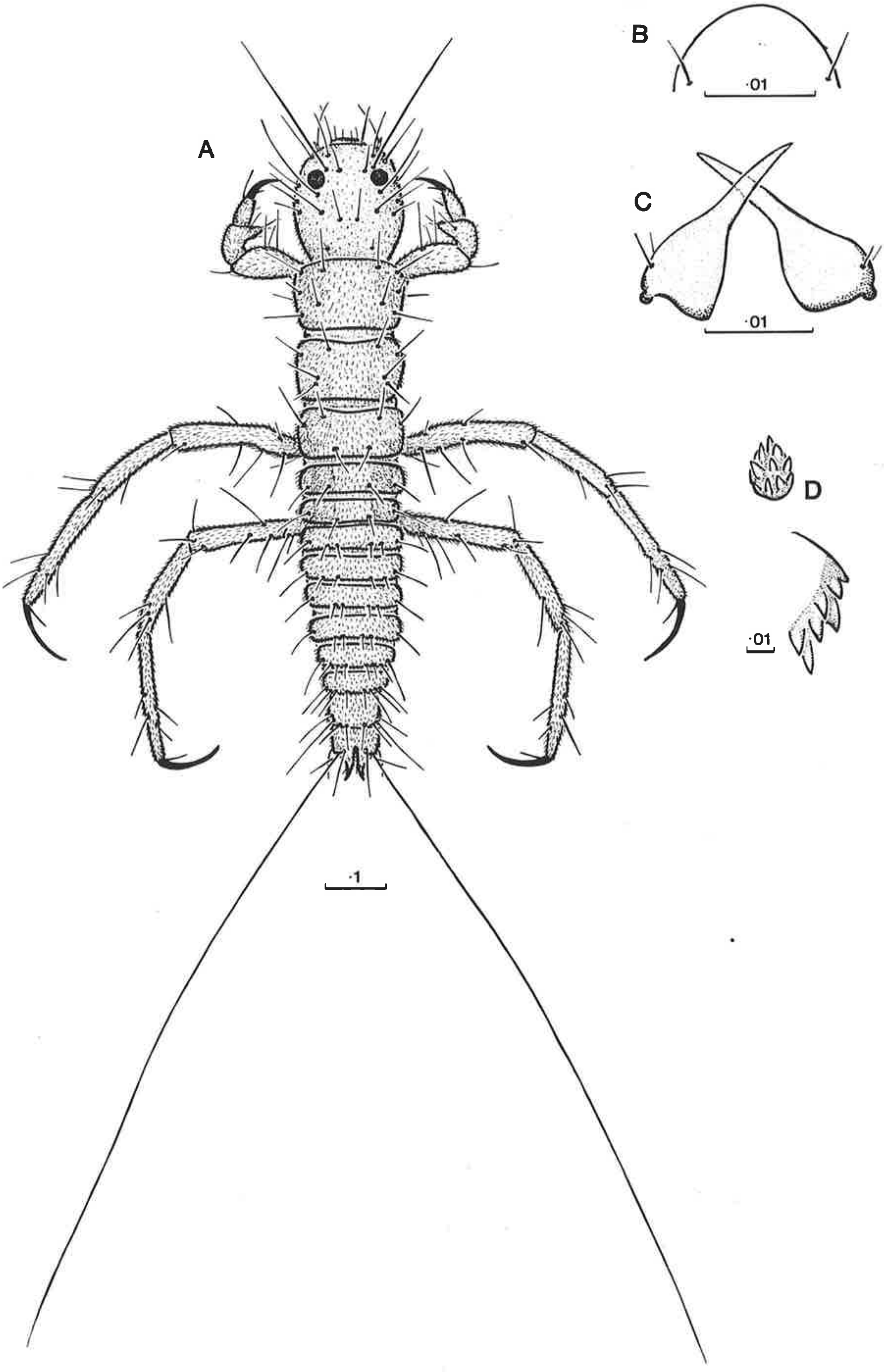


Plate 90A–D. Hellyethira simplex (Mosely): A, fourth-instar larva; B, pupal labrum; C, pupal mandibles; D, pupal hook plates.

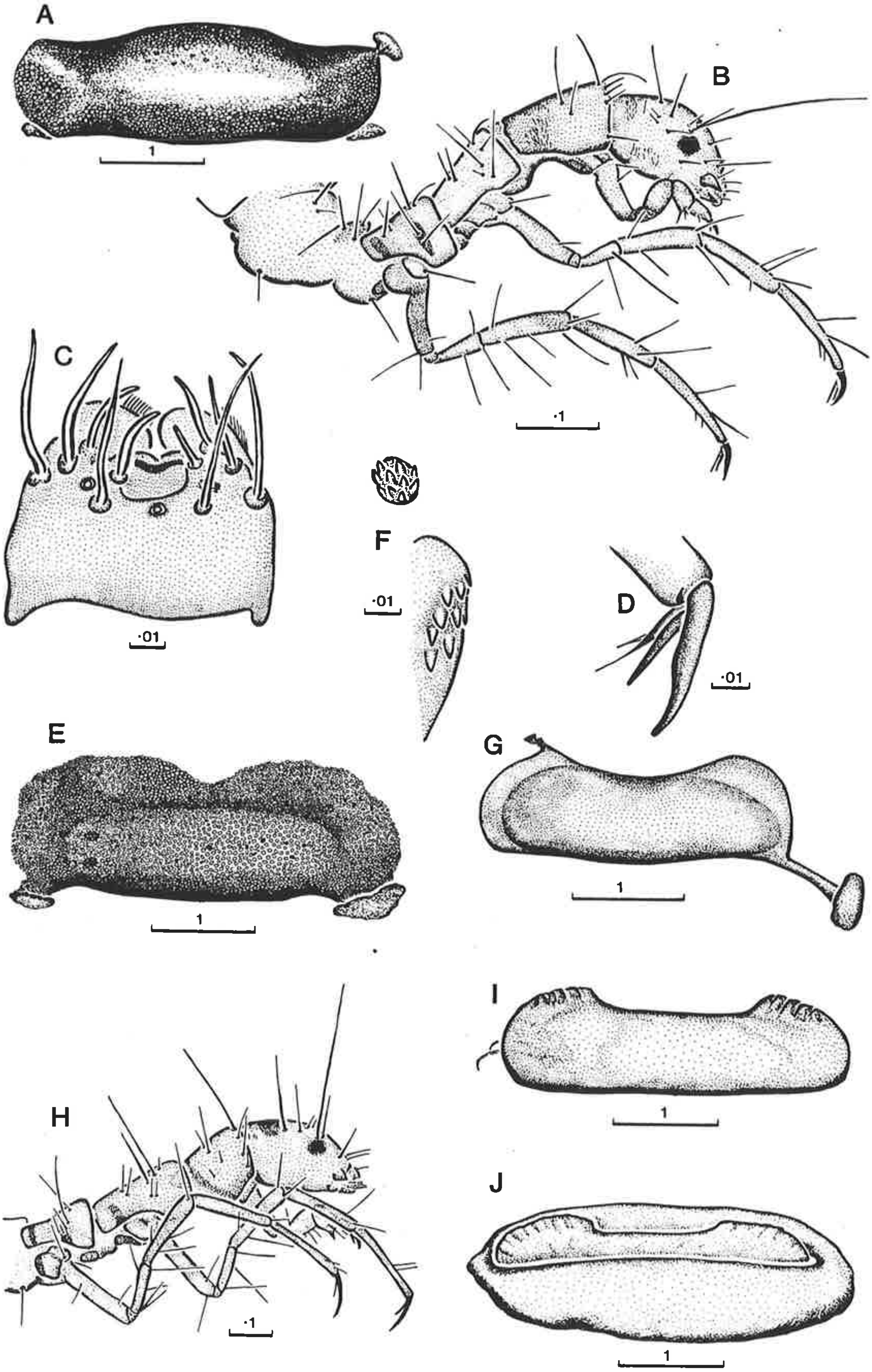


Plate 91A-J. A-D, Hellyethira basilobata Wells: A, case; B, mature larva; C, labrum; D, midtarsal claw.
E,F, H. allynensis Wells: E, case; F, pupal hook plates.
G, H. cubitans Wells, case.
H-J, H. exserta Wells: H, mature larva; I, basic case; J, case with secretion shield.

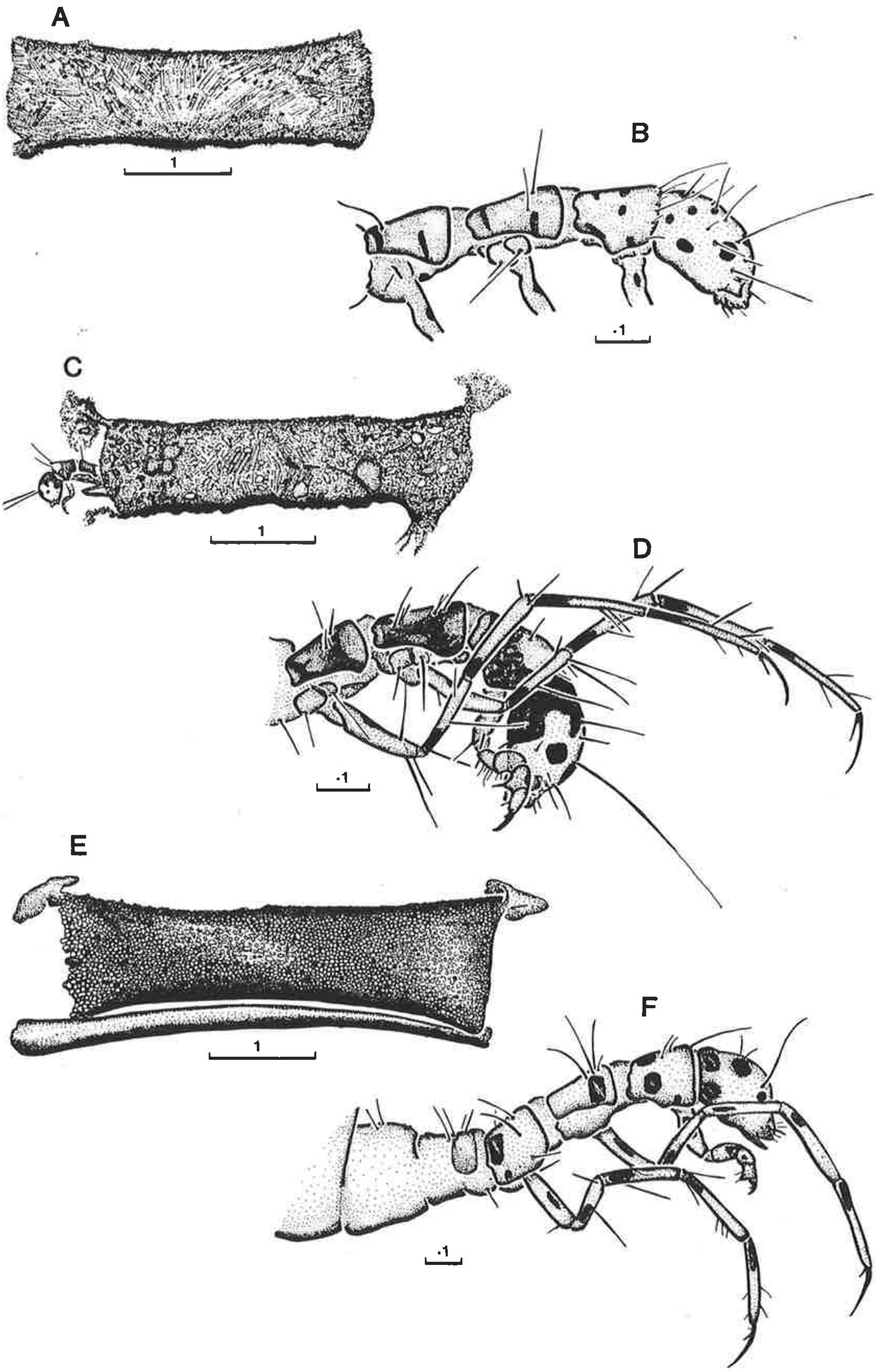


Plate 92A–F. A,B, *Hellyethira* *ramosa* Wells: A, case; B, mature larva.
C,D, *H*. *vernoni* Wells: C, case; D, mature larva.
E,F, *H*. *eskensis* (Mosely): E, case; F, mature larva.

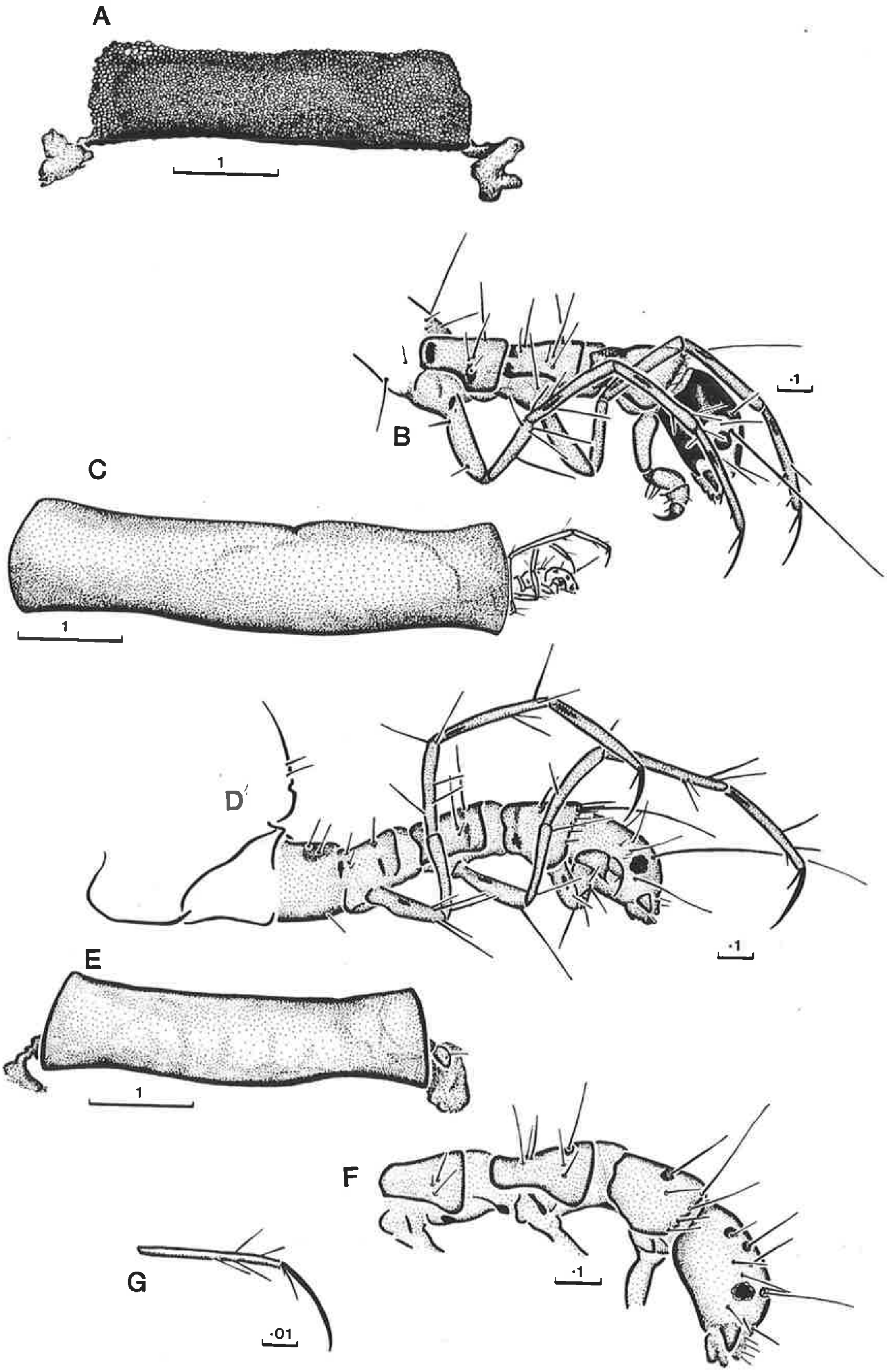


Plate 93A–G. A,B, Hellyethira cornuta Wells: A, case; B, mature larva.
C,D, H. malleoforma Wells: C, case; D, mature larva.
E–G, H. litua Wells: E, case; F, mature larva; G, midtarsal claw.

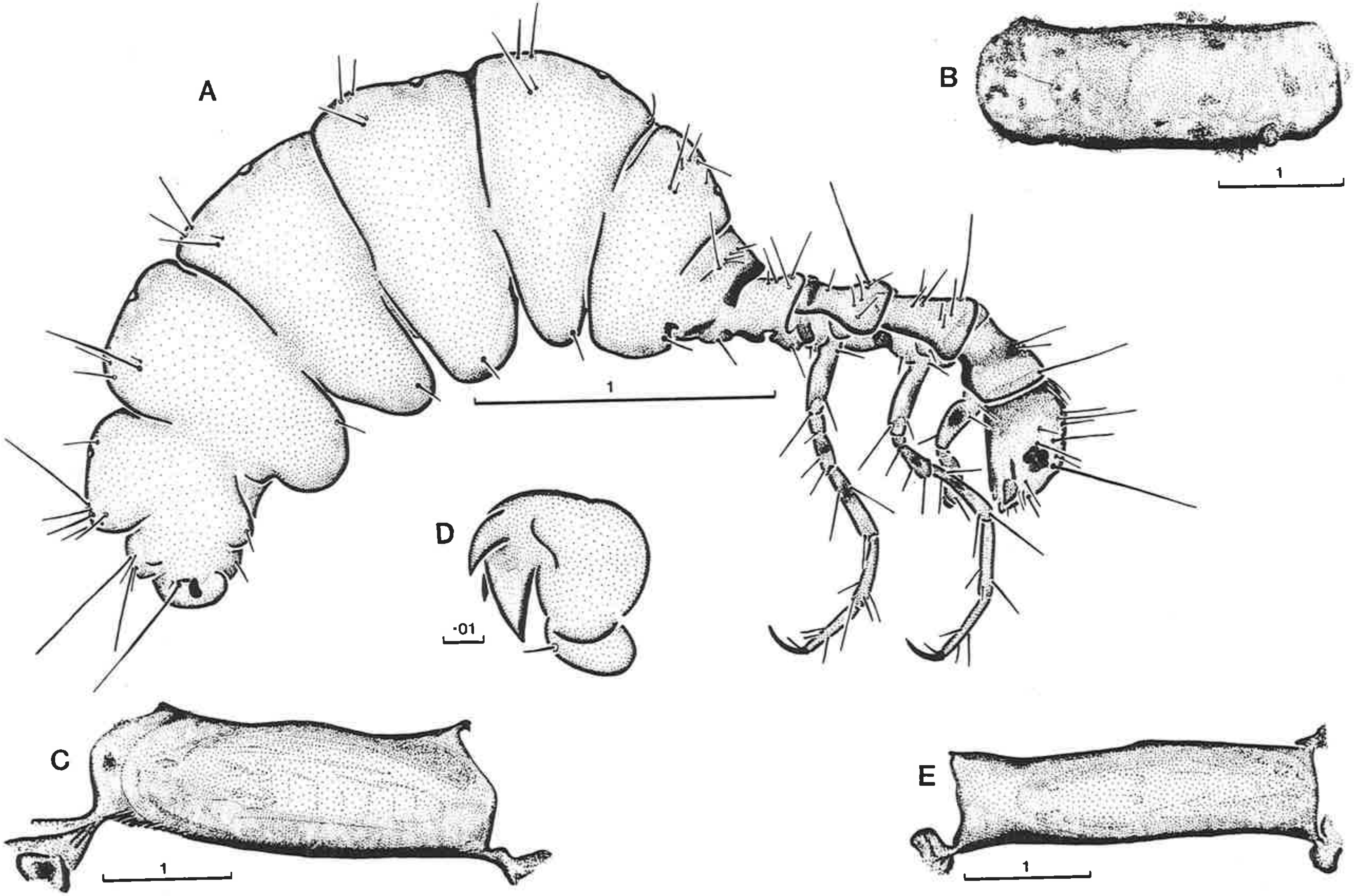


Plate 94A-E. A-D, Acritoptila globosa Wells: A, mature larva; B, larval case; C, pupal case; D, anal claw. E, A. margaretae Wells, pupal case.

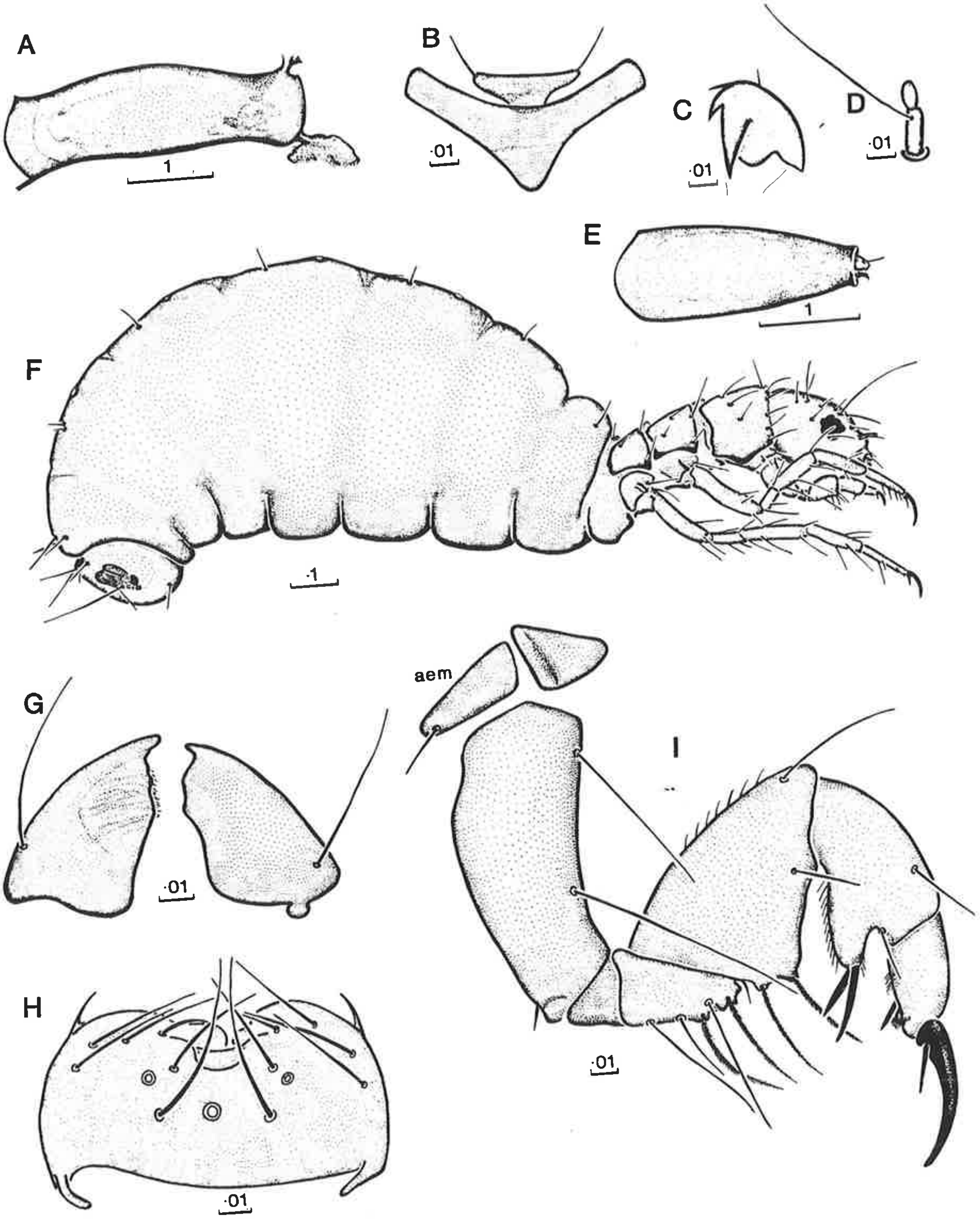


Plate 95A-I. A-D, Acanthotrichia bilamina Wells: A, pupal case; B, ventral sclerites of larval head; C, anal claw of larva; D, larval antenna.
E-I, Oxyethira columba (Neboiss): E, case; F, mature larva; G, mandibles; H, labrum; I, forelimb and propleuron.

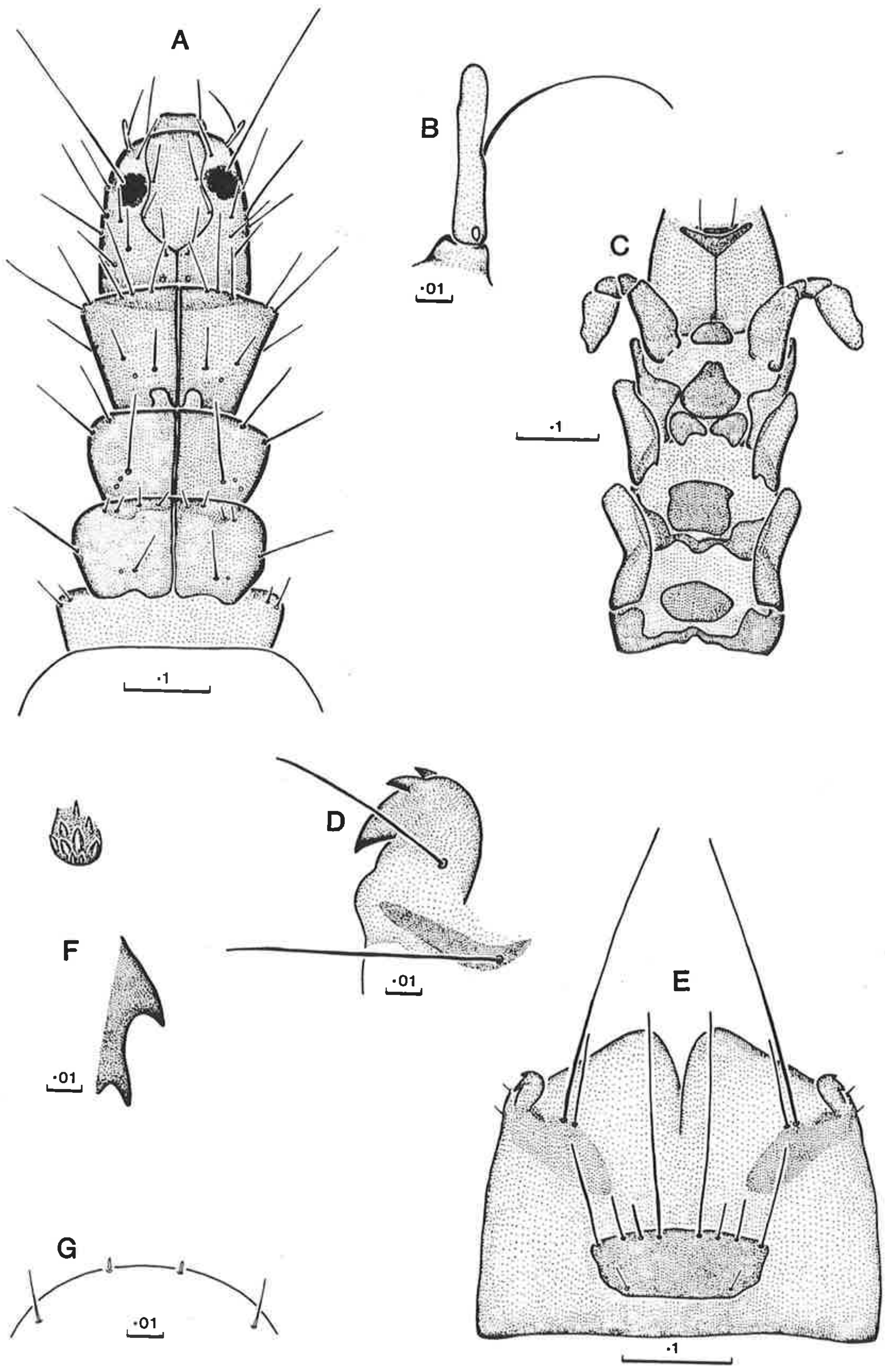


Plate 96A-G. *Oxyethira columba* (Neboiss): A, head and thorax, dorsal view; B, antenna; C, thorax, ventral view; D, anal claw; E, abdominal segments IX and X, dorsal view; F, pupal hook plates; G, pupal labrum.

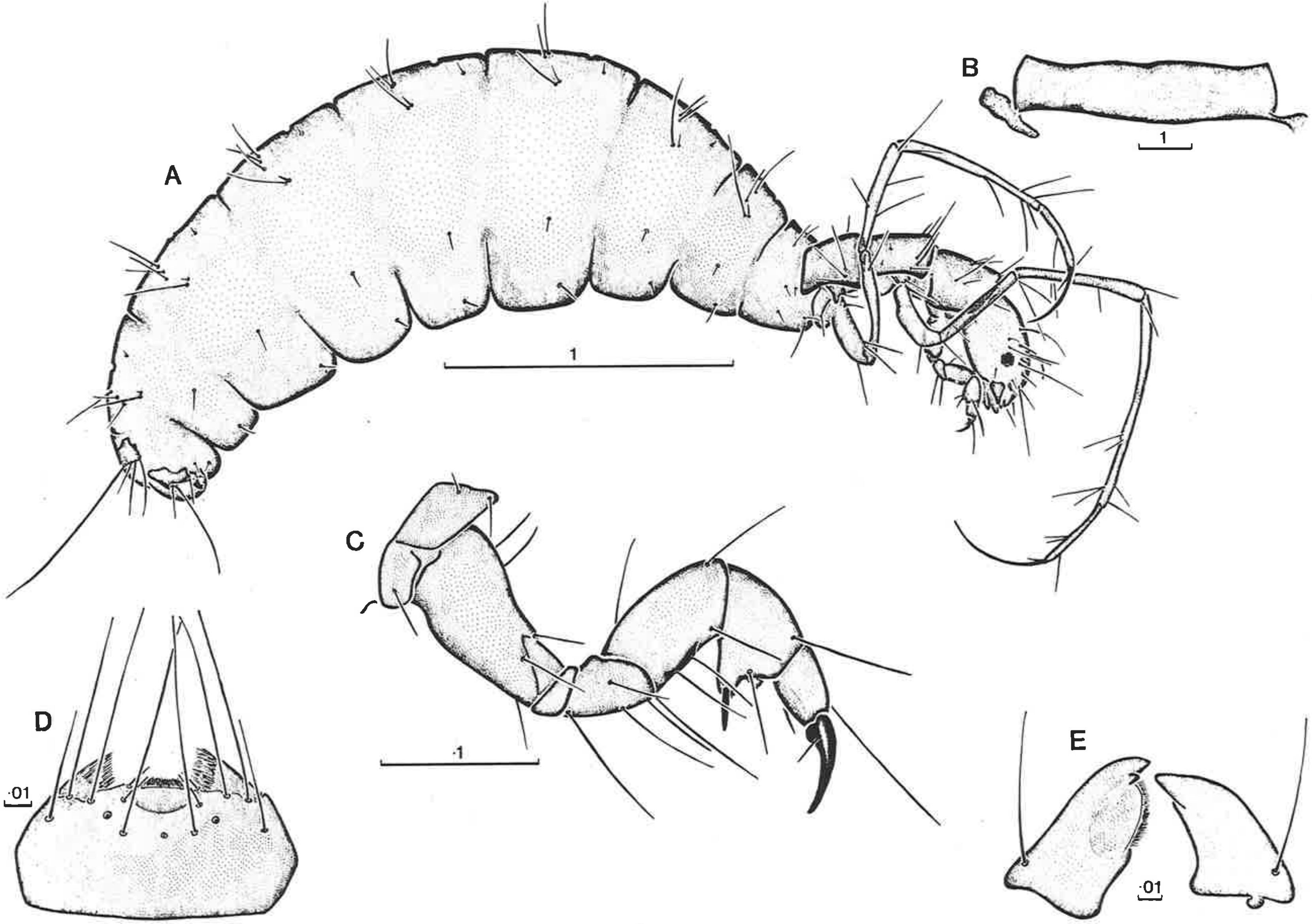


Plate 97A-E. *Tricholeiochiton* *fidelis* Wells: A, mature larva; B, case; C, forelimb and propleuron; D, labrum; E, mandibles.

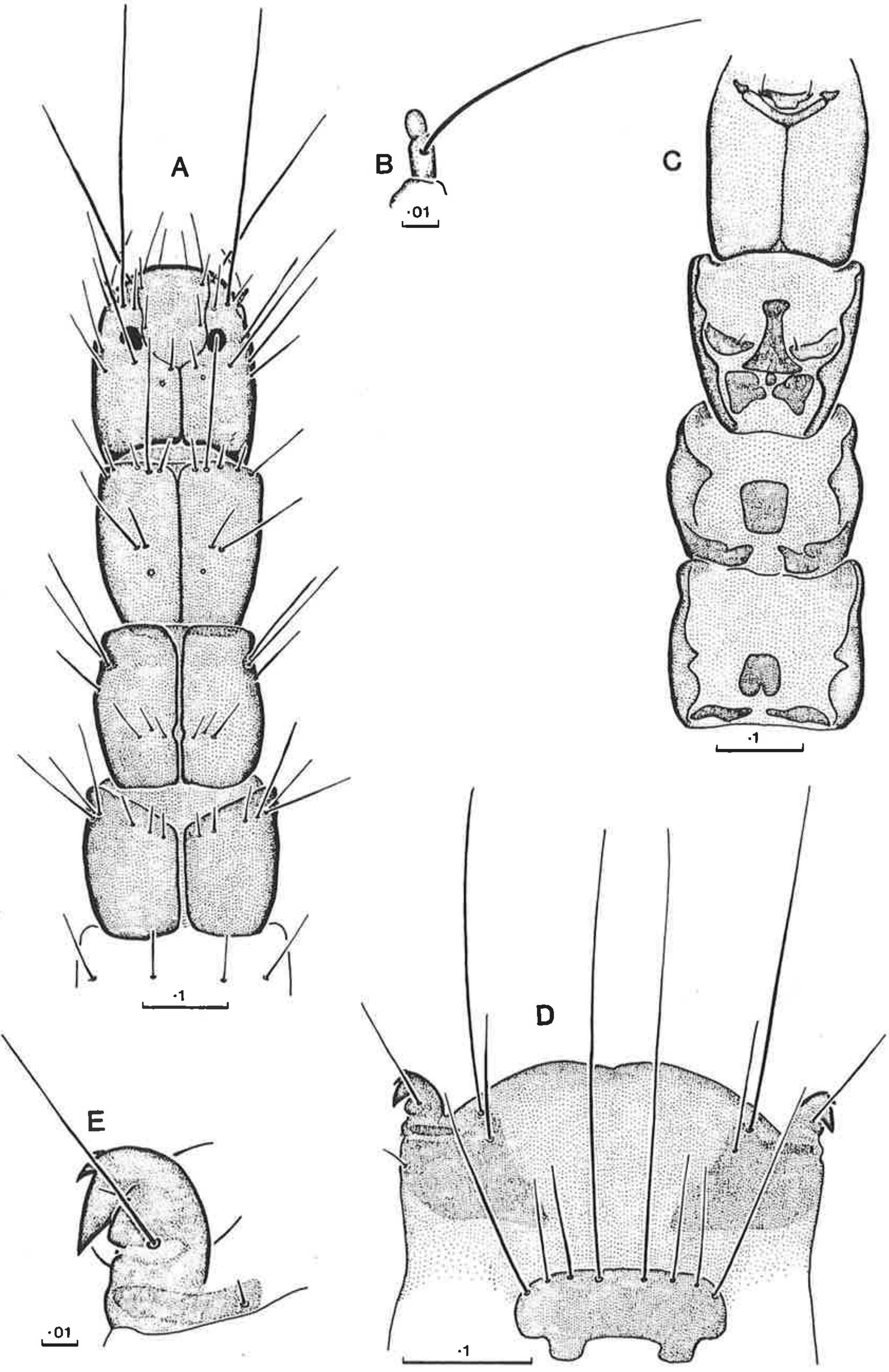


Plate 98A-E. *Tricholeiochiton fidelis* Wells, mature larva: A, head and thorax, dorsal view; B, antenna; C, head and thorax, ventral view; D, abdominal segments IX and X, dorsal view; E, anal proleg.

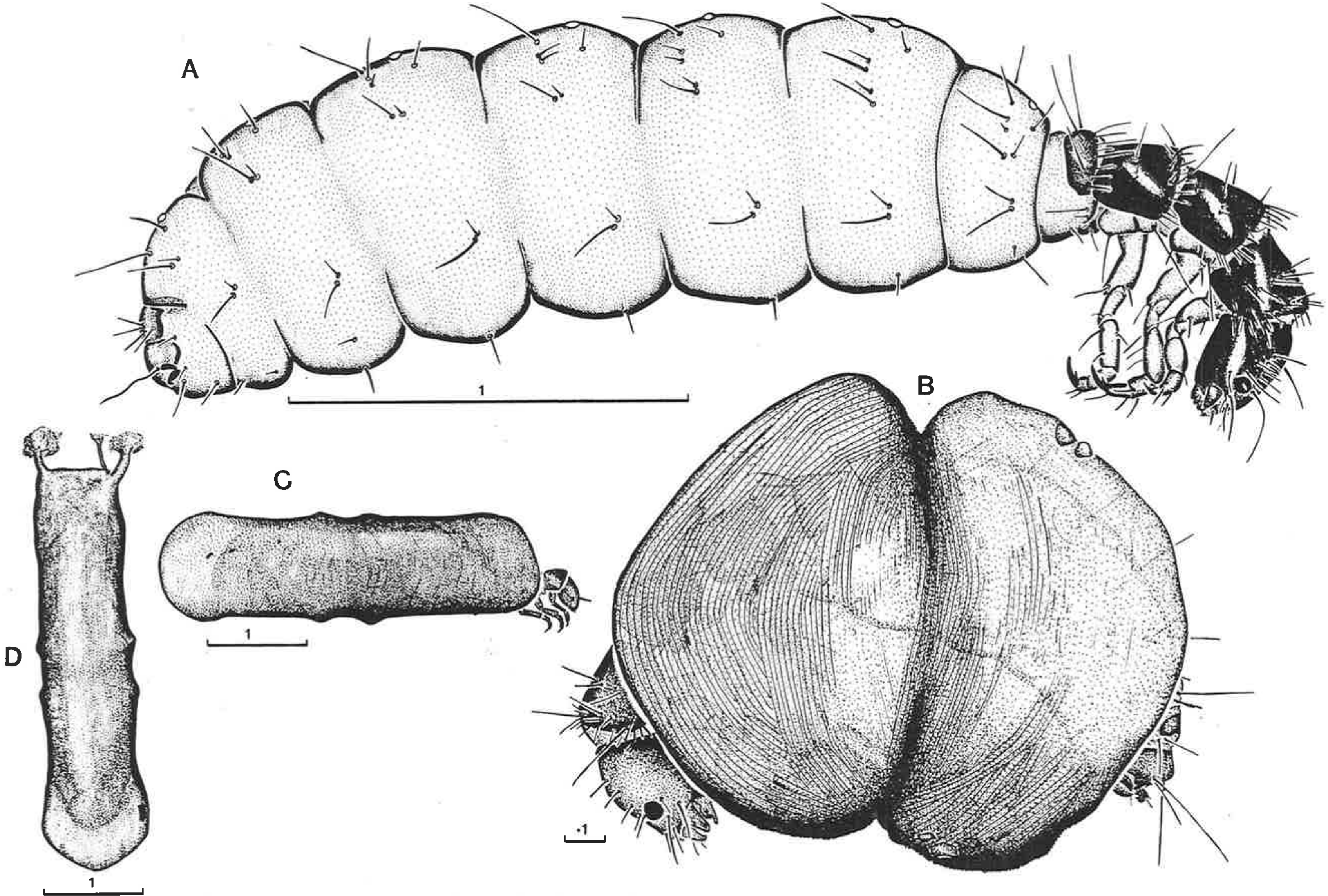


Plate 99A-D. *Orphninotrichia maculata* Mosely: A, mature larva; B, early fifth-instar larva and case; C, mature larval case; D, pupal case.

