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# LWRRDC Final Report: Quality assurance of identifications for the MRHI state/territory bioassessment program

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*supervising scientist*

# LWRRDC Final Report

# Project MDR16

**Project title:** Quality assurance and control for the MRHI state/territory bioassessment program

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## Abstract

Project number MDR16 was developed as part of the Monitoring River Health Initiative (MRHI) to provide initial training and taxonomic keys for the identification of aquatic macroinvertebrates by State and Territory agencies and to provide external quality assurance to ensure a high standard of taxonomic identification. To this end, the Murray-Darling Freshwater Research Centre (MDFRC) conducted a taxonomic workshop in the early stages of the MRHI and all agencies responsible for invertebrate identification have had 5% of their identifications checked externally by either the MDFRC or the Environmental Research Institute of the Supervising Scientist (ERISS). Feedback from the QA process to agencies has often resulted in the reduction of identification error rates to acceptable levels. Non-conformance to specified taxonomic levels, lack of in-house training by agencies for new staff and overall lack of taxonomic experience were identified as key factors leading to error.

## Objectives

1. To provide taxonomic training for biologists from the state/territory (MRHI) agencies.
2. To provide quality control and assurance of the agencies' specimen identification.
3. To report the quality assurance assessment to the state/territory agencies.
4. To provide an assessment of all agencies and report to NRHP committee.

## Methods

### Objective 1 - taxonomic training

Training for MRHI participants was given through a two day taxonomy workshop. An MRHI Taxonomic Workshop Handbook (Supporting Document 1) was presented detailing a list of taxa, references for specific taxonomic information as well as keys to the major families to assist in family level identifications. The major speakers were John Lawrence (Coleoptera), Peter Cranston (Diptera), Phil Suter (Plecoptera and Ephemeroptera), John Dean (Ephemeroptera and Trichoptera), Ros St Clair and David Cartwright (Trichoptera) and John Hawking (Odonata, Hemiptera, Megaloptera and other non-insect groups). Identification sessions were held by the taxonomic experts to train participants in the use of taxonomic keys and assist in identification of specimens from difficult groups.

### Objective 2 - quality assurance

Details about the methods used for selection of samples for cross-checking were included in the first milestone report for this project. Since the original development of the project the scope for external checking has been reduced to quality assurance (QA) with agencies assuming responsibility for quality control. In summary, 5% of samples identified by each agency within each sampling round were requested for cross-checking of agency identifications. Selection of samples aimed to cover the range of biogeographic regions and habitats sampled (and thus the broadest range of taxa likely to be encountered). Samples were selected randomly from within a given biogeograpic region and habitat with secondary selection criteria based on coverage of the range of staff who performed the original identifications. Table 1 gives a breakdown of the progress in cross-checking.

Table 1: Total number of MRHI agencies participating in each sampling round and details of samples yet to have external QA/QC checking.

| Sampling round | No. agencies participating | No. agencies where checking is complete | Agencies with unchecked samples |
|---|---|---|---|
| 1 | 16 | 15 | NT Dept Land Planning & Environment |
| 2 | 16 | 14 | NT Dept Land Planning & Environment |
| | | | QLD Dept Primary Industries |
| 3 | 15 | 14 | QLD Dept Primary Industries |
| 4 | 15 | 12 | NT Dept Land Planning & Environment |
| | | | QLD Dept Primary Industries |
| | | | WA Conservation & Land Management |

Checking of the above agencies was not completed because they had not finished identifications by a cut-off date in April 1997. The exception to this was Queensland for round 2 where identifications were done but samples were not checked because specimens of different taxonomic groups were not put into separate vials as requested.

Details about procedures for cross-checking were included in the first milestone report. In summary, QA staff identify and enumerate all specimens in a given sample and check them off against results sent by the agency (*note:* this procedure may change somewhat in the future if enumeration of samples is no longer required). Specimens that the QA staff had difficulty in identifying (because they are poorly described, undescribed, or simply taxonomically difficult) were sent to the national specialist for that particular group for confirmation (for details of this procedure see Supporting Document 2). Discrepancies between results from sample identification and the QA check were recorded on appropriate QA data sheets (see first milestone report), copies of which were forwarded to the agency. Details about how QA data sheets were filled in and how pass and fail criteria were calculated are presented in Supporting Document 3. For this first phase of the program an error rate of greater or equal to 10% for either the new taxa or misidentification criteria, or a Bray Curtis dissimilarity of greater than or equal to 0.1 constituted a fail. These levels were selected on a trial basis and in accordance with comparable programs overseas.

**Objective 3 - Reporting to agencies**

Feedback to agencies from the QA process has taken several forms:

1. Reporting of results based on the three assessment criteria (Appendix 1). The three assessment criteria used in quality control of macroinvertebrate identifications in the Monitoring River Health Initiative were described in the first milestone report. The criteria reflect the key aspects of community structure that may be affected by errors in enumeration and identification i.e. richness (number of taxa) and relative abundance of taxa as univariate and multivariate measures.
2. Advice on how errors may have occurred and how they may be avoided in future were also included in reports to agencies (Appendix 1).
3. Guidelines have been developed to deal with common problem areas (e.g. how to deal with damaged and immature specimens) and these have been distributed to agencies (Supporting Document 2).
4. Separating and labelling specimens that have been misnamed to allow visual reinforcement of the features of problem taxa. These specimens can then be used by the agency as reference material.

**Objective 4 - reporting to NRHP committee**

Meetings and Workshops held for the MRHI program have been attended by QA staff to give ongoing progress reports to the NRHP Management Committee. This includes the NRHP meeting in Canberra on the 22-24 May, 1995 and a program review undertaken at the MRHI Workshop on 22-24 October, 1996. A seminar outlining the results of the QA program was also given at the LWRRDC meeting held at the Murray-Darling Freshwater Research Centre (Albury) on 3 December, 1996. Two milestone reports have been submitted to LWRRDC, one in May 1996 and

the other in December 1996, detailing quality assurance checking procedures and reporting on agency progress.

## Results

### Objective 1 - taxonomic training

Initial taxonomic training provided during the Albury workshop in 1995 provided a basis for which agency staff inexperienced in taxonomy could undertake the program. Ongoing training has been via feedback to agencies from QA of identifications.

### Objective 2 - quality control and assurance

*Victoria*

The Victorian Environmental Protection Agency and Water Ecoscience were the two agencies undertaking macroinvertebrate identifications for the MRHI in Victoria. A high percentage of the errors detected in Victorian EPA samples (Fig. 1) were due to Physidae/Planorbidae (Mollusca) not being enumerated separately on data sheets. This is probably because accurate separation of these two taxa can require an extra processing stage (boiling of radulas). Fails (> 10% error) were given in two criteria in round 2 because trichopteran specimens were not sent for checking (Appendix 2). Round 3 achieved total passes, while miscounts and grouping of molluscs accounted for two fails in a sample from round 4 (Fig. 1, Appendix 2).

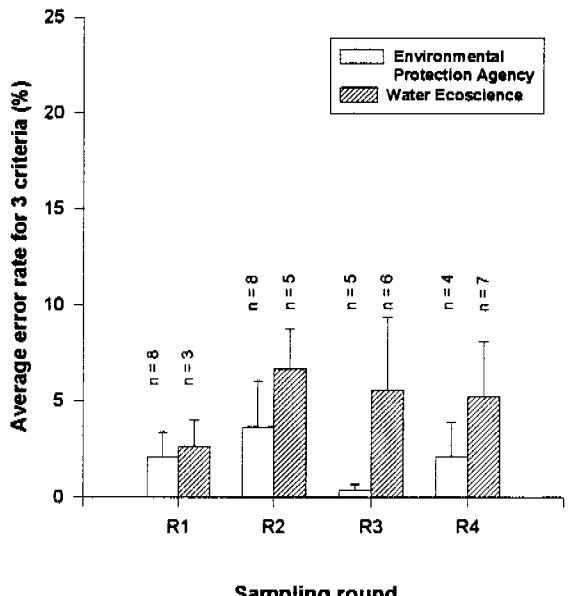



**Figure 1** Average error rates for Victorian agencies based on three QA/QC criteria (number of new taxa, number of misidentifications and Bray Curtis dissimilarity) with number of samples checked and one standard deviation shown.

Physid and planorbid molluscs were also grouped by Water Ecoscience. This and the misidentification of lymnaeid molluscs accounted for fails across three criteria in all rounds (except round 1 - Appendix 2). Additional miscounts and missing specimens increased the error margins. Two sites in the fourth round failed all categories due to the lack of experience of the staff member undertaking identifications.

Overall, error rates for Victorian agencies were below 10% and these levels could be reduced by agencies conforming to standard taxonomic levels. The EPA generally had significantly lower error rates than Water Ecoscience which may reflect a difference in the experience of staff between the two agencies.

*New South Wales*

Five agencies undertook invertebrate identifications for the MRHI in NSW (Fig.2). The Environmental Protection Agency had a number of samples fail the three QA criteria in the first round (Appendix 2) due to incorrect identifications and chironomids not being keyed to subfamily. In the following three sampling rounds only a few misidentifications occurred and passes were given in all criteria. Therefore, overall performance improved over time (Fig. 2).

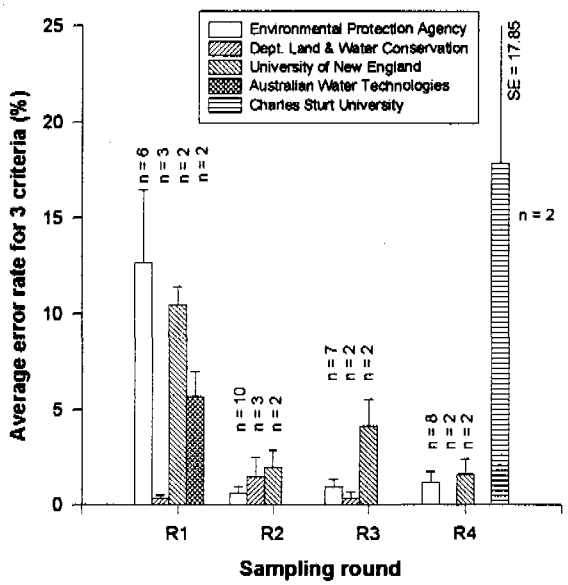



**Figure 2** Average error rates for New South Wales agencies based on three QA/QC criteria (number of new taxa, number of misidentifications and Bray Curtis dissimilarity) with number of samples checked and one standard deviation shown.

(Fig. 2).

Results from the Department of Land and Water Conservation were generally very good in all rounds (Fig. 2) although, in comparing these results with other agencies, low average richness in DLWC samples needs to be considered (Appendix 2). Only one fail was given, in round 2 (Appendix 2), for the new taxa criterion due to the misidentification of one taxon (Tanypodinae misidentified as Tabanidae). The only other criticism of the agency was failure to include identifier/date labels with samples in rounds 1 and 2.

Australian Water Technologies was only involved in the first two sampling rounds. Errors in the first round were due to a number of missing specimens. In the second round the agency made no errors

Samples identified by the University of New England in the first round failed in two of the assessment criteria due to absence of taxa recorded on data sheets in samples, unidentified and miscounted specimens (Appendix 2). These errors were minimized in subsequent rounds (Fig. 2) and no fails were given (Appendix 2).

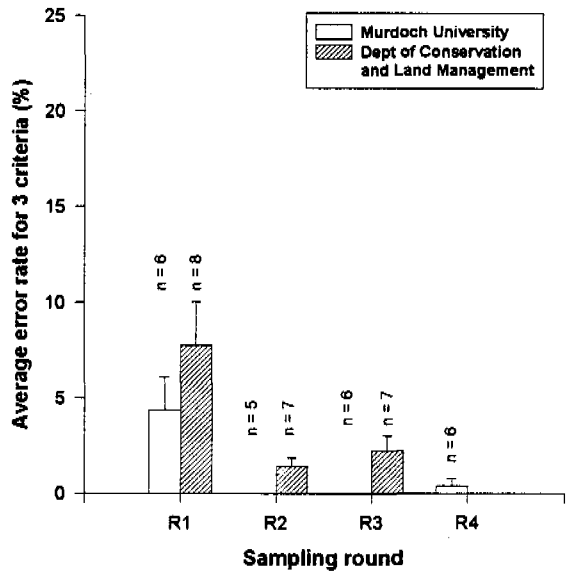
Charles Sturt University disposed of samples collected in the first three rounds so these could not be checked. Fourth round errors included miscounts, misidentifications and failure to record specimens on data sheets. These errors resulted in fails in all criteria at one site while another site had no errors (Appendix 2). It would appear there were two identifiers involved, however, no names were provided by the agency.

Overall, error rates decreased for all NSW agencies after the first round (Fig. 2). This may be a function of feedback from QA and increasing experience of agency staff. Charles Sturt University (CSU) is the main exception to this, being the only agency that didn't have samples from the first rounds checked. If the trends for other agencies are a guide, the high error rate for CSU in round 4

(Fig. 2) may be representative of the quality of results from the previous unchecked rounds. These results highlight the need for checking to take place from the outset to ensure that problems are rectified at an early stage.

*Western Australia*

Four agencies were involved in identification of invertebrate samples for the MRHI in Western Australia. Edith Cowan University and the University of Western Australia passed all QA criteria in all samples checked (Appendix 2) and so are not included in Figure 3 (below). Both Murdoch University and the Department of Conservation and Land Management (CALM) had highest error rates in the first round and showed improvement thereafter (Fig. 3). Misidentifications, miscounts, missing specimens, and unrecorded families accounted for fails being given to Murdoch in the first round. The fourth round was within limits eventhough the molluscs were misidentified. Errors in round 1 samples from CALM were in the form of miscounts, misidentifications (mainly hemipterans and odonates) and omission of taxa from data sheets. Fails were generally given for samples identified by a new staff member not familiar with the northern fauna. Subsequent new staff members performed better. Round 4 was not assessed for CALM.




Overall, results from WA showed an improvement after the first round when error rates dropped to below an average of 5% (Fig. 3). Low overall error rates in WA may be related to low diversity in this state (except for the northern regions sampled by CALM).

**Figure 3** Average error rates for Western Australian agencies based on three QA/QC criteria (number of new taxa, number of misidentifications and Bray Curtis dissimilarity) with number of samples checked and one standard deviation shown.

*South Australia - Environment Protection Agency*

Passes were given in all sampling rounds except for round 3, which had a low number of taxa, and one misidentification led to a fail in the new taxa category (Appendix 2). Errors were minimal in rounds 1 and 2 and no errors were made in round 4(Fig. 4).

*Australian Capital Territory - University of Canberra*

Errors repeated throughout the four rounds meant a high fail rate for this agency across the three identification criteria (Fig. 4). Amphipods were not keyed to family level in any round and accounted for many fails. Many misidentifications occurred across both non-insect and insect groups. Specimens of Oligochaeta and Acarina were often not recorded on data sheets which led to fails in the new taxa criterion, particularly in round 1 where fails were given at all sites (Appendix 2). The consistently poor performance of this agency may be attributed to staff inexperienced in identification, non-conformance to specified taxonomic levels and a degree of carelessness.

*Tasmania - Department of Primary Industry and Fisheries*

Samples from round 2 were identified first by DPIF. A high fail rate in round 2 was due to chironomids not being keyed to subfamily. In subsequent rounds chironomids were identified to the appropriate level and rounds 1 and 3 passed all the identification criteria with minimal errors (Fig. 4). One site in round 4 attracted fails in all three criteria (Appendix 2) due to misidentifications of a significant proportion of taxa. The errors cannot be attributed to a new identifier but possibly to carelessness, either in identifications or in the recording of specimens on data sheets.

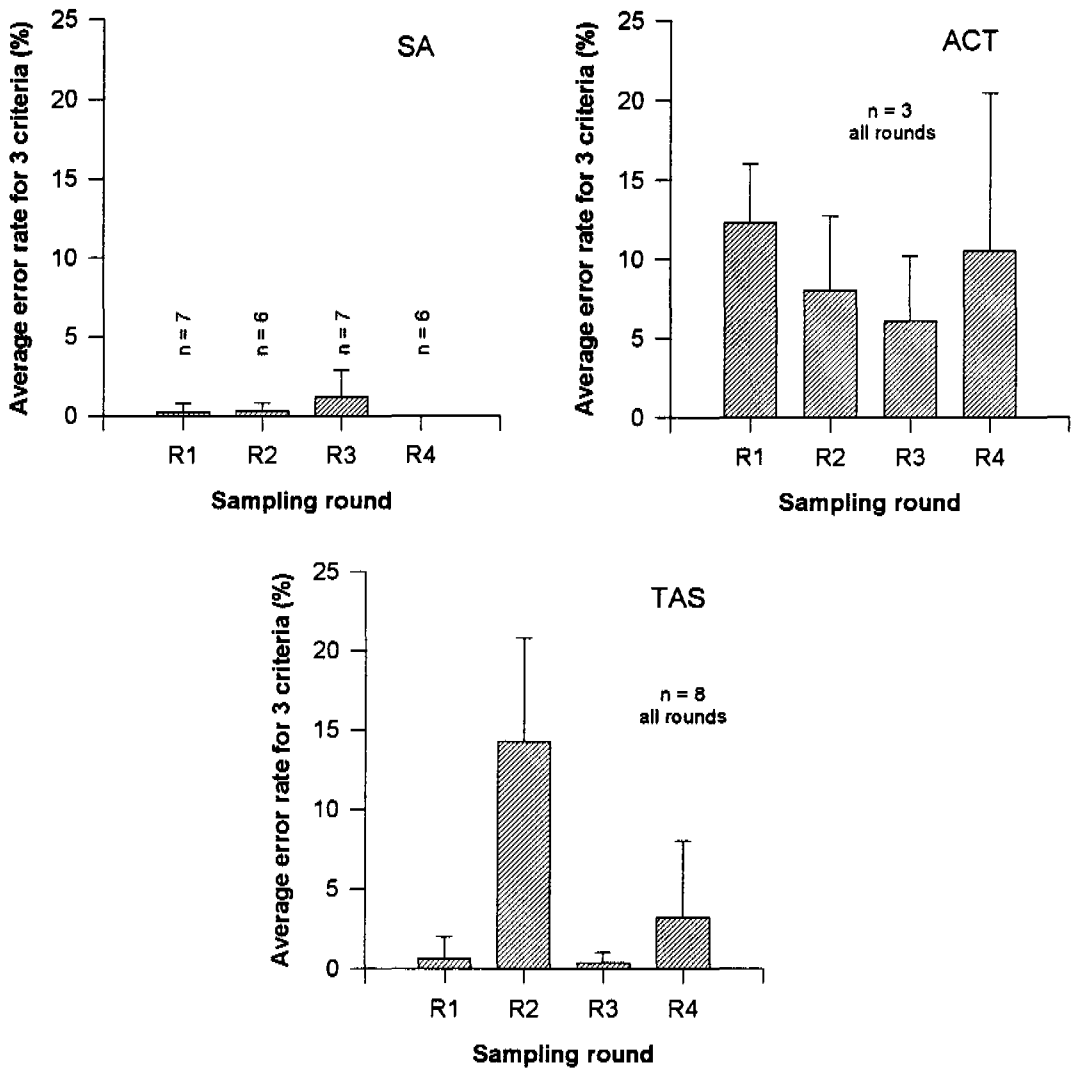



**Figure 4** Average error rates for South Australia, Australian Capital Territory and Tasmania based on three QA/QC criteria (number of new taxa, number of misidentifications and Bray Curtis dissimilarity) with number of samples checked and one standard deviation shown.

*Queensland and the Northern Territory*

Only one round from both Queensland and the Northern Territory could be checked. Checking for the NT is incomplete, consisting of two habitats with one of these incomplete. Overall, both

agencies achieved passes in the round checked (Table 2). Queensland samples were checked in two stages and an improvement in error rate was noticed, probably due to increasing experience of staff.

Table 2: Summary of results for Queensland and Northern Territory showing the number of samples checked, average % error (based on the 3 QA/QC critera) and the standard error associated with the average.

| | Queensland | Northern Territory |
|---|---|---|
| Number of samples checked | 27 | 9 |
| Average error (%) | 3.6 | 3.7 |
| Standard error | 3.5 | 2.6 |

**Objective 3 - Reporting to agencies**

A QA summary report was produced and sent to agencies for each round that was checked. Reports included a summary of results, commentary about errors (Appendix 1) and copies of QA/QC data sheets which detail all errors and calculation of the three assessment criteria.

**Objective 4 - reporting to NRHP committee**

Collation of data from cross-checking of macroinvertebrate identifications for four rounds of the MRHI has highlighted several key points:

1. Error rates were often contributed to by non-conformance to specified taxonomic levels (particularly molluscs, chironomids and amphipods). Non-conformance did not always result from lack of communication, so responses to deliberate non-conformance may need to be assessed.
2. In-house training of new staff in identification and induction with relation to MRHI protocols is necessary to maintain low levels of error (this is part of quality assurance).
3. Feedback from external cross-checking is essential for all agencies involved in the program, preferably after the first round of sampling, to avoid compounding of errors over time.

## Implications of results

Acceptable error levels need to be reassessed in the light of data collected to date. Such an assessment may look at whether the continued use of an acceptance sampling approach (i.e. management decides on an acceptable level of error) is appropriate and review of the acceptance level, possibly from the current 10% to 5%. Factors that may be taken into consideration in making this decision include:

1. Results of the modelling process: acceptable error rates may be linked to those that will start to cause a breakdown in the predictive model, this may also involve assessing the contribution of identification errors to other sources of error such as bias resulting from live-sorting.
2. Protocols developed elsewhere such as the US which advocate a 10% error rate for a lower level of taxonomic resolution (generally genus - Cuffney et al. 1993). Results from the current QA work suggest a 5% target for family-level is now attainable.

3. It is envisaged that future sample identification for testing and use of the AUSRIVAS model will be on a presence/absence basis. Miscounts will cease to be a criteria and error rates are likely to be reduced (see Appendix 2 for recalculation of results using presence/absence data). This represents another argument for reduction of the acceptable error rate from 10% to 5%.

Alternately a true quality control approach may be adopted whereby an acceptable level of variability is determined empirically, as per the British approach (Van Dijk 1994). In the current approach, inherent variability may be partially masked by the buffer zone of accepting miscounts of <5% or 1.

## Recommendations

A QA/QC manual should be produced that is available to all people interested in applying the AUSRIVAS model. This would include all aspects of QA/QC such as sample collection, sorting etc with QA/QC of identifications being only one component. An area highlighted in this document that is also worthy of inclusion is provision of in-house training for new staff. The manual should also suggest protocols for action when a sample fails one of the three criteria i.e. quality control procedures. This may consist of an appropriate block of samples being reidentified by the agency and QA/QC repeated. External QA/QC should continue at the current rate to ensure ongoing quality of data with regard identifications.

## Communication of results/ adoption activities

- presentation of guide/workshop
- constant feedback to agencies via reports for each round

## List of publications, sources of further information

Cuffney T.F., Gurtz M.E. and Meador M.R. (1993). Guidelines for the processing and quality assurance of benthic invertebrate samples collected as part of the national water-quality assessment program. U.S. Geological Survey Open-File Report 93-407, 88pp.

Van Dijk P. (1994). Analytical quality control for macroinvertebrate enumeration. National Rivers Authority R&D Note 331, Bristol, 37pp.

### Supporting documents

1. Monitoring River Health Initiative taxonomic workshop handbook. (J Hawking ed) 1995.

2. Guidelines for identification and quantification for agencies participating in the MRHI based on quality control procedures. (JH Hawking & R O'Connor) 1997.

3. Calculation and documentation of QA/QC error rates.

## Acknowledgments

Thanks go to Chris Humphrey for his help in establishing this project, Di Crowther and Jo Thompson for their technical and professional support, and finally Peter Davies and Nick Schofield for providing advice throughout the project.

# APPENDIX 1: EXAMPLE OF PROGRESS REPORT

DATE: 4th March, 1996.

PROGRESS REPORT ON QUALITY CONTROL CHECKING OF MACROINVERTEBRATE IDENTIFICATIONS.

CONTACT: Garry Bennison

STATE/TERRITORY: Victoria

AGENCY: Water Ecoscience Pty Ltd

SAMPLING OCCASSION: Mar/Apr 1995

Samples cross-checked and summary of results:

| Biogeographic region | Site | Habitat | Assessment criteria | | |
|---|---|---|---|---|---|
| | | | NT | IE | BC |
| Region 1, Moorabool River Basin | Moorabool River at Sheoaks | Pool | F | P | P |
| Region 2, Tambo River Basin | Tambo River downstream Peters Creek | Pool | P | P | P |
| Region 3, Werribee River Basin | Kororoit Creek, Beatty's Road Crossing | Pool | P | P | P |
| Region 4 Maribyrnong River Basin | Deep Creek, Darraweit Guim | Pool | F | P | P |
| Region 5, Broken River Basin | Broken Creek downstream of Nathalia | Pool | P | P | P |

NT=percent new taxa IE=percent incorrect identifications or counts BC=Bray Curtis

- Assessment criteria: P=Pass, F=Fail.

Comments

Region 1, Moorabool River at Sheoaks

- 6 chironomids only identified to family level. These specimens should have been taken to sub-family.
- Molluscs only identified to Physidae/Planorbidae. The snails were all Physids and should have been identified. (ref: Smith and Kershaw,1979, Field Guide to the Non-Marine Molluscs of South Eastern Australia, page 75)
- The two Oligochaeta specimens were missing.
- The Megaloptera specimen was missing
- The Protoneuridae and Zygoptera damaged specimens both keyed to Isostictidae (Hawking 1995 - MTHI workshop key.) Confusion may be due to Isostictidae originally being a sub-family of Protoneuridae (see Hawking 1986).

Region 2, Tambo River downstream of Peters Creek

- The three Mollusca specimens should not have been lumped into Planorbidae/ Physidae. They have been identified by Brian Smith and are all Lymnaeidae Austropeplea tomentosa.
- There were 6 Ecnomidae not 5.
- Unknown coleoptera (possibly terrestrial) has been sent to J. Lawrence for determination.
- A Blephariceridae (pupae) was not listed on the data sheet.

Region 3, Kororoit creek, Beatty's Road

- Once again the Mollusca were only identified to Planorbidae/Physidae. The specimen was *Physa acuta* (Physidae).
- Incorrect counts for Corixidae and Dytiscidae were taken as errors.

Region 4, Deep Creek, Darraweit Guim

- The Mollusca were not identified to family level (MRHI- protocol)
  The group contained both the families suggested. Identification is simple and can be achieved by boiling the radula out from an example of each different looking specimen.
  The method is found in Smith & Kershaw, 1979.(as above)

Region 5, Broken Creek downstream of Nathalia

- One Palaemonidae (prawn) was recorded incorrectly as an Atyidae (shrimp)
- The Simuliidae specimen was missing
- Notonectidae count was 14 specimens, not 13.

Cheers,

John Hawking

# APPENDIX 2

## Assessment of the MRHI Agencies performance for "Rank abundance" and "Presence/absence"

## data for Rounds 1 to 4

## ASSESSMENT OF VICTORIAN AGENCIES PERFORMANCE (RANK ABUNDANCE) FOR ROUNDS 1-4

| ROUND/ | 1 | | 2 | | 3 | | 4 | |
|---|---|---|---|---|---|---|---|---|
| AGENCY | EPA | WES | EPA | WES | EPA | WES | EPA | WES |
| #Sites | 172 | 44 | 172 | 44 | 102 | 44 | 65 | 46 |
| #Sites Cross-checked | 8 | 3 | 8 | 5 | 5 | 6 | 4 | 7 |
| New Taxa (Pass) | 7 | 3 | 8 | 3 | 5 | 6 | 4 | 5 |
| Incorrect (Pass) | 8 | 3 | 7 | 5 | 5 | 5 | 3 | 5 |
| Bray-Curtis (Pass) | 8 | 3 | 7 | 5 | 5 | 5 | 3 | 5 |
| Assessment | 0.02 | 0 | 0.04 | 0.07 | 0 | 0.05 | 0.09 | 0.16 |
| Pass/Fail | P | P | P | P | P | P | P | F |
| Average Richness | 17 | 22 | 17 | 21 | 17 | 20 | 15 | 15 |
| Total Abundance | 1274 | 1301 | 1537 | 1969 | 873 | 1751 | 516 | 1339 |
| Average Abundance | 159 | 434 | 192 | 394 | 175 | 292 | 129 | 191 |
| Sample | LP | LP | LP | LP | LP | LP | LP | LP |

LP=Live Pick Assessment=Bray-Curtis index on possible passes vs. attained passes for 3 criteria (pass<0.1)

## ASSESSMENT OF VICTORIAN AGENCIES PERFORMANCE (PRESENCE/ABSENCE) FOR ROUNDS 1-4

| ROUND/ | 1 | | 2 | | 3 | | 4 | |
|---|---|---|---|---|---|---|---|---|
| AGENCY | EPA | WES | EPA | WES | EPA | WES | EPA | WES |
| #Sites Cross-checked | 8 | 3 | 8 | 5 | 5 | 6 | 4 | 7 |
| New Taxa: 10% (Pass) | 7 | 3 | 8 | 3 | 5 | 6 | 4 | 5 |
| New Taxa: 5% (Pass) | 7 | 3 | 7 | 1 | 5 | 4 | 4 | 5 |
| Index (Pass) | 7 | 3 | 8 | 5 | 5 | 6 | 4 | 5 |

Index=Bray-Curtis assessment on agency taxa list vs. cross-check taxa list

## ASSESSMENT OF NEW SOUTH WALES AGENCIES PERFORMANCE (RANK ABUNDANCE) FOR ROUNDS 1-4

| ROUND/ | 1 | | | | | 2 | | | | | 3 | | | | 4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AGENCY | EPA | L&W | AWT | CSU | UNE | EPA | L&W | AWT | CSU | UNE | EPA | L&W | CSU | UNE | EPA | L&W | CSU | UNE |
| #Sites | 146 | 46 | 19 | 10 | 35 | 146 | 51 | 19 | 10 | 35 | 146 | 55 | 23 | 35 | 146 | 55 | 23 | 35 |
| #Sites C/C | 6 | 3 | 2 | 2 | 2 | 10 | 3 | 2 | 2 | 2 | 7 | 2 | 2 | 2 | 8 | 2 | 2 | 2 |
| New Taxa (P) | 2 | 3 | 2 | * | 0 | 10 | 2 | 2 | * | 2 | 7 | 2 | * | 2 | 8 | 2 | 1 | 2 |
| Incorrect (P) | 3 | 3 | 1 | * | 0 | 10 | 3 | 2 | * | 2 | 7 | 2 | * | 2 | 8 | 2 | 1 | 2 |
| B-C (P) | 4 | 3 | 2 | * | 2 | 10 | 3 | 2 | * | 2 | 7 | 2 | * | 2 | 8 | 2 | 1 | 2 |
| Assessment | 0.33 | 0 | 0.16 | * | 0.50 | 0 | 0.05 | 0 | * | 0 | 0 | 0 | * | 0 | 0 | 0 | 0.33 | 0 |
| Pass/Fail | F | P | F | * | F | P | P | P | * | P | P | P | * | P | P | P | F | P |
| Av. Richness | 15 | 6 | 18 | * | 21 | 14 | 8 | 16 | * | 20 | 18 | 8 | * | 14 | 15 | 11 | 8 | 20 |
| Total Abund. | 450 | 175 | 169 | * | 249 | 1150 | 305 | 164 | * | 177 | 1101 | 94 | * | 253 | 1304 | 248 | 159 | 748 |
| Av. Abund. | 75 | 58 | 85 | * | 125 | 115 | 102 | 82 | * | 89 | 157 | 47 | * | 127 | 163 | 124 | 80 | 374 |
| Sample | LP | LP | LP | LP | LP | LP | LP | LP | LP | LP | LP | LP | LP | LP | LP | LP | LP | LP |

C/C=Cross-check P=Pass B-C=Bray-Curtis Av=Average Abund=Abundance LP=Live Pick

Assessment=Bray-Curtis index on possible passes vs. attained passes for 3 criteria (pass<0.1)

* - samples discarded by agency; no assessment possible

## ASSESSMENT OF NEW SOUTH WALES AGENCIES PERFORMANCE (PRESENCE/ABSENCE) FOR ROUNDS 1-4

| ROUND/ | 1 | | | | | 2 | | | | | 3 | | | | 4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AGENCY | EPA | L&W | AWT | CSU | UNE | EPA | L&W | AWT | CSU | UNE | EPA | L&W | CSU | UNE | EPA | L&W | CSU | UNE |
| #Sites C/C | 6 | 3 | 2 | 2 | 2 | 10 | 3 | 2 | 2 | 2 | 7 | 2 | 2 | 2 | 8 | 2 | 2 | 2 |
| NT: 10% (P) | 2 | 3 | 2 | * | 0 | 10 | 2 | 2 | * | 2 | 7 | 2 | * | 2 | 8 | 2 | 1 | 2 |
| NT: 5% (P) | 1 | 3 | 2 | * | 0 | 8 | 2 | 2 | * | 1 | 5 | 2 | * | 1 | 7 | 2 | 1 | 2 |
| Index (P) | 2 | 3 | 1 | * | 0 | 9 | 3 | 2 | * | 2 | 7 | 2 | * | 2 | 8 | 2 | 1 | 2 |

C/C=Cross-check NT=New Taxa P=Pass

Index=Bray-Curtis assessment on agency taxa list vs. cross-check taxa list

* - samples discarded by agency; no assessment possible

## ASSESSMENT OF SOUTH AUSTRALIAN AGENCY PERFORMANCE (RANK ABUNDANCE) FOR ROUNDS 1-4

| ROUND/ AGENCY | 1 EPA SA | 2 EPA SA | 3 EPA SA | 4 EPA SA |
|---|---|---|---|---|
| #Sites | 141 | 125 | 141 | 132 |
| #Sites Cross-checked | 7 | 6 | 7 | 6 |
| New Taxa (Pass) | 7 | 6 | 6 | 6 |
| Incorrect (Pass) | 7 | 6 | 7 | 6 |
| Bray-Curtis (Pass) | 7 | 6 | 7 | 6 |
| Assessment | 0 | 0 | 0.06 | 0 |
| Pass/Fail | P | P | P | P |
| Average Richness | 14 | 20 | 17 | 22 |
| Total Abundance | 8270 | 34529* | 5148 | 7253 |
| Average Abundance | 1181 | 5755 | 735 | 1209 |
| Sample | FP | FP | FP | FP |

FP=Field Preservation Assessment=Bray-Curtis index on possible passes vs. attained passes for 3 criteria (pass<0.1)

*represents total abundancebeing entered on QA/QC sheet (generally a 10% subsample would be cross-checked in this case)

## ASSESSMENT OF SOUTH AUSTRALIAN AGENCY PERFORMANCE (PRESENCE/ABSENCE) FOR ROUNDS 1-4

| ROUND/ AGENCY | 1 EPA SA | 2 EPA SA | 3 EPA SA | 4 EPA SA |
|---|---|---|---|---|
| #Sites Cross-checked | 7 | 6 | 7 | 6 |
| New Taxa: 10% (P) | 7 | 6 | 6 | 6 |
| New Taxa: 5% (P) | 7 | 6 | 6 | 6 |
| Index (P) | 7 | 6 | 6 | 6 |

P=Pass Index=Bray-Curtis assessment on agency taxa list vs. cross-check taxa list

## ASSESSMENT OF TASMANIAN AGENCY PERFORMANCE (RANK ABUNDANCE) FOR ROUNDS 1-4

| ROUND/ AGENCY | 1 DPI TAS | 2 DPI TAS | 3 DPI TAS | 4 DPI TAS |
|---|---|---|---|---|
| #Sites | | | | |
| #Sites Cross-checked | 8 | 8 | 8 | 8 |
| New Taxa (Pass) | 8 | 0 | 8 | 6 |
| Incorrect (Pass) | 8 | 2 | 8 | 7 |
| Bray-Curtis (Pass) | 8 | 6 | 8 | 7 |
| Assessment | 0 | 0.5 | 0 | 0.09 |
| Pass/Fail | P | F | P | P |
| Average Richness | 15 | 16 | 15 | 17 |
| Total Abundance | 1048 | 1192 | 1325 | 1760 |
| Average Abundance | 131 | 149 | 166 | 220 |
| Sample | FP | FP | FP | FP |

FP=Field Preservation Assessment=Bray-Curtis index on possible passes vs. attained passes for 3 criteria (pass<0.1)

## ASSESSMENT OF TASMANIAN AGENCY PERFORMANCE (PRESENCE/ABSENCE) FOR ROUNDS 1-4

| ROUND/ AGENCY | 1 DPI TAS | 2 DPI TAS | 3 DPI TAS | 4 DPI TAS |
|---|---|---|---|---|
| #Sites Cross-checked | 8 | 8 | 8 | 8 |
| New Taxa 10% (Pass) | 8 | 0 | 8 | 6 |
| New Taxa 5% (Pass) | 8 | 0 | 7 | 5 |
| Index (Pass) | 8 | 1 | 8 | 8 |

Index=Bray-Curtis assessment on agency taxa list vs. cross-check taxa list

## ASSESSMENT OF WESTERN AUSTRALIAN AGENCIES PERFORMANCE (RANK ABUNDANCE) FOR ROUNDS 1-4

| ROUND/ | 1 | | | | 2 | | | | 3 | | | | 4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AGENCY | CALM | UWA | MURD | ECU | CALM | UWA | MURD | ECU | CALM | UWA | MURD | ECU | CALM | UWA | MURD | ECU |
| #Sites | 56 | 55 | 50 | 42 | 56 | 55 | 50 | 42 | 54 | 55 | 50 | 52 | -- | 55 | 50 | 53 |
| #Sites C/C | 8 | 5 | 6 | 3 | 7 | 5 | 5 | 3 | 7 | 5 | 6 | 3 | -- | 5 | 6 | 3 |
| New Taxa (P) | 5 | 5 | 3 | 3 | 7 | 5 | 5 | 3 | 6 | 5 | 6 | 3 | -- | 5 | 6 | 3 |
| Incorrect (P) | 7 | 5 | 5 | 3 | 7 | 5 | 5 | 3 | 7 | 5 | 6 | 3 | -- | 5 | 6 | 3 |
| B-C (P) | 6 | 5 | 6 | 3 | 7 | 5 | 5 | 3 | 7 | 5 | 6 | 3 | -- | 5 | 6 | 3 |
| Assessment | 0.14 | 0 | 0.12 | 0 | 0 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | -- | 0 | 0 | 0 |
| Pass/Fail | F | P | F | P | P | P | P | P | P | P | P | P | -- | P | P | P |
| Av. Richness | 17 | 13 | 11 | 8 | 17 | 10 | 10 | 8 | 17 | 15 | 11 | 7 | -- | 13 | 13 | 11 |
| Total Abund. | 1111 | 514 | 788 | 45 | 797 | 482 | 481 | 317 | 750 | 800 | 761 | 363 | -- | 727 | 829 | 318 |
| Av. Abund. | 139 | 103 | 131 | 15 | 114 | 96 | 96 | 106 | 107 | 160 | 127 | 121 | -- | 145 | 138 | 106 |
| Sample | LP | LP | LP | LP | LP | LP | LP | LP | LP | LP | LP | LP | LP | LP | LP | LP |

C/C=Cross-check P=Pass B-C=Bray-Curtis Av=Average Abund=Abundance LP=Live Pick

Assessment=Bray-Curtis index on possible passes vs. attained passes for 3 criteria (pass<0.1)

-- samples not received; results pending

## ASSESSMENT OF WESTERN AUSTRALIAN AGENCIES PERFORMANCE (PRESENCE/ABSENCE) FOR ROUNDS 1-4

| ROUND/ | 1 | | | | 2 | | | | 3 | | | | 4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AGENCY | CALM | UWA | MURD | ECU | CALM | UWA | MURD | ECU | CALM | UWA | MURD | ECU | CALM | UWA | MURD | ECU |
| #Sites C/C | 8 | 5 | 6 | 3 | 7 | 5 | 5 | 3 | 7 | 5 | 6 | 3 | -- | 5 | 6 | 3 |
| NT: 10% (P) | 5 | 5 | 3 | 3 | 7 | 5 | 5 | 3 | 6 | 5 | 6 | 3 | -- | 5 | 6 | 3 |
| NT: 5% (P) | 3 | 5 | 2 | 3 | 6 | 5 | 5 | 3 | 6 | 5 | 6 | 3 | -- | 5 | 5 | 3 |
| Index (P) | 5 | 5 | 5 | 3 | 7 | 5 | 5 | 3 | 7 | 5 | 6 | 3 | -- | 5 | 6 | 3 |

C/C=Cross-check NT=New Taxa P=Pass

Index=Bray-Curtis assessment on agency taxa list vs. cross-check taxa list

-- samples not received; results pending

## ASSESSMENT OF A.C.T. AGENCY PERFORMANCE (RANK ABUNDANCE) FOR ROUNDS 1-4

| ROUND/ AGENCY | 1 UC | 2 UC | 3 UC | 4 UC |
|---|---|---|---|---|
| #Sites | 60 | 60 | 60 | 62 |
| #Sites Cross-checked | 3 | 3 | 3 | 3 |
| New Taxa (Pass) | 0 | 0 | 1 | 2 |
| Incorrect (Pass) | 1 | 3 | 1 | 1 |
| Bray-Curtis (Pass) | 2 | 3 | 3 | 3 |
| Assessment | 0.5 | 0.2 | 0.12 | 0.2 |
| Pass/Fail | F | F | F | F |
| Average Richness | 17 | 17 | 21 | 17 |
| Total Abundance | 585 | 478 | 764 | 572 |
| Average Abundance | 195 | 159 | 255 | 191 |
| Sample | FP | FP | FP | FP |

Assessment=Bray-Curtis index on possible passes vs. attained passes for 3 criteria (pass<0.1) FP=Field Preservation

## ASSESSMENT OF A.C.T. AGENCY PERFORMANCE (PRESENCE/ABSENCE) FOR ROUNDS 1-4

| ROUND/ AGENCY | 1 UC | 2 UC | 3 UC | 4 UC |
|---|---|---|---|---|
| #Sites Cross-Checked | 3 | 3 | 3 | 3 |
| New Taxa: 10% (P) | 0 | 0 | 2 | 2 |
| New Taxa: 5% (P) | 0 | 0 | 1 | 1 |
| Index (P) | 1 | 0 | 2 | 3 |

P=Pass Index=Bray-Curtis assessment on agency taxa list vs. cross-check taxa list

## ASSESSMENT OF QUEENSLAND AGENCY PERFORMANCE (RANK ABUNDANCE) FOR ROUNDS 1-4

| ROUND/ AGENCY | 1 DPI | 2 DPI | 3 DPI | 4 DPI |
|---|---|---|---|---|
| #Sites | 217 | -- | -- | -- |
| #Sites Cross-checked | 27 | -- | -- | -- |
| New Taxa (Pass) | 25 | -- | -- | -- |
| Incorrect (Pass) | 24 | -- | -- | -- |
| Bray-Curtis (Pass) | 26 | -- | -- | -- |
| Assessment | 0.03 | -- | -- | -- |
| Pass/Fail | P | -- | -- | -- |
| Average Richness | 15 | -- | -- | -- |
| Total Abundance | 2267 | -- | -- | -- |
| Average Abundance | 84 | -- | -- | -- |
| Sample | LP | -- | -- | -- |

Assessment=Bray-Curtis index on possible passes vs. attained passes for 3 criteria (pass<0.1) LP=Live Pick
-- samples not received; results pending

## ASSESSMENT OF QUEENSLAND AGENCY PERFORMANCE (PRESENCE/ABSENCE) FOR ROUNDS 1-4

| ROUND/ AGENCY | 1 DPI | 2 DPI | 3 DPI | 4 DPI |
|---|---|---|---|---|
| #Sites Cross-checked | 27 | -- | -- | -- |
| New Taxa: 10% (P) | 25 | -- | -- | -- |
| New Taxa: 5% (P) | 18 | -- | -- | -- |
| Index (P) | 26 | -- | -- | -- |

P=Pass Index=Bray-Curtis assessment on agency taxa list vs. cross-check taxa list -- samples not received; results pending

## ASSESSMENT OF NORTHERN TERRITORY AGENCY PERFORMANCE (RANK ABUNDANCE) FOR ROUNDS 1-4

| ROUND/ AGENCY | 1 P&W | 2 P&W | 3 P&W | 4 P&W |
|---|---|---|---|---|
| #Sites | -- | -- | 63 | -- |
| #Sites Cross-checked | -- | -- | 6 | -- |
| New Taxa (Pass) | -- | -- | 6 | -- |
| Incorrect (Pass) | -- | -- | 4 | -- |
| Bray-Curtis (Pass) | -- | -- | 6 | -- |
| Assessment | -- | -- | 0.05 | -- |
| Pass/Fail | -- | -- | P | -- |
| Average Richness | -- | -- | 14 | -- |
| Total Abundance | -- | -- | 1297 | -- |
| Average Abundance | -- | -- | 216 | -- |
| Sample | -- | -- | LP | -- |

Assessment=Bray-Curtis index on possible passes vs. attained passes for 3 criteria (pass<0.1) --samples not received; results pending

## ASSESSMENT OF NORTHERN TERRITORY AGENCY PERFORMANCE (PRESENCE/ABSENCE) FOR ROUNDS 1-4

| ROUND/ AGENCY | 1 P&W | 2 P&W | 3 P&W | 4 P&W |
|---|---|---|---|---|
| #Sites Cross-checked | -- | -- | 6 | -- |
| New Taxa: 10% (Pass) | -- | -- | 6 | -- |
| New Taxa: 5% (Pass) | -- | -- | 4 | -- |
| Index (Pass) | -- | -- | 6 | -- |

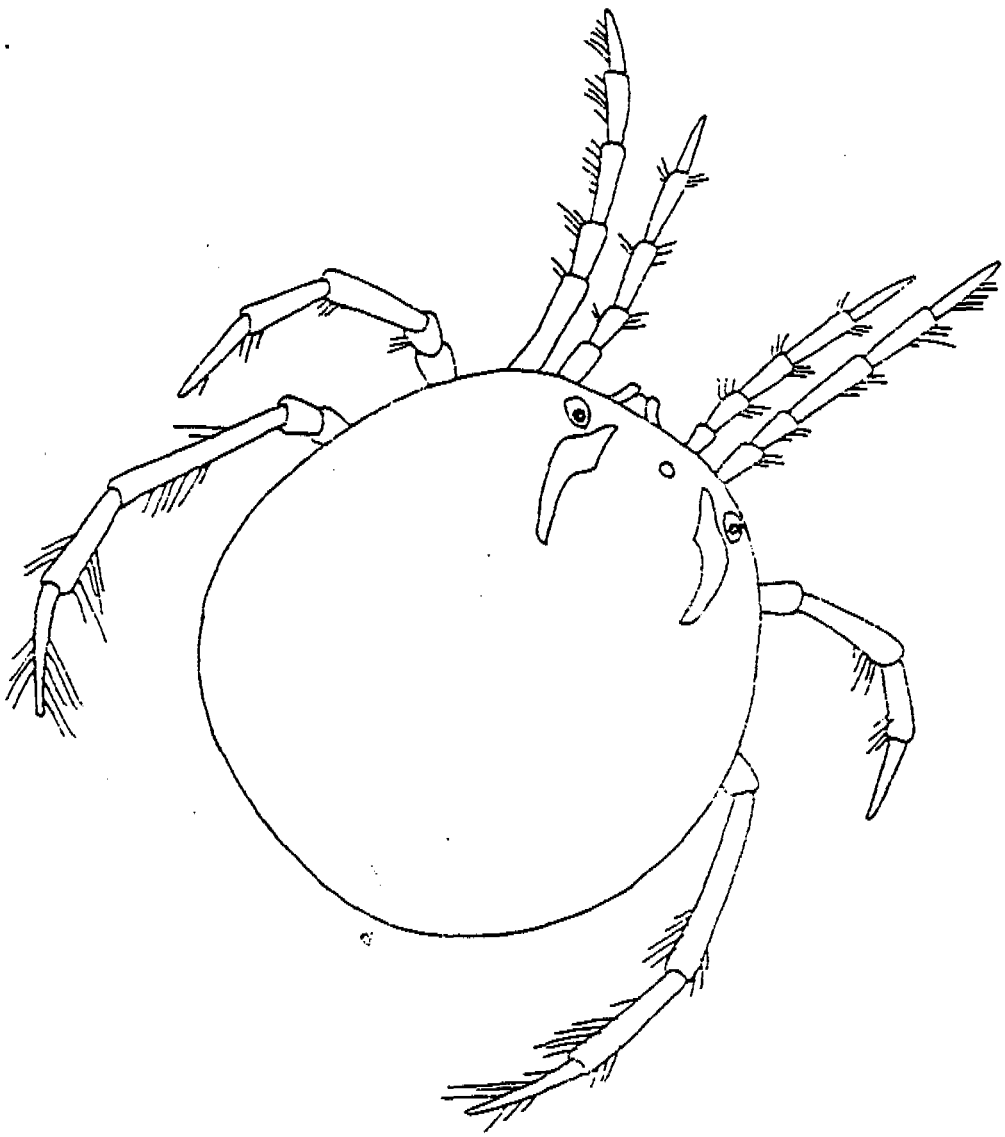
Index=Bray-Curtis assessment on agency taxa list vs. cross-check taxa list --samples not received; results pending

# SUPPORT DOCUMENT 1

# MONITORING RIVER HEALTH INITIATIVE TAXONOMIC WORKSHOP HANDBOOK

# MONITORING RIVER HEALTH INITIATIVE

# TAXONOMIC WORKSHOP HANDBOOK



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Murray-Darling Freshwater Research Centre

Monitoring River Health Initiative Workshop, 6-7th February 1995

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Handbook layout and design, Karlie Hawking

# CONTENTS

## List of the Major Groups and their families

Platyhelminthes : Temnocephalidea
- Temnocephalidae

Platyhelminthes : Turbellaria
- Dugesiidae

Nemertea
- All families

Nematoda
- All families

Nematomorpha
- Gordiidae
- Chordodidae

Mollusca : Gastropoda
- Viviparidae
- Thiaridae
- Neritidae
- Iravadiidae
- Stenothyridae
- Bithyniidae
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Mollusca : Bivalvia
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- Sphaeriidae

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- Richardsonianidae
- Ornithobdellidae
- Erpobdellidae

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- Branchipodidae
- Thamnocephalidae

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- All families

Crustacea : Conchostraca
- All families

Crustacea :Isopoda
- Cirolanidae
- Sphaeromatidae
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- Phreatoicoidae

Crustacea : Amphipoda
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- Palaemonidae
- Parastacidae
- Hymenosomatidae
- Sundathelphusidae

Insecta : Ephemeroptera
- Siphlonuridae
- Baetidae
- Oniscigastridae
- Ameletopsidae
- Coluburiscidae
- Leptophlebiidae
- Ephemerellidae
- Caenidae
- Prosopistomatidae

Insecta : Odonata
- Hemiphlebiidae
- Coenagrionidae
- Isostictidae
- Protoneuridae
- Lestidae
- Lestoideidae
- Megapodagrionidae
- Synlestidae
- Amphipterygidae
- Calopterygidae
- Chorocyphidae
- Aeshnidae
- Gomphidae
- Neopetaliidae
- Petaluridae
- Corduliidae
- Libellulidae

Insecta : Plecoptera
- Eustheniidae
- Austroperlidae
- Gripopterygidae
- Notonemouridae

Insecta : Hemiptera
- Mesoveliidae
- Hebridae
- Hydrometridae
- Veliidae
- Gerridae
- Leptopodidae
- Saldidae
- Nepidae

Belostomatidae
Ochteridae
Gelastocoridae
Corixidae
Naucoridae
Notonectidae
Pleidae

Insecta : Megaloptera
Sialidae
Corydalidae

Insecta : Neuroptera
Osmylidae
Neurorthidae
Sisyridae

Insecta : Coleoptera
Micosporidae
Carabidae
Haliplidae
Hygrobiidae
Noteridae
Dytiscidae
Gyrinidae
Hydrophilidae
Hydraenidae
Staphylinidae
Scirtidae
Elmidae
Limnichidae
Heteroceridae
Psephenidae
Ptilodactylidae
Chrysomelidae
Brentidae
Curculionidae

Insecta : Mecoptera
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Insecta : Diptera
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Tanyderidae
Blephariceridae
Simuliidae
Chaoboridae
Dixidae
Culicidae
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Chironomidae : Chironominae
Chironomidae : Podonominae
Chironomidae : Diamesinae
Chironomidae : Tanypodinae
Ceratopogonidae
Thaumaliidae
Psychodidae
Athericidae
Tabanidae
Stratiomyidae
Empididae
Dolichopodidae
Syrphidae
Sciomyzidae
Ephydridae
Muscidae

Insecta : Trichoptera
Hydrobiosidae
Glossosmatidae
Polycentropodidae
Philopotamidae
Psychomyiidae
Hydroptilidae
Ecnomidae
Hydropsychidae
Limnephilidae
Tasimiidae
Kokiriidae
Odontoceridae
Helicopsychidae
Philorheithridae
Leptoceridae
Calamoceratidae
Atriplectididae
Calocidae
Helicophidae
Conoesucidae
Plectrotarsidae
Oeconesidae
Antipodoeciidae
Dipseudopsidae

Insecta : Lepidoptera
Pyralidae

# CHAPTER 2

# TAXONOMIC INFORMATION

The key in Williams (1980, pp. 22-25) is recommended to identify the major higher groups (Phyla, and in some groups, Classes) of Australian free-living aquatic macroinvertebrates. Other useful keys: Pennak (1989), Thorp and Covich (1991) and Quigley (1977).

