Larval stages of three *Meropatthus* species (Coleoptera: Hydraenidae: Ochthebiinae) from New Zealand

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Abstract  The three larval stages of two New Zealand species of *Meropatthus* Enderlein, 1901—*M. campbellensis* Brookes, 1951 and *M. zelandicus* Ordish, 1984—are fully described, including the first detailed account of their chaetotaxy. The second instar of a third species—*M. johnsi* Ordish, 1971—is recorded but not fully described. The morphological characters which distinguish the larvae of *M. campbellensis* from those of *M. zelandicus*, as well as those distinguishing them from other hydraenid larvae, are given. A key to identify the three larval instars within a species is also given. The presence or absence of larval anal hooks in Hydraenidae is discussed.

Keywords  Coleoptera; Hydraenidae; *Meropatthus*; larvae; chaetotaxy; New Zealand

INTRODUCTION

*Meropatthus* Enderlein, 1901 comprises 12 species with a southern circumpolar distribution (Bameul 1989; Hansen 1991). Four species are found in the New Zealand subregion (Ordish 1984): *M. campbellensis* Brookes, 1951; *M. johnsi* Ordish, 1971; *M. aucklandicus* Ordish, 1971 and *M. zelandicus* Ordish, 1984. Hansen (1991: 46) discussed the uncertain generic position of some Australian species placed in *Meropatthus* by Janssens (1967) and Bameul (1989). He concluded that, depending on the interpretation of their features and on the definition of the genera, those species could be transferred either to the closely related genus *Timpanogaster* Janssens, 1967, or to a new genus. A similar conclusion was reached by Perkins (1997: 145) who stated: “The placement of some eastern Australian and Tasmanian species in *Meropatthus* by Janssens (1967) and Bameul (1989) are in error; these species will be properly placed elsewhere, within the context of a generic revision”.

The unusually high interest shown towards the larvae of *Meropatthus* may be due to the facts that, unlike most hydraenids, both adults and larvae are found in terrestrial habitats rich in moisture or in the vicinity of water, and that most *Meropatthus* species are endemic to small isolated islands or archipelagos. Hence, collecting the larvae is comparatively easy, and their association with adults can be made with a high degree of confidence. Knowledge of the detailed larval morphology of *Meropatthus*, *Timpanogaster* and other related genera within the Ochthebiinae may prove useful in elucidating their phylogenetic relationships (see Hansen 1991).

*Meropatthus* larvae have attracted the attention of several workers, and the larvae of three species have been described. Enderlein (1909) dealt with those of *Meropatthus randi* Jannell, 1953 from Crozet Islands in the Indian Ocean, although he misidentified them as the staphylinid *Antarctophytopus atriceps* Westwood (see Paulian (1941) under *Meropatthus chuni*) Enderlein, 1901; adult beetles of *Meropatthus* from Crozet Islands were later described as *M. randi* by Jannell (1953)). Both Jannell (1940) and Paulian (1941) studied the larvae of *M. chuni* from the Kerguelen Islands, also in the Indian Ocean. Samuelson (1964) described the larvae of the third species, *M. campbellensis* Brookes, 1951, from Campbell Island in the Pacific Ocean.

Nevertheless, detailed knowledge of *Meropatthus* larval morphology is still incomplete. The
descriptions lack well defined characters to achieve correct species identifications and to distinguish between the three larval instars within one species. According to Newton (1990) this is typical of most larval descriptions within the Staphylinoidae. For example, Enderlein’s (1909) description of *M. randi* is based on one damaged specimen only, as shown by Paulian (1941). Further, Paulian’s (1941) description of *M. chunt*, although lengthy, lacks good illustrations to enable a correct interpretation of the features described, and Samuelson (1964) gives equivocal characters for the identification of *M. campbellensis* (see below).

In this paper, we (a) describe the three larval stages of two species—*M. campbellensis* and *M. zelandicus*—with special emphasis on their chaetotaxy, and record one stage of a third species—*M. johnsi*; (b) give characters to distinguish the larvae of the first two species from each other and from other Hydroiidae larvae; (c) give a key to identify the three larval instars within a species; (d) discuss the presence or absence of larval anal hooks in Hydroiidae.

**MATERIAL AND METHODS**

The material studied for this paper originated from two collections: the New Zealand Arthropod Collection held in Landcare Research, N.Z. Limited, Auckland (NZAC), and the Entomology Collection of the Museum of New Zealand Te Papa Tongarewa, Wellington (MONZ).