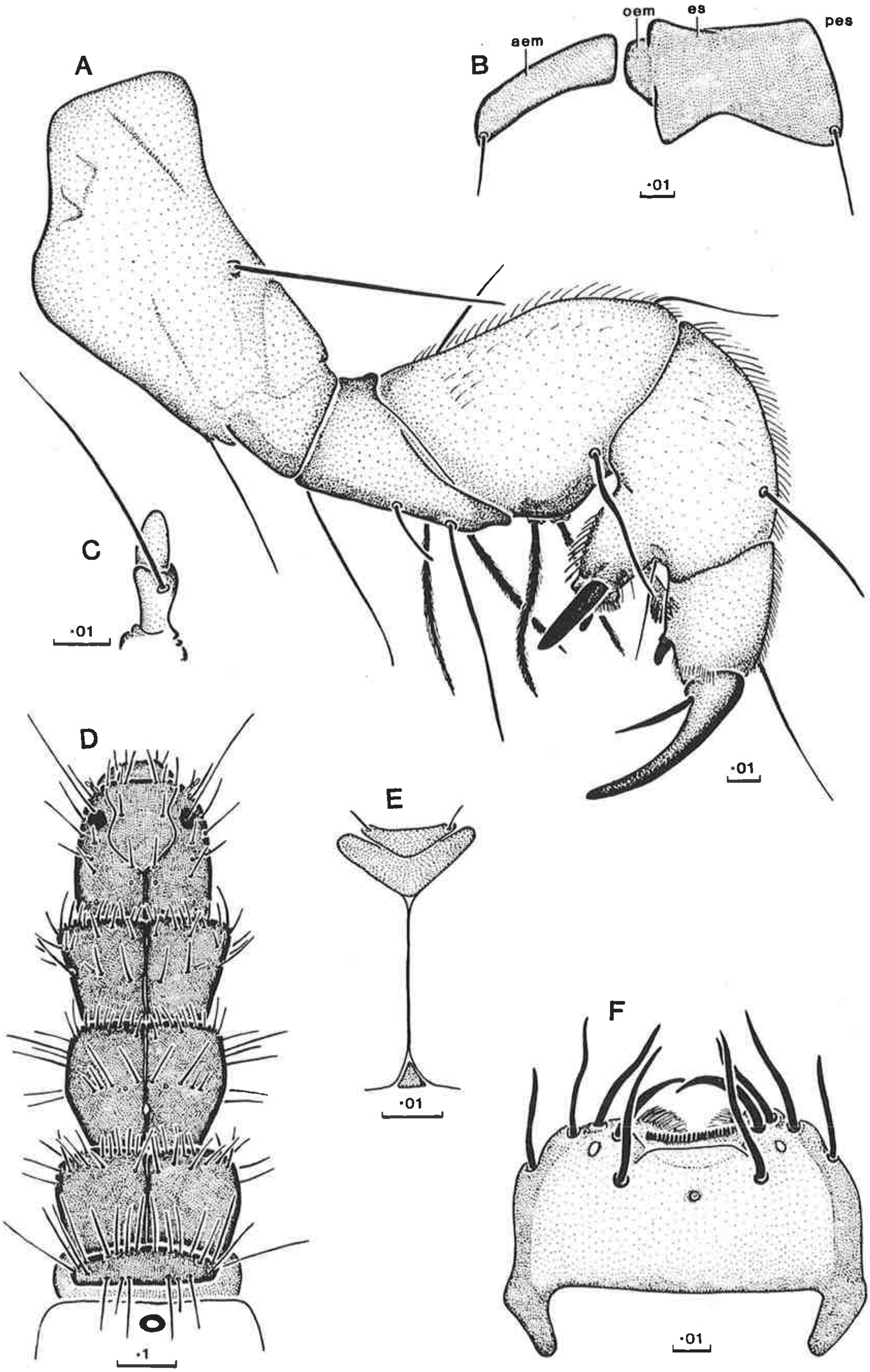


Plate 100A-F. <u>Orphninotrichia</u> <u>maculata</u> Mosely, mature larva: A, forelimb; B, propleuron; C, antenna; D, head and thorax, dorsal view; E, ventral sclerites of head; F, labrum.

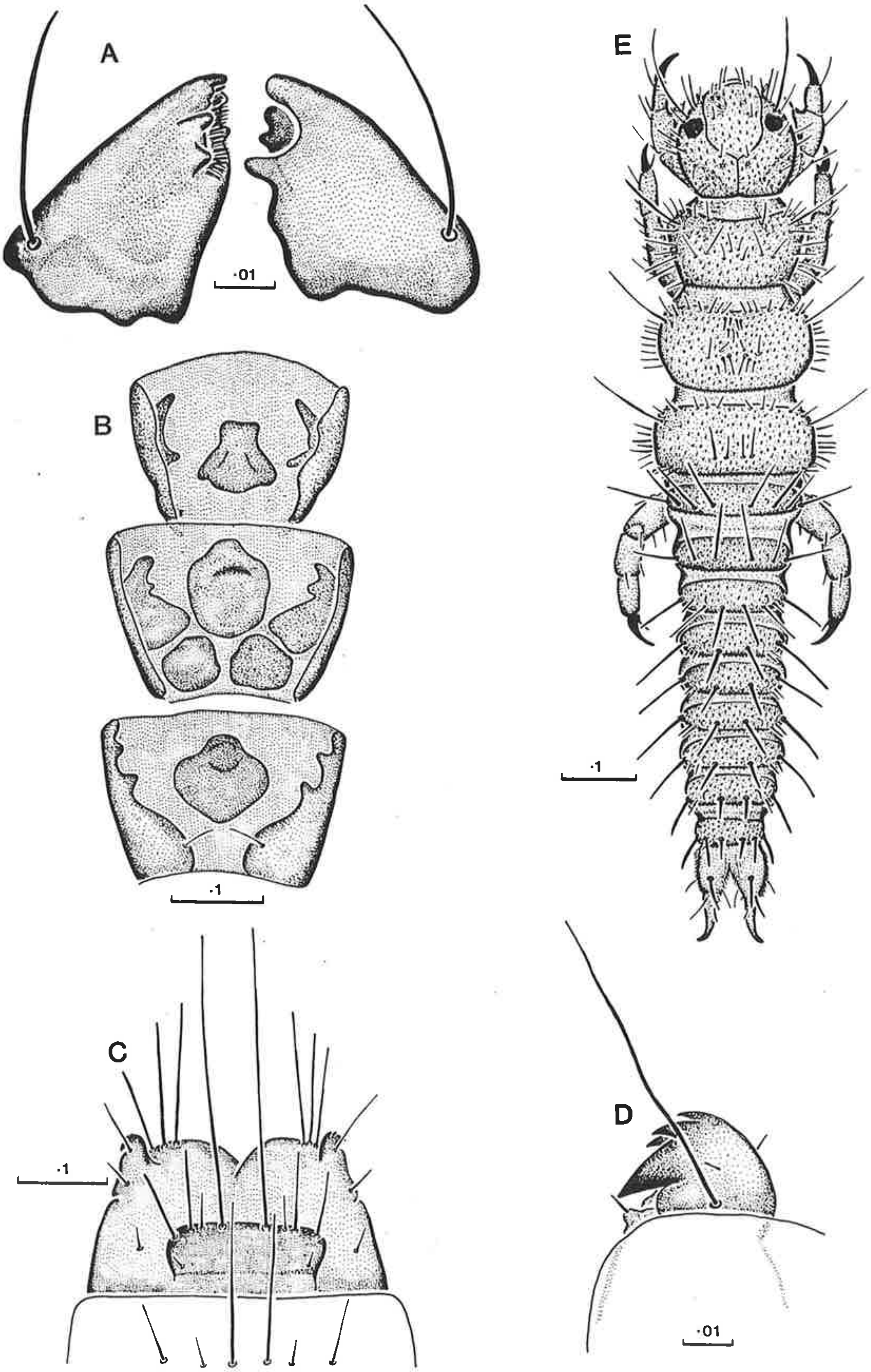


Plate 101A-E. A-D, *Orphninotrichia maculata* Mosely, mature larva: A, mandibles; B, thorax, ventral view; C, abdominal segments IX and X, dorsal view; D, anal proleg. E, *O. maculata* Mosely, fourth-instar larva.

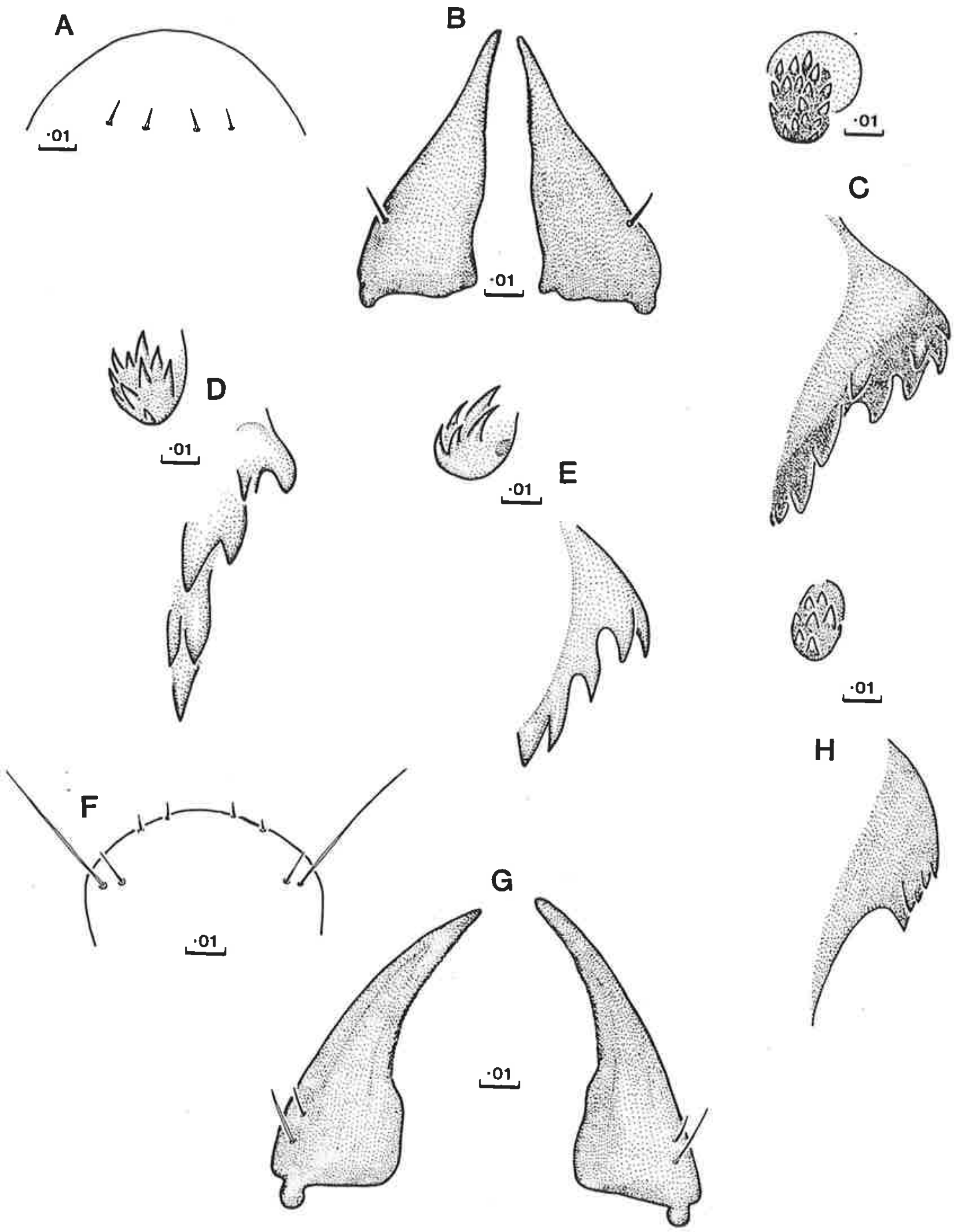


Plate 102A-H. A-C, *Orphninotrichia maculata* Mosely, pupal parts:
A, labrum; B, mandibles; C, hook plates.
D, *O. benambrica* Wells, pupal hook plates.
E, *O. subulata* Wells, pupal hook plates.
F-H, *Maydenoptila rupina* Neboiss, pupal parts: F, labrum;
G, mandibles; H, hook plates.

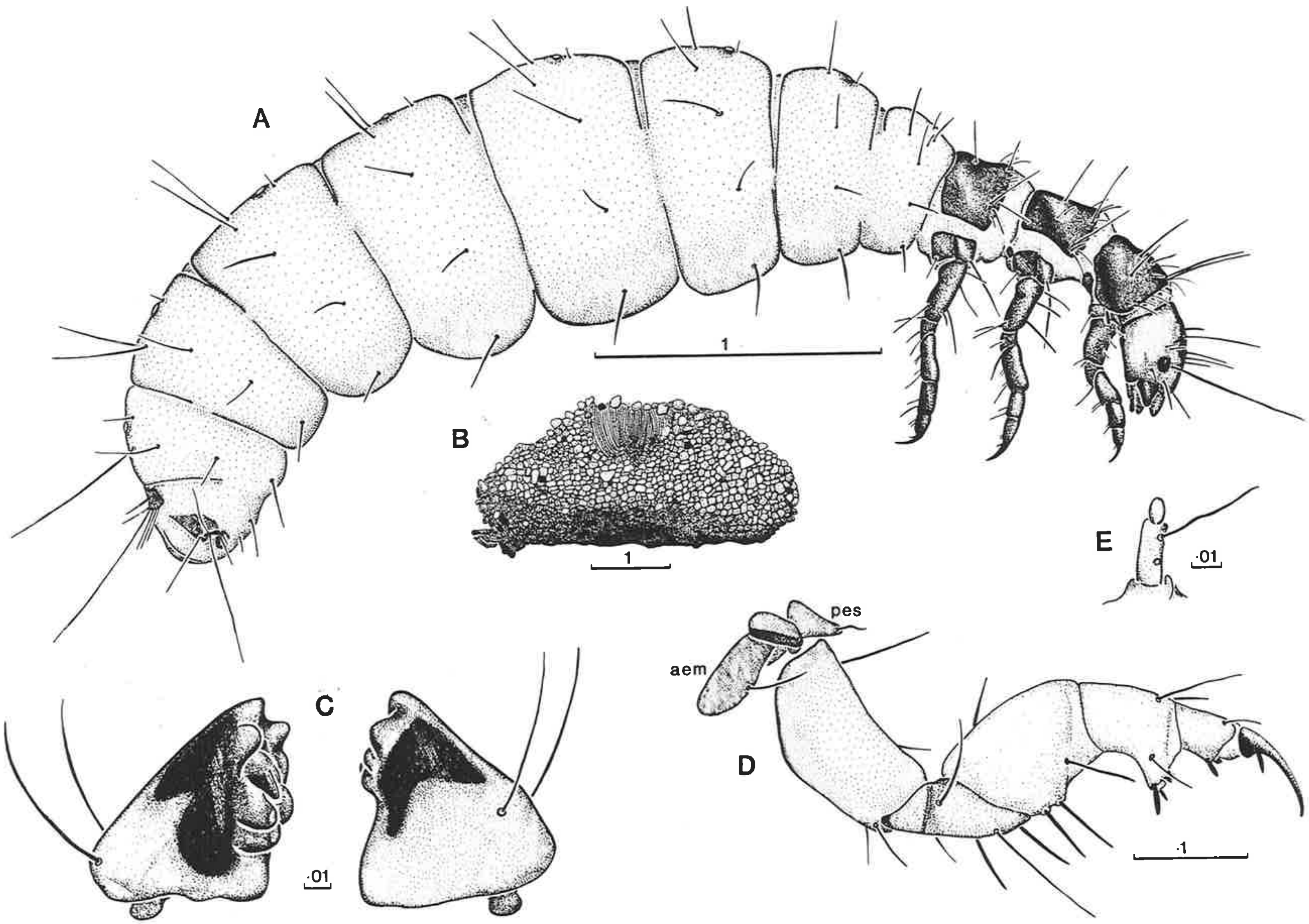


Plate 103A-E. Maydenoptila rupina Neboiss: A, mature larva; B, case; C, mandibles; D, forelimb and propleuron; E, antenna.

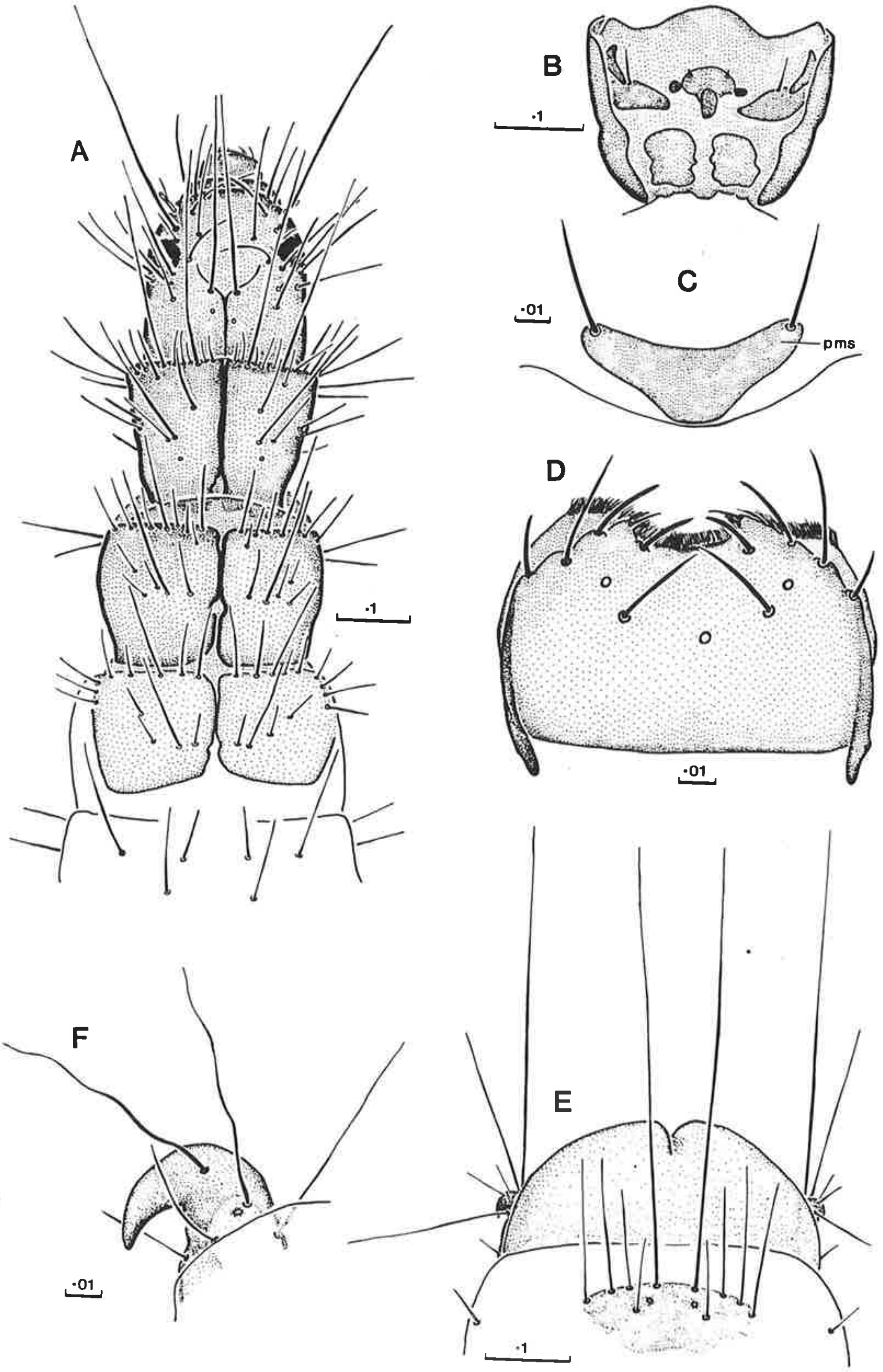


Plate 104A–F. *Maydenoptila rupina* Neboiss, mature larva: A, head and thorax, dorsal view; B, prothorax, ventral view; C, postmental sclerite; D, labrum; E, abdominal segments IX and X, dorsal view; F, anal proleg.

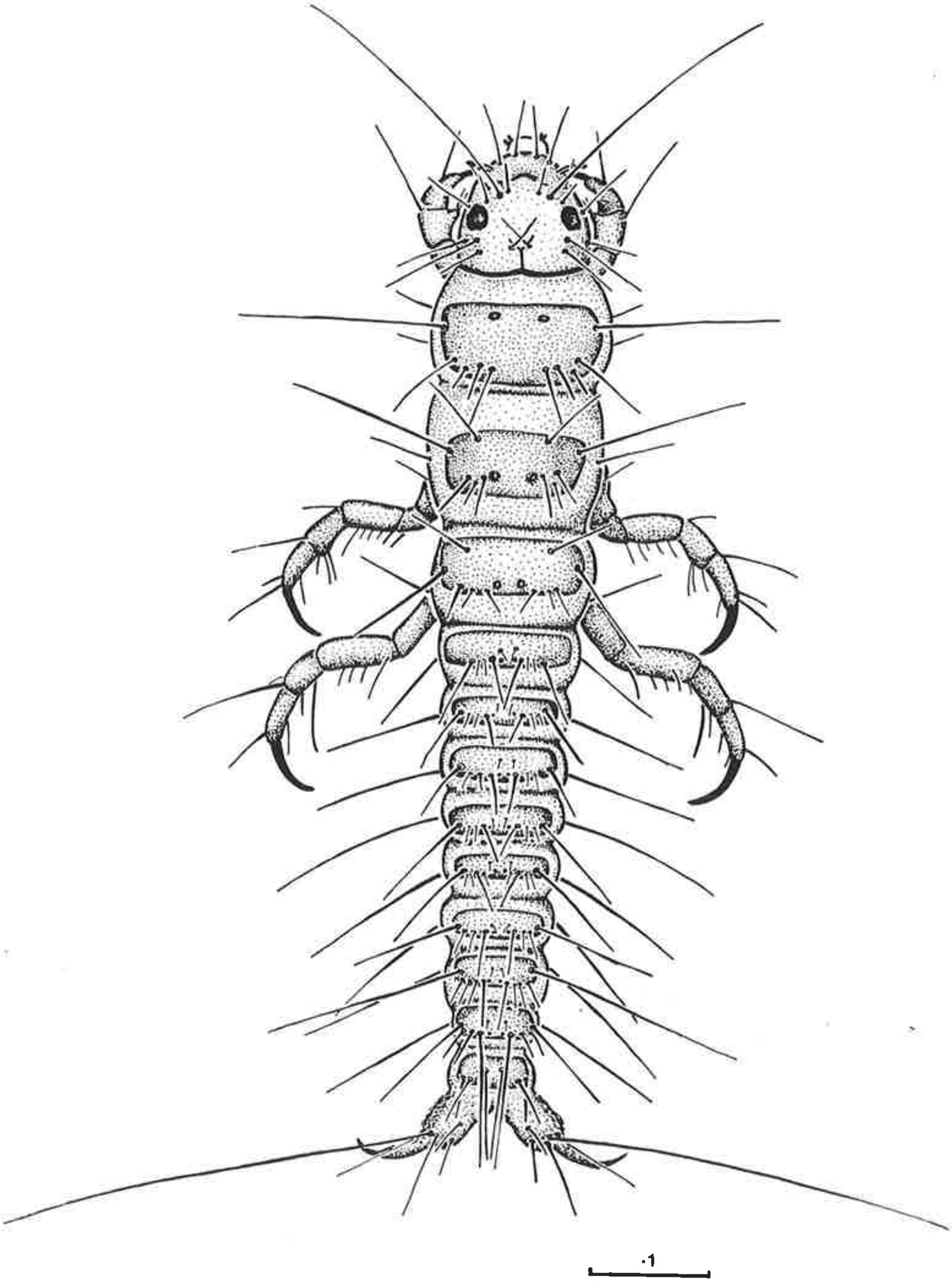


Plate 105. Maydenoptila rupina Neboiss, fourth-instar larva.

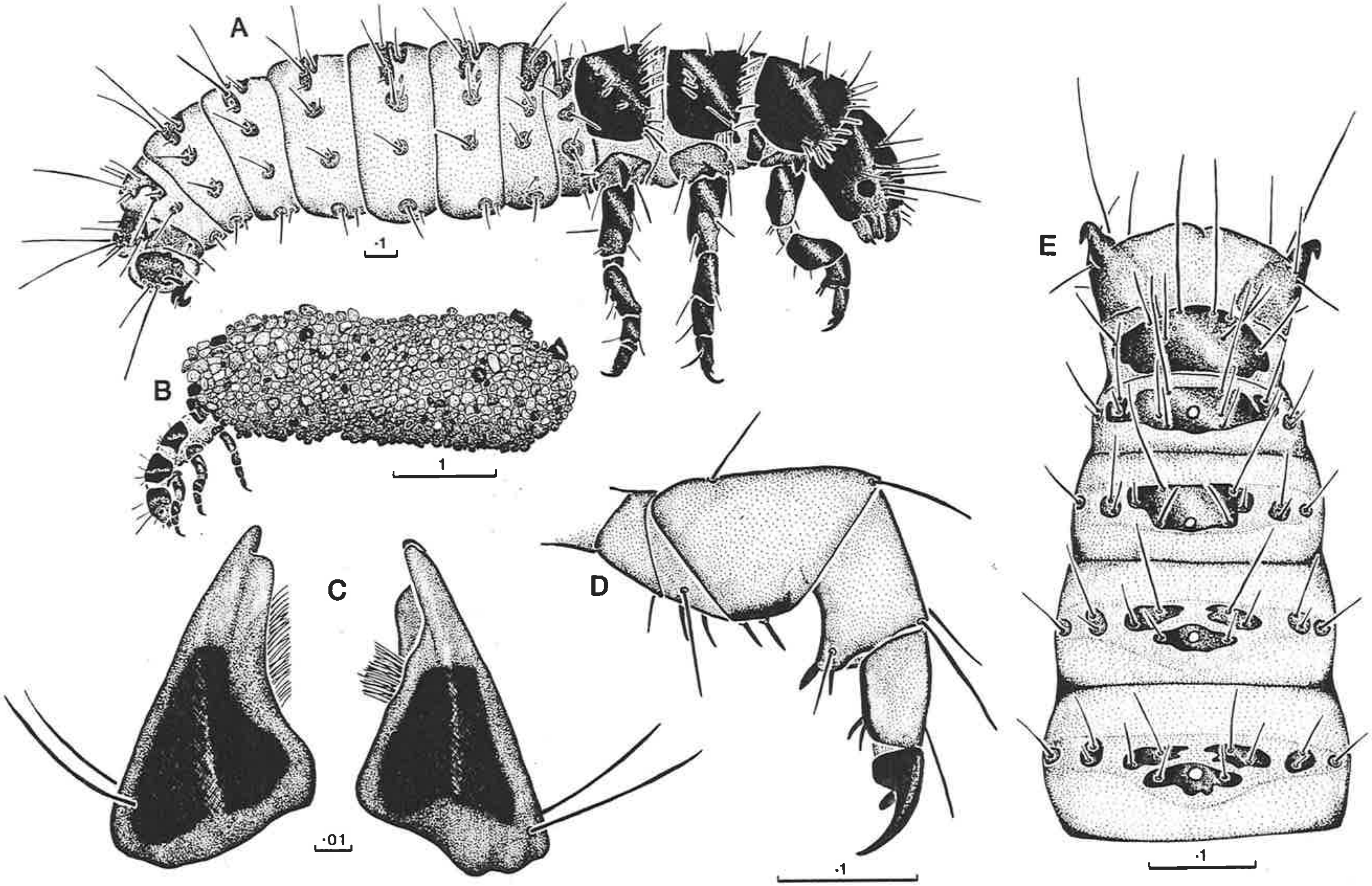


Plate 106A–E. Maydenoptila baynesi Wells: A, mature larva; B, mature larval case; C, mandibles; D, forelimb; E, terminal abdominal segments, dorsal view.

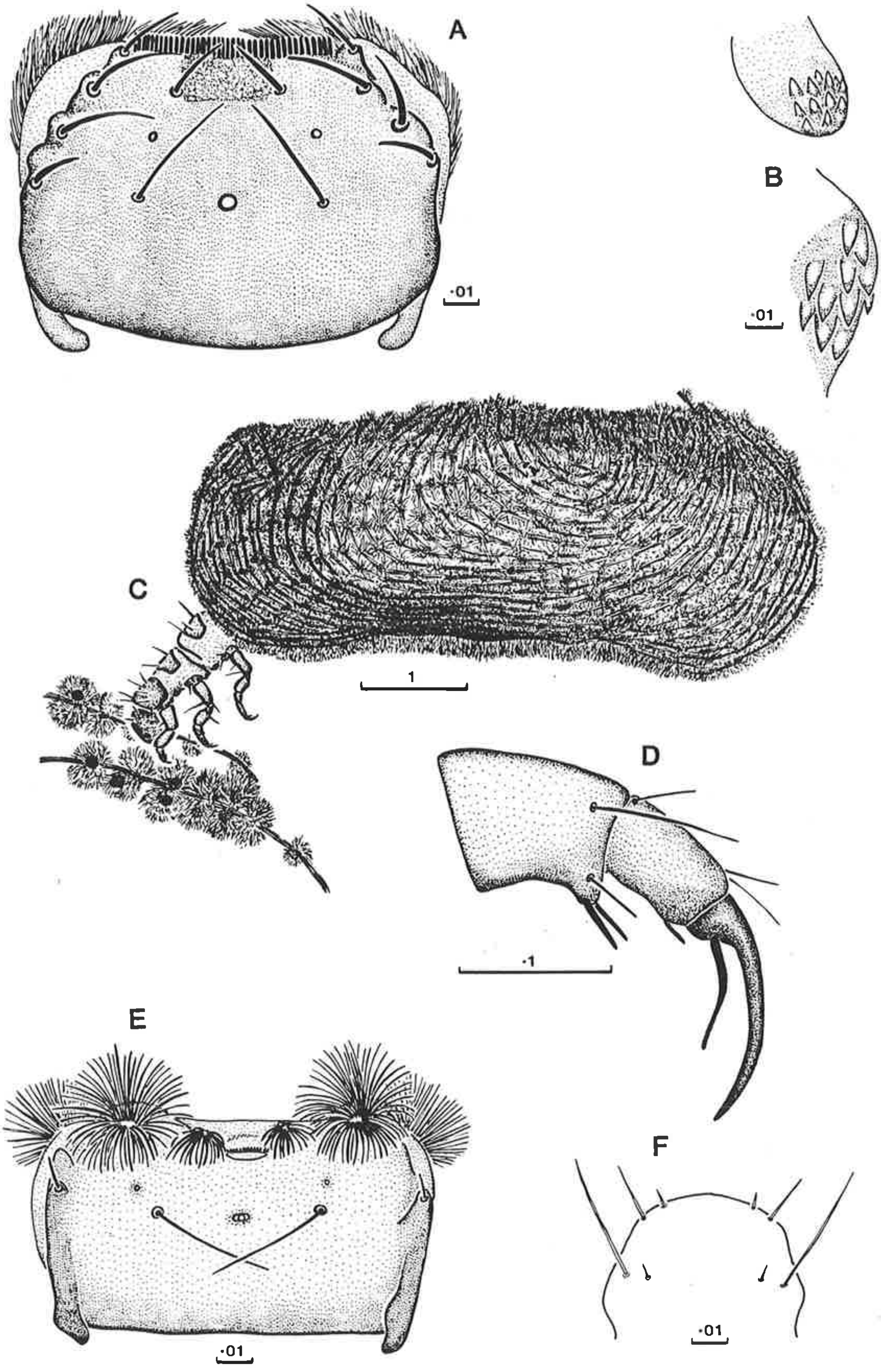


Plate 107A-F.   A,B, *Maydenoptila baynesi* Wells: A, larval labrum; B, pupal hook plates.
C-F, *M. cuneola* Neboiss: C, mature larval case; D, distal elements of forelimb; e, larval labrum; E, pupal labrum.

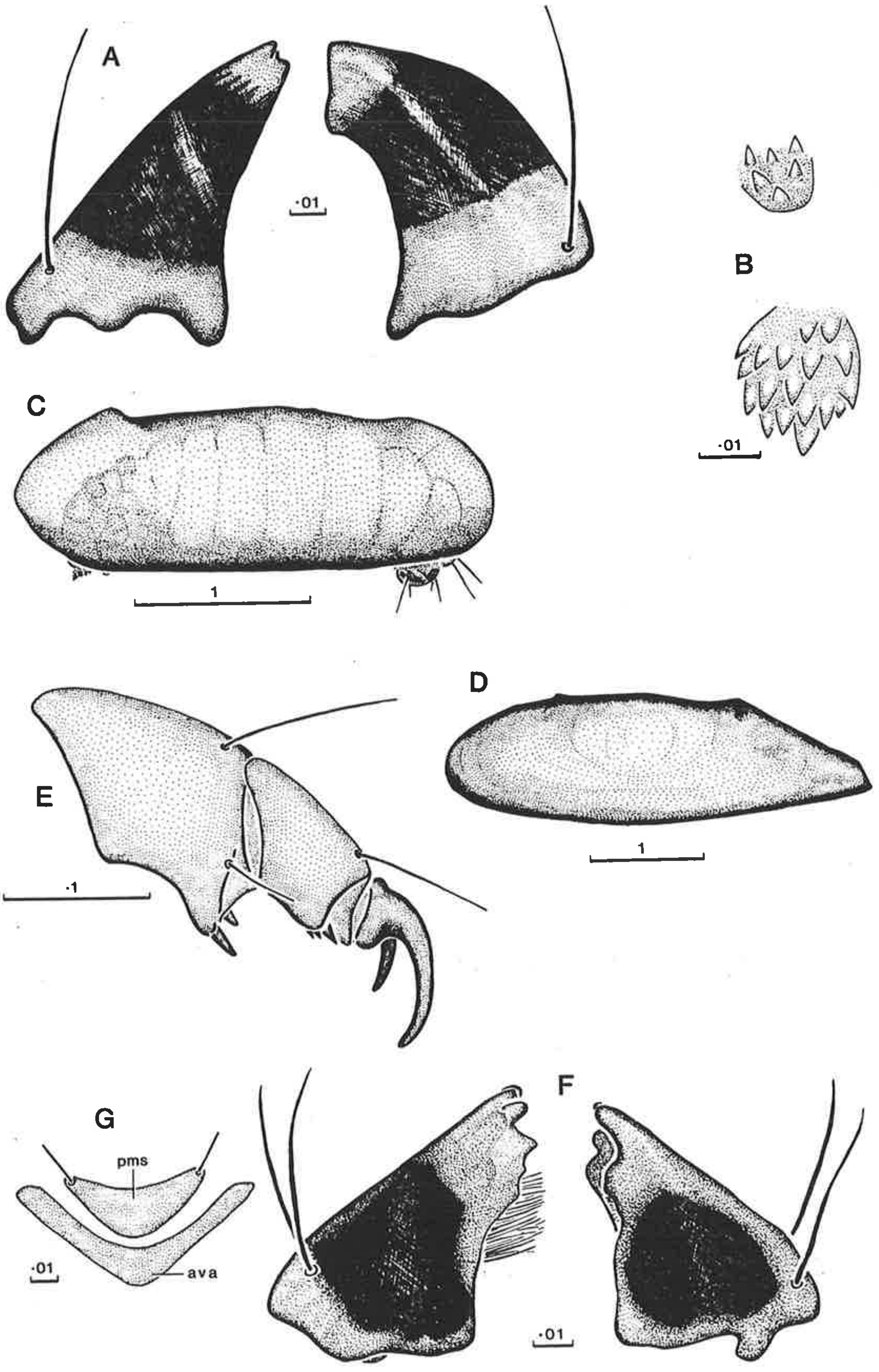


Plate 108A-G. A,B, Maydenoptila cuneola Neboiss: A, larval mandibles; B, pupal hook plates.
C-G, M. pseudorupina Wells: C, mature larval case; D, pupal case; E, distal elements of forelimb; F, larval mandibles; G, ventral sclerites of head.

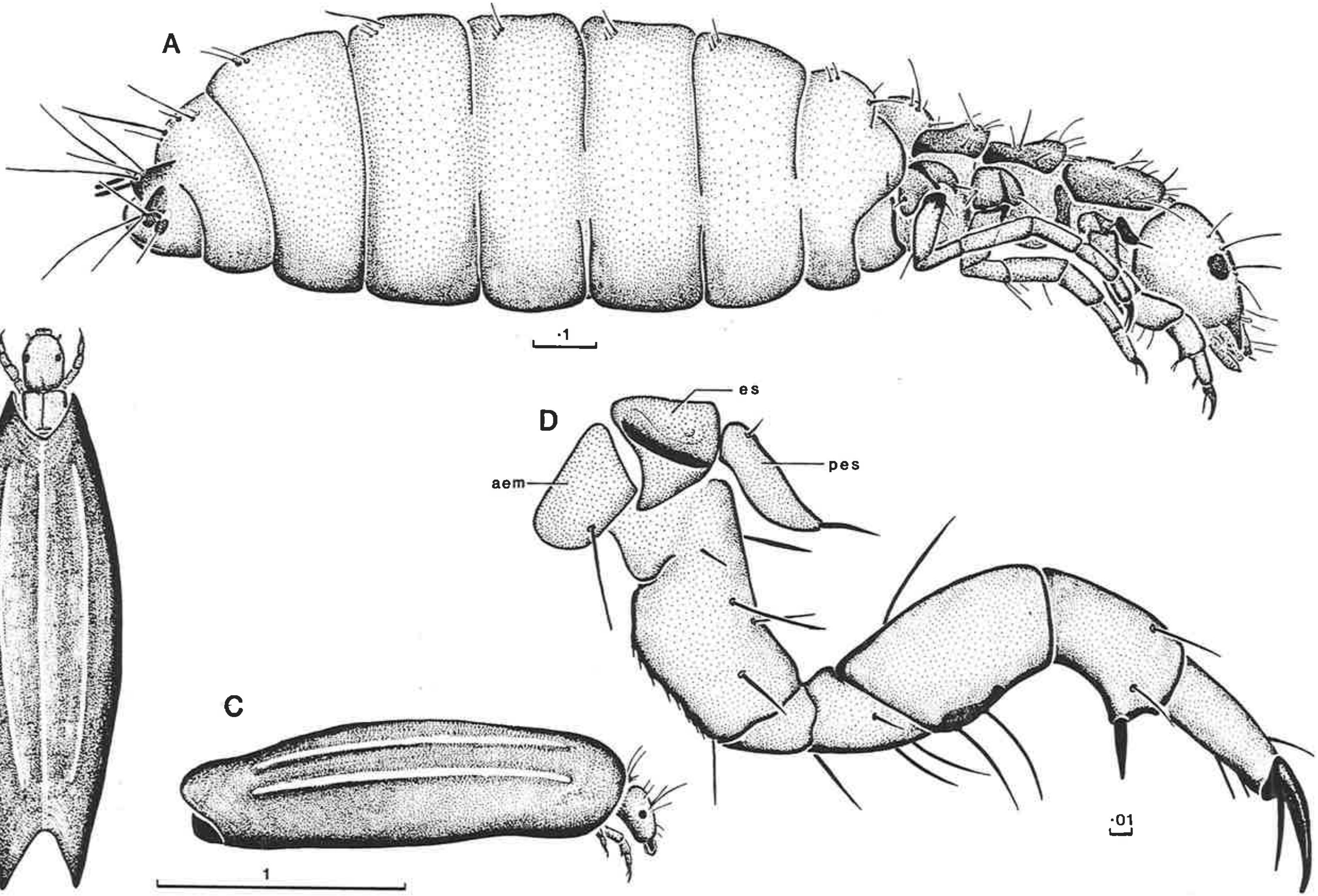


Plate 109A-D. *Orthotrichia bishopi* Wells: A, mature larva, lateral view; B, mature larval case, dorsal view; C, mature larval case, lateral view; D, forelimb and propleuron.