## PHYLUM PLATYHELMINTHES (Flatworms)

### CLASS TURBELLARIA, ORDER TRICLADIDA

There are no keys to the species from Australia and the taxonomic status of this Order is discussed in Williams (1980, p. 45-53).

### CLASS TEMNOCEPHALIDAE

The information and key provided by Williams (1980, p. 46-49) is currently used by most biologists. Information is available on the Tasmanian species (Hickman 1967).

## PHYLUM NEMERTEA

Williams (1980, p. 53-55) provides an account of the taxonomic status, distribution and ecology of this group.

## PHYLUM NEMATODA (Roundworms

The information provided by Williams (1980, p. 55-57) is still relevant.

## PHYLUM NEMATOMORPHA

Williams (1980, p. 58-60) to the two families commonly encounted.

## PHYLUM MOLLUSCA

### CLASS GASTROPODA (Snails)

The Gastropda can be identified to genera by the key in Williams (1980, p. 91-97) or from the original key by McMichael (1967). Biologists in south-eastern Australia and Tasmania will find it easier to use the regional keys of Smith and Kershaw (1979; 1981). Smith (1992) provides distributional information on all species.

### CLASS BIVALVIA (Mussels)

The Bivalvia can be identified to genera by the key in Williams (1980, p. 84-85) or from the original key by McMichael (1967). As with the gastropods, biologists in south-eastern Australia and Tasmania will find it easier to use the regional keys of Smith and Kershaw (1979; 1981). Additional information (McMichael & Hiscock 1958).

## PHYLUM ANNELIDA

### CLASS HIRUDINEA (Leeches)

The leeches are still a difficult group and the information and key to the families in Williams (1980, p. 104-111) should still be used.

## PHYLUM ARTHROPODA
## CLASS CRUSTACEA

The key of Horwitz *et al.* (1995) should be used to key malacostracan crustacean groups to family level and Williams (1980, pp. 124–125) for the non-malacostracan groups. The families of Decapoda can be identified by Horwitz (1995).

## CLASS INSECTA (Insects)

The key in Williams (1980, p. 186) is adequate to distinguish the insect orders which have aquatic stages. There is also a key in CSIRO's (1991) "Insects of Australia" (Lawrence *et al* 1991, p. 24) which is very good, but also includes the terrestrial Insect Orders. "Insects of Australia" should be referred to for additional information because it provides the most recent taxonomic and ecological information available, although generally only to family level. Another excellent reference book on aquatic insects is Merritt and Cummins (1984). A good reference text on the terminology of insect taxonomy/morphology is Torre-Bueno (1985).

### ORDER EPHEMEROPTERA (Mayflies)

The key of Suter (Chapter 3) should be used to identify nymphs of the families. Where appropriate the following regional keys can be used: South Australia (Suter 1986) and the Alligator Rivers Region, Northern Territory (Suter 1992). Additional information is provided by Peters and Campbell (1991).

### ORDER ODONATA (Dragonflies and damselflies)

The key of Hawking (Chapter 4) should be used to identify the Odonata families. Where appropriate the following regional keys can be used: south-eastern Australia (Hawking 1986), Tasmanian (Allbrook 1979), south-western Australia (Watson 1962) and from the "Top End" of the Northern Territory (Hawking 1993). Additional information is provided by Watson and O'Farrell (1991).

### ORDER PLECOPTERA (Stoneflies)

The Stonefly larvae can be identified to family level using the key by Theischinger (1991a). The following state keys should be used for the respective state: Tasmania (Hynes 1989); Victoria (Hynes 1978), South Australia (Suter and Bishop 1990) and Western Australia (Hynes and Bunn 1984).

### ORDER HEMIPTERA (Bugs)

The key in Williams (1980, p. 213) should be used to identify the families of aquatic Hemiptera. Additional information is provided by Carver, *et al.* (1991).

### ORDER MEGALOPTERA (Alderflies, dobsonflies)

The key in Williams (1980, p. 229) should be used and additional information is found in Theischinger (1991b).

### ORDER NEUROPTERA (Lace-wings)

Williams (1980, p. 230) provides a key to identify the larvae from the three families with aquatic habitats. Further information is available in New (1991).

### ORDER MECOPTERA (Scorpion-flies, hanging-flies)

Williams (1980, p. 230) and Byers (1991, p. 696) provide general information on this order. Pilgrim (1972) describes and figures the larva and pupa of *Choristella philpotti*.

### ORDER COLEOPTERA (Beetles)

The most appropriate key for identification of the families of Coleoptera is the key of Lawrence (1992), which has been reproduced in Chapter 5. Additional information is provided by Lawrence and Britton (1991). The keys in Williams (1980, p. 269, 275) are still useful for reference. useful keys for South Australians are the guides to the adult beetles of South Australia (Matthews 1980, 1982).

### ORDER TRICHOPTERA (Caddisflies)

The families of Trichoptera can be identified using the new key prepared for this workshop (Chapter 6). Additional information is provided by Neboiss (1991). The regional keys, south-western Australia, larvae (Dean and Bunn 1989) and the Alligator Rivers Region of the Northern Territory (Wells 1991) can also be used.

### ORDER DIPTERA (Two-winged flies)

Cranston (1995) provides a key to the dipteran families which have aquatic larvae. The key in Williams (1980, p.232) is helpful, but does not include all the families. Additional information is available in Colless and McAlpine (1991).

### ORDER LEPIDOPTERA (Aquatic Moths)

The aquatic caterpillars belong to the family Pyralidae, subfamily Nymphulinae. The Australian adults are in need of revision and the known larvae are identified by Northern Hemisphere keys. John Hawking has 34 voucher species from throughout Australia in the MDFRC reference collection.

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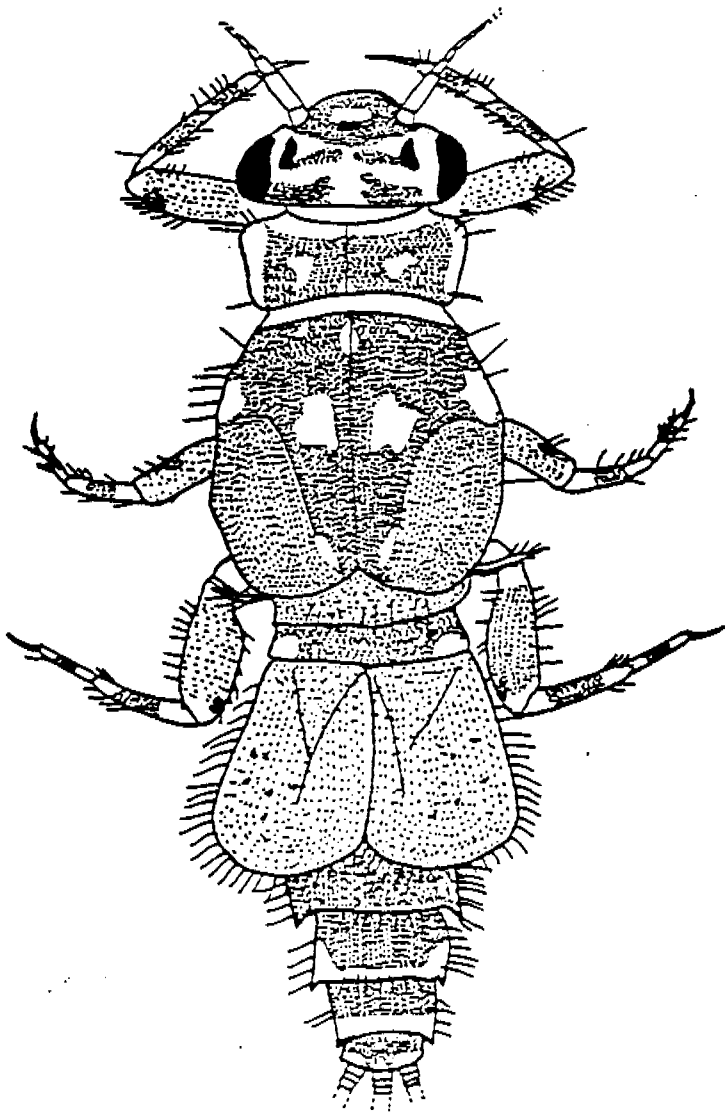
CHAPTER 3

# KEY TO THE FAMILIES OF EPHEMEROPTERA KNOWN IN AUSTRALIA (NYMPHS)



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## Key to Family

1. Mesonotum forms an ovoid carapace that covers the metanotum and abdominal segments 1-6; legs not visible from above; three terminal filaments retracted, not apparent.....**Prosopistomatidae**

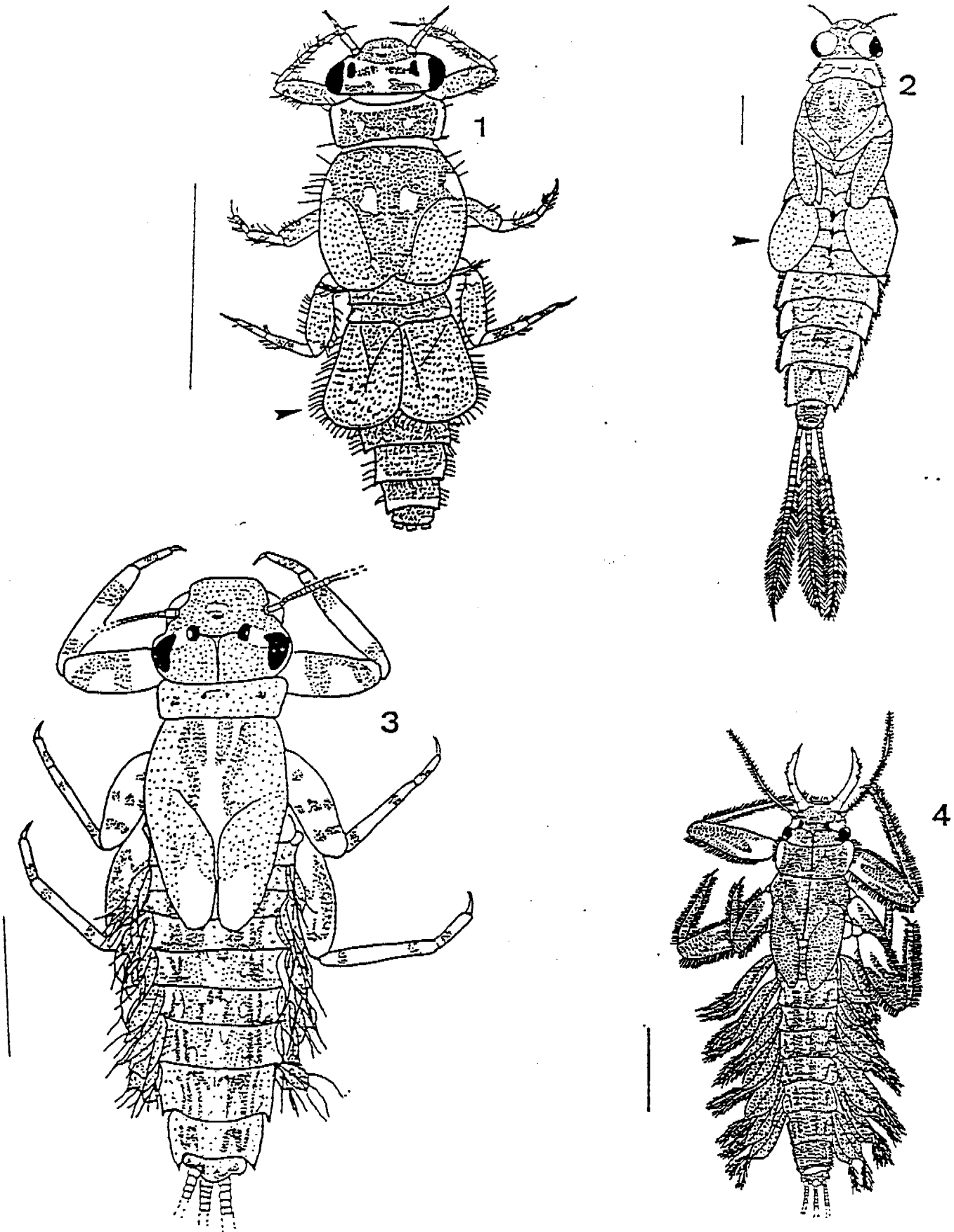
   Mesonotum not produced into a carapace; legs long, usually visible from above; three terminal filaments obvious (Fig. 1).....2

2. Adbomen with operculate gills on segments one (Fig. 2) or two (Fig. 1), covering remaining gills; gills present on segments 1-6 or 1-4 .....3

   Adbomen without operculate gills; all gills similar in shape, present on segments 1-7 (Figs. 3 and 4), 2-6, or 2-7.....4

## Notes

**Prosopistomatidae:** Nymphs usually <5mm long and have been found in North Queensland (Pearson and Penridge (1979). All nymphs were collected in drift samples from large rivers (1-4m deep) with mud/sand, coarse sand and "rubble" substrate (Pearson and Penridge 1979). Peters and Campbell (1991) consider these specimens as representatives of a new species of *Prosopistoma* Latrielle, 1833.




**Figures 1–4.** 1. Nymph of *Tasmanocoenis* (Caenidae). 2.Nymph of *Tasmanophlebia* (Oniscigastridae). 3. Nymph of *Atalophlebia* (Leptophlebiidae). 4. Nymph of *Jappa* (Leptophlebiidae). Scale Lines 1mm.

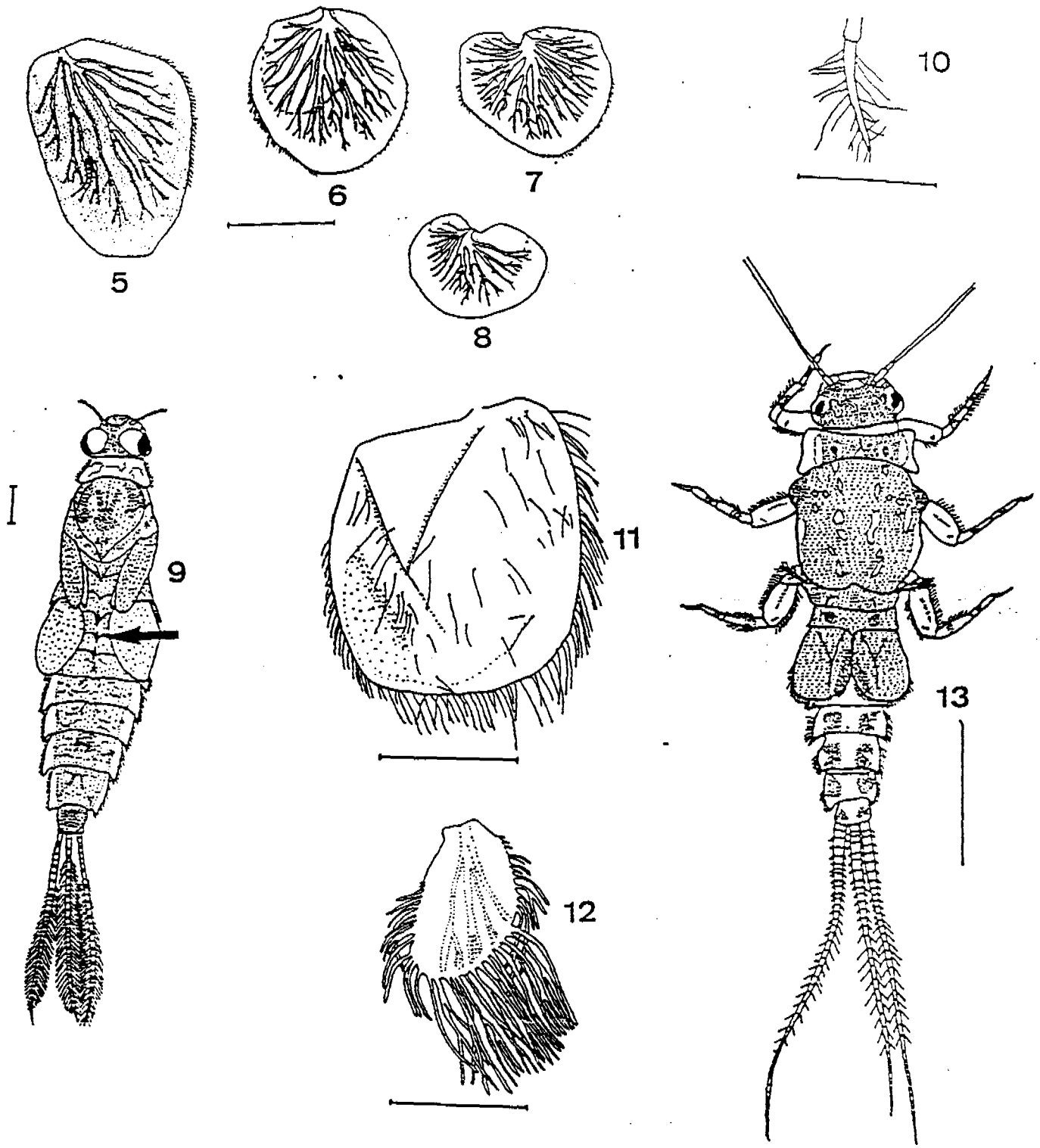
3. Gills on abdominal segments 1-4, first pair operculate (Fig. 5), other pairs plate-like and each with paired lamellae (Figs. 6, 7 and 8); lateral margins of terminal filament and inner margins of cerci fringed with long fine setae; abdomen with a median dorsal crest of tubercules on at least segments 1-4 (Fig. 9) ..... **Oniscigastridae**

Gills on segments 1-6, first pair a monofilament (Fig. 10), second pair operculate (Fig 11), other pairs lamellate and with 40-50 tracheal fringes (Fig. 12); lateral margins of caudal filaments without long fine setal fringe;apex of each segment with a whorl of setae; abdomen without a dorsal crest (Fig. 13) .....**Caenidae**

## Notes

**Oniscigastridae:** Is represented in Australia by the genus *Tasmanophlebia* Tillyard, 1921. Species are found in lakes and streams in New South Wales, Victoria, Tasmania (Tillyard 1921, 1933; Riek 1955) and South Australia (Suter 1986) which have a sandy substrate and fine organic material (ie in depositional zones). Campbell (1985) noted hat nymphs ate the fine particulate detritus.

**Caenidae:** Is represented in Australia by two genera, *Tasmanocoenis* Lestage, 1930 and *Wundacaenis* Suter, 1993. They occur in lakes and rivers at all altitudes, but usually in slow-flowing, depositional zones. *Tasmanocoenis* occurs in all states and territories (Suter 1984, 1986; Campbell 1988; Peters and Campbell 1991) while *Wundacaenis* has been recorded from Northern Western Australia, Northern Territory, Queensland, and New South Wales (Suter 1993) but also may occur in Victoria.




Figures 5-13. 5. First gill of *Tasmanophlebia*. 6. Second gill of *Tasmanophlebia*. 7. Third gill of *Tasmanophlebia*. 8. Fourth gill of *Tasmanophlebia*. 9. Nymph of *Tasmanophlebia* showing dorsal crest of tubercles. 10. First gill of *Tasmanocoenis*. 11. Second gill of *Tasmanocoenis*. 12. Third gill of *Tasmanocoenis*. 13. Nymph of *Wundacaenis* (Caenidae). Scale Lines Figs. 5-9 and 13 = 1mm; Figs 10 - 12 = 0.5mm.

4 Abdominal gills on segments 2-6; ventral lamellae of gills subdivided into 2 series of small, overlapping lobes.....**Ephemerellidae**
(See Figure 16.13 E in The Insects of Australia 1991 or Riek (1963) Figure 1)

Abdominal gills on segments 1-7 or 2-7; ventral lamellae of gills plate-like (Fig. 14), fibrilliform (Fig. 15) or absent (Fig. 16).....5

5 Gills on abdominal segments 1-7,each sclerotised deeply bifid and strongly spinose with ventral lamellae unsclerotised, fibrilliform (Fig. 17); thorax strongly humped .....**Coloburiscidae**

Gills not sclerotised, lacking spines, dorsal lamellae usually plate-like, ventral lamellae plate-like (Fig. 14), fibrilliform (Fig. 15) or absent (Fig. 16).....6

6 Head prognathous (Fig. 18); body usually dorso-ventrally flattened.....7

Head hypognathous(Fig. 19); body oval to circular in cross-section.....9

7 Gills on segments 2-7, each plate-like and single, terminal filament reduced to <6 segments (Fig. 20); body length less than 4mm.....**Baetidae (in part)**

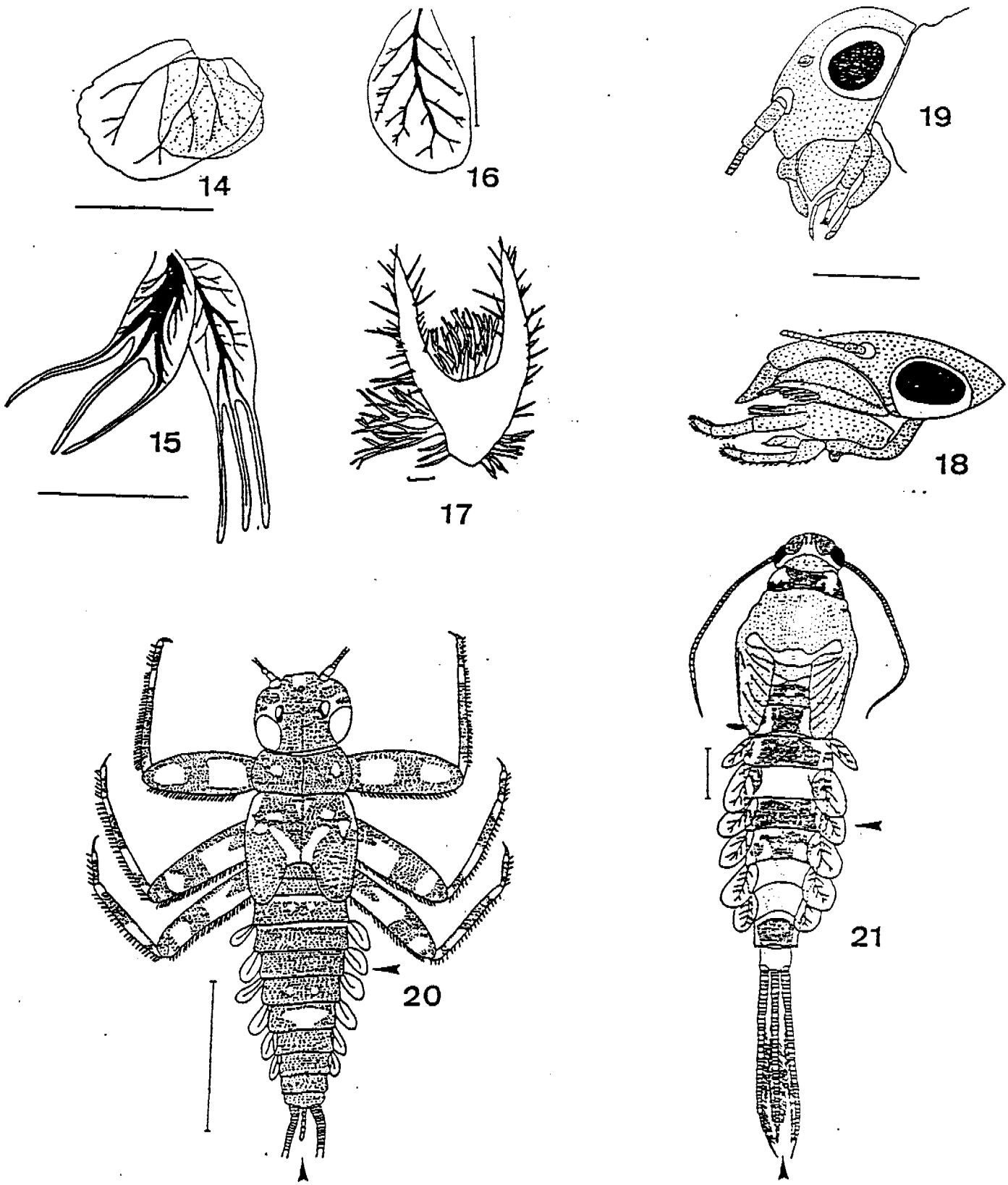
Gills on abdominal segments 1-7; terminal filament long and multi-segmented (Fig. 21); body length greater than 4mm.....8

## Notes

**Ephemerellidae:** Is represented in Australia by only one species *Ephemerellina (Austremerella) picta* (Riek 1963). It has only been recorded from the type locality in the Lamington National Park, Queensland (Riek 1963).

**Coloburiscidae:** Is represented in Australia by one genus, *Coloburiscoides* Lestage, 1935, and has a restricted distribution in the highlands of the southeastern mainland (Tillyard, 1933; Campbell, 1981).

**Baetidae:** This family is represented by four cosmopolitan genera (*Baetis* Leach, 1815; *Cloeon* Leach, 1815; *Centroptilum* Eaton, 1869 and *Pseudocloeon* Klapálek, 1905) and one endemic genus (*Bungona* Harker, 1957). However, recent work suggests there are at least 4 undescribed genera (Suter, 1991) and one dorso-ventrally flattened species from the Northern Territory has been included in this key.




**Figures 14-21.** 14. Gill of *Cloeon* (Baetidae). 15. Gill of *Atalophlebia*. 16. Gill of *Centroptilum* (Baetidae). 17. Gill of *Coloburiscoides* (Coloburiscidae). 18. Lateral view of head of *Atalophlebia*. 19. Lateral view of head of *Cloeon*. 20. Nymph of a new genus of Baetidae from the Northern Territory. 21. Nymph of *Centroptilum*. Scale Lines Figs. 14 - 17 = 0.5mm; Figs. 18 - 20 = 1mm

8. Terminal filament with lateral margins lined with long fine setae, lateral filaments with long fine setea on inner margins (Fig. 16.11 A in *The Insects of Australia* 1991); dorsal portion of gills plate-like, ventral portion fibrilliform (Fig. 16.14 C in *The Insects of Australia* 1991); maxillary and labial palps multi-segmented, maxilla with long curved apical spines.....Ameletopsidae

Caudal filaments with whorls of setae at apex of each segment (Fig. 22); dorsal and ventral portions of gills on segments 2-7 similar in shape and structure (Figs. 23 - 31); maxillary and labial palps 3-segmented; maxilla lacking long curved spines.....Leptophlebiidae

9 Antennae long, greater than twice head length (Fig. 32 and Figure 16.10 A in The Insects of Australia 1991); postero-lateral projections of abdomen weak or absent (Fig. 33).....Baetidae (In part)

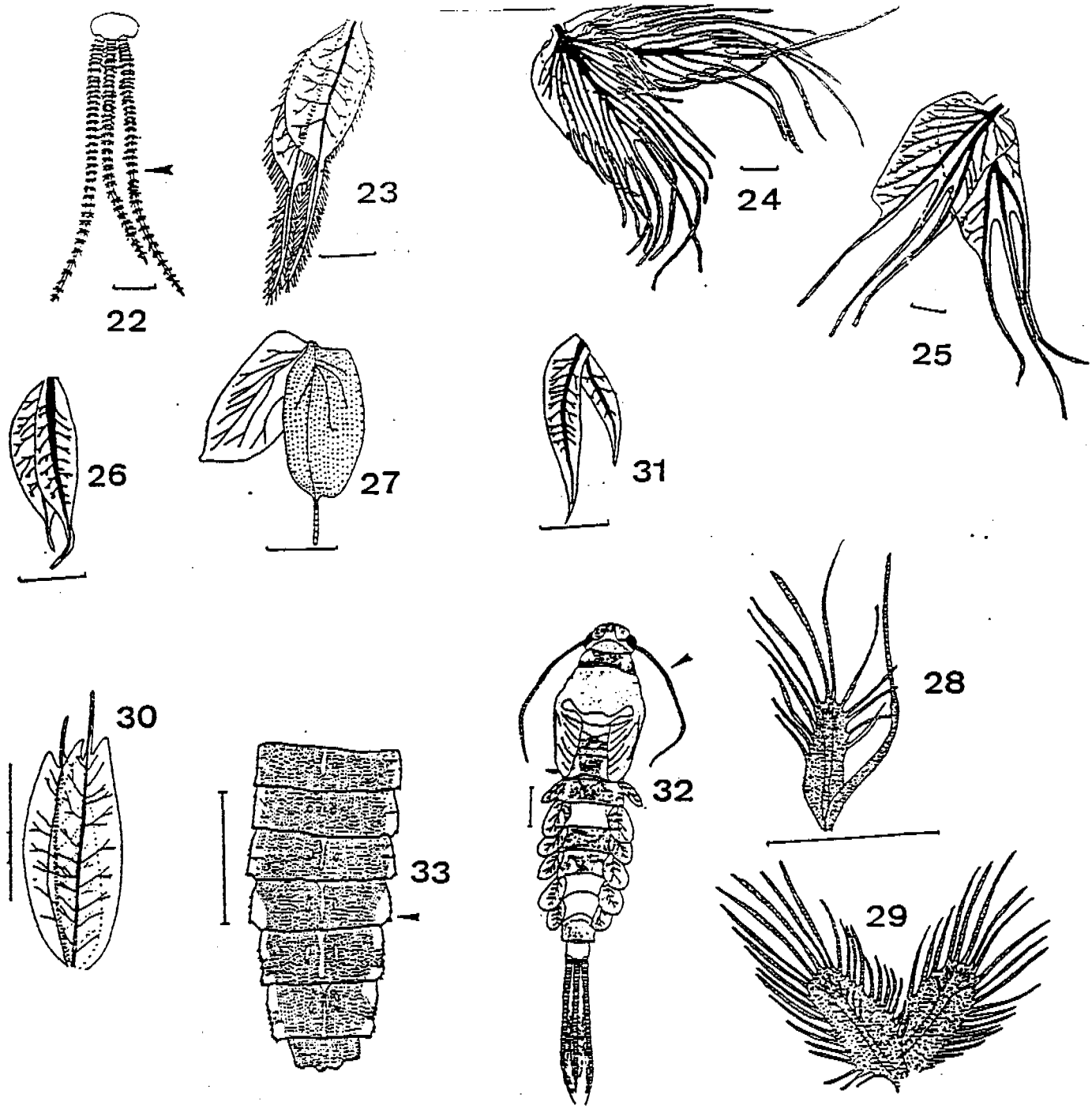
Antennae short, less than head length (Figure 16.10 C in The Insects of Australia 1991): lateral margins of abdomen with postero-lateral projections well developed .....Siphlonuridae

## Notes

**Ameletopsidae:** Is represented by only one genus in Australia (*Mirawara* Harker, 1954). The nymphs are found in stony upland streams from North Queensland to southern Victoria (Campbell 1981, 1988) where they are nocturnal and carnivorous (Cambell 1985).

**Leptophlebiidae:** This is the largest family of mayflies in Australia with 13 described genera ( see Peters and Campbell,1991) and a number of undescribed genera (Dean 1989).The family is recorded from all states and territories. Suter (1991) recognised two species of *Thraulus* in the Northern Territory and gill characters are included in the key.

**Siphlonuridae:** Only a single genus, *Ameletoides* Tillyard, 1933, is known from southeastern highlands of New South Wales and Victoria and also in Tasmania (Campbell, 1981, 1988).




Figures 22-33: 22. Caudal filaments of *Nousia* (Leptophlebiidae). 23. Gill of *Ulmerophlebia* (Leptophlebiidae) 24. Gill of *Atalophlebia* (Leptophlebiidae). 25. Gill of *Atalophlebia*. 26. Gill of *Nousia*. 27 Gill of *Garinjuga* (Leptophlebiidae). 28 First gill of *Thraulus* (Leptophlebiidae). 29. Third gill of *Thraulus*. 30. Gill of *Bibulmena* (Leptophlebiidae). 31 Gill of *Austrophlebioides* (Leptophlebiidae). 32 Nymph of *Centroptilum* (Baetidae). 33 Abdomen of *Cloeon*.(Baetidae). Scale Lines Figs. 22-29 and 31 = 0.5mm; Figs 32,33 and 35 = 1mm.

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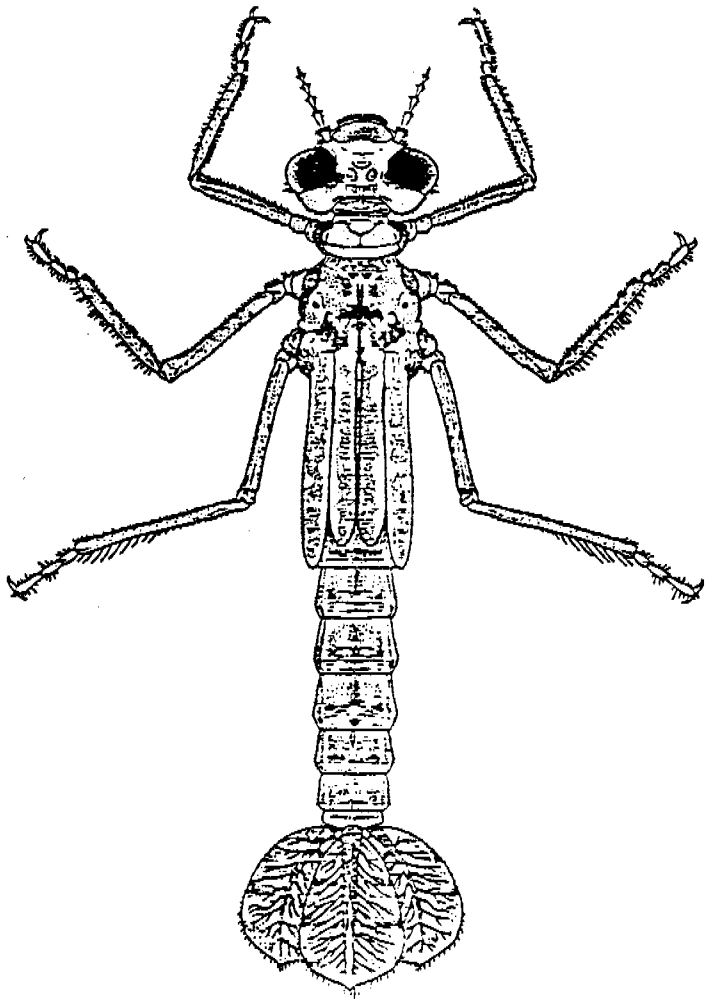
# EPHEMEROPTERA NOTES

CHAPTER 4

# KEY TO THE FINAL INSTAR LARVAE OF AUSTRALIAN ODONATA FAMILIES



John H. Hawking

Murray Darling Freshwater Research Centre

## Key* to Final Stage Larvae of suborders and zygopteran families of Odonata

1. Body usually slender, bearing three (rarely only two) leaf-like or saccoid tracheal gills attached to tip of abdomen (Figs 3, 5, 7, 11, 12, 15,16).....Suborder **ZYGOPTERA** (damselflies).....2
- Body usually stout, without external tracheal gills, but with three conspicuous substantial spine-like or triangular processes at tip of abdomen, forming 'anal pyramid' surrounding anus (Figs 21, 30, 31, 32).....Suborder **ANISOPTERA** (dragonflies).....(Page 27)

2. Median gill reduced to spine (Fig. 18).....**Chlorocyphidae**
- Median gill not reduced to spine (Fig.5).....3

3. Median gill short, lamellate; lateral gills triangular in cross-section (Fig. 17) ..... **Calopterygidae**
- All three gills similar in shape (Fig.5).....4

4. Caudal gills saccoid or triquetral, i.e. more or less rounded or triangular in cross-section.....5
- Caudal gills flat, leaf-like (Fig.5) .....8

5. Gills with a constriction or node (Fig.7) .....6
- Gills without a node, but tapering sharply to a point.....7

6. Mental setae present (Fig. 7); two parts of gill similar in width..... some **Isostictidae**
- Mental setae absent; distal part of gill filamentous ..... some **Megapodagrionidae**

7. Gills about half as long as rest of body (Fig. 16); outer border of labial palp with row of short, stout setae .....**Amphipterygidae**
- Gills much less than half as long as rest of body; outer border of labial palp with basal tuft of long setae (Fig. 11) .....**Lestoideidae**

8. Gills with constriction or node much nearer to apex than to base .....9
- Gills without a node (Fig. 10) .....10

9. Mental setae present (Fig. 19); two parts of gill similar in width (Fig. 6)..... **Isostictidae**
- Mental setae absent; distal part of gill filamentous (Fig. 13)..... some **Megapodagrionidae**

10. Very small larvae with paraglossae on median lobe of labium (Fig. 1).....**Hemiphlebiidae**
- Paraglossae absent; size various (Fig. 2).....11

11. Gill lamellae spread horizontally, broad, rounded (Fig. 12).....most **Megapodagrionidae**
- Gill lamellae held with edges uppermost, shape various (Fig. 5).....12

12. Labial palps deeply cleft, pronged; moveable hook of labial palp bearing setae (Fig. 9) .....**Lestidae**
- Labial palps not deeply cleft; movable hook of labial palp without setae .....13

13. Labial palps lacking setae (Fig. 14).....**Chlorolestidae**
- Labial palps with setae (Fig. 2) .....14

14. More than two pairs of premental setae (Fig. 2, 4)..... most **Coenagrionidae**
- At most one pair of premental setae (Fig. 8).....15

15. Posterior corners of head flared (Fig. 3) ..... **Coenagrionidae** (*Caliagrion billinghursti*)
- Posterior corners of head rounded (Fig. 20)..... **Protoneuridae**

* Sections of the key modified from Watson & O'Farrell (1991).

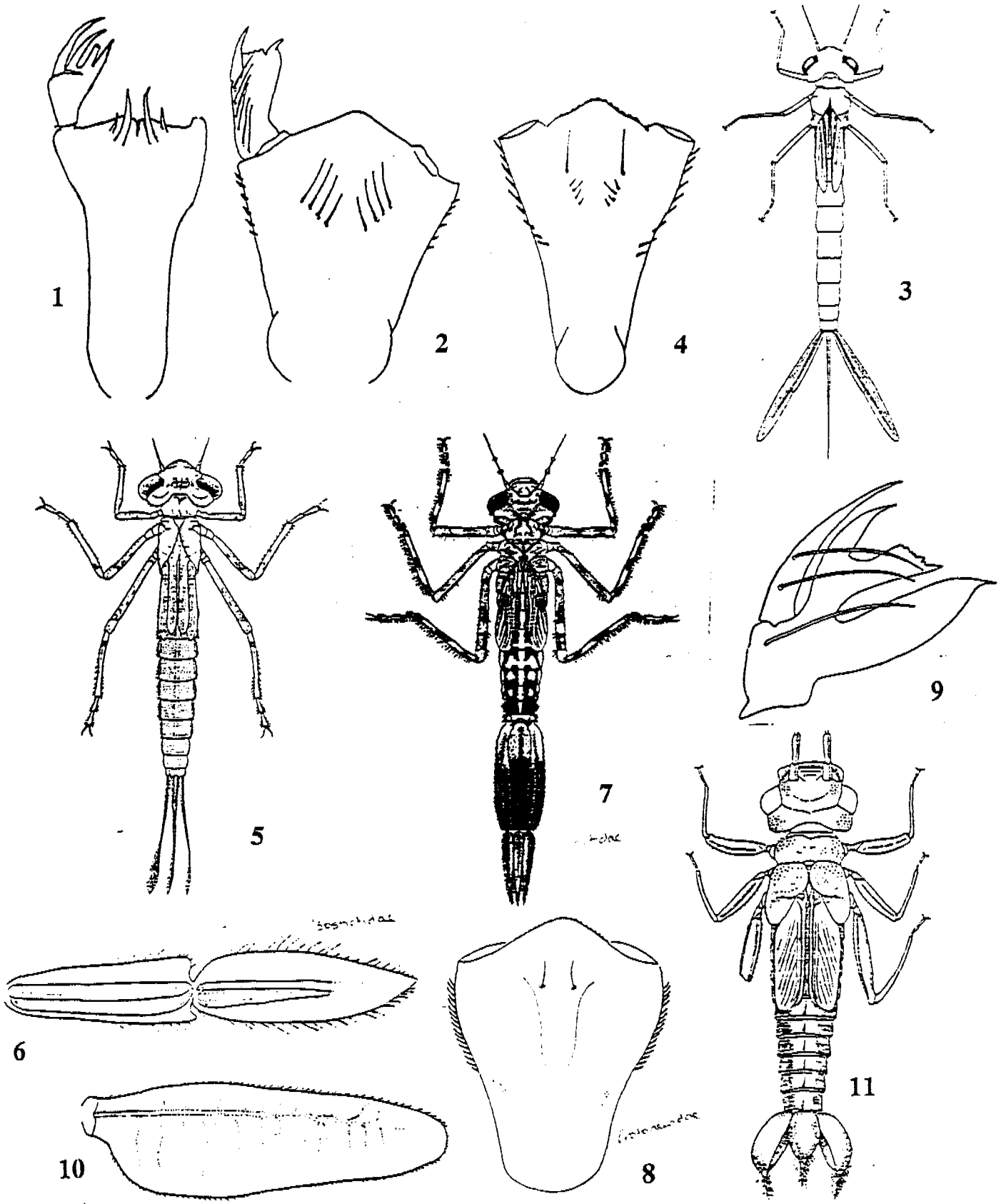



Fig. 1-11. (1) *Hemiphlebia mirabilis*, dorsal view of labium; (2) *Ischnura heterosticta*, dorsal view of labium; (3) *Caliagrion billinghursti*, dorsal view of head (From Watson & O'Farrell 1991); (4) *Pseudagrion aureofrons*, dorsal view of labium; (5) *Ischnura a. aurora*, larva; (6) *Rhadinosticta simplex*, lateral view of gill; (7) *Lithosticta macra*, larva; (8) *Nososticta solida*, dorsal view of labium; (9) *Austrolestes leda*, left labial palp; (10) *Austrolestes cingulatus*, lateral view of gill; (11) *Lestoidea conjuncta*, larva (From Fraser 1956).

## Taxonomic and biological information on the Zygopteran families

### Hemiphlebiidae

Only one species, *Hemiphlebia mirabilis*, of this primitive family has been found in Australia. The larva is very small (total length, 14mm or less) and possesses paraglossae on the median lobe of the labium (Fig. 1). **Habitat:** Swamps and backwaters of rivers. **Distribution:** Southern Victoria and northern Tasmania.

### Coenagrionidae

This mainly northern Australian family is represented by 31 species, in 13 genera. All larvae possess between 3 to 6 pairs of premental setae (Fig. 2), except *Caliagrion billinghursti* which has only one pair. It can be recognised by its large size (C. 38mm) and its conspicuous flared post ocular lobes (Fig. 3). Species of the genus *Pseudagrion* also have flared post ocular lobes, but differ in that they have subnodate gills and their premental setal arrangement is; 1 long and 3-4 very small pairs (Fig. 4). **Habitat:** Most species are found amoung vegetation in stillwaters, although species of *Ischnura* (Fig. 5) and *Pseudagrion* are also found amoungst vegetation in streams. **Distribution:** Australia wide.

### Isosticidae

This family is represented in Australia by 15 species, in 7 genera. All isosticid larvae have 2-4 pairs of premental setae (Fig. 19) and nodate gills. The larvae can have flat (Fig. 6) or saccoid gills (Fig. 7). **Habitat:** Streams and rivers. **Distribution:** Vic, NSW, Qld, NT & north WA.

### Protoneuridae

The 11 known species of Protoneuridae all belong to the genus *Nososticta*. All protoneuid larvae have 1 pair of premental setae (Fig. 8) and denodate gills. **Habitat:** Streams and rivers. **Distribution:** All states, except Tas.

### Lestidae

This family is represented in Australia by 14 species, in 3 genera. Lestid larvae have setae on the movable hook of the palp (Fig. 9) and flat gills, with the gill tracheoles at right angles to the mid tracheal vein (Fig. 10). **Habitat:** Standing waters, pools in temporary streams. **Distribution:** Australia wide.

### Lestoideidae

This family is represented in Australia by 2 species, in the genus *Lestoidea*. Distinguishing features of the species are the gills being only a quarter the length of the totallength of the body (Fig. 11) and the outer margin of the labial palp with a basal tuft of long setae. **Habitat:** Rainforest streams. **Distribution:** North-east Qld.

### Megapodagrionidae

This family is represented in Australia by 22 species, in 3 genera. Most of the larvae of this family have not been associated with their respective adults and presently only the larvae of 6 species can be distinguished. The known larvae all have flat, leaf-like, gills, which are held horizontally (Fig. 12, 13). Some species such as *Argioleste minimus*, from Western Australia, has long filaments on the distal end of the gill (Fig. 13). **Habitat:** Streams and boggy seepages. **Distribution:** All states, except Tas and SA.

### Synlestidae

This family is represented in Australia by 9 species, in 3 genera. The synlestid larvae are distinguished by the absence of palpal setae (Fig. 14) and premental setae, small caudal gills and long antennae (Fig. 15). A key and descriptions of the larvae of the 9 species are provided by Theischinger *et al.* (1993). **Habitat:** Streams and rivers. **Distribution:** Eastern Australia; Victoria to North Queensland.

**Amphipterygidae**

Six species of amphipterygid are recorded and belong to the genus *Diphlebia*. The larvae are distinguished by their large saccoid gills (without a node) (Fig. 16), long gills (half as long as the total length of the body) and outer border of labial palp with a row of short stout setae. **Habitat:** Streams and rivers. **Distribution:** Vic, NSW & Qld.

**Chlorocyphidae**

This family is represented in Australia by a single species, *Rhinocypha tincta semitincta*, which was recorded as adults from Cape York, late last century (Watson *et al.* 1991). The most distinguishing feature of the larva is the median gill which is reduced to a short spine (Fig. 18). **Habitat:** Streams and rivers. **Distribution:** South-western Pacific (Watson *et al.* 1991).

**Calopterygidae**

As with the previous family only one species, *Neurobasis australis*, has been recorded as adults from Cape York. The larva is recognised by its median gill being short and lamellate whereas the lateral gills are triangular in cross-section (Fig. 17). **Habitat:** Streams and rivers. **Distribution:** New Guinea

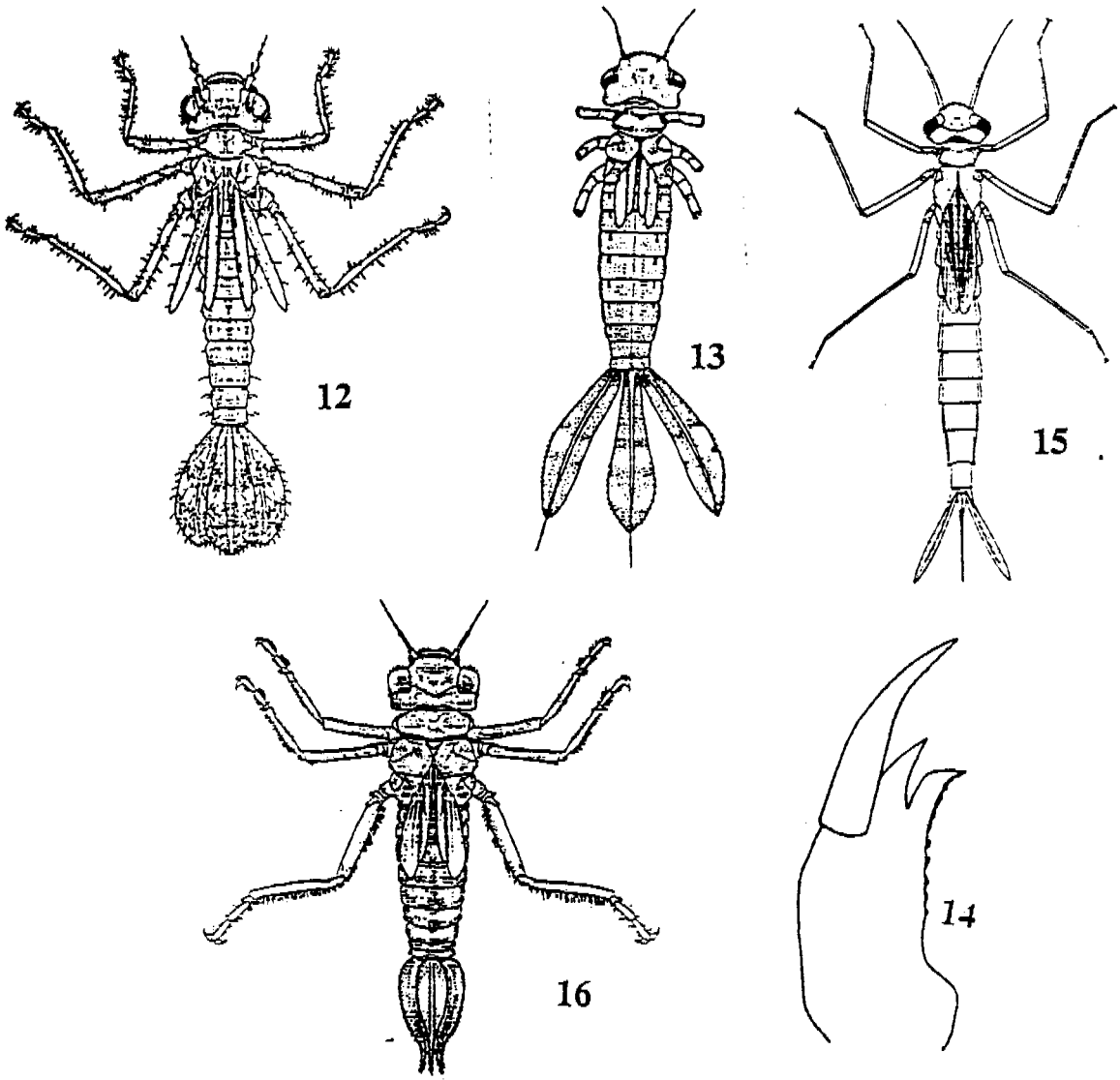



Fig. 12-16. (12) *Austroargiolestes icteromelas*, larva; (13) *Argiolestes minimus*, larva (From Watson 1962); (14) *Synlestes w. tillyardi*, left labial palp; (15) *Synlestes w. weyersi*, larva (From Watson & O'Farrell 1991); (16) *Diphlebia euphaeoides*, larva.

Key* to the late stage larvae of the families and some subfamilies of Anisoptera

1. Labium flat or nearly so, lying below head when closed; prementum without setae (Fig. 22) ..... 2
- Labium deeply concave, ladle-shaped, labial palps much broadened, forming mask in front of head when closed; prementum bearing large setae (Fig. 23) ..... 5

2(1) Antennae four-segmented (Fig. 25), usually flattened; fore tarsi two-segmented ..... **Gomphidae**
- Antennae six- or seven-segmented (Fig. 24); tarsi of all legs three-segmented ..... 3

3(2) Labial palp with small spine at base of movable hook ..... **Petaluridae**
- No spine at base of movable hook ..... 4

4(3) Abdominal segments with broad, rounded to triangular lateral lobes, lacking on seg. 9 (Fig. 26) ..... **Neopetaliidae**
- Some abdominal segments, including seg. 9, with sharp lateral spines (Fig. 21) ..... **Aeshnidae**

5(1) Wing sheaths diverging, so that apical ends are wide apart ..... **Corduliidae : Synthemistinae**
- Wing sheaths lying parallel to one another, tips close together (but in cast larval skins they may appear divergent) ..... 6

6(5) Distal border of labial palp toothed, the teeth lacking spines (Fig. 27) ..... **some Corduliidae : Gomphomacromiinae**
- Distal border of labial palp toothed, the teeth with spines (Fig. 28) ..... 7
- Distal border of labial palp without teeth, but vestigial teeth sites with spines (Fig. 29) ..... **some Libellulidae**

7(6) Anal pyramid short; cerci much more than half length of epiproct, sometimes almost as long ..... **Corduliidae**
Anal pyramid well-developed, or cerci approximately half length of epiproct ..... **Libellulidae**

* Sections of the key modified from Watson & O'Farrell (1991).

## Taxonomic and biological information on the Anisopteran families

**Aeshnidae**

This family is represented in Australia by 45 species, in 15 genera. The larvae are resdily identified by their elongated form (Fig. 21). Other distinguishing features are: the absence of premental setae (Fig. 22); tarsi of all legs three-segmented; some abdominal segments, including 9, with sharp lateral spines. **Habitat:** Occur in all microhabitats in standing and flowing water. **Distribution:** Australia wide.

**Gomphidae**

This family is represented in Australia by 38 species, in 6 genera. The major features that distinguish the larvae are: the flattened labium, lying below head when closed; absence of premental setae; four-segmented antennae, usually flattened (Fig. 25); two-segmented fore tarsi. **Habitat:** Rivers and streams, and pools in temporary streams. **Distribution:** Australia wide.