All the larvae were collected together with adults. The adults were identified by Ordish (1971). The larvae were identified by us based on their association with the adults.

To study their chaetotaxy, larvae were dissected and mounted in Canada Balsam as permanent preparations. This is a variation on previous hydroiidae larval studies where Hoyer’s solution was used as a mounting medium (Delgado & Soler 1996a, b, 1997a, b, c). The main reason for changing the mounting medium was the need to stain the specimens to enhance relevant features before dissecting them. Unlike the larval material used by Delgado & Soler (1996a, b, 1997a, b, c), we worked with very faded larvae which had been stored in 70% ethyl alcohol for almost three decades. Thus, we found that the Canada Balsam technique, as published by Palma (1978) for lice, was ideal for detecting, examining and drawing a number of minute characters which otherwise would have gone unnoticed, e.g. the hooks on the anal vesicle (see Fig. 17–20).

The nomenclatural system used for the chaetotaxy follows that of Delgado & Soler (1996a, b, 1997a, b, c), which is a modification of the system proposed by Asher & Watrous (1984) for larvae of Staphylinidae.

**DESCRIPTORS OF LARVAE**

*Merothatus campbellensis* Brookes, 1951

(Fig. 1–2, 21–22)

Material examined


**First Instar**

Whole animal as in Fig. 1 and 2. Total body length about 2.0 mm.

**Head**

Capsule width 0.40 ± 0.01 mm (mean ± S.D.; n=6); ecdysial suture Y-shaped; five stemmata are present on each ocular area. Chaetotaxy of head capsule (Fig. 3–4): Frontal region (Fig. 3) on each side with four setae, two frontal dorsal setae (Ed1, Fd2), one frontal lateral seta (F11) and one frontal marginal seta (Fm1); without campaniform sensilla but with one pair of egg-bursters (EB). Clypeus with three setae on each side (C1—C3). Epicranial regions (Fig. 3), each with two campaniform sensilla (Ec1, Ec2), one cephalic gland (CG) and 10 setae: a row of four minute posterior setae (P1—P4), two epicranial dorsal setae (Ed1, Ed2), two epicranial lateral setae (El1, El2) and two epicranial marginal setae (Em1, Em2). Temporal regions (Fig. 4), each with four setae (T1—T4). Lateral regions (Fig. 4), each with one campaniform sensillum (Lc1) and two setae (L1, L2). Ventral regions (Fig. 4), each with two setae.

**Fig. 1–2** *Merothatus campbellensis*, whole animal views of first instar larva: 1, dorsal; 2, lateral. Scale: 0.5 mm.
(V1, V2). Labrum (Fig. 5), on each side with two campaniform sensilla (C1, C2) and seven setae arranged in two rows: two discal setae (Ld1, Ld2) and five marginal setae (Lt1—Lt5); setae Lm1, Lm3 and Lm5 situated dorsolaterally, Lm2 and Lm4 ventrolaterally (Fig. 6); Lm2 is pectinate. Epipharynx as in Fig. 6. Mandibles (Fig. 7) almost identical in size and shape; each with two campaniform sensilla (C1, C2) and two setae (M1, M2); prostheca long and slender. Antennae short (Fig. 8); segment I without setae but with four distal campaniform sensilla; segment II about 3.6x as long as segment I, with four setae and two solenidia (IIS1, IIS2); segment III about 0.7x as long as II, with four setae and three short apical solenidia. Maxillae as in Fig. 9; cardo small and triangular, with one seta (Cdo1); stipes with four setae (Stp1—Stp4) and one campaniform sensillum; palpi with one seta (Pfl); lacinia not filiform, with six stout setae (La1—La6); maxillary palp with three segments: proximal segment with two campaniform sensilla, without setae, segment II with two setae (Pm1, Pm2), apical segment with a conspicuous, digitiform, sensorial appendage on the external surface (SD). Labium (Fig. 10) consisting of three sclerites: submentum (Smmnt) with two setae, mentum (Mnt) with four setae and two campaniform sensilla, and prementum (Pmnt) with two long and two minute setae as well as two campaniform sensilla—two labial palps and a well-developed, globose ligula (Lg), bearing many small papillae.