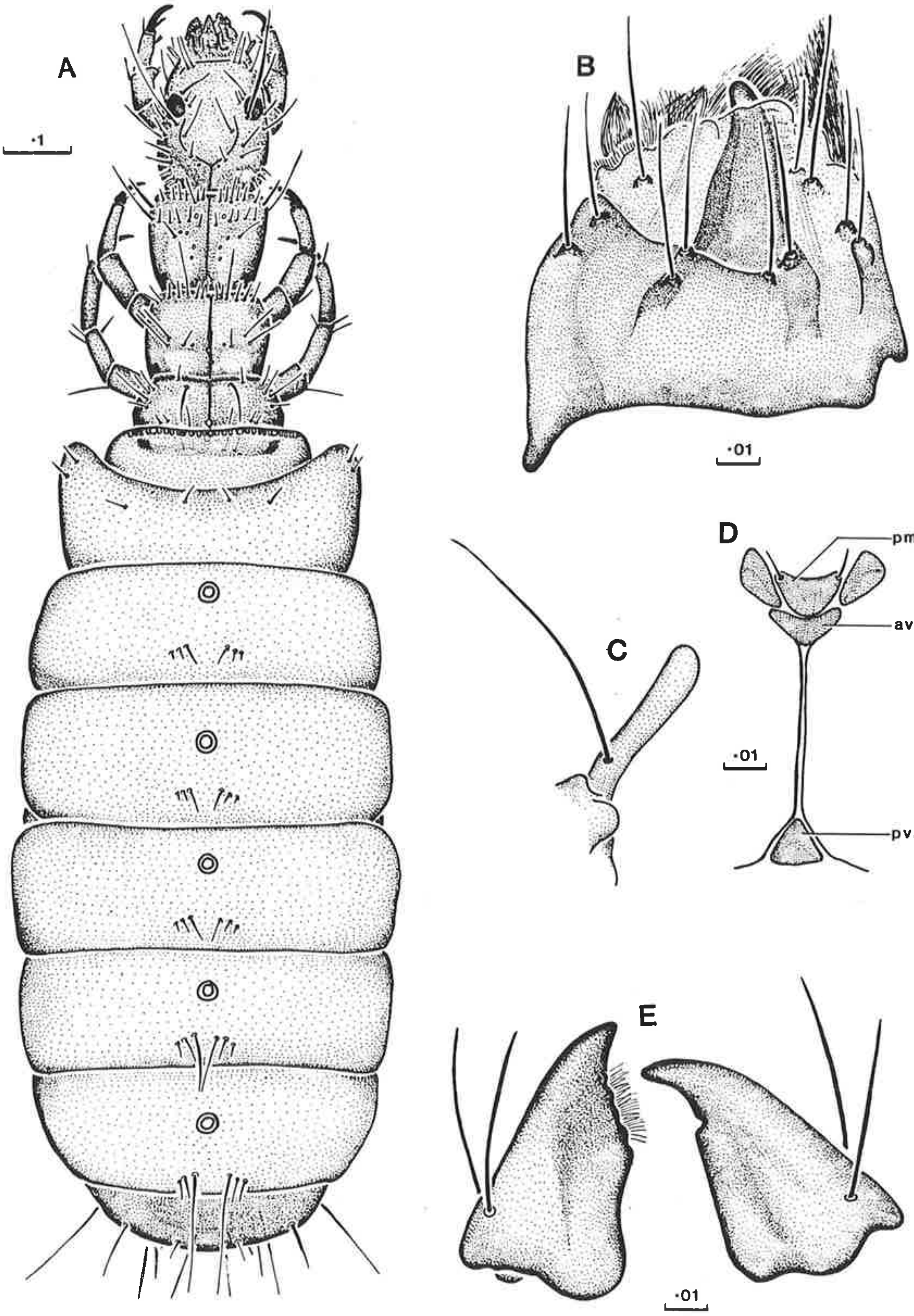


Plate 110A–E. Orthotrichia bishopi Wells, mature larva: A, dorsal view; B, labrum; C, antenna; D, ventral sclerites of head; E, mandibles.

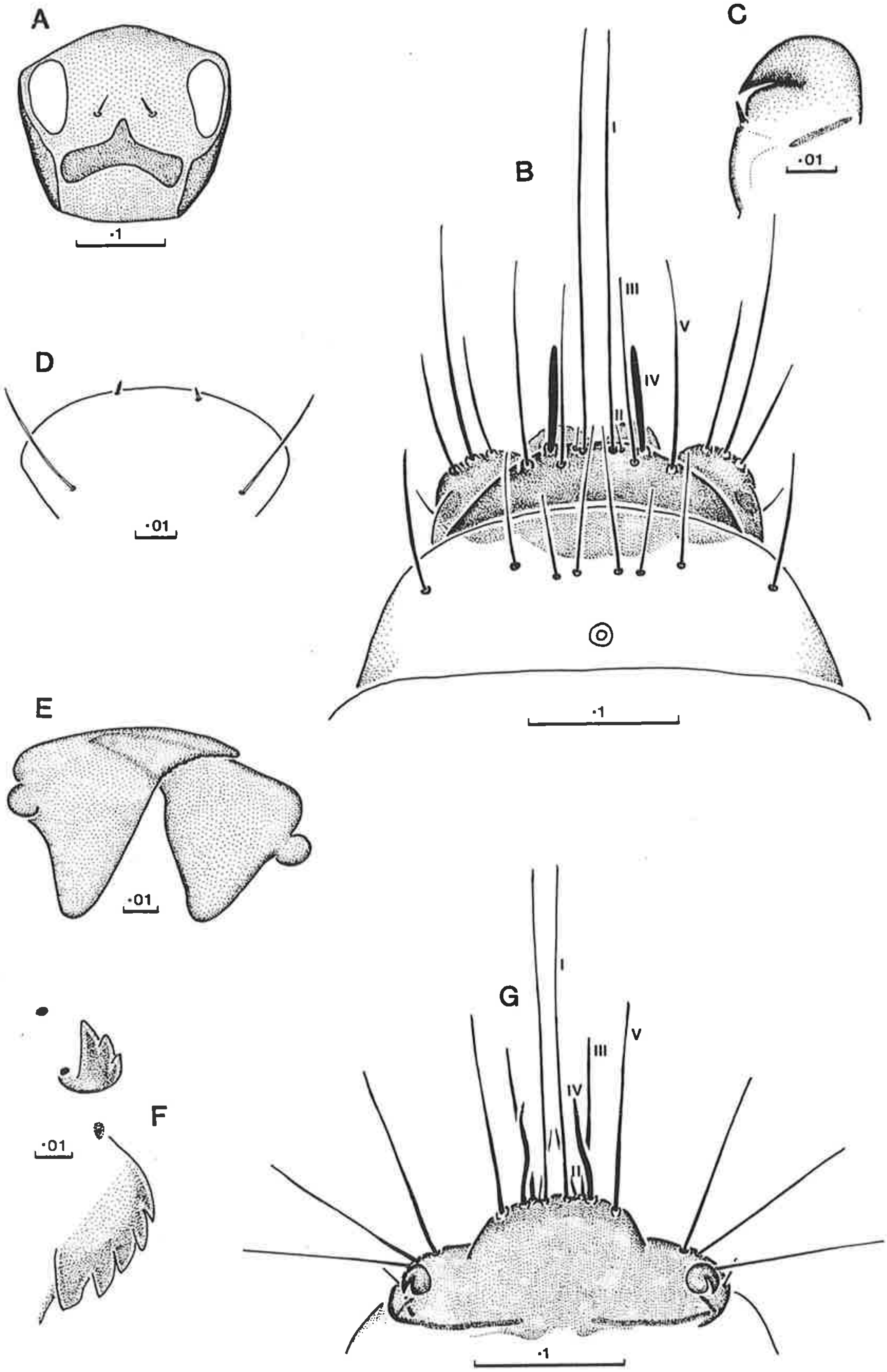


Plate 111A-G. *Orthotrichia bishopi* Wells: A, prothorax, ventral view; B, terminal abdominal segments, dorsal view; C, anal proleg; D, pupal labrum; E, pupal mandibles; F, pupal hook plates; G, abdominal segments IX and X, ventral view.

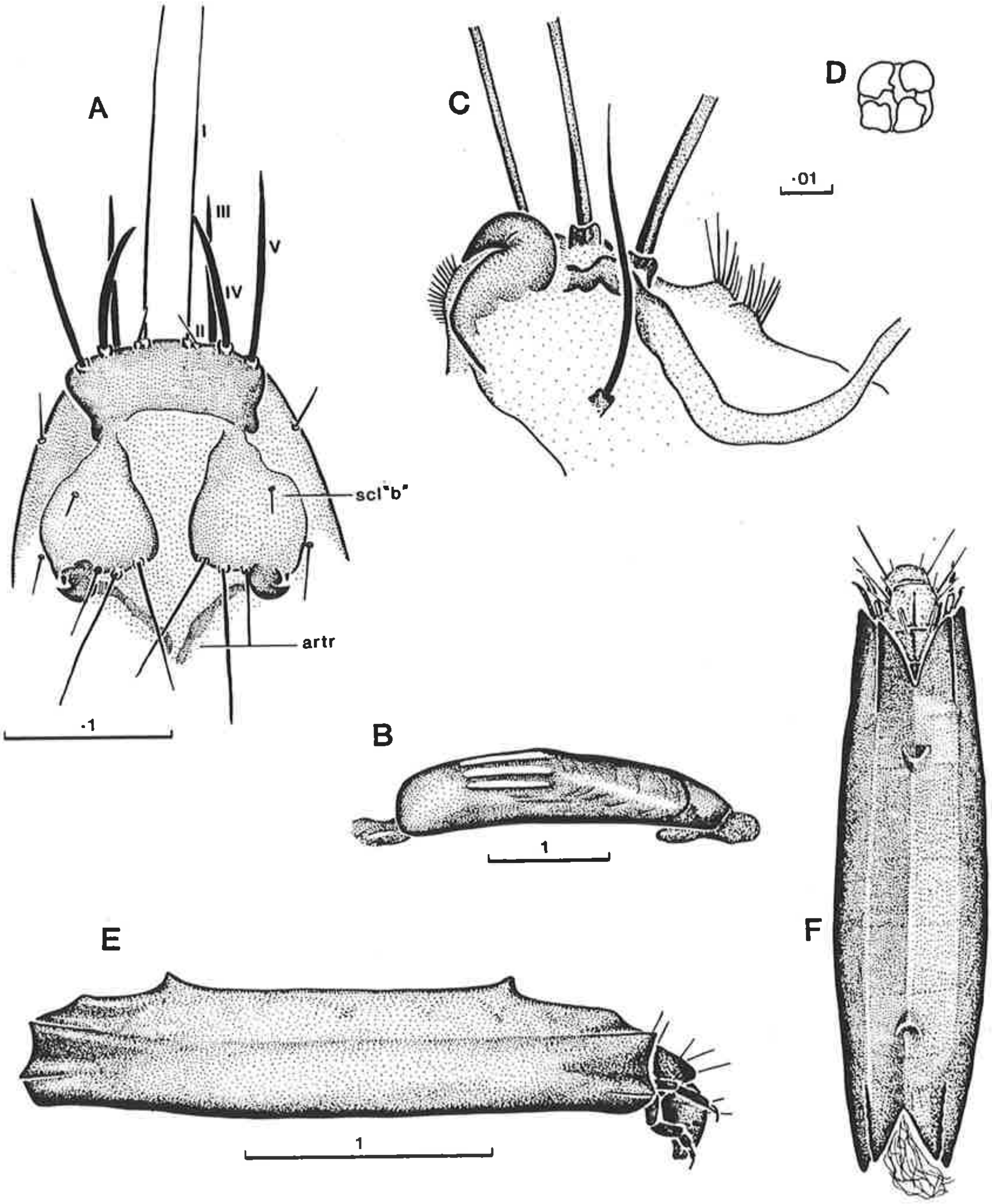


Plate 112A-F. A, Orthotrichia atraseta Wells, abdominal segments IX and X, ventral view.
B, O. armata Wells, pupal case.
C-F, O. turrita Wells: C, anal proleg; D, dorsal chloride epithelia; E, mature larval case, lateral view; F, mature larval case, dorsal view.

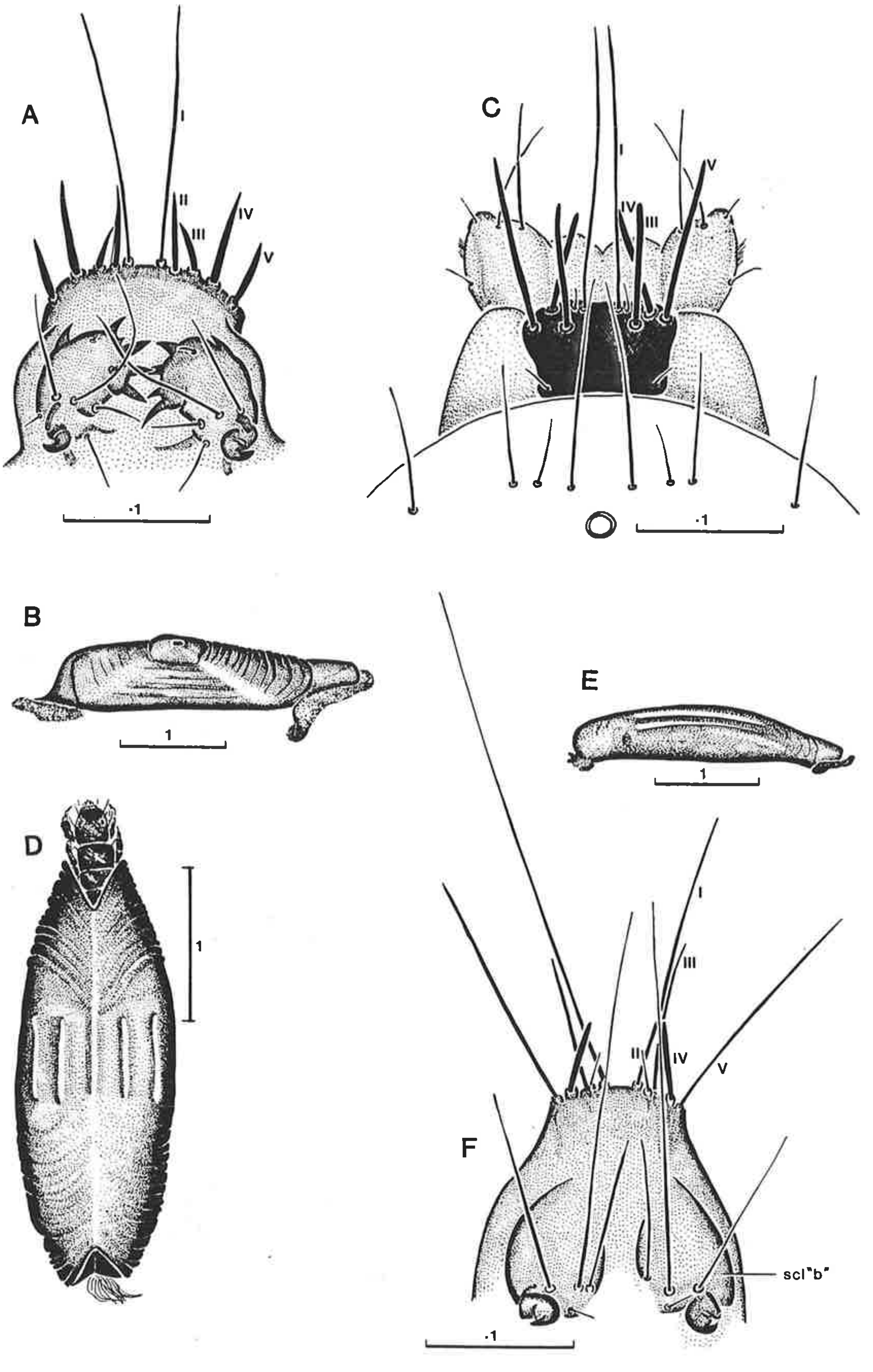


Plate 113A-F. A, *Orthotrichia velata* Wells, abdominal segments IX and X, ventral view.
B, *O. morula* Wells, pupal case.
C,D, *O. tortuosa* Wells: C, abdominal segments IX and X, dorsal view; D, mature larval case, dorsal view.
E, *O. stipa* Wells, pupal case.
F, *O. capillata* Wells, abdominal segments IX and X, ventral view.

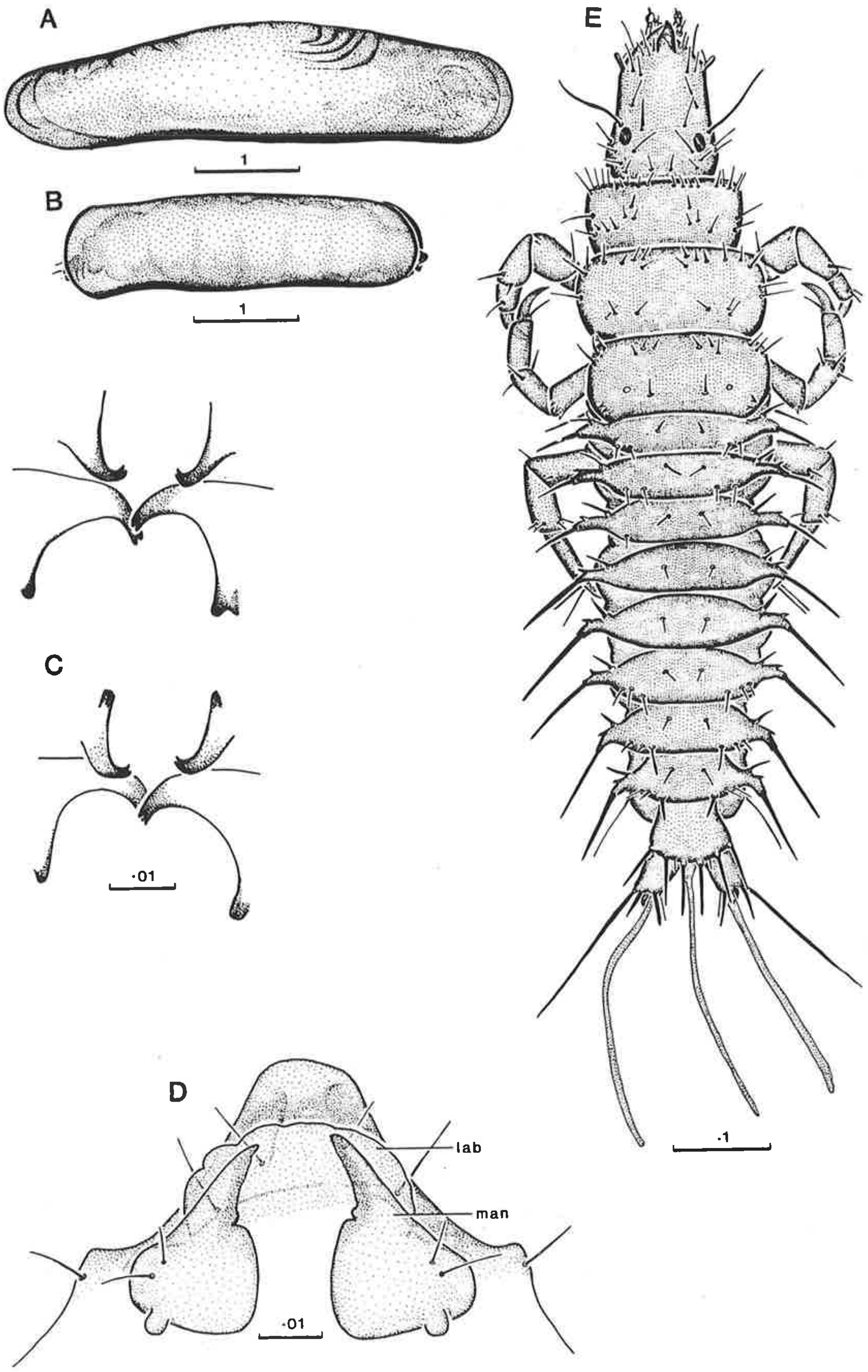


Plate 114A-E. A-D, *Orthotrichia aberrans* Wells: A, pupal case; B, larval case; C, pupal hook plates; D, pupal head, ventral view.
E, *Orthotrichia* sp., early-instar larva.

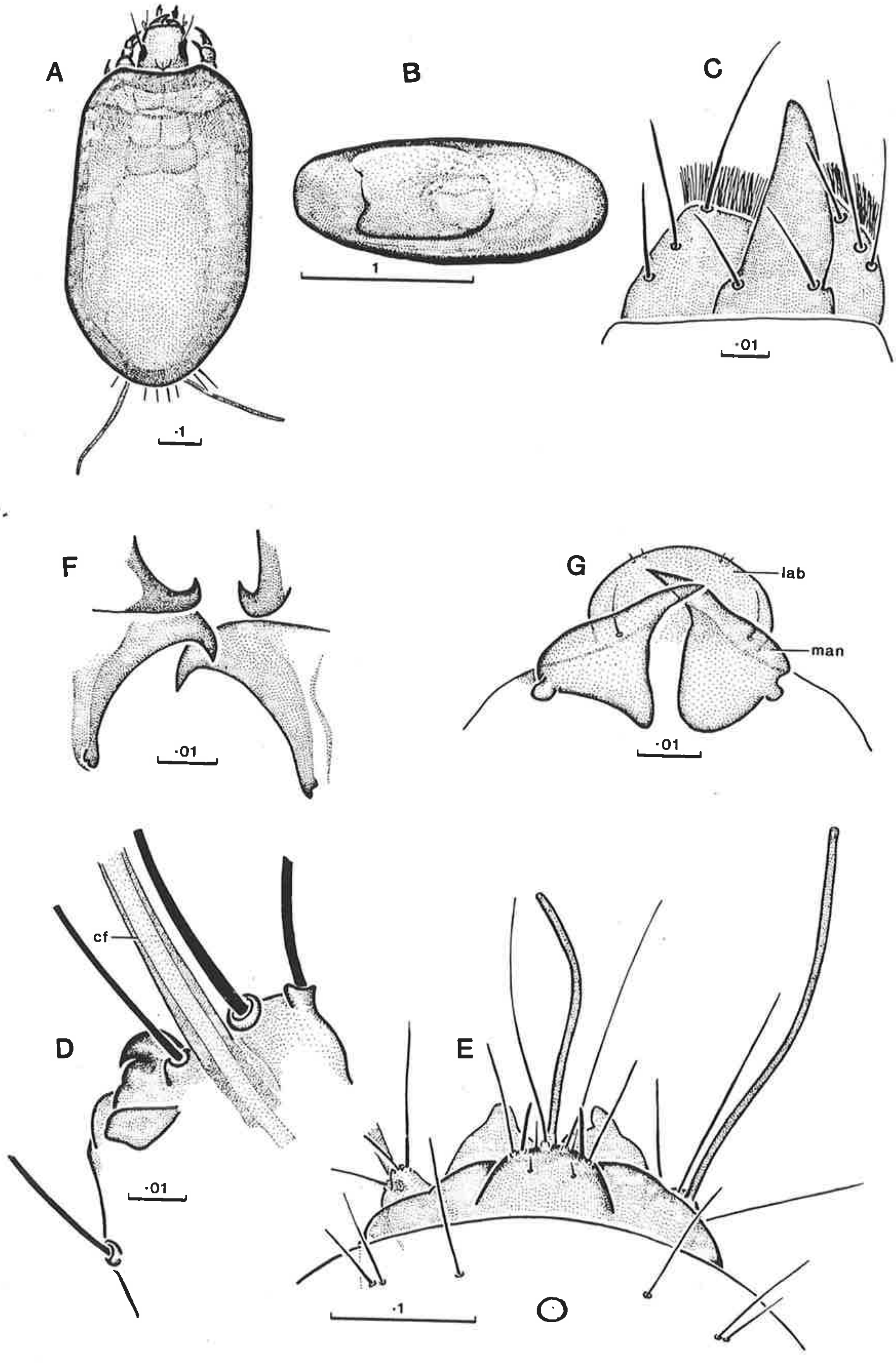


Plate 115A-G. Orthotrichia conferta Wells: A, early fifth-instar larva and case; B, later fifth-instar larva and case; C, larval labrum; D, anal proleg; E, abdominal segments IX and X, dorsal view; F, pupal hook plates; G, pupal labrum and mandibles.

Plate 116A–F. A,B, *Maydenoptila cuneola* Neboiss, male:
A, antennal flagellar segment;
B, a group of slender tapered clothing hairs.

C,D, *Orthotrichia adornata* Wells, male: C, antennal flagellar segment; D, a group of fimbriate clothing hairs.

E,F, *Hellyethira simplex* (Mosely): E, antennal flagellar segments; F, a group of fimbriate clothing hairs.

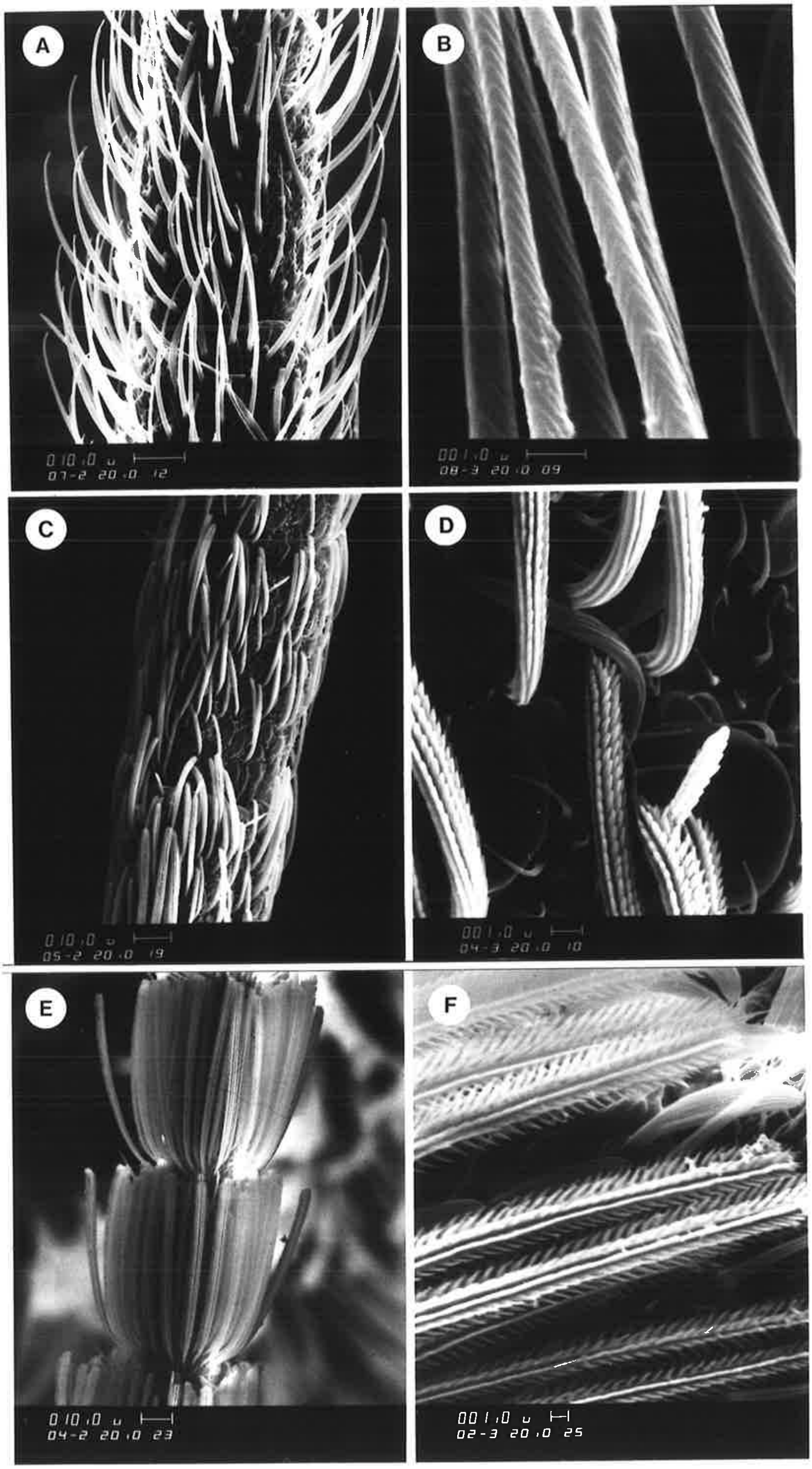

A
0101:0 u
07-2 20:0 12
B
001:0 u
08-3 20:0 09
C
0101:0 u
05-2 20:0 19
D
001:0 u
04-3 20:0 10
E
0101:0 u
04-2 20:0 23
F
001:0 u
02-3 20:0 25

Plate 117A-D. A, *Sensilla chaetica* type 1A and *s. basiconica* type 1B on distal rim of segment of *Orthotrichia adornata* Wells, male;

B, *S. chaetica* type 1A and *s. basiconica* type 1B on *Orthotrichia tortuosa* Wells, male;

C, *S. chaetica* type 1B on *Maydenoptila pseudorupina* Wells, female;

D, *S. trichoidea* type 1B on *Acanthotrichia bilamina* Wells, male.

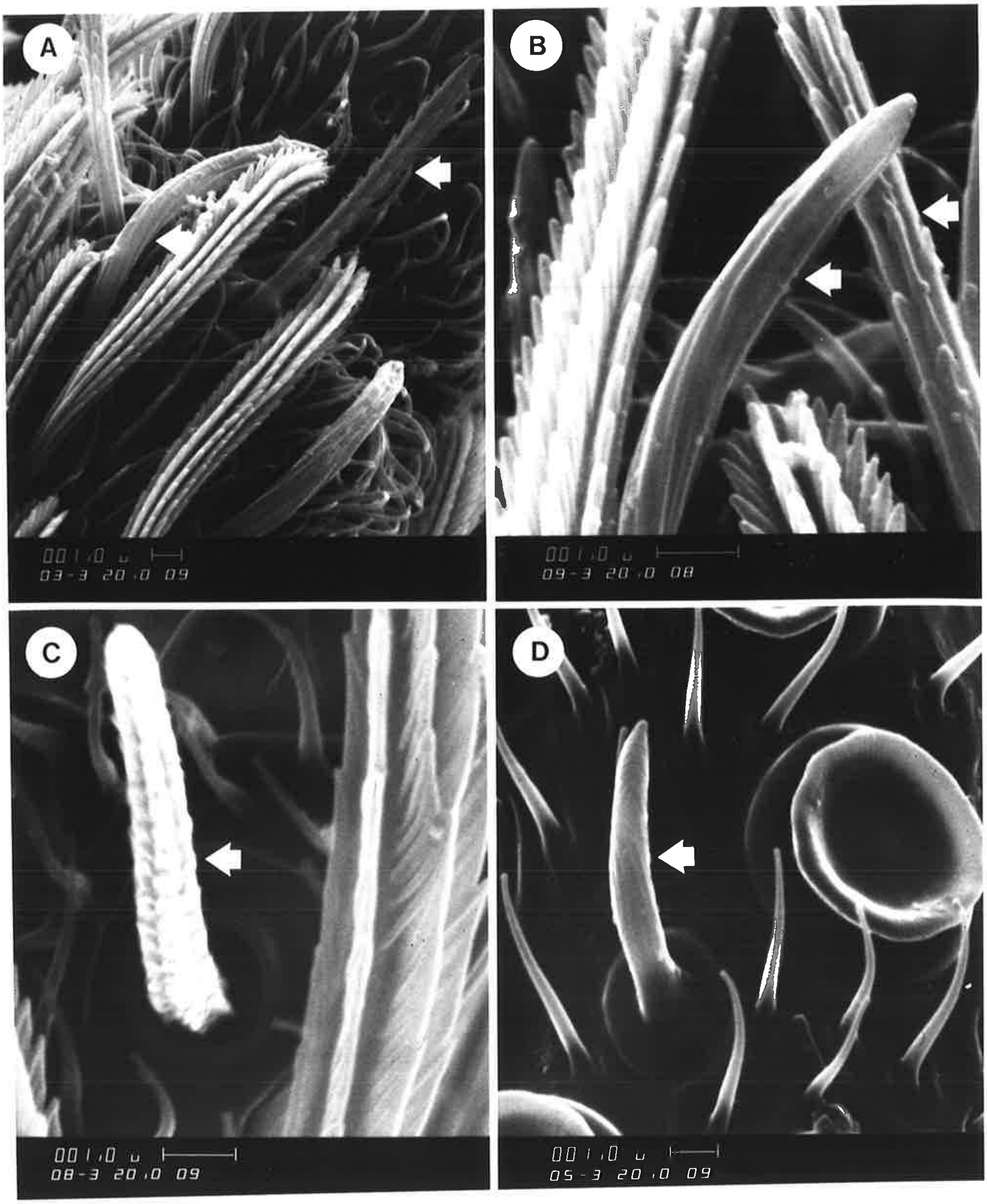

A
001.0 u
03-3 20.0 09
B
001.0 u
09-3 20.0 08
C
001.0 u
08-3 20.0 09
D
001.0 u
05-3 20.0 09

Plate 118A-D. Sensilla coeloconica or peg pits:
A, Orthotrichia aberrans Wells, male;

B, Hydroptila acinacis Wells, male;

C, Orthotrichia aberrans Wells, female;

D, Hydroptila obscura Wells, male.

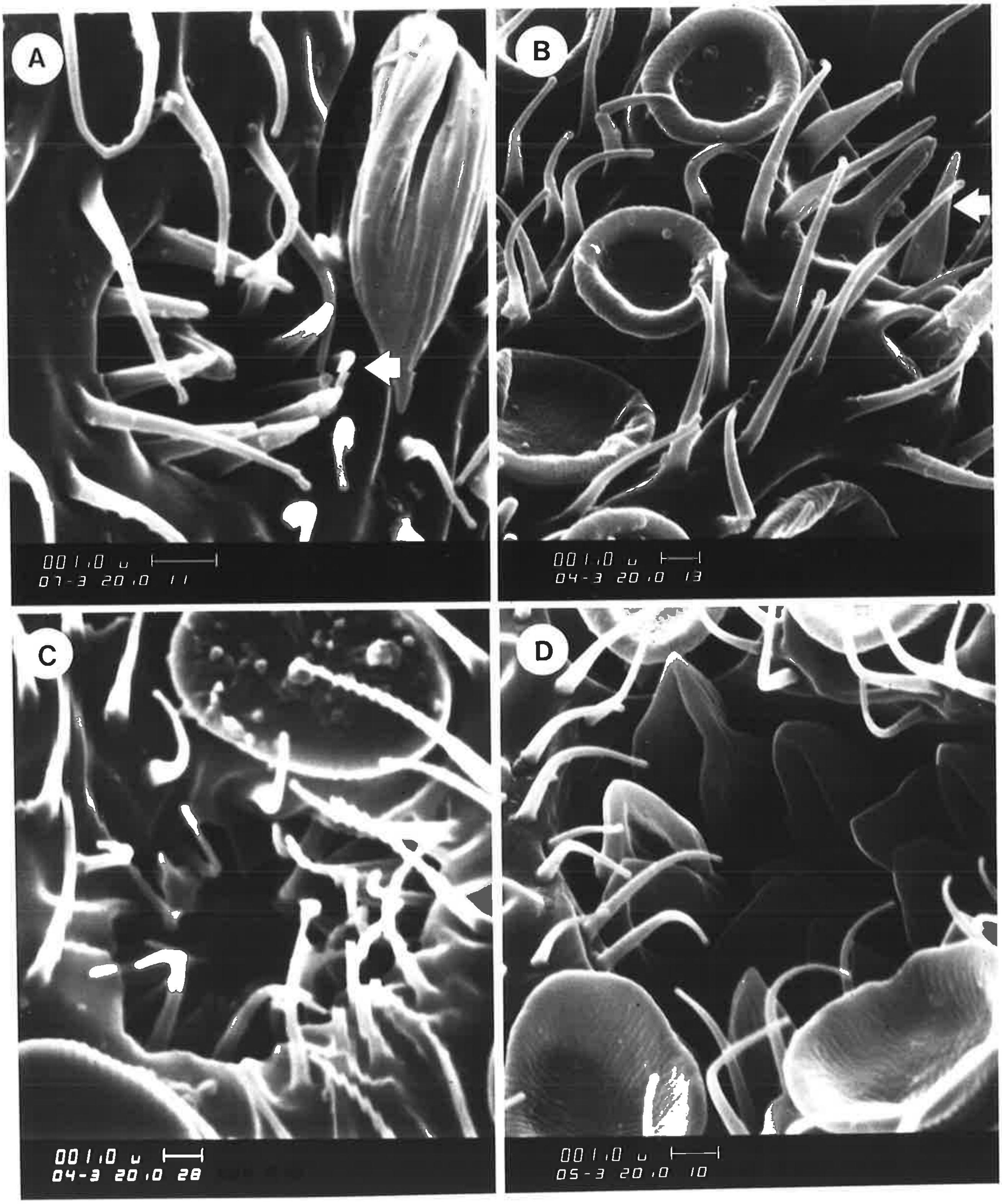

A
001 1.0 u
07-3 20 1.0 11
B
001 1.0 u
04-3 20 1.0 13
C
001 1.0 u
04-3 20 1.0 28
D
001 1.0 u
05-3 20 1.0 10

Plate 119A-D. Sensilla placodea: A, two forms on Orthotrichia aberrans Wells, male;

B, two forms on Hydroptila acinacis Wells, male;

C, a "donut" form on Hydroptila scamandra Neboiss, female;

D, a "mushroom" on Hydroptila scamandra Neboiss female.

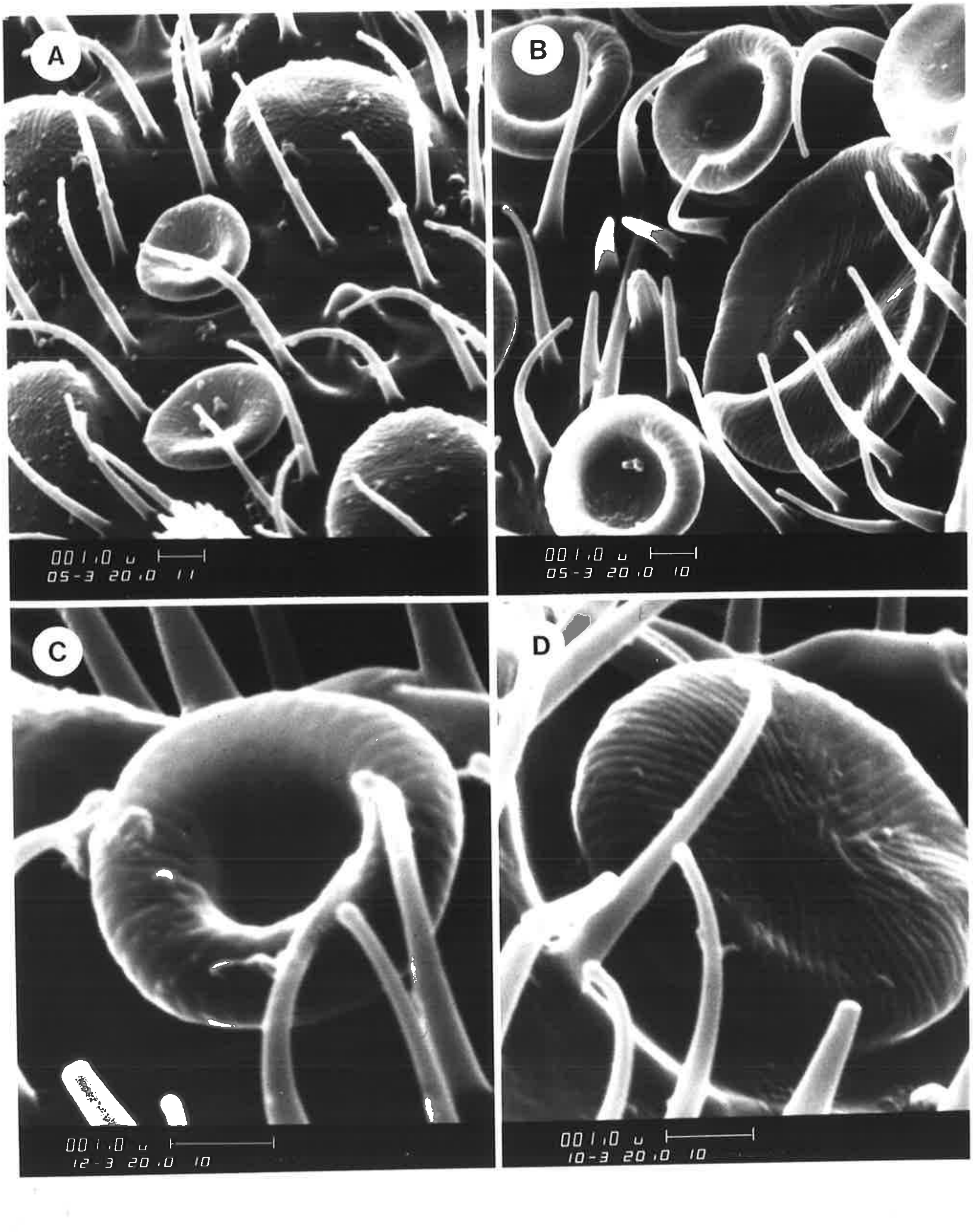

A
001.0 u
05-3 20.0 11
B
001.0 u
05-3 20.0 10
C
001.0 u
12-3 20.0 10
D
001.0 u
10-3 20.0 10

Plate 120A-D. A, a "rosetted" placodeum on *Hydroptila incertula* Mosely, male;

B, a *s. coelosphaericum* on *Hydroptila incertula* Mosely, male;

C, a "donut" placodeum on *Orphninotrichia benambrica* Wells, male;

D, smooth disc placodea on *Hellyethira simplex* (Mosely), male.