**Neopetaliidae**

This family is represented in Australia by one genera of two species, *Archipetalia auriculata* (larva figured by Allbrook 1979) and *Austropetalia patricia*. The larvae have hard exoskeletons and appear as primitive animals. The major features that distinguish the larvae are: the flattened labium, lying below head when closed; absence of premental setae; tarsi of all legs three-segmented; Abdominal segments with broad, rounded to triangular lateral lobes, lacking on 9 (Fig. 26). **Habitat:** *A. auriculata* streams, boggy seepages; *A. patricia*, splash zones of waterfalls and stream margins. **Distribution:** *A.. auriculata*, Tas; *A. patricia*, Vic & eastern NSW (Watson *et al.* 1991).

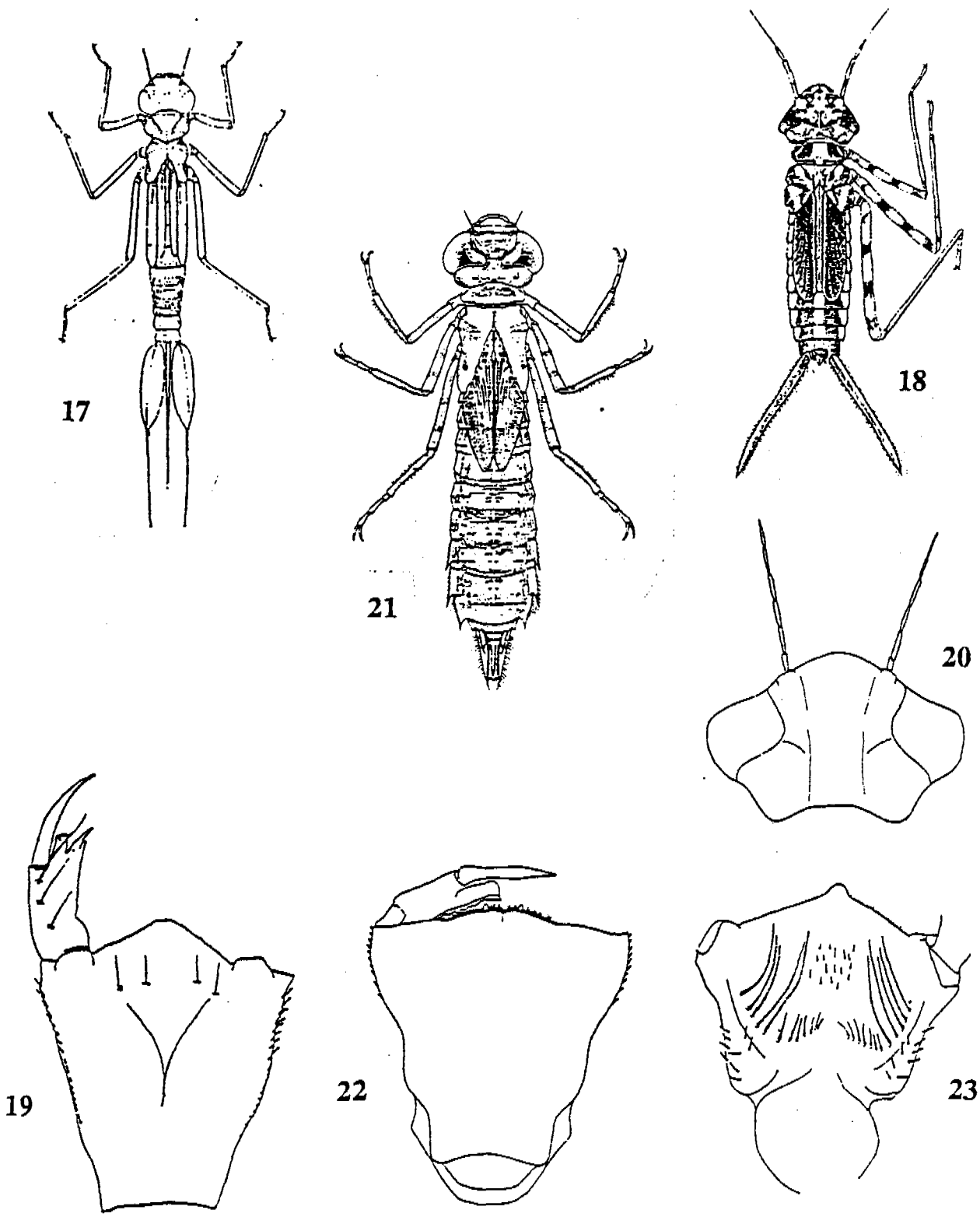



Fig. 17-23. ; (17) *Drepanosticta sudana*, larva (From Lieftinck 1962); (18) *Rhinocypha fenestrata* larva, (From Lieftinck 1962); (19) *Eurysticta kununurra*, labium; (20) *Nosostcta solida*, head (21) *Hemianax papuensis*, larva; (22) *Austroaeschna atrata*, labium; (23) *Eusynthemis brevistyla*, labium.

**Petaluridae**

This family is represented in Australia by 4 species, in the genus *Petalura*. The major features that distinguish the larvae are: labium flat or nearly so, lying below head when closed; prementum without setae; antennae seven-segmented; tarsi of all legs three-segmented; segments 4-7 of antennae stout; median lobe of prementum sharply triangular. Watson (1962) figures the larva of *Petalura hesperia* and Tillyard (1909) the larva of *P. gigantea*. **Habitat:** The larvae live in burrows opening above water level in boggy seepages and swamps as well as in margins of rainforests streams (Watson et al. 1991). **Distribution:** South W.A. & eastern Australia.

**Corduliidae**

This family is represented in Australia by 53 species, in 18 genera. The major features that distinguish the larvae are: deeply concave, ladle-shaped, labium (Fig 17); labial palps much broadened, forming mask in front of head when closed; prementum bearing large setae; palps with dentations/teeth on the distal margin, the teeth with setae, except in the subfamily Synthemistinae and two species of the subfamily Gomphomacromiinae. **Habitat:** Occur in most microhabitats in standing and flowing water. **Distribution:** Australia wide.

**Libellulidae**

This family is represented in Australia by 55 species, in 26 genera. The major features that distinguish the larvae are: deeply concave, ladle-shaped, labium; labial palps much broadened, forming mask in front of head when closed; prementum bearing large setae; papal teeth absent in most species. Unfortunately about 10 species have teeth and these can be confused with species of Corduliidae. In the species that have teeth, the anal pyramids are long while cerci are usually less than half as long as the paraprocts. In the north Australia, species of *Agrionoptera*, *Pantala*, *Trapezostigma* and *Urothemis* are exceptional in that they have long cerci. **Habitat:** Most libellulids only occur only in standing waters, whereas species of the genera *Diplacodes* and *Orthetrum* (Fig. 32) occur in both in standing waters and streams. In contrast, species of *Nannophlebia* (Fig. 28) only occur in rivers and streams. **Distribution:** Australia wide.

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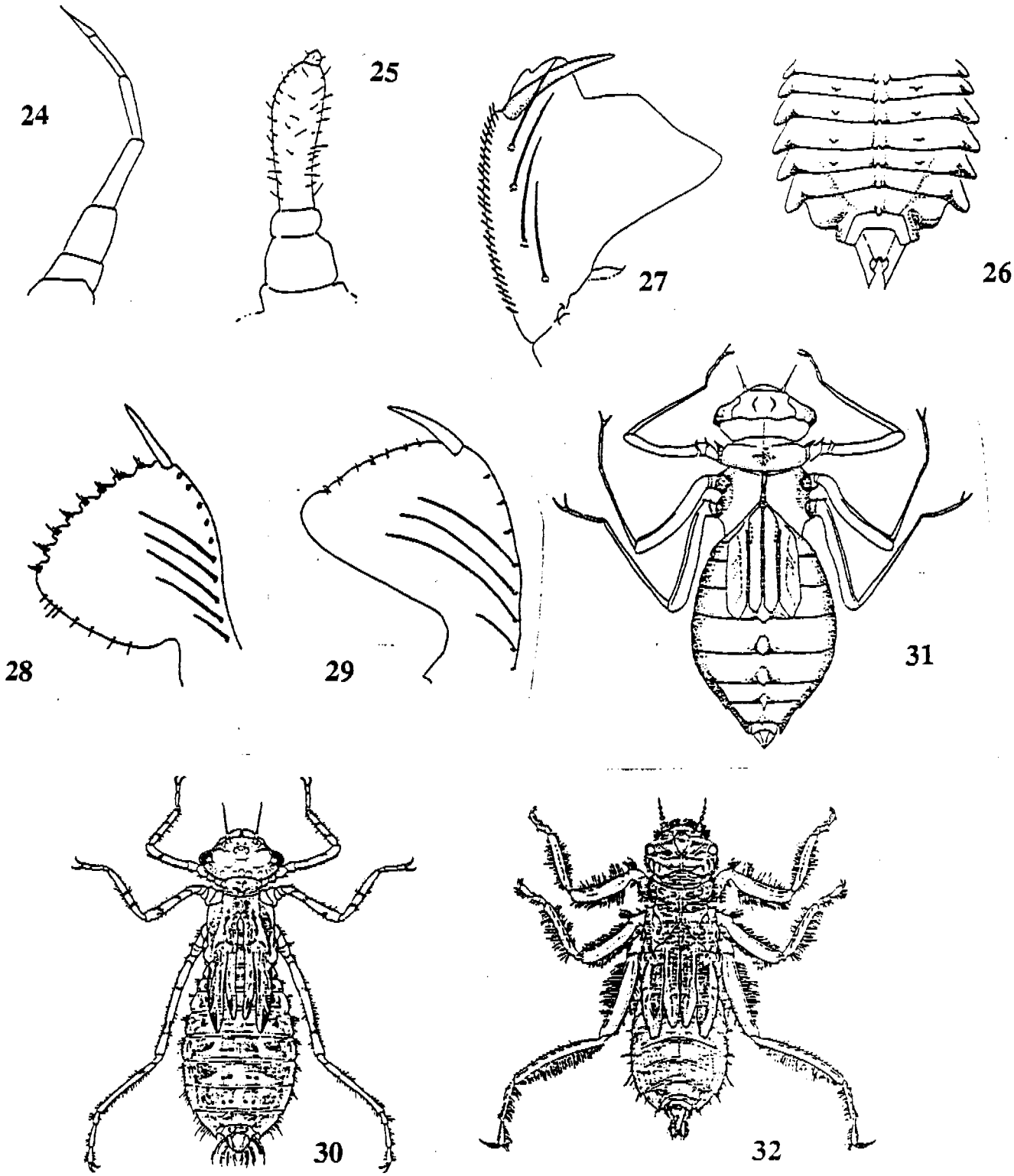


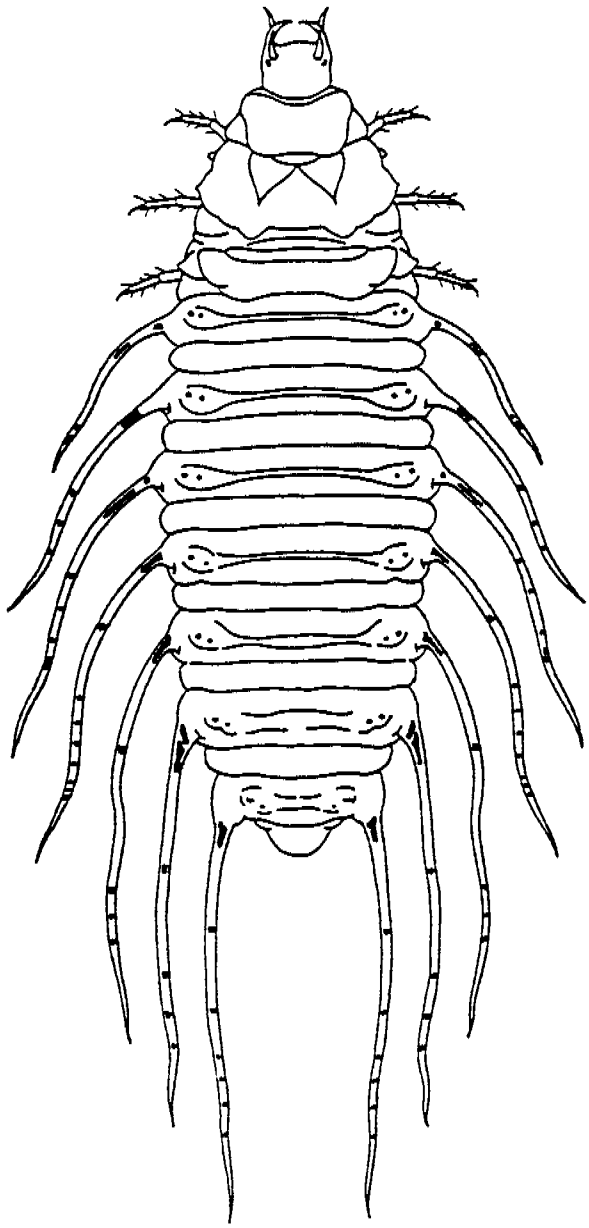

Fig. 24-32. (24) *Spinaeschna tripunctata*, antenna; (25) *Austrogomphus australis*, antenna; (26) *Austropetalia patricia*, dorsal abdomen; (27) *Archaeophya magnifica*, left labial palp (From Theischinger & Watson 1984); (28) *Nannophlebia risi*, right labial palp; (29) *Orthetrum caledonicum*, labial palp; (30) *Hemicordulia tau*, larva; (31) *Nannophlebia risi* , larva; (32) *Orthetrum caledonicum*, larva.

# ODONATA NOTES

CHAPTER 5

# KEY TO THE FAMILIES OF COLEOPTERA,

# (ADULTS AND LARVAE), WITH AQUATIC STAGES



Dr J. F. Lawrence
Australian National Insect Collection
CSIRO, Division of Entomology

# COLEOPTERA NOTES

## AUSTRALIAN AQUATIC COLEOPTERA (ADULTS)

1(0). Prothorax with pair of notopleural sutures (distinct from sharp lateral margins) separating notum from externally visible pleuron on each side (pleura may or may not be separated from sternum by additional pair of pleurosternal sutures) (Fig. 1); abdomen with ventrite 1 divided into 2 or 3 parts by hind coxae (Figs 6, 49, 53); tarsi always 5-segmented, antennae never with a 3-segmented club, and length always greater than 1 mm. ..... 2

Prothorax without notopleural sutures, ventral portion of the notum (hypomeron) on each side joined directly to the sternum by notosternal suture and pleuron reduced and concealed (Fig. 2–4), except in *Microsporus*, where tarsi are 3-segmented, the antennae have 3-segmented club and length is less than 1 mm (Fig. 31); ventrite 1 not divided by hind coxae (Fig. 7). ..... 7

2(1). Metacoxae not extending laterally to meet elytra, so that junction of metepimeron and first ventrite is usually visible (Fig. 6); antennae largely pubescent; fore tibia notched, forming antenna cleaner (Fig. 36); dorsal surfaces with well-developed, erect, sensory setae at fixed positions (Fig. 36); mesocoxal cavities distinctly closed laterally by meeting of mesosternum and metasternum (Fig. 8). ..... CARABIDAE

Metacoxae extending laterally to meet elytra, so that junction of metepimera and first ventrite is not visible (Figs 49, 53); antennae entirely or almost entirely glabrous; fore tibia without antenna cleaner; dorsal surfaces rarely with erect, fixed sensory setae; mesocoxal cavities open laterally (partly closed by mesepimeron) (Figs 5, 49, 53). ..... 3

3(2). Metacoxae with very large plates concealing basal ventrites and most of the hind femora (Fig. 38); metasternum with distinct transverse suture; elytra with large punctures forming regular rows (Fig. 37). ..... (*Haliplus*) HALIPLIDAE

Metacoxal plates absent or consisting of narrow mesal portion only, not concealing basal ventrites or femora (Fig. 49, 53); if metasternal suture present, then elytra without regular puncture rows. ..... 4

4(3). Metasternum with transverse suture (Fig. 49); head more exserted, eyes protuberant and well separated from anterior edge of prothorax (Fig. 48); metacoxae relatively small, their lateral portions shorter than metasternum (Fig. 49). ..... (*Hygrobia*) HYGROBIIDAE

Metasternum without transverse suture; head less exserted, eyes not protuberant and usually in contact with anterior edge of pronotum (Figs 52, 53); metacoxae much larger, their lateral portions longer than metasternum (Fig. 53). ..... 5

5(4). Eyes completely divided into dorsal and ventral portions (Fig. 44); antennae very short and thick, with less than 11 segments, the first of which is very large (Figs 43, 44); elytra truncate exposing most of one abdominal tergite (Fig. 43); front legs long and raptorial, middle and hind legs short and paddle-like (Fig. 43). ..... GYRINIDAE

Eyes not completely divided; antennae longer, 11-segmented, without enlarged 1st segment (Figs 52, 57); elytra concealing abdominal tergites; front legs not long and raptorial, middle and hind legs longer and narrower (Figs 53, 57). ..... 6

6(5). Dorsal surface strongly convex; scutellum not visible (Fig. 52); ventral surface flattened; metacoxae with characteristic longitudinal plates covering bases of trochanters (Fig. 53); junction between metasternum and metacoxae angulate in middle (Fig. 53). ..... NOTERIDAE

Dorsal surface hardly more convex than ventral surface; scutellum usually visible (Fig. 57);

metacoxae without plates; junction of metasternum and metacoxae arcuate. .....
..... DYTISCIDAE

7(1). Abdomen with only 3 ventrites; antennae with a distinct, 3-segmented club; body minute (less than 1 mm long) (Fig. 31). ..... (*Microsporus*) MICROSPORIDAE
Abdomen with more than 3 ventrites (Fig. 7). ..... 8

8(7). Head without elongate rostrum. ..... 9
Head with rostrum which is longer than it is broad (Figs 147, 148). ..... 24

9(8). Elytra exposing less than 2 complete abdominal tergites; body less than 4 times as long as wide. ..... 10
Elytra exposing more than 4 complete abdominal tergites (Figs 99, 101); body narrowly elongate, more than 4 times as long as wide. ..... STAPHYLINIDAE

10(9). Antennae 11-segmented, without distinct club (sometimes gradually clavate) (Figs 106, 115, 121, 128, 129, 136, 142)). ..... 11
Antennae with less than 11 segments and with distinct club consisting of from 1 to 7 segments (Figs 69, 76, 83–85). ..... 18

11(10). Tarsi with penultimate segment strongly lobed and densely setose below, excavate above, terminal segment arising from its base (Fig. 108); head with paired genal ridges beneath, which fit against edges of procoxae (Fig. 106); tibiae each with 2 fine longitudinal carinae; without connate ventrites. ..... SCIRTIDAE
Tarsi with penultimate segment highly reduced, segment preceding it strongly bilobed and densely setose below (Fig. 141); head without paired genal ridges; tibiae without longitudinal carinae; abdomen without connate ventrites. ..... 12
Tarsi simple, without lobed segments, penultimate segment not much shorter than segment preceding it (Figs 115, 121, 128,129, 134, 136); head without paired genal ridges; tibiae without longitudinal carinae; abdomen with at least 3 connate ventrites. ..... 13

12(11). Lateral pronotal carinae complete and sharply defined (Fig. 4); protrochantins at least partly exposed (Fig. 137); procoxal cavities externally open, moderately to widely separated (by more than 0.4 times coxal width). ..... (Alticini) CHRYSOMELIDAE
Lateral pronotal carinae incomplete absent (Fig. 3; protrochantins completely concealed or apparently absent; procoxal cavities externally closed and narrowly separated (by less than 0.4 times coxal width). ..... (*Donacia*) CHRYSOMELIDAE

13(11). Posterior edge of pronotum simple, not distinctly crenulate (Figs 115, 121, 128, 129); frontoclypeal suture distinct (Fig. 116); mesocoxal cavities moderately to widely separated (by more than 0.4 times coxal width). ..... 14
Posterior edge of pronotum distinctly crenulate (Fig. 134, 136, 137); frontoclypeal suture absent or indistinct; mesocoxal cavities narrowly separated (by less than 0.4 times coxal width). ..... 17

14(13). Lateral pronotal carinae complete and sharply defined (Fig. 4); outer edge of middle tibia simple; tarsi 5-segmented. ..... 15
Lateral pronotal carinae absent (Fig. 115); outer edge of middle tibia bearing spines or teeth along most of its length (Figs 115, 117); tarsi 4-segmented. .....
..... (*Heterocerus*) HETEROCERIDAE

15(14). Protrochantins at least partly exposed (Fig. 137); antennae distinctly pubescent with segments 7–10 ovate, serrate or transverse (Figs 121, 122, 128); upper surfaces almost always densely pubescent (Figs 121, 128). ..... 16

Protrochantins completely concealed or apparently absent (Fig. 2); antennae glabrous with segments 7–10 parallel-sided and distinctly longer than wide (Fig. 129); upper surfaces subglabrous or with hairs sparsely distributed (Fig. 129). ..... (Elminae) ELMIDAE

16(15). Head hypognathous and strongly retracted, antennae and mouthparts usually concealed by prosternum, which is produced forward (Figs 121, 123); antennae slender, segment 1 only slightly longer than 2 and 7–10 usually longer than wide, widest at middle and narrowed at either end (Figs 121, 122); body ovate, usually less than 2 times as long as wide, pronotal and elytral bases equal in width and closely joined, forming an unbroken lateral outline (Fig. 121). ..... LIMNICHIDAE

Head less strongly declined and only slightly retracted, antennae and mouthparts always visible and prosternum not or only slightly produced forward; antennae moderately stout, segment 1 more than 2 times as long as 2 and 7–10 transverse or occasionally serrate (Fig. 128); body more than 2 times as long as wide, base of prothorax distinctly narrower than combined elytral bases, so that lateral outline is broken (Fig. 128). ..... ..... (Larinae) ELMIDAE

17(13). Prosternum in front of coxae as long as or shorter than intercoxal process (Fig. 137); body more than 1.5 times as long as wide (Fig. 136); intercoxal process on ventrite 1 acute. ..... (*Byrrocryptus*) PTILODACTYLIDAE

Prosternum in front of coxae much longer than intercoxal process; body very short and broad, less than 1.5 times as long as wide (Fig. 134); intercoxal process on ventrite 1 narrowly rounded. ..... (*Sclerocyphon*) PSEPHENIDAE

18(10). Prosternum completely concealed by enlarged, contiguous procoxae (which are fused with trochanters) and strongly declined head (Fig. 69); mid and hind coxae very widely separated, the distance between them greater than a coxal width; minute (less than 1.5 mm), dull, with pronotal tubercles and elytral carinae (Fig. 68). ..... ..... (*Georissus*) HYDROPHILIDAE

Prosternum more or less visible in front of coxae, which are not fused with trochanters; mid and hind coxae usually subcontiguous or narrowly separated, never separated by more than a coxal width; without other characters in combination. ..... 19

19(18). Antennae 9-segmented with 5-segmented club (Figs 91–94) ..... 20

Antennae 7- to 9-segmented with 3- or 4-segmented club (Figs 75, 76, 80, 82–85). ..... 22

20(19). Procoxal cavities externally closed; maxillary palp much longer than head (Fig. 91). ..... ..... (*Hydraena*) HYDRAENIDAE

Procoxal cavities externally open; maxillary palp shorter than head. ..... 21

21(20). Elytra apunctate or with confused punctation (Fig. 92); preapical segment of maxillary palp as long as or shorter than and about as wide as apical segment; mesocoxal cavities moderately to widely separated, by more than 0.4 times coxal width; antennal club compact. ..... (*Limnebius*) HYDRAENIDAE

Elytra with distinct puncture rows (Fig. 93); preapical segment of maxillary palp longer than and distinctly wider than apical segment; mesocoxal cavities narrowly separated, by less than 0.4 times coxal width; antennal club loose. .... (Ochthebiinae) HYDRAENIDAE

22(19). Antennae 7-segmented with 4-segmented, asymmetrical club preceded by minute glabrous cupule (Fig. 76); body ovate, less than 2 times as long as wide, and highly convex, upper surfaces dull and clothed with short, erect bristles (Fig. 75). ..... (*Spercheus*) HYDROPHILIDAE

Antennae 7- to 9-segmented with 3-segmented club preceded by well-developed glabrous cupule (Figs 82–85); if body ovate, then upper surfaces smooth, shiny and glabrous (Fig. 82). ..... 23

23(22). Mesocoxal cavities distinctly closed laterally by meeting of mesosternum and metasternum (Fig. 8); body elongate, more than 2 times as long as wide; upper surfaces more or less granulate and dull (Fig. 80). ..... (*Hydrochus*) HYDROPHILIDAE

Mesocoxal cavities open laterally (partly closed by mesepimeron) (Fig. 5); body ovate, less than 2 times as long as wide; upper surfaces smooth, shiny and glabrous (Figs 82). ..... (major part) HYDROPHILIDAE

24(8). Antennal insertions concealed from above by projections of frons (Fig. 147); intercoxal process on ventrite 1 broadly rounded; antennal club loose (Fig. 147). ..... (*Nanophyes*) BRENTIDAE

Antennal insertions exposed from above (Fig. 148); intercoxal process on ventrite 1 truncate; antennal club compact (Fig. 148). ..... (Erirhininae) CURCULIONIDAE

## AUSTRALIAN AQUATIC COLEOPTERA (LARVAE)

1(0). Labrum separated from head capsule by complete suture (Figs 13, 97, 102). ..... 2
Labrum completely fused to head capsule (suture absent) (Figs 35, 40, 77, 104). ..... 12

2(1). Mandibular mola absent (Figs 16–19). ..... 3
Mandibular mola present (Figs 14, 15). ..... 10

3(2). Legs 4-segmented (Fig. 28); spiracles on segment 8 forming pair of projecting spines (Fig. 145); body lightly sclerotised and clothed with fine hairs (Fig. 143). .....
..... (*Donacia*) CHRYSOMELIDAE
Legs 5-segmented, including pretarsus (claw) (Fig. 27, 146). ..... 4
Legs absent (Figs 149, 152). ..... 9

4(3). Abdominal apex without hinged operculum or anal gill tufts (sometimes short anal papillae present, Fig. 139). ..... 5
Abdominal apex with ventrally hinged operculum concealing 3 extrusible tufts of fine, slender gills (Figs 131–133). ..... 8

5(4). Median endocarina absent or not extending anterad of epicranial stem (Figs 97, 119, 125); head prognathous or slightly declined (Figs 95, 118, 124); antennae more than half as long as head width (Fig. 138) or stemmata 6 on each side (Figs 119, 124). ..... 6
Median endocarina moderately to very long, extending anterad of epicranial stem (Fig. 13); head moderately to strongly declined (hypognathous) (Figs 9, 146); antennae minute (less than 0.1 times as long as head width) and 2-segmented (Fig. 146); stemmata on each side 1. ..... (Alticini) CHRYSOMELIDAE

6(5). Maxillary palp 3-segmented (Fig. 23); tergum 9 with articulated urogomphi (Fig. 29, 102); apex of antennal segment 2 oblique, so that sensorium arises proximad of segment 3 (Fig. 12); spiracles annular (Fig. 20). ..... (Oxytelinae) STAPHYLINIDAE
Maxillary palp 4-segmented (Fig. 126); tergum 9 without articulated urogomphi; apex of antennal segment 2 truncate, so that sensorium and segment 3 arise together (Fig. 11); spiracles biforous, with 2 parallel openings and an ecdysial scar (Fig. 21). ..... 7

7(6). Postmentum not divided longitudinally (Fig. 126; mesal surface of mandibular base simple or slightly expanded (Fig. 18); maxillary articulating area absent and cardines closely contiguous, not separated by labium (Fig. 126); epicranial stem present (Fig. 125); antennae less than half as long as head width; with 6 well separated stemmata on each side (Figs 124, 125). ..... LIMNICHIDAE
Postmentum divided longitudinally into 3 parts (Fig. 22); mesal surface of mandibular base with brush of hairs or spines (Fig. 17); maxillary articulating area present but more or less concealed behind expanded postmentum, cardines separated from each other by labium (Fig. 22); epicranial stem absent; antennae more than half as long as head width (Fig. 138); stemmata closely clustered, sometimes fused into a single mass (Fig. 130). Fig 139?
..... (*Byrrocryptus*) PTILODACTYLIDAE

8(4). Antennae less than half as long as head width (Fig. 130); body elongate, not broadly ovate and strongly flattened; head not concealed from above (Fig. 130). ..... ELMIDAE
Antennae more than half as long as head width; body broadly ovate, strongly flattened and disc-like (Fig. 135); head completely concealed from above by prothorax (Fig. 135). ..
..... (*Sclerocyphon*) PSEPHENIDAE

9(3). Labial palps 1-segmented (Fig. 151); spiracles not forming forming spine-like processes; tergum 3 with 2 transverse plicae (Fig. 149); frontal arms reaching mandibular articulations. ..... (*Nanophyes*) BRENTIDAE

Labial palps 2-segmented (Fig. 153); abdominal spiracles usually forming spine-like processes (Fig. 152); tergum 3 with 3 transverse plicae (Fig. 152); frontal arms not reaching mandibular articulations (ending at antennal insertions) (Fig. 150). .....
..... (Erirhininae) CURCULIONIDAE

10(2). Antennae 2-segmented; maxillary palp 2-segmented; abdominal spiracles 1–8 forming balloon-like tracheal gills (Figs 32, 33); minute larvae occurring in interstitial spaces in sand or gravel along stream edges. ..... (*Microsporus*) MICROSPORIDAE

Antennae 3-segmented; maxillary palps 3-segmented. ..... 11

Antennae with 10 or more segments (Fig. 109–111); maxillary palp 4-segmented. .....
..... SCIRTIDAE

11(10). Tergum 9 without articulated urogomphi (Fig. 118); basal portion of labium completely or almost completely connate with maxillae (Fig. 126); bases of frontal arms distinctly separated, epicranial stem absent (Fig. 119). ..... HETEROCERIDAE

Tergum 9 with articulated urogomphi (Fig. 29, 95, 96); basal portion of labium completely free or basally connate (Fig. 97, 98); with maxillae; bases of frontal arms contiguous, epicranial stem present (Fig. 97, 98). ..... HYDRAENIDAE

12(1). Abdominal tergum 8 usually subterminal, not forming spiracular siphon or spiracular chamber (Figs 29, 34, 39, 105), if more or less terminal, then segments 1–7 with lateral gills (Fig. 87). ..... 13

Abdominal tergum 8 terminal, forming tapered process, simple at apex (Fig. 50); gills arising from coxal bases and abdominal sterna 1–3 (Fig. 50). ..... (*Hygrobia*) HYGROBIIDAE

Abdominal tergum 8 terminal, forming tapered process (siphon) bearing spiracles at apex (Figs 30, 54, 58–67), without ventral gills. ..... 17

Abdominal tergum 8 subterminal, forming with segment 9 a spiracular chamber housing enlarged 8th spiracles (Figs 77, 81, 86–90). ..... 18

13(12). Legs 3-segmented (Fig. 73). ..... (*Georissus*) HYDROPHILIDAE

Legs 5-segmented, including pretarsus (claw) (Fig. 27) ..... 14

Legs 6-segmented, including pretarsus (claw or paired claws) (Figs 25, 26). ..... 15

14(13). Antennae 3-segmented, shorter than head width; maxillary palp 4-segmented, with digitiform appendage on segment 1 (Fig. 24); abdominal segments 1–7 each with pair of lateral gills (Fig. 87); tergum 9 without articulated urogomphi. ... (Berosinae) HYDROPHILIDAE

Antennae 4-segmented, longer than head width (Fig. 103–105); maxillary palp 3-segmented, without digitiform appendage on first segment (Fig. 103); abdominal segments without lateral gills; tergum 9 with articulated urogomphi (Fig. 105). .....
..... (*Stenus*) STAPHYLINIDAE

15(13). Mandible without groove or perforation (Figs 34, 35); tergum 9 bearing pair of well-developed urogomphi (Fig. 34, 35). ..... CARABIDAE

Mandible with internal perforation (Figs 42, 46); tergum 9 without paired urogomphi, sometimes with 2 pairs of gills (Fig. 47). ..... 16

16(15). Labial palps 2-segmented; antennae shorter than head width (Figs 40, 41 ); maxillary palp 3-segmented; mandibles broad at base and narrow at apex (Fig. 42); abdominal segment 10 much longer than 9, without hooks at apex (Fig. 39). . . . . (*Haliplus*) HALIPLIDAE

Labial palps 3-segmented; antennae longer than head width; maxillary palp 4-segmented; mandibles narrow and falcate (Fig. 46); abdominal segment 10 not or only slightly longer than 9, with 2 pairs of hooks at apex (Fig. 45, 46). . . . . GYRINIDAE

17(12). Antennae less than half as long as head width; head transverse and partly retracted into prothorax (Fig. 54, 55); mandible without mesal groove or internal perforation (Fig. 56); legs short and often concealed from above; body compact and fusiform; urogomphi highly reduced and usually not visible (Fig. 54). . . . . (Hydrocanthinae) NOTERIDAE

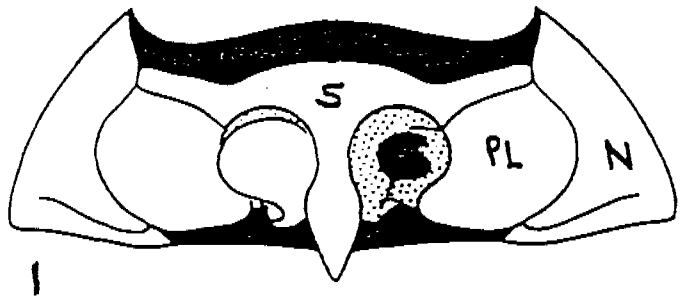
Antennae usually more than half as long as head width, often longer than head width and sometimes with more than 4 segments (Figs 58–67); head usually longer than wide, often with a distinct neck; mandible either grooved or perforate (Figs 46); legs longer and easily visible from above; urogomphi usually well-developed (Fig. 58–67). . . DYTISCIDAE

18(12). Labial palps 1-segmented; apex of mandible bidentate (Fig. 78); maxilla with distinct mala (Fig. 79); stipes wider than long; first segment of maxillary palp with large, digitiform appendage (Fig. 79); gular sutures separate; distinctive larva with large head, strongly tapered abdomen and lateral processes on first 8 abdominal segments (Fig. 77). . . . . (Spercheinae) HYDROPHILIDAE

Labial palps 2-segmented; apex of mandible unidentate; maxilla with stipes longer than wide and without mala (Fig. 24). . . . . 19

19(18). First segment of maxillary palp without digitiform appendage; mesal surface of mandibular base with pubescent lobe (Fig. 81); gular sutures separate. . . . . (*Hydrochus*) HYDROPHILIDAE

First segment of maxillary palp with digitiform appendage (Fig. 24); mesal surface of mandibular base simple or slightly expanded (Fig. 88); gular sutures fused posteriorly. . . . . (major part) HYDROPHILIDAE

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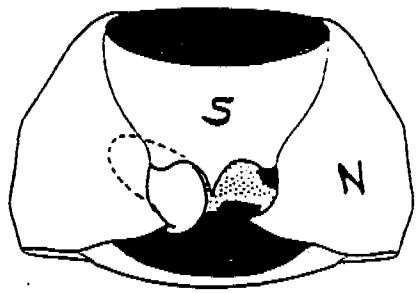


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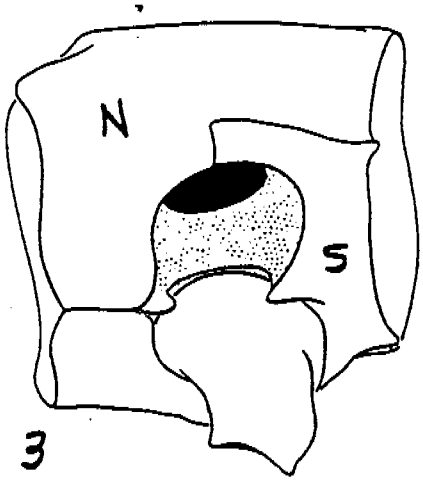


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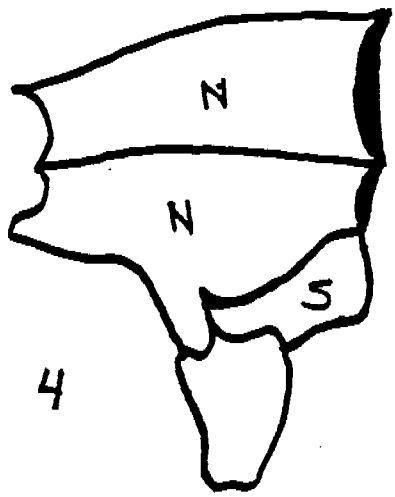


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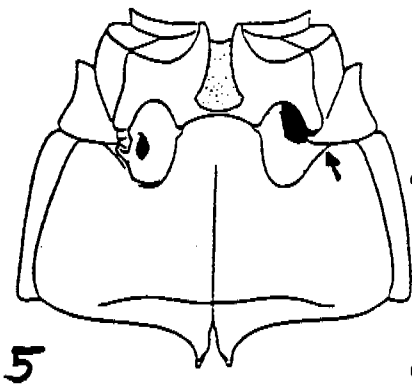

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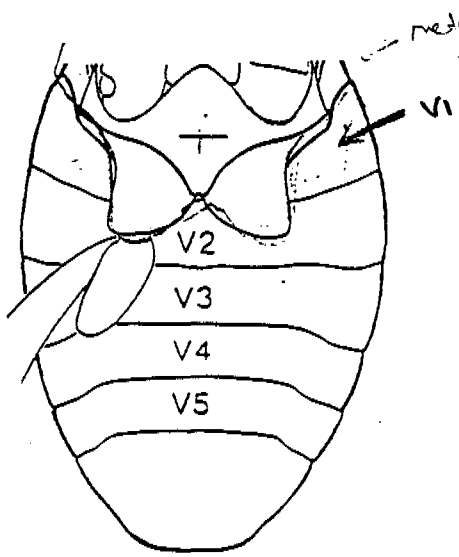


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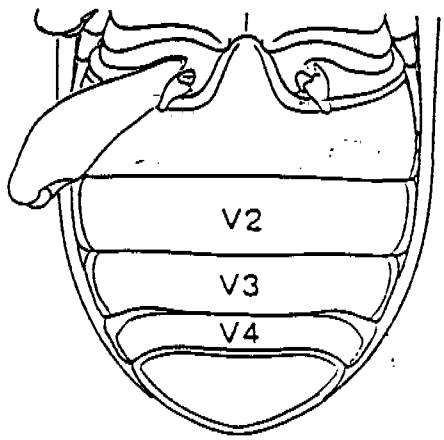


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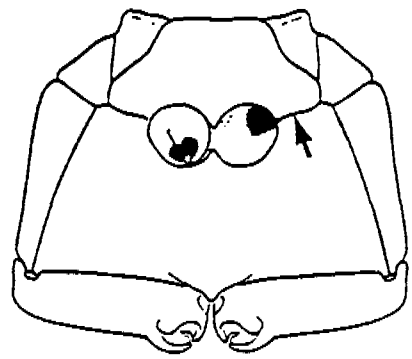

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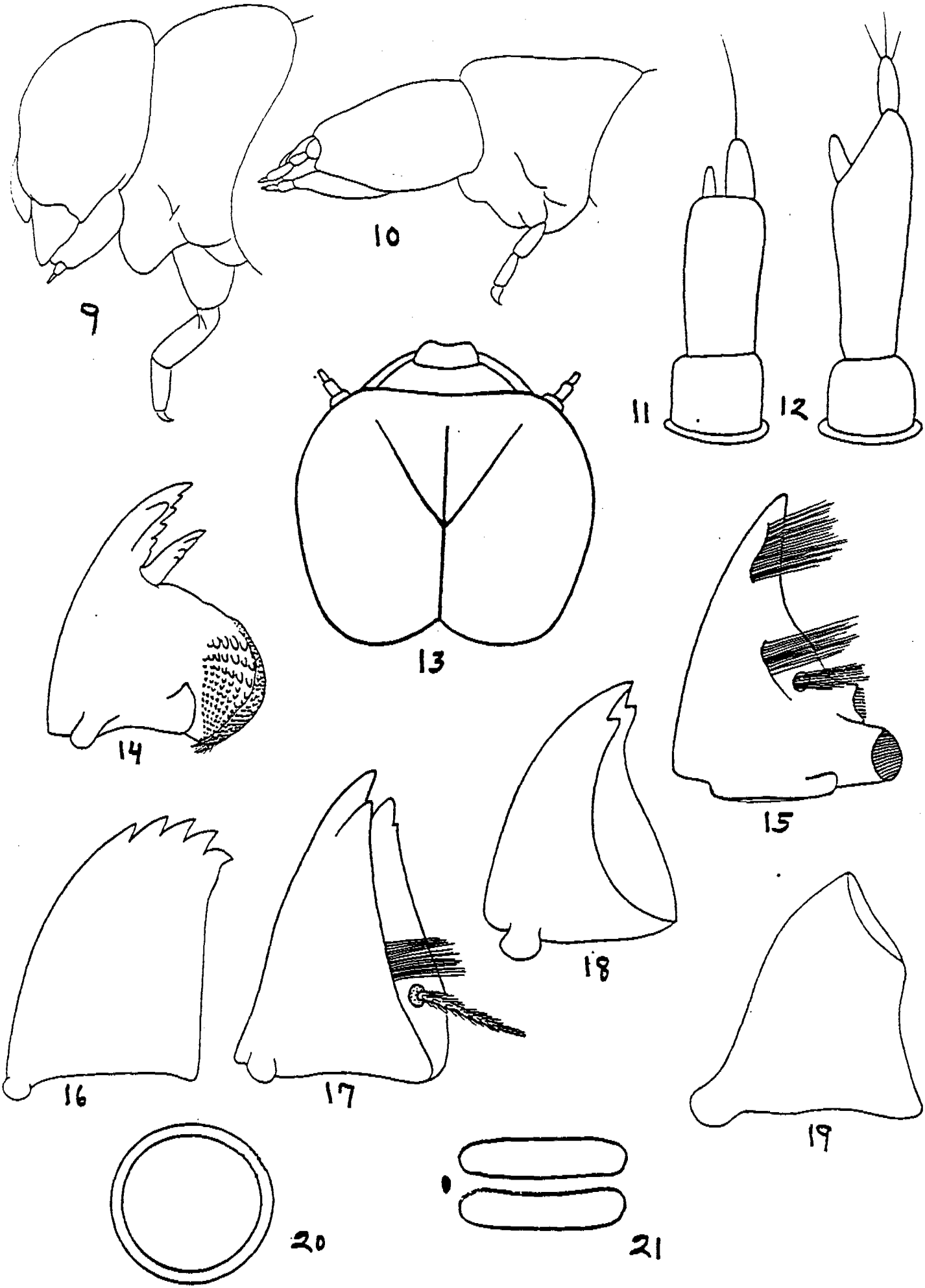
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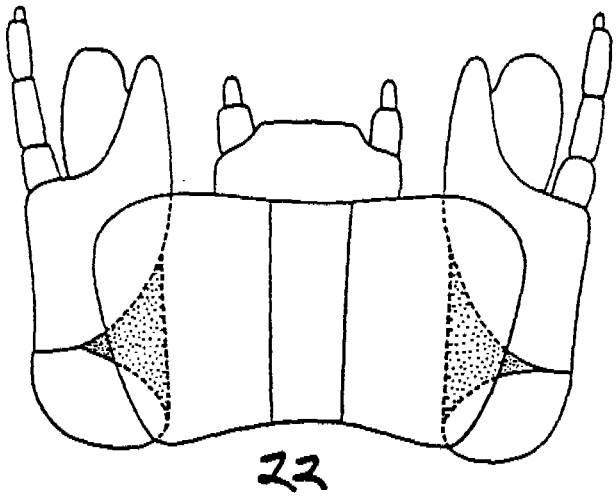

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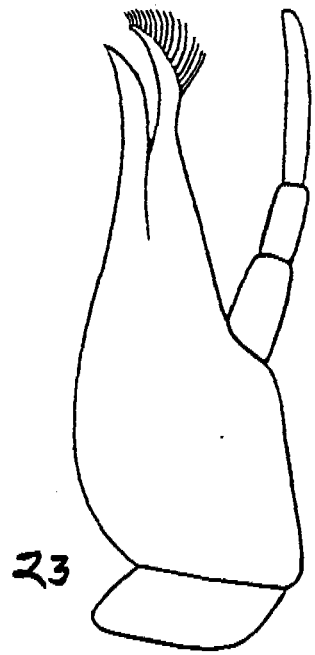

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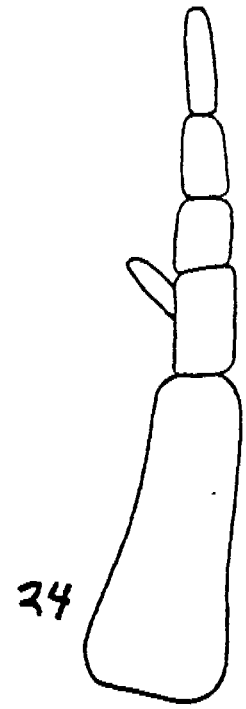

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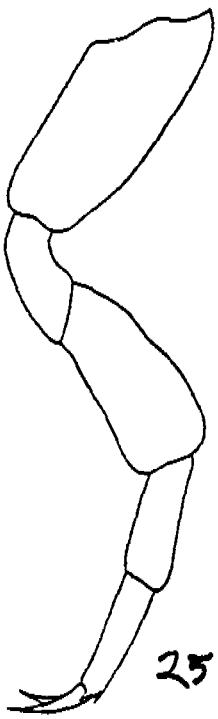

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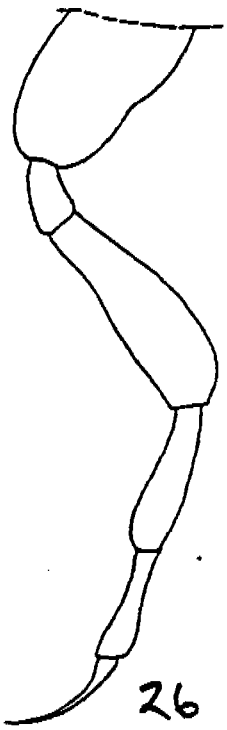

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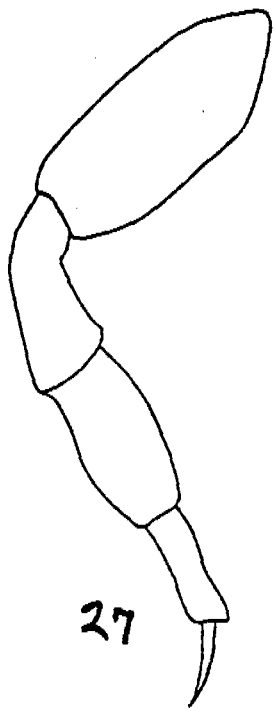

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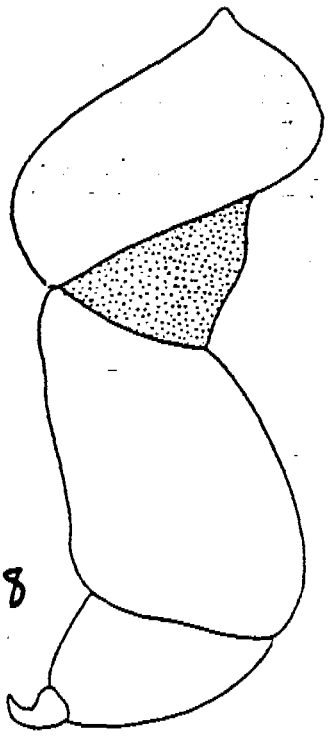

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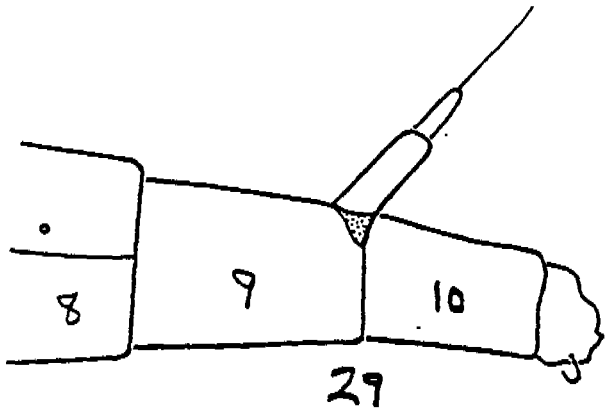


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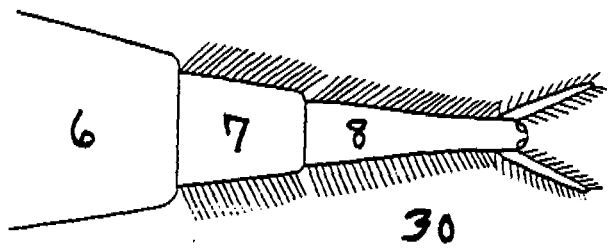


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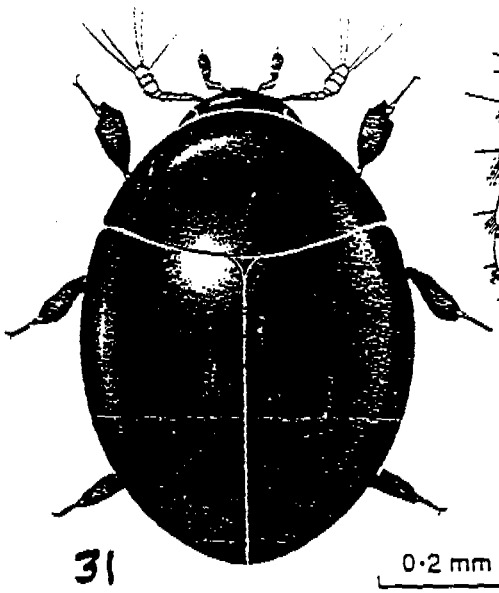

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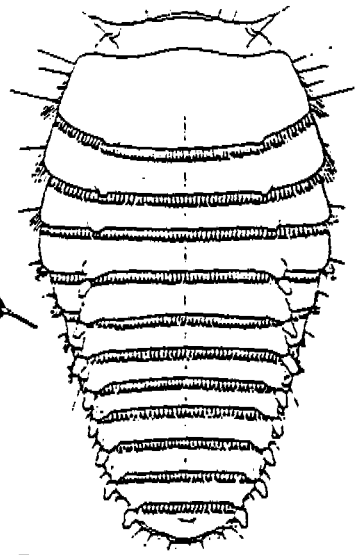

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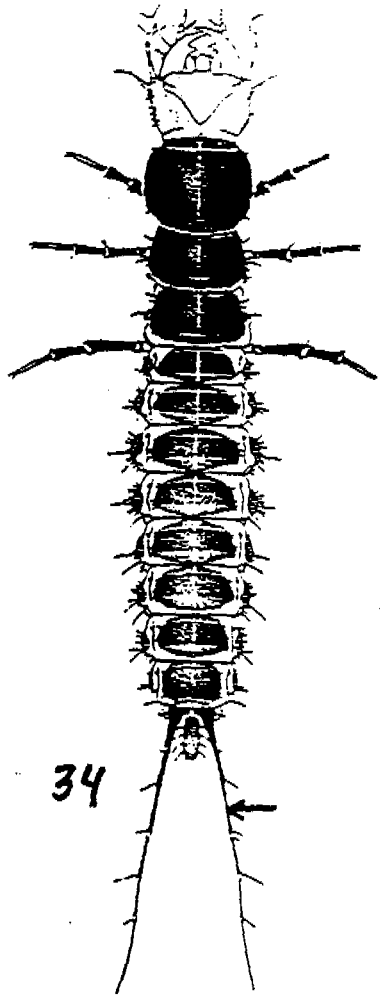

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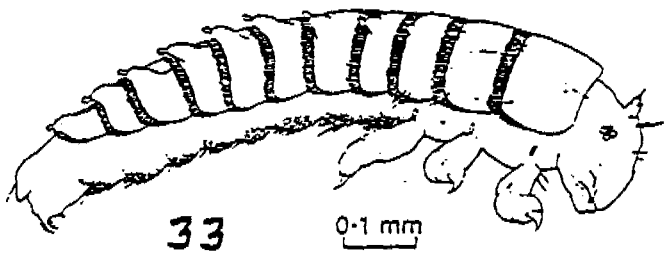

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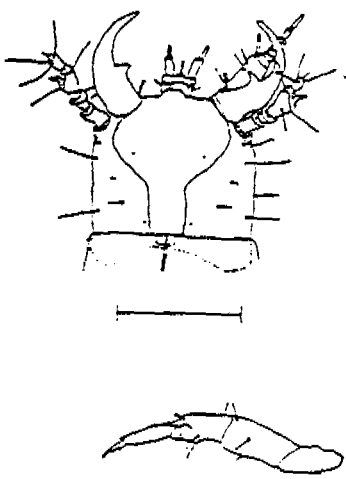

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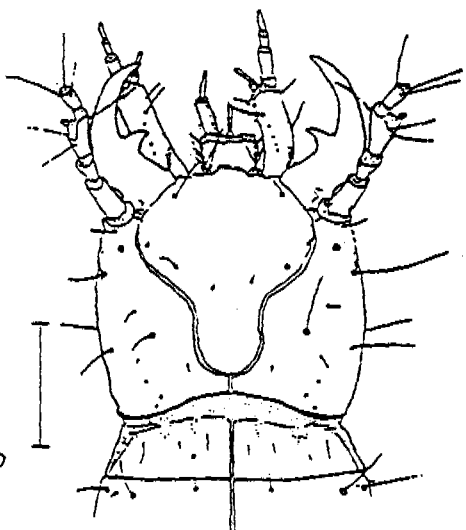