**Thorax**

Pronotum (Fig. 11) with 14 setae and six campaniform sensilla on each side. Setae: four at anterior row A (A1—A4); three in lateral row L (L1—L3) with L2 shortest; four in posterior row P (P1—P4); and one in each of the three discal groups (Da1, Db1, De1). Pronotal campaniform sensilla: C1—C5, plus C’ between C1 and C2. Mesonotum (Fig. 12) with 14 setae and three campaniform sensilla on each side. Setae: four minute setae in anterior row A (A1—A4); three longer setae in lateral row L (L1—L3) with L2 shortest; four in posterior row P (P1—P4); and one in each of the three discal groups (Da1, Db1, De1). Mesonotal campaniform sensilla: C3—C5 (C1, C2 and C’ absent). Metanotum similar to mesonotum.

**Abdomen**

Tergites I—VIII as in Fig. 13. Setae and campaniform sensilla as in mesonotum but with reduced numbers: P2, Db1, De1 and C4 absent. Dorsopleural sclerites of segment I to VIII (Fig. 13) each with a spiral... (SP) and two setae (DP1, DP2). Sternite I (Fig. 14) with four setae on each side: one pleurosternal (Ps1), one discal (D1) and two posterior setae (P1, P2). Ventropleural sclerites of segment I (Fig. 14) each with one seta (VP1). Sternites II to VII (Fig. 15) differ from sternite I by having an additional discal seta (D2) and by P2 being much longer than P1. Ventropleural sclerites of segments II to VII each with two setae (VP1, VP2) as in Fig. 15. Segments IX and X as in Figs 17–18. Each urogomphus (Fig. 16) with two segments: segment I (U1) not fused to tergite IX, with six setae (U1—U6) and four campaniform sensilla (C1—C4); segment II (U1I1) 0.6x as long as segment I, wide at its base but tapering abruptly and with a long seta (AS) on its apex. Segment X has on each side three long ventrolateral setae and three spine-like ventral setae of unknown homology, hence we do not name them. Anal vesicle without hooks, but with two small scolerosized areas (Fig. 17–18) where the anal hooks are situated in other species.

**Second Instar**

Total body length about 2.5 mm. Head capsule width: 0.50 ± 0.01 mm (mean ± S.D.; n=6). Chaetotaxy identical to that of the first instar but discal seta Da1 absent from all abdominal tergites. Abdominal tergites with a tergal gland (TG) situated in the discal area on each side (as in Fig. 22). Without subterminal setae (see below under M. zelandicus) in any discal group.

![image](image-url)
Third Instar
Total body length about 3.5 mm. Head capsule width: 0.56 ± 0.01 mm (mean ± S.D.; n=6). Pronotum as in Fig. 21. Chaetotaxy as that of second instar, with the following differences (resulting from the fusion of the dorsopleural and ventropleural sclerites to the tergites and sternites respectively): abdominal tergites I-VIII (Fig. 22) with two additional lateral setae on each side (DP1, DP2) and with a spiracle (SP); abdominal sternite I with one additional lateral seta (VP1) on each side; and abdominal sternites II-VIII with two additional setae (VP1, VP2) on each side. Abdominal tergites with a tergal gland (TG) situated in the discal area on each side (Fig. 22). Without subprimary setae (see below under Meropatus zelandicus) in any discal group.

Remarks
The tergal glands are clearly seen in the second and third instars only. They may be present in the first instar, but we have not been able to observe them.

Samuelson (1964) described and figured what he called “mature larva”. Judging from its length, i.e. 3.9 mm, we regard it definitively as a third instar. He described the first two abdominal segments as “subrounded in cross section and smaller in size causing body to appear constricted from dorsal aspect” and his figure 1a shows a constriction very clearly. We have examined four third instars of Meropatus campbellensis without finding such a constriction. The other 25 larvae of Meropatus campbellensis we studied for this paper—first and second instars—have no indication of a constriction either. In our opinion, that constriction is an artifact of preservation and/or preparation of the specimens studied by Samuelson.

Meropatus zelandicus Ordish, 1984
(Fig. 19–20, 23–24)

Material examined
Nine first instars, three second instars and four third instars, Main Dome (South), Mid Sister Island, Chatham Islands, 24 November 1973, A. Whittaker & C.J. Robertson, in litter, 73/152 (MONZ).

First instar
Total body length about 1.8 mm. Head capsule width: 0.33 ± 0.01 mm (mean ± S.D.; n=6). Slightly smaller than the first instar of Meropatus campbellensis but otherwise morphologically very similar and with identical chaetotaxy. With two minute anal hooks (AH) on the anal vesicle (Fig. 19–20).