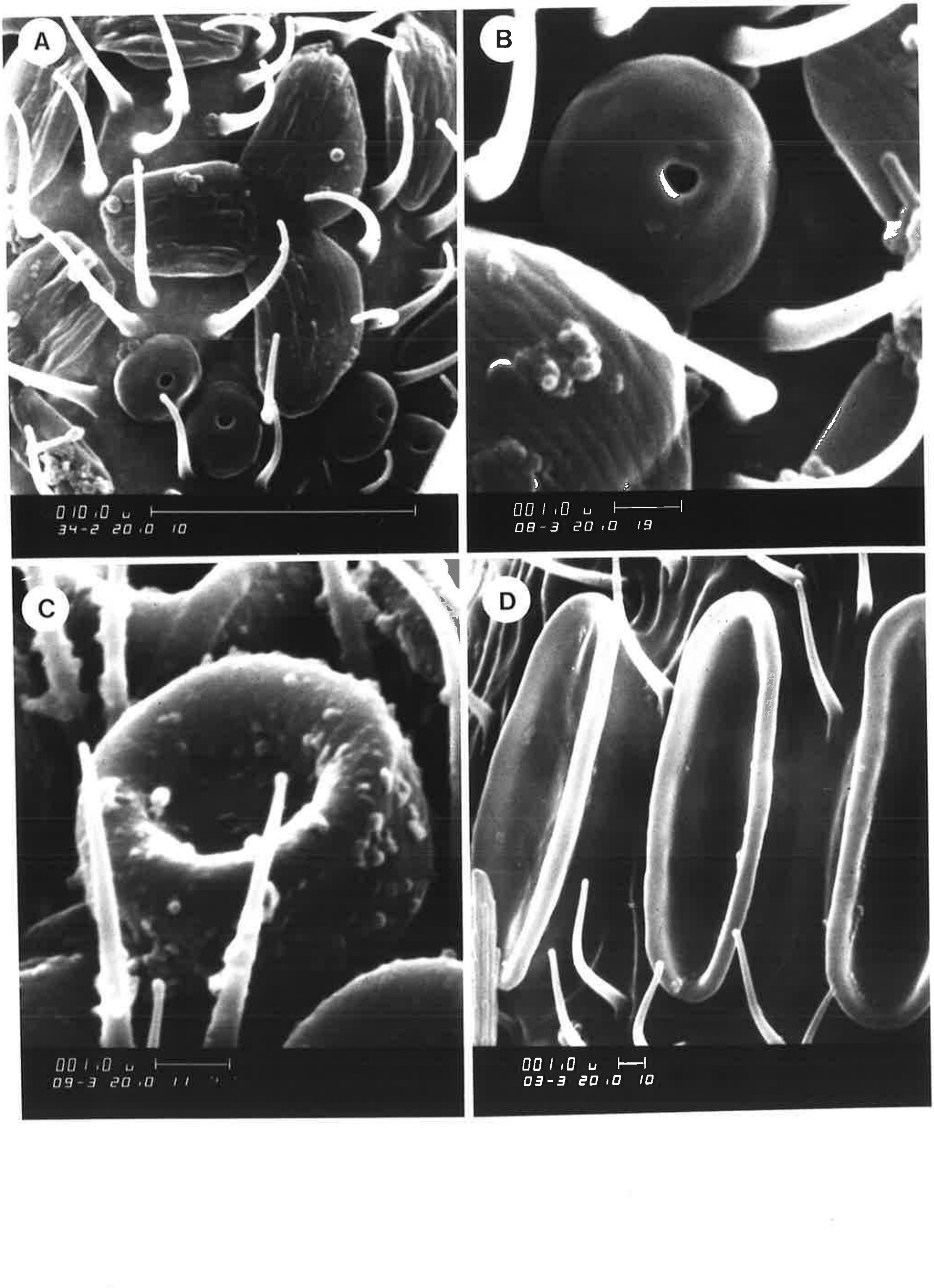

A
010.0 u
34-2 20.0 10
B
001.0 u
08-3 20.0 19
C
001.0 u
09-3 20.0 11
D
001.0 u
03-3 20.0 10

Plate 121A-D. A, a "butter pat" *auricillicum* on *Hellyethira simplex* (Mosely), female;

B, more elongate *auricillica* on *Oxyethira retracta* Wells, female;

C, folded "shoe horn" *auricillica* on *Maydenoptila rupina* Neboiss, male;

D, *S. stylonica* on *Acritoptila globosa* Wells, male.

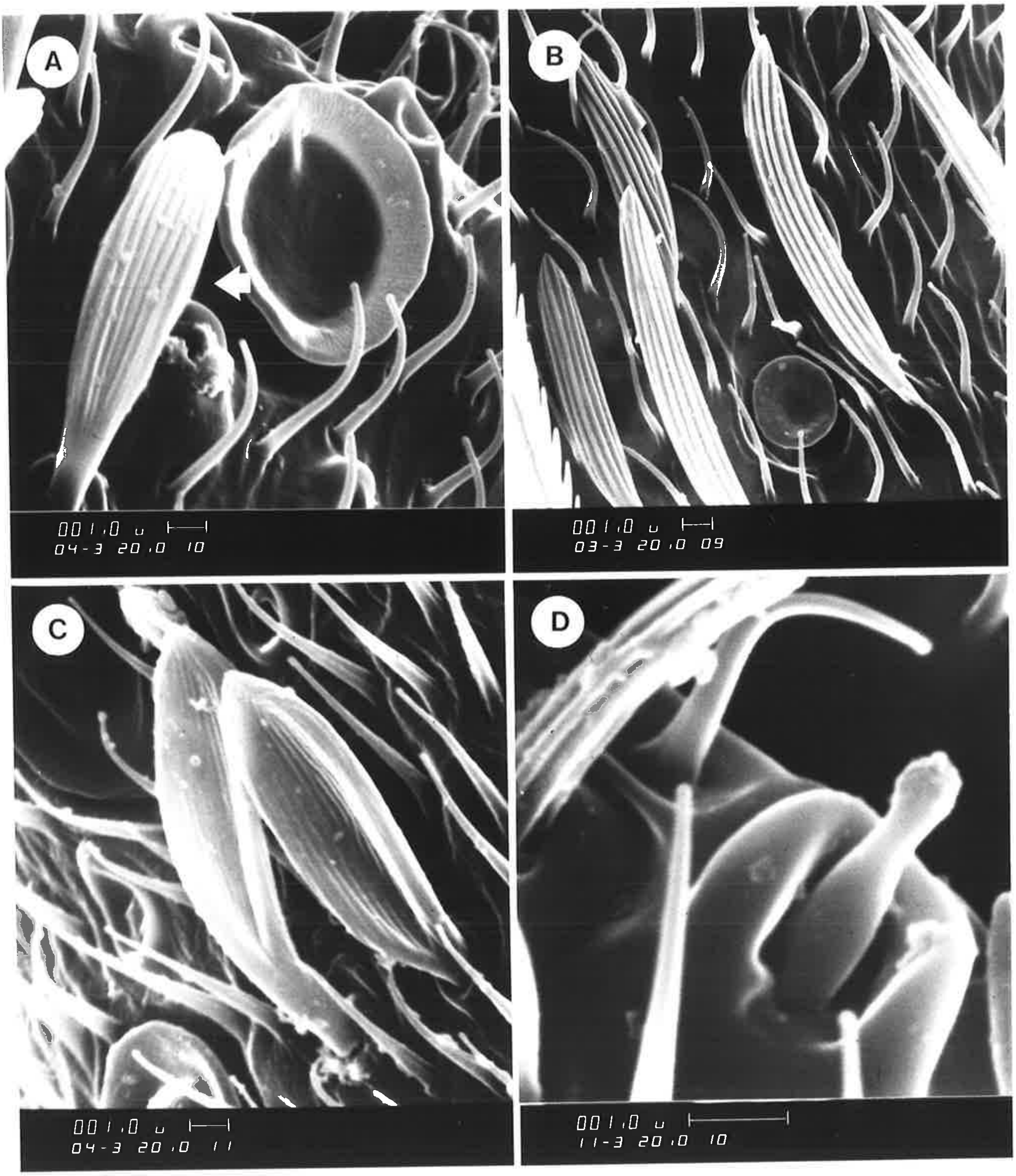

A
001,0 u
04-3 20,0 10
B
001,0 u
03-3 20,0 09
C
001,0 u
04-3 20,0 11
D
001,0 u
11-3 20,0 10

Plate 122A-F. A,B, Maydenoptila cuneola Neboiss:
A, male; B, female.

C,D, Orthotrichia gracilis Wells: C, male; D, female.

E,F, Hydroptila scamandra Neboiss: E, male; F, female.

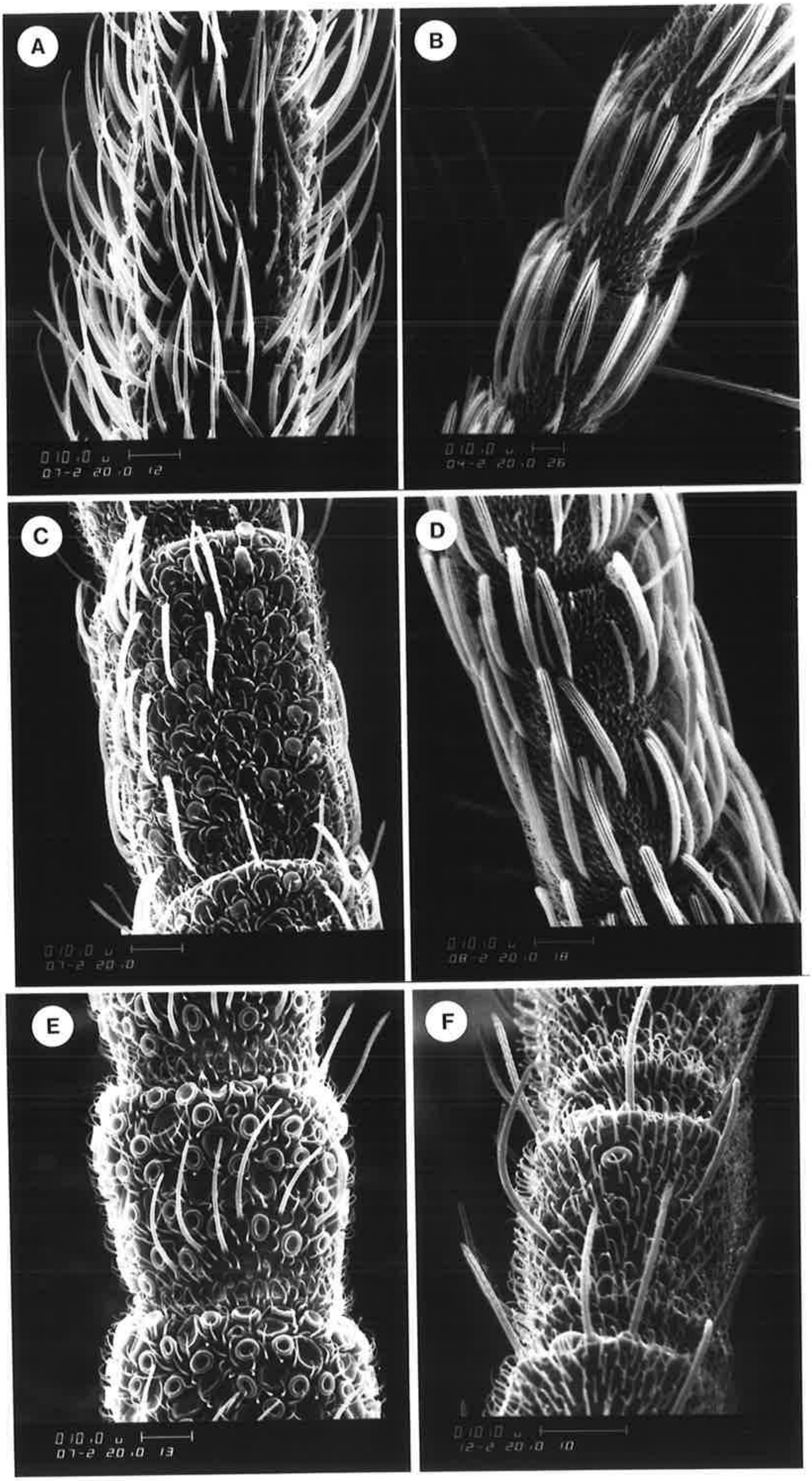

A
010.0 u
07-2 20.0 12
B
010.0 u
04-2 20.0 26
C
010.0 u
07-2 20.0
D
010.0 u
08-2 20.0 18
E
010.0 u
07-2 20.0 13
F
010.0 u
12-2 20.0 10

Plate 123A-D. A,B, Tricholeiochiton tridens Wells:
A, male; B, female.

C,D, Acanthotrichia bilamina Wells: C, male; D, female.

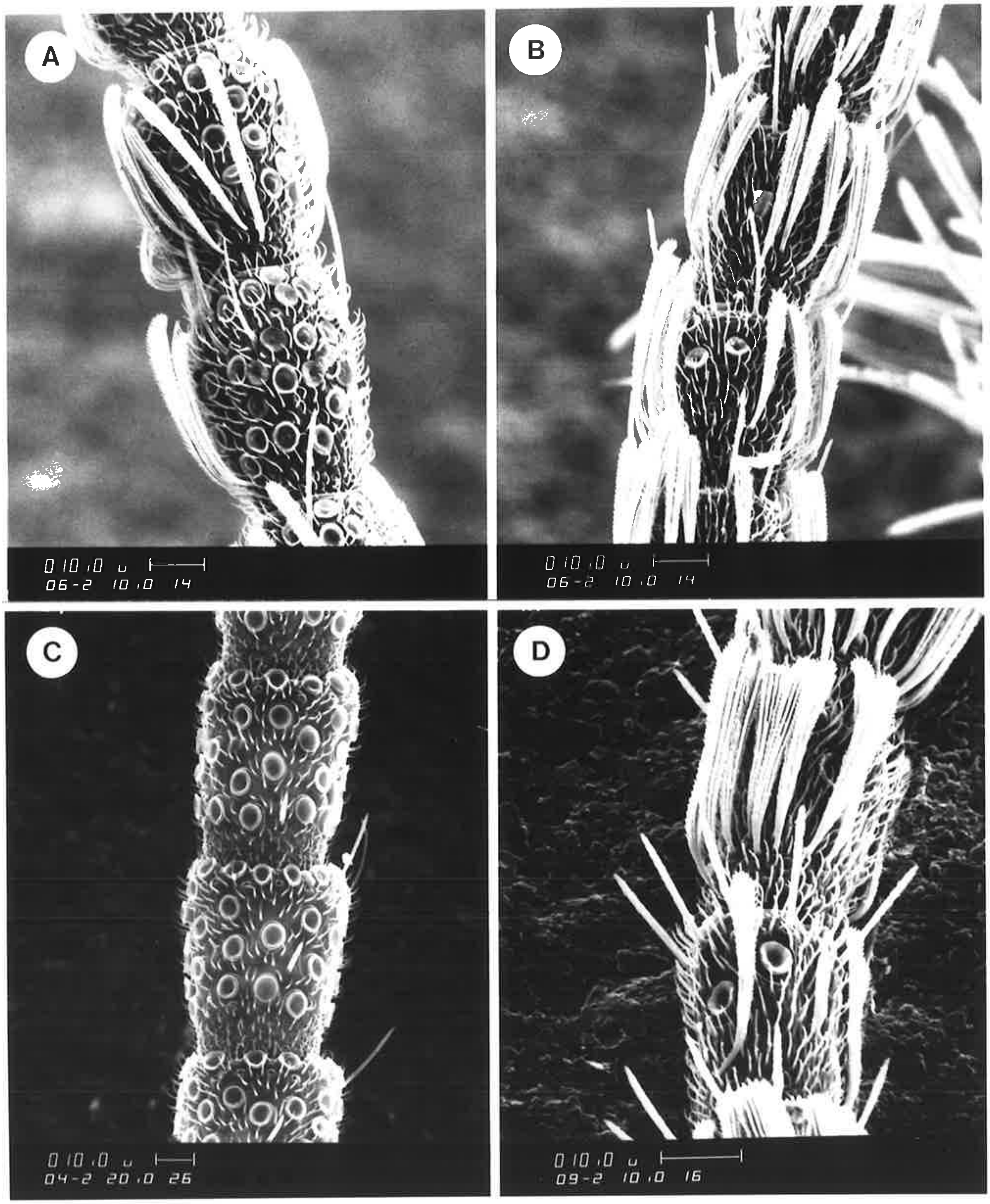

A
0 10.0 u
06-2 10.0 14
B
0 10.0 u
06-2 10.0 14
C
0 10.0 u
04-2 20.0 26
D
0 10.0 u
09-2 10.0 16

Plate 124A-D. A,B, Hellyethira simplex (Mosely):
A, male; B, female.

C,D, Oxyethira columba (Neboiss): C, male; D, female.

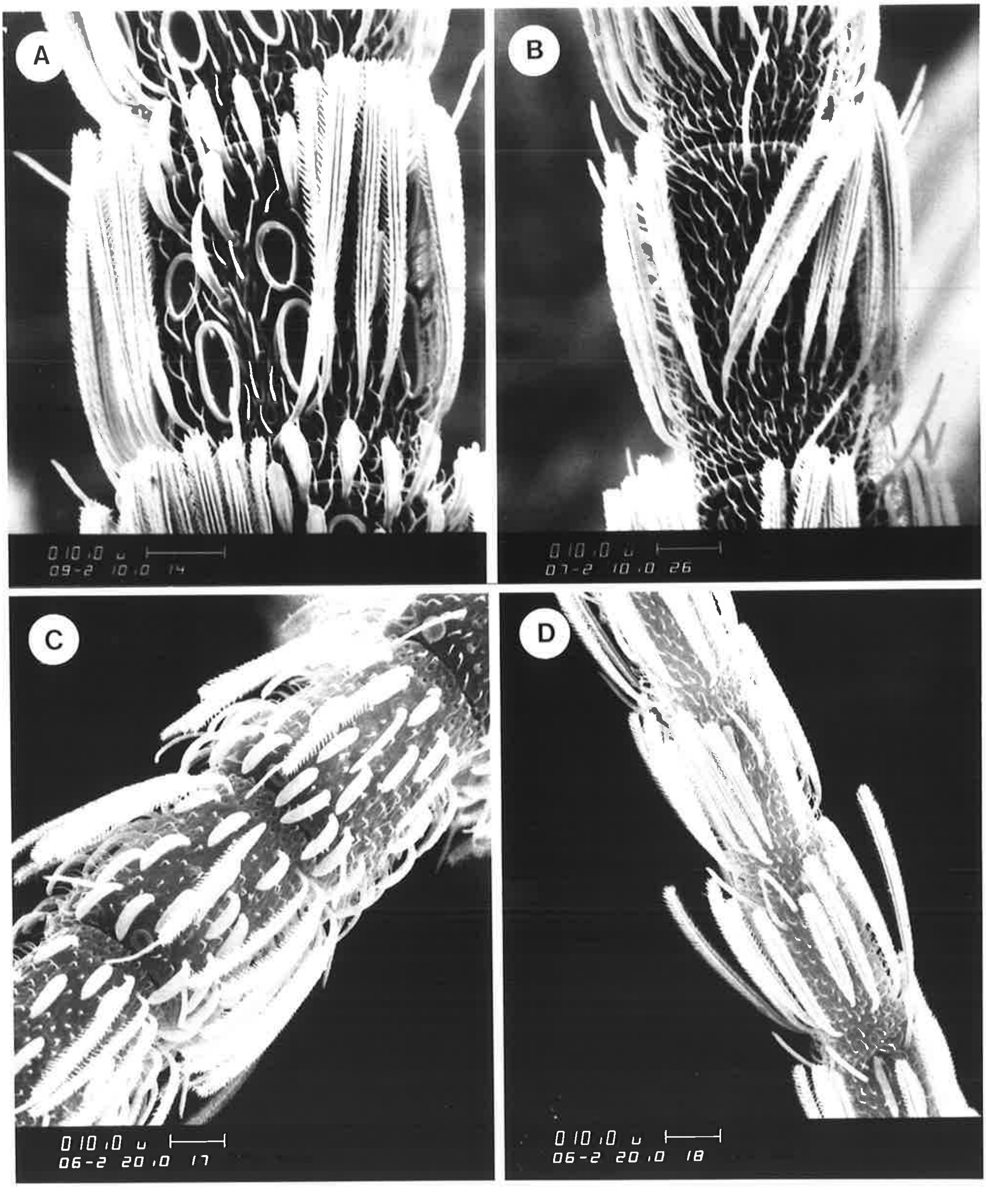

A
010.0 u
09-2 10.0 14
B
010.0 u
07-2 10.0 26
C
010.0 u
06-2 20.0 17
D
010.0 u
06-2 20.0 18

Plate 125A,B. A, Warren River, S of Pemberton, WA, Sept. 1980. Locality at which adult and immature *Hellyethira litua* and *Hydroptila losida* were taken.

B, North Dandelup River, WA. A typical collecting site for *Maydenpoptila baynesi*. Larvae were picked off small falls and bed-rock in Sept. 1980.

A

B

Plate 126A,B. A, Apsley Falls, S of Ebor, NSW, Oct. 1980. A typical habitat for *Orphninotrichia*: a collecting site for *O. maculata*.

B, Cann River, upper reaches: site at which *Hellyethira exserta*, *H. simplex*, *Hydroptila scamandra* and *Oxyethira columba* were taken at a light in Nov. 1981.

A

B

Plate 127A,B. A, Boyd River, E of Dalmerton, NSW, Oct. 1981. *Mulgravia carteri* and *Orthotrichia conferta* were collected here.

B, Congeratinga Creek, Second Valley, SA, Nov. 1983. *Maydenoptila rupina* swarms here in October before the stream dries up.

A

B

Plate 128A,B. A, Styx River in Styx State Forest, NSW, Oct. 1981. Type locality for *Orthotrichia rostrata*, and collecting site for *Hellyethira eskensis*, *H. exserta*, *H. simplex*, *Hydroptila scamandra*, and *Oxyethira columba*.

B, Horton River, S of Upper Horton, NSW, Oct. 1981. *Hellyethira simplex*, *H. malleoforma* and *Hydroptila losida*, were taken at a light here.

A

B

4. RESULTS: ANTENNAL FEATURES

4.1 Introduction

General antennal features are included in the diagnoses in Chapter 3. More detailed results of S.E.M. studies were given in a preliminary report (Wells 1984a) and are here expanded.

Normally each antennal segment and its sense organs and tomentum of microtrichia is covered and concealed by a thick clothing of hair. Sensilla do not occur on the first 2 segments of antennae, ie. stapes and pedicel, and the arrangement of hair on the stapes may differ from other segments.

4.2 Hair and microtrichia

The type and arrangement of clothing hair varies according to genus (Wells 1984a). Hair occurs in 2 alternative forms:-

(1) Slender tapered hairs with spiral surface sculturing (Fig. 4.1a), possibly equivalent to the "macrotrichia" of the limnephilid, <u>Frenesia</u> <u>missa</u> (Milne) (Slifer and Sekhon 1971).

(2) Blunt fimbriate hairs (Fig. 4.1b).

Both forms are deciduous and therefore frequently lost. They may be scattered over the whole segment (Fig. 4.1c&d, Pl. 116A,C), or grouped into a tight basal whorl (Fig. 4.1e, Pl. 116E). Whatever the arrangement, only fimbriate hair is found on female antennae; and only fimbriate hair occurs in whorls. In genera whose males have tapered hairs, females have scattered fimbriate hairs.

The particular arrangements found in all genera in the Australian fauna, and a selection of non-Australian genera, are given in Table 4.1. Asterisks indicate taxa for which only light microscope observations are available. With the exception of <u>Maydenoptila</u>, all

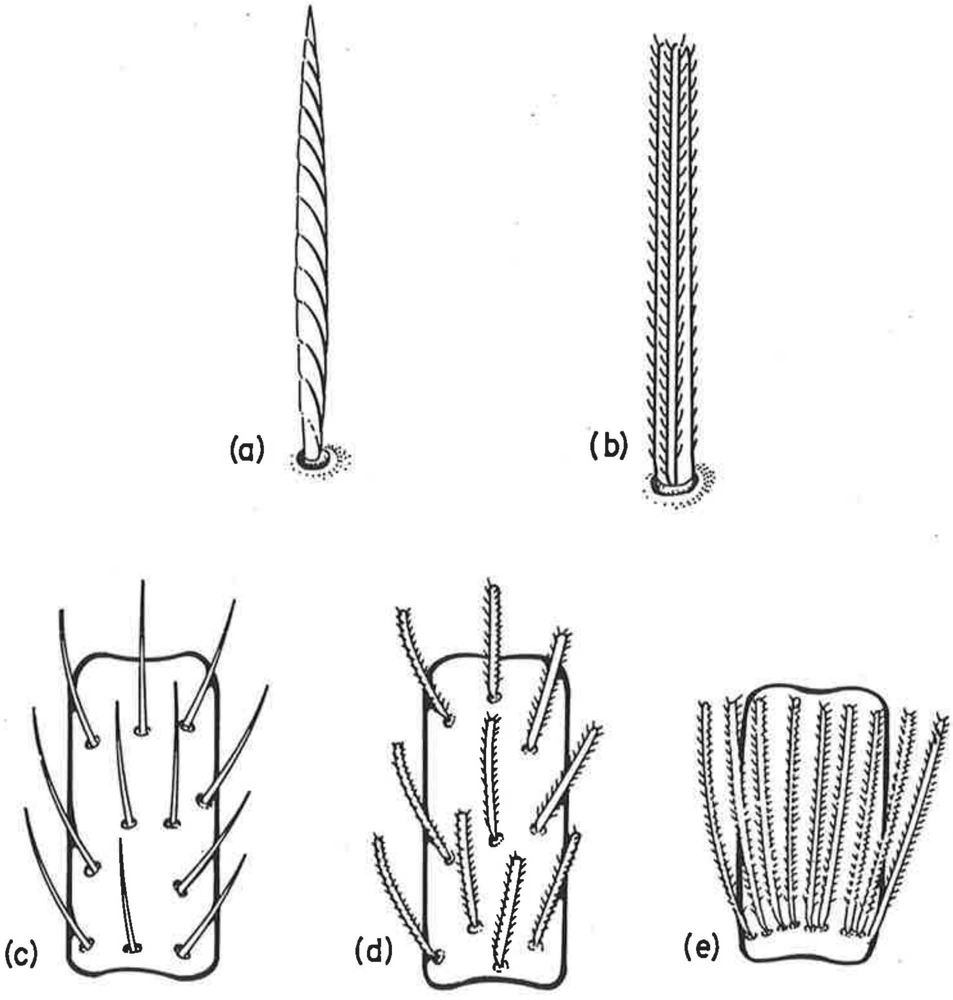


Figure 4.1. Form and arrangement of clothing hair on antennal segments of the Hydroptilidae: (a) slender, tapered hair; (b) blunt fimbriate hair; (c) scattered, tapered hair; (d) scattered fimbriate hair; (e) whorled fimbriate hair.

Table 4.1. Arrangement of clothing hair in selected hydroptilid genera.

		Arrangement of clothing hair		
Tribe	Genus	♂ scattered "macrotrichia" ♀ fimbriate hair	♂ & ♀ scattered fimbriate hair	♂ & ♀ whorled fimbriate hair
<u>Australian</u>				
<u>Incertae sedis</u>	<u>Maydenoptila</u>	+		
Orthotrichiini	<u>Orthotrichia</u>		+	
Hydroptilini	<u>Hydroptila</u>			+
	<u>Tricholeiochiton</u>			+
	<u>Oxyethira</u>			+
	<u>Orphninotrichia</u>			+
	<u>Acanthotrichia</u>			+
	<u>Hellyethira</u>			+
	*<u>Austratrichia</u>			+
	<u>Mulgravia</u>			+
	*<u>Xuthotrichia</u>			+
	<u>Acritoptila</u>			+
<u>Non-Australian</u>				
<u>Incertae sedis</u>	*<u>Dibusa</u>	+		
	*<u>Nothotrichia</u>	+		
	*<u>Caledonotrichia</u>	+		
Ochrotrichiini	*<u>Ochrotrichia</u>	+		
Hydroptilini	*<u>Agraylea</u>	+		
	*<u>Allotrichia</u>	+		
	*<u>Paroxyethira</u>			+
Orthotrichiini	*<u>Ithytrichia</u>		+	
Leucotrichiini	*<u>Leucotrichia</u>		+	
Neotrichiini	*<u>Neotrichia</u>		+	

*Light microscope observations only.

Australian micro-caddis flies have only fimbriate hair, and only Maydenoptila and Orthotrichia have scattered hair.

Microtrichia always abound, but are denser on female than on male antennae (see Pls 122-124). Similar structures on Frenesia missa were shown to be non-innervated (Slifer and Sekhon 1971); their function is probably protective.

4.3 Sensilla

At least 19 distinct morphological types of antennal sensilla have been recognized in Australian hydroptilids (Fig. 4.2); all antennae have from 3-7 of these types; females always have fewer sensilla and generally fewer types than males.

Details of size, position and abundance are given in Table 4.2; Table 4.3 summarises the distribution of sensilla types.

Sensilla chaetica of two kinds are found on all flagellar segments of all antennae: type IA (Fig. 4.2; Pl. 117A) is abundant, particularly on distal rims of segments; type IB (Fig. 4.2; Pl. 117C) is scarce. Similar structures in Frenesia missa are multiporous, probably olfactory, chemosensilla, and thick-walled, uniporous, possibly gustatory, chemosensilla, respectively (Slifer and Sekhon 1971). However, the chaetica type IA of several hydroptilids that I examined failed to stain when the standard crystal-violet test for chemosensilla (Slifer 1960) was applied. It is therefore possible that they have a different function. Their position on the distal rims of segments suggests that they could be mechano-receptors for sensing the position of subsequent segments.

Sensilla coeloconica, or "peg pits", of type IA (Fig. 4.2; Pl. 118A,B) are widespread but never abundant, and like chaetica type IA

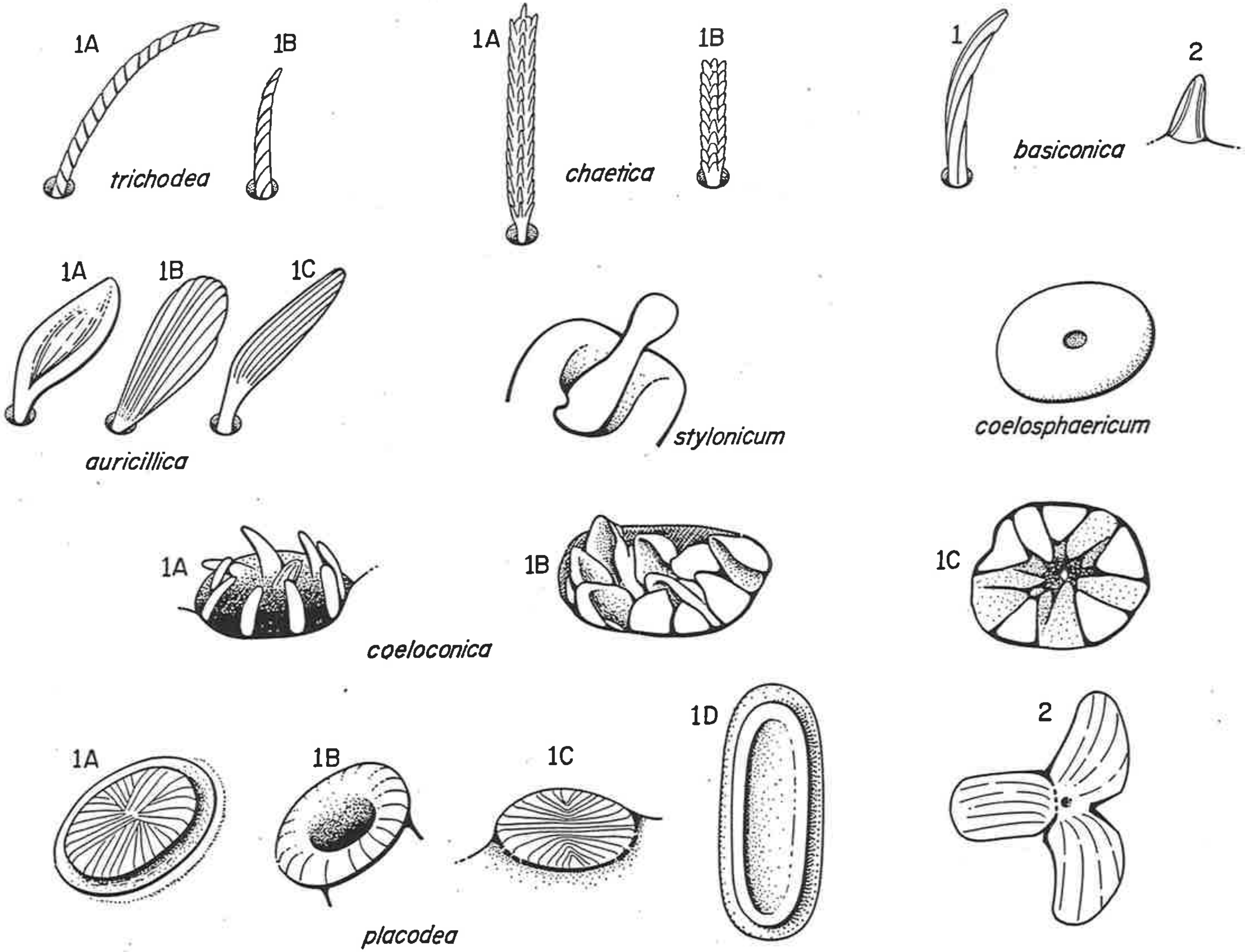


Figure 4.2. Sensilla types on antennal segments of Australian Hydroptilidae.

Table 4.2. Sensilla types, approximate dimensions, abundance and position on antennal segments of Australian Hydroptilidae.

Sensilla	Approximate size (µm)	Position on segments	Abundance	Sex	Taxa
S. trichodea 1A	18-20 x 0.7-1	distal	few	M,F	Orthotrichia Orphninotrichia Oxyethira Hellyethira
S. trichodea 1B	8	medial	few	M	Acanthotrichia
S. chaetica 1A	14-28 x 0.8-1.5	distal rim medial	ring few	M,F	all genera
S. chaetica 1B	6-11 x 0.8-1.5	medial	1 or 2	M,F	all genera
S. basiconica 1A	11-13	distal	many	M,F	Orthotrichia
S. basiconica 2A	1.3-6	distal	few	M	Orphninotrichia
S. auricillica 1A	6-11 x 2-3	scattered	few to many	M,F	Maydenoptila
S. auricillica 1B	10-18 x 2-3	scattered	few to many	M,F	Oxyethira Hellyethira Mulgravia
S. auricillica 1C	13-15	distal	few	M	Acritoptila
S. stylonica	1.3-6	distal	1 or 2	M,F	Hellyethira Mulgravia Oxyethira Acritoptila
S. coelospherica	Ø 3-4	proximal on lower segs.	few	M	Hydroptila incertula
S. coeloconica 1A		distal	few	M,F	most genera
" " 1B		medial	1	M	Orthotrichia aberrans
" " 1C		medial	1	M	Hydroptila obscura
S. placodea 1A ('domes, discs')	Ø 4-6	scattered	few many	F M	Maydenoptila Orthotrichia Hydroptila Tricholeiochiton Oxyethira
S. placodea 1B ('do-nuts')	Ø 3-5	scattered	few to many	F M	Hydroptila Orphninotrichia
S. placodea 1C (ovoid domes)	4.6 x 6	scattered	many	M	Orthotrichia
S. placodea 1D (smooth discs)	7-15 x 4	scattered	many few	M F	Hellyethira Mulgravia Acritoptila
S. placodea 2 (rosettes)		scattered	many	M	Hydroptila incertula

Table 4.3. Summary of occurrence of sensilla types in genera in the Australian Hydroptilidae.

Genus	S. trichodea		S. chaetica		S. basiconica		S. auricillica			S. stylonica	S. coelosphericum	S. coeloconica			S. placodea				
	1A	1B	1A	1B	1A	2A	1A	1B	1C			1A	1B	1C	1A	1B	1C	1D	2
<u>Maydenoptila</u>	+		+	+			+	+							+				
<u>Orthotrichia</u>			+	+	+							+	+		+		+		
<u>Hydroptila</u>			+	+							+	+		+	+	+			+
<u>Tricholeiochiton</u>			+	+								+			+				
<u>Acanthotrichia</u>		+	+	+								+							
<u>Orphninotrichia</u>	+		+	+		+						+			+	+			
<u>Oxyethira</u>	+		+	+					+	+		+			+				
<u>Hellyethira</u>			+	+					+	+		+						+	
<u>Mulgravia</u>			+	+					+	+		+						+	
<u>Acritoptila</u>			+	+					+	+		+						+	

they are usually on distal rims. Some have a central fluted peg, and the number of peripheral grooved pegs may vary. Other types of pits (Fig. 4.2; Pl. 118C,D) have been seen in males only, and always only one per segment. At present these appear to be species specific.

Sensilla placodea (Fig. 4.2; Pls 119,120) are highly variable in form, and attempts to group them are arbitrary; the surfaces of many bear fine radial striae, while others are quite smooth; those forms tested stained positively as for multiporous chemosensilla. It seems certain that placodea function, at least in part, as olfactory receptors. Type IA (Fig. 4.2; Pl. 119A,C) is more widespread and generally occurs in both sexes while, with some variation, other general forms are specific to genera or groups of genera; the "rosetted" form (Fig. 4.2; Pl. 120A) has only been found in males of Hydroptila incertula. In most genera, placodea are far more numerous on male than female antennae; in Oxyethira they are scarce on both.

In contrast with placodea, s. auricillica (Fig. 4.2; Pl. 121), which occur in small to moderate numbers in a number of genera, are the commonest sensilla in Oxyethira (Pl. 124C). They are always more abundant in males; their surfaces are coarsely corrugated, and they stain in a way consistent with an olfactory function. Some variation in form is seen, with flattened "butter-pat" auricillica in Oxyethira, Hellyethira and Mulgravia (Pl. 121A,B), and folded "shoe-horn" forms in Maydenoptila (Pl. 121C). They are absent from Hydroptila, Tricholeiochiton and Acanthotrichia.

Structures here designated s. trichodea type IA, but closely resembling the tapered deciduous clothing hairs of Maydenoptila, are found in small numbers towards the distal rims of segments in several genera, e.g. Hellyethira and Orphninotrichia. Single grooved pegs or basiconica type 2 (Fig. 4.2) occur in Orphninotrichia, and abundant basiconica type 1 occur in all species of Orthotrichia (Fig. 4.2; Pl. 117B). One or more s. stylonica - short, smooth stubs in large sockets (Fig.4.2; Pl. 121D) - are found on the distal rims in males and females of Oxyethira, Hellyethira, Mulgravia and Acritoptila .

In some species there are unique types of sensilla such as the "rosetted" placodea and coelospherica - smooth domes with central pores - which are known only from male Hydroptila incertula. A small trichoid sensillum (Fig. 4.2; Pl. 117D) has been seen only in males of the monotypic genus Acanthotrichia. Yet the general form and arrangement of sensilla and hair is constant and usually distinctive at the genus level. Typical patterns for a number of genera are illustrated in Pls 122-124. Clothing hair has been lost from some segments, but its distribution can be seen from the positions of the sockets.

5. RESULTS: CHARACTER STATE ANALYSIS (for *Oxyethira* group)

5.1 Introduction

Many characters were examined, but only those with 2 or more discrete states are included in the analysis. Arguments are advanced for polarities of adult and larval character states; no pupal characters are included as they show little variability.

5.2 Adult characters

1. *Ocelli*. May be present or absent.

   They are absent from *Hydroptila*, but this is considered to be the derived state for they are present in members of the *Agraylea* group and in most Hydroptilinae, as well as many other groups of insects.

   Ocelli present (0)

   Ocelli absent (1)

2. *Antennal sensilla*. In males of *Hydroptila*, *sensilla placodea* are the common sensory structures, while in *Oxyethira*, *s. auricillica* are generally the most abundant type. In other genera there is a mixture of both types. Those members of the *Agraylea* group that have been examined are similar to *Hydroptila*. Thus, the state they share is taken to be the more primitive, while segments with mainly *auricillica* are in the most derived state.

   Antennal segments with a predominance of *sensilla placodea*, without *auricillica* (0)

   Antennal segments with a mixture of *placodea* and *auricillica* (1)

Antennal segments with a predominance of auricillica (2)

3. Spur formula. The common spur formula in the Hydroptilini is 0,3,4; only a few genera show the reduced number of 0,2,4, which is thus assumed to be the derived state. Hydroptila has the formula 0,2,4.

Spurs 0,3,4 (0)

Spurs 0,2,4 (1)

4. Width of wings. Broad wings are found in the sister group of the Hydroptilidae, the Glossosomatidae, and in the more primitive hydroptilid sub-family, the Ptilocolepinae. Reductions in width are seen in the Hydroptilini. Thus, broad wings are taken to be primitive, narrower wings derivative.

Wings narrow, but not extremely so (0)

Wings very slender (1)

5. Jugal lobe. The jugal lobe was probably present primitively as it occurs in the Ptilocolepinae and in Agraylea and Hydroptila, but is absent in many other groups.

Jugal lobe present (0)

Jugal lobe absent (1)

6. Wing venation. As wing size has decreased, veins have been fused or lost. More complete venation is considered to be primitive; R_1 and R_2 arising together is primitive, loss of footstalk, R_{2+3}, derived.

R_2 and R_3 with common footstalk (0)

R_2 and R_3 without footstalk (1)

R_2 and R_3 fused or lost (2)

7. *Abdominal segment VIII of male*. The normal state for Trichoptera, including most Hydroptilidae, is to have a discrete sternite and tergite on this segment. In 1 or 2 genera only, the plates are fused to form an annulus.

Segment VIII with discrete plates	(0)
Segment VIII an annulus	(1)

8. *Shape of anterior margin of abdominal segment IX*. The anterior margin of abdominal segment IX is normally shallowly concave except in several genera where it is rounded, more-or-less triangular, or skewed. In *Hydroptila* and the *Agraylea* group the margin is concave. The other states are most probably derived.