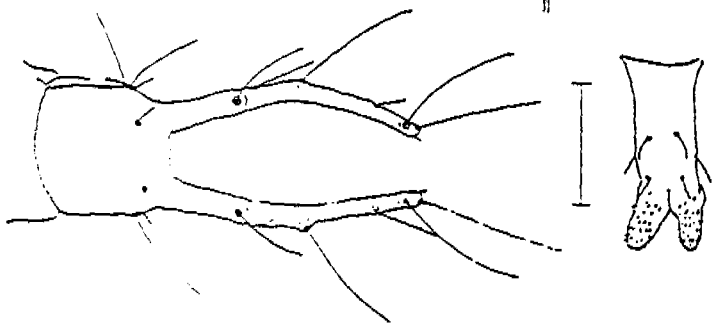

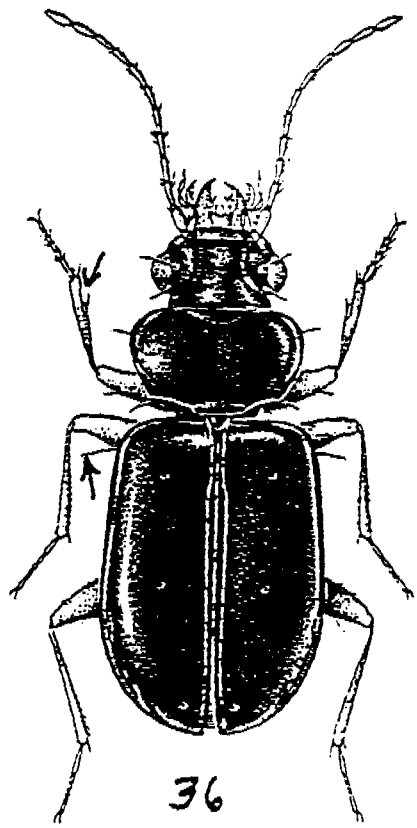

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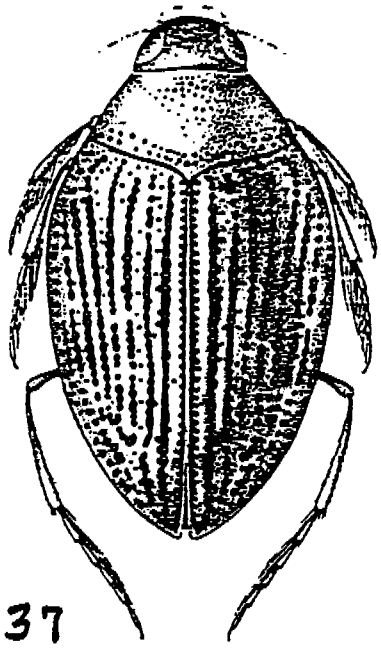

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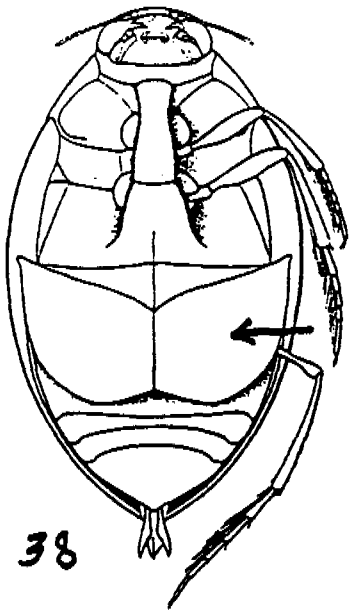

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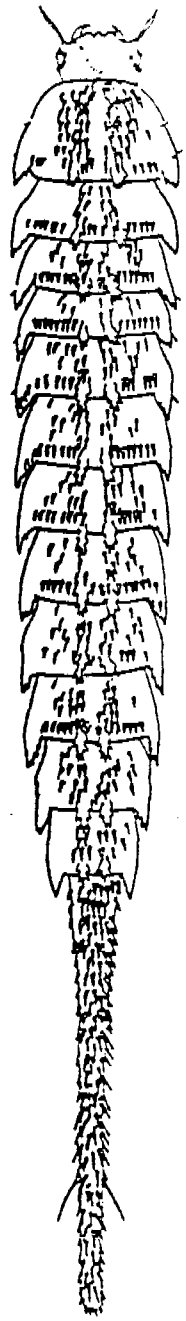

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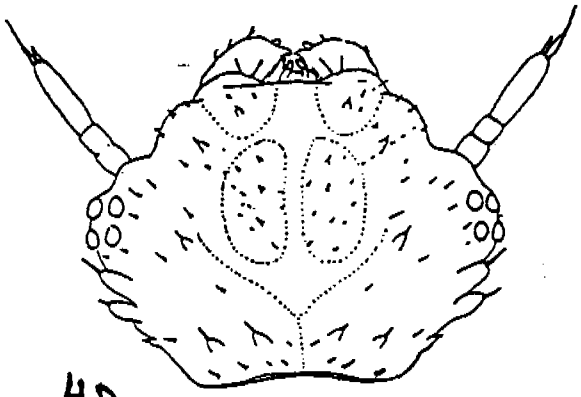

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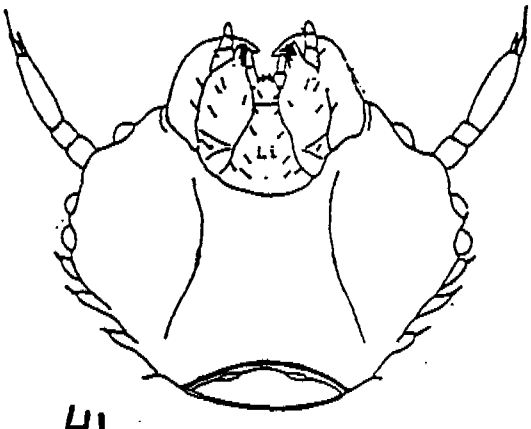

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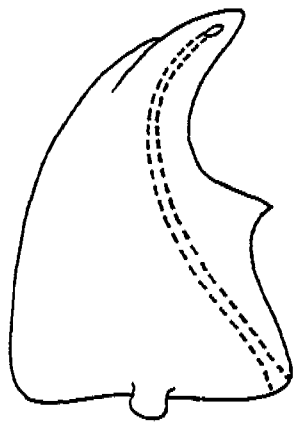

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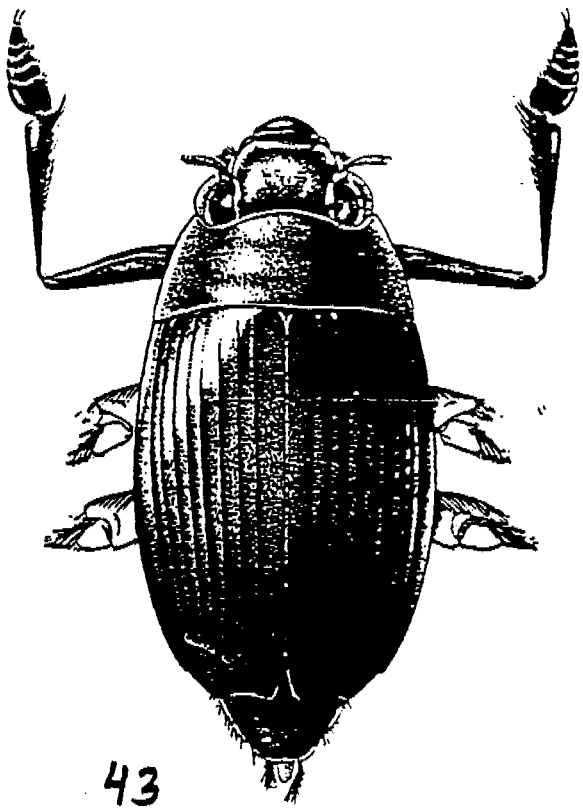

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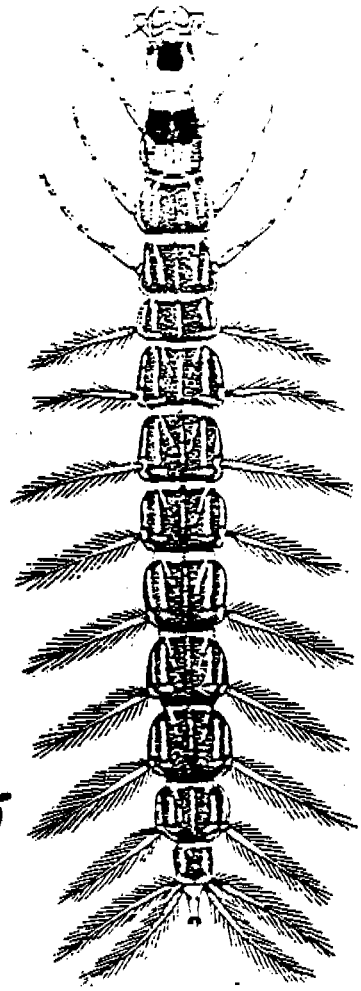

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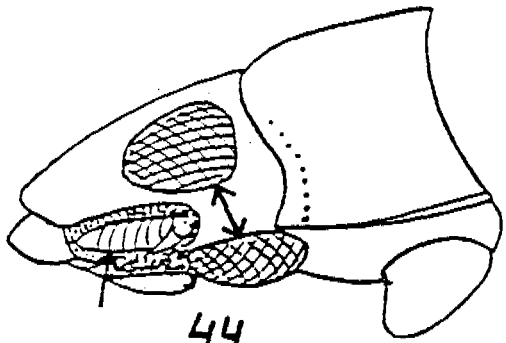

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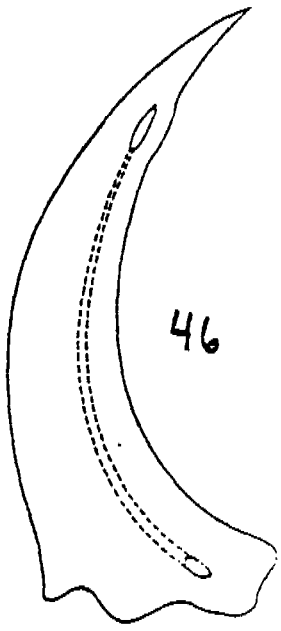

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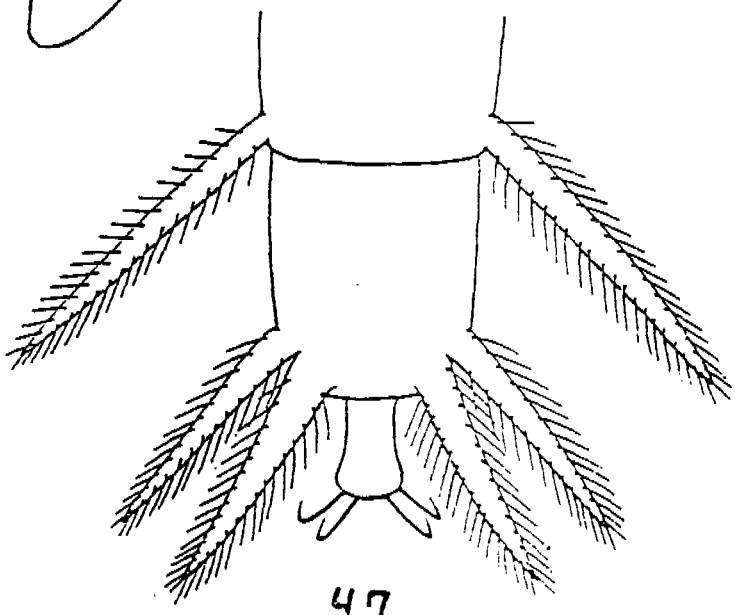

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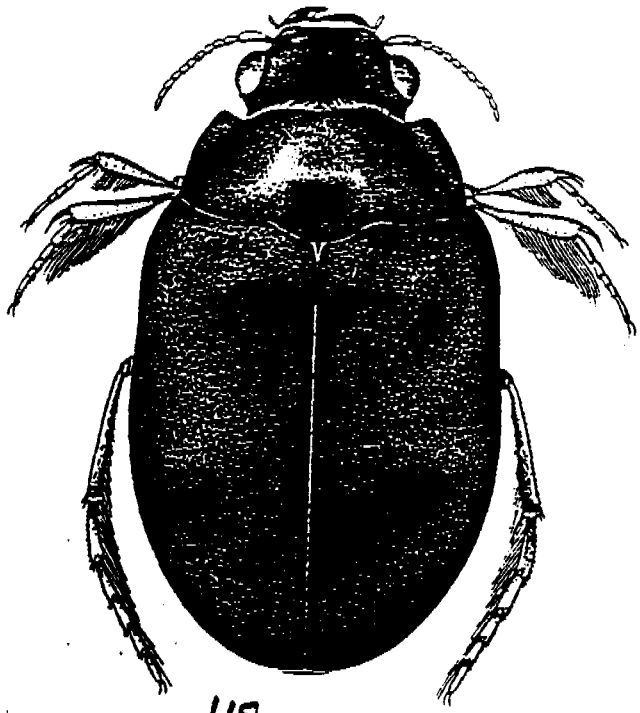

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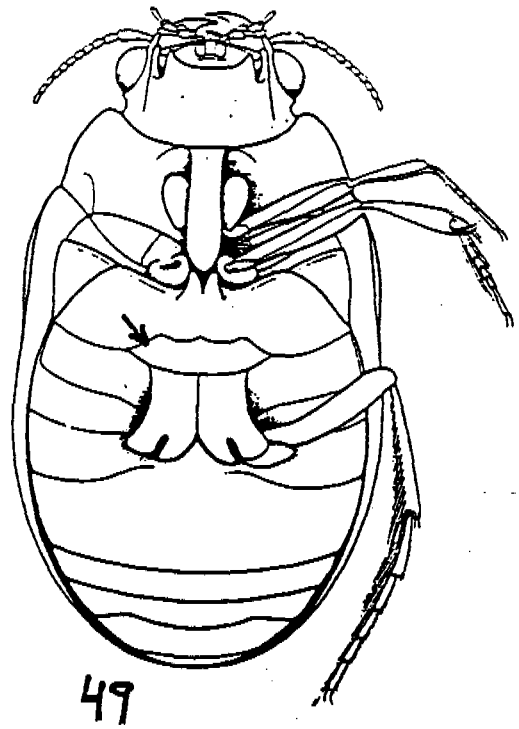

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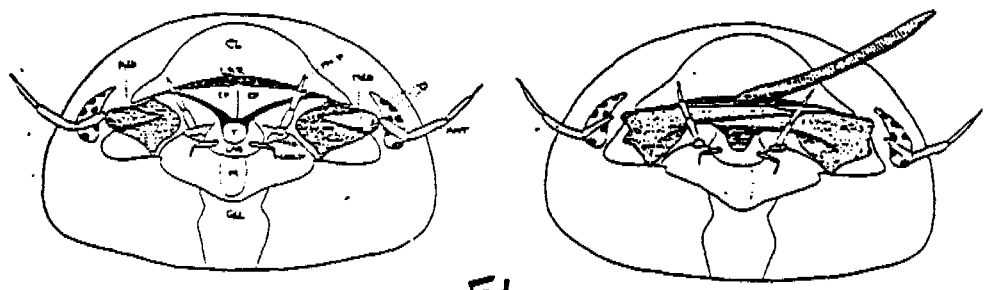

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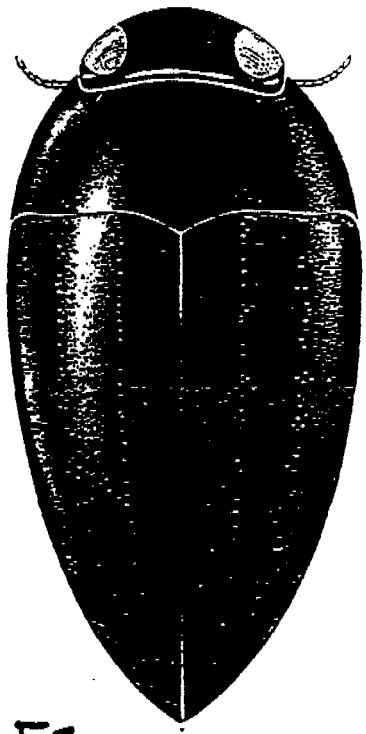

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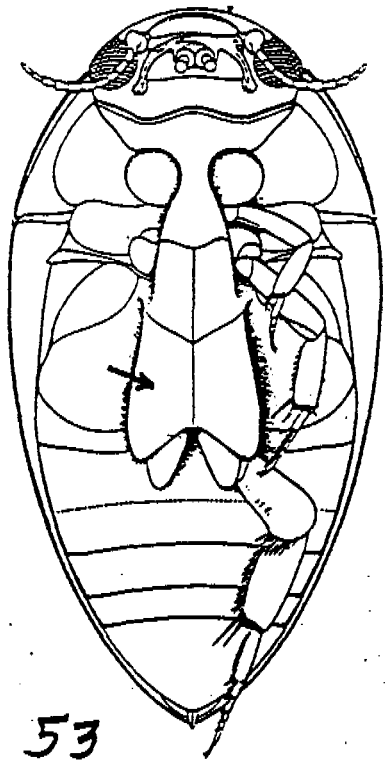

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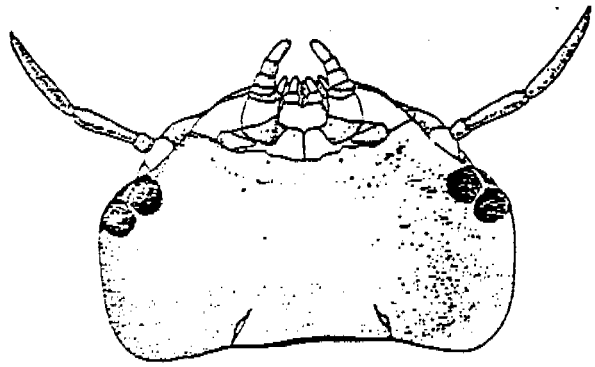

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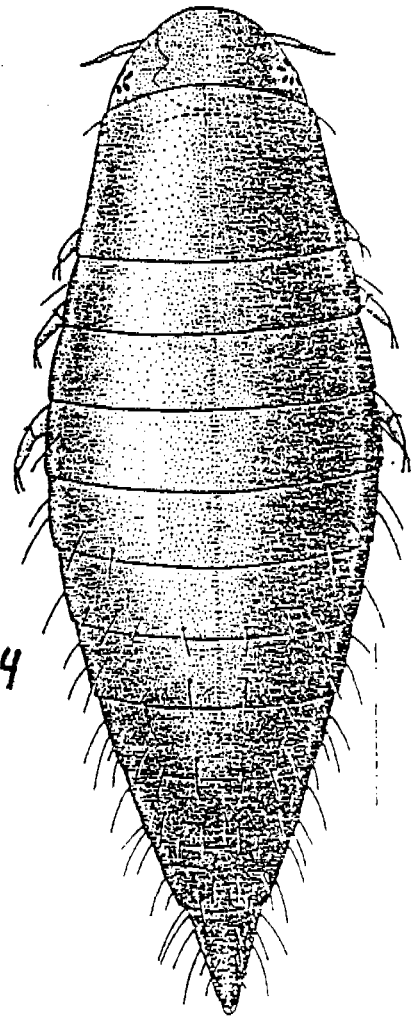

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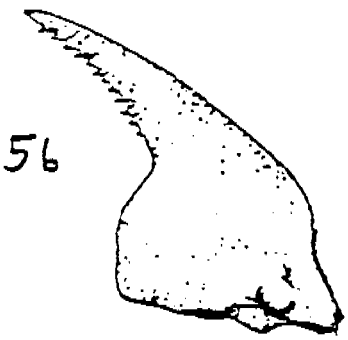

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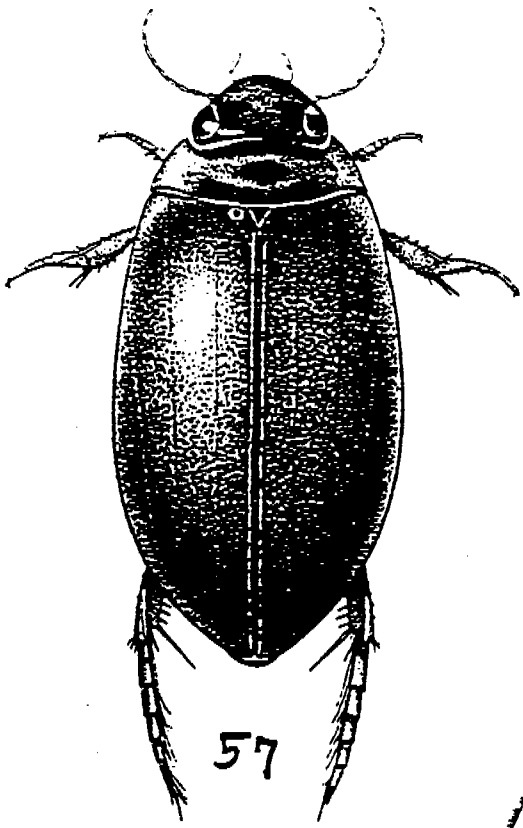

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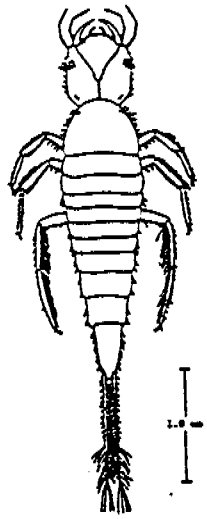

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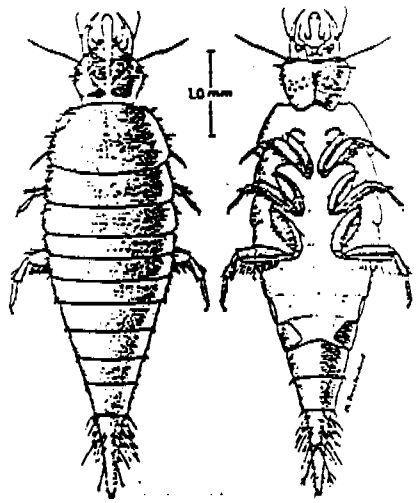

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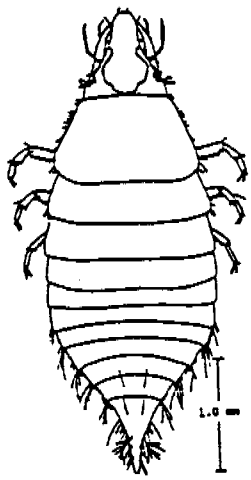

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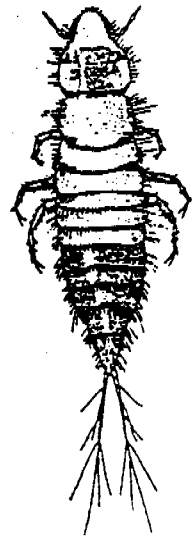

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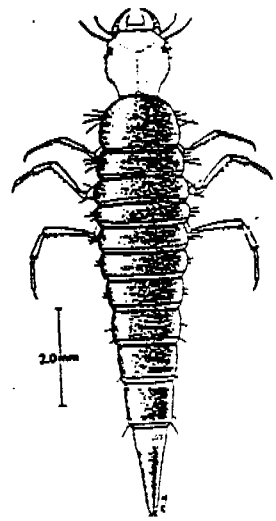

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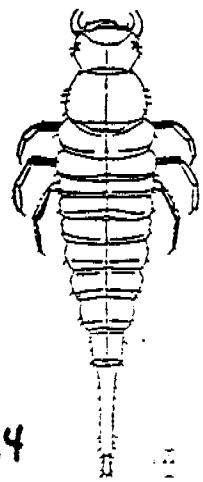

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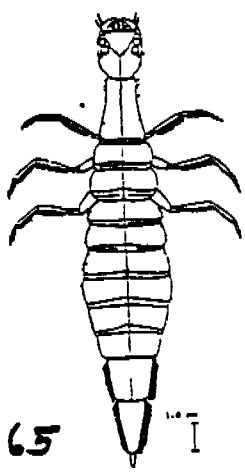

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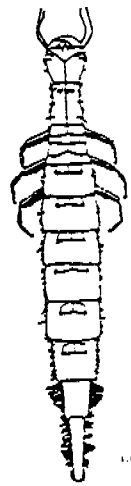

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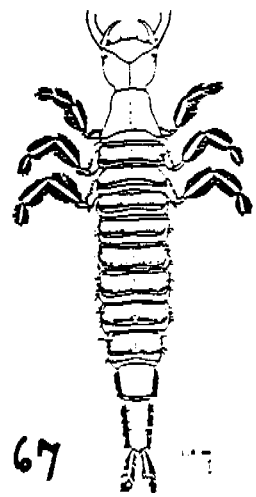

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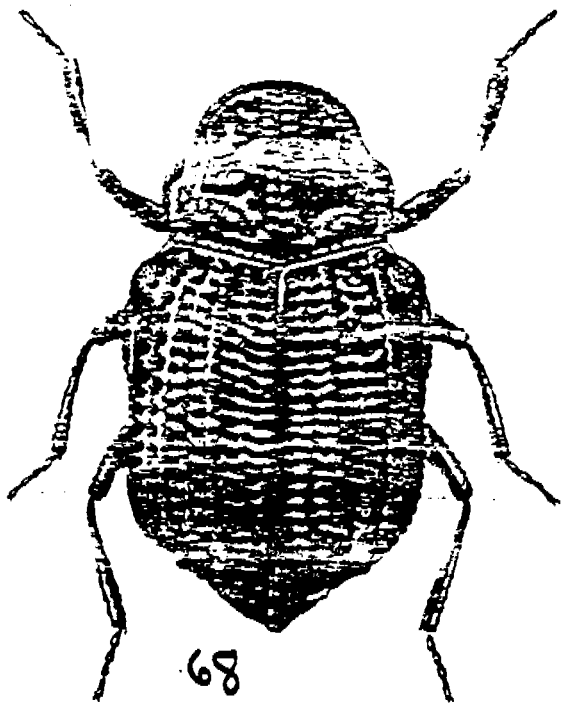

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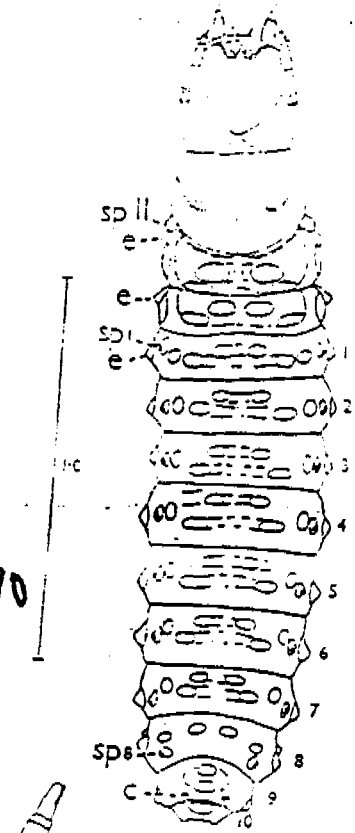


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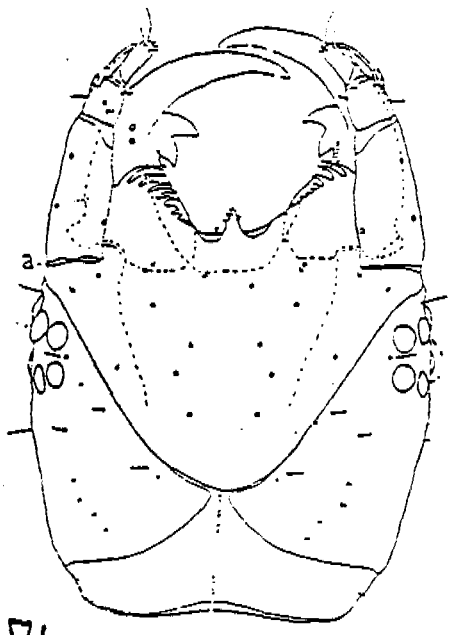


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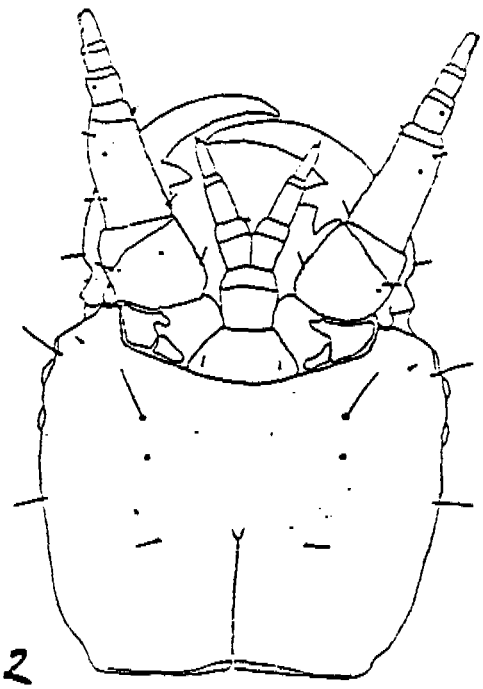

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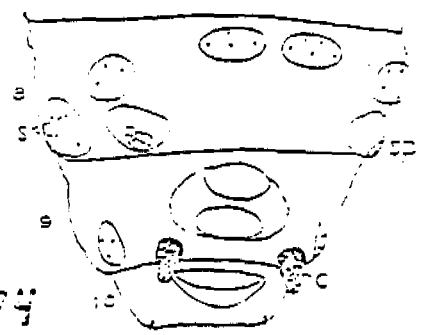


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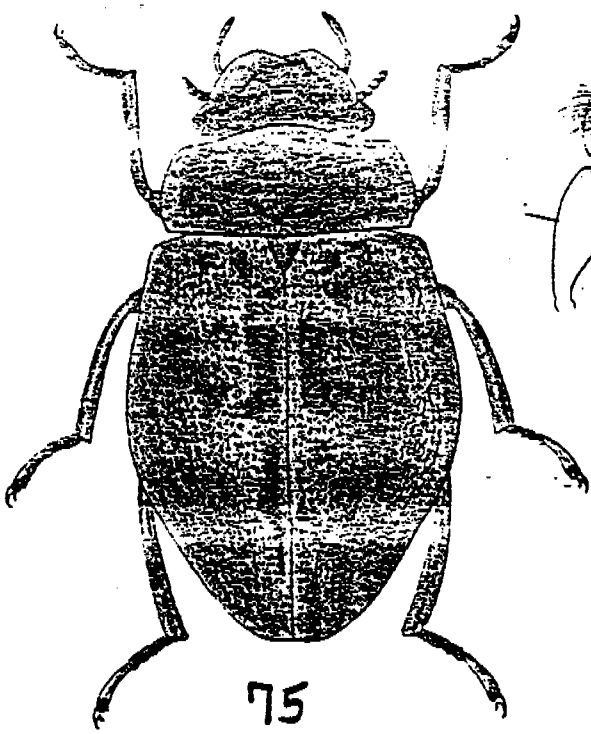

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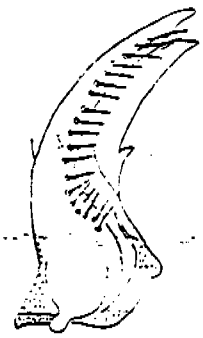

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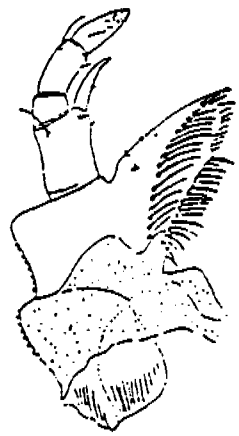

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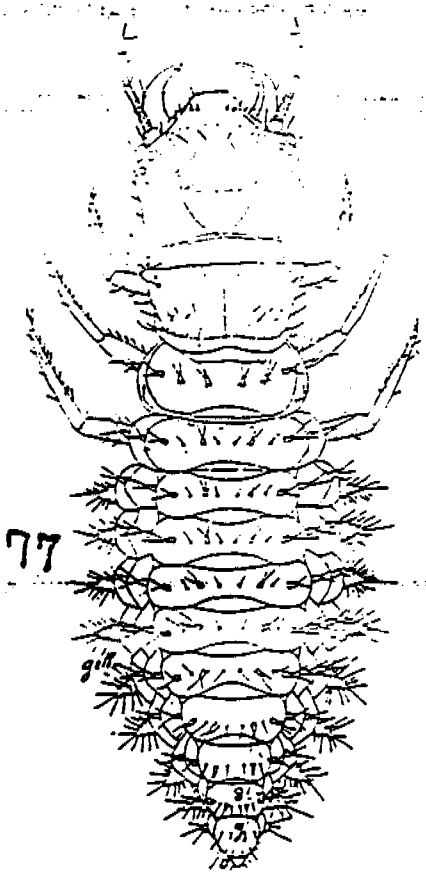

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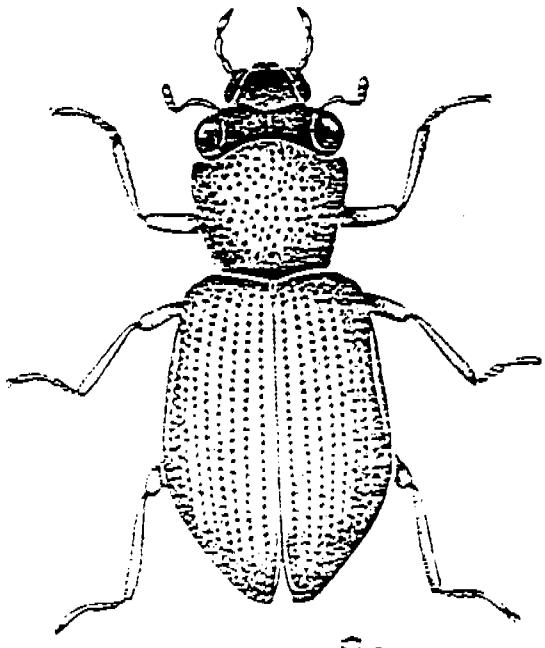

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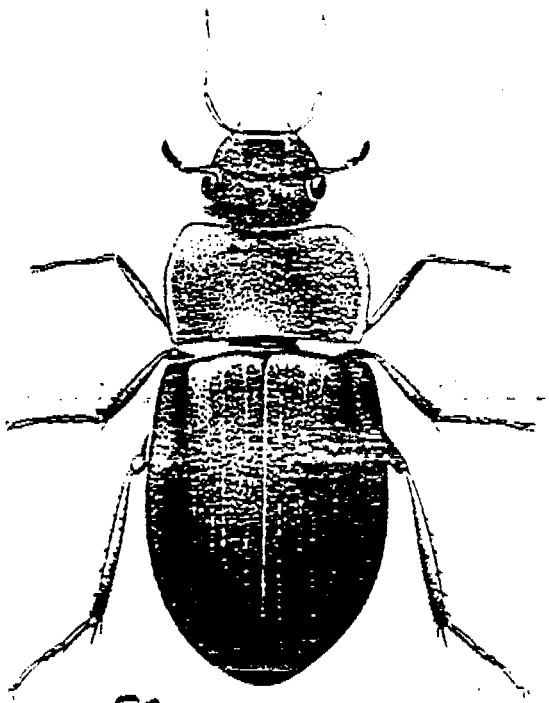

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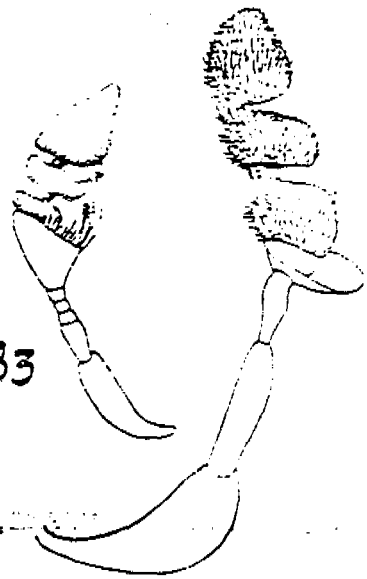

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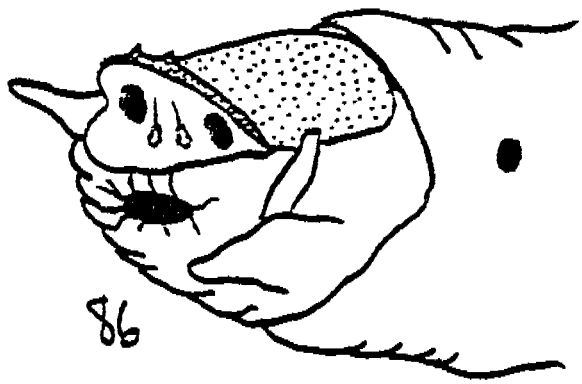

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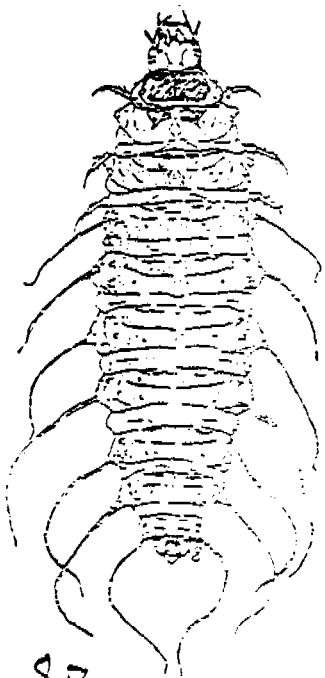

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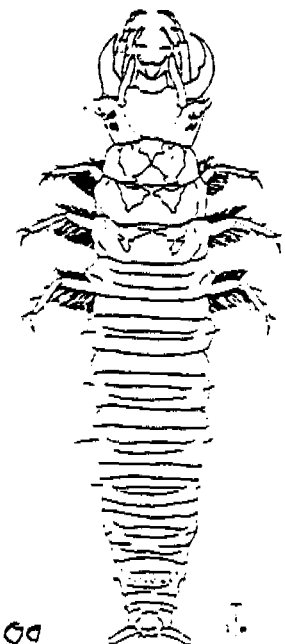

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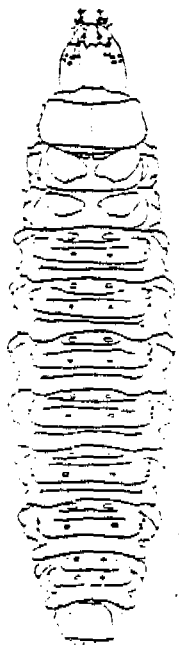

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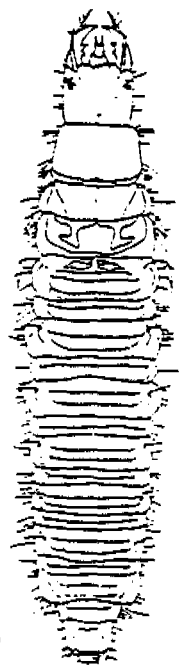

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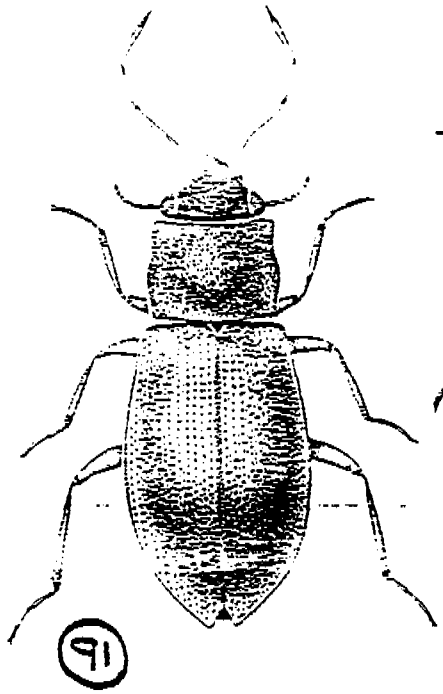
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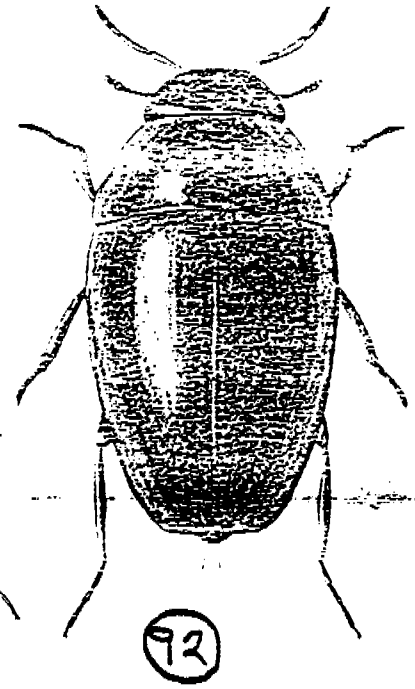
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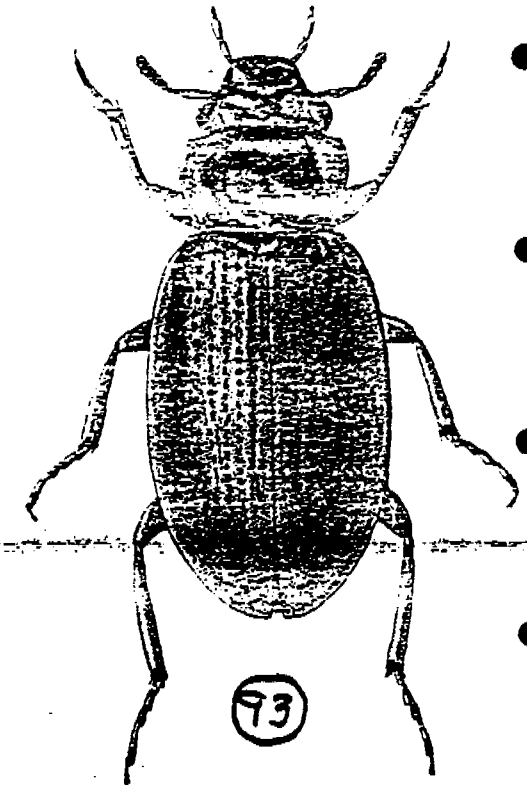
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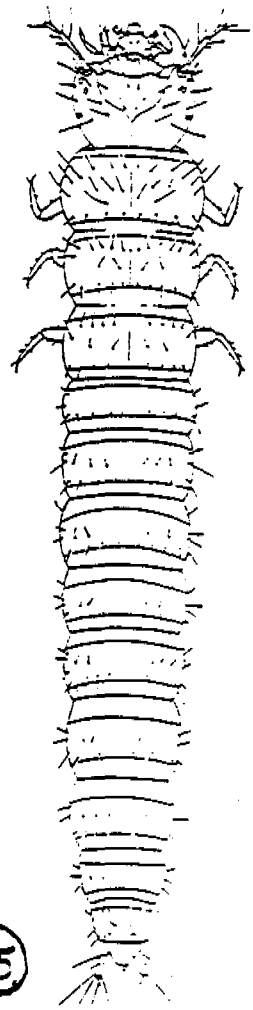
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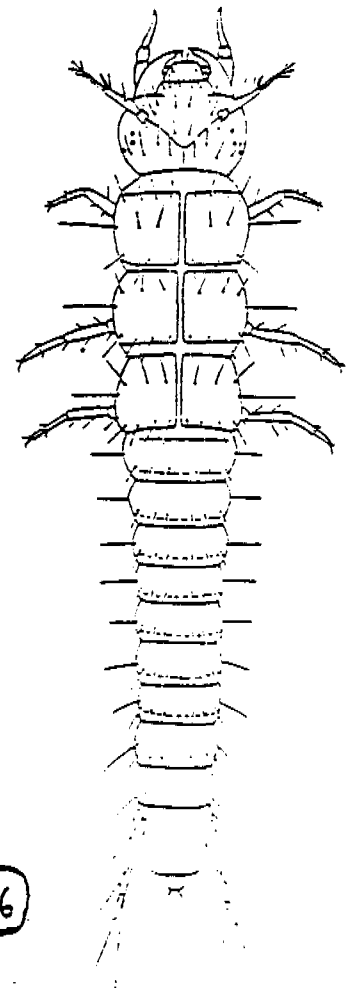
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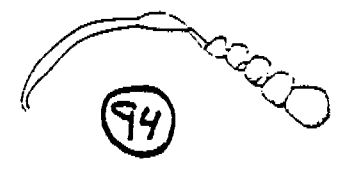
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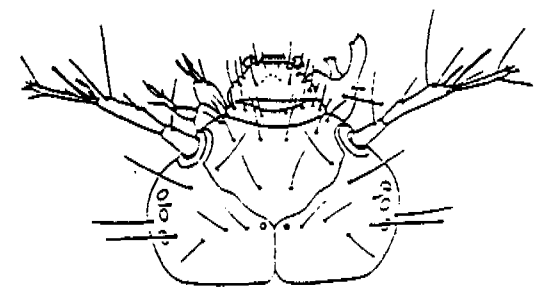
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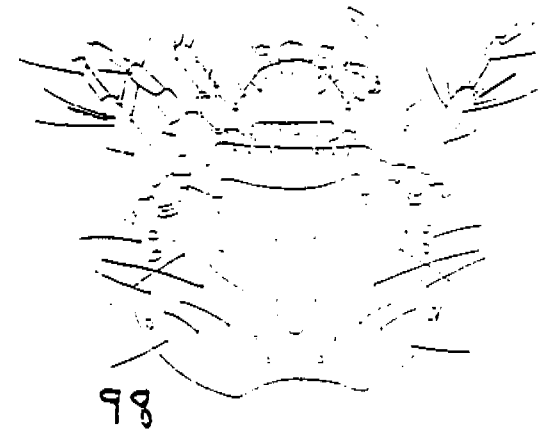
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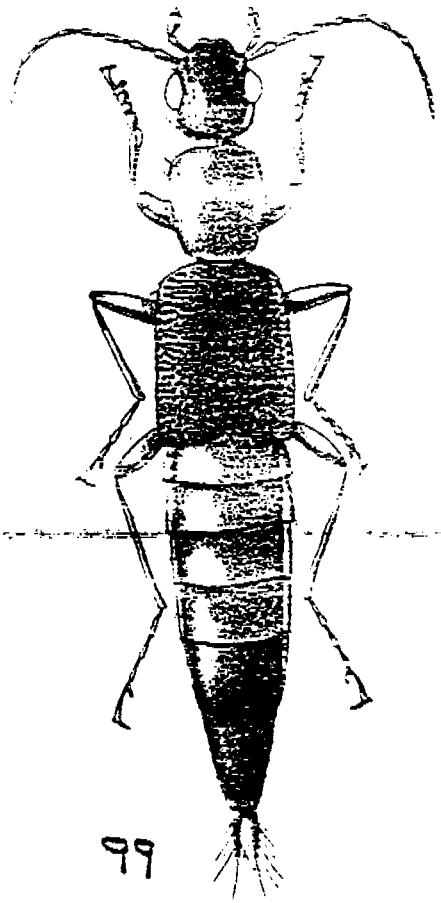

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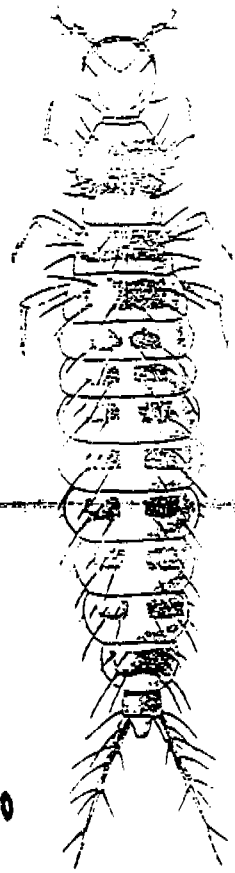

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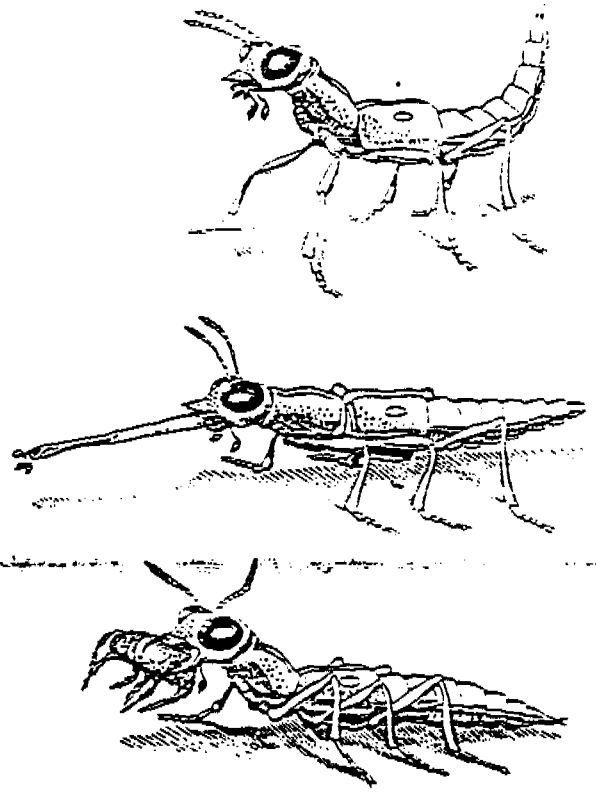

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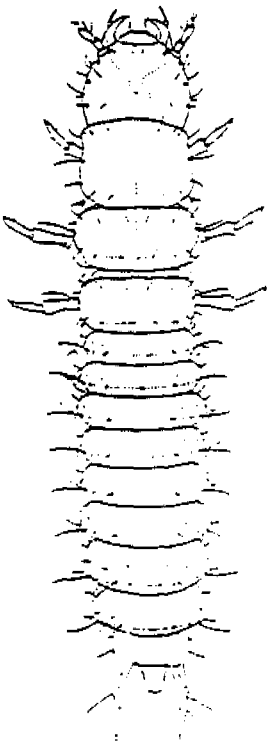

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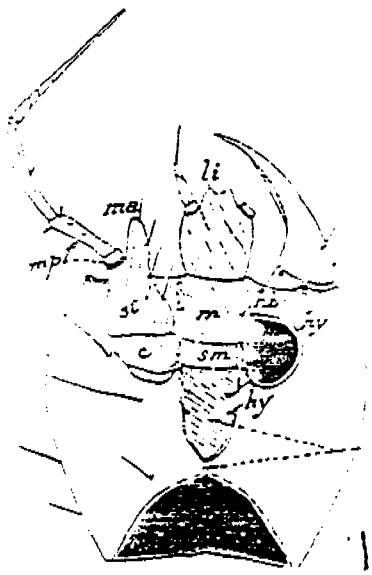


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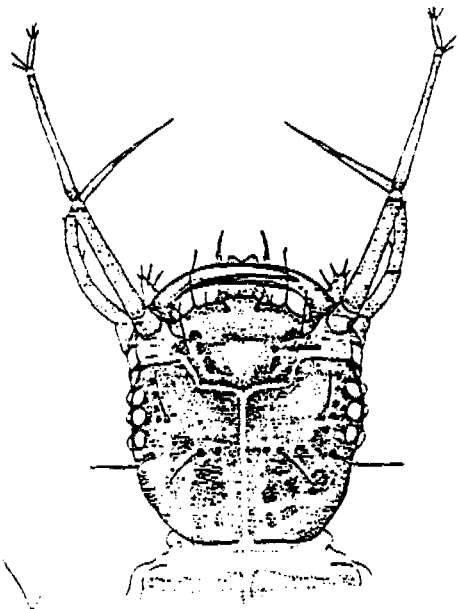

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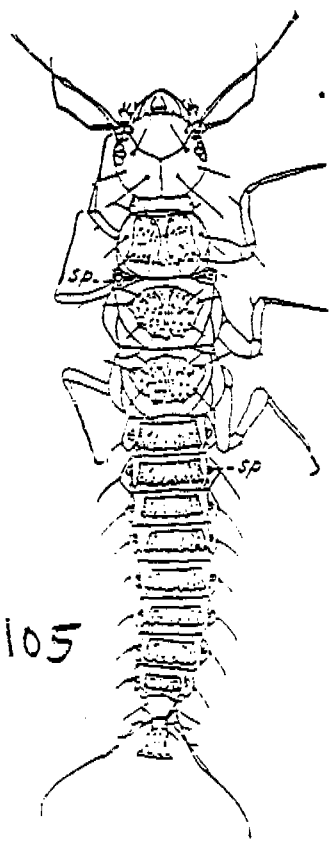


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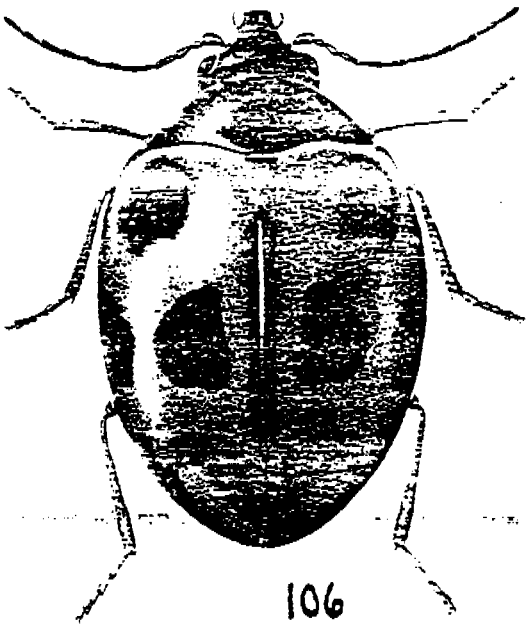