Anterior margin of IX concave	(0)
Anterior margin of IX rounded	(1)

9. *Length of abdominal segment IX*. This segment is usually as long as other abdominal segments, but in several genera it is retracted within segment VIII. In *Hydroptila* and most *Oxyethira* group genera the "normal" state, which is assumed to be primitive, prevails.

Segment IX not retracted into VIII	(0)
Segment IX well retracted into VIII	(1)

10. *Form of inferior appendages*. Primitively, the inferior appendages of Trichoptera are clasping structures. Simple cylindrical claspers occur in the more primitive species in *Hydroptila*, while a tendency to reduction and fusion of inferior appendages occurs in some other *Hydroptila* and many other taxa. Inferior appendages in the form of cylindrical

lobes, single or branched, is the primitive state. Reduction and fusion is derivative.

Lobes cylindrical, single or branched	(0)
Lobes reduced, rounded or bract-like	(1)
Lobes reduced, fused	(2)
Lobes reduced to spines	(3)

11. *Position of insertion of inferior appendages*. Functionally, the insertion of inferior appendages in lateral positions, as in *Hydroptila*, would probably facilitate clasping. A medial insertion of these structures must have accompanied a shift in function and is seen as the derived state.

Inferior appendages inserted laterally	(0)
Inferior appendages inserted medially	(1)

12. *Form of the aedeagus*. Kelley (1984) states that the primitive state for the aedeagus of *Oxyethira* is with a titillator: this is the condition that occurs in *Hydroptila* and many but not all *Oxyethira* group members.

Aedeagus with titillator	(0)
Aedeagus without titillator and without spines	(1)
Aedeagus without titillator and with spines	(2)

13. *Tip of aedeagus*. In 2 genera, *Tricholeiochiton* and *Orphninotrichia*, the tip of the aedeagus is highly distinctive, being dilated. This form does not occur in other *Oxyethira* group members, or *Hydroptila*, and is considered to be derived.

Tip of aedeagus not dilated and bilobed	(0)
Tip of aedeagus dilated and bilobed	(1)

14. Number of genitalic parts present in male.

Marshall (1979) describes the "basic" structure of hydroptilid male genitalia. Hydroptila has a basic set of parts and any reduction of this basic complement is considered to be derived.

Dorsal plate (segment X) present	(0)
Dorsal plate absent	(1)

15. Form of female genitalia. Primitively the hydroptilid female had elongate terminalia (Nielsen 1980), forming an ovipositor. This is the arrangement seen in Hydroptila. In all Oxyethira group females the terminalia are foreshortened to form what Marshall (1979) terms a "modified oviscapt".

Terminalia elongate	(0)
Terminalia a modified oviscapt	(1)

5.3 Summary of coded character states of adults in genera in the Australasian Hydroptilini

A data matrix of coded character states for Australasian Hydroptilini is given in Table 5.1. Note that on the basis of the characters considered in these data, Acritoptila and Austratrichia are indistinguishable. In subsequent sections they will be considered together. (See Chapter 10 for discussion of their relationships).

Table 5.1. Data matrix of coded character states for adults of genera in the Australasian Hydroptilini. (Character identification numbers are taken from Section 5.2; data on *Paroxyethira* are from Marshall (1979) and my own observations).

Character Genus	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hydroptila	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Hellyethira	0	1	0	0	1	0	0	0	0	0	1	1	0	0	1
Acritoptila	0	1	0	0	1	0	0	0	0	2	1	1	0	0	1
Austratrichia	0	1	0	0	1	0	0	0	0	2	1	1	0	0	1
Xuthotrichia	0	1	0	0	1	0	0	0	0	3	0	1	0	0	1
Mulgravia	0	1	0	0	1	0	0	0	0	0	1	2	0	0	1
Acanthotrichia	0	0	0	1	1	2	0	0	0	0	1	0	0	0	1
Oxyethira	0	2	0	1	1	2	1	1	1	1	1	0	0	0	1
Tricholeiochiton	0	0	0	0	1	1	0	0	0	0	1	0	1	0	1
Orphninotrichia	0	0	1	0	1	1	0	0	1	0	1	0	1	0	1
Paroxyethira	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1

5.4 Larval characters (fifth or final instar)

1. *Ecdysial sutures of head*. These may be present or absent. Nielsen (1948) says of the head sutures "... in *Agraylea* and *Hydroptila* they have disappeared." They are normally present in other families. It is therefore assumed that absence in *Hydroptila* is derived, while presence is primitive.

Sutures well defined (0)

Sutures fused, wholly or in part (1)

2. Ventral head sclerites. Postmental sclerites may be paired or fused; they are paired in *Hydroptila*. Nielsen (1948) says of *Rhyacophyla* "the mentum is paired ..., and thus it can probably be said to be more closely related to the original type than in other caddisfly larvae". In Hydroptilidae, paired postmental sclerites are assumed to be primitive, fused derivative.

Postmental sclerites paired	(0)
Postmental sclerites fused	(1)

3. Antennae. The larval antenna ranges in form from a structure with a basal segment tipped with 2 distal sensilla, to a basal segment with a single distal sensillum, to a simple structure in which the sensillum appears to have fused with the segment. Nielsen (1948) derives the hydroptilid antenna from that of Glossosomatidae, which has 2 distal sensilla, by translocation of one sensillum on the other, but I find his explanation difficult to follow. However, if we accept his hypothesis, then an antenna-with-2-sensilla is the primitive form, antenna with one sensillum is derived, and antenna fused without a discrete terminal sensillum, more derived. In *Hydroptila* and most *Oxyethira* group genera the intermediate condition is found. For this study it is considered primitive.

Antenna with a distal sensillum	(0)
Antenna fused	(1)

4. Shape of thoracic nota. This varies from almost quadrate in dorsal view, to saddle-shaped. In *Hydroptila* the nota are subquadrate, as they are also in *Agraylea* group larvae. Strongly tapered to saddle-shaped nota are derived.

Nota subquadrate	(0)
Nota saddle-shaped	(1)

5. Extent of notal cover. The extent to which thoracic nota cover the dorsa of segments varies: in *Hydroptila* and most "generalised" larvae, cover is far from complete, which is taken to be the primitive state. In many genera in the *Oxyethira* group, almost the entire dorsal surface of each thoracic segment is sclerotised.

Thoracic nota incompletely cover dorsum	(0)
Thoracic nota completely cover dorsum	(1)

6. Thoracic pleura. These are considered by Marshall (1979) to consist of 4 pleurites which may be free or in various states of fusion. The primitive state for the Hydroptilidae, found in Ptilocolepinae and some Hydroptilinae, appears to be pre-episternite free, episternite and oral epimeron fused, and anal epimeron free, on all pleura. In *Hydroptila* the pre-episternite and anal epimeron are free on the propleuron only, which is considered to be the primitive state in the Hydroptilini. Fusion of pre-episternite only is considered to be relatively derived, and fusion of both pre-episternite and anal epimeron the most highly derived state.

All pleurites free on propleuron (0)
Only anal epimeron free on propleuron (1)
All pleurites fused on propleuron (2)

7. *Setae on thoracic nota*. Setation of nota as seen in *Hydroptila* is of the generalised pattern for the Trichoptera, as described by Williams and Wiggins (1981), except for the presence of many secondary setae on anterior margins. *Hydroptila* differs little from *Agraylea* (Nielsen 1948) and thus this condition is probably ancestral for the Hydroptilinae. Modifications, such as re-alignment of anterior marginal setae, and absence of secondary setae, are probably derived.

Setation complete (0)
Setation reduced, few anterior marginal setae on mesonotum (1)
Setae realigned, no anterior marginal setae on meso- or metanota (2)

8. *Length of setae on thoracic nota*. These vary in length on each notum, some being short, others longer; but in "generalised" larvae, e.g. *Hydroptila*, many are as long or longer, or at least half the length of the nota. Reduction of the length of setae to form short bristles is here taken to be a derived condition.

Setae of nota up to, or greater than, half length of nota (0)
Setae on nota less than half length of nota (1)

9. Length of legs. Legs in the Hydroptilidae are basically ambulatory (Marshall 1979), and thus subequal, as in *Hydroptila*. Specialisations have occurred in 2 directions: legs are stouter in torrenticolous forms, and mid and hind legs more elongate in filamentous alga feeders.

Legs short, subequal (0)
Mid and hind legs 1½-2x length of fore legs, segments subequal (1)
Mid and hind legs > 3x fore legs, segments subequal (2)
Mid and hind legs 3x fore legs, tibiae much longer than tarsi (3)

10. Inner femoral and trochantal setae. Paired trichobothria are found on the inner ventral side of the fore femora and trochanters in the *Oxyethira* group, but have not been observed in any other Hydroptilidae. Nielsen (1948) describes the usual condition in the Trichoptera as "spur-like". Ciliate hairs, or trichobothria, are considered to be derivative.

No trichobothria on fore limb (0)
Trichobothria present on fore limb (1)

11. General shape of body. Body shape ranges from slightly compressed dorso-ventrally to strongly compressed laterally. It is probable that the dorsoventrally flattened larva, found in Glossosomatidae and Ptilocolepinae, represents the ancestral form for the family. The larva of *Hydroptila* is slightly compressed laterally, which is taken to be the ancestral state in the

Hydroptilini, while many members of the *Oxyethira* group are strongly compressed laterally which is interpreted as derived.

Body slightly compressed laterally (0)

Body strongly compressed laterally (1)

12. *Shape of abdominal segments*. In the "generalised" larva the abdominal segments gradually increase in size from segment I to IV or V, which I interpret as the primitive condition, whereas in some of the *Oxyethira* group, I and II form a narrow "waist" beyond which the segments increase in size abruptly, which is a derived condition.

Abdominal segments gradually increasing in size from I to IV or V (0)

Abdominal segments I and II forming a narrow "waist" (1)

13. *Number of abdominal tergites*. Following Marshall (1979), the term "tergite" has been used for what is really a dorsal sclerite (Wiggins 1977), or the "anal plate" of Nielsen (1948). Commonly, Trichoptera have few sclerites on abdominal segments. Several small sclerites on the anal prolegs are associated with the anal claws, and in some families, including Hydroptilidae, a dorsal sclerite occurs on segment IX. In some hydroptilids this basic (=primitive) plan is modified, with sclerites ("tergites") occurring on other segments, and rarely on all segments.

Tergite IX only (0)

Tergites I and IX present (1)

14. Position of anal prolegs. Freeliving caddisflies have elongate anal prolegs, while they are more reduced in case builders and generally positioned laterally. A few specialised hydroptilids have their prolegs positioned ventrally which is considered to be a derived state.

Prolegs lateral	(0)
Prolegs ventral	(1)

15. Caudal filaments. These are rare in Hydroptilidae. They occur in Hydroptila but not in Oxyethira group larvae, which suggests that this is an autapomorphy for Hydroptila. The absence of caudal filaments in the Agraylea group supports this conclusion.

Caudal filaments absent	(0)
Caudal filaments present	(1)

16. Mode of case construction. I believe that innovations in case building have been important in the Hydroptilidae. Much energy is invested in construction of the case and its subsequent carriage. Benefits accrued probably include protection (mostly from predators), provision of ballast, and under some circumstances improved respiratory ventilation. Changes in case construction have generally afforded better protection. Some case designs are probably highly specialised to cope with the flow dynamics of the microenvironment. Increased protection for the larva has been achieved by a change from the primitive mode of case construction seen in Hydroptila and Agraylea, where the case is opened on the ventral side or both sides to allow

increases in size, and where increments are added to both ends and one or both sides of an initial small cockle-shell shaped case. In most Oxyethira group genera, the initial case is as wide as the median section of the mature case, and it is added to at both ends. In Oxyethira, additions are made at one end only.

Additions to case made on 3 or 4 sides	(0)
Additions to case made on ends only	(1)
Additions to case made on 1 end only	(2)

17. Size of case relative to larva. Many cases are built as tight coverings around the incumbent larvae. Others, including those of the Oxyethira group, are "roomy", ie. large relative to the size of larva. As suggested under 16, a relatively large case would allow more efficient ventilation of the respiratory surface (which is usually the general body surface) by allowing freer undulations of the body within the case. This would be advantageous to hydroptilids in warmer lentic waters and can be seen as an alternative strategy to the development of caudal gills. Hydroptila, which has caudal gills, has a relatively tight fitting case.

Case a tight fit	(0)
Case large relative to size of larva	(1)

5.5 Summary of coded character states of larvae

A data matrix of coded character states of known larvae of genera in the Australasian Hydroptilini is given in Table 5.2.

Table 5.2. Data matrix of coded character states of known larvae of genera in the Australasian Hydroptilini. (Character identification numbers are taken from Section 5.4; data on *Paroxyethira* are from my own observations).

Character Genus	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Hydroptila	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Hellyethira	0	1	0	1	0	0	2	0	2	1	1	1	1	0	0	1	1
Acritoptila	0	1	0	1	0	0	2	0	2	1	1	0	0	0	0	1	1
Oxyethira	0	1	1	0	1	1	1	0	1	1	1	0	0	1	0	2	1
Tricholeoichiton	0	1	0	0	0	2	1	0	3	1	1	0	0	0	0	1	1
Orphninotrichia	0	1	0	0	1	1	0	1	0	1	0	0	1	0	0	1	1
Paroxyethira	0	1	0	0	0	2	0	0	2	1	1	0	0	0	0	1	1

6. RESULTS: CLADISTIC ANALYSES

6.1 Introduction

Three alternative phylogenies for the Oxyethira group of Hydroptilini are presented in Figs. 6.1–6.3, all derived from data in Table 5.1. Fig. 6.1 represents a simple Hennigian analysis: taxa are clustered on the basis of shared derived character states and hypothetical ancestors (ANC's) are used to indicate branching points. Fig. 6.2 results from clustering of taxa which share derived steps, according to the method outlined by Farris, Kluge and Eckhardt (1971) (their Weighted Invariant Step Strategy). Fig. 6.3 was constructed following manual computation of intervals between taxa and hypothetical ancestors, using the algorithm of Kluge and Farris (1969). Monophyly of the clade formed by Hydroptila and the Oxyethira group is supported by tentorium reduced medially, antennal hair in a basal whorl in adults, and presence of accessory hooks on anal claws in larvae. Each analysis is described in turn.

6.2 The Hennigian analysis

The cladogram in Fig. 6.1 was constructed by erecting hypotheses of monophyly based on synapomorphies.

Monophyly of the Oxyethira group is supported by synapomorphies in characters 5 and 15, ie. loss of jugal lobe in anterior wing and modification of female terminalia to form a short oviscapt respectively. The dichotomy between the Oxyethira group and Hydroptila is strenghtened by recognition of 3 autapomorphies in Hydroptila (in characters 1, 3 and 6, which are loss of ocelli, loss of subapical spur of mid tibiae, and changes in venation).

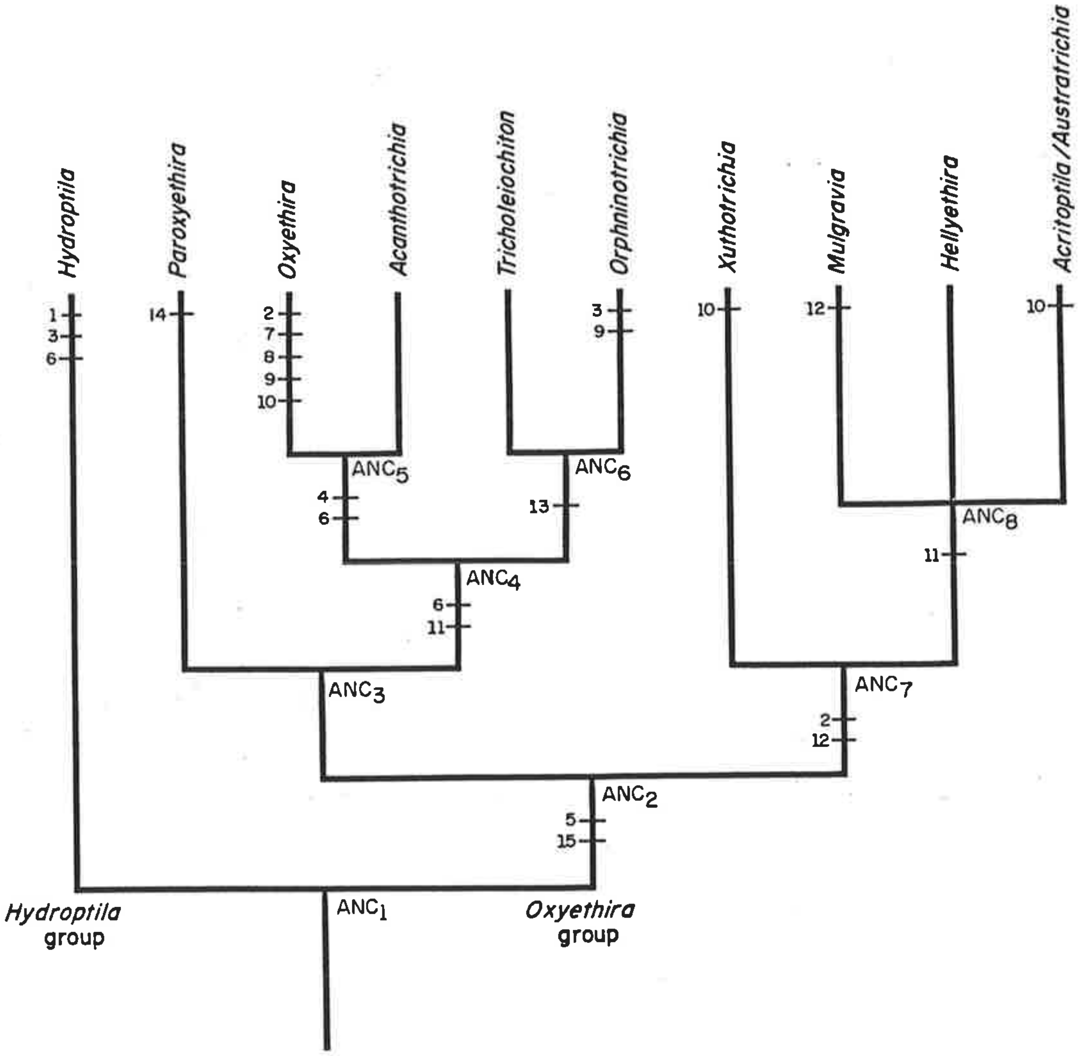


Figure 6.1. Cladogram of relationships of genera in the Australasian Hydroptilini, derived by an Hennigian analysis. Lines indicate apomorphies: numbers refer to coded adult character states from Section 5.2. Hypothetical ancestors, ANC$_{1-8}$, are designated to facilitate discussion.

Within the Oxyethira group, genera can be grouped on the basis of the form of the aedeagus. Aedeagus-without-titillator, argued in Chapter 5 to be the derived state, occurs in Hellyethira, Xuthotrichia, Mulgravia, and Acritoptila/Austratrichia (henceforth referred to collectively as the "Hellyethira complex"), but not in any other genera (except some Oxyethira) and is used to establish monophyly of the Hellyethira complex. This is supported by a synapomorphy in character 2, the presence of auricillica. Although this sensilla type also occurs in Oxyethira, that genus is considered to show a more highly derived state than is seen in the Hellyethira complex. To include Oxyethira with the Hellyethira complex on the basis of character 2 would give a clade based upon a shared derived step, which is not the intention of this analysis.

Monophyly of Hellyethira, Mulgravia and Acritoptila/Austratrichia is based upon a derived state of character 11, a shift to medial insertion of inferior appendages; and Xuthotrichia is defined by the autapomorphous state of its inferior appendages. Autapomorphies are also recognised in Mulgravia and Acritoptila/Austratrichia, but not in Hellyethira. These 3 taxa form a trichotomy.

A synapomorphy in character 13 establishes the monophyly of Orphninotrichia-Tricholeiochiton. Here again, a taxon, Tricholeiochiton, is indistinguishable from its immediate ancestor, although its sister group, Orphninotrichia, shows several autapomorphies.

Monophyly of Oxyethira-Acanthotrichia rests upon sharing of reduction in wing size and fusion of veins, which I think is rather weak evidence (see Chapter 10). Acanthotrichia is not distinguishable from its immediate ancestor, but Oxyethira has 5 autapomorphies. The clade formed by these genera and Orphninotrichia-Tricholeiochiton is supported by a derived state of character 11. Although I have included character 6 with 11, this represents a derived step, not state, since Oxyethira-Acanthotrichia show a more apomorphous condition than Orphninotrichia-Tricholeiochiton. On the other branch of this clade, Paroxyethira shows an autapomorphous state of character 14 (a reduction in genitalic parts).

The cladogram thus derived shows 4 examples of parallelism. In the following taxa, the same states must have evolved independently: character 3 in Hydroptila and Orphninotrichia; character 6 in Hydroptila and ANC_4; character 9 in Orphninotrichia and Oxyethira; and character 11 in ANC_4 and ANC_8. No reversals are required, but a trichotomy is unresolved, and 3 taxa are indistinguishable from their immediate ancestors.

6.3 The WISS analysis

The WISS analysis bases hypotheses of monophyly upon sharing of derived steps and was used to produce Fig. 6.2.

The dichotomy between Hydroptila and the Oxyethira group is the same in practice as in Fig. 6.1. The subsequent dichotomies were argued as follows:- With the exceptions of Paroxyethira and Xuthotrichia, taxa in the Oxyethira group share a step leading to derived states of character 11. Since Paroxyethira alone does not share a step for character 2 upon which monophyly of the Oxyethira-Hellyethira complex can be based, and since monophyly of a clade formed by Acanthotrichia-Tricholeiochiton-Orphninotrichia can be established, it is postulated that in Xuthotrichia, character 11 has undergone reversal to the primitive state. Thus, monophyly of HTU_3 (hypothetical ancestor representing the branching point) is based upon a

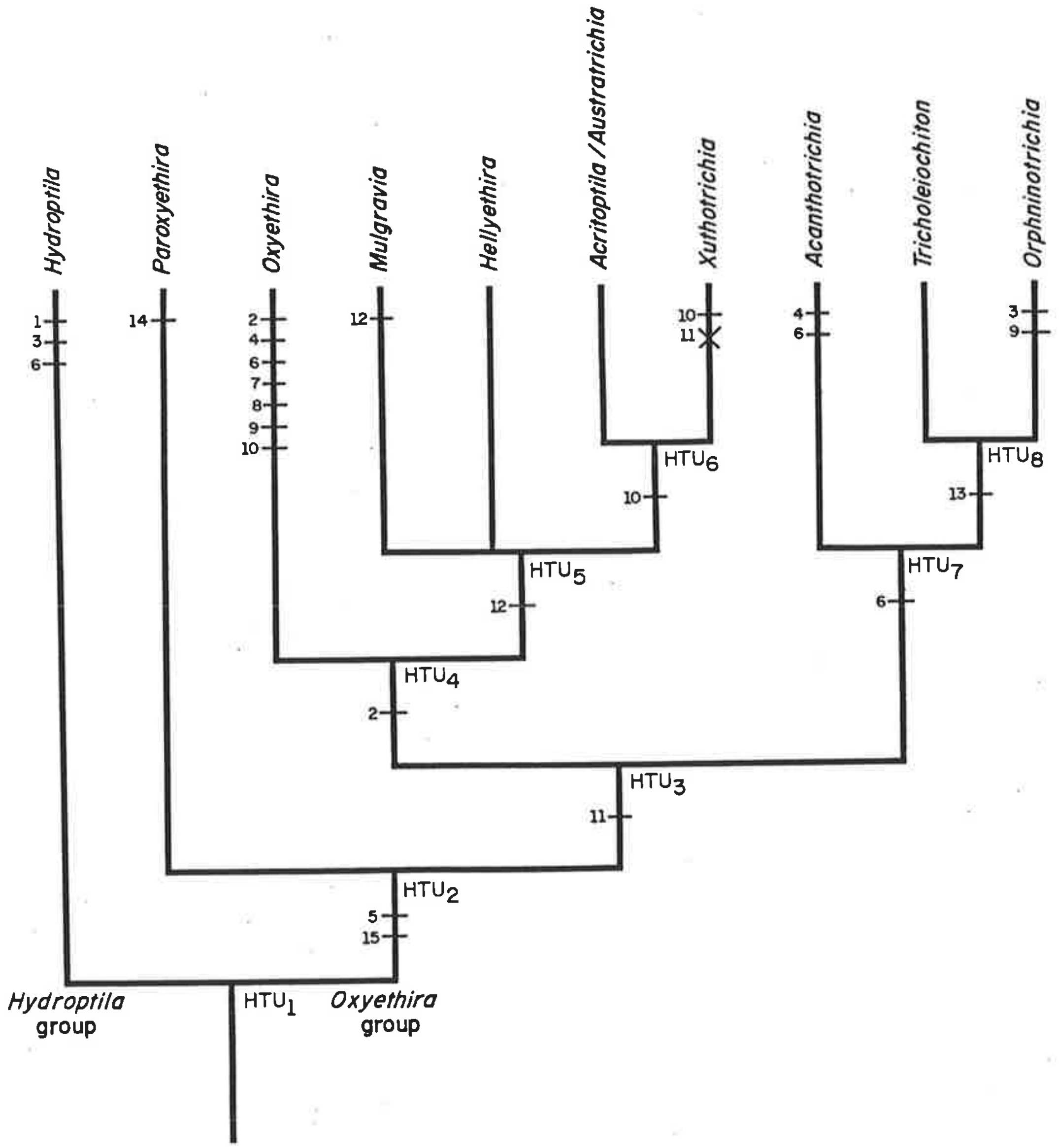


Figure 6.2. Cladogram of relationships of genera in the Australasian Hydroptilini, derived by the WISS method. HTU's are hypothetical ancestors which share derived steps: lines indicate derived steps: a cross indicates a reversal in a transformation series: numbers refer to coded adult characters from Section 5.2.

shared transformation in character 11. HTU_4 and HTU_7 diverged with changes in state of characters 2 and 6 respectively. Monophyly of the Hellyethira complex, descendents of HTU_5, derives from sharing of a step leading to a change in character 12. This step did not occur in the sister group, Oxyethira, which is distinguished by 7 autapomorphies. A step leading to reduction in inferior appendages, (10), unites Acritoptila/Austratrichia and Xuthotrichia, and a further transformation in 10 distinguishes Xuthotrichia. Mulgravia diverged from Hellyethira with a modification of the aedeagus (12).

Amongst descendents of HTU_7, Tricholeiochiton and Orphninotrichia form a monophyletic group based on a step leading to modification of the aedeagus in HTU_8. Both the sister taxon of HTU_8, Acanthotrichia, and Orphninotrichia, show several autapomorphies.

Fig. 6.2 shows 1 reversal in state (character 11) in Xuthotrichia, and 5 parallelisms - character 3 in Hydroptila and Orphninotrichia, 9 in Oxyethira and Orphninotrichia, 10 in Oxyethira and HTU_6, and 4 and 6 in Oxyethira and Acanthotrichia. The first 2 of these also occur in the Hennigian analysis. Note that 4 of these homoplasies involve Oxyethira and can be attributed to the decision to base the third dichotomy on derived steps in characters 2 and 6. As in Fig. 6.1, 3 taxa are indistinguishable from their immediate ancestors, and there is a trichotomy.

6.4 Wagner Tree (method of Kluge and Farris (1969))

The steps taken to produce the cladogram in Fig. 6.3 are outlined in some detail below. The character matrix in Table 6.1 includes the data from Table 5.1 as well as ancestral states computed in the analysis. Since several autapomorphies are recognised in the out-group, *Hydroptila*, a hypothetical ancestor, ANC, is designated with the state 0 for all characters.

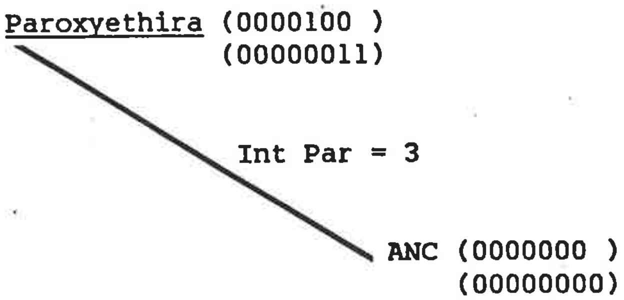
Table 6.1. Matrix of data on adult character states for *Hydroptila* and *Oxyethira* group genera and for computed hypothetical ancestors.

Character Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Σ
Hydroptila	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	3
Hellyethira	0	1	0	0	1	0	0	0	0	0	1	1	0	0	1	5
Acritoptila	0	1	0	0	1	0	0	0	0	2	1	1	0	0	1	7
Xuthotrichia	0	1	0	0	1	0	0	0	0	3	0	1	0	0	1	7
Mulgravia	0	1	0	0	1	0	0	0	0	0	1	2	0	0	1	6
Acanthotrichia	0	0	0	1	1	2	0	0	0	0	1	0	0	0	1	6
Oxyethira	0	2	0	1	1	2	1	1	1	1	1	0	0	0	1	12
Tricholeiochiton	0	0	0	0	1	1	0	0	0	0	1	0	1	0	1	5
Orphninotrichia	0	0	1	0	1	1	0	0	1	0	1	0	1	0	1	7
Paroxyethira	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	3
ANC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
ANC_1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	
ANC_2	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	
ANC_3	0	0	0	0	1	1	0	0	0	0	1	0	0	0	1	
ANC_4	0	1	0	0	1	0	0	0	0	0	1	1	0	0	1	
ANC_5	0	0	0	0	1	1	0	0	0	0	1	0	1	0	1	
ANC_6	0	1	0	1	1	2	0	0	0	0	1	0	0	0	1	

The first step was to determine the taxon which is the shortest distance from ANC, using the formula:-

$D(A,ANC)=\sum_i |X(A,i)-X(ANC,i)|$ where A is any taxon under consideration, X(A,i) is a particular character for the taxon A and i is the i^{th} character of the taxon A.

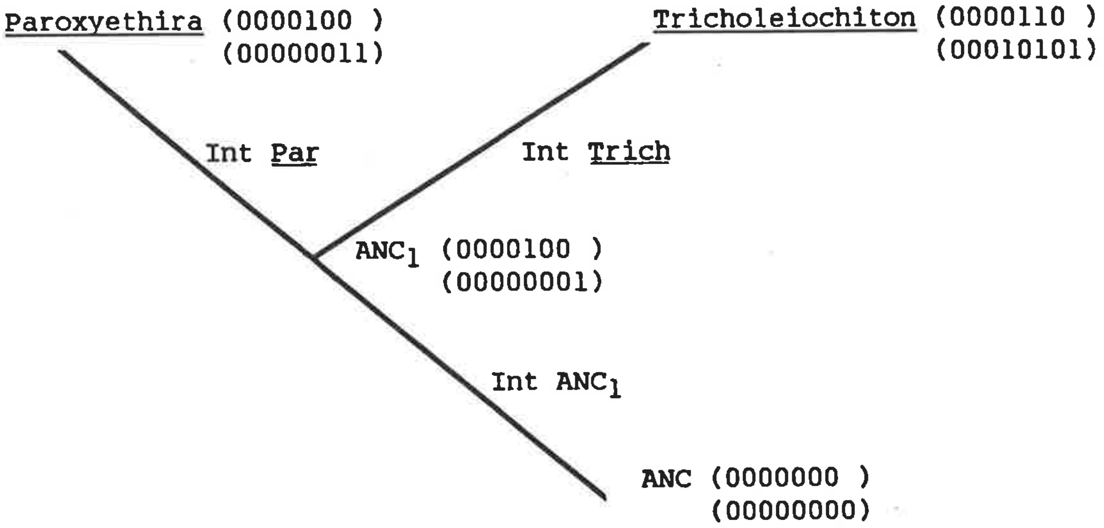
Both *Hydroptila* and *Paroxyethira* are found to be 3 units from ANC. *Hydroptila* is the out-group. *Paroxyethira* is connected to ANC as follows:-



The taxon with the next shortest distance from ANC is now chosen. Both _Hellyethira_ and _Tricholeiochiton_ are 5 units from ANC. _Tricholeiochiton_ is chosen first, although the order does not matter. _Tricholeiochiton_ must be connected to the interval between _Paroxyethira_ and ANC, Int Par. This is done by finding the median of each transformation series of _Paroxyethira_, _Tricholeiochiton_, and ANC.

Character Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ANC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paroxyethira	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1
Tricholeiochiton	0	0	0	0	1	1	0	0	0	0	1	0	1	0	1
ANC_1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1

Tricholeiochiton is connected to Int Par at ANC_1.



Next the position of Hellyethira is determined. Since the tree now has 3 intervals, the distance of Hellyethira from all 3 intervals must be calculated to find the shortest distance. The calculations are as follows:-

$D(Helly,Int(ANC_1)) =$

$^1/_2(D(Helly,ANC_1)+D(Helly,ANC)-D(ANC_1,ANC)) = 3$

$D(Helly,Int(Par)) =$

$^1/_2(D(Helly,Par)+D(Helly,ANC_1)-D(Par,ANC_1)) = 3$

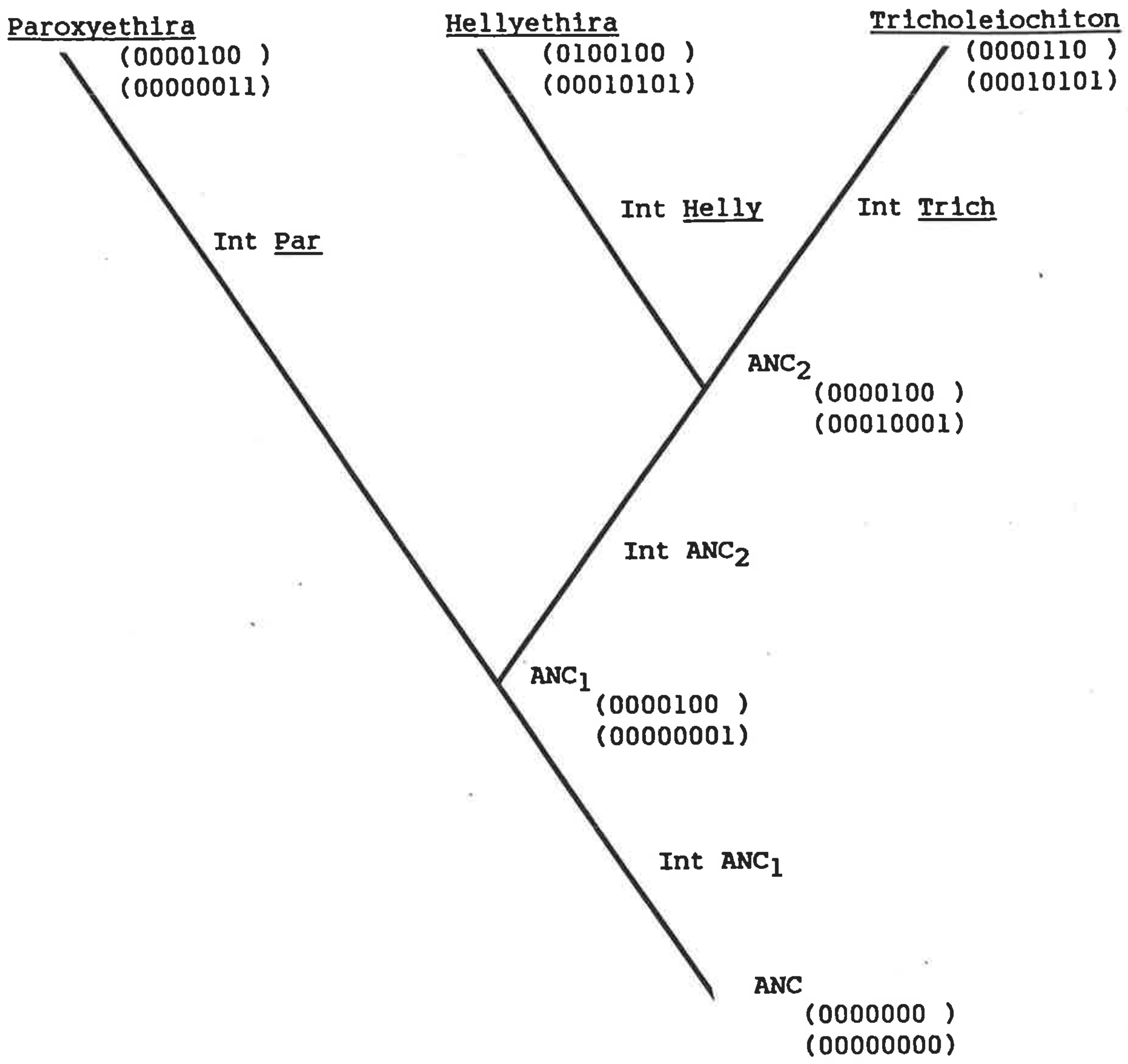
$D(Helly,Int(Trich)) =$

$^1/_2(D(Helly,Trich)+D(Helly,ANC_1)-D(Trich,Anc_1)) = 2$

ie. Hellyethira is to be placed on Int Trich. The median, ANC_2, is calculated as the branching point.

Character Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hellyethira	0	1	0	0	1	0	0	0	0	0	1	1	0	0	1
Tricholeiochiton	0	0	0	0	1	1	0	0	0	0	1	0	1	0	1
ANC_1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
ANC_2	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1

The connection is made to the cladogram.



Taking the next step, we find that 2 taxa are 6 units from ANC. Each is considered in turn as for Hellyethira, except that 5 and then 7 intervals must be taken into account. The procedure is followed until all taxa are connected. Fig. 6.3 represents a minimum length cladogram or Wagner Tree for the data in Table 6.3.

Near the base of Fig 6.3, this cladogram is closer to Fig. 6.2 than to 6.1 but its terminal groupings are very close to those derived by the Hennigian analysis (Fig. 6.1). The major difference is in the position of Oxyethira.

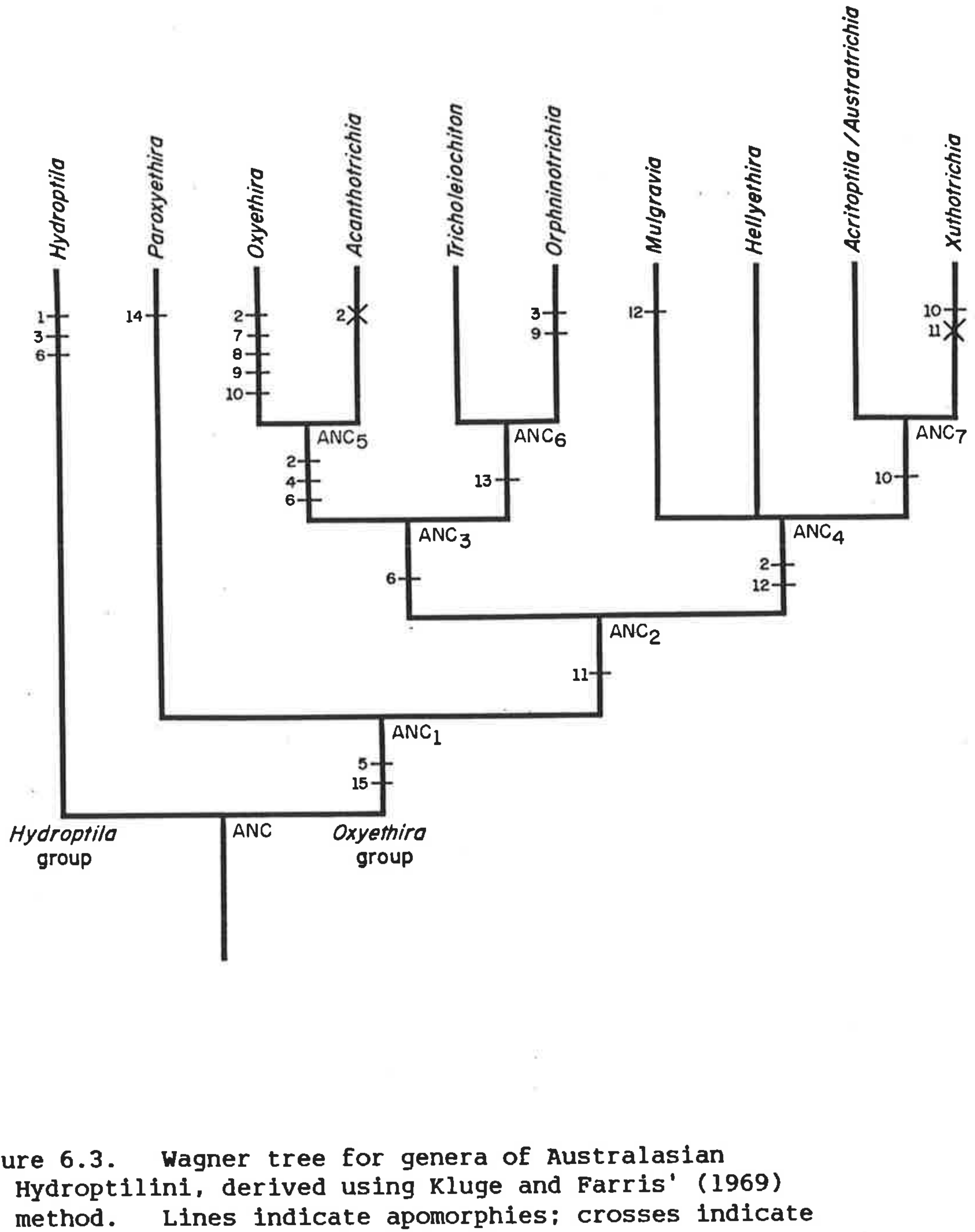


Figure 6.3. Wagner tree for genera of Australasian Hydroptilini, derived using Kluge and Farris' (1969) method. Lines indicate apomorphies; crosses indicate reversals in character states; numbers refer to coded adult characters from Section 5.2.