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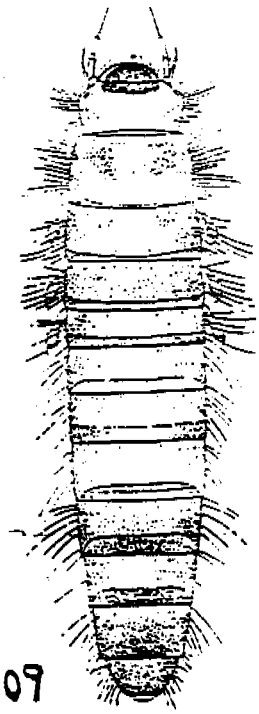

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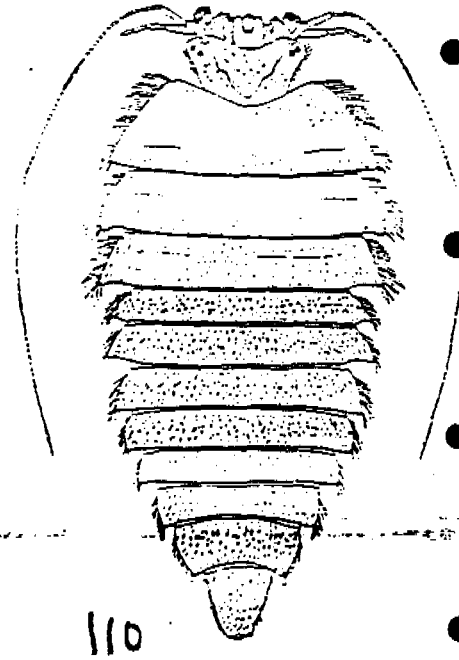

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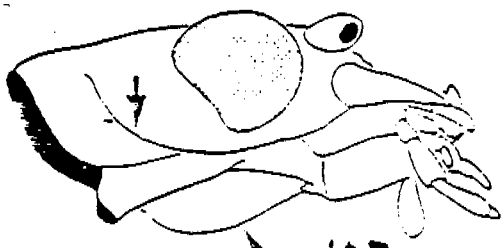

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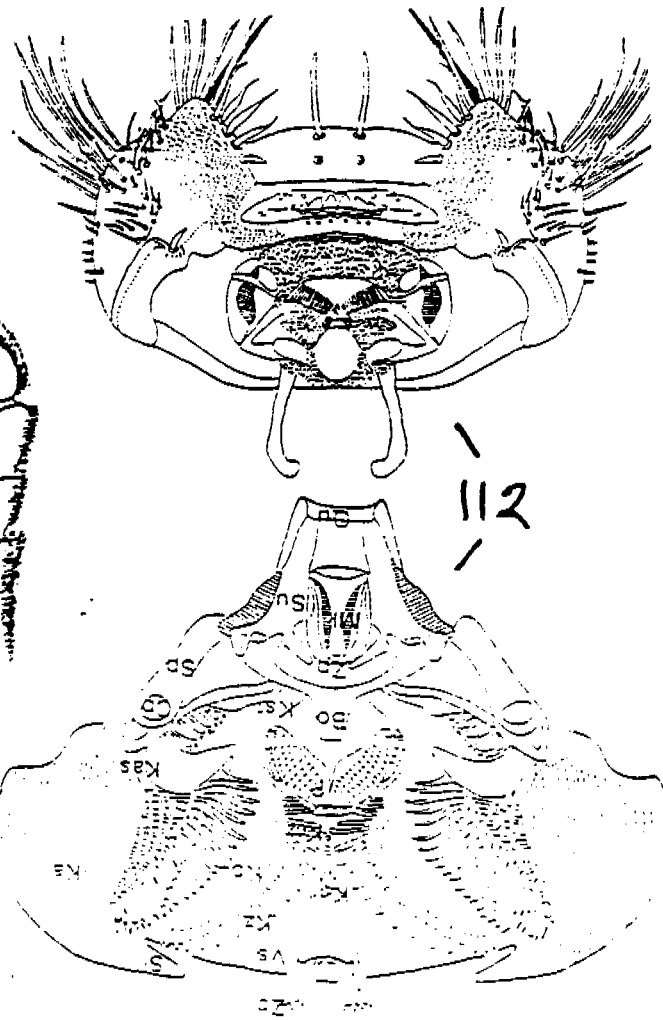

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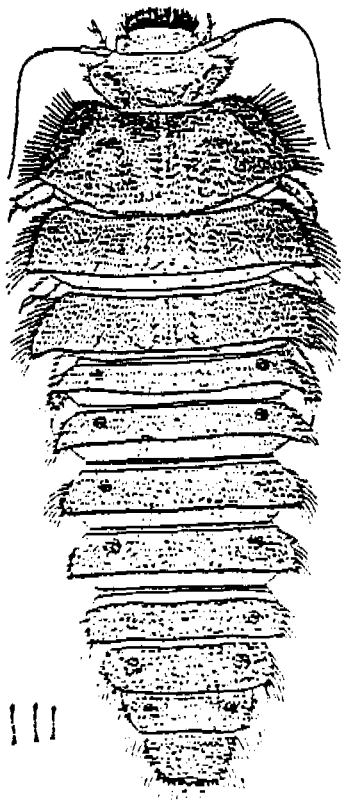

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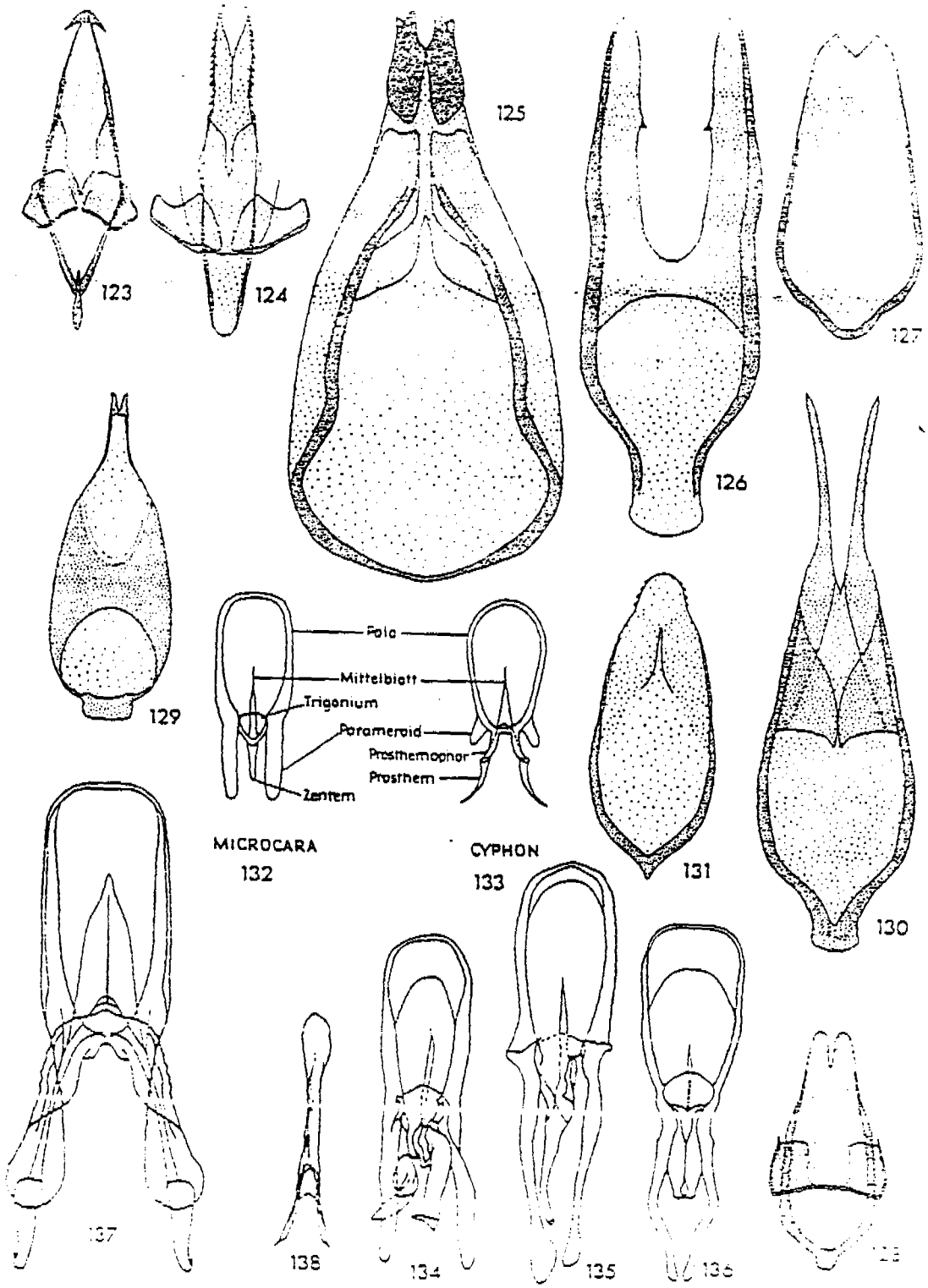
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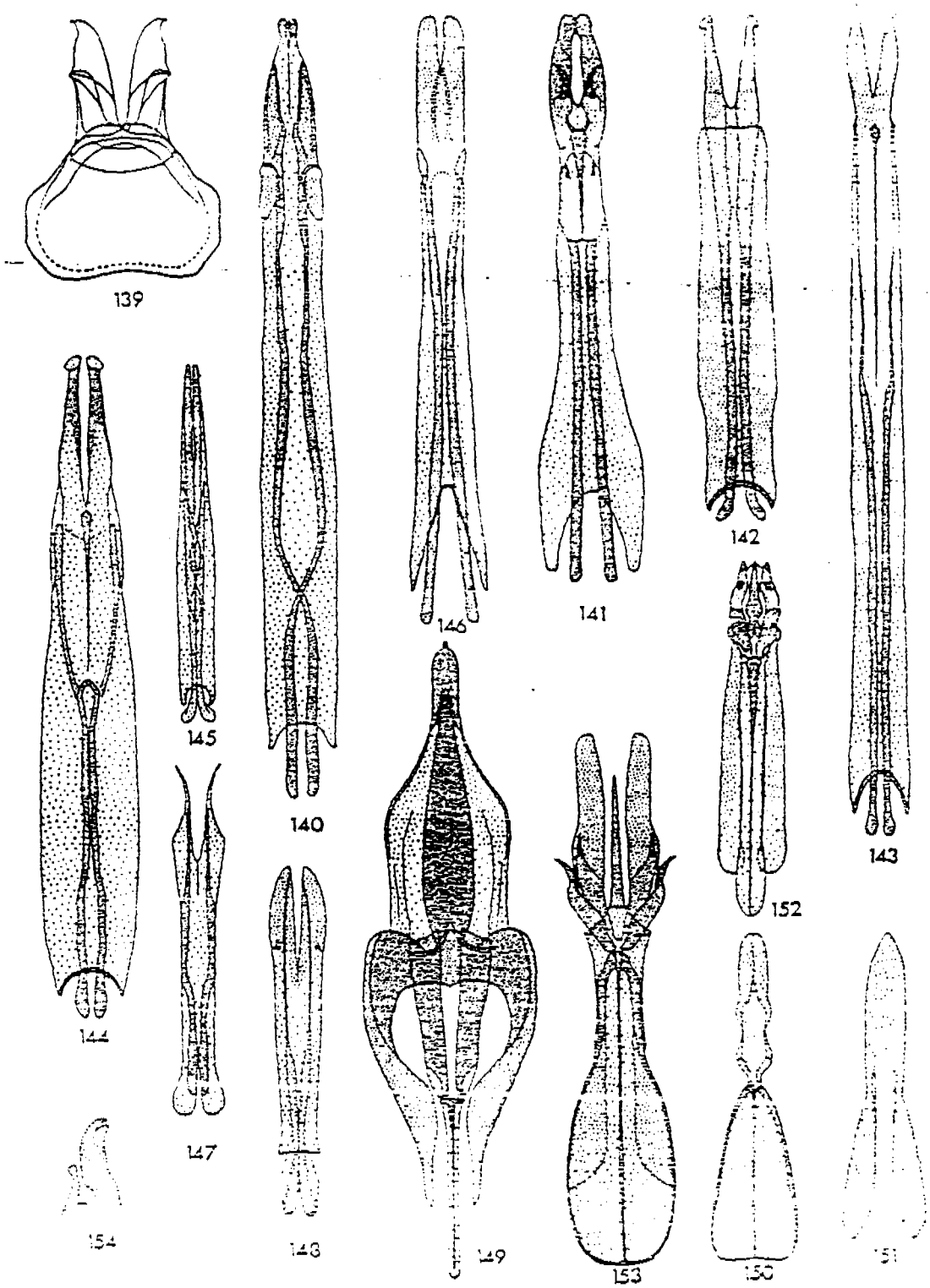
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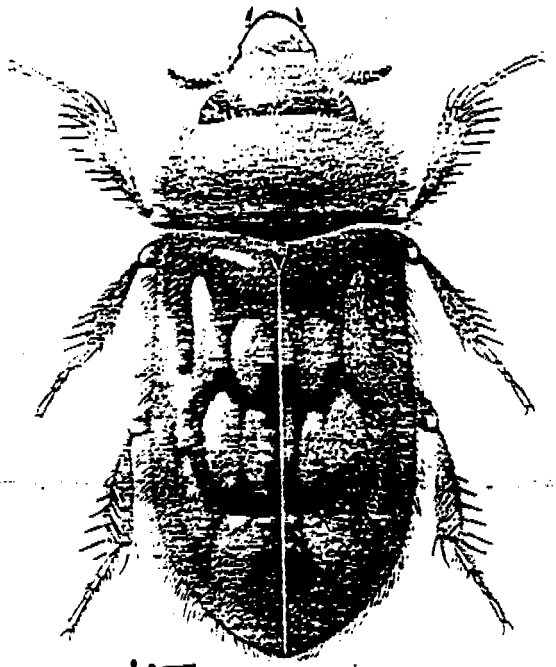

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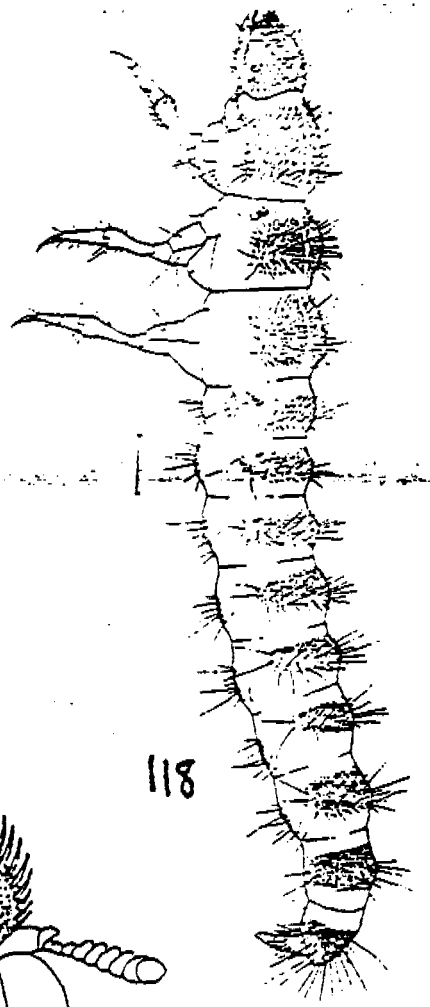

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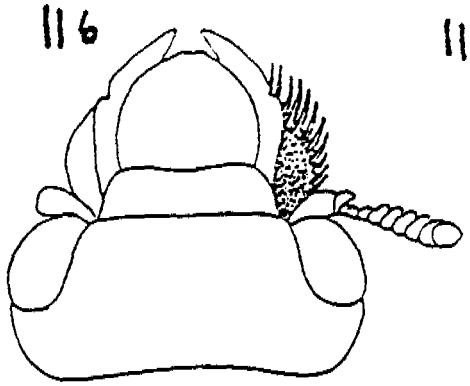

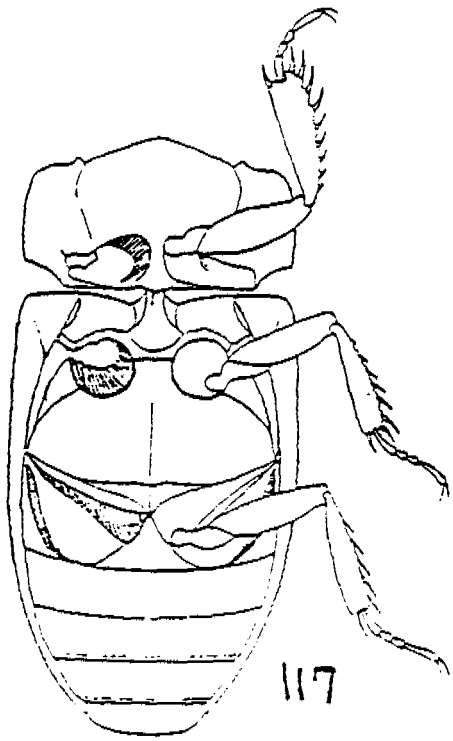

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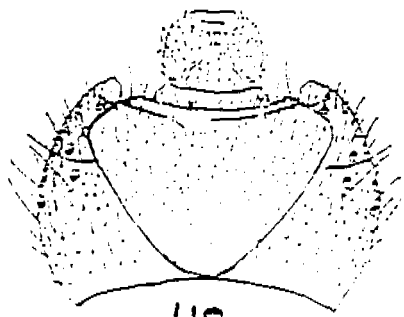

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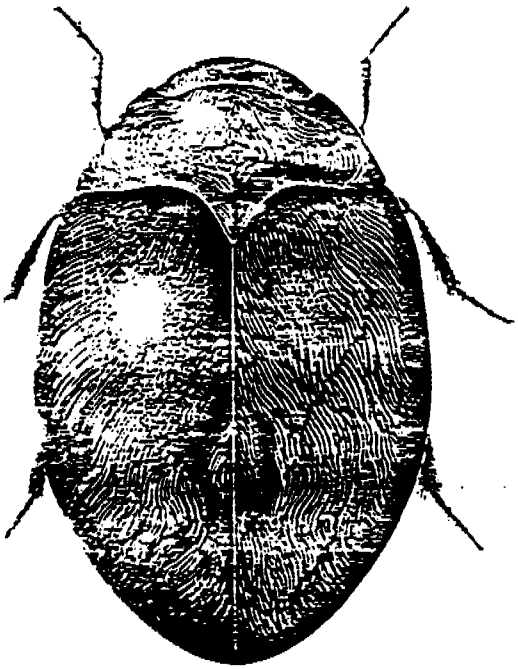

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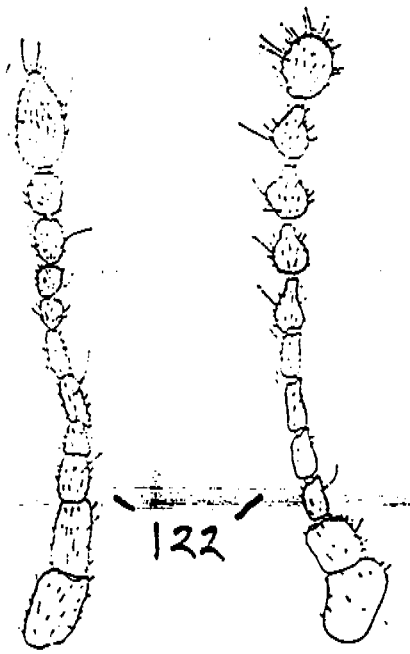

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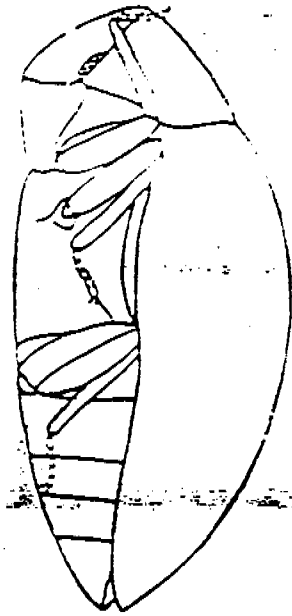

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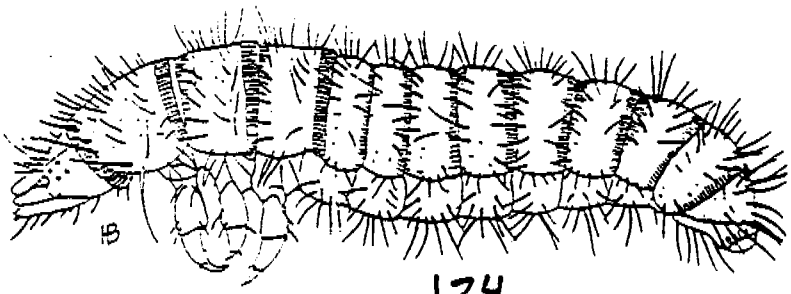

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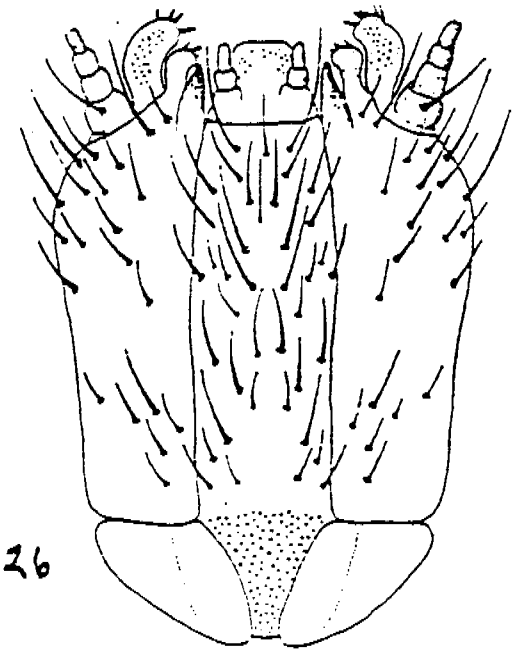

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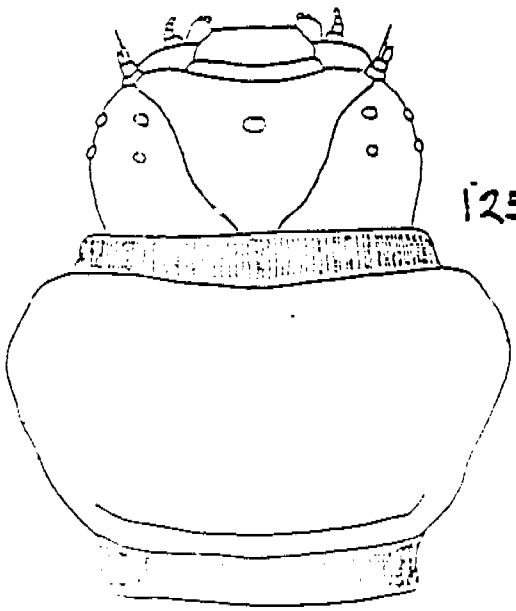

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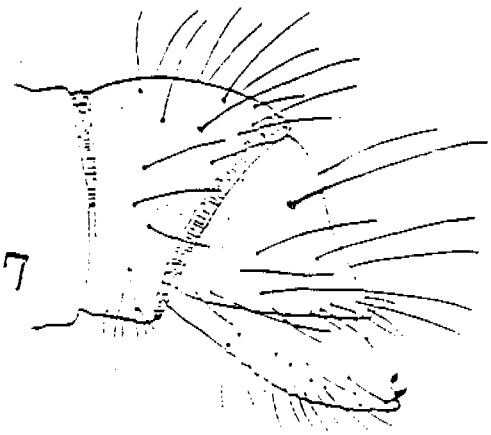

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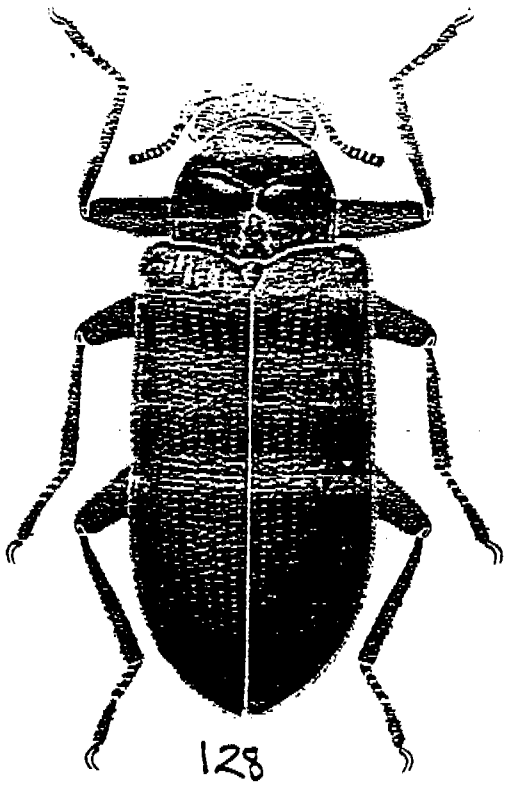

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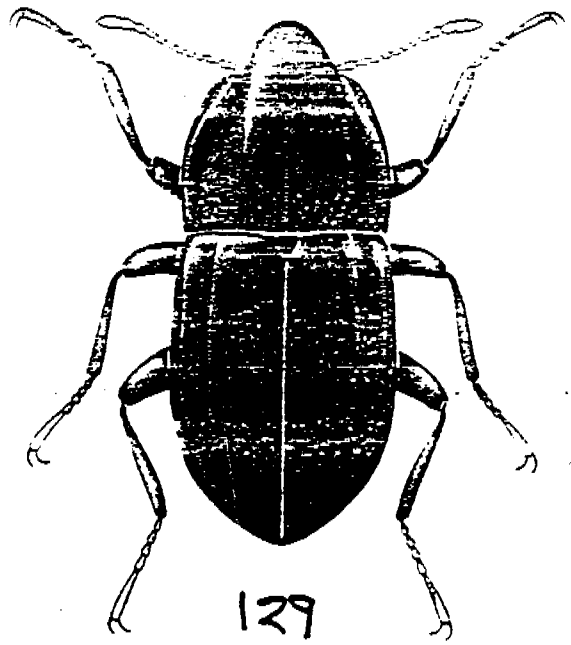

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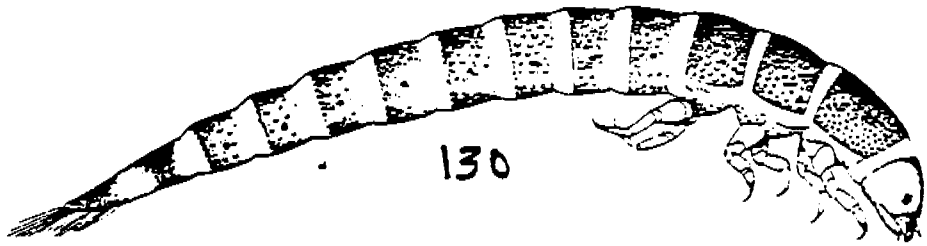

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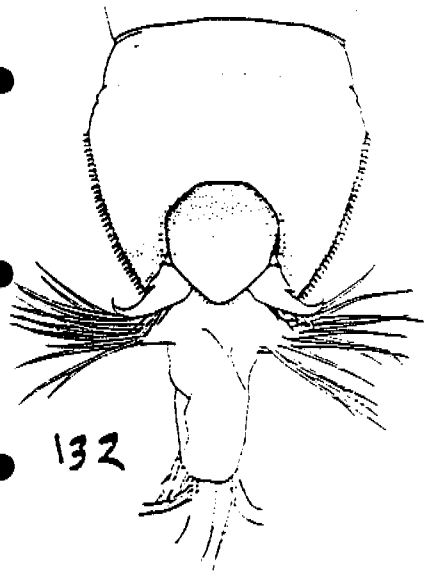

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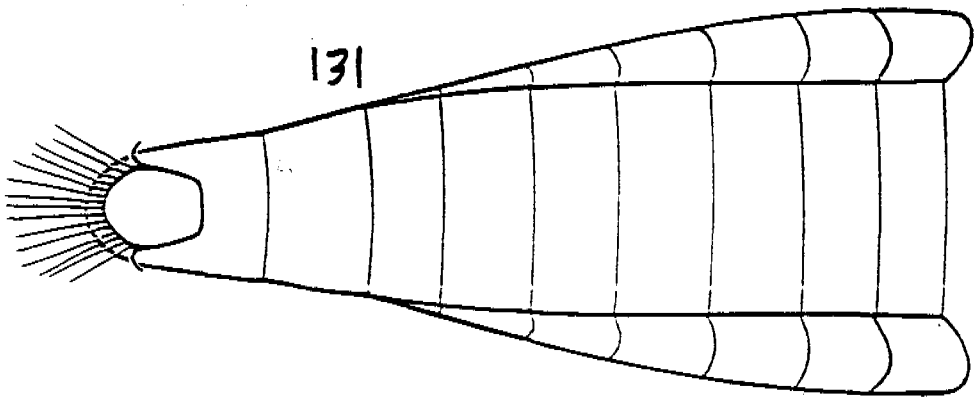

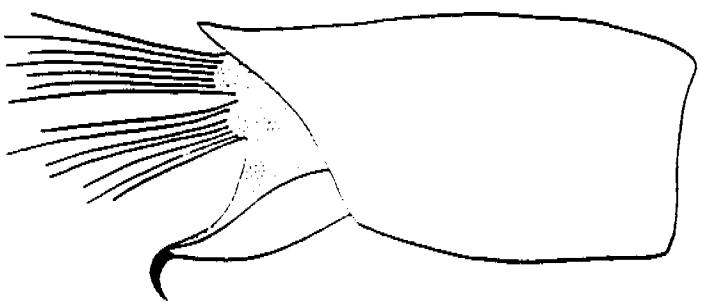

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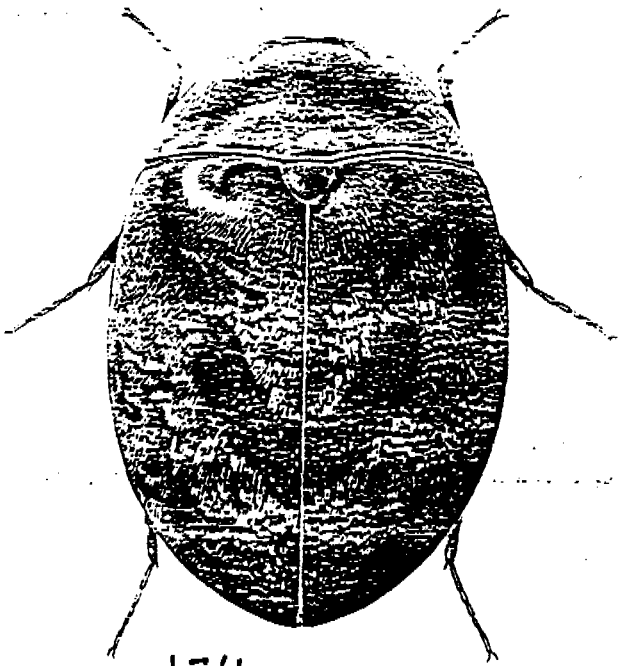

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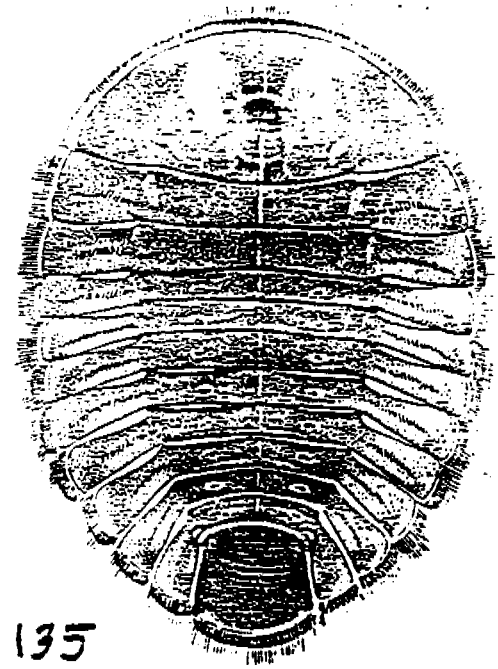

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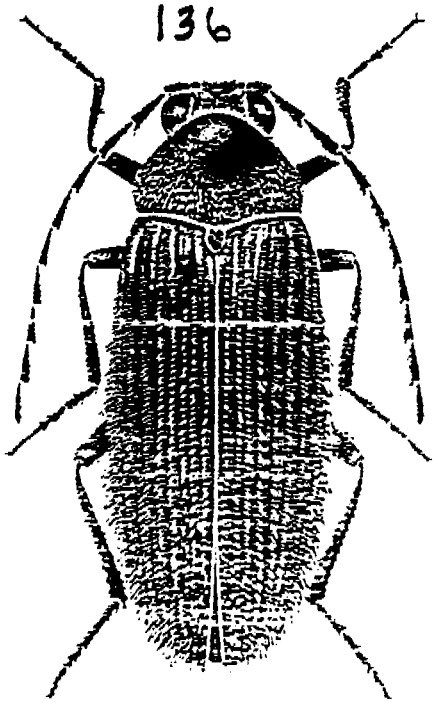

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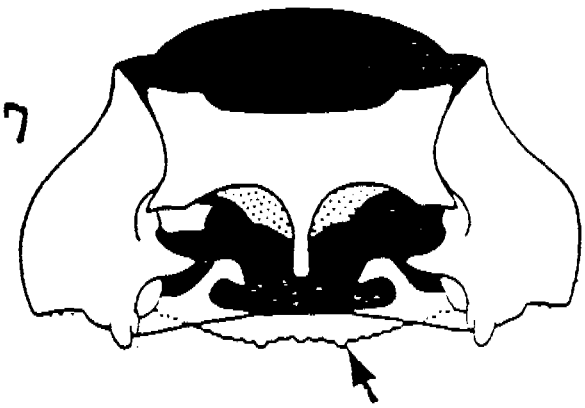

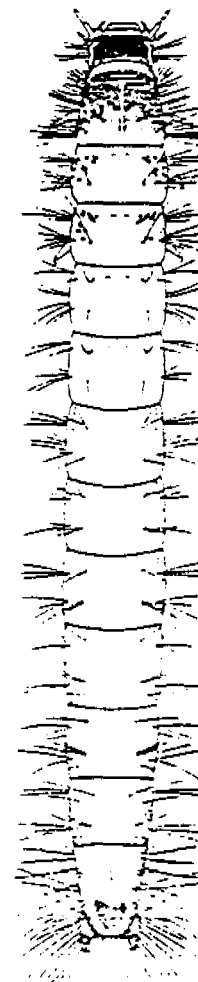

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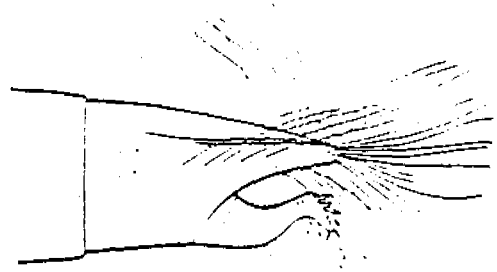

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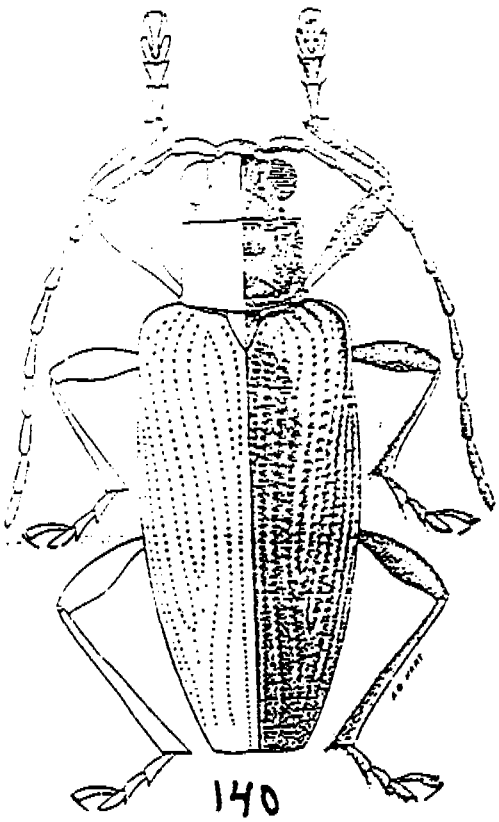

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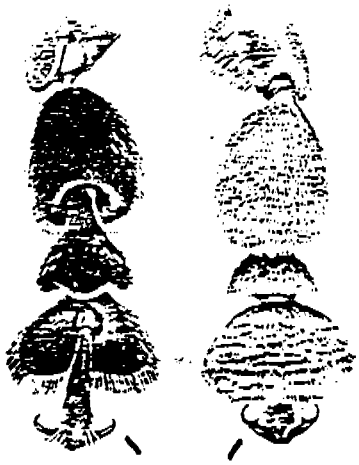

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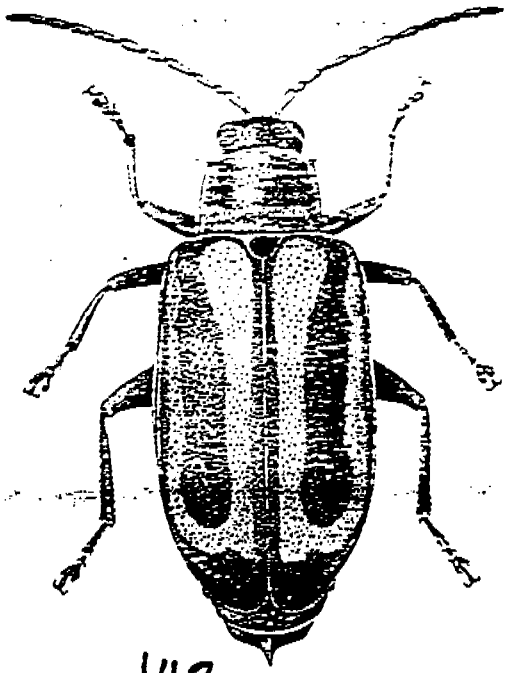

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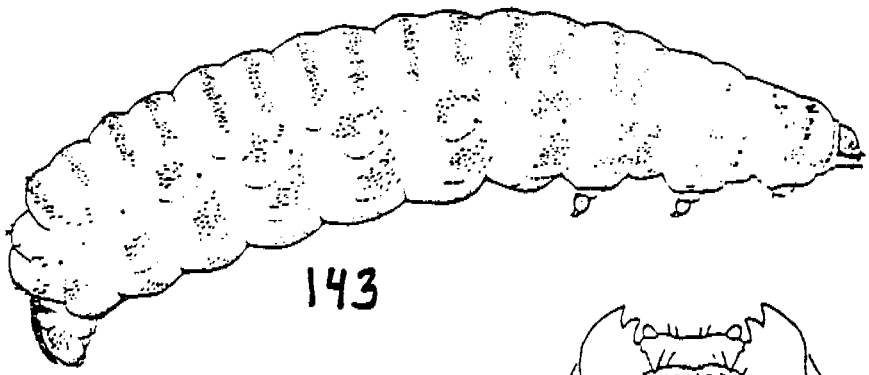

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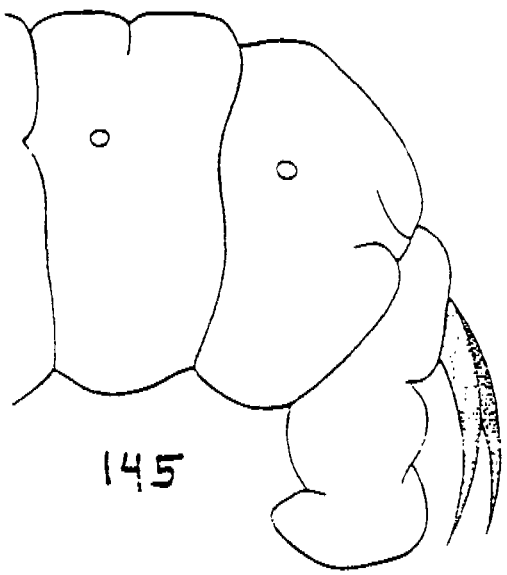

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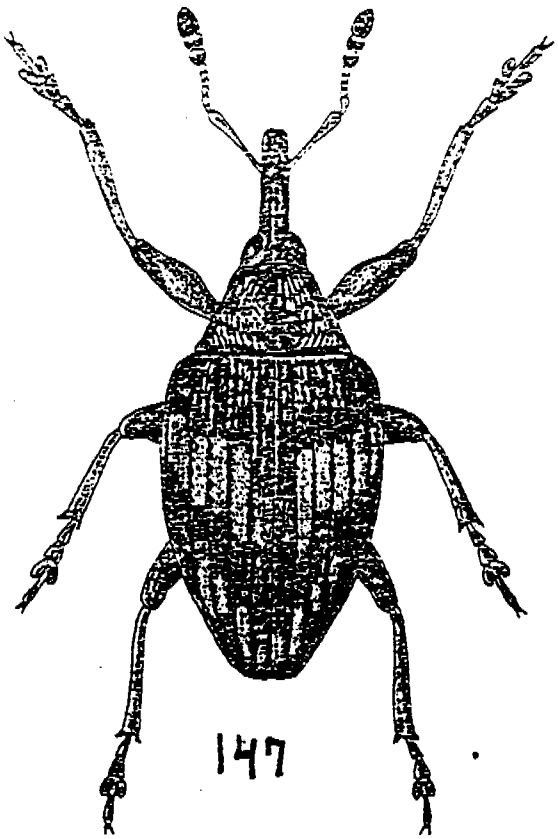

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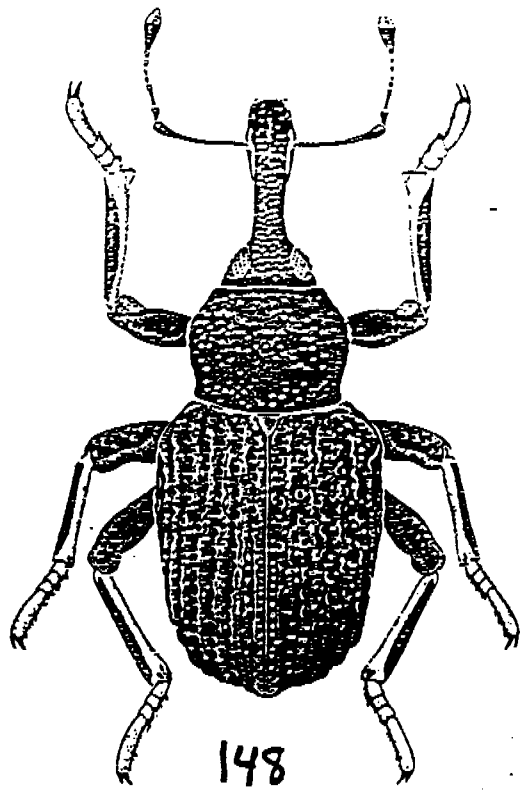

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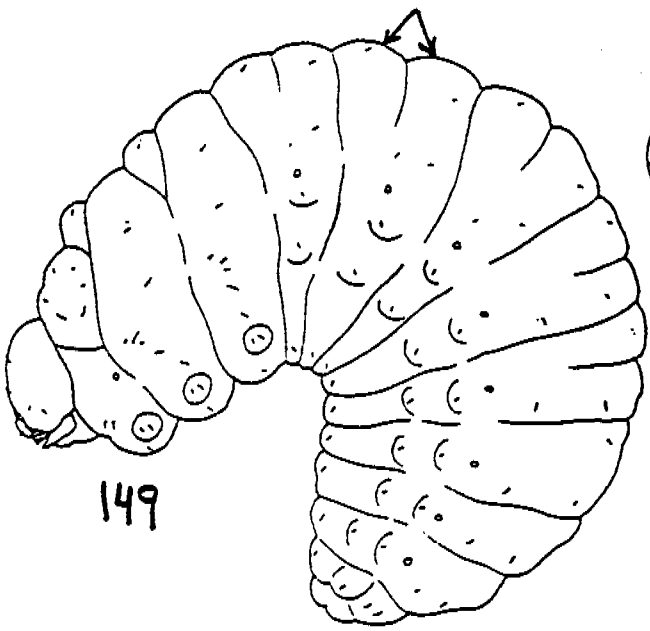

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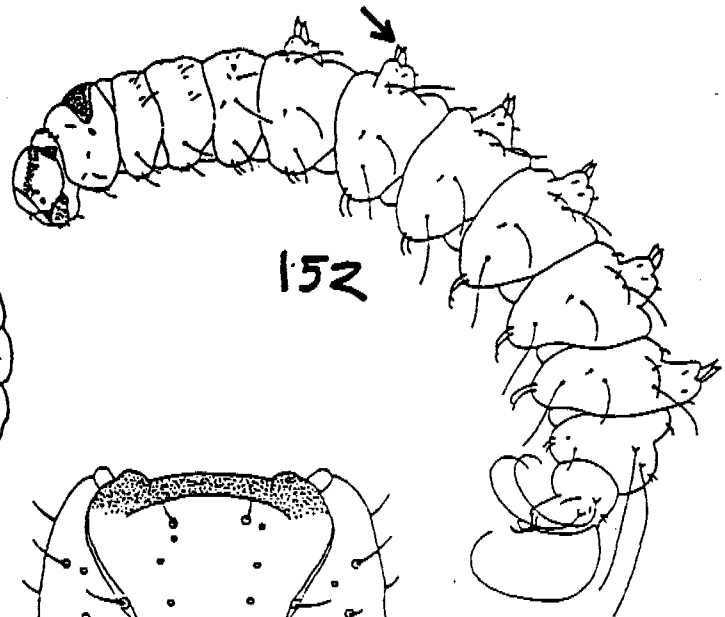

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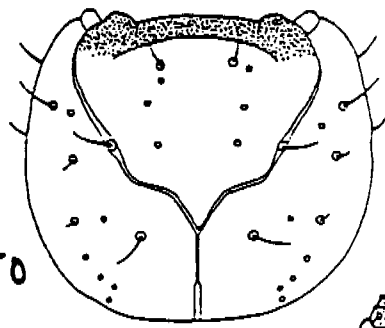

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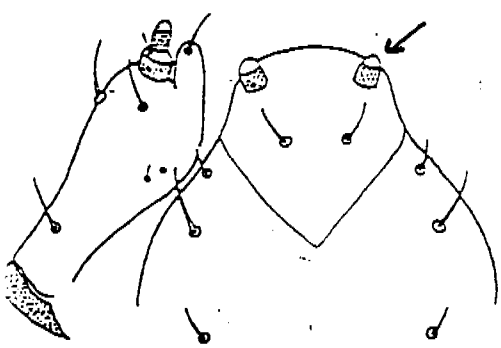

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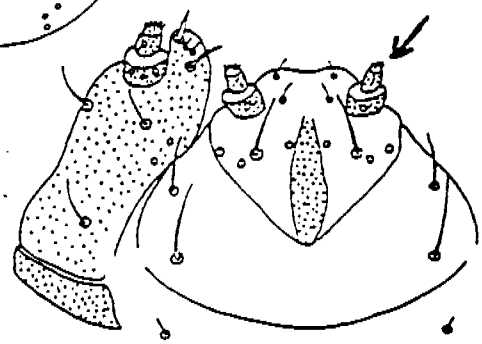

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# COLEOPTERA NOTES

# COLEOPTERA NOTES

# CHAPTER 6

# A KEY TO LATE INSTAR LARVAE OF AUSTRALIAN TRICHOPTERA FAMILIES

**J.C.Dean[1] , R.M.St Clair[1] & D.I.Cartwright[2]**

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Trichoptera larvae are morphologically and ecologically diverse, and have been recorded from a wide range of aquatic habitats. Larvae can be free-living, live in fixed retreats on the surface of solid substrates, construct tubes or galleries which meander along the surface of rocks or through bottom sediments, or can construct portable cases from a variety of materials such as sand, gravel, leaves, twigs/wood or secreted silk. Trophic characteristics are also diverse, with predators, algal grazers, shredders and detritus feeders all well represented.

Twenty-six families of Trichoptera are at present recognised from Australia, and twenty-four have been included in the following key. The two families not included are Chathamiidae, the larvae of which are entirely marine, and Stenopsychidae, larvae of which are unknown. The key does not, however, allow separation of the families Calocidae and Helicophidae. While there are several morphological characters which distinguish confirmed larvae of these two families in south-eastern Australia, there are unidentified larvae in eastern Australia which exhibit a mosaic of the same characters and which will key either to Calocidae or Helicophidae depending on which character is used. Until these larvae have been identified by rearing to adults this problem will remain unresolved.

Most of the characters used in the key have been illustrated. Notes and additional figures are provided for each family in alphabetical order, and reference to these should allow confirmation of identifications. It should be remembered that the key is for late instar larvae only, and while most characters used in the key hold for earlier instars, there are exceptions. For example, first instars of at least some Hydropsychidae do not have abdominal gills, while early instars of Philorheithridae do not have the tibia and tarsus in the middle leg fused. Identification of early instars should only be attempted with extreme care.

# TERMINOLOGY

## HEAD

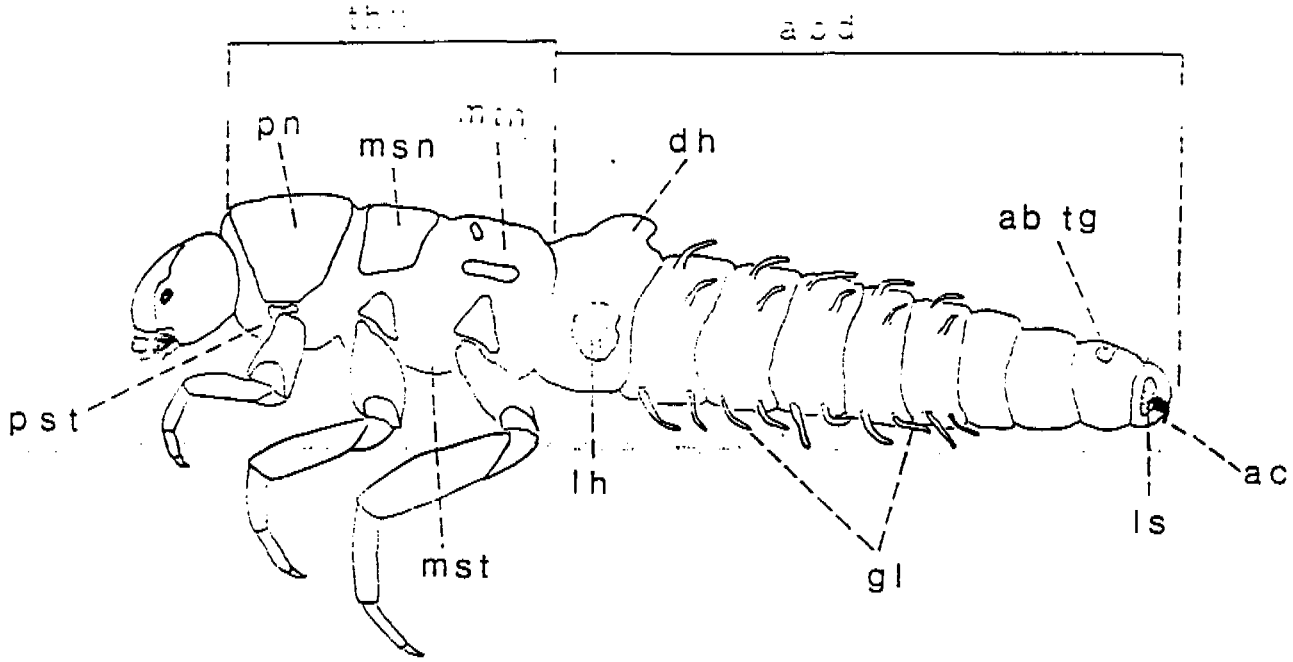
| | |
|---|---|
| ant | antenna |
| ava | anterior ventral apotome |
| el | ecdysial line |
| fc | frontoclypeus |
| gen | gena |
| lb | labrum |
| lm | labium |
| md | mandible |
| pms | post mental sclerites |
| pva | posterior ventral apotome |
| sp | spinneret |
| va | ventral apotome |

## THORAX AND ABDOMEN

| | |
|---|---|
| abd | abdomen |
| ab tg | abdominal tergite 9 |
| ac | anal claw |
| ap | abdominal proleg |
| dh | dorsal hump |
| gl | abdominal gills |
| lh | lateral hump |
| ls | lateral sclerite |
| msn | mesonotum |
| mst | metasternum |
| mtn | metanotum |
| pn | pronotum |
| pst | prosternum |
| thx | thorax |

## FORELEG

| | |
|---|---|
| cx | coxa |
| fm | femur |
| ftr | fore trochantin |
| tb | tibia |
| tc | tarsal claw |
| ts | tarsus |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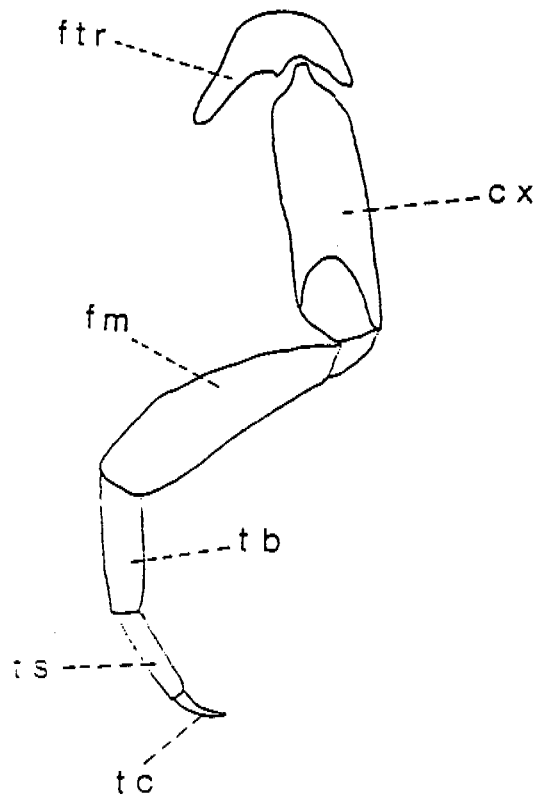
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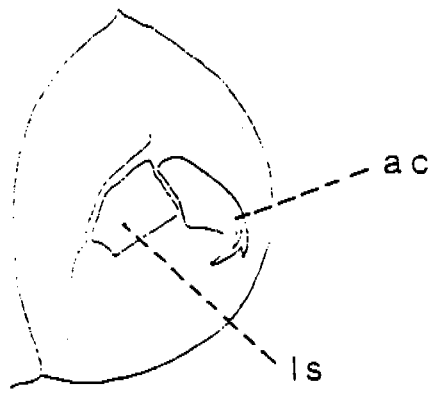
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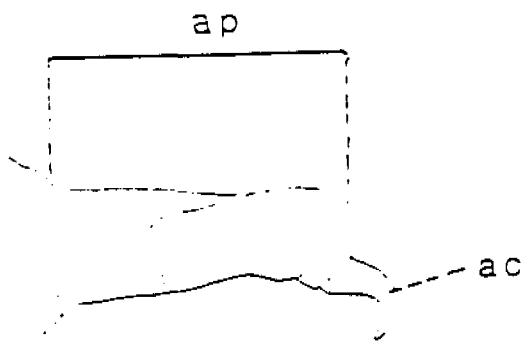
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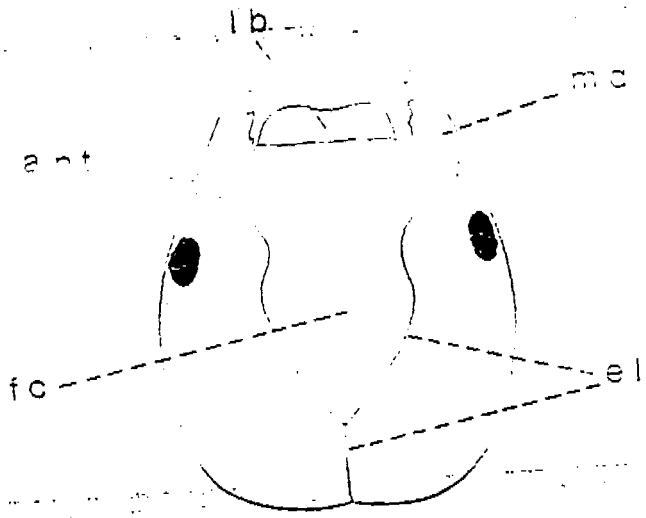
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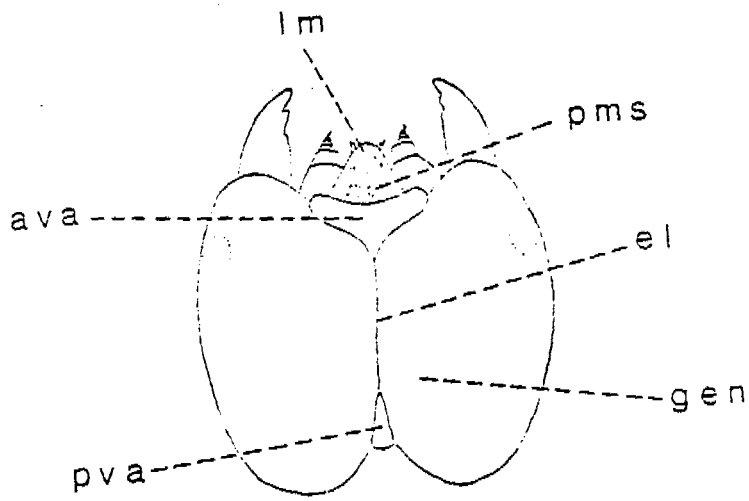
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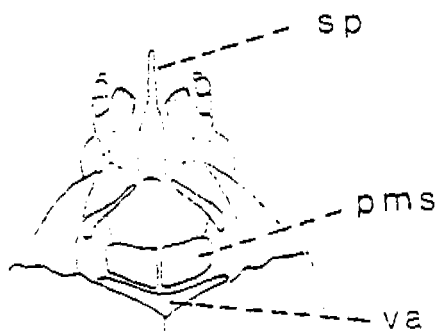
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## KEY TO FAMILIES OF LATE INSTAR TRICHOPTERA LARVAE

1 Abdomen usually swollen, broader and deeper than thorax. Figs. 44,46,47; abdominal prolegs fused, anal claws small, lateral (Figs. 44,46,47); constructing portable [illegible] sand grains ..... **Hydroptilidae**

- Mesonotum and metanotum each with one pair of very small sclerites (Fig. 33); abdominal prolegs medium length, fused in basal half only, anal claws terminal, small (Fig. 34); constructing a portable dome-shaped sand case (Fig. 32) ..... **Glossosomatidae**

- Larvae free-living or living in fixed retreats: first abdominal segment without humps or lateral pad-like surfaces ; anal claws large, terminal on well developed abdominal prolegs (Figs. 25,28,37,42,79) ..... 2

- **Larvae constructing portable cases (Figs. 4,7,9,14,19,22,35,51,64,85); first abdominal segment with dorsal and/or lateral humps, lateral humps with pad-like surface usually bearing spines, spicules, setae or small sclerites (Figs. 1,8,20,48,57,84); anal claws usually small, laterally placed on an apparent tenth abdominal segment formed by fusion of the abdominal prolegs (Figs. 1,8,18,20,54,60,75)** ..... 8

2 Dorsal sclerotisation on all three thoracic segments, although sometimes incomplete on mesonotum and metanotum (Figs. 28,29,30,41,42) ..... 3

- Dorsal sclerotisation on first thoracic segment only (Figs. 25,37) ..... 4

3 Abdominal gills present (Figs. 41,42) ..... **Hydropsychidae**

- Abdominal gills absent; ..... **Ecnomidae**

4 Labrum membranous, anterior margin considerably broader than posterior margin (Fig. 65) ..... **Philopotamidae**

- Labrum sclerotised, anterior margin not broader than posterior margin ..... 5

5 Foreleg modified, either chelate or with femur broadened and bearing a field of stout spines (Figs. 39,40); fore trochantin reduced (Fig. 39) ..... **Hydrobiosidae**

- Foreleg not modified (Figs. 78,82); fore trochantin distinct and well developed (Figs. 25,78,82); ..... 6

6 Labium modified to form elongate spinneret, longer than head capsule (Fig. 27) ; frontoclypeus extending to posterior of head capsule (Fig. 26) ..... **Dipseudopsidae**

- Spinneret, if present, considerably shorter than head capsule (Figs. 77,81); frontoclypeus not extending to posterior of head capsule ..... 7

7 Fore trochantin slender, tapered (Fig. 78); post mental sclerites fused (Fig. 77) ..... **Polycentropodidae**

- Fore trochantin broad, blade-like (Fig. 82); post mental sclerites discrete (Fig. 81) ..... **Psychomyiidae**

8 Larvae constructing helical case of sand grains (Fig. 35); anal claw with dorsal tooth modified to form a comb-like structure (Fig. 36) ..... **Helicopsychidae**

- Larvae not constructing helical case of sand grains; anal claw with dorsal teeth simple or absent ..... 9

9 Head reduced, without visible ecdysial lines; pronotum with two pairs of sclerites on anterior half, posterior half membranous, and not retractable into mesonotum (Fig. 5) ..... **Atriplectididae**

\- Head not reduced, ecdysial lines usually distinct; pronotum completely sclerotised, not retractable into mesonotum ..... 10

10 **Middle leg with tibia and tarsus fused (Figs. 50,68)** ..... 11

\- **Middle leg with tibia and tarsus not fused** ..... 12

11 Fore leg with tibia and tarsus fused (Fig. 49); ventral apotome of head capsule extending to occipital margin, completely separating genae ..... **Kokiriidae**

\- Fore leg with tibia and tarsus not fused; ventral apotome of head capsule not extending to occipital margin ..... **Philorheithridae**

12 Prosternum with median horn-shaped process (Figs. 56,74) ..... 13

\- Prosternum without median horn-shaped process ..... 14

13 Mesonotum with three pairs of small-medium sclerites (Fig. 73); venter of first abdominal segment with three pairs of setae ..... **Plectrotarsidae**

\- Mesonotum with single large sclerite (Fig. 57); venter of first abdominal segment with numerous setae (Fig. 56) ..... **Limnephilidae**

14 Metasternum with two or more setae ..... 15

\- Metasternum without setae ..... 16

15 Antennae often long and prominent (Fig. 52), although sometimes short (Figs. 53,55); pronotum usually not densely covered with setae on anterior half, but if dense setae are present then metasternum bearing small sclerites ..... **Leptoceridae**

\- Antennae minute; pronotum densely covered with long setae on anterior half (Fig. 11); metasternum densely covered with setae but without sclerites ..... an unidentified genus of **Calocidae or Helicophidae**

16 Abdominal segments with conspicuous lateral fringe of fine setae (Fig. 8) ..... 17

\- Abdominal segments without conspicuous lateral fringe of fine setae ..... 19

17 Head capsule with prominent carina (Fig. 63) ..... Oeconesidae

\- Head capsule without carina ..... 18

18 Hind legs approximately equal in length to fore legs (Fig.84), case constructed of sand/gravel (Fig.85) ..... Tasimiidae

\- Hind legs about twice length of fore legs (Fig. 8); case constructed of leaf fragments (Fig. 9) ..... Calamoceratidae

19 Prosternum with large sclerite or sclerites (Fig. 59) ..... Odontoceridae

\- Prosternum membranous ..... 20

20 Ventral surface of head capsule with genae widely separated at occipital margin (Figs. 21,24) ..... Conoesucidae

\- Ventral surface of head capsule with genae close together and almost abutting at occipital margin (Figs. 2,12,15) .....21

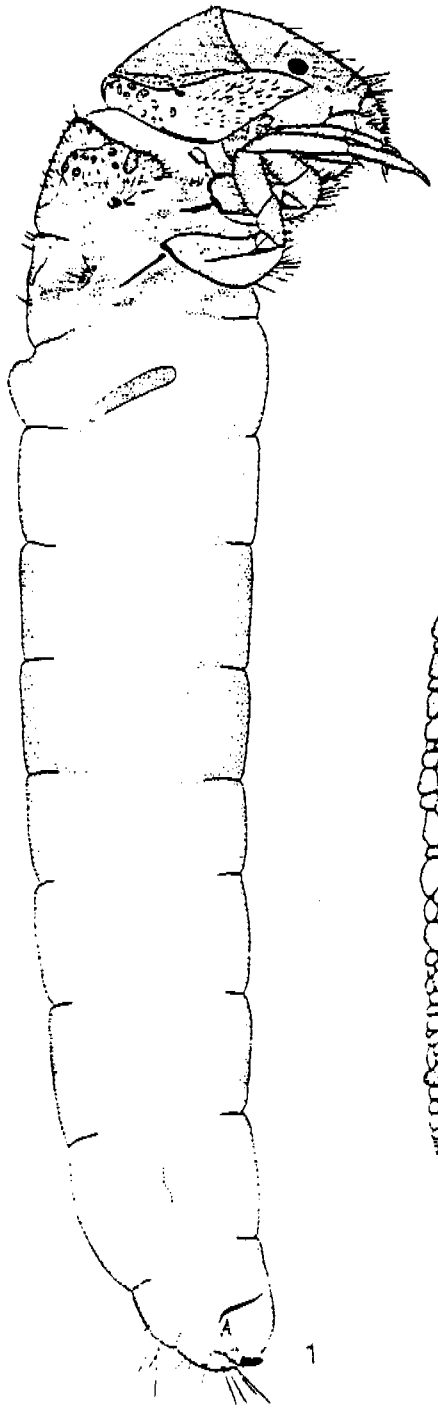
21 Strong beaded carina extending obliquely across pronotum, terminating in a pointed and dorso-ventrally flattened projection at each antero-lateral corner (Fig. 3) ..... **Antipodoeciidae**

\- Carina (if present) not beaded, not terminating in dorso-ventrally flattened projection at each antero-lateral corner (Figs. 10,13,17) .....**Calocidae or Helicophidae**

## FAMILY ANTIPODOECIIDAE

Larvae small (about 5 mm long), constructing cylindrical case of sand grains. Head round in dorsal view. Ventral apotome triangular, genae abutting at occipital margin. Pronotum strongly sclerotised, with beaded oblique carina and anterolateral margin extended as dorsoventrally flattened and acute projection. Mesonotum moderately sclerotised, metanotum weakly sclerotised. Abdominal gills and lateral fringe absent.

Distribution: Q'land, NSW, Vic.

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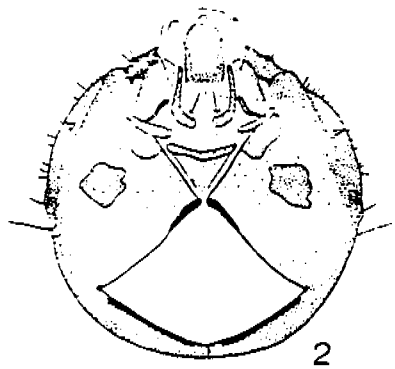

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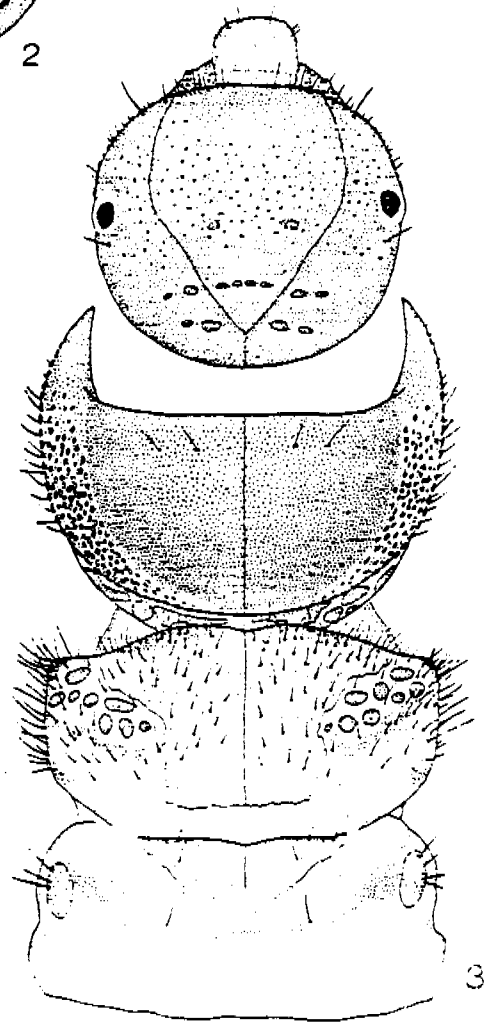

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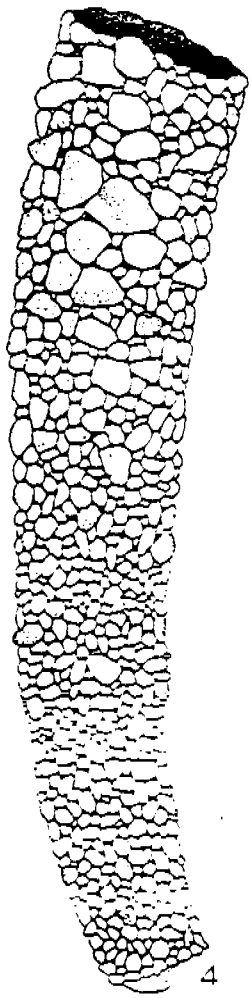

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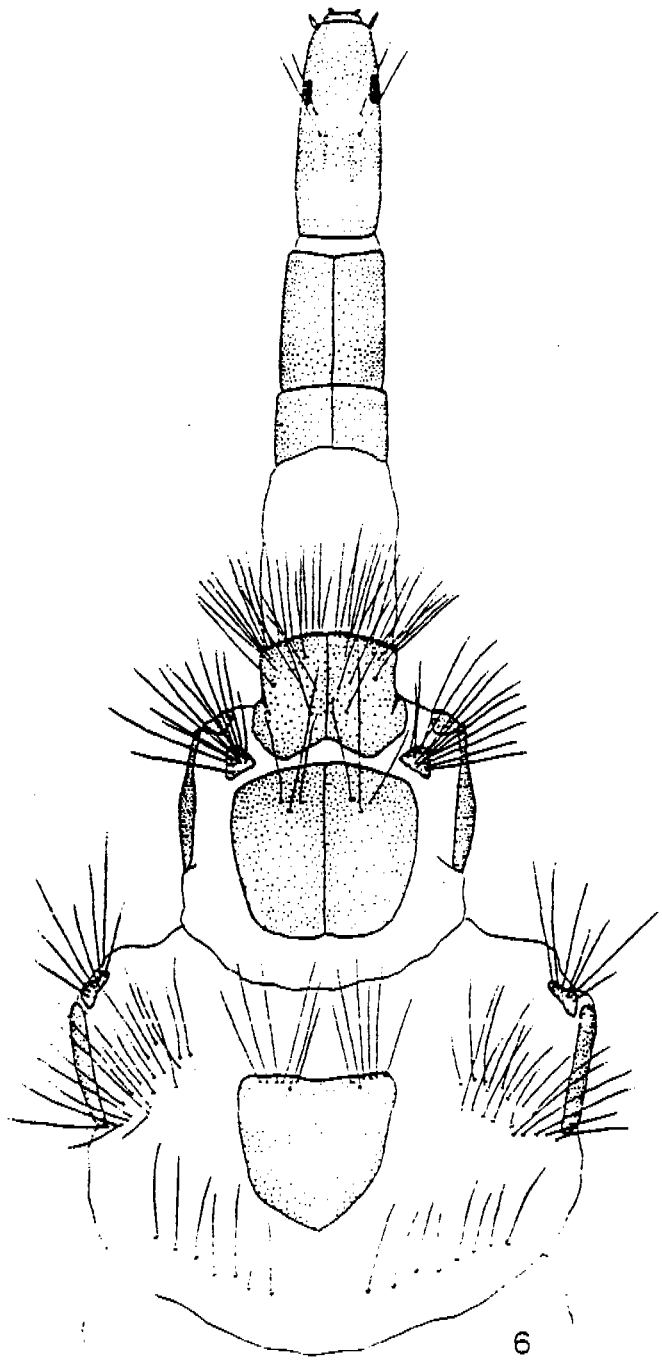
## FAMILY ATRIPLECTIDIDAE

Larvae medium to large (8-18 mm long), constructing tube cases of gravel or fine sand/silt. Head small, elongate, ecdysial lines not visible. Pronotum slender, two pairs of sclerites on anterior half, posterior half membranous and retractable into mesothorax. Mesonotum and metanotum considerably broader than pronotum. Abdominal gills present.

Distribution: N Q'land, NSW (?), Vic, Tas, SW Aust.



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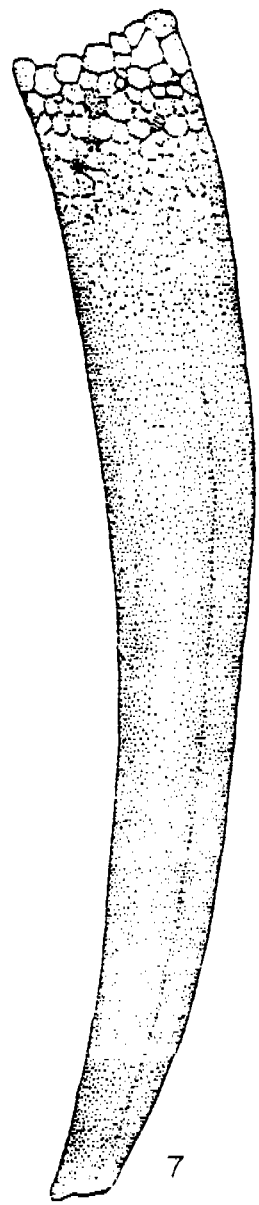

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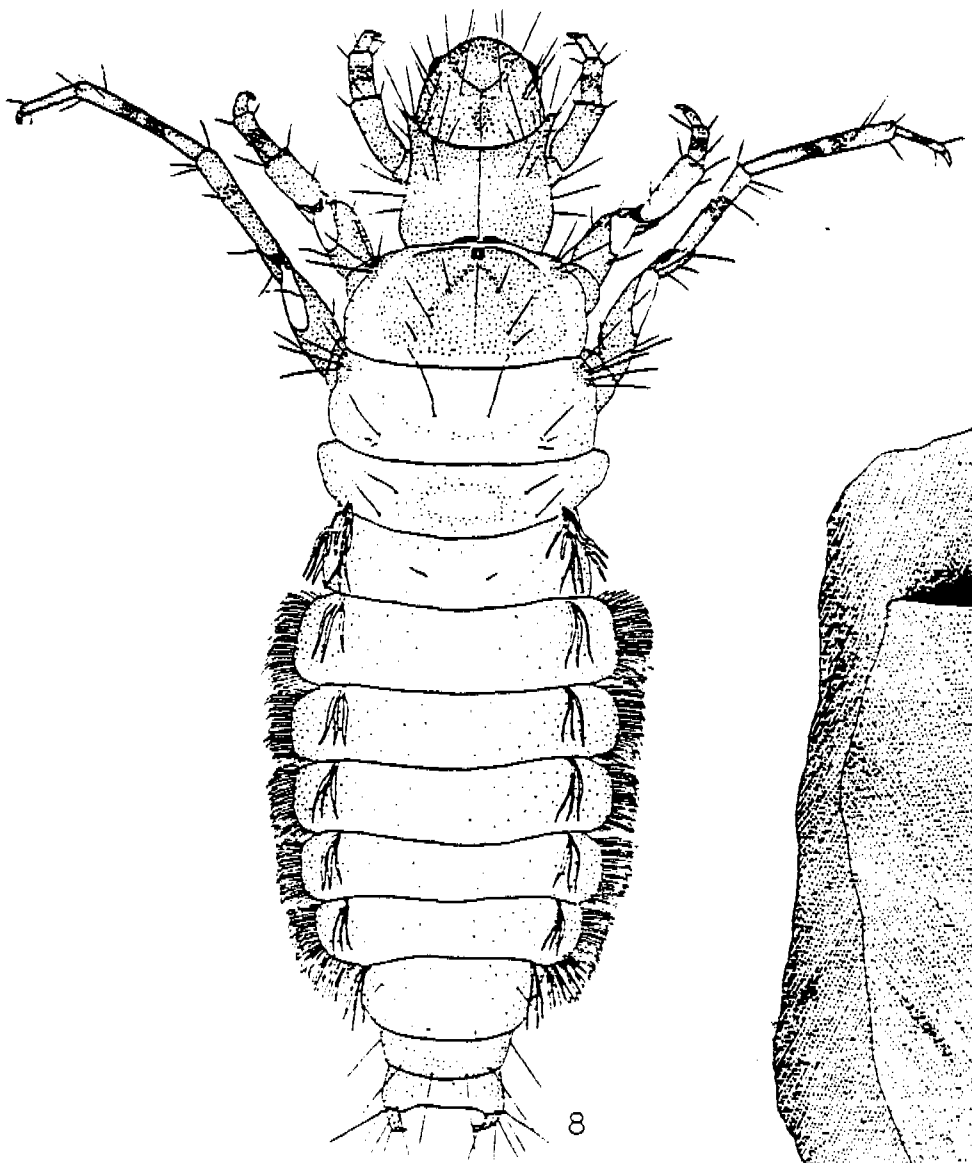
## FAMILY CALAMOCERATIDAE

Larvae of moderate size (about 8-12 mm in length), case constructed from two panels of leaves. Pronotum with rounded projections at anterolateral corners. Mesonotum moderately sclerotised, metanotum almost completely membranous. Hind legs twice length of fore legs. Abdominal segment one with large dorsal and lateral humps. Abdomen bearing gills and with a dense lateral fringe of setae.

Distribution: Australia wide except SW Aust.



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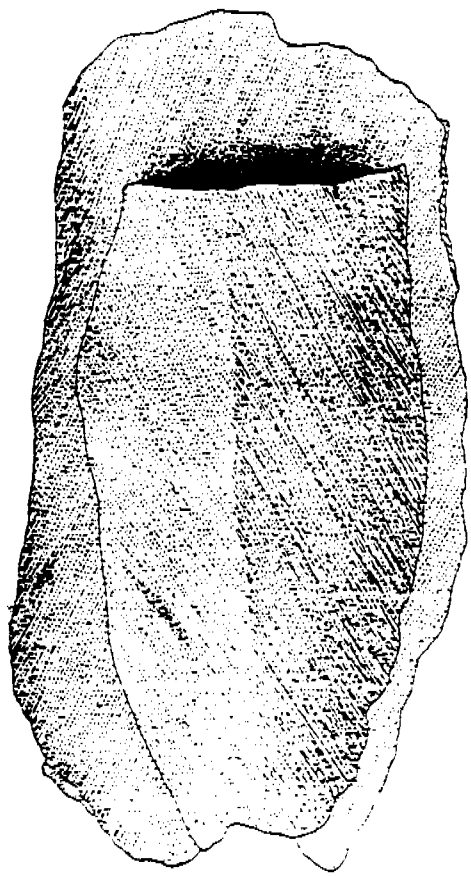

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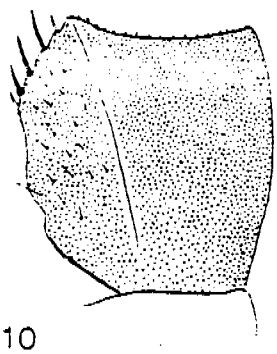
**FAMILIES CALOCIDAE AND HELICOPHIDAE**

Larvae small to medium size (usually 8-12 mm long). Cases varied, either constructed solely from silk or incorporating sand grains or plant material. Antenna small, located either close to anterior margin of head capsule or about halfway between eye and anterior margin. Ventral apotome triangular, often unpigmented in posterior half; genae abutting at occipital margin. Pronotum strongly sclerotised, without acute projections at anterolateral margins. Abdominal gills absent.

**NOTE:** These Families cannot be separated reliably, see comments in introduction.

Distribution: Q'land, NSW, Vic, Tas.



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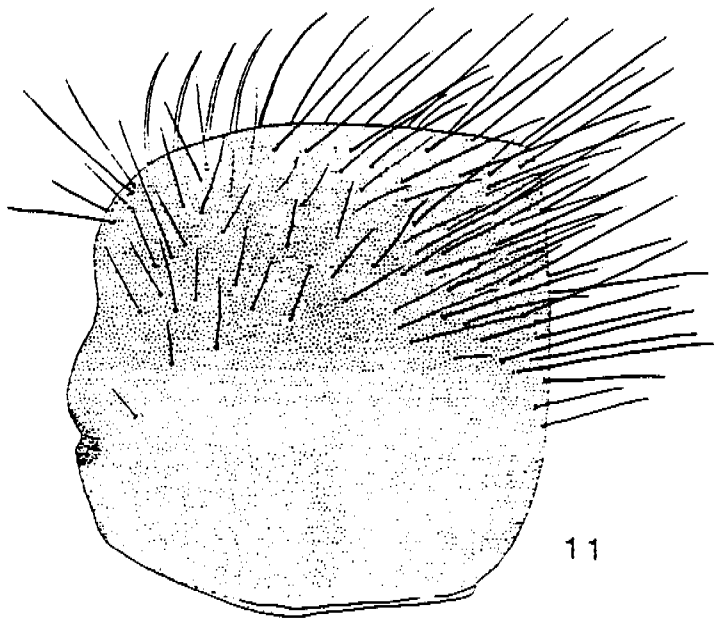

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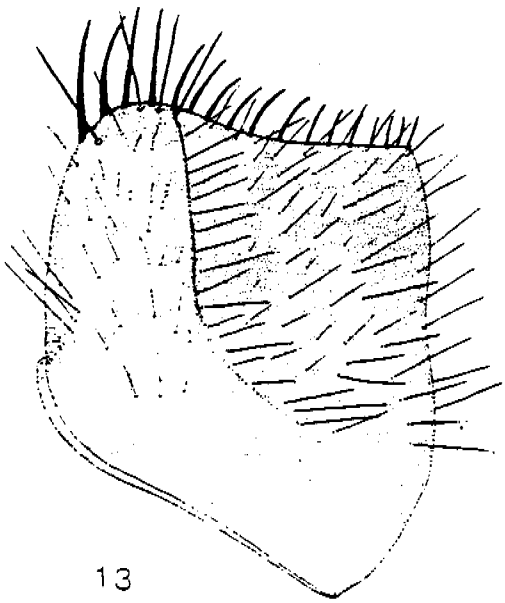

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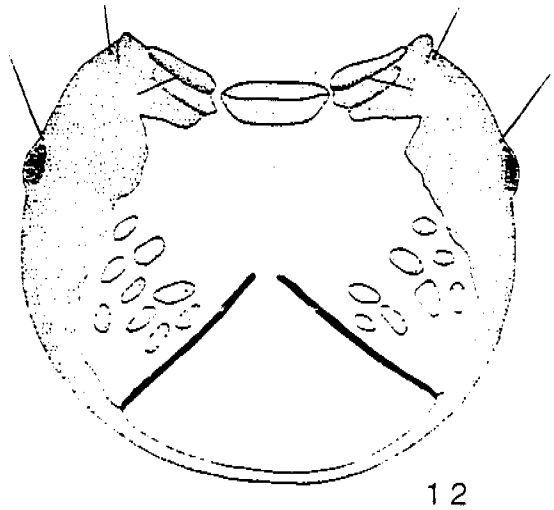

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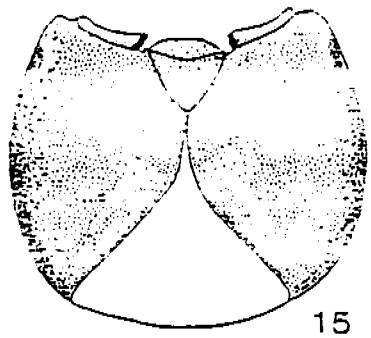

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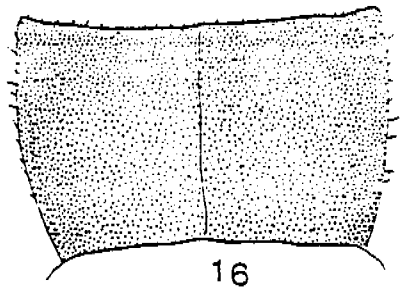

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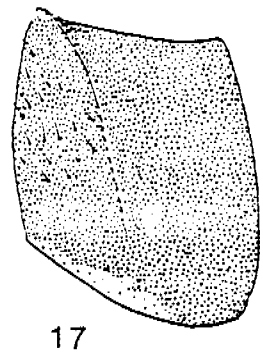

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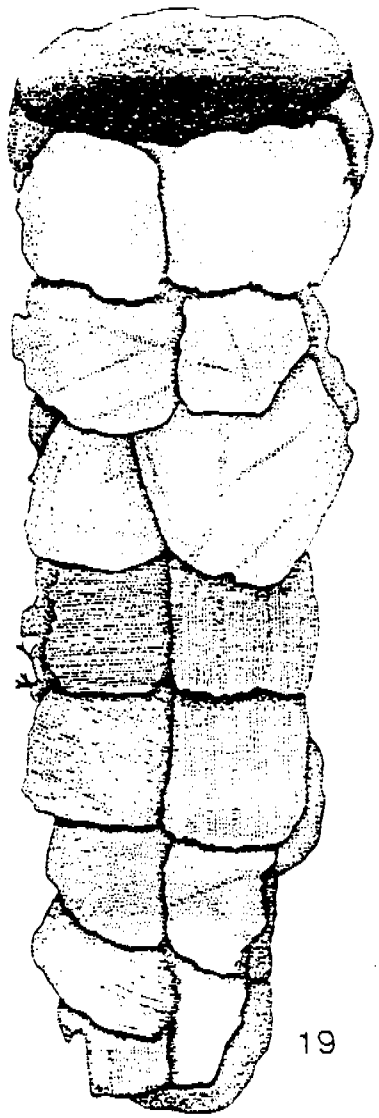

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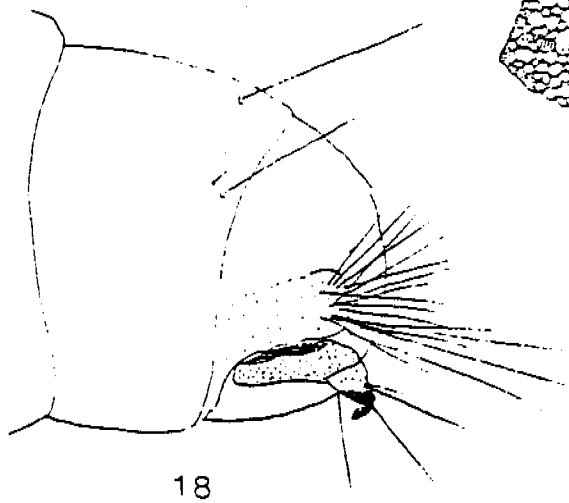

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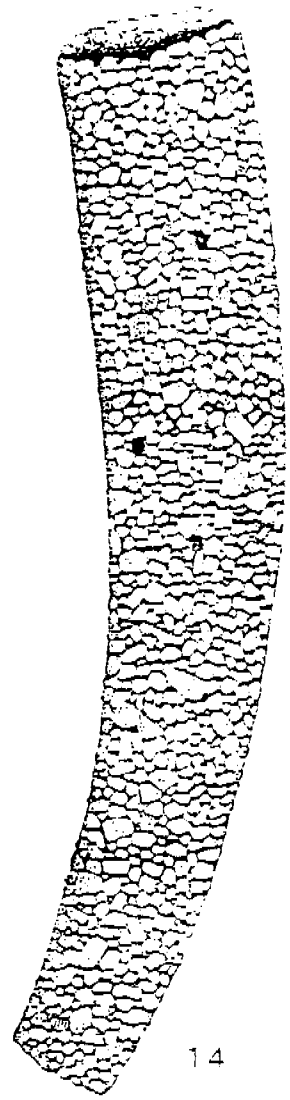
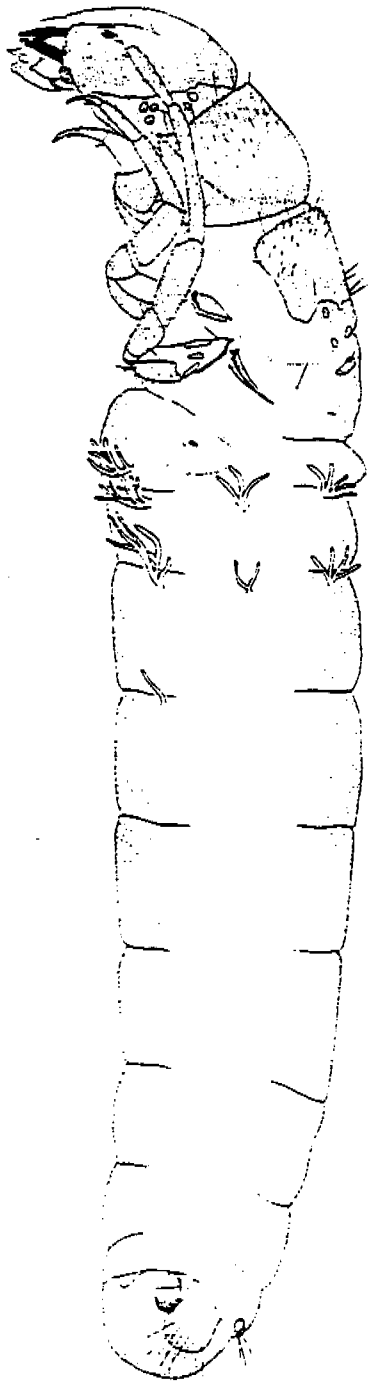


14

## FAMILY CONOESUCIDAE

Larvae moderately small (5-8 mm long), tube cases either constructed solely of silk or with incorporated materials such as sand grains and plant fragments. Head rounded in dorsal view; ventral apotome quadrangular, genae widely separated at occipital margin. Mesonotum almost entirely sclerotised, metanotum predominantly membranous with 1 or 2 pairs of small sclerites. Abdominal gills present or absent.

Distribution: Q'land, NSW, Vic, Tas, Sth Aust.



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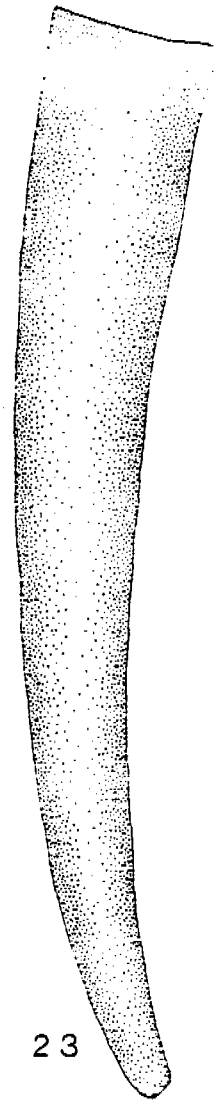

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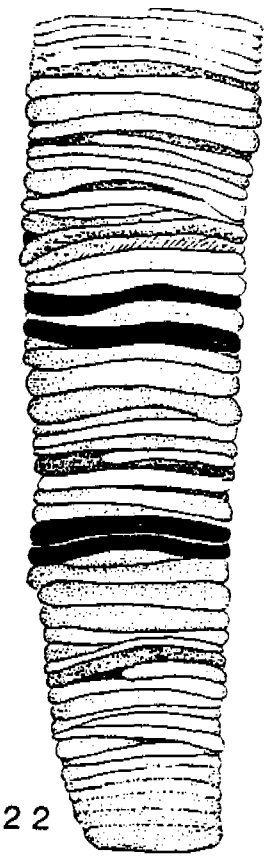

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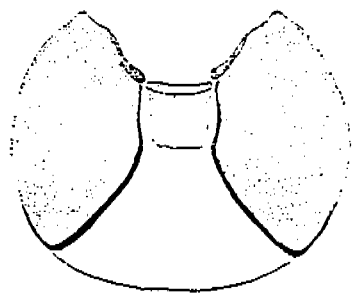

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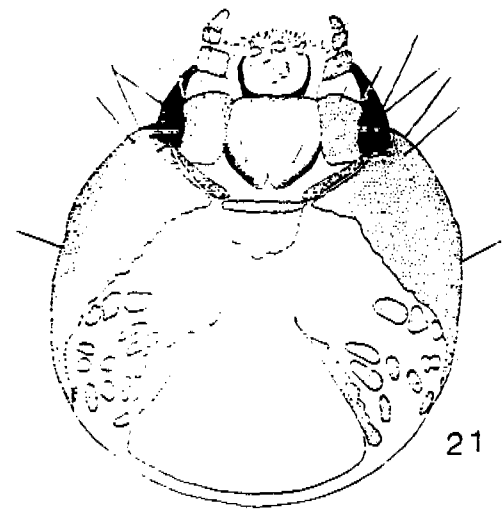
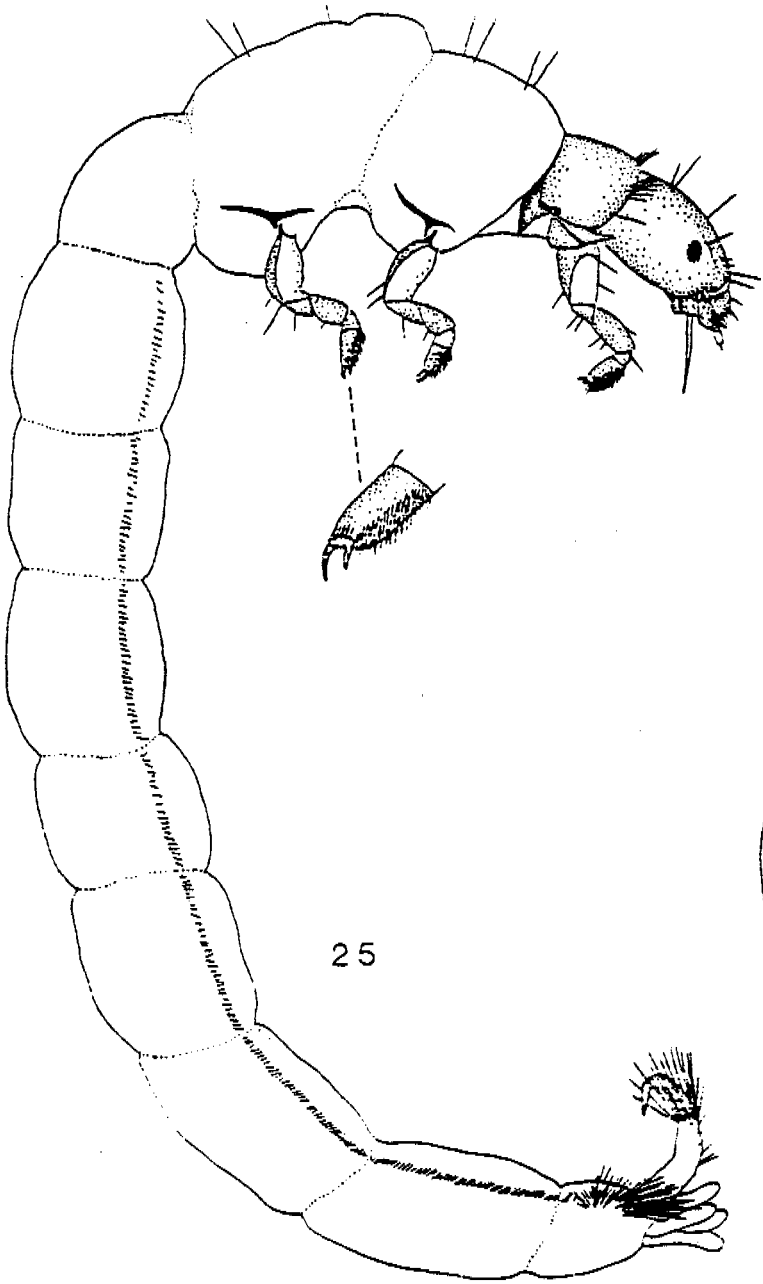


21

## FAMILY DIPSEUDOPSIDAE

Medium to large larvae (6-14 mm long), retreats consisting of branched silken tubes attached to logs deeply embedded in sand. Labium modified to form elongate spinneret, extending well beyond anterior margin of head capsule. Frontoclypeus reaching posterior margin of head capsule. Pronotum sclerotised, mesonotum and metanotum membranous. Abdomen without gills. Abdominal prolegs strongly developed, anal claws terminal.

Distribution: N Q'land.



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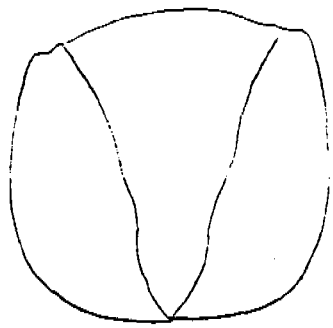

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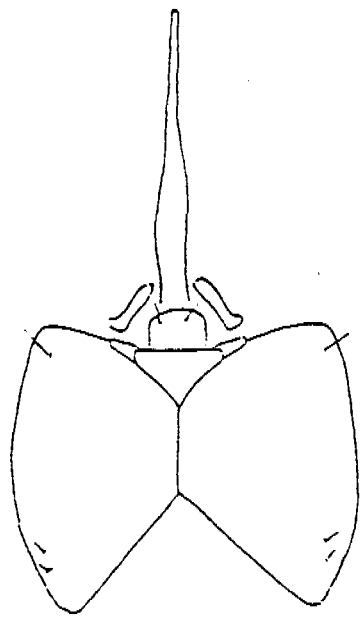
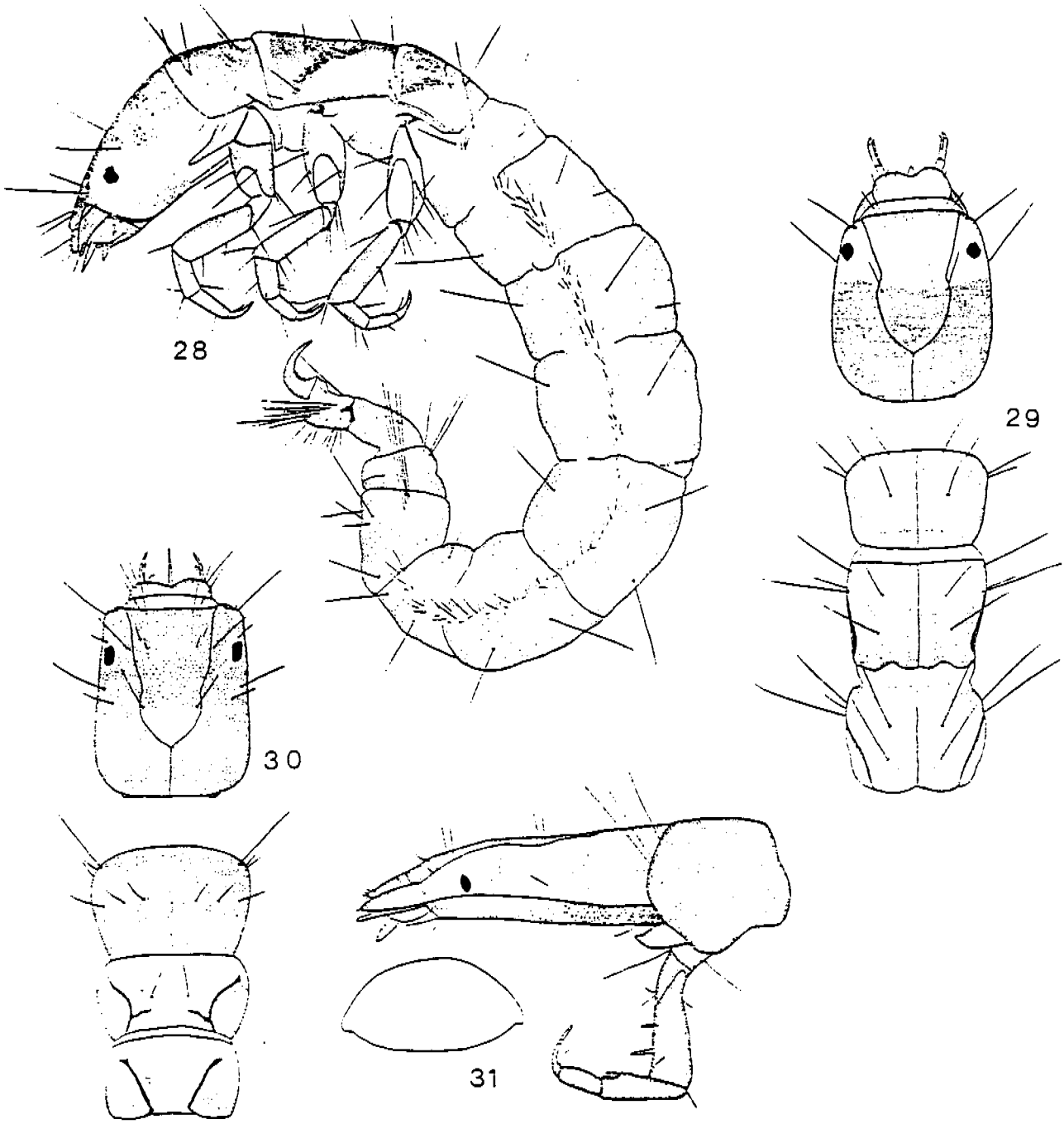


27

## FAMILY ECNOMIDAE

**Medium size larvae (5-10 mm long), constructing fixed retreats consisting of silken tubes** attached to solid substrates such as rocks and logs. All thoracic nota sclerotised, although in some species the mesonotum and metanotum are membranous along the midline. Fore trochantin elongate, slender. Abdomen without gills, abdominal prolegs strongly developed with large anal claws.

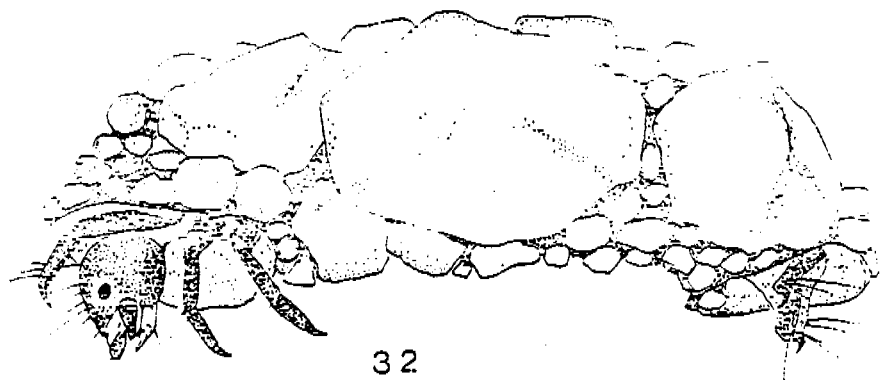
Distribution: Australia wide.



## FAMILY GLOSSOSOMATIDAE

Moderately small larvae (about 5-8 mm long), constructing portable stone "saddle cases". Pronotum completely sclerotised, mesonotum and metanotum each with a pair of small sclerites. Abdominal gills absent. Abdominal prolegs fused in basal half only, anal claws terminal.

Distribution: Q'land, NSW, Vic, Tas.