Homoplaseous events required in Fig. 6.3 include 4 parallelisms, 2 of which occur in all 3 trees. Character 10 shows parallel changes in *Oxyethira* and the ancestor of *Acritoptila*/*Austratrichia* and *Xuthotrichia* both here and in the WISS analysis, except that here it evolves further along the transformation series in ANC$_7$. In what appears to be a most unparsimonious arrangement, character 2 evolves to the same state in ANC$_4$ and ANC$_5$, only to undergo a reversal in an immediate descendent of ANC$_5$.

In addition, this cladogram requires a trichotomy, involving *Hellyethira*, *Mulgravia* and ANC$_7$, and 2 reversals - character 2 reverts to the primitive state in *Acanthotrichia* and in *Xuthotrichia* this happens to character 11.

6.5 Consideration of larval data

Data on larval character states could have been included in these analyses but since information is not available for all genera, I decided to use this data, which is presented in Table 5.2, to test the hypotheses of relationships based on adult characters alone.

Several larval characters support monophyly of the *Oxyethira* group, and 2 more autapomorphies are added to the set for *Hydroptila*. All known *Oxyethira* group larvae have fused ventral head sclerites (character 2), trichobothria on fore femora and trochanters (character 10), and relatively spaceous cases. They also show similarities in case construction, although *Oxyethira* shows a more highly derived state than the others.

No autapomorphies are recognised in larval *Paroxyethira*, but it shares an apomorphous state of character 6 with *Tricholeiochiton*, which gives some support for monophyly of a clade formed by these 2 taxa.

Character 9, the relative lengths of leg segments, provides a strong autapomorphy for *Tricholeiochiton*.

Limited data are available for *Acanthotrichia*, but they indicate that their larvae are quite unlike those of *Oxyethira* which show several autapomorphies including fused antenna (character 3), and case shape or mode of construction (character 16). In all known larval features, *Acanthotrichia* resembles *Hellyethira* (see Table 5.2). This places doubt on the proposed sister group relationships between *Oxyethira* and *Acanthotrichia* in Figs 6.1 and 6.3, although it does nothing to confirm the closer relationship of *Acanthotrichia* to *Tricholeiochiton*-*Orphninotrichia* shown in Fig. 6.2.

In the *Hellyethira* complex, only *Hellyethira* and *Acritoptila* larvae are known. Since they are indistinguishable, they add nothing to discrimination within the complex.

7. RESULTS: PATTERNS OF DISTRIBUTION

At the level of the genus, the geographical distributions of Hydroptilidae in Australia (including Tasmania) fall into 3 categories (Table 7.1):-

(1) Widespread

Orthotrichia, *Hydroptila* and *Oxyethira* are in this group. The known distributions of *Orthotrichia* and *Hydroptila* are illustrated in Fig. 7.1. *Orthotrichia* seems to be absent from SW Australia, and from New Zealand and New Caledonia, but occurs elsewhere in Australia and is common and diverse in New Guinea and SE Asia. *Hydroptila* occurs around the periphery of the Australian continent but is absent from New Zealand. Only *H. losida* occurs in New Caledonia. Both genera are widespread elsewhere in the world, although *Orthotrichia* is not recorded from South America and *Hydroptila* is unknown from southern South America.

Superficially, the distribution of *Oxyethira* appears similar to *Hydroptila*, except that one species occurs in New Zealand (and also on several subantarctic islands (Wise 1972, 1978)) and several are known from S South America (Flint 1982). An entirely different picture emerges, though, if the sub-genera of *Oxyethira* are considered.

In Australia, *O.* (*Dampfitrichia*) is restricted to the north, while it occurs elsewhere in New Caledonia and Vanuatu (Kelley pers. comm.), and SE Asia and the Neotropics (see Fig. 7.2). *O.* (*Trichoglene*) is Australasian with 1 New Zealand and 1 New Caledonian, and 5 Australian members, which are eastern, south-central and south-western in distribution (see Fig. 7.3).

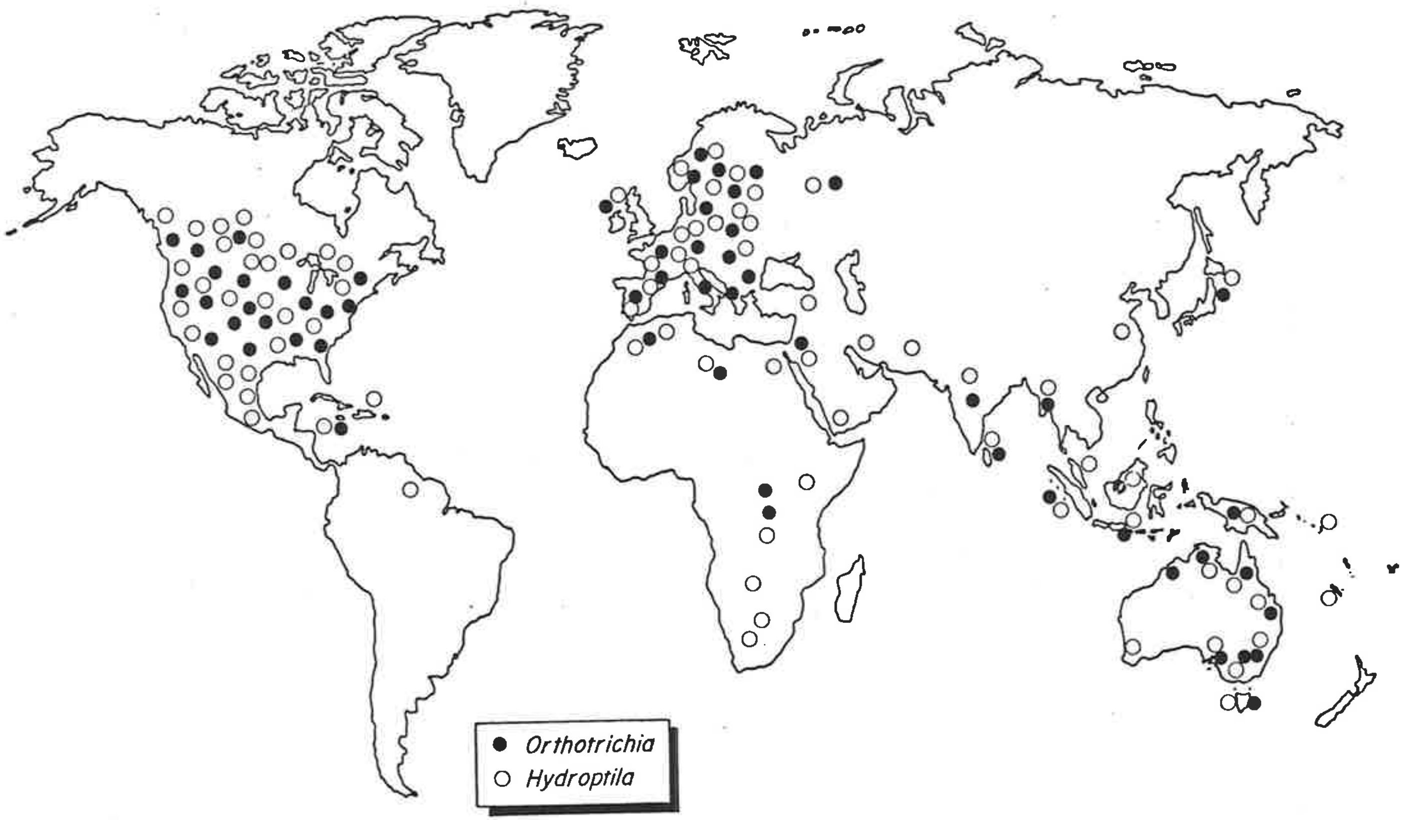


Figure 7.1. Distributions of <u>Orthotrichia</u> Eaton and <u>Hydroptila</u> Dalman. Points indicate general localities, mostly taken from Fischer (1961, 1971). The actual distributions may be much wider.

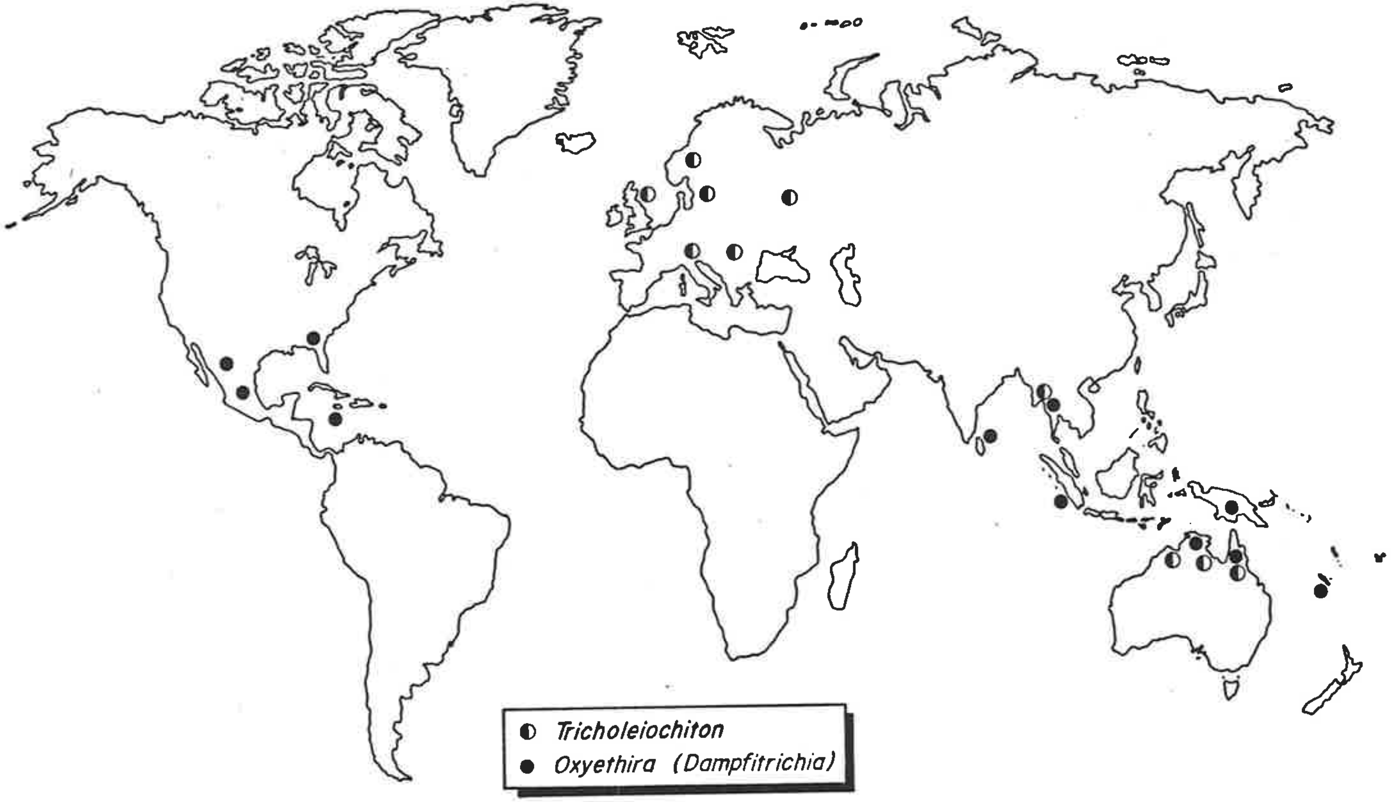


Figure 7.2. Distributions of Tricholeiochiton Kloet and Hincks and Oxyethira (Dampfitrichia) (Mosely).

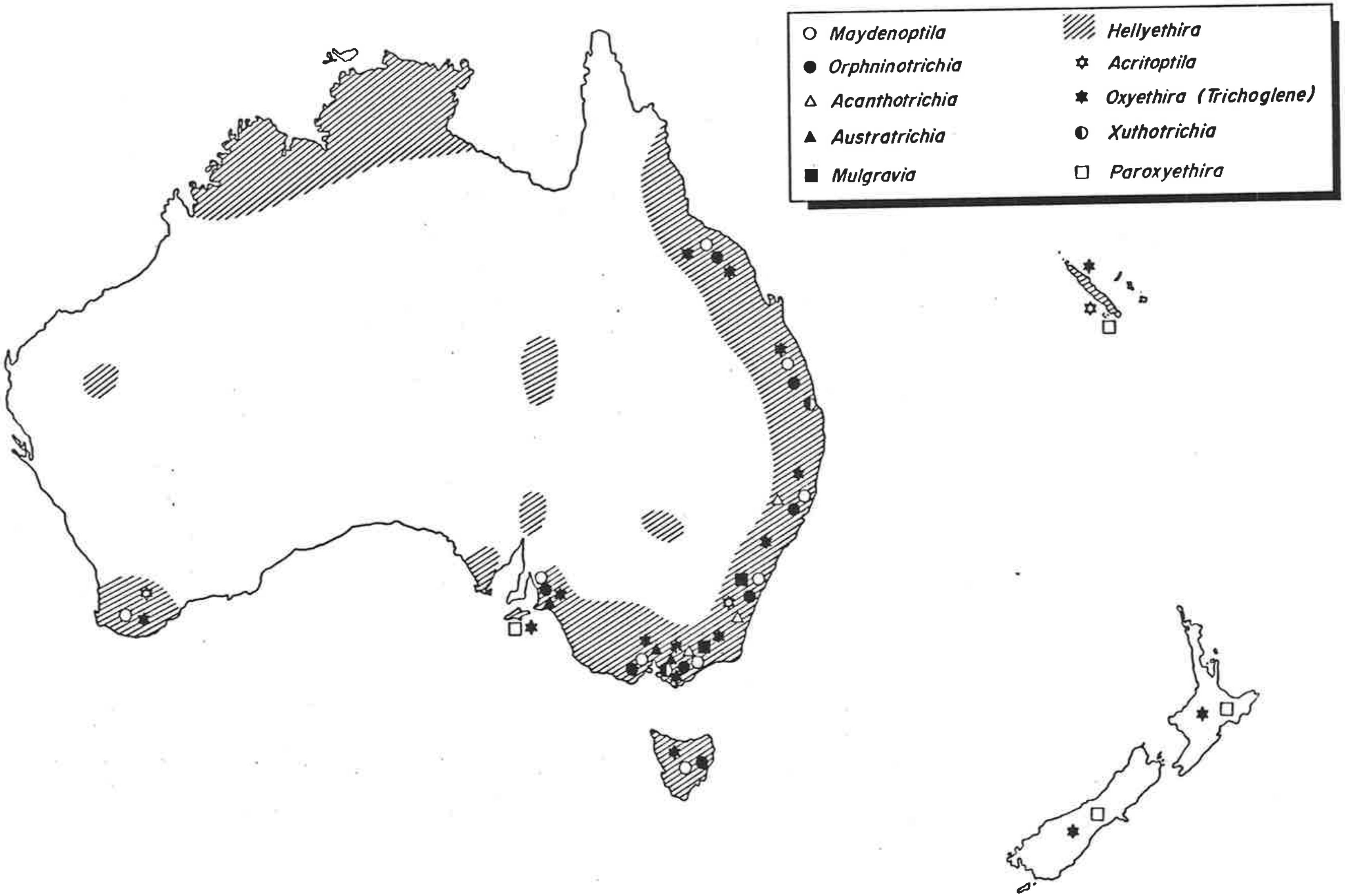


Figure 7.3. Distributions of Australasian genera and <u>Oxyethira</u> (<u>Trichoglene</u>) Neboiss.

(2) North Australian

Tricholeiochiton is in this category; its distribution is shown in Fig. 7.2; five Australian, 2 SE Asian and 1 Palaearctic species are known.

(3) Australasian, including endemics

The distributions of taxa in this category are illustrated in Fig. 7.3. It is noticeable that all genera but Hellyethira are restricted to the wetter ranges of the east, south-east, and south-west of the continent. The widespread Hellyethira, with H. malleoforma ranging throughout eastern, south-central, and south-western Australia, also occurs in New Caledonia, and is thus not truly endemic, although I prefer to include it in this category (see discussion). The other Australian endemics are Maydenoptila, found in the east, south-east, and south-west, Acanthotrichia, east only, and Orphninotrichia, Austratrichia, Mulgravia and Xuthotrichia, east or south-east only.

Acritoptila occurs in both the east and the south-west, and several distinct species are found in New Caledonia.

Figs 7.4-7.6 were produced by substituting broad geographic distributions for taxa in the cladograms presented in Figs 6.1-6.3. Distributions of hypothetical ancestral taxa are determined by applying the "commonality rule". If sister taxa each have some members in a region, then that region is postulated as the centre of origin of their common ancestor. Regions occupied by only one member of a clade are assumed to have been populated by dispersal of an immediate ancestor.

All 3 area cladograms are basically similar. They suggest a Gondwanan origin for the immediate ancestor of Hydroptila and the Oxyethira group, followed by wide dispersal of Hydroptila and diversification of the Oxyethira group in Australasia. The Hellyethira complex is Australian, although several taxa have dispersed to New Caledonia. Orphninotrichia-Tricholeiochiton also appears to be Australian in origin. Thus, it is postulated that Tricholeiochiton dispersed from Australia to SE Asia and the Palaearctic.

The cosmopolitan distribution of Oxyethira amidst Australasian distributions of other related taxa is puzzling. This and other aspects of the area cladograms are discussed in Chapter 11.

TABLE: 7.1 Summary of distributions of hydroptilid genera found in Australia.

1.WIDESPREAD

Hydroptila (9) (Unknown in New Zealand and S South America)

Orthotrichia (35) (Unknown in SW Australia, New Zealand, New Caledonia, and South America)

Oxyethira (9)

2.NORTH AUSTRALIAN, AND LIMITED DISTRIBUTION ELSEWHERE

Tricholeiochiton (5) (SE Asia (2), Palaearctic (1))

3.AUSTRALASIAN

(a) Australian endemics

Acanthotrichia (1)

Austratrichia (1)

Hellyethira (18)

Maydenoptila (8)

Mulgravia (2)

Orphninotrichia (9)

Xuthotrichia (1)

(b) Australia-New Caledonia

Acritoptila (3,6)

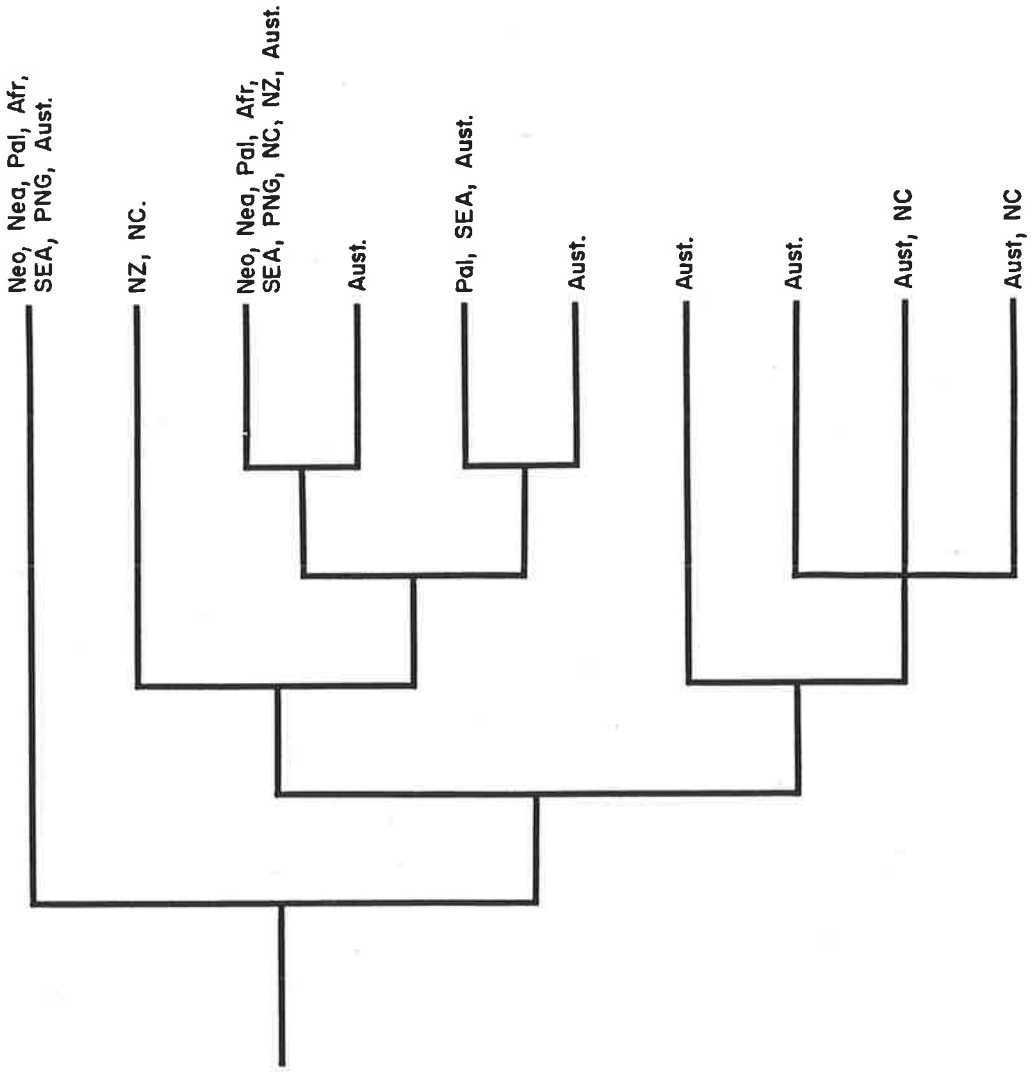


Figure 7.4. Area cladogram for taxa in Fig. 6.1. Abbreviations are as follows: Afr, Africa; Aust, Australia; NC, New Caledonia; Nea, Nearctic; Neo, Neotropics; NZ, New Zealand; Pal, Palaearctic; PNG, New Guinea; SEA, SE Asia.

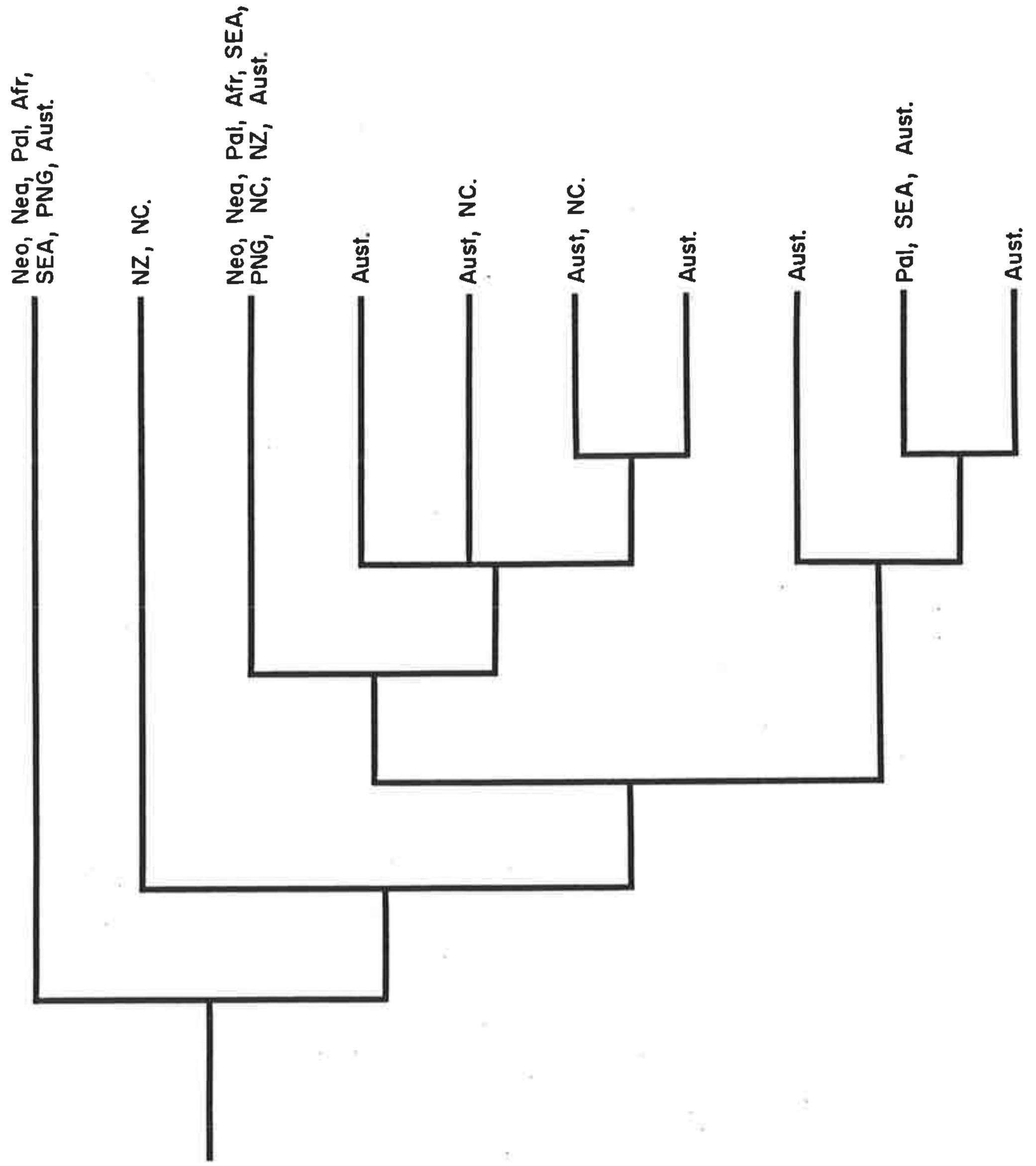


Figure 7.5. Area cladogram for taxa in Fig. 6.2. Abbreviations as for Fig. 7.4.

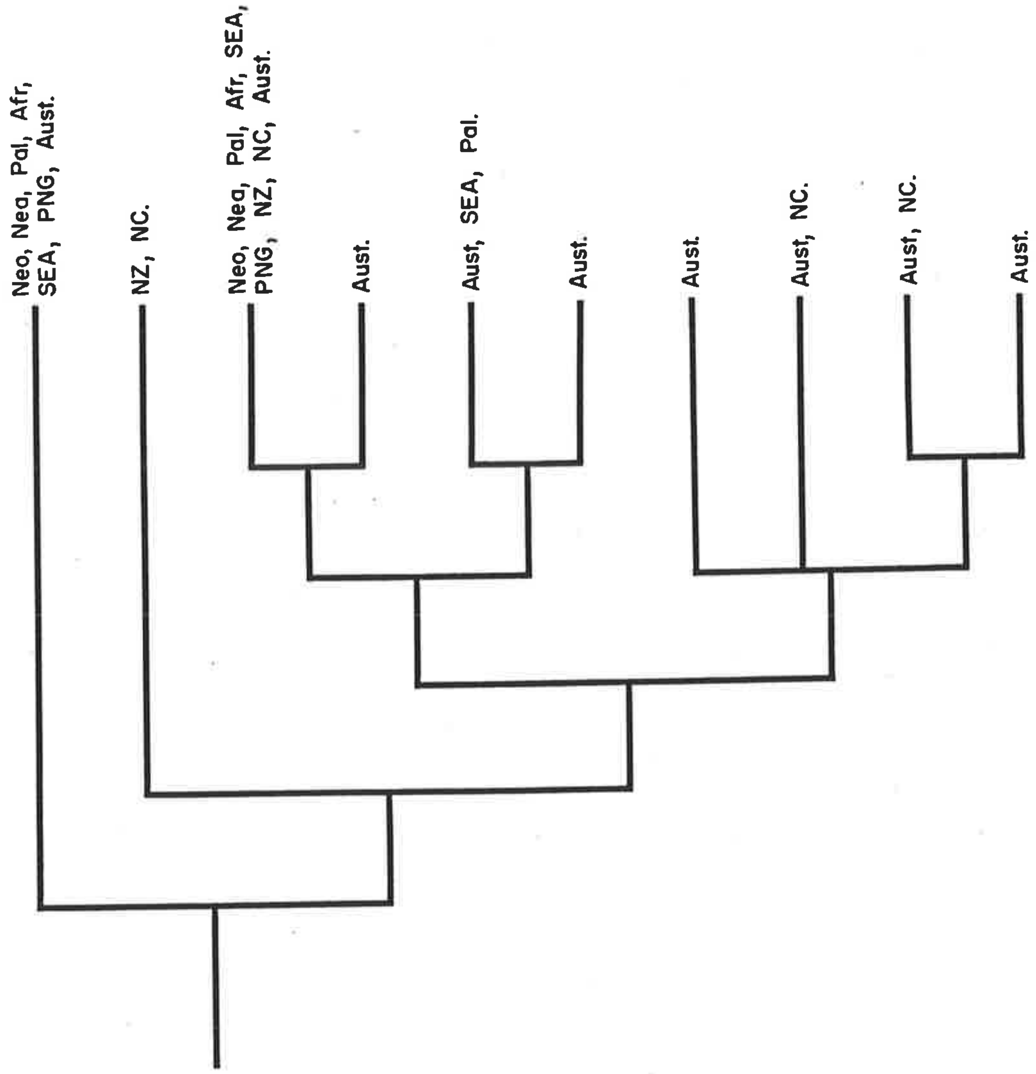


Figure 7.6. Area cladogram for taxa in Fig. 6.3. Abbreviations as for Fig. 7.4.

8 DISCUSSION: ADAPTATIONS IN AUSTRALIAN HYDROPTILIDAE

8.1 Introduction

Given the relatively restricted life habits of the adult hydroptilid, (a short-lived, terrestrial/aerial, non-feeding, reproductive, and presumably dispersive stage), few specialisations might be expected, and even less in the limited pupal stage. In contrast, larval stages, which are more protracted and occupy varied habitats and diverse niches, would be expected to show a variety of adaptations.

8.2 Adults

In most respects, adults of Australian Hydroptilidae are unremarkable, and probably more conservative than those from some other regions:- For example, males of many northern hemisphere Hydroptila have elaborate eversible scent organs shielded by post-occipital caps or lobes (Roemhild 1980); many Leucotrichiini have areas of androconia on their wings, and elaborations on the antennae (Mosely 1937). Such features are rare in the Australian fauna, in which occipital scent organs have been observed in only one species of Hydroptila, and only 2 species are known with androconia on general body regions (ie. Oxyethira artuvillosus and O. plumosa).

Several characteristics seen in Australian hydroptilids, such as reduction in spur number and decrease in wing size, appear to be paralleled in genera elsewhere. Spur counts of 0,2,4 occur in Orphninotrichia, Hydroptila and several Oriental and Neotropical genera, while other Australian genera have 3 spurs (spines) on the mid tibiae.

The significance of such reduction is unknown; these structures are probably used in grooming.

Wings of 3 main types occur in Australian hydroptilids:- *Maydenoptila* has broad wings with very complete venation, and relatively short fringes. *Acanthotrichia*, another endemic, and also *Oxyethira*, have slender, strongly acuminate wings with reduced venation and very long fringes, and all other genera have wings more-or-less intermediate in form between these 2 conditions. If an analogy between micro-caddis flies and birds is valid, the slender, "high aspect ratio" wings could be specially adapted for fast flight, while the broad "low aspect ratio" wings allow only slow flight, but greater maneuvreability. The long fringes on the narrow wings are generally considered to compensate for loss of wing area (Marshall 1979). But this may not be so. While feathers interlock to increase the area of the bird's aerofoil, whilst allowing a reduction in weight, and can be manipulated to modify wing shape during flight, so far as I am aware the fringes on micro-caddis flies are simply a finely divided attachment on the wing margin. Thus, I suggest they have a very different function: possibly they act to increase buoyancy of the tiny insects in air currents, in much the same way as hairs, "thistle down", aid buoyancy of thistle seeds. If so, they may play a role in dispersal of the species. Certainly *Oxyethira*, the most widespread of all hydroptilids, has slender wings with very long fringes, and *Acanthotrichia* is quite widely distributed along the Great Dividing Range.

Long hair is not restricted to wings. Male *Oxyethira artuvillosus* and *O. plumosa* have unusually long fringes on their hind tibiae. I can only speculate that these are associated in some way with the androconia on their abdominal tergites. Perhaps the hair is brushed over the androconia to disperse scents.

On the basis of colour and diel activity, 2 groups can be recognised in the Australian fauna: diurnal species with black wings, usually with a mid-dorsal white spot visible at rest (e.g. Maydenoptila and Orphninotrichia); and nocturnal species, mottled fawn/grey/cream in colour and probably cryptic (most other genera). The significance of the different diel activity-patterns is unknown. Pressures leading to nocturnal activity could include predation and high diurnal temperatures; while the dark colour of diurnal species probably has the function of increasing heat absorbence, hence extending the period of reproductive activity in cool or unpredictable climates.

In several respects, the aberrans group in Orthotrichia differs from other Orthotrichia. Adults are generally large and dark grey to black, yet since often taken at lights and not observed by day, they are probably nocturnal. In a large sample of female aberrans collected at lights in late summer (February), none had mature ovarioles. This is unusual since many of the female hydroptilids taken at lights, are gravid, with mature ovarioles. Possibly adult aberrans live longer.

8.3 Pupae

Most pupae are extremely uniform, with only small variations in hook-plates, but Orthotrichia conferta has an unusual antero-dorsal projection on the head. I am unable to suggest its function.

Pupal cases generally differ little from those of the larva, although some modifications occur, such as the addition of a shield surrounding the case in Hellyethira exserta. This probably gives added protection to the overwintering pupa, which is positioned on the upper surface of a rock. Other small modifications include the extension of one end of the case in most Orthotrichia and in Maydenoptila pseudorupina, which probably influences water flow; and additions of small pieces of stem to the side of the case, as in Hellyethira eskensis, which acts as camouflage. The clustering of pupae and alignment with the current seen in M. pseudorupina could be adaptations which increase protection and ensure adequate ventilation.

8.4 Larvae

Several genera show little or no variation, while others include a range of case forms and other adaptations.

Two genera are extremely conservative:- Known immatures of Australian Oxyethira species agree in every respect with those in other regions; and no interspecific differences are recognised amongst the endemic Orphninotrichia. No single explanation accounts satisfactorily for the conservatism of these genera. Orphninotrichia occupies a restricted niche to which I presume it is narrowly adapted. This could conceivably be so for Oxyethira also, but given the broad range of habitats that it occupies, perhaps its form and physiology merely happen to be particularly versatile.

Immatures of only 2 species of Tricholeiochiton (1 Palaearctic and 1 Australian) are known. They are highly specialized and indistinguishable, which, since the world distribution of the genus is quite narrow, suggests that this genus, too, may occupy a restricted niche.

Hydroptila and Orthotrichia are almost as widely distributed as Oxyethira, but more variable. In Australian Hydroptila, cases vary little in shape but considerably in materials. Use of particular materials by some species appears to be obligate (e.g. cases of obscura are always composed of filamentous algae), by others facultative -

possibly dependent on their availability, or on velocity of current (it is suggested that sand acts as ballast). Larvae of *Hydroptila* show only small differences in colour or markings, and are generally uniform in structure. *H. acinacis* is exceptional in having mouthparts more ventrally placed and forelimbs more stoutly chelate. While a shift in position of the mouthparts in this species may have accompanied a change from feeding on algal filaments, this seems to conflict with the form of the forelimb. It is more as illustrated for northern hemisphere *Hydroptila* (Nielsen 1948; Marshall 1979), and being more strongly chelate would afford a firmer grip on filaments in swift currents.

The more restricted world distribution of *Hydroptila* in comparison with *Oxyethira* could be related to a narrower habitat preference. *Hydroptila* is generally found only in flowing water amongst filamentous algae on the substrate, although plasticity in case materials has probably enabled some expansion of its habitat range.

Larvae and cases of most Australian *Orthotrichia* vary little. Differences in the form and length of setae on abdominal tergite IX may be related to case building behaviour and therefore to details of case form, while respiratory modifications, such as caudal filaments on larvae, or vents in cases, are probably adaptations to habitats with reduced oxygen levels. However, the 2 known members of the *aberrans* group are widely divergent. The grossly swollen abdomens of their mature larvae suggest that they accumulate abnormally large food reserves. This supports the idea that their imaginal life may be unusually prolonged (see Section 8.2). The *aberrans* group is known from SE and E Australia and Indonesia (a pupa and a case which surely belong to this group were described by Ulmer (1957) from Java). Thus, it appears to range from cool temperate to tropical regions, rather than being narrowly restricted to a particular climatic zone; but whether the tropical species has the same unusual habits as Australian members is unknown. Future detailed studies of the life history of these species may determine the significance of the aberrant larval form.

Another unanswered question is whether the labral tooth of Orthotrichia larvae is truly an extreme specialisation for feeding on algal filaments as suggested by Nielsen (1948), or whether it evolved as an adaptation to predation, secondarily used to advantage by forms that turned to feeding on filamentous algae. It is notable that amongst putative filamentous algae feeders, Orthotrichia alone lacks modified forelimbs.

Like Hydroptila, Hellyethira is conservative in larval form but uses a variety of materials in case construction. However, unlike Hydroptila, the shape of the case also varies considerably, and is relatively more spaceous. I suggest that the 2 widespread species, Hellyethira malleoforma and H. simplex, which appear to be generalists, have retained the primitive case form and habits of the genus. Thus, the ancestor of Hellyethira is envisaged as a filamentous alga feeder, living in slow or lentic waters. Its smooth, rectangular, secretion case, held upright, slipped easily between algal threads, while the narrow waist increased the agility of the larva, and also facilitated turning and twisting within its case. The larger case improved respiratory ventilation brought about by undulation of the abdomen.

If malleoforma and simplex larvae have retained the primitive habits of Hellyethira, then this lineage began in lentic or slow waters and subsequently radiated into lotic habitats. Thus, I am postulating a reversal of the usual trend in Trichoptera, and other aquatic insects (Wiggins 1984). The movement into lotic habitats was accompanied by changes in case design and materials because the large, flat, ancestral case was disadvantageous in faster water.

Acritoptila is poorly represented in Australia, with only 3 known species. Larvae of 2 have been identified and these are similar to *Hellyethira*; both have secretion cases. Species diversity of *Acritoptila* is greater in New Caledonia (Kelley pers. comm.) where the extent and pattern of variability of immatures appears to parallel that of *Hellyethira* in Australia (Wells unpublished data).

Of all Australian Hydroptilidae, members of the endemic *Maydenoptila* show the greatest diversity of larval and case forms. *M. cuneola* is peculiarly adapted for its feeding and case building association with red algae, *baynesi* for its torrenticolous habitat, and *rupina* for life in ephemeral streams; but the significance of the modifications of *pseudorupina* is unknown. These divergent forms are best explained as highly specialised relicts of what was once a larger and more widespread group.

The diverse forms of immature *Maydenoptila* are consistent with the thesis that it is an old Australian group. Yet this is not to imply that uniform groups must have a more recent history: as is almost certainly true of *Oxyethira*, they may simply have evolved a very successful (versatile) form.

While the range of larval forms in the Australian Hydroptilidae is comparable, overall, with that on other continents, the relative abundance of particular types differs. This can be interpreted as a direct reflection of the habitats available but may also be partly due to genetic constraints within the taxa represented. Forms adapted to swift waters or rapids are rare, but long-legged forms are common.

Fast flowing waters and rapids are less common in Australia than many other continents with higher relief, but none the less these habitats are present - usually occupied only by Orphninotrichia, or in the SW of Western Australia, by Maydenoptila baynesi. Long-legged larvae are generally considered to be adapted for feeding on, and moving amongst, filamentous algae. A predominance of these types can be correlated with the relative abundance of slow streams and lakes, which, coupled with the cool to warm temperate climate that prevails over much of the continent, provide suitable habitats for algal growth.

9. DISCUSSION: ANTENNAL FEATURES

These studies have shown that the fine structure of the antenna, including form, arrangement and distribution of clothing hair and sensilla, is sufficiently conservative to provide reliable generic characters. In a preliminary report, I used this new suite of characters to test Marshall's (1979) hypotheses of relationships, which she had produced without reference to them, and discovered a number of conflicts in the family as a whole, and also in the tribe Hydroptilini (Wells 1984a).