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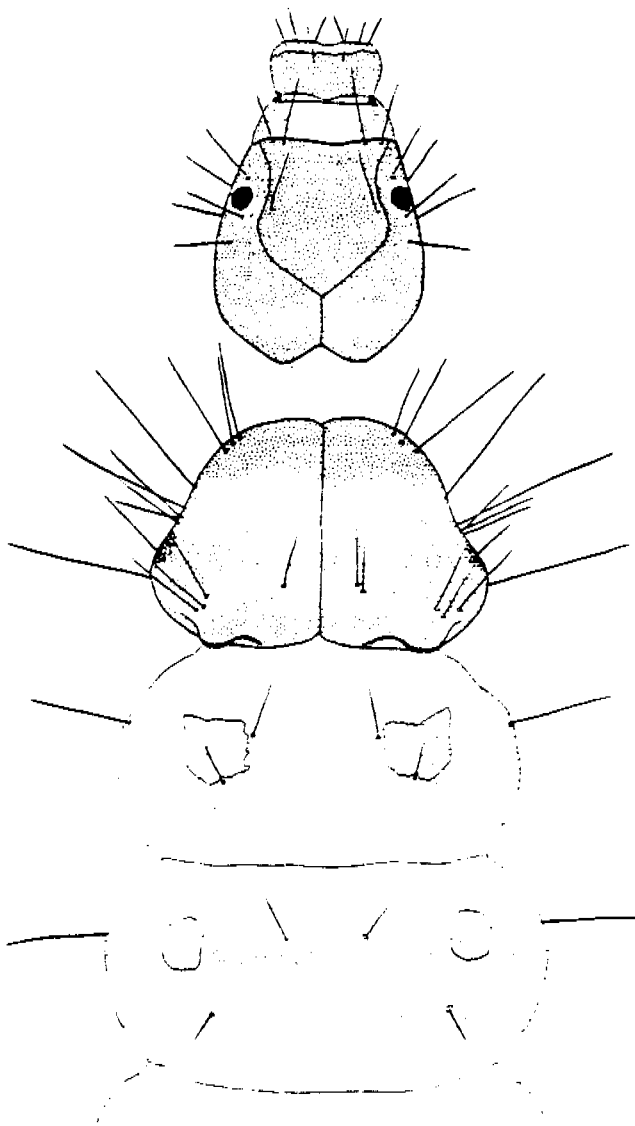

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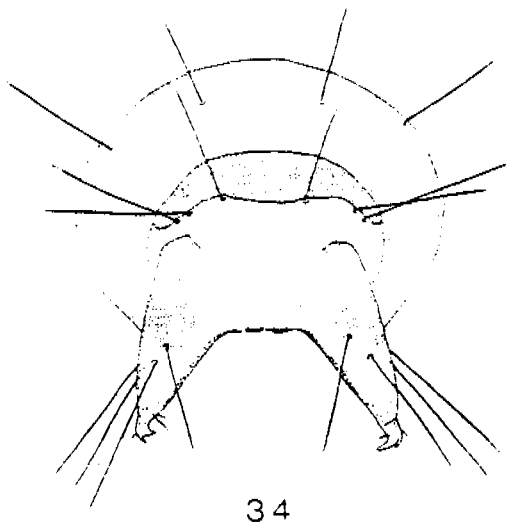
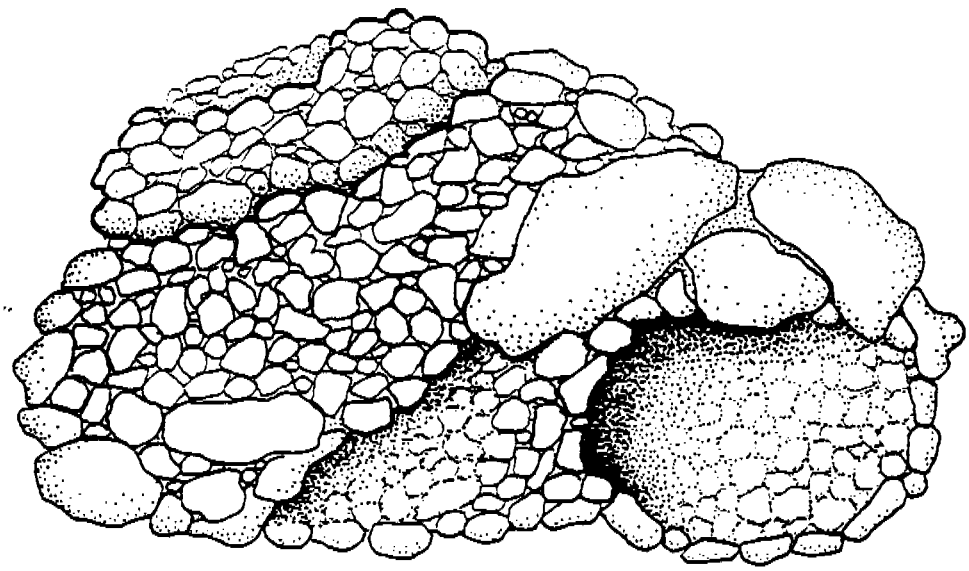


34

**FAMILY HELICOPSYCHIDAE**

Larvae moderately small (about 6 mm long), constructing helical case of sand grains. Pronotum and mesonotum heavily sclerotised, metanotal sclerites small. Fore trochantin long, narrow. Abdominal gills present. Anal claw small, bearing dorsal comb of fine teeth.
Distribution: NW Aust, NT, Q'land, NSW, Vic, Tas.



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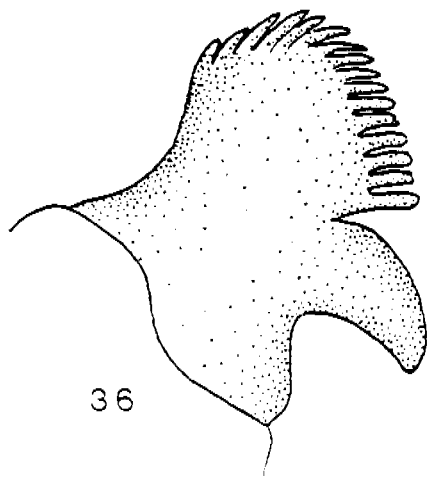
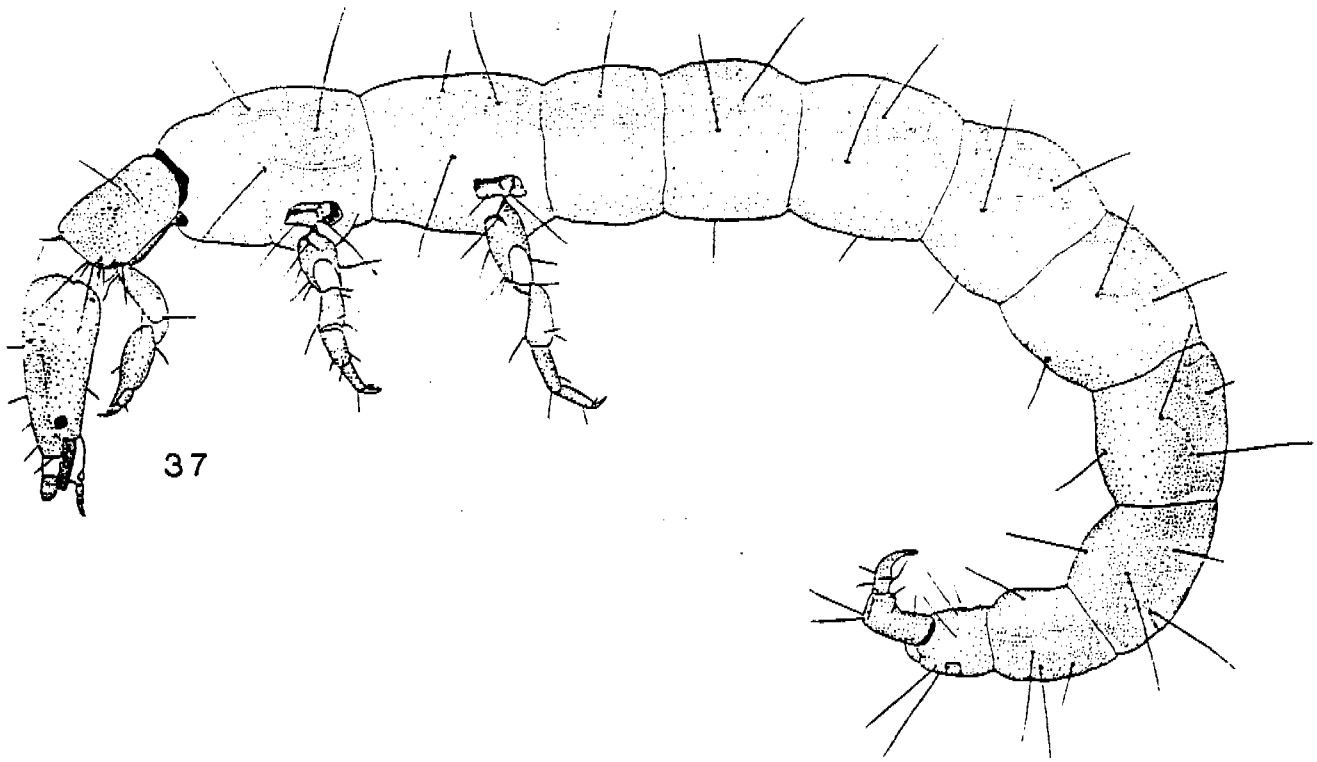


36

## FAMILY HYDROBIOSIDAE

**Medium to large larvae, (8-15 mm long), free living. Head and pronotum sclerotised,** prosternum usually with central sclerite. Mesonotum and metanotum membranous. Fore-leg modified, either chelate or with tarsal claw elongate. Abdominal gills absent. Abdominal prolegs strongly developed, anal claws large.

Distribution: Q'land, NSW, Vic, Tas, Sth Aust, SW Aust.



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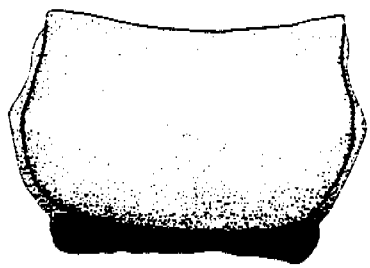

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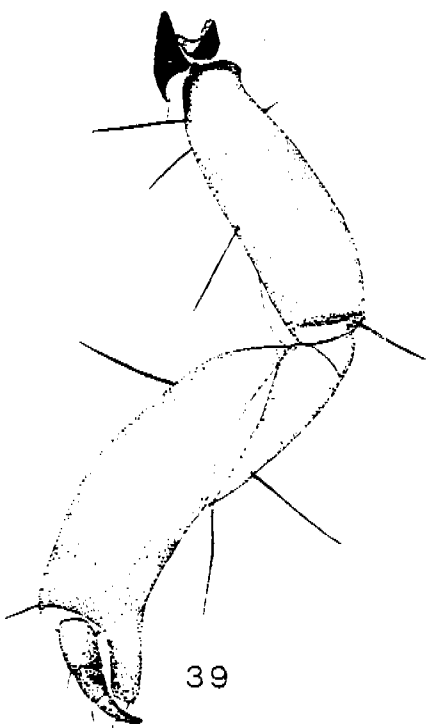

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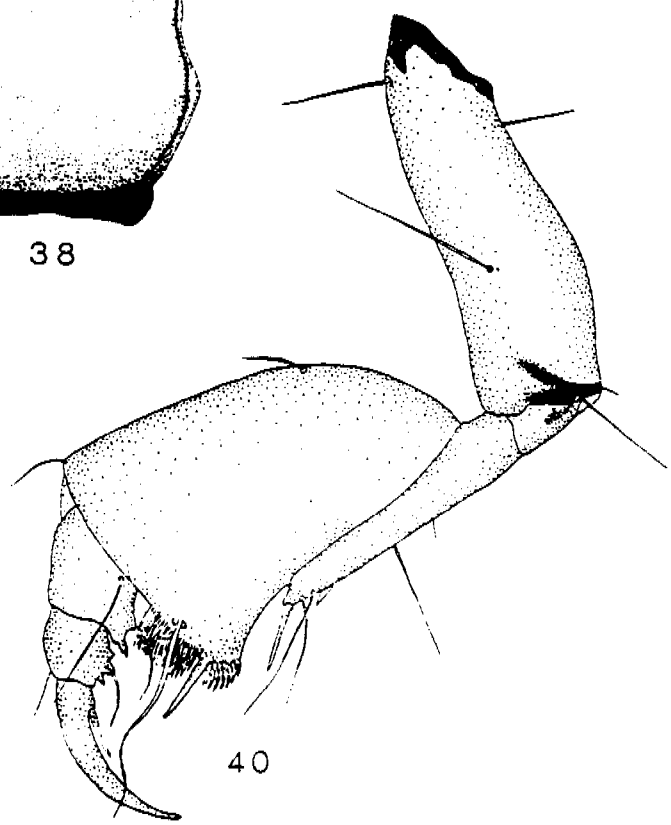
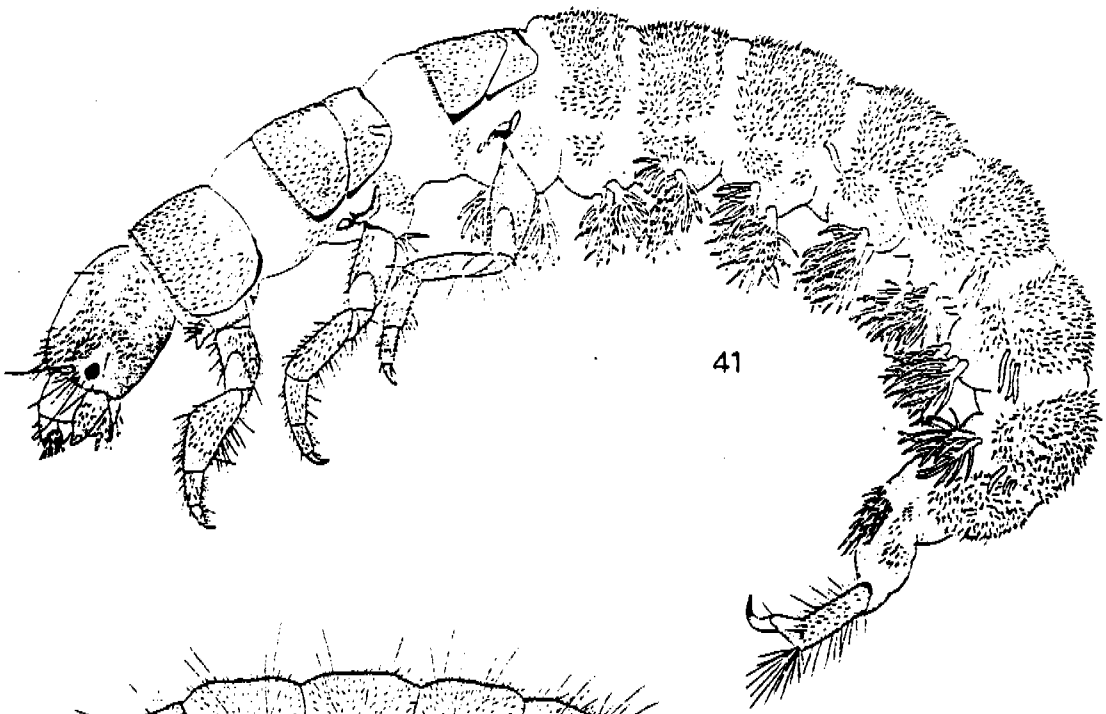


40

**FAMILY HYDROPSYCHIDAE**

Medium to large larvae (5-15 mm long), constructing silken retreats incorporating plant material and mineral particles, and at the upstream end a silk capture net. All thoracic nota sclerotised. Abdomen with conspicuous branched gills, abdominal prolegs strongly developed with terminal anal claws.

Distribution: Australia wide.



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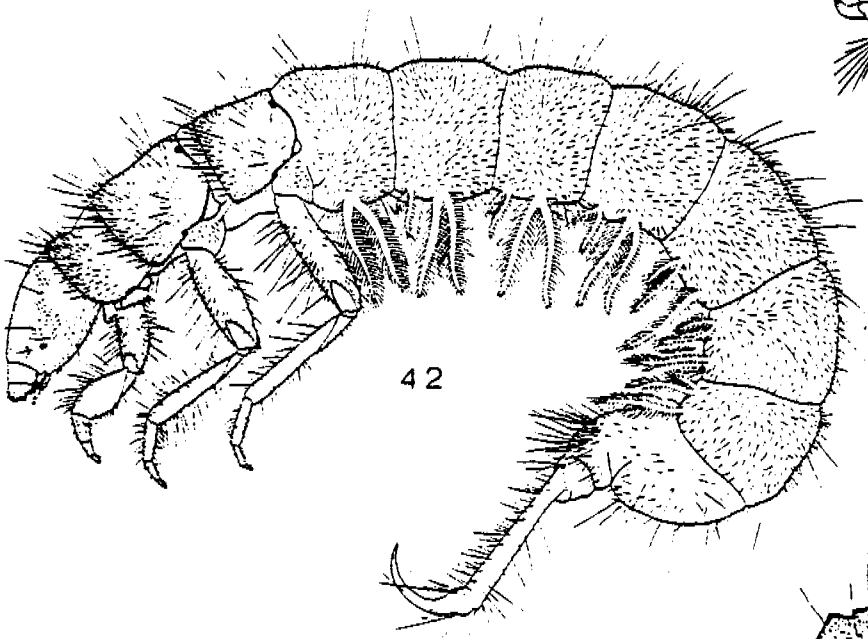

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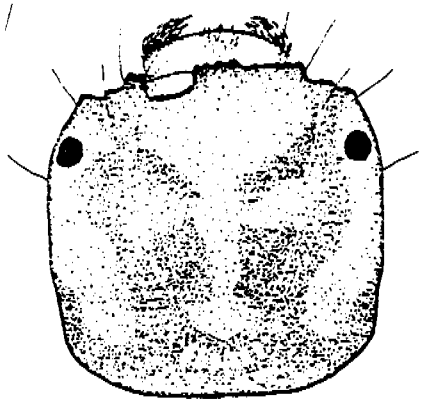
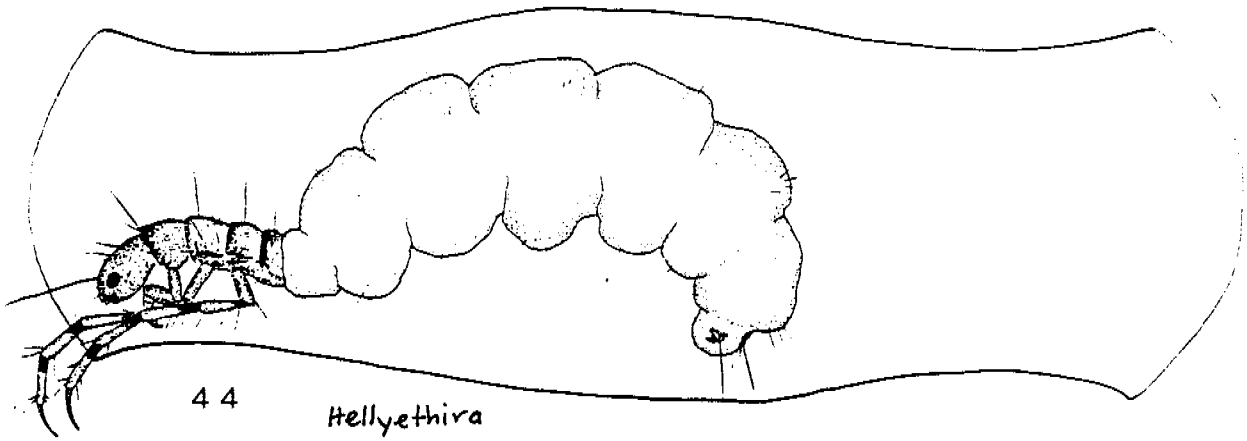


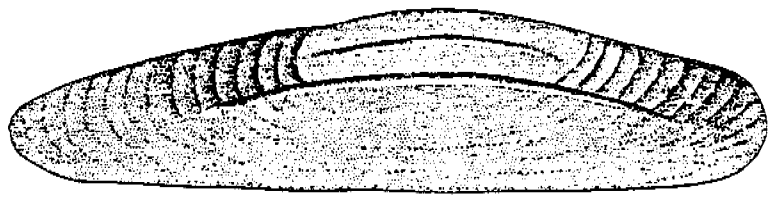
43

## FAMILY HYDROPTILIDAE

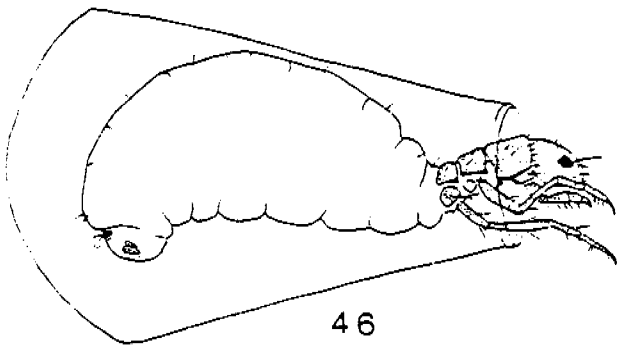
**Small larvae (usually 2-6 mm long), early instars free living and final instars constructing** purse-like cases of silk, often incorporating sand grains or algal material. All thoracic nota sclerotised. Abdominal gills absent, abdomen usually greatly enlarged relative to the thorax. Abdominal prolegs fused, anal claws small and laterally placed on terminal segment.
Distribution: Australia wide.



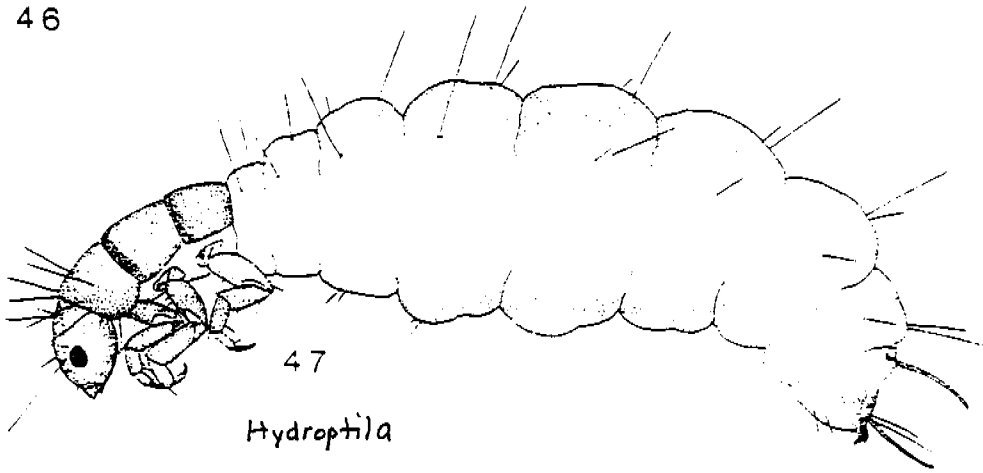
44 Hellyethira



Orthotrichia 45



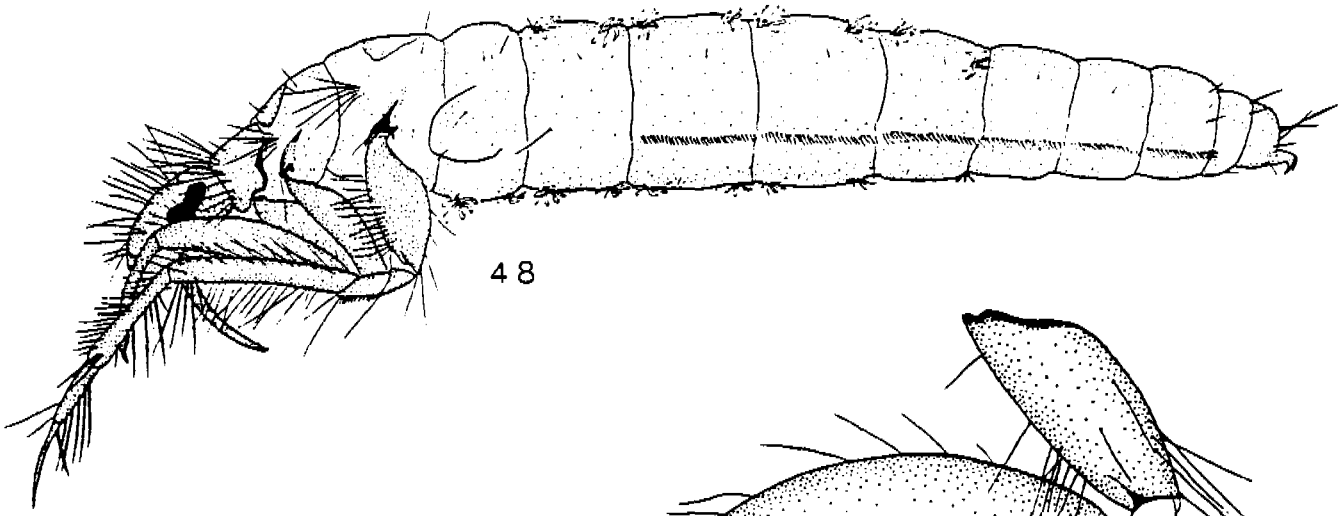
46 Oxyethira



47 Hydroptila

## FAMILY KOKIRIIDAE

Medium sized larvae, constructing portable cases of sand/gravel. Head strongly dome-shaped, eyes often large, elongated. Mesothorax and metathorax weakly sclerotised. Fore and middle legs with tibia and tarsus fused. Abdomen with gills and a lateral fringe of setae.
Distribution: Vic, Tas.



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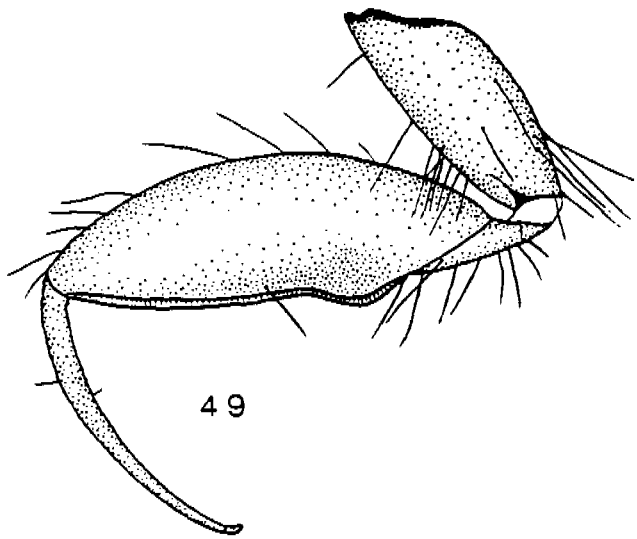

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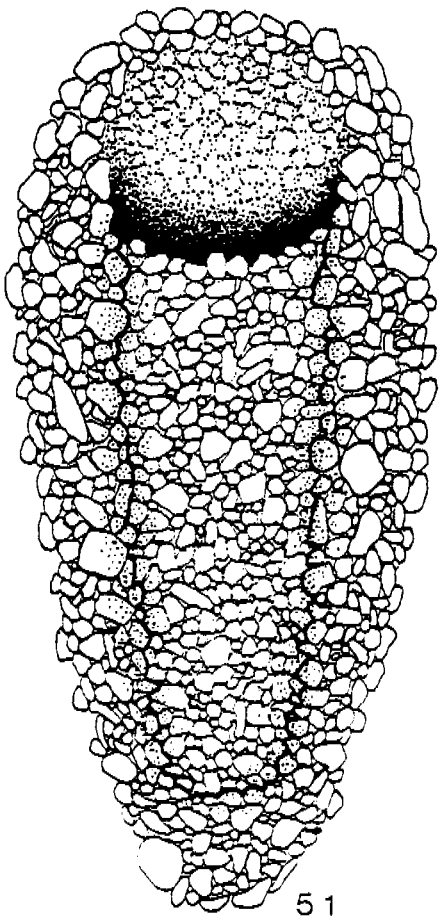

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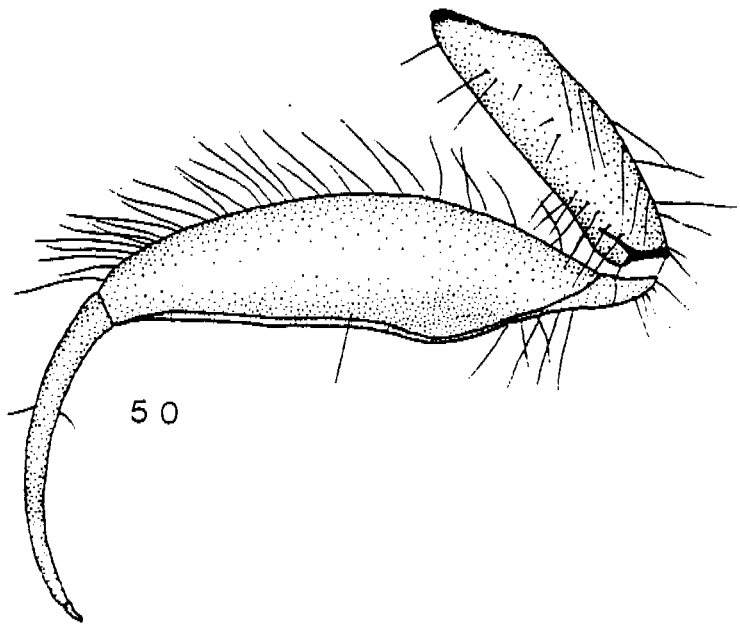
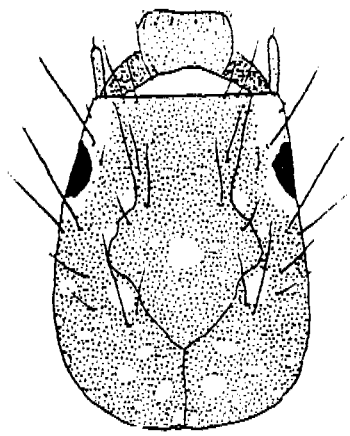


50

## FAMILY LEPTOCERIDAE

Small to large larvae (2-17 mm long), constructing cases from mineral and plant material arranged in a variety of ways, with some species hollowing out a single twig or grass stem.
The antennae are usually obvious and often relatively long, at least 1/5 the width of the anterior margin of the frontoclypeus. When shorter, the antennae are usually still obvious, except for *Triplexa* (Fig 5 5). Pronotum and mesonotum strongly sclerotised, metanotum either completely membranous or predominantly membranous with 2-5 sclerites. Metasternum with at least two and often many setae. Hind legs considerably longer than fore legs, hind femur divided and, in some genera, hind tibia also. Abdominal gills usually present.
Distribution: Australia wide.



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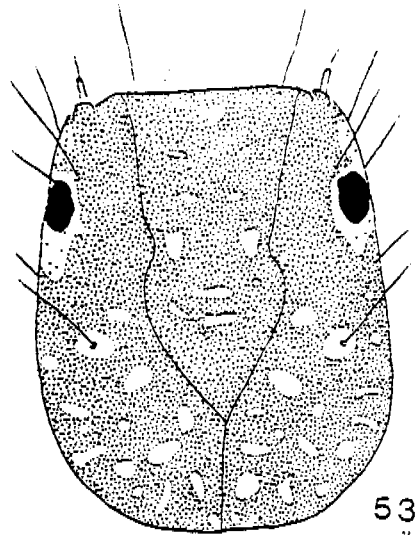

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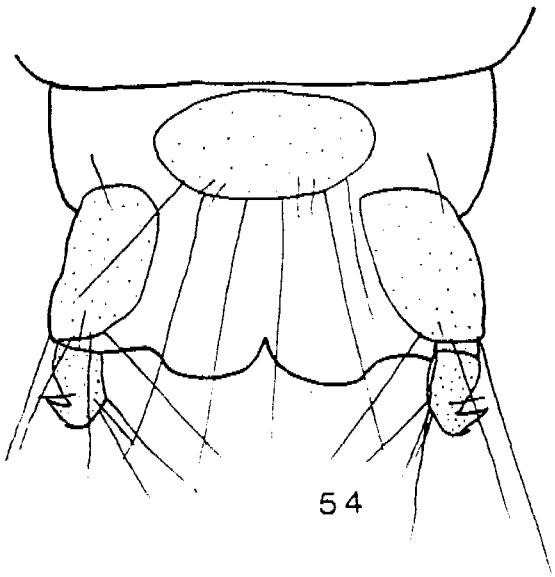

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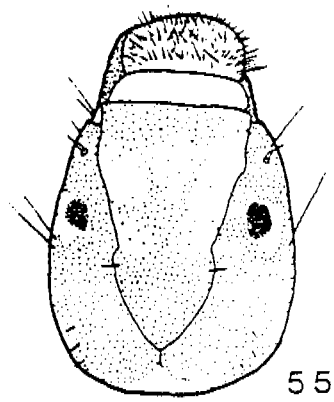
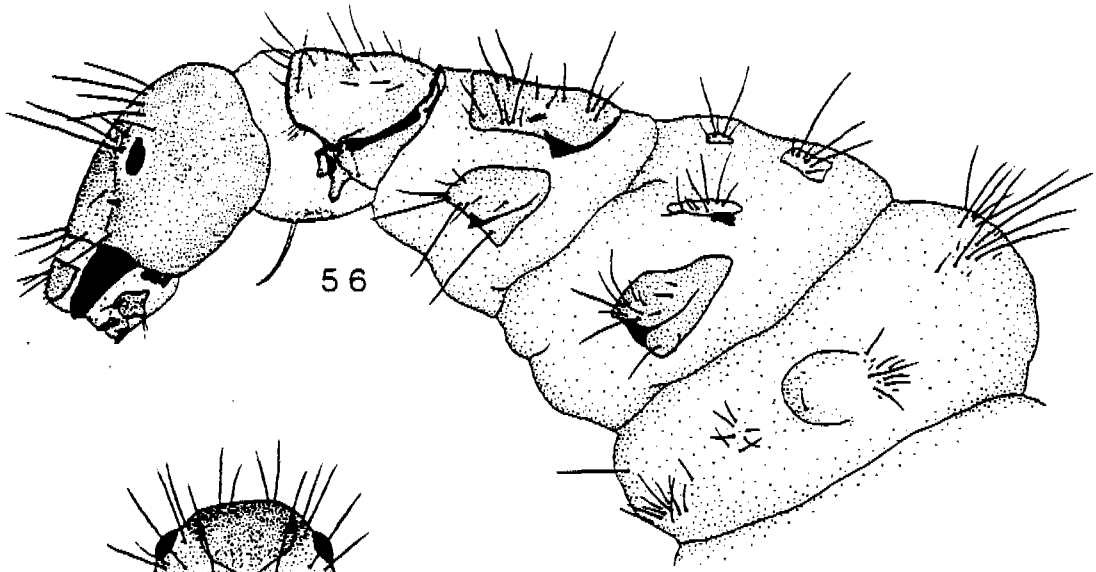


55

**FAMILY LIMNEPHILIDAE**

Larvae moderate to large (up to 20 mm long), constructing tube cases of gravel, vegetable material, or a combination of both. Prosternal horn present. Metanotum with 2 or 3 pairs of small sclerites. Lateral fringe of setae on most abdominal segments, abdominal gills present. Distribution: NSW, Vic, Tas.



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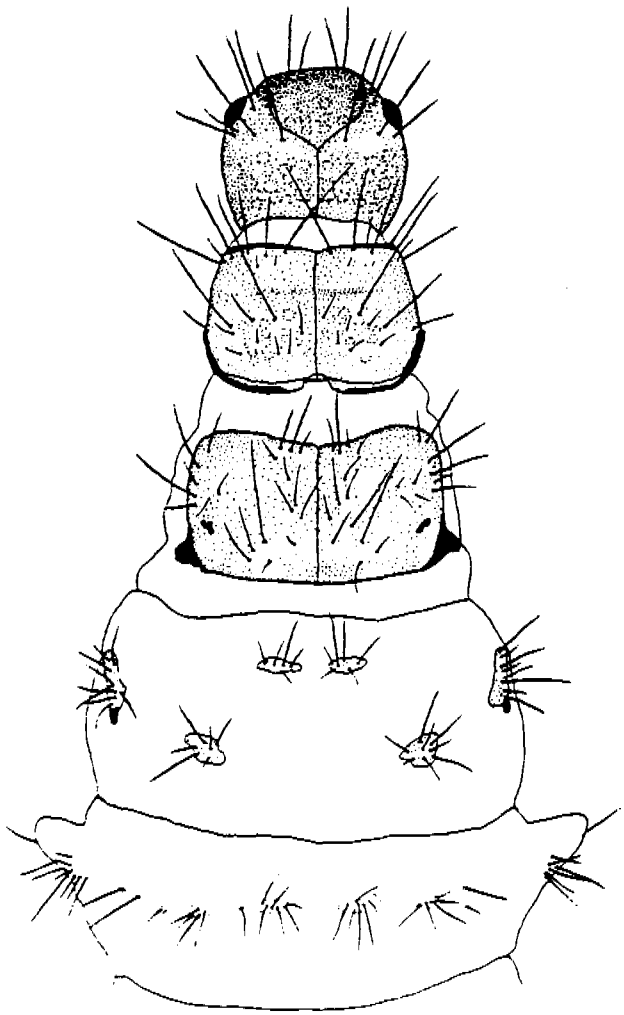
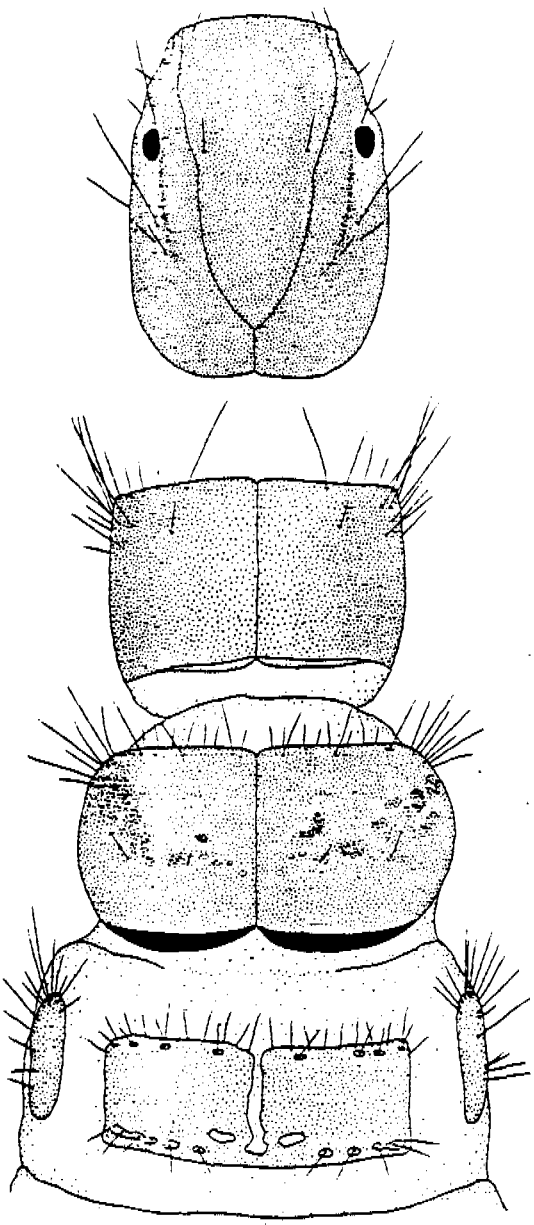


57

## FAMILY ODONTOCERIDAE

Moderate to large larvae (8-16 mm long), constructing tubular cases from sand and fine gravel. Head with lateral carina, sometimes weak. Pronotum and mesonotum completely sclerotised, metanotum with 2-4 pairs of sclerites. Prosternum with single large sclerite or a pair of smaller sclerites. Abdominal gills present.

Distribution: Q'land, NSW, Vic.



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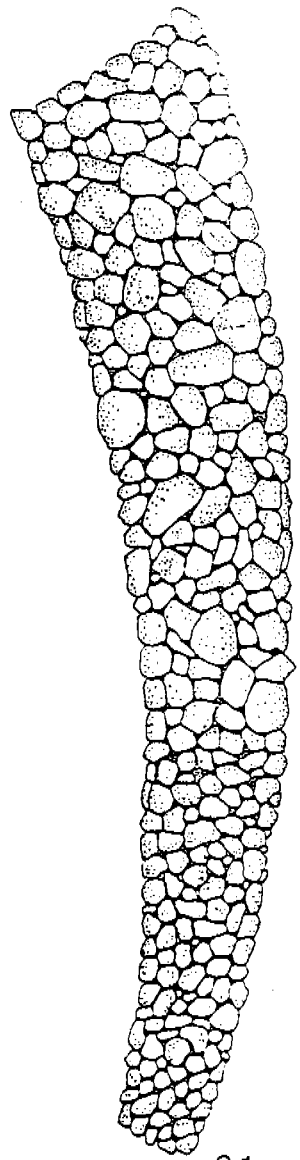

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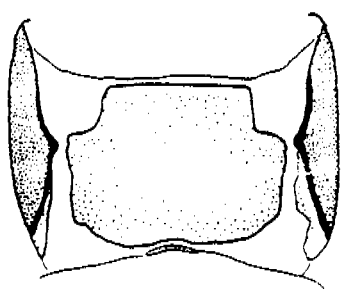

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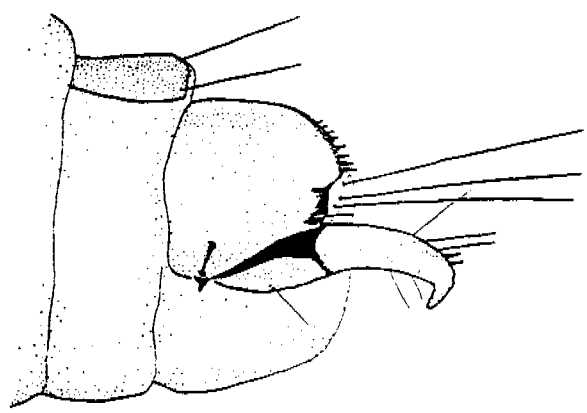
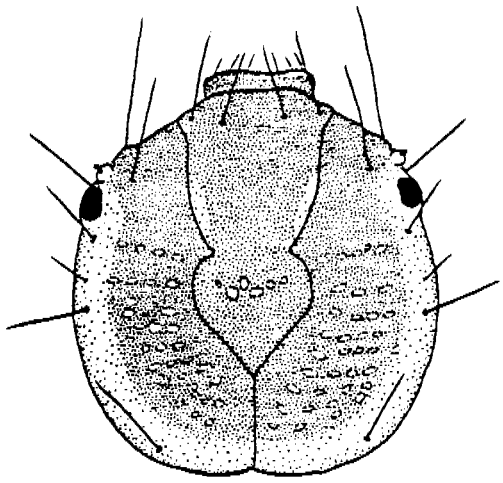


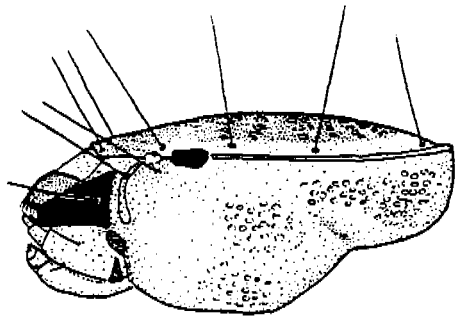
60

**FAMILY OECONESIDAE**

Moderately large larvae, cases constructed of irregular pieces of plant material. Head capsule almost circular, with strong carina. Pronotum with transverse elliptical bulge on each side, mesonotum and metanotum each with three pairs of sclerites. Abdomen with lateral fringe of fine setae, abdominal gills present.

Distribution: Tas.





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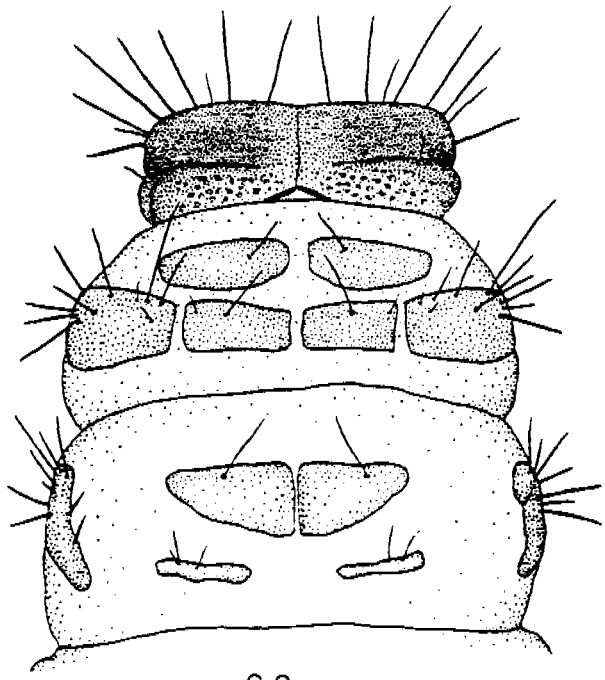

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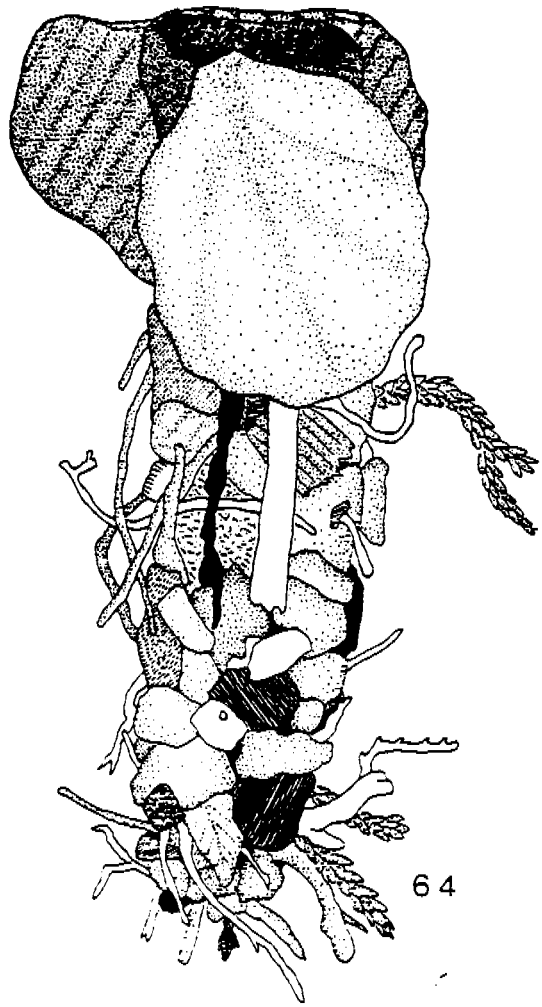
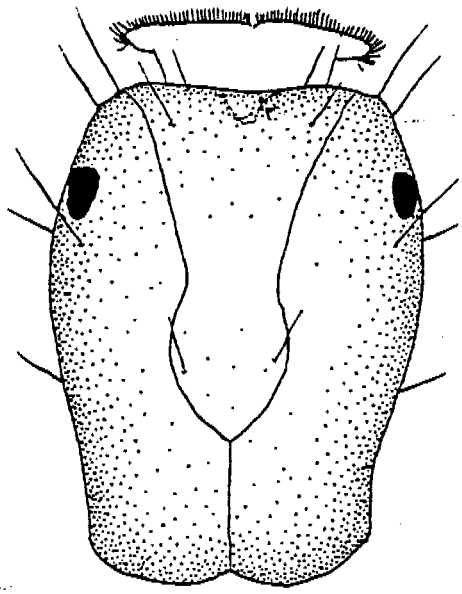


64

## FAMILY PHILOPOTAMIDAE

Medium size larvae (8-12 mm long), constructing silken retreats on the underside of rocks in flowing water. Head and pronotum sclerotised, mesonotum and metanotum membranous. Labrum membranous, anterior margin broader than posterior margin. Abdomen white or yellowish, without gills. Abdominal prolegs strongly developed, anal claws terminal.
Distribution: Australia wide.



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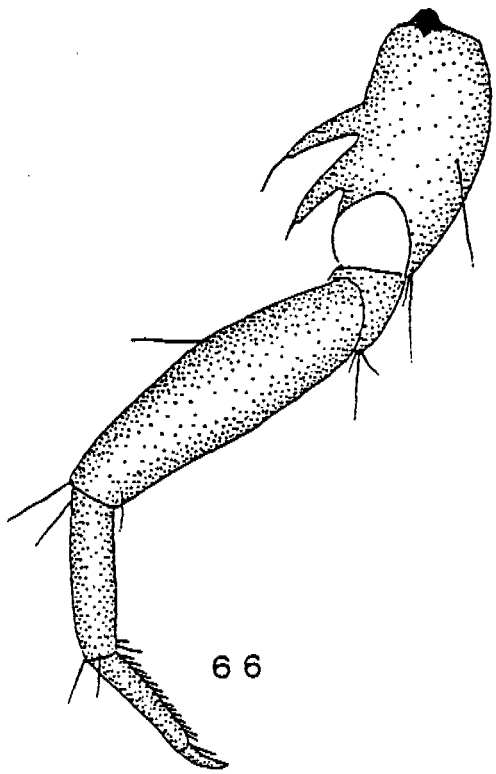
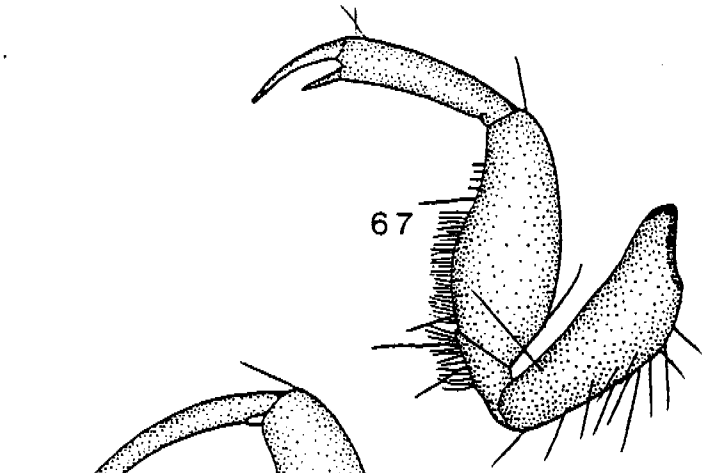


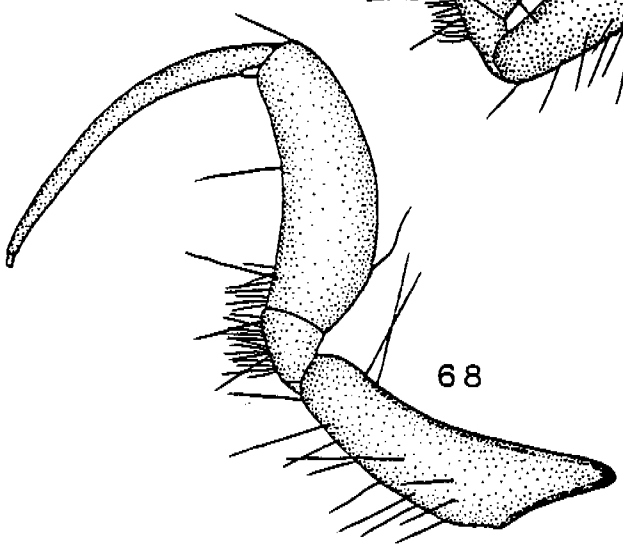
66

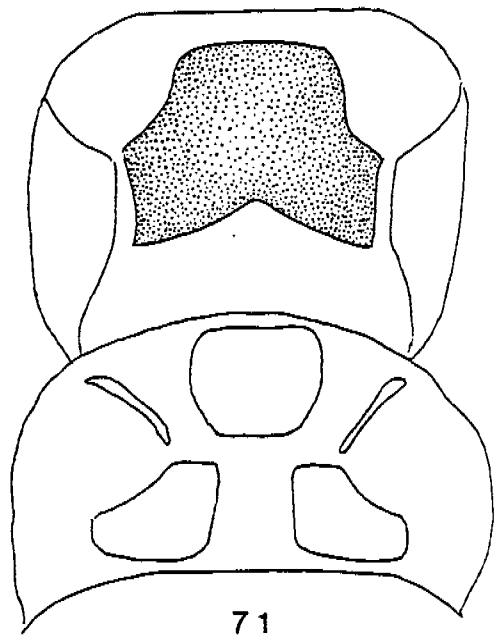
**FAMILY PHILORHEITHRIDAE**

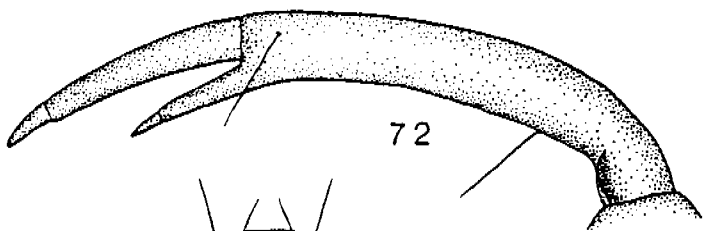
Moderate to large larvae (8-12 mm long), constructing portable cases of sand and gravel. Antennae small, close to anterior margin of head capsule. Ventral apotome triangular, not separating genae. Pronotum and mesonotum fully sclerotised, metanotum usually predominantly sclerotised, with 1-3 pairs of sclerites. Prosternum with large sclerite. Middle leg with tibia and tarsus fused. Abdominal gills present. Large sclerite on abdominal tergite nine.

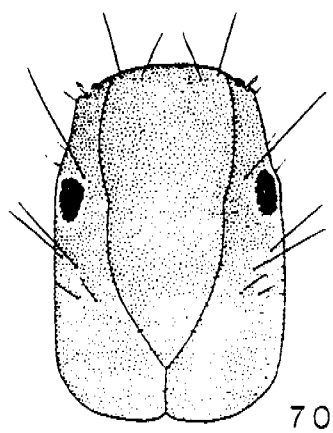
Distribution: Q'land, NSW, Vic, Tas, SW Aust.