The cladograms in Chapter 6 are based in part on antennal features. Therefore these features cannot be used to test those cladograms. However, to demonstrate their value in taxonomy, I have added the Agraylea group from Marshall's (1979) phylogeny, which did not involve the use of data from antennae, to Fig. 6.2, the cladogram derived by the WISS method. This simple exercise, illustrated in Fig. 9.1, shows an anomally in arrangement of hair in the Agraylea group. Normally, in Hydroptilidae, clothing hair is scattered on antennal segments (see Wells 1984a), which condition appears to be ancestral. Since whorled hair occurs only in the Hydroptilini (and in one species of Orthotrichia (see Section 3.5)), where it is the usual arrangement, it is probably a derived state, that arose in the ancestor of the tribe. Thus, the simplest explanation for the scattered arrangement in Allotrichia and Agraylea is that it results from a reversal to the plesiomorphic form. Other interpretations, such as retention of the primitive state, call for careful reappraisal of relationships.

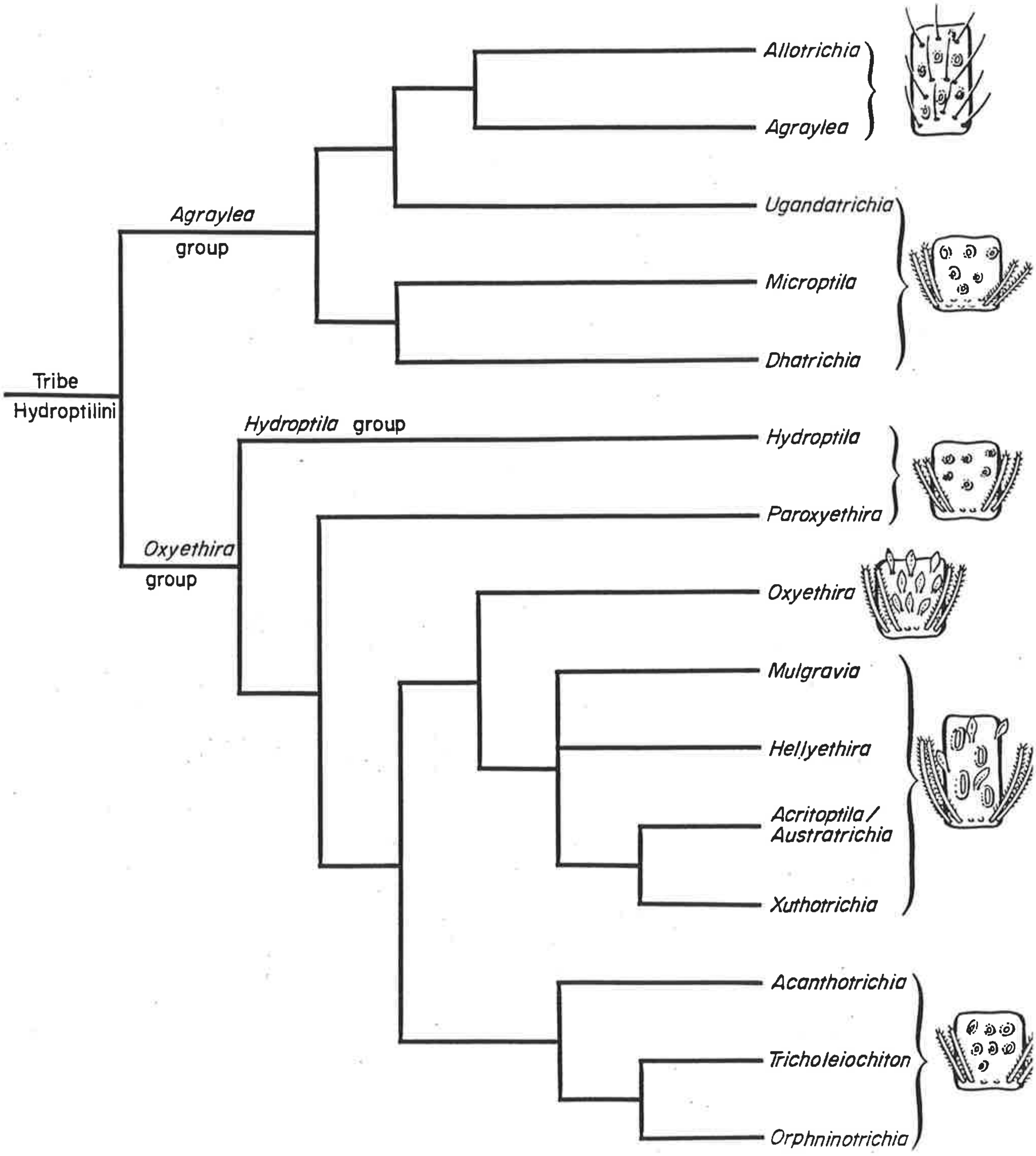


Figure 9.1. General cuticular features of antennal flagellar segments, superimposed upon a cladogram of relationships of genera in the Hydroptilini (derived in part from Fig. 6.2 and in part from Marshall's (1979) phylogeny).

In Chapter 5, outgroup comparisons were employed to derive hypotheses about polarities of states for hair and sensilla patterns. The evolutionary significance of the trends is unknown, but I have suggested that the more apomorphic whorled arrangement of hair, which effectively forms a tight cone around each segment in Hydroptila and genera of the Oxyethira group, "would afford better protection for underlying sense organs, and conceivably enable more accurate assessment of the direction from which stimuli are proceeding; or they may direct air flow across sensilla" (Wells 1984a).

I was unable to decide whether tapered hair is more primitive than fimbriate hair, or vice versa. It seems plausible that fimbriate hair, whether whorled or scattered, could act as a filter to protect delicate sensory structures from particulate matter, whilst still allowing air flow.

Little is known about evolutionary trends in form, arrangement and distribution of sensilla. In discussing the evolution of arthropod antennae and their sensilla, Callahan (1979) concluded that the more primitive insect orders tend to have fewer types of sensilla, the more advanced orders more. While a similar trend seems to occur in hydroptilids, data from a wider survey of genera is required before it can be confirmed. Similarly, although Callahan also perceived trends towards more complex surface sculpturing on sensilla in higher orders, far more information is required on the form and function of sensilla before other evolutionary trends can be ascertained. None the less, it is challenging to speculate on the role that antennal features may have played in the evolution of a group such as the Hydroptilidae.

There can be little doubt that sexual dimorphism in multiporous chemosensilla (placodea and auricillica) is due to a role played in mate recognition:- This is supported by the fact that in all species examined it is the male that has the most diverse sensilla and the largest numbers of particular types, while females of many genera have prominent abdominal glands which appear to open externally and are probably involved in pheromone production. Further indirect support for a primary reproductive function of these sensilla lies in the facts that adult hydroptilids appear not to feed, and that their females always oviposit in or close to water. Thus, their non-reproductive activities are possibly rather limited and stereotyped, and one might suppose they would all require much the same sensory information from a standardized set of receptors. But of course the antennal receptors vary greatly from group to group.

Antennal chemosensilla of the Hydroptilidae may, then, be important as receptor components of specific mate recognition systems, sensu Paterson (1978). According to Paterson, the selective forces in speciation are directed towards mate recognition, rather than factors which reproductively isolate one group from another. This is consistent with the theory of allopatric speciation, since in isolation from other populations the prime concern of individuals is to find mates. The finding of unique species characteristics in hydroptilid olfactory sensilla supports the idea that they are involved in specific mate recognition.

10. DISCUSSION: PHYLOGENETIC RELATIONSHIPS

It was fortuitous for this study that the majority of Australian hydroptilids are in one section of one tribe, the Hydroptilini. This enabled me to produce a detailed analysis of the relationships of those taxa (see Chapter 6). Maydenoptila and Orthotrichia, which are not in that tribe, were omitted from the formal analyses for reasons given in Section 2.7.1.

No new insight into the relationships of Maydenoptila derives from this study. That it shares unique male genitalic features with Caledonotrichia (New Caledonian) is strong evidence of their close sister group relationship. Yet the 2 show considerable disparity in larval features (e.g. case form, thoracic pleura). I have suggested that these genera are most closely allied to Nothotrichia and Dibusa from the New World (Wells 1980). However, this is speculative, because while the 4 taxa share several plesiomorphic features, I am unable to identify any synapomorphies. Further investigation of the relationships of these genera awaits a future revision of the whole family.

Similarly, nothing new can be said of the relationships of the genus Orthotrichia, although some interesting questions are raised about the origins of the genus, species relationships, and zoogeography: further studies of SE Asian and Western Pacific faunas are required before intrageneric relationships can be reviewed.

Australian Hydroptila and those in New Guinea (Wells 1984b), form a relatively uniform and conservative group within the genus. Their male genitalia are basic in form and lack structures such as the parameres of other groups. Males of only one species are known to have occipital scent organs, and they are relatively simple compared with some of the elaborate adornments of many northern hemisphere species (Roemhild 1980). A thorough review of Hydroptila is necessary but it appears that the Australian-New Guinean losida group is a conservative and perhaps primitive lineage in the genus.

The phylogenetic analyses in this thesis (Chapter 6) lead to some insight into relationships of the Hydroptila and Oxyethira groups in the tribe Hydroptilini. Monophyly of the cluster formed by the 2 groups is supported by synapomorphies such as reduction of the tentorium and development of accessory hooks on the anal claws of larvae. In all analyses, Hydroptila is well separated from the Oxyethira group by a set of autapomorphies including reduction in spur number, loss of ocelli, and modified venation in the anterior wing.

Marshall (1979) asserted that the Oxyethira group is "heterogeneous with regard to adult features ...". However, loss of jugal lobe in the anterior wing and modification of female terminalia to form a short oviscapt are synapomorphies confirming the monophyly of the group. Synapomorphies are also recognised in larval features, including fused post-mental sclerites, mode of case construction, and trichobothria on fore femora and trochanters. Autapomorphies in Hydroptila larvae include fusion of dorsal head sclerites and presence of caudal filaments.

The Hennigian analysis (Fig. 6.1) and the Wagner Tree (Fig. 6.3) show similar clusters of terminal taxa. Yet they differ in their initial branchings. In the 3 basal steps, the Wagner Tree is congruent with the WISS analysis (Fig. 6.2), and moreover, at each dichotomy monophyly of each taxon is supported by at least one apomorphous state or step. This is not so in Fig. 6.1 where, although monophyly of the

Hellyethira complex is established by 2 apomorphies in ANC_7, the sister taxon, represented by ANC_3, is unsupported.

Figs 6.2 and 6.3 differ with respect to the position of Oxyethira. In Fig. 6.2 it clusters with the Hellyethira complex as one of the descendents of HTU_4, all of which share a step leading to a change in antennal sensilla (the development of s. auricillica). This transformation proceeds further in Oxyethira but not in the Hellyethira complex, for which monophyly derives from sharing of a step leading to loss of the titillator on the aedeagus (character 12).

In the Wagner Tree (Fig. 6.3), Oxyethira clusters with Acanthotrichia on the basis of synapomorphies in antennal sensilla and wing features (characters 2, 4 and 6). However, as I suggested in Section 6.3, to postulate a transformation in antennal features here - a homoplaseous step, since the same change must have occurred in the ancestor of the Hellyethira complex - seems most unparsimonious. This is particularly so when an immediate reversal must be invoked in a descendent in order to explain the state in Acanthotrichia. Just how much confidence can be placed in reduction in wing width and extent of fusion of veins in these genera is uncertain, because Marshall (1979) says such features tend to be unreliable. In view of this, together with my speculations in Chapter 9 that changes in antennal sensilla were fundamental in the evolution of hydroptilids, I favour the cladogram produced by the WISS analysis. Support for this preference comes from consideration of larval characters, which suggest that Oxyethira and Acanthotrichia are probably not close sister groups (see Section 6.4).

It could be argued that the Wagner Tree, which is constructed objectively, should be accepted as the most parsimonious cladogram. However, it is impossible to remove all uncertainties from decisions about polarities, which are, after all, only hypotheses about direction of change. Thus, this is not a strong argument. One disconcerting feature of the WISS analysis is the number of parallelisms that involve Oxyethira. But perhaps that is not surprising for a genus which appears to be more highly evolved than any of the others in the group, to the extent of showing apomorphous states in 10 of 15 adult and 11 of 17 larval characters.

The remainder of this discussion is based upon the WISS cladogram, which, for the reasons given above, is considered to represent the most plausible phylogeny for Hydroptila and the Oxyethira group genera.

The Oxyethira group originated as a result of divergence of HTU_2 from Hydroptila, with the loss of the jugal lobe in the anterior wing and shortening of the female terminalia. The significance of the first of these changes is unknown. It may simply be one step in the process of narrowing the wings, which is probably correlated with reduction in body size (see Section 8.1). Presumably the elongate terminalia of the female functioned primitively as an ovipositor. Many Trichoptera dive into the water and deposit their eggs beneath rocks, possibly probing into crevices with their slender ovipositors. Shortening of the terminalia, leading to a loss of this function must have conferred some advantage, perhaps associated with a change in oviposition behaviour in slower waters.

A dichotomy resulting in a lineage with medially inserted inferior appendages, (HTU_3), also gave rise to Paroxyethira. Paroxyethira evolved distinctive male genitalia, which lack a dorsal plate but have a prominent medial lobe posteriorly on sternite VIII.

The form of the inferior appendages suggests a secure clasping function, and in this respect they resemble those of Hydroptila.

All descendents of HTU_3 have inferior appendages which appear to be more-or-less inadequate for their original function. They are reduced, often fused, and inserted mid-ventrally. Perhaps correlated with changes in these features, and accompanying changes in mating or courtship behaviour, we see modifications to antennal sensilla in one of the descendents of HTU_3. The increase in the array of sensilla types in HTU_4 was probably associated with further changes in mating behaviour.

Divergence of Oxyethira from the Hellyethira complex must have been an important event. Compared with the magnitude of differences between other related taxa, Oxyethira is almost in the "hopeful monster" category (Goldschmidt 1940). In a chance combination of genetic potential and selective pressures, a highly specialised form evolved. Changes in the adult included further transformation of antennal sensilla, reductions in wing width and venation, modification of abdominal segments VIII and IX, and strong reduction of inferior appendages. A novel case shape was adopted, and the larval antenna was fused. It is surprising that in spite of this suite of autapomorphies Oxyethira is probably the most widespread and diverse genus in the entire family. This seems to contradict ideas such as those propounded by Parsons (1983) about colonising abilities and generalists: perhaps the specialised morphology belies a highly adaptable physiology.

Loss of titillator on the aedeagus supports monophyly of the descendents of HTU_5, amongst which are several lineages, all with distinctive male genitalia. Although in determining polarities in Chapter 5, I accepted Kelley's (1984) statement about the derived nature of loss-of-titillator in Oxyethira, I believe this character requires close examination. According to Kelley, in Oxyethira, both the oldest and most primitive subgenus, Trichoglene, and several other more highly derived subgenera, have lost the titillator (although he says that a vestige remains in one species of Trichoglene). It is conceivable that independent evolution of the same feature occurred in HTU_5 and in several lineages in Oxyethira. An alternative which Kelley does not appear to consider is that the loss occurred in the ancestor HTU_4 with subsequent reversal within Oxyethira to the plesiomorphic state. This seems to be equally plausible, especially considering the state found in HTU_5.

Returning to the right-hand-side of the cladogram, to the sister taxon of HTU_4:- There is strong evidence for monophyly of the descendent clade formed by Orphninotrichia-Tricholeiochiton, but only rather weak support for monophyly of its ancestor-in-common with Acanthotrichia, HTU_7. This derives from a change in venation, which is further transformed in Acanthotrichia, in parallel with Oxyethira.

The position of Acanthotrichia is not particularly strong. Although I argued above that the relationships postulated in Figs 6.1 and 6.3 were less satisfactory than that postulated by the WISS analysis, doubts still remain.

In view of the close similarities between their male genitalia, a sister group relationship between Orphninotrichia and Tricholeiochiton is not surprising. Yet their larvae are quite disparate in form. Thus, this represents another remarkable dichotomy.

Several aspects of this cladogram are particularly noteworthy. One is the number of taxa based upon apomorphies in genitalic or other reproductive features. Among adults of the Oxyethira group, only

Oxyethira and *Orphninotrichia* are clearly distinguished by non-reproductive morphological features. In addition, attention is drawn to the validity of splitting the *Hellyethira* complex, genera of which are difficult to distinguish on the basis of characters used in this study. An extreme case is seen in the inability to discriminate between *Acritoptila* and *Austratrichia*, but the other genera are also very close and may eventually have to be recombined. Yet, as I argued previously (Wells 1983), the discontinuities between all of these genera are greater than those between distinct lineages within *Hellyethira*. More detailed analysis of genitalic parts is required before taxonomic changes are made.

Larval adaptations have clearly been important in the evolution of the *Oxyethira* group. Many of the initial dichotomies probably resulted from shifts by larvae to new adaptive zones, followed by relatively minor changes in adults, associated with mate recognition. For example, the relationship between *Tricholeiochiton* and *Orphninotrichia* could have arisen in this way, with the initial split perhaps resulting from a major chromosomal change (ie. an example of stasipatric speciation (see White 1968)), followed by slight changes in adults to reinforce mate recognition. The dichotomy between *Oxyethira* and the *Hellyethira* complex could have had a similar origin, although that between *Paroxyethira* and HTU$_3$ is better explained as a result of vicariance (see Chapter 11). The study of karyotypes may lead to some understanding of these events.

Larval characters have proved to be informative. *Oxyethira*, *Tricholeiochiton*, *Orphninotrichia* and the *Hellyethira* complex, as well as *Hydroptila*, all show autapomorphous larval character states. Only *Paroxyethira* (and possibly *Acanthotrichia*) is not so defined. The basal dichotomy is also well supported by larval synapomorhphies. However, some conflicts are apparent, such as sharing of apomorphous states by _Tricholeiochiton_ and _Paroxyethira_, and _Hellyethira_ and _Orphninotrichia_. Never-the-less, Wiggin's (1981) assessment of the value of data on immatures is confirmed.

The application of several methods of cladistic analysis failed to lead to a consensus on relationships of the taxa under study. Yet the exercise was useful, even if only because it raised doubts and produced discussion. A more detailed analysis of functions and homologies of genitalic parts and antennal features was beyond the scope of this thesis. Such studies, together with more complete data on immatures, and karyological and behavioural studies, may eventually lead to greater insight into phylogenetic relationships of the _Oxyethira_ group, and other Hydroptilidae.

11. DISCUSSION: BIOGEOGRAPHICAL RELATIONSHIPS

As noted in Chapter 10, the Australian Hydroptilidae are sparsely represented at sub-familial and tribal levels. Only the subfamily Hydroptilinae is present, and within it, with the exception of Maydenoptila (incertae sedis), only the 2 most highly derived tribes, the Hydroptilini and Orthotrichiini. In contrast, according to Marshall (1979), all other regions have a greater diversity at this level, although the numbers of genera are similar:- The Nearctic has both sub-families, and 6 tribes of the Hydroptilinae; Palaearctic both sub-families, 3 tribes; Neotropics, Hydroptilinae only, with 5 tribes; and Africa and SE Asia, Hydroptilinae only, and 3 tribes each. Little is known of the Hydroptilidae of SE Asia and parts of Africa, and thus future research may well alter this view of their faunas, but that would only serve to emphasize the restricted nature of the Australian Hydroptilidae, which are now reasonably well known.

Amongst 12 genera that are in Australia, 3 of the most diverse are also the most widespread on a world scale, 3 have limited representation outside Australia, and 6 are endemic.

Orthotrichia is almost world-wide (see Table 7.1), is the most diverse genus in Australia, and is, moreover, far more diverse in Australia than elsewhere. It appears to be absent, though, from SW Australia, and also from New Zealand, New Caledonia, and South America. Several species groups which occur in Australia are recognised from SE Asia and more from New Guinea (Wells 1984b): some Australian and New Guinea species are closely allied.

It is possible that Orthotrichia had a southern origin, or that it was an old, widespread genus. Either of these hypotheses requires that it has become extinct in a number of southern regions. An alternative, and perhaps more likely theory is that *Orthotrichia* reached Australia from the north following the meeting of the Australian and Sunda Plates about 15-20 my BP. Repeated migrations have probably occurred in both directions, even to recent times. No species are particularly widespread, which suggests that they have narrow ecological tolerances. This seems an unusual feature in a group with such a broad distribution. The absence of *Orthotrichia* from SW Australia, New Zealand and New Caledonia may be indicative of poor powers of long distance dispersal, or it may simply be that they have been unable to establish there. An analysis of intra-generic relationships to determine the distributions of plesiomorphic and apomorphic subgroups is needed before we can discriminate between the above hypotheses. As with *Oxyethira*, such studies can drastically change interpretations.

Maydenoptila is almost certainly Gondwanan in origin:- With its close sister group in New Caledonia, and with several species that are quite widespread and others that are specialized, it has the appearance of a group with a long history. The ancestor of *Maydenoptila* and *Caledonotrichia* must have been present in Gondwanaland and the vicariant event which led to the evolution of 2 distinct genera was possibly the northward movement of New Caledonia at about 60-50 my BP. (An earlier event probably separated the ancestor of *Dibusa*-*Nothotrichia* from the ancestor of these genera). The extent to which the biology of extant species represents the ancestral state is unknown: *M. rupina*, the most widespread species, ranges from cool montane streams in Tasmania to warmer, predictably temporary, streams in coastal South Australia. The sister genus in New Caledonia is found in relatively warm but probably permanent streams.

Except for the broadly tolerant H. losida in SW Australia and New Caledonia, the distribution of Hydroptila in Australasia almost parallels that of Orthotrichia, and again, closely allied species (and even one of the same species) occur in New Guinea. Thus, superficially it appears that similar explanations can be invoked to account for their distributions in Australia. Yet the nature of Australian representation of this genus is different from Orthotrichia: species diversity is far lower, and ranges of individual species generally much wider; in addition, the general impression emerges that this is a relatively primitive sector of the genus.

The biogeographical relationships of Hydroptila and the Oxyethira group were examined using methods outlined in Section 2.8. All 3 cladograms of distributions given in Figs 7.4-7.6 are very similar. All show the same conflicts of the distribution of Tricholeiochiton beyond Australasia, and the broader distribution of Oxyethira. None can be explained strictly in terms of vicariance; all require dispersal of some taxa. Some members of all taxa have Australasian distributions, but difficulties arise in determining the origin of the common ancestor of Hydroptila and the Oxyethira group. Only a Gondwanan or Pangaean origin can be inclusive of all terminal taxa, since Paroxyethira has no Australian members.

In order to clarify this point, a cladogram of distributions was constructed for the tribe Hydroptilini (Fig. 11.1). This was produced in part from the cladogram in Fig. 6.2 (to be consistent with the approach in Chapter 10), and in part from Marshall's (1979) phylogeny (see Fig. 2.1), and is reduced to a general area cladogram in Fig. 11.2. This is similar to the general reduced area cladogram for a number of unrelated taxa, redrawn in Fig. 11.3 from Humphries (1981),

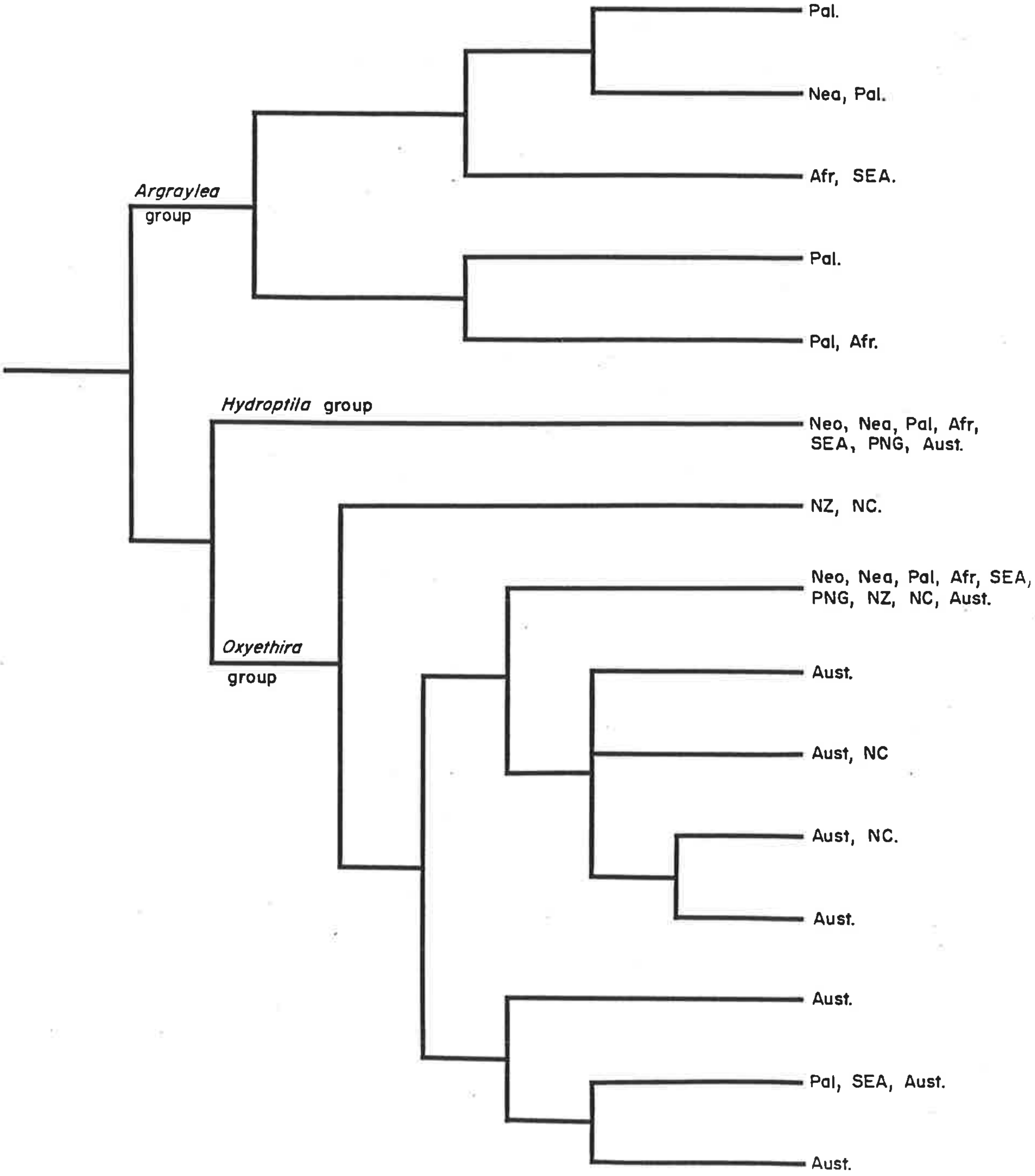


Figure 11.1. Area cladogram for taxa in Fig. 9.1 (derived by combining Fig. 6.2 with Marshall's (1979) phylogeny for the Agraylea group). Abbreviations as for Fig. 7.4.

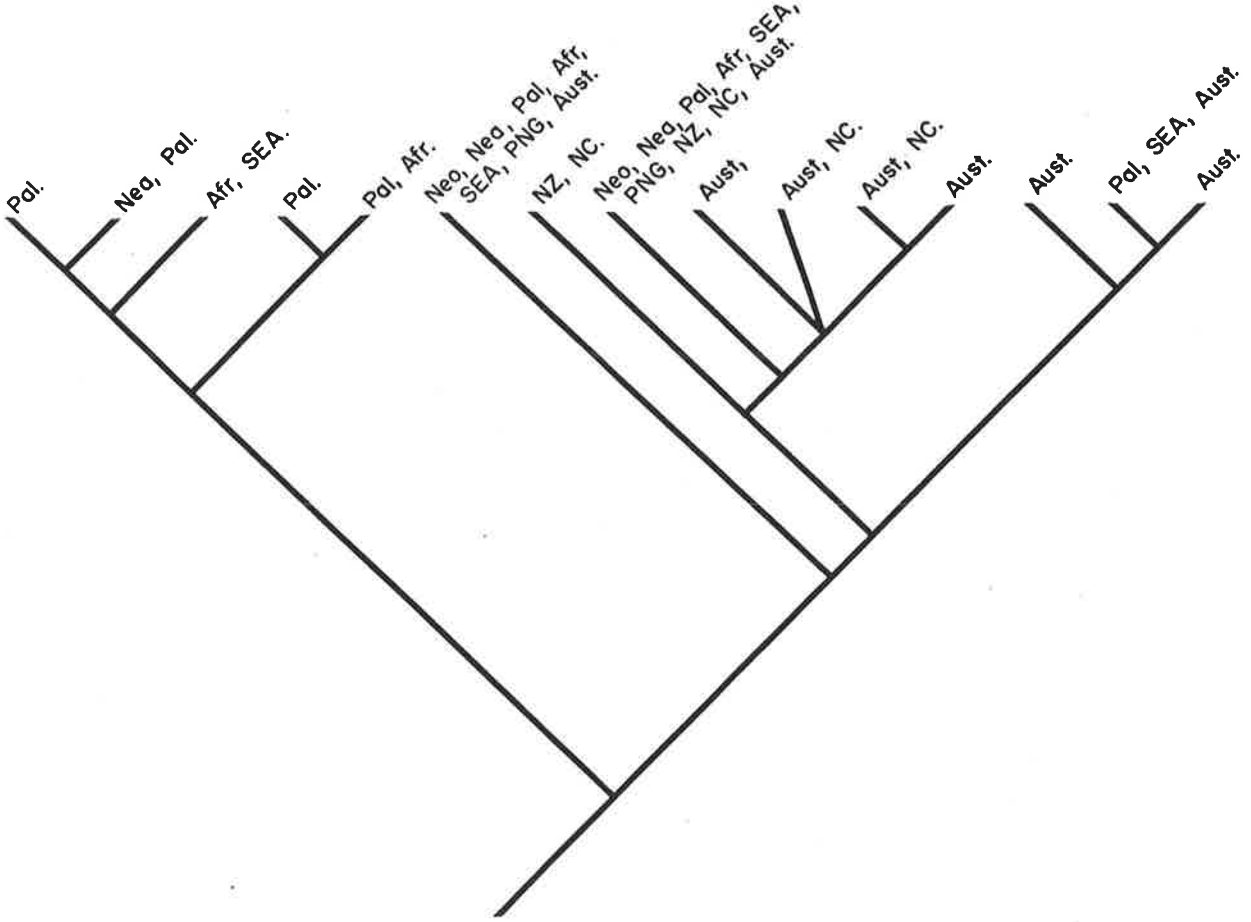


Figure 11.2. General pattern of area relationships for the cladogram in Fig. 11.1. Abbreviations as for Fig. 7.4.

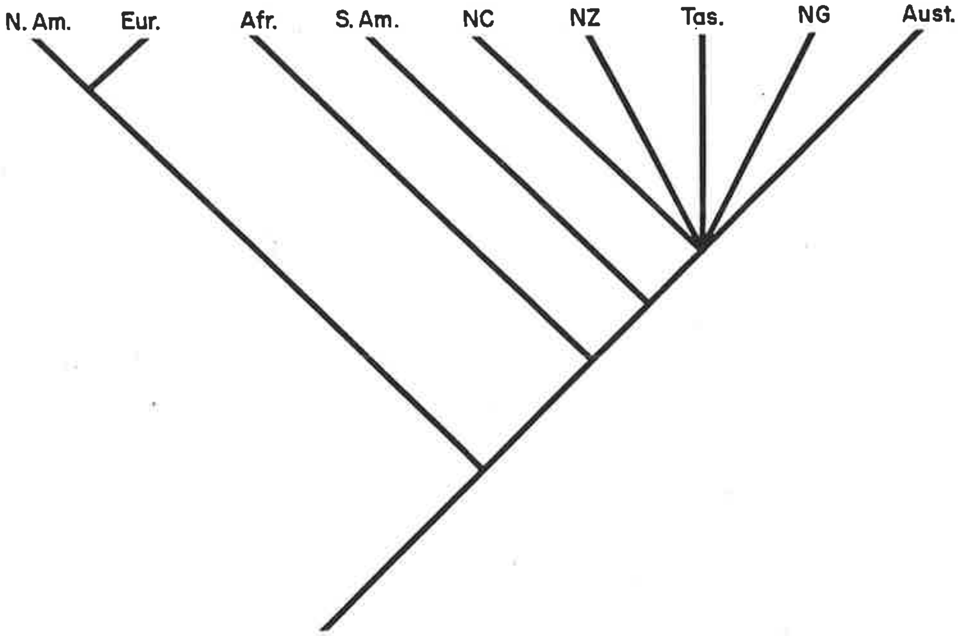


Figure 11.3. General reduced area cladogram for unrelated taxa, after Humphries (1981).

and thus the group could be part of a generalised "track", in Croizat's (1958) sense. However, the distributions of *Hydroptila*, and particularly of *Oxyethira*, are anomolous.

Present day distributions of the *Agraylea* group are mainly Palaearctic. One genus extends into Africa, and another is found only in Africa and SE Asia. If this incongruity is explained as resulting from dispersal from the Palaearctic, or from extinctions in the Palaearctic, a Laurasian origin for the group can be invoked. To consider Africa or SE Asia as a centre of origin requires a Pangaean or Gondwanan origin for the *Agraylea* group, which is inconsistent with its absence from Australasia. Of course it is not inconceivable that it was once in Australasia, and has become extinct there, but until further evidence is available, a Laurasian origin is postulated.

The distribution-in-common for the *Hydroptila*-*Oxyethira* group clade is Gondwanaland, which is consistent with a Laurasian origin for the *Agraylea* group. This would place the origin of the tribe Hydroptilini in Pangaea; the vicariant event which initially split the tribe could have been the separation of Laurasia from Gondwanaland. That is dated about 190 my BP and although Permian and Triassic Trichoptera are known from Australia (Riek 1970), this seems rather too early, especially in the light of Ross' (1967) concept of a more recent age for significant diversification in the order. Alternatively the vicariant event involved may have been the more recent separation of Africa from the rest of Gondwanaland.

Either of the above hypotheses leaves the ancestor of *Hydroptila*-*Oxyethira* groups in Gondwanaland. When and where these 2 groups diverged is unknown. Information is required on relationships within *Hydroptila*. If it is confirmed that Australasian members are among the most primitive, an old southern origin for Hydroptila would be probable. This would be in keeping with my perception of the nature of Australian Hydroptila, but not with its absence from New Zealand. The diversity in New Guinea would be consistent with more recent speciation following migration from Australia in the last 15-20 my BP. Alternatively, Australian Hydroptila could be relicts of an early, and widespread, basal section of the genus.

Difficulties arise in attempting to account for several of the dichotomies in the Oxyethira group, although others are more straightforward. Paroxyethira is most diverse in New Zealand and also has 2 species in New Caledonia. It probably diverged in isolation following the northward rafting of New Zealand from Gondwanaland, and more recently dispersed to New Caledonia. Edmunds (1972) and Craw (1982) suggest that New Zealand and New Caledonia were once part of a single land mass, forming an "area of endemism", but distributions of hydroptilids, including Paroxyethira, are more simply explained in terms of discrete well separated islands.

Despite its present broader distribution, 2 factors support an Australian origin for Tricholeiochiton:- (i) its close sister group relationship with the endemic Orphninotrichia, and, to a lesser extent, (ii) its greater diversity in N Australia (5 spp.), in comparison with SE Asia (2) and the Palaearctic (1). However, dispersal to the west (against prevailing winds) must be invoked to explain the presence of Tricholeiochiton in SE Asia and the Palaearctic. This is improbable, but not impossible and has been postulated by others, e.g. Darlington (1971) for 7 species of Carabidae. In Chapter 10, I speculated that the ancestors of Tricholeiochiton and Orphninotrichia may have diverged as a result of stasipatric processes (since their larvae are so dissimilar, but their adults very close). Perhaps their common ancestor, HTU_8, separated from Acanthotrichia in the same way. All these events could have occurred following uplift of the Great Divide, as Australia began its northward movement.

The Hellyethira complex of genera, descendents of HTU_5, probably arose in Australia. In Acritoptila speciation has occurred in New Caledonia, which is suggestive of a fairly early arrival there. More recently, Hellyethira malleoforma has reached New Caledonia, presumably by air borne dispersal. There it still retains its identity, as does also Hydroptila losida.

Satisfactory hypotheses for the past history of Oxyethira are more elusive. According to Fig. 6.2, Oxyethira and its sister group, descendents of HTU_5, arose as a result of a split in HTU_3. All other Oxyethira group members are Australasian, as is also the most primitive sub-genus, Trichoglene. In addition, the more apomorphic sub-genus, Dampfitrichia, in N Australia, appears to be a relatively recent arrival. Thus far, all is consistent with an Australasian origin for Oxyethira. However, if so it is difficult to explain its psesent wide distribution and diversity.

The group that Kelley (1984) considers to be closest to Trichoglene, sub-genus Oxyethira, is Holarctic in distribution. That is more suggestive of an earlier Pangaean origin, with Trichoglene persisting in Australasia as a relict and the other sub-genera arising following separation of Laurasia or Africa/greater India. This is plausible but perhaps less parsimonious than the previous hypothesis since it implies that splitting of HTU_2, to give rise to HTU_3 and Paroxyethira, must have preceeded the break-up of Gondwanaland, and raises the question of why no Trichoglene members are found outside Australasia.

But perhaps the early Pangaean origin is most likely. I believe that a simple cladogram, as shown in Fig. 6.2, can be misleading. It only depicts an hypothesis relating to the sequences of branching events. There is no time component. Thus, HTU_4 could have diverged to give rise to Oxyethira prior to the fragmentation of Pangaea or Gondwanaland, and HTU_7 may only have split in more recent times, following northward movement of Australia. There is no reason to suppose that cladogenesis in sister groups keeps pace. This is a less parsimonious explanation but more consistent with the nature and distribution of Oxyethira in Australia and elsewhere. Distributions and relationships of most of these taxa are such that only the evolution of Paroxyethira is best explained as resulting from a major vicariant event.

We can only hope for a glimmer of insight into the past history of any such group of organisms. Present day distributions are partly due to subsequent dispersal and extinction, as well as to climatic and geographic events (Endler 1982). In a number of respects, it is the gaps in distributions that are of special interest. Why, for example, are no forms allied to Maydenoptila/Caledonotrichia found in New Zealand? Is it just that they have low vagility? If indeed Acritoptila dispersed to New Caledonia after the northward rafting of Australia, why did other taxa not do the same? Why did none reach New Zealand? It is probable, I believe, that dispersal has been far more frequent than appears, but that actual colonisation has been rare.

By far the most interesting aspect of the Australian Hydroptilidae, is its relatively apomorphous nature, even with respect to the "older southern element". Contrary to the situation in other groups, for example the Plecoptera (Illies 1965), triclads (Ball 1974), etc., this is not a "rather, though not extremely, early level in the evolution of (the group)" (Mackerras 1970). More usually, apomorphous groups are postulated to have relatively recent northern origins, although among the Chironomidae, Brundin (1965) concludes that several tribes with close South American-Australian links have their more apomorphous sectors in Australia.

Marshall viewed the Hydroptilini as a highly specialised group of filamentous alga feeders. Feeding on filamentous algae probably allowed hydroptilids to radiate from the cool montane streams that were their ancestral habitat, into warmer waters where green algae were abundant. I suggest the following possible sequence of events:- In the mild, equable climate of the relatively low relief Gondwanaland of late Cretaceous/early Palaeocene, slow and even still waters with abundant filamentous algae were common. Rather than producing a refuge for cool adapted forms, as is usually proposed, the Tertiary uplift of the Eastern Highlands, presented new adaptive zones into which members of the _Oxyethira_ group, originally adapted to warm, slow or still waters, radiated. (I suggest that cool-adapted forms were rare, if not non-existent, amongst southern Gondwanaland Hydroptilidae). Tyler (1979) also argues in favour of a warmer subtropical environment in Australia in the Early Tertiary, rather than the more frequently postulated cool temperate conditions; and Edmunds (1982) says that in North America, austral Ephemeropteran genera are in "warm, usually silted, lowland streams".

In consequence, in the east we see a torrenticolous genus, Orphninotrichia, being secondarily derived from long-legged alga-feeders, and a shift from secretion cases to heavier sand cases as Hellyethira radiated into faster streams. In the south-west, isolated from the east by increasing aridity in central Australia from Miocene to recent times, Maydenoptila baynesi has diverged to occupy the torrenticolous niche. Aridity has tended to isolate east and west and to confine most Hydroptilidae to the periphery of the continent, but several of the more tolerant forms have persisted in the hotter, drier regions. I suggest that the aggregation of cool-adapted forms in Tasmania and the south-east of the continent is not a result of the persistence of relict forms in those areas, as suggested by many authors for other taxa (e.g. Ross 1967, Riek 1976, Edmunds 1975), but a consequence of adaptive radiations among descendents of a warmer, slow-water fauna. It can also be seen, in part at least, as an artefact of present day edaphic factors, for these are regions of more abundant fresh water habitats in a particularly dry continent.

Orthotrichia probably entered Australia when contact with the Oriental region was established in the Miocene. Subsequently it has radiated explosively into diverse niches, hitherto unoccupied or only occupied by a fauna which lacked the genetic variability for further adaptation to novel habitats.

Edmunds (1982) believes that life cycle patterns can be informative of past histories. Thus, in the North American Ephemeroptera he recognises late summer emergence as a characteristic of taxa of austral origins. Species from Laurasian lineages generally emerge in spring and early summer. In the Australian fauna, only south-eastern Orthotrichia clearly show a pattern of mid to late summer emergence. Yet this need not conflict with their putative Oriental origin. Amongst the tropical species, some at least show no seasonality (Malipatil, pers. comm.), and southern species could, simply as a result of a tropical ancestry, be strongly temperature dependent.

Of other genera, only Maydenoptila shows a clearly defined spring emergence pattern: larvae appear in mid-winter and adults emerge in a short spring flush. The remaining genera, at least superficially, appear to be facultatively bi- or multi-voltine and are probably temperature dependent, although I am uncertain of the situation in Hydroptila. In most, final instar larvae, pre-pupae or pupae over-winter, and the adults emerge to lay eggs as soon as temperatures rise in spring. While this is the pattern one might expect in warm adapted groups, it conflicts with Edmunds findings for the mayflies.

The univoltine Maydenoptila shows a pattern more like that of cold temperate species: this could be yet another plesiomorphic state in this genus. If so, it is one which has been exploited by species such as M. rupina as a pre-adaptation for life in temporary streams.

A particularly unusual aspect of elements that I have postulated to be southern in origin is their lack of allied forms in southern South America. Winterbourne (1980) gives a summary of the many insect groups found to have closely allied groups in Australasia and Chile, including members of the Trichoptera other than Hydroptilidae. Yet, apart from the possible sister group relationship between Maydenoptila-Caledonotrichia and Nothotrichia-Dibusa (South and North American), all known southern South American hydroptilids appear to have Neotropical associations. However, at present little is known of that fauna and it could be found to have a greater Gondwanan component. My ideas of the probable habitats of Gondwanan hydroptilids predict that relicts will be found in slow to still waters, which are less attractive localities for collectors of other Trichopteran families. The areas that should now be investigated are the lower Andean slopes of south-eastern Argentina.

It is not unusual to find Gondwanan and Australian elements in New Guinea, although most groups are predominantly Oriental in affinity (Gressitt 1982). No forms allied to *Maydenoptila*, *Caledonotrichia*, *Paroxyethira* or *Oxyethira* (*Trichoglene*) have yet been recognised in New Guinea, but an undescribed genus of the *Oxyethira* group with particularly asymmetrical genitalia occurs there (Wells, unpublished data).

In summary, the Australian Hydroptilidae are perceived as a relatively derivative sector of the family, consisting of a majority of taxa with Gondwanan affinities and several that represent at least two distinct waves of invasion from the Oriental region, one probably in the Miocene and the other more recent.

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APPENDIX 1

SPECIES EXAMINED BY SCANNING ELECTRON MICROSCOPY

Acanthotrichia bilamina Wells, ♂, ♀

Acritoptila globosa Wells, ♂, ♀

Hellyethira cubitans Wells, ♂, ♀
eskensis (Mosely), ♂, ♀
exserta Wells, ♂, ♀
malleoforma Wells, ♂, ♀
multilobata Wells, ♂, ♀
simplex (Mosely), ♂, ♀

Hydroptila acinacis Wells, ♂, ♀
calcara Wells, ♂
incertula Mosely, ♂
losida Mosely, ♂, ♀
obscura Wells, ♂, ♀
scamandra Neboiss, ♂, ♀

Maydenoptila cuneola Neboiss, ♂, ♀
explicata Wells, ♂
pseudorupina Wells, ♂, ♀
rupina Neboiss, ♂, ♀

Mulgravia carteri Wells, ♂, ♀

Orphninotrichia benambrica Wells, ♂, ♀
justini Wells, ♂
maculata Mosely, ♂, ♀

Orthotrichia aberrans Wells, ♂, ♀
adornata Wells, ♂, ♀
atraseta Wells, ♂, ♀
attenuata Wells, ♂
capillata Wells, ♂, ♀
exiqua Wells, ♂, ♀
gracilis Wells, ♂, ♀
tortuosa Wells, ♂, ♀
turrita Wells, ♂
velata Wells, ♂

Oxyethira columba (Neboiss), ♂, ♀
incana Ulmer, ♂
mienica Wells, ♂
retracta Wells, ♀

Tricholeiochiton fidelis Wells, ♂
tridens Wells, ♂, ♀

APPENDIX 2

CHECKLIST OF AUSTRALIAN HYDROPTILIDAE

(modified after Neboiss 1983)

Genus *Acanthotrichia* Wells, 1982

Type species: *Acanthotrichia bilamina* Wells, 1982 (Victoria)

bilamina Wells, 1982

Acanthotrichia bilamina Wells, 1982 p. 269, Figs. 51-57;
Wells, 1985a p. 16, Figs 69-72 (larva, pupa)

HOLOTYPE ♂ (NMV): Vic; Genoa River, Wangarabell, 18 Mar. 1977;
paratypes (NMV)

DISTRIBUTION: E Vic. to NE Qld.

Genus *Acritoptila* Wells, 1982

Type species: *Acritoptila globosa* Wells, 1982 (Western Australia)

globosa Wells, 1982

Acritoptila globosa Wells, 1982 p. 265, Figs 39-43;
Wells, 1985a p. 15, Figs 64-67 (immatures)

HOLOTYPE ♂ (NMV): WA; Harvey River, 21 Nov. 1978;
paratypes (NMV)

DISTRIBUTION: SW Aust.

hamatus Wells, 1982

Acritoptila hamatus Wells, 1982 p. 265, Figs 44-46

HOLOTYPE ♂ (NMV): Qld; Mothar Mt., SE Gympie, 29 OCT. 1980;
paratypes (NMV)

DISTRIBUTION: SE Qld.

margaretae Wells, 1982

Acritoptila margaretae Wells, 1982 p. 265, Figs 47-50;
Wells, 1985a p. 15, Fig. 68 (case)

HOLOTYPE ♂ (NMV): WA; Harvey River, below falls, 15 Nov. 1980;
paratypes (NMV)

DISTRIBUTION: SW Aust.

Genus Austratrichia Wells, 1982

Type species: Austratrichia neboissi Wells, 1982 (Victoria)

neboissi Wells, 1982

Austratrichia neboissi Wells, 1982 p. 260, Figs 26-34

HOLOTYPE ♂ (NMV); Vic; Mitta Mitta River-Snowy Ck. junctn.
3 Nov. 1976; paratype (NMV)

DISTRIBUTION: Vic; SA (Fleurieu Pen., K.I.)

Genus Gnathotrichia Ulmer, 1951 - see Oxyethira Eaton, 1873

Genus Hellyethira Neboiss, 1977

Type species: Xuthotrichia simplex Mosely, 1934 (Queensland)

allynensis Wells, 1979

Hellyethira allynensis Wells, 1979a p. 316, Figs 14,15;
Wells, 1985a p. 11, Figs 45,46 (immatures)

HOLOTYPE ♂ (ANIC): NSW; Upper Allyn River, 8 Jan. 1958;
paratype (ANIC)

DISTRIBUTION: NE NSW; E & central Vic.

basilobata Wells, 1979

Hellyethira basilobata Wells, 1979a p. 316, Figs 11-13;
Wells, 1985a p. 10, Figs 41-44 (immatures)

HOLOTYPE ♂ (NMV): Vic; below Upper Yarra Dam, 28 Feb. 1976;
paratypes (NMV)

DISTRIBUTION: E & central Vic; Tas.

cornuta Wells, 1979

Hellyethira cornuta Wells, 1979a p. 325, Figs 37-40;
Wells, 1985a p. 13, Figs 57,58 (immatures)

HOLOTYPE ♂ (ANIC): Qld; Little Mulgrave River, 28 June 1971;
paratypes (ANIC)

DISTRIBUTION: NE Qld.

cubitans Wells, 1979

Hellyethira cubitans Wells, 1979a p. 317, Figs 16-18;
Wells, 1985a p. 11, Fig. 47 (pupa, case)

HOLOTYPE ♂ (ANIC): Qld; Palmer River, 20 June 1971;
paratypes (ANIC)

DISTRIBUTION: NE Qld; N NT; NW Aust

dentata Wells, 1979

Hellyethira dentata Wells, 1979a p. 319, Figs 24-26

HOLOTYPE ♂ (WAM): WA; Mitchell Plateau, 31 Jan. 1978;
paratypes (WAM)

DISTRIBUTION: NW Aust.

eskensis (Mosely, 1934)

Xuthotrichia eskensis Mosely, 1934 p. 141, Figs 9-12

Xuthotrichia eskensis, Mosely and Kimmins, 1953 p. 526, Fig. 535

Hellyethira eskensis, Wells, 1979a p. 321, Figs 27-30;

Wells, 1985a p. 12, Figs 55,56 (immatures)

TYPE ♂ (BMNH): Qld: Esk, 9 Jul. 1916

DISTRIBUTION: E Qld; NE NSW.

exserta Wells, 1979

Hellyethira exserta Wells, 1979a p. 319, Figs 19-23;

Wells, 1985a p. 11, Figs 48-50 (immatures)

HOLOTYPE ♂ (NMV); Boonoo Boonoo River, 11 Oct. 1973

paratypes (NMV)

DISTRIBUTION: NE NSW; SE & central Vic; Tas; SA (KI).

fimbriata (Mosely, 1934)

Xuthotrichia fimbriata Mosely, 1934 p. 142, Figs 13-16

Xuthotrichia fimbriata, Mosely and Kimmins, 1953 p. 523, Fig. 352

Hellyethira fimbriata, Wells, 1979a p. 320

TYPE ♂ (BMNH): NSW; Heathcote, 26 Aug. 1916

DISTRIBUTION: NSW; known only from type locality.

litua Wells, 1979

Hellyethira litua Wells, 1979a p. 328, Figs 51,52;

Wells, 1985a p. 13, Figs 61-63 (immatures)

HOLOTYPE ♂ (ANIC): WA; Jandacot, 15 Jan. 1973;

paratype (ANIC)

DISTRIBUTION: SW Aust.

loripes Wells, 1979

Hellyethira *loripes* Wells, 1979a p. 322, Figs 33,34

HOLOTYPE ♂ (WAM): WA; Mitchell Plateau, 30 Jan. 1978;
paratypes (WAM)

DISTRIBUTION: NW Aust; known only from type locality.

malleoforma Wells, 1979

Hellyethira *malleoforma* Wells, 1979a p. 325, Figs 41-46;
Wells, 1985a p. 13, Figs 59,60 (immatures)

HOLOTYPE ♂ (ANIC): SA; Uraidla, 28 Nov. 1975;
paratypes (ANIC, BMNH, NMV)

DISTRIBUTION: S Qld; NSW; Vic; Tas; SA; New Caledonia.

multilobata Wells, 1979

Hellyethira *multilobata* Wells, 1979a p. 326, Figs 47-50

HOLOTYPE ♂ (ANIC): Vic; Lake Purrumbete, 23 Feb. 1970
paratypes (ANIC)

DISTRIBUTION: NE NSW; Vic; Tas; SA (Fleurieu Pen. & KI).

pulvina Wells, 1979

Hellyethira *pulvina* Wells, 1979a p. 324, Figs 35,36

HOLOTYPE ♂ (WAM): WA; Mitchell Plateau, 31 Jan. 1978;
paratypes (WAM)

DISTRIBUTION: NW Aust; known only from type locality.

ramosa Wells, 1983

Hellyethira ramosa Wells, 1983 p. 632, Figs 9-11;
Wells, 1985a p. 12, Figs 51,52 (immatures)

HOLOTYPE ♂ (NMV): NT: Jabiru, 27 June 1979;
paratypes (NMV)

DISTRIBUTION: NW Aust; NE NT

sentisa Wells, 1979

Hellyethira sentisa Wells, 1979a p. 322, Figs 31,32

HOLOTYPE ♂ (ANIC): WA; Millstream H.S., 2 Apr. 1971;
paratypes (ANIC)

DISTRIBUTION: NW Aust.

simplex (Mosely, 1934)

Xuthotrichia simplex Mosely, 1934 p. 145, Figs 17-19

Xuthotrichia simplex, Mosely and Kimmins, 1953 p. 521, Fig. 351

Hellyethira vallecula Neboiss, 1977 p. 42, Figs 182-187

Hellyethira simplex, Wells, 1979a p. 315, Figs 3-10;
Wells, 1985a p. 10, Figs 25-40 (immatures)

TYPE ♂ of Xuthotrichia simplex (Mosely) (BMNH): Qld; Warwick,
Oct.

HOLOTYPE ♂ of Hellyethira vallecula Neboiss (NMV): Tas;
Hellyer River Gorge, 9 Feb. 1971; paratypes (ANIC, NMV)

DISTRIBUTION: E Qld; E NSW; Vic; Tas; S SA.

vallecula Neboiss - see Hellyethira simplex (Mosely) vernoni Wells, 1983

Hellyethira vernoni Wells, 1983 p. 632, Figs 5-8;
Wells, 1985a p. 12, Figs 53,54 (immatures)

HOLOTYPE ♂ (NMV): Qld; Crystal Creek, Mt. Spec. 17 Apr. 1979;
paratypes (NMV)

DISTRIBUTION: NE Qld; NW Aust; N NT.

veruta Wells, 1985

Hellyethira veruta Wells, 1985b p. 97, Figs 1-3

HOLOTYPE ♂ (NTM): NT; Magela Creek, 11 Jul. 1983;
paratypes (NTM)

DISTRIBUTION: N NT.

Genus Hydroptila Dalman, 1819

Type species: Hydroptila tineoides Dalman, 1819 (Sweden)

acinacis Wells, 1978

Hydroptila acinacis Wells, 1978 p. 755, Figs 30-34;
Wells, 1985a p. 6, Figs 23,24 (immatures)

HOLOTYPE ♂ (NMV): Vic; Koornalla, Traralgon Creek, 16 Feb. 1974;
paratypes (NMV)

DISTRIBUTION: E NSW; central Vic; Tas.

calcara Wells, 1978

Hydroptila calcara Wells, 1978 p. 753, Figs 23-29;
Wells, 1985a p. 6, Fig. 19 (immatures)

HOLOTYPE ♂ (NMV): NSW; Maclaughlin River, Ando, 20 Nov. 1965;
paratypes (NMV)

DISTRIBUTION: E NSW; central Vic; SA (Fleurieu Pen.).

incertula Mosely, 1934

Hydroptila incertula Mosely, 1934 p. 145, Figs 20-23

Hydroptila incertula, Mosely and Kimmins, 1953 p. 507, Fig. 343

Hydroptila incertula, Wells, 1978 p. 761, Figs 52-54;
Wells, 1985a p. 7, Fig. 22 (immatures)

Type ♂ (BMNH): Qld; Brisbane (no other data)

DISTRIBUTION: E Qld; NW Aust; Papua New Guinea; Vanuatu.

losida Mosely, 1953

Hydroptila losida Mosely, Mosely and Kimmins, 1953 p. 505,
Figs 341,342

Hydroptila losida, Wells, 1978 p. 757, Figs 35-38;
Wells, 1985a p. 6, Figs 17,21 (immatures)

Type ♂ (ANIC): Qld; Eidswold (no date); paratype (ANIC)

DISTRIBUTION: Qld; NSW; Vic; SA; SW Aust; New Caledonia

obscura Wells, 1978

Hydroptila obscura Wells, 1978 p. 758, Figs 39-46;
Wells, 1985a p. 7, Figs 16,20 (immatures)

HOLOTYPE ♂ (ANIC): Qld; Palmer River, 20 June, 1971

DISTRIBUTION: NE Qld; NE NSW.

robusta Wells, 1978

Hydroptila robusta Wells, 1978 p. 747, Figs 1-11;
Wells, 1985a p. 5, Fig. 18 (immatures)

HOLOTYPE ♂ (NMV): Vic; Millgrove, Yarra River, 24 Feb. 1976;
paratypes (NMV)

DISTRIBUTION: E & central Vic.

scamandra Neboiss, 1977

Hydroptila scamandra Neboiss, 1977 p. 41, Figs 174-176

Hydroptila scamandra, Wells, 1978 p. 751, Figs 16-22;
Wells, 1985a p. 5, Figs 1-15 (immatures)

HOLOTYPE ♂ (NMV): Tas; Scamander River, 9 Nov. 1972;
paratypes (NMV)

DISTRIBUTION: E Qld; E NSW; Vic; Tas; SA (Fleurieu Pen.).

sinuosa Wells, 1978

Hydroptila sinuosa Wells, 1978 p. 759, Figs 47-51

HOLOTYPE ♂ (ANIC): Qld; Little Mulgrave River, 28 June 1971;
paratype (ANIC)

DISTRIBUTION: NE Qld; known from type locality only.

tasmanica Mosely, 1934

Hydroptila tasmanica Mosely, 1934 p. 147, Figs 24-27

Hydroptila tasmanica, Mosely and Kimmins, 1953 p. 509, Fig. 344

Hydroptila tasmanica, Wells, 1978 p. 749, Figs 12-15

Type ♂ (BMNH): Tas; Wilmot, 9 Jan. 1917; paratypes (ANIC, BMNH)

DISTRIBUTION: Tas.

Genus Maydenoptila Neboiss, 1977

Type species: Maydenoptila cuneola Neboiss, 1977 (Tasmania)

antennifera Wells, 1983

Maydenoptila antennifera Wells, 1983 p. 630, Figs 3,4

HOLOTYPE ♂ (NMV): NSW; Wiangaree State Forest, via Kyogle,
18 Nov. 1974; paratype (NMV)

DISTRIBUTION: NE NSW; known from type locality only.

baynesi Wells, 1983

Maydenoptila *baynesi* Wells, 1983 p. 630, Figs 1,2; Wells, 1985a p. 24, Figs 1-15 (immatures)

HOLOTYPE ♂ (NMV): WA; Marrinup Brook, nr Dwellingup, 9 Sep. 1980; paratypes (NMV)

DISTRIBUTION: SW Aust.

commista Wells, 1980

Maydenoptila *commista* Wells, 1980 p. 641, Figs 33,34

HOLOTYPE ♂ (NMV): Vic; Dee River, Millgrove, 24 Feb. 1976; paratypes (NMV)

DISTRIBUTION: Vic; known from type locality only.

cuneola Neboiss, 1977

Maydenoptila *cuneola* Neboiss, 1977 p. 44, Figs 194-197, 203

Maydenoptila *cuneola*, Wells, 1980 p. 637, Figs 23-30; Wells, 1985a p. 25, Figs 137-142 (immatures)

HOLOTYPE ♂ (NMV): Tas; Wedge River, 17 Feb. 1971; paratypes (NMV)

DISTRIBUTION: Vic; Tas.

explicata Wells, 1980

Maydenoptila *explicata* Wells, 1980 p. 639, Figs 31,32

HOLOTYPE ♂ (NMV): Tas; Gordon River, First Split, 11 Jan. 1977; paratypes (NMV)

DISTRIBUTION: Tas.

kurandica Wells, 1980

Maydenoptila kurandica Wells, 1980 p. 641, Figs 35,36

HOLOTYPE ♂ (NMV): Qld; Kuranda, 7 Aug. 1972

DISTRIBUTION: NE Qld; known only from type locality.

pseudorupina Wells, 1980

Maydenoptila pseudorupina Wells, 1980 p. 643, Figs 43-45; Wells, 1985a p. 25, Figs 143-147 (immatures)

HOLOTYPE ♂ (NMV): Vic; Brodribb River nr Orbost, 16 Dec. 1976; paratypes (NMV)

DISTRIBUTION: SE Qld; NSW; Vic.

rupina Neboiss, 1977

Maydenoptila rupina Neboiss, 1977 p. 45, Figs 198-202

Maydenoptila rupina, Wells, 1980 p. 643, Figs 37-42; Wells, 1985a p. 24, Figs 115-129 (immatures)

HOLOTYPE ♂ (NMV): Tas; Guide River Falls, Ridgely, 18 Nov. 1972; paratypes (NMV)

DISTRIBUTION: SE & central Vic; Tas; SA (Fleurieu Pen. & KI).

Genus Mulgravia Wells, 1982

Type species: Mulgravia coronata Wells, 1982 (Queensland)

carteri Wells,1983

Mulgravia carteri Wells, 1983 p. 647, Figs 44-46

HOLOTYPE ♂ (NMV): NSW; Boyd River, 27 Oct. 1981; paratypes (NMV)

DISTRIBUTION: E NSW.

coronata Wells, 1982

Mulgravia carteri Wells, 1982 p. 262, Figs 35-38

HOLOTYPE ♂ (ANIC): Qld; Little Mulgrave River, 28 June 1971;
paratype (ANIC)

DISTRIBUTION: NE Qld; known only from type locality.

Genus *Orphninotrichia* Mosely, 1934

Type species: *Orphninotrichia maculata* Mosely, 1934 (NSW)

acta Neboiss, 1977

Orphninotrichia acta Neboiss, 1977 p. 40, Figs 166-73

Orphninotrichia acta, Wells, 1980 p. 632, Figs 9-11

HOLOTYPE ♂ (NMV): Tas; Ulverstone, 18 Nov. 1972;
paratypes (NMV)

DISTRIBUTION: Tas.

benambrica Wells, 1983

Orphninotrichia benambrica Wells, 1983 p. 646, Figs 38,39,41;
Wells, 1985a p. 21, Fig. 113 (immatures)

HOLOTYPE ♂ (NMV): Vic; Benambra Creek, 17 Jan. 1982;
paratypes (NMV)

DISTRIBUTION: NE Vic; known from type locality only.

justini Wells, 1983

Orphninotrichia justini Wells, 1983 p. 645, Figs 36,37;
Wells, 1985a p. 21 (immatures)

HOLOTYPE ♂ (NMV): Vic; Stevensons Falls, Upper Gellibrand
River, 20 Jan. 1982; paratypes (NMV)

DISTRIBUTION: Vic; known only from type locality.

maculata Mosely, 1934

Orphninotrichia maculata Mosely, 1934, p. 139, Figs 1-4

Orphninotrichia maculata, Mosely and Kimmins, 1953 p. 511, Fig. 345

Orphninotrichia maculata, Wells, 1980 p. 630, Figs 1-8; Wells, 1985a p. 21, Figs 95-112 (immatures)

Type ♂ (BMNH): NSW; Hornsby, 31 Aug. 1916

DISTRIBUTION: SE Qld; E NSW; Vic; Tas; S SA.

media Wells, 1980

Orphninotrichia media Wells, p. 632, Figs 15,16

HOLOTYPE ♂ (NMV): Vic; Porepunkah, 27 Jan. 1957

DISTRIBUTION: Vic; known only from type locality.

papillata Wells, 1980

Orphninotrichia papillata Wells, p. 635, Figs 17-20

HOLOTYPE ♂ (NMV): Vic; Tawonga, 28 Jan. 1957; paratype (NMV)

DISTRIBUTION: NE Vic; known only from type locality.

regia Wells, 1980

Orphninotrichia regia Wells, 1980 p. 632, Figs 12-14

HOLOTYPE ♂ (NMV): Vic; Kinglake, 29 Nov. 1955; paratypes (NMV)

DISTRIBUTION: Vic.

silicis Wells, 1980

Orphninotrichia silicis Wells, 1980 p. 635, Figs 21,22

HOLOTYPE ♂ (NMV): Qld; Tinaroo Lake road, 6 Aug. 1972

DISTRIBUTION: NE Qld; known only from type locality.

subulata Wells, 1983

Orphninotrichia subulata Wells, 1983 p. 647, Figs 42,43; Wells, 1985a p. 21, Fig. 114 (immatures)

HOLOTYPE ♂ (NMV): NSW; Undercliffe Falls, 24 Oct. 1981

DISTRIBUTION: NE NSW; known only from type locality.

Genus Orthotrichia Eaton, 1873

Type species: Hydroptila angustella McLachlan, 1865 (Britain)

aberrans Wells, 1979

Orthotrichia aberrans Wells, 1979b p. 621, Figs 76,77; Wells, 1985a p. 31, Figs 176-179 (immatures)

HOLOTYPE ♂ (NMV): Vic; Mitta Mitta River, Benambra, 5 Feb. 1974; paratypes (NMV)

DISTRIBUTION: NE Vic.

aculeata Wells, 1979

Orthotrichia aculeata Wells, 1979b p. 603, Figs 38-40

HOLOTYPE ♂ (WAM): WA; Ord River Dam, Spillway Creek, 2 Feb. 1978; paratypes (WAM)

DISTRIBUTION: NW Aust; N NT.

adornata Wells, 1979

Orthotrichia adornata Wells, 1979b p. 590, Figs 1-9

HOLOTYPE ♂ (NMV): Vic; Yarra River, Millgrove, 24 Feb. 1976; paratypes (NMV)

DISTRIBUTION: NSW; Vic; Tas.

alveata Wells, 1979

Orthotrichia alveata Wells, 1979b p. 610, Figs 52,53
HOLOTYPE ♂ (ANIC): NE Qld; Mossman Gorge, 16 June 1971;
paratype (ANIC)
DISTRIBUTION: NE Qld; known only from type locality.

armata Wells, 1979

Orthotrichia armata Wells, 1979b p. 594, Figs 17,18;
Wells, 1985a p. 29, Fig. 165 (immatures)
HOLOTYPE ♂ (NMV): Vic; Snobs Creek, 24 Jan. 1956;
Paratypes (NMV)
DISTRIBUTION: Vic; known only from type locality.

attenuata Wells, 1983

Orthotrichia attenuata Wells, 1983 p. 643, Figs 33-35
HOLOTYPE ♂ (NMV): NSW; Darling River, Burtundy Station,
31 Mar. 1981; paratypes (NMV)
DISTRIBUTION: SW NSW; NW Vic.

atraseta Wells, 1979

Orthotrichia atraseta Wells, 1979b p. 594, Figs 14-16;
Wells, 1985a p. 28, Fig. 164 (immatures)
HOLOTYPE ♂ (NMV): Vic; Yarra River, Millgrove, 24 Feb. 1976;
paratypes (NMV)
DISTRIBUTION: ACT; Vic.

bellicosa Wells, 1979

Orthotrichia *bellicosa* Wells, 1979b p. 618, Figs 72,73

HOLOTYPE ♂ (WAM): WA; Camp Creek, Mitchell Plateau, 31 Jan. 1978; paratypes (ANIC; NMV; WAM)

DISTRIBUTION: NW Aust; NE NT.

bishopi Wells, 1979

Orthotrichia *bishopi* Wells, 1979b p. 596, Figs 19-22; Wells, 1985a p. 28, Figs 148-163 (immatures)

HOLOTYPE ♂ (ANIC): SA; Anacotilla Creek, Second Valley, 20 Oct. 1976; paratypes (ANIC; NMV)

DISTRIBUTION: SA (Fleurieu Pen.).

bullata Wells, 1979

Orthotrichia *bullata* Wells, 1979b p. 602, Figs 36,37

HOLOTYPE ♂ (ANIC): Qld; Mossman Gorge, 16 June 1971; paratypes (ANIC; NMV)

DISTRIBUTION: NE Qld; NW Aust.

capillata Wells, 1979

Orthotrichia *capillata* Wells, 1979b p. 620, Figs 74,75; Wells, 1985a p. 31, Fig. 175 (immatures)

HOLOTYPE ♂ (ANIC): Qld; Mossman Gorge, 16 June 1971; paratypes (ANIC; NMV)

DISTRIBUTION: E Qld; NE NSW; Vic.

conferta Wells, 1983

Orthotrichia conferta Wells, 1983 p. 634, Figs 12-14; Wells, 1985a p. 32, Figs 181-187 (immatures)

HOLOTYPE ♂ (NMV): Vic; Wellington River, Licola, 14 Feb. 1977; paratype (NMV)

DISTRIBUTION: NE Qld; E NSW; E Vic.

dilgri Wells, 1983

Orthotrichia dilgri Wells, 1983 p. 640, Figs 24-26

HOLOTYPE ♂ (NMV): NSW; Dilgry River, NW of Rawdon Vale, 18 Feb. 1980; paratypes (NMV)

DISTRIBUTION: NSW.

divaricata Wells, 1983

Orthotrichia divaricata Wells, 1983 p. 639, Figs 22,23

HOLOTYPE ♂ (NMV): Qld; Upper Freshwater Creek, 24 Aug. 1974

DISTRIBUTION: NE Qld; known only from type locality.

eurhinata Wells, 1985

Orthotrichia eurhinata Wells, 1985b p. 102, Figs 10-12

HOLOTYPE ♂ (NTM): NT; Georgetown Billabong, nr Jabiru, 17 June 1983

DISTRIBUTION: N NT; known only from type locality.

exiqua Wells, 1979

Orthotrichia exiqua Wells, 1979b p. 616, Figs 67-69

HOLOTYPE ♂ (WAM): WA; Fine Spring Creek, nr Lake Argyle, 23 Feb. 1977; paratypes (ANIC; NMV; WAM)

DISTRIBUTION: NW Aust; N NT; NE Qld.

flabella Wells, 1983

Orthotrichia flabella Wells, 1983 p. 637, Figs 18,19

HOLOTYPE ♂ (NMV): Vic; McKenzie River, W of Cann River, 24 Jan. 1975

DISTRIBUTION: E Vic; known from type locality only.

gracilis Wells, 1979

Orthotrichia gracilis Wells, 1979b p. 610, Figs 54-57; Wells, 1985a p. 30 (immatures)

HOLOTYPE ♂ (ANIC): NSW; Coraki, 10 Jan. 1958; paratypes (ANIC)

DISTRIBUTION: SE Qld; NE NSW; Murray-Darling system.

inornata Wells, 1979

Orthotrichia inornata Wells, 1979b p. 605, Figs 41,43,44

HOLOTYPE ♂ (WAM): WA; Mitchell Plateau, 30 Jan. 1978; paratypes (ANIC; NMV; WAM)

DISTRIBUTION: NW Aust; N NT.

kholoensis Wells, 1979

Orthotrichia kholoensis Wells, 1979b p. 612, Figs 61,62

HOLOTYPE ♂ (NMV): QLD; Brisbane River, Kholo, 9 Mar. 1973; paratype (NMV)

DISTRIBUTION: E Qld; N NT.

morula Wells, 1979

Orthotrichia morula Wells, 1979b p. 608, Figs 48-51;
Wells, 1985a p. 30, Fig. 171 (pupa, case)

HOLOTYPE ♂ (ANIC): Qld; Mossman Gorge, 16 June 1971;
paratypes (ANIC)

DISTRIBUTION: NE Qld.

muscari Wells, 1983

Orthotrichia muscari Wells, 1983 p. 638, Figs 20,21

HOLOTYPE ♂ (NMV): Qld, Iron Range, 2-9 Oct. 1974

DISTRIBUTION: Qld; known from type locality only.

orbostensis Wells, 1979

Orthotrichia orbostensis Wells, 1979b p. 596, Figs 23,24

HOLOTYPE ♂ (NMV): Vic; Brodribb River, Orbost, 16 Dec. 1977

DISTRIBUTION: E Vic; known from type locality only.

paranga Wells, 1979

Orthotrichia paranga Wells, 1979b p. 614, Figs 63,64

HOLOTYPE ♂ (WAM): WA; Ord River Dam, 21 Mar. 1977;
paratypes (ANIC; WAM)

DISTRIBUTION: NW Aust.

pectinella Wells, 1983

Orthotrichia pectinella Wells, 1983 p. 635, Figs 15-17

HOLOTYPE ♂ (NMV): Vic; Warburton, Yarra River, 17 Feb. 1979;
paratypes (NMV)

DISTRIBUTION: N central Vic.

rostrata Wells, 1979

Orthotrichia rostrata Wells, 1979b p. 598, Figs 25-28

HOLOTYPE ♂ (NMV): NSW; Styx River, nr Ebor, 17 Oct. 1973; paratypes (NMV)

DISTRIBUTION: NE NSW; known from type locality only.

scutata Wells, 1979

Orthotrichia scutata Wells, 1979b p. 600, Figs 29-32

HOLOTYPE ♂ (WAM): WA; Spillway Creek, Ord River Dam, 20 Feb. 1977; paratypes (ANIC; NMV; WAM)

DISTRIBUTION: N NT; NW Aust.

stipa Wells, 1979

Orthotrichia stipa Wells, 1979b p. 614, Figs 65,66; Wells, 1985a p. 31, Fig 174 (immatures)

HOLOTYPE ♂ (WAM): WA; Camp Creek, Mitchell Plateau, 26 Feb. 1978; paratypes (ANIC; NMV; WAM)

DISTRIBUTION: NW Aust; known only from type locality.

suteri Wells, 1979

Orthotrichia suteri Wells, 1979b p. 605, Figs 42, 45-47

HOLOTYPE ♂ (WAM): WA; Camp Creek, Mitchell Plateau, 13 July 1978; paratypes (ANIC; NMV; WAM)

DISTRIBUTION: NW Aust; known only from type locality.

tortuosa Wells, 1979

Orthotrichia tortuosa Wells, 1979b p. 612, Figs 58-60; Wells, 1985a p. 30, Figs 172,173 (immatures)

HOLOTYPE ♂ (NMV): Vic; Genoa River, nr Wangarabell, 18 Mar. 1977; paratypes (NMV)

DISTRIBUTION: NE Qld; NE NSW; E Vic.

turrita Wells, 1979

Orthotrichia turrita Wells, 1979b p. 600, Figs 33-35; Wells, 1985a p. 29, Figs 166-169 (immatures)

HOLOTYPE ♂ (WAM): WA; Four Mile Creek, nr Lake Argyle, 2 Feb. 1978; paratypes (NMV; WAM)

DISTRIBUTION: N Aust.

tyleri Wells, 1979

Orthotrichia tyleri Wells, 1979b p. 618, Figs 70, 71

HOLOTYPE ♂ (WAM): WA; Camp Creek, Mitchell Plateau, 20 July 1978; paratypes (ANIC; NMV; WAM)

DISTRIBUTION: NW Aust; N NT.

velata Wells, 1983

Orthotrichia velata Wells, 1983 p. 641, Figs 27-29; Wells, 1985a p. 30, Fig. 170 (immatures)

HOLOTYPE ♂ (NMV): Qld; Upper Ross River, 8 May 1979; paratypes (NMV)

DISTRIBUTION: N NT; NE Qld; NW Aust.

yabbaca Wells, 1983

Orthotrichia yabbaca Wells, 1983 p. 642, Figs 30-32

HOLOTYPE ♂ (NMV): Qld: Yabba Creek, W of Imbil, 26 Oct. 1980; paratypes (NMV)

DISTRIBUTION: E Qld; known from type locality only.

zonata (Neboiss, 1977)

Targatrichia zonata Neboiss, 1977 p. 41, Figs 177-181

Orthotrichia zonata, Wells, 1979b p. 591, Figs 10-13

HOLOTYPE ♂ (NMV): Tas; St. Patricks River, Targa, 22 Feb. 1971; paratypes (NMV)

DISTRIBUTION: Tas.

Genus Oxyethira Eaton, 1873

Type species: Hydroptila costalis Curtis, 1834 (Britain)

artuvillosus (Wells, 1981)

Stenoxyethira artuvillosus Wells, 1981 p. 114, Figs 29-34

Oxyethira artuvillosus, Kelley, 1984 pp. 436,438

HOLOTYPE ♂ (WAM): WA; Camp Creek, Mitchell Plateau, 15 Feb. 1979; paratypes (ANIC; NMV; WAM)

DISTRIBUTION: NW Aust.

brevis Wells, 1981

Oxyethira brevis Wells, 1981 p. 110, Figs 17,18,22

HOLOTYPE ♂ (NMV): WA; Cape Leeuin Nat. Park, 25 Nov. 1978; paratypes (NMV)

DISTRIBUTION: SW Aust.

columba (Neboiss, 1977)

Trichoglene columba Neboiss, 1977 p. 43, Figs 188-193

Oxyethira columba, Wells, 1981 p. 106, Figs 1-10;

Wells, 1985a p. 17, Figs 73-84 (immatures)

HOLOTYPE ♂ (NMV): Tas; Dove River, Cradle Mtn. 14 Dec. 1974;

paratypes (NMV)

DISTRIBUTION: E Qld; NSW; Vic; Tas; SA.

incana Ulmer, 1906

Oxyethira incana Ulmer, 1906 p. 102, Fig. 114

Stenoxyethira excisa Kimmins, 1951, Kelley, 1984 p. 436,439

Gnathotrichia isabellina Ulmer, 1951, Kelley, 1984 p. 436,439

Gnathotrichia australiensis Wells, 1981, Kelley, 1984 p. 436,439

Type ♂ (UHZIM): Oxyethira incana Ulmer, Burma

DISTRIBUTION: Burma to Australia.

mienica Wells, 1981

Oxyethira mienica Wells, 1981 p. 108, Figs 14-16

HOLOTYPE ♂ (NMV): Tas; Ouse River, Miena, 28 Feb. 1967;

paratypes (NMV)

DISTRIBUTION: Tas.

plumosa (Wells, 1981)

Stenoxyethira plumosa Wells, 1981 p. 117, Figs 35-37

Oxyethira plumosa, Kelley, 1984 pp. 436,438

HOLOTYPE ♂ (NMV): Qld; Mulgrave River, 29 Apr. 1979

DISTRIBUTION: NE Qld; known only from type locality.

retracta Wells, 1981

Oxyethira retracta Wells, 1981 p. 110, Figs 19-21

HOLOTYPE ♂ (NMV): WA: Serpentine River, Serpentine Falls, 20 Nov. 1978; paratypes (NMV)

DISTRIBUTION: SW WA.

triangulata Wells, 1981

Oxyethira triangulata Wells, 1981 p. 108, Figs 11-13; Wells, 1985a p. 17 (immatures)

HOLOTYPE ♂ (NMV): Qld; Crystal Creek, Mt. Spec, 2 May 1979; paratypes (ANIC; NMV)

DISTRIBUTION: NE Qld.

warramunga Wells, 1985

Oxyethira warramunga Wells, 1985b p. 99, Figs 4,8,9

HOLOTYPE ♂ (NTM): NT; Georgetown Billabong, nr. Jabiru, 21 July 1983; paratypes (NTM)

DISTRIBUTION: NE NT.

Genus Stenoxyethira Kimmins, 1951 - see Oxyethira Eaton, 1873

artuvillosus Wells - see Oxyethira artuvillosus (Wells)

plumosa Wells - see Oxyethira plumosa (Wells)

Genus Targatrichia Neboiss, 1977 - see Orthotrichia Eaton, 1873

zonata Neboiss - see Orthotrichia zonata (Neboiss)

Genus Trichoglene Neboiss, 1977 - see Oxyethira Eaton, 1873

columba Neboiss - see Oxyethira columba (Neboiss)

Genus Tricholeiochiton Kloet and Hincks, 1944

Type species: Leiochiton fagesii Guinard, 1879 (France)

bifurca Wells, 1982

Tricholeiochiton bifurca Wells, 1982 p. 256, Figs 17-21

HOLOTYPE ♂ (NMV): WA; Mitchell Plateau, Camp Creek, 31 Jan.1978; paratypes (NMV)

DISTRIBUTION: NW Aust; NE NT.

edmondsi Wells, 1982

Tricholeiochiton edmondsi Wells, 1982 p. 259, Figs 22-25

HOLOTYPE ♂ (NMV): WA; Stonewall Creek, 2 Feb. 1978; paratypes (NMV)

DISTRIBUTION: NW Aust.

fidelis Wells, 1982

Tricholeiochiton fidelis Wells, 1982 p. 253, Figs 1-10; Wells, 1985a p. 19, Figs 85-94 (immatures)

HOLOTYPE ♂ (NMV): Qld; Alice River on Hervey Range Road, 9 May 1979; paratypes (NMV)

DISTRIBUTION: NE Qld; N NT.

jabirella Wells, 1985

Tricholeiochiton jabirella Wells, 1982 p. 99, Figs 3,6,7

HOLOTYPE ♂ (NTM): NT, Corndorl Billabong, nr Jabiru, 20 Mar. 1983; paratypes (NTM)

DISTRIBUTION: NE NT.

tridens Wells, 1982

Tricholeiochiton tridens Wells, 1982 p. 256, Figs 11-16

HOLOTYPE ♂ (NMV): WA; Mitchell Plateau, 30 Jan. 1978; paratypes (NMV)

DISTRIBUTION: NW Aust; NE NT

Genus Xuthotrichia Mosely, 1934

Type species: Xuthotrichia ochracea Mosely, 1934 (Queensland)

eskensis Mosely - see Hellyethira eskensis (Mosely)

fimbriata Mosely - see Hellyethira fimbriata (Mosely)

ochracea Mosely, 1934

Xuthotrichia ochracea Mosely, 1934 p. 140, Figs 5-8

Xuthotrichia ochracea, Mosely and Kimmins, 1953 p. 520, Fig. 350

Xuthotrichia ochracea, Wells, 1979a p. 312, Figs 1,2

Type ♂ (BMNH): Qld; Brisbane, 30 Sept. 1920

DISTRIBUTION: SE Qld; E Vic.

simplex Mosely - see Hellyethira simplex (Mosely)