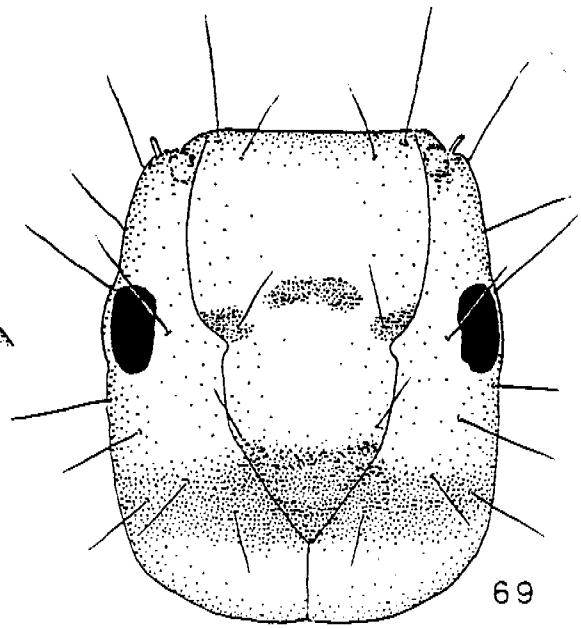


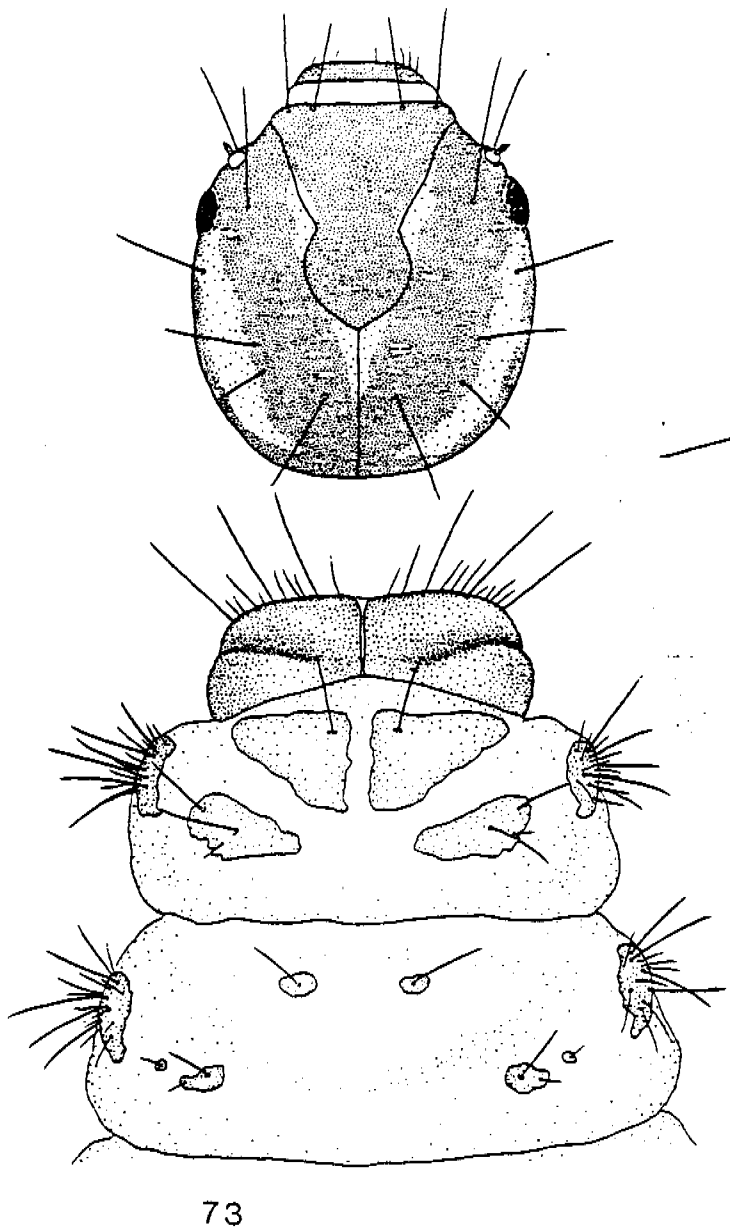



## FAMILY PLECTROTARSIDAE

Small to medium sized larvae, constructing untidy tubular cases from vegetable material. Pronotum short with transverse elliptical bulge. Prosternum with median horn-shaped process rather short. Mesonotum and metanotum each with three pairs of sclerites. Legs stout. Abdominal gills present.

Larvae are known for only one of the three Australian genera.

Distribution: Vic, Tas, SW Aust.



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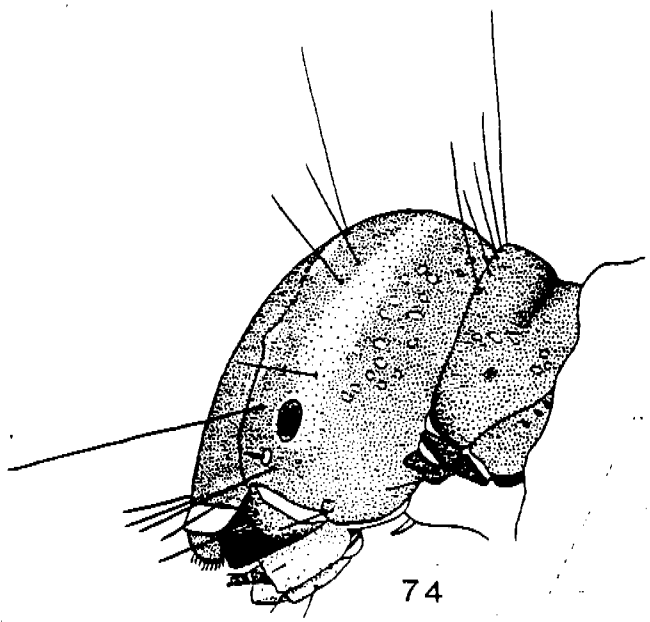

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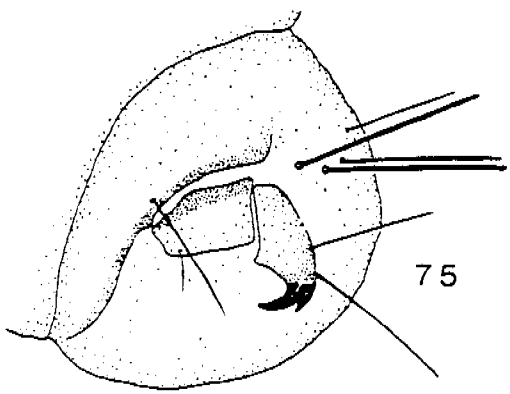

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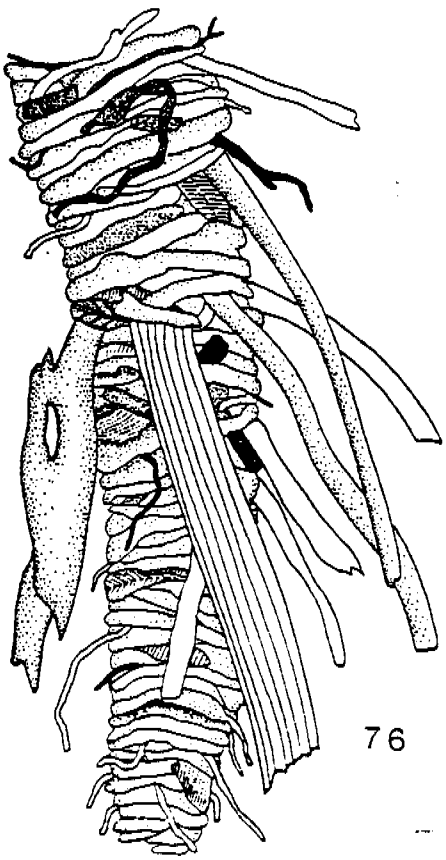

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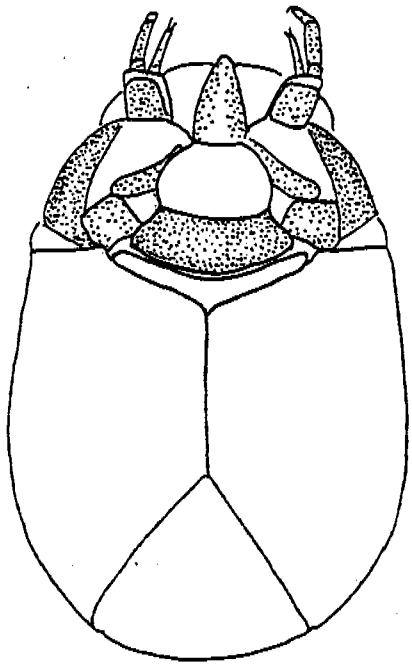
**FAMILY POLYCENTROPODIDAE**

Medium to large larvae (6-16 mm long), constructing fixed retreats on the sides and undersurface of large rocks. Ventral surface of head with post mental sclerites fused. Pronotum sclerotised, mesonotum and metanotum membranous. Fore trochantin well developed, slender and tapered. Abdomen without gills. Abdominal prolegs strongly developed, anal claws large.

Distribution: Australia wide.



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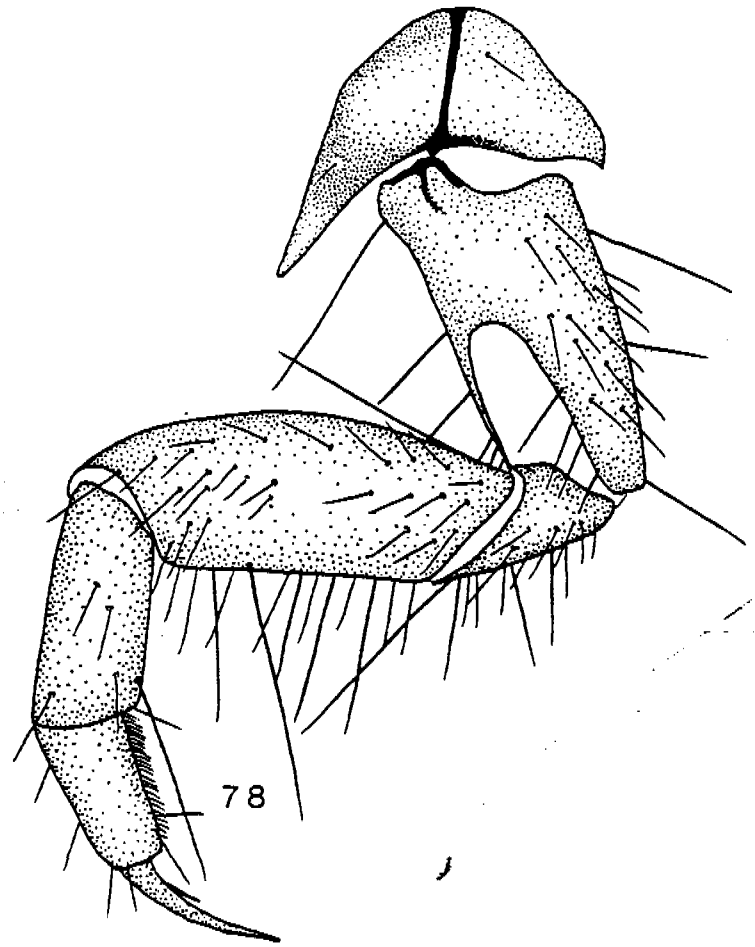

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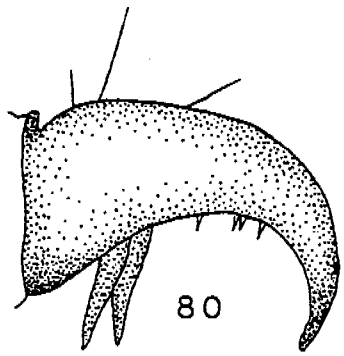

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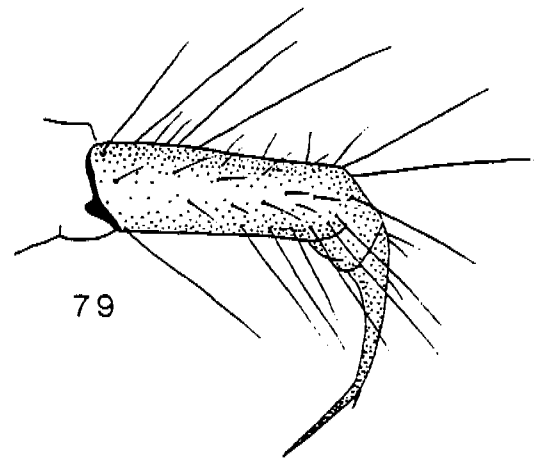

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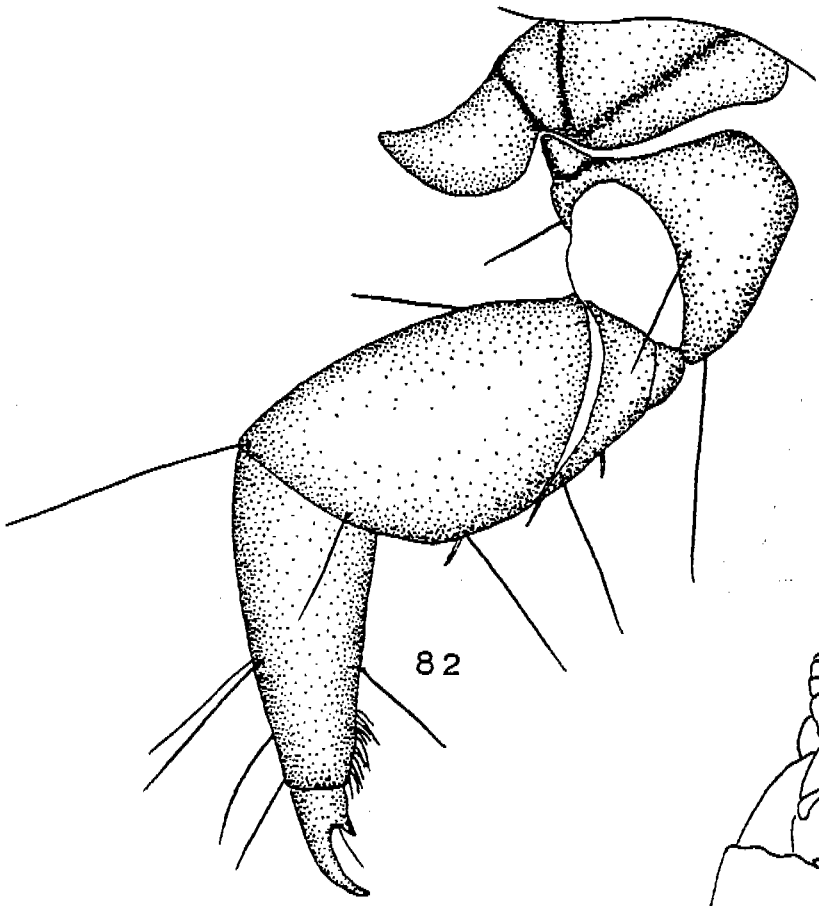
**FAMILY PSYCHOMIIDAE**

Medium sized larvae, (7-10 mm long). Constructing silken retreats on solid substrates. Pronotum sclerotised, mesonotum and metanotum membranous. Labium modified to form spinneret, which extends beyond anterior margin of head capsule. Post mental sclerites discrete. Fore trochantin broad, hatchet shaped. Abdomen without gills; basal segment of abdominal proleg much shorter than distal segment.

Distribution: NT, N Q'land.



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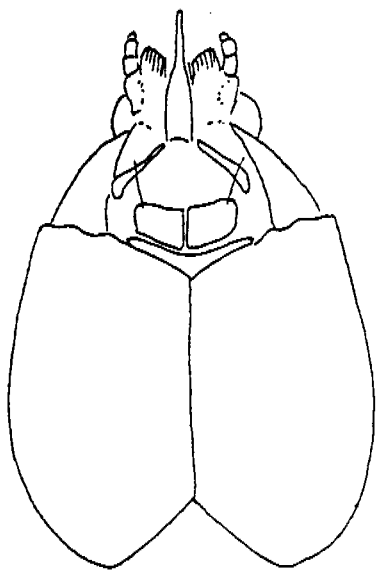

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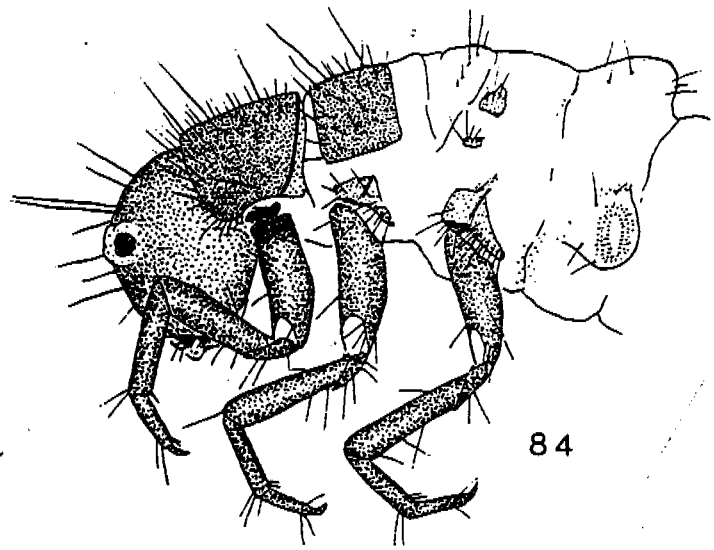
**FAMILY TASIMIIDAE**

Moderately small larvae (5-6 mm long), case dorsoventrally flattened and constructed of mineral particles. Head rounded, eyes bulging. Pronotum and mesonotum with large sclerites, metanotum with two pairs of small sclerites. Legs subequal in length. Abdomen with strongly developed lateral fringe of setae. Abdominal gills present.

Distribution: Q'land, NSW, Vic, Tas, Sth Aust.



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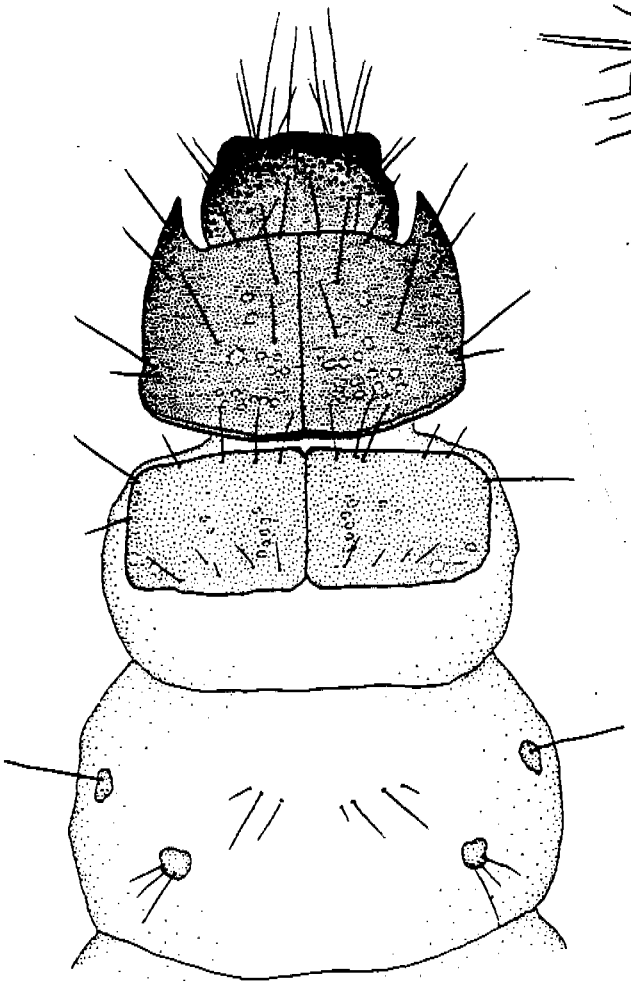

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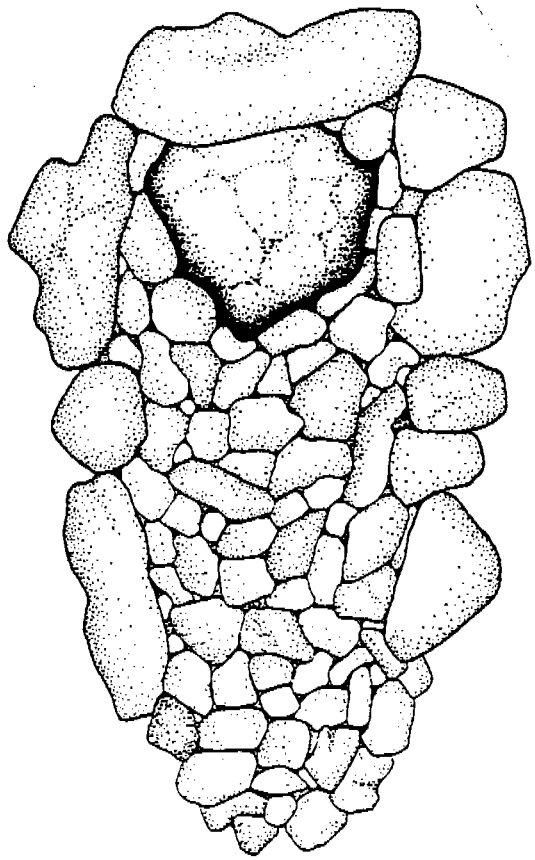

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# TRICHOPTERA NOTES

# TRICHOPTERA NOTES

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# SUPPORT DOCUMENT 2

# GUIDELINES FOR IDENTIFICATION AND QUANTIFICATION FOR AGENCIES PARTICIPATING IN THE MRHI BASED ON QUALITY CONTROL PROCEDURES

# GUIDELINES FOR IDENTIFICATION AND QUANTIFICATION FOR AGENCIES PARTICIPATING IN THE MRHI BASED ON QUALITY CONTROL PROCEDURES

John Hawking (CRCFE/MDFRC) and Ruth O'Connor (ERISS)

Draft 6 June 1997

## 1. BACKGROUND

The quality control / quality assurance (QA/QC) procedures are designed to establish an acceptable taxonomic standard of macroinvertebrate identifications for the state/territory agencies involved in the MRHI bioassessment. The quality control component is to determine the variation in the level of identifications and monitor this to detect changes in quality, and quality assurance provides potential users with the assurance that the accuracy of the results is within controlled limits.

Approximately 5% of the samples identified by each agency, as collected within each sampling round, were requested for cross-checking. The samples were selected with the aim to cover a range of biogeographical regions and habitats sampled (and thus the broadest range of taxa likely to be encountered). The samples were selected on a stratified / random basis, by (a) catchment (b) habitat (c) sampler. Samples were selected randomly from within a given biogeographical region and habitat. Duplicate samples from within biogeographical region and habitat were also selected to allow for breakages and to increase the scope of checking a broad range of staff who performed the original identifications.

Each laboratory is requested to forward the samples to be cross-checked, with the organisms sorted to order level (single order per vial) or if possible to family level, especially when the family is abundant. The order level separation eliminates any high level discrepancies. This also is needed for future curatorial preservation and storage. Sample vials should be individually wrapped or placed in polystyrene containers and packaged securely to avoid breakage during shipping.

The MRHI Technical Working Group has determined a taxonomic level for a selected list of macroinvertebrate taxa (Appendix 1). All taxa are to be identified to family level, except in the following cases: **(a)** Nemertea, Nematoda, Oligochaete, Polychaete, Conchostraca, Ostracoda (WA only, optional for other states/territories), Acarina and Collembola, which are to a higher level and **(b)** chironomids which are to the lower level of subfamily. Excluded from the list are some of the primitive groups, Porifera (sponges), Polyzoa (bryozoans) and the microinvertebrates (Rotifera, Cladocera, Copepoda, Branchiura, Tardigrada and Gastrotricha). The majority of the taxa listed in Appendix I are identifiable by the keys listed in the "MRHI Workshop Handbook" (Hawking 1995) and for lower level identifications use the keys suggested in the "Guide to keys" (Hawking 1994).

In the process of undertaking external QA/QC of invertebrate identifications for the Monitoring River Health Initiative, several common taxonomic problem areas have

been highlighted. Problems have arisen where there was confusion as to the required taxonomic level, or where the required level did not conform to that which the agency traditionally used, or where a subjective judgement was required as to whether a specimen was identifiable or not. This document aims to clarify required taxonomic levels, and give guidance on how to deal with problematic taxonomic groups. The outcome will hopefully be for a more consistent approach to macroinvertebrate identification across agencies and fewer identification errors.

## 2. TAXONOMIC PROCEDURES FOR IDENTIFIERS

### 2.1 Identification Tree

Specific instructions will be given for particular taxa which have commonly been misidentified, but it was recognised that it would be impossible to cover every potential identification problem in this way. Therefore to provide a generic procedure to be applied for the identification process a decision tree (Appendix II) has been formulated. The decision tree should be used if any uncertainty arises as to whether or not a specimen can be identified.

### 2.2 Voucher collection

Representatives (late instar/stage specimens) of all taxa must be kept aside and curated to form a reference voucher collection. The collection should be arranged systematically, in phylogenetic order, with accompanying voucher sheets and a list of the references used [The operation and maintenance of the voucher collection will be detailed in the QA/QC Procedures Manual, in preparation]. These reference specimens should be validated (have their identifications confirmed by a specialist) and then can be used for comparison with new specimens.

### 2.3 Specialist Taxonomists

The MRHI has provided funds (presently till December 1997) to support the taxonomic studies of a few specialists: John Dean, David Cartwright, Ros St Clair and Jean Jackson (taxonomic studies of Trichoptera families) and John Dean and Phil Suter (families of Ephemeroptera). The other specialist taxonomists have not been provided with funding and have to charge an identification fee (approximately $75.00 per hour). **This is a very small cost in the projects funding, especially considering its importance, to the validity of the results for the model.** Davies (1994) provided a list of the specialist taxonomists, which has been updated and included as Appendix III. **It is important** to contact the specialist and discuss your requirements before sending specimens.

## 3. COMMON TAXONOMIC PROBLEMS

Listed below are procedures to follow when unknown, immature, pupae, damaged, exuviae and terrestrial specimens are encountered.

### 3.1 Unknown specimens

Agency staff are expected to identify all specimens and this should be possible to the expected level, except in the cases discussed below. In the case of new or unknown taxa the identifier should attempt the identification and then (1) give the taxa a temporary code with its associated details on a temporary taxa sheet [This will be detailed in the QA/QC Procedures Manual] and (2) have the identification confirmed by a specialist (Appendix III). No taxon should be recorded as unidentified. It is the responsibility of the agency to make an effort to identify the specimen.

### 3.2 Immature specimens

Early instars/stages of many groups are difficult to identify as they lack the distinguishing features needed to identify them in a key In this case, as long as the specimens are immatures and only someone with specialist skills could identify the specimen, the identifier will not be penalised in QA/QC (see decision tree - Appendix II). When it is impossible to identify these specimens, as they lack distinguishing features, it is appropriate to list the specimens as immatures (eg. immature Trichoptera). In many cases there are late instar specimens of a particular taxa that can be used for comparison to immature specimens. The other possibility is to mount the diagnostic features on a microscope slide and identify it under a compound microscope.

Some examples of immature specimens that can be misidentified are:

(1) Discriminating between the very early instars of corduliid and libellulid odonate larvae can be difficult, as the libellulid larvae that have palpal dentations, a major feature of the corduliids. This problem will be encountered mostly in northern Australia.

(2) Confusion can occur with the early instar ecnomids, first instar hydropsychids and hydroptilids which have come out of their cases.

(3) Immature specimens of Corbiculidae can be confused with mature Sphaeriidae specimens.

### 3.3 Pupae

Many insect pupae can't be identified due to the lack of keys and it is acceptable for staff to record them to order (eg. Diptera pupae, Trichoptera pupae, etc). Many can be identified to family and this is encouraged. In the assessment pupae will not be counted as a new taxa because they are only another stage of a taxon (eg. larva, pupa and adult of a single taxon). If they can be identified they should be added to the numbers for larvae of that particular family.

### 3.4 Damaged specimens

Many specimens are damaged during collection and a few simple rules can be applied to determine if a specimen should be included and how to estimate the number of specimens that are present.

(1) Heads and bums of damaged specimens should be counted and the highest number recorded. If a specimen cannot be identified due to damaged/missing features then it should be listed as damaged on data sheets e.g.Ephemeroptera (damaged).

(2) Oligochaetes are damaged easily and break-up into segments. Therefore their numbers must be estimated by counting the number of head and bum ends in the sample.

(3) Gills are an important feature in the identification of Ephemeroptera and zygopteran odonates. If Zygoptera are missing all caudal gills they may be identified by using other features eg. premental setae, along with distribution information (see decision tree - Appendix II). For example, if a taxonomic feature is common only to Families A and B, but Family A has never been recorded in the area, then it is reasonable to record the specimen as Family B based on its distribution in the area. The same principle can be applied to mayflies missing gills.

### 3.5 Exuviae and empty mollusc shells

Exuvial skins and empty shells should be disregarded as they are not indicative of the fauna at the particular site at that present time.

### 3.6 Terrestrial

Terrestrial animals are not to be counted but can be kept as examples for later reference. To be certain that the specimen is terrestrial, its identification should be confirmed by a specialist. If an aquatic organism is identified and recorded as terrestrial, then it is a misidentification and is counted as an error.

### 3.7 Difficult groups and commonly confused taxa

From the first phase of the monitoring program the following problem areas were recognised:

- The larvae of *Archichauliodes* (Megaloptera: Corydalidae) are commonly confused with gyrinid larvae (Coleoptera: Gyrinidae). The Corydalidae larvae have 8 pairs of lateral gills and the apical segment of abdomen with a pair of prolegs, whereas the gyrinid larvae have feathery gills on the first 8 abdominal segments, 2 pairs of gills on the 9th segment, and 2 pairs of hooks at the end of the 10th segment.

- Ecnomid, hydropsychid, philopotamid and polycentropid larvae are commonly confused. Ecnomid and hydropsychid larvae have sclerotization on the first three thoracic segments, whereas the philopotamid and polycentropid larvae have sclerotization only on the first thoracic segment (pronotum). Hydropsychids have abdominal gills (except in the first instar) whereas they are absent on ecnomids.

- Physids/planorbids have been grouped in the past (a decision made by some agencies). The separation of the two families is possible and the agencies that have keyed them out have attained good results. The radula should be boiled out

in dilute potassium hydroxide to positively confirm the identification and from this the major differences between the families will become apparent. There are other features that are diagnostic, as in the case of Physidae, the mottling, digitate processes on the mantle edge and the light coloured shell are easily recognisable, especially in larger specimens, which can be readily identified under the microscope. The methods and notes on the distinguishing features of the families are adequately covered in Smith (1996).

- The late stages, as with the immatures, of some species of the odonate family Libellulidae (those with palpal dentations) will key out to the family Corduliidae. All of the libellulids with palpal dentations can be distinguished by their short cerci (approximately half the length of epiproct), except species of *Agrionoptera*, *Pantala*, *Trapezostigma* and *Urothemis*. and these should be sent off for confirmation.

- Empidids and dolichopodids (Diptera) can be difficult to separate and may need to be grouped together when the identifier cannot reasonably separate them.

- Some of the families of Hemiptera (Salididae, Hebridae, Mesoveliidae) are mistaken as terrestrial bugs.

- The baetid, *Platybaetis* (from the NT) could be confused with the leptophlebiids, because of its prognathous head, but differs in that it has a very short median terminal filament (Dean & Suter 1996, Suter 1997).

- Confusion has arisen in the instances where the family name or status has changed.
  **(a)** Odonata: Family Chlorolestidae changed to **Synlestidae;** subfamily Isostictinae raised to family status, **Isostictidae;** family Macrodiplactidae reduced to subfamily status in the family **Libellulidae**; family Synthemidae reduced to subfamily status in the family **Corduliidae**.
  (b) Coleoptera: Family **Hydrochidae** reduced to subfamily status in the family **Hydrophilidae**; family **Scirtidae** formerly known as Helodidae; family **Elmidae** formerly known as Helminthidae.

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## CONTACTS

John Hawking, Cooperative Research Centre for Freshwater Ecology / Murray Darling Freshwater Research Centre, P.O. Box 921, Albury, NSW, 2640. Ph 060-582340, Fax 060-431626, Email hawkingj@mdfrc.canberra.edu.au

Ruth O'Connor, Environmental Research Institute of the Supervising Scientist, Locked Bag 2, Jabiru, NT, 0886. Ph (08) 89799713, Fax (08) 89792149, Email rutho@eriss.erin.gov.au

## ACKNOWLEDGEMENTS

Diane Crowther is thanked for her help in formulating these guidelines.

## APPENDIX I: LIST OF THE MAJOR GROUPS AND THEIR FAMILIES

| Phylogenetic Level | Reporting level |
|---|---|
| Platyhelminthes : Temnocephalidea | |
| Temnocephalidae | Family |
| Platyhelminthes : Turbellaria | |
| Dugesiidae | Family |
| Nemertea | |
| All families | Phylum |
| Nematoda | |
| All families | Phylum |
| Nematomorpha | |
| Gordiidae | Family |
| Chordodidae | Family |
| Mollusca : Gastropoda | |
| Viviparidae | Family |
| Thiaridae | Family |
| Neritidae | Family |
| Iravadiidae | Family |
| Stenothyridae | Family |
| Bithyniidae | Family |
| Hydrococcidae | Family |
| Hydrobiidae | Family |
| Ancylidae | Family |
| Planorbidae | Family |
| Lymnaeidae | Family |
| Physidae | Family |
| Mollusca : Bivalvia | |
| Hyriidae | Family |
| Corbiculidae | Family |
| Sphaeriidae | Family |
| Annelida : Hirudinea | |
| Glossiphoniidae | Family |
| Ozobranchidae | Family |
| Richardsonianidae | Family |
| Ornithobdellidae | Family |
| Erpobdellidae | Family |
| Annelida : Oligochaeta | |
| All families | Class |
| Annelida : Polychaeta | |
| All families | Class |
| Diplopoda | |
| Siphonotidae | Family |
| Arachnida : Acarina | |
| All families | Order |
| Crustacea : Anostraca | |
| Artemiidae | Family |
| Branchipodidae | Family |
| Thamnocephalidae | Family |
| Crustacea: Notostraca | |
| All families | Order |
| Crustacea : Conchostraca | |
| All families | Suborder |
| Crustacea : Ostracoda* | |
| All families | Subclass |

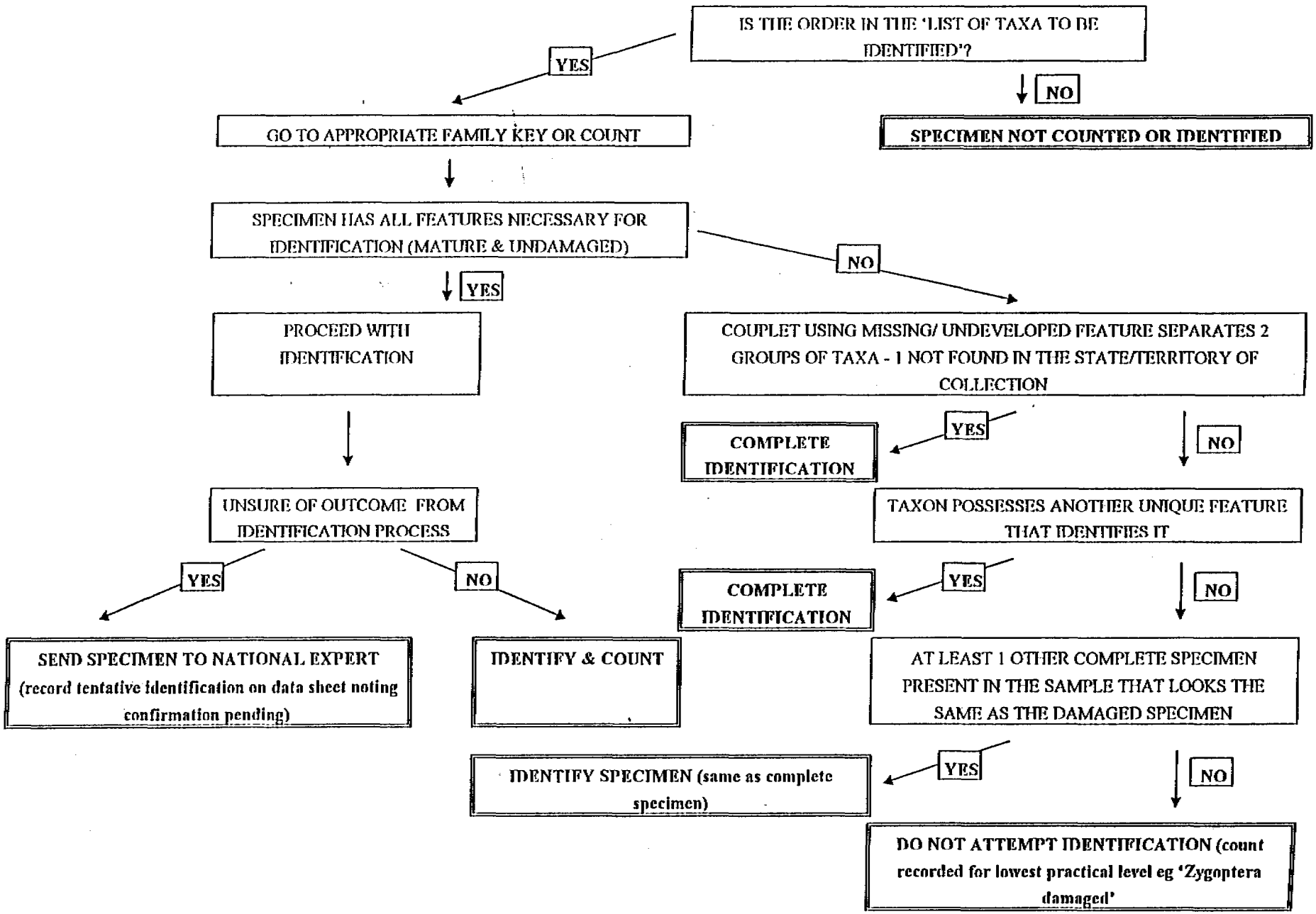
| Phylogenetic Level | Reporting level |
|---|---|
| Crustacea : Isopoda | |
| Cirolanidae | Family |
| Sphaeromatidae | Family |
| Janiridae | Family |
| Oniscidae | Family |
| Phreatoicoidae | Family |
| Crustacea : Amphipoda | |
| Corophiidae | Family |
| Ceinidae | Family |
| Paramelitidae | Family |
| Paracalliopidae | Family |
| Perthiidae | Family |
| Neoniphargidae | Family |
| Eusiridae | Family |
| Talitridae | Family |
| Crustacea : Decapoda | |
| Atyidae | Family |
| Palaemonidae | Family |
| Parastacidae | Family |
| Hymenosomatidae | Family |
| Sundathelphusidae | Family |
| Collembola | |
| All families | Class |
| Insecta : Ephemeroptera | |
| Siphlonuridae | Family |
| Baetidae | Family |
| Oniscigastridae | Family |
| Ameletopsidae | Family |
| Coluburiscidae | Family |
| Leptophlebiidae | Family |
| Ephemerellidae | Family |
| Caenidae | Family |
| Prosopistomatidae | Family |
| Insecta : Odonata | |
| Hemiphlebiidae | Family |
| Coenagrionidae | Family |
| Isostictidae | Family |
| Protoneuridae | Family |
| Lestidae | Family |
| Lestoideidae | Family |
| Megapodagrionidae | Family |
| Synlestidae | Family |
| Amphipterygidae | Family |
| Calopterygidae | Family |
| Chlorocyphidae | Family |
| Aeshnidae | Family |
| Gomphidae | Family |
| Neopetaliidae | Family |
| Petaluridae | Family |
| Corduliidae | Family |
| Libellulidae | Family |

| Phylogenetic Level | Reporting level |
|---|---|
| Insecta : Plecoptera | |
| Eustheniidae | Family |
| Austroperlidae | Family |
| Gripopterygidae | Family |
| Notonemouridae | Family |
| Insecta : Hemiptera | |
| Mesoveliidae | Family |
| Hebridae | Family |
| Hydrometridae | Family |
| Veliidae | Family |
| Gerridae | Family |
| Leptopodidae | Family |
| Saldidae | Family |
| Nepidae | Family |
| Belostomatidae | Family |
| Ochteridae | Family |
| Gelastocoridae | Family |
| Corixidae | Family |
| Naucoridae | Family |
| Notonectidae | Family |
| Pleidae | Family |
| Insecta : Megaloptera | |
| Sialidae | Family |
| Corydalidae | Family |
| Insecta : Neuroptera | |
| Osmylidae | Family |
| Neurorthidae | Family |
| Sisyridae | Family |
| Insecta : Coleoptera | |
| Microsporidae | Family |
| Carabidae | Family |
| Haliplidae | Family |
| Hygrobiidae | Family |
| Noteridae | Family |
| Dytiscidae | Family |
| Gyrinidae | Family |
| Hydrophilidae | Family |
| Hydraenidae | Family |
| Staphylinidae | Family |
| Scirtidae | Family |
| Elmidae | Family |
| Limnichidae | Family |
| Heteroceridae | Family |
| Psephenidae | Family |
| Ptilodactylidae | Family |
| Chrysomelidae | Family |
| Brentidae | Family |
| Curculionidae | Family |
| Insecta : Mecoptera | |
| Nannochoristidae | Family |
| Insecta : Diptera | |
| Tipulidae | Family |
| Tanyderidae | Family |
| Blephariceridae | Family |
| Simuliidae | Family |
| Chaoboridae | Family |
| Dixidae | Family |
| Culicidae | Family |
| Chironomidae : | |
| Orthocladiinae | Subfamily |
| Chironominae | Subfamily |
| Podonominae | Subfamily |
| Diamesinae | Subfamily |
| Tanypodinae | Subfamily |
| Aphroteniinae | Subfamily |
| Telmatogetoninae | Subfamily |
| Ceratopogonidae | Family |
| Thaumaleidae | Family |
| Psychodidae | Family |
| Athericidae | Family |
| Tabanidae | Family |
| Stratiomyidae | Family |
| Empididae | Family |
| Dolichopodidae | Family |
| Syrphidae | Family |
| Sciomyzidae | Family |
| Ephydridae | Family |
| Muscidae | Family |
| Insecta : Trichoptera | |
| Hydrobiosidae | Family |
| Glossosomatidae | Family |
| Polycentropodidae | Family |
| Philopotamidae | Family |
| Psychomyiidae | Family |
| Hydroptilidae | Family |
| Ecnomidae | Family |
| Hydropsychidae | Family |
| Limnephilidae | Family |
| Tasimiidae | Family |
| Kokiriidae | Family |
| Odontoceridae | Family |
| Helicopsychidae | Family |
| Philorheithridae | Family |
| Leptoceridae | Family |
| Calamoceratidae | Family |
| Atriplectididae | Family |
| Calocidae | Family |
| Helicophidae | Family |
| Conoesucidae | Family |
| Plectrotarsidae | Family |
| Oeconesidae | Family |
| Antipodoeciidae | Family |
| Dipseudopsidae | Family |
| Insecta : Lepidoptera | |
| Pyralidae | Family |

*only to be included by W.A. agencies
(optional for other states/territories)

# APPENDIX II

## DECISION TREE FOR THE IDENTIFICATION PROCESS



# APPENDIX III

## TAXONOMIC SPECIALISTS

**This list provides contact numbers for specialist invertebrate taxonomists who can be consulted over the identification of specimens in their particular field**

### GASTROPODA

**Brian Smith** Ph: (03) 6331-6777, Fax: (03) 6334-5230, E-mail: brian@qvmag.tased.edu.au

**Winston Ponder** Ph: (02) 9320-6120, Fax: (02) 9320-6073

### OLIGOCHAETA

**Adrian Pinder** Ph: (09) 4055176.

### ACARINA

**Jane Growns** Ph: (060) 582-324, Fax: (060) 431-626, E-mail: grownsj@mdfrc.canberra.edu.au

### AMPHIPODA

**John Bradbury** Ph: (08)83035847

### DECAPODA

**Pierre Horwitz** Ph: (09) 4005558, E-mail: p.horwitz@cowan.edu.au

### EPHEMEROPTERA

**Phil Suter** Ph: (060) 58-3889, Fax: (060) 58-3888, E-mail: p.suter@aw.latrobe.edu.au **Baetidae/Caenidae**

**John Dean** Ph: (03) 9628-5921, Fax: (03) 9614-3575 **Leptophlebiidae**

### ODONATA

**John Hawking** Ph: (060) 582-340, Fax: 060) 431-626, E-mail: hawkingj@mdfrc.canberra.edu.au

### PLECOPTERA

**Gunther Theischinger** Ph: (02) 9540-1795

**Cathy Yule** Ph: 0011 609 312-1069, Fax: 0011 609 312-1069

### HEMIPTERA

**Tom Weir** Ph: (06) 246-4267, Fax: (06) 246-4000

### MEGALOPTERA

**Gunther Theischinger** Ph: (02) 9540-1795

### COLEOPTERA

**Chris Watts** Ph: (08) 8207-7500, Fax: (08) 8207-7430 **Dytiscidae & Hydrophilidae**

**Alena Glaister** Ph: (03) 9905-5648, E-mail: alena.glaister@sci.monash.edu.au **Elmidae larvae**

## COLEOPTERA (continued)

**Andrew Calder** Ph: (06) 246-4269 **Elmidae adults**

**Jenny Davis** Ph: (09) 360-2939, Fax: (09) 310-4997 **Psephenidae**

**John Lawrence** Ph: (06) 246-4268, Fax: (06) 246-4000 **Coleoptera**

**Tom Weir** Ph: (06) 246-4267, Fax: (06) 246-4000 **Coleoptera adults**

## DIPTERA

**Peter Cranston** Ph: (06) 246-4282, Fax: (06) 246-4000

## TRICHOPTERA

**David Cartwright** Ph: (03) 9742-9245, Fax: (03) 9642-9288 **Philopotamidae/Ecnomidae/Tasimiidae**

**John Dean** Ph: (03) 9628-5921, Fax: (03) 9614-3575 **Hydrobiosidae/Hydropsychidae & general families**

**Jean Jackson** Ph: (03) 6226-2522 or (03) 6223-7133, E-mail: Jean.Jackson@zoo.utas.edu.au **Calocidae/Helicophidae/Conoesucidae**

**Ros St Clair** Ph: (03) 9628-5921, Fax: (03) 9614-3575 **Helicopsychidae/Philorheithridae/Leptoceridae/ Calamoceratidae**

**Alice Wells** Ph: (06) 250 9450, Fax: (06) 250-9448 **Hydroptilidae**

*N.B. A number of groups have not been covered in this list and further information can be obtained from the contact personnel.*

# SUPPORT DOCUMENT 3

# CALCULATION AND DOCUMENTATION OF QA/QC ERROR RATES

SUPPORT DOCUMENT 3

# CALCULATION AND DOCUMENTATION OF QA/QC ERROR RATES

## Breakdown of discrepancy types

*e.g. 1 miscount within accepted limits*

agency result: Caenidae 50

QA/QC result Caenidae 48

This discrepancy would not be recorded on the list of revisions sheet because the QA/QC result was less than the agency result by less than 5%. The acceptable level for miscounts is if the QA/QC count is less than agency count by 1 or 5% of the count (in this instance 47-50 acceptable). **In the calculation of Bray Curtis dissimilarity the QA/QC result would be altered to coincide with the agency result.**

*Note:* The only exception to this rule is where the agency count =1, QA/QC result = 0 which constitutes an error.

*e.g.2 miscount beyond accepted limits*

agency result: Caenidae 50

QA/QC result: Caenidae 43

This discrepancy would be recorded as follows:

| List of revisions to identifications and enumerations: | | | |
|---|---|---|---|
| **Taxon** | | **Quantity** | |
| **Original identification** | **Corrected identification** | **Original** | **Re-count** |
| | | | |
| Caenidae | | 50 | 43 |
| | | | |

This error would be assimilated into the data analysis by having 7 'incorrect identifications or counts' and by a discrepancy in Bray Curtis. *Note:* this form of error becomes redundant when only presence/absence data is used.

*e.g.3 misidentification leading to change in original taxa list*

| | | |
|---|---|---|
| agency result: | Caenidae | 5 |
| | Leptophlebiidae | 0 |
| QA/QC result: | Caenidae | 0 |
| | Leptophlebiidae | 5 |

i.e. 5 leptophlebiids misidentified as caenids

This discrepancy would be recorded as follows:

| **List of revisions to identifications and enumerations:** | | | |
|---|---|---|---|
| **Taxon** | | **Quantity** | |
| **Original identification** | **Corrected identification** | **Original** | **Re-count** |
| | | | |
| Caenidae | | 5 | 0 |
| Caenidae | Leptophlebiidae | 0 | 5 |
| | | | |

This error would appear in all 3 criteria: in percent new taxa there would be 1 new taxon, in incorrect Ids/counts there would be 5 and the discrepancy between the 2 data sets would also be manifest in Bray Curtis.

*e.g.4 misidentification that does not lead to an addition to the taxa list*

| | | |
|---|---|---|
| agency result: | Caenidae | 5 |
| | Leptophlebiidae | 5 |
| QA/QC result: | Caenidae | 6 |
| | Leptophlebiidae | 4 |

i.e. 1 caenid misidentified as a leptophlebiid

This discrepancy would be recorded as follows:

| **List of revisions to identifications and enumerations:** | | | |
|---|---|---|---|
| **Taxon** | | **Quantity** | |
| **Original identification** | **Corrected identification** | **Original** | **Re-count** |
| | | | |
| Caenidae | | 5 | 6 |
| Leptophlebiidae | | 5 | 4 |
| | | | |

This error would appear in: incorrect Ids/counts as 1 and as a discrepancy in Bray Curtis. *Note:* eventhough the QA/QC count for Leptophlebiidae is within the miscount acceptance range, it is still included as an error because in this instance a misidentification rather than a miscount occurred.

*e.g.5 incorrect (higher) taxonomic level used*

agency result: Chironomidae 10

QA/QC result: Orthocladiinae 6

Tanypodinae 4

This is an example of the agency not identifying specimens to the required taxonomic level (in this case family rather than sub-family level).

This discrepancy would be recorded as follows:

| **List of revisions to identifications and enumerations:** | | | |
|---|---|---|---|
| **Taxon** | | **Quantity** | |
| **Original identification** | **Corrected identification** | **Original** | **Re-count** |
| | | | |
| Chironomidae | | 10 | 0 |
| Chironomidae | Orthocladiinae | 0 | 6 |
| Chironomidae | Tanypodinae | 0 | 4 |
| | | | |

What generally occurred in the development of identification protocols for the MRHI was that errors such as that shown above were not counted in the first round but were mentioned in the accompanying report. If such errors were repeated, calculations were as follows: in e.g.5 new taxa would be 2, 10 miscounts/identifications and Bray Curtis dissimilarities would be calculated as they appear in the above table. *Note:* when the wrong taxonomic level was specified and the correct level had only one taxon, this was not counted as an error but was noted in the accompanying report to the agency. e.g. 'Tricladida' instead of 'Dugesiidae'.

*e.g. 6 inclusion of terrestrial taxa*

agency result: Hebridae 1

QA/QC result: terrestrial hemiptera 1

This discrepancy would be recorded as follows:

| **List of revisions to identifications and enumerations:** | | | |
|---|---|---|---|
| **Taxon** | | **Quantity** | |
| **Original identification** | **Corrected identification** | **Original** | **Re-count** |
| | | | |
| Hebridae | | 1 | 0 |
| Hebridae | terrestrial hemiptera | 0 | 1 |

This error would not be included in new taxa calculations (as the new taxa is not included in the final database) but would appear as 1 miscount/misidentification. Calculations of Bray Curtis would not include the terrestrial taxon but a discrepancy between the original data set and the QA/QC data set would be manifest by the presence of 1 hebrid in the original and none in the QA/QC. *Note:* In the opposite situation i.e. an aquatic taxon not included in the original because it was classified as terrestrial, there would be: 1 new taxon, 1 misidentification/miscount and the discrepancy in Bray Curtis would consist of 1 hebrid being present in the QA/QC but not the original.

**Fully worked example**

Below is an example of a potential outcome of QA/QC with data from the agency and QA/QC results from the corresponding sample.

| Agency data | |
|---|---|
| **Taxon** | **Count** |
| Chironominae | 133 |
| Orthocladiinae | 6 |
| Caenidae | 3 |
| Corixidae | 1 |
| Gomphidae | 1 |
| Isostictidae | 7 |
| Ecnomidae | 4 |
| | |
| Hydroptilidae | 10 |
| Thiaridae | 1 |
| no. taxa=9 | Σ x 166 |

| QA/QC data | |
|---|---|
| **Taxon** | **Count** |
| Chironominae | 125 |
| Orthocladiinae | 6 |
| Caenidae | 3 |
| Corixidae | 1 |
| Gomphidae | 1 |
| Isostictidae | 7 |
| Ecnomidae | 3 |
| Polycentropodidae | 1 |
| Hydroptilidae | 9 |
| Thiaridae | 1 |
| no. taxa=10 | Σ x 157 |

The corresponding QA/QC list of revisions and enumerations would be as follows:

| **List of revisions to identifications and enumerations:** | | | |
|---|---|---|---|
| **Taxon** | | **Quantity** | |
| **Original identification** | **Corrected identification** | **Original** | **Re-count** |
| Chironominae | | 133 | 125 |
| | | | |
| Ecnomidae | | 4 | 3 |
| Ecnomidae | Polycentropodidae | 0 | 1 |

| **Percent new taxa** | | **Incorrect identifications or counts** | |
|---|---|---|---|
| **Total number of taxa (a)** | **10** | **Total number of organisms in sample (a)** | **157** |
| **Number of new taxa (b)** | **1** | **Number of organisms incorrectly identified (b)** | **9** |
| **Percent ([b/a] x 100)** | **10** | **Percent ([b/a] x 100)** | **5.7** |
| **Pass or fail? (Pass if < 10%)** | **F** | **Pass or fail? (Pass if < 10%)** | **P** |

**Bray Curtis dissimilarity index: 0.03 Pass or fail? (Pass if index <0.1) P**

Total number of taxa - taken from the QA/QC result.

Number of new taxa - taxa present in QA/QC result that are not present in agency result (in this instance Polycentropodidae only taxon therefore no. new taxa=1).

Total number of organisms - taken from the QA/QC result.

Number of organisms incorrectly identified - difference between QA/QC result and agency ie Chironominae accounted for 8 miscounts and 1 misidentified polycentropodid = 9.

Bray Curtis: $\frac{\Sigma \mid Dij - Dik \mid}{\Sigma ( Dij + Dik)} = \frac{8+0+0+0+0+0+1+1+0+0}{258+12+6+2+2+14+7+1+20+2} = 0.03$

*Note:* Hydroptilidae not included as a miscount or in Bray Curtis because it was within the accepted <5% or 1 range.