Second instar
Total body length about 2.3 mm. Head capsule width: 0.40 ± 0.01 mm (Mean ± S.D.; n=3). Chaetotaxy as in the second instar of Meropatus campbellensis but with (a) four subprimary setae (Da', Db', Dc', De') on each side of the pro-, meso- and metanotum in addition to primary setae Da1, Db1 and De1 in the discal groups (as in Fig. 23); and (b) discal seta Da1 is present on all abdominal tergites (as in Fig. 24). Abdominal tergites with a tergal gland (TG) situated in the discal area on each side (as in Fig. 24). Anal hooks present (as in Fig. 19–20).

Third instar
Total body length about 3.1 mm. Head capsule width: 0.50 ± 0.01 mm (mean ± S.D.; n=4). Pronotum as in Fig. 23. Chaetotaxy as in the third instar of Meropatus campbellensis but with two key differences: (a) four subprimary setae (Da', Db', Dc', De') on each side of the pro-, meso- and metanotum in addition to setae Da1, Db1 and De1 in the discal group (Fig. 23) and (b) discal seta Da1 is present on all abdominal tergites (Fig. 24). Abdominal tergites with a pair of tergal glands (TG) situated in the discal area (Fig. 24). Anal hooks present (as in Fig. 19–20).

Remarks
In summary, all larval instars of Meropatus zelandicus can be distinguished from those of Meropatus campbellensis by the presence of anal hooks (Fig. 19–20). In addition, the second and third instars of Meropatus zelandicus differ from those of Meropatus campbellensis by the presence of (a) four pairs of subprimary setae (Da', Db', Dc', De') on the thoracic terga (Fig. 23), and (b) the pair of discal setae (Da1) on all abdominal tergites (Fig. 24).
Fig. 17–20 *Meropodrus* spp., last abdominal segments (IX, X) of first instar larvae. *M. campbellensis*: 17, lateral view; 18, ventral view. *M. zelandicus*: 19, lateral view; 20, ventral view. Abbreviations: AH, anal hooks; U, urogomphus. (Setae of segment IX and its urogomphal setae U1–U6 are omitted). Scale: 0.1 mm.

Fig. 21–24 *Meropodrus* spp., pronota and first abdominal tergites of third instar larvae. *M. campbellensis*: 21, pronotum; 22, first abdominal tergite. *M. zelandicus*: 23, pronotum; 24, first abdominal tergite. Abbreviations: A1–4, anterior setae; C1–5, campaniform sensilla; C', additional campaniform sensillum; Da1, Db1, Dc1, primary discal setae; Da', Db', Dc', Dc'', subprimary discal setae; DP1–2, dorsopleural setae; L1–3, lateral setae; P1–4, posterior setae; SP, spiracle; TG, tergal gland. Scale: 0.3 mm.
Meropatus johnsi Ordish, 1971

Material examined

One second instar, Mollymawk Islet, Snares Islands, 24 February 1967, P.M. Johns (NZAC).

First and third instars

No specimens available.

Second instar

Total body length about 1.7 mm. Head capsule width: 0.40 mm (n=1). The absence of cephalic egg-bursters and the presence of separate dorsopleural and ventropleural abdominal sclerites clearly indicate that this specimen is a second instar.

Remarks

We have found no morphological difference between our single specimen and the second instar of M. campbellensis. The total body length and the head capsule width are significantly smaller in the M. johnsi larva than in those of M. campbellensis. Although adults of M. johnsi are smaller than those of M. campbellensis (see Ordish 1984), we do not regard those dimensional differences of the larvae as conclusive.

KEY TO IDENTIFY THE THREE LARVAL INSTARS WITHIN A SPECIES

1. With a pair of egg-bursters (EB) on the frontal region of the head (Fig. 1, 3)........... First instar
1'. Without cephalic egg-bursters......................2

2. With distinct dorsopleural and ventropleural sclerites in the abdomen (as in Fig. 13–15)...... Second instar
2'. Without distinct dorsopleural and ventropleural sclerites in the abdomen (Fig. 22, 24)...... Third instar

DISCUSSION

The larvae of the three species studied here are remarkably similar in general appearance and, except M. johnsi, they can only be identified to species with a detailed study of their chaetotaxy. This situation is similar to that of several other hydraenid genera containing morphologically closely related species (Delgado, pers. obs.), and to that in other families of aquatic Coleoptera (e.g. Alarie 1991).

Meropatus larvae can be distinguished from all other known hydraenid larvae by the presence of a pair of additional campaniform sensilla on the pronotum (C' in Fig. 11, 21, 23); i.e. Meropatus larvae have six pairs of campaniform sensilla on the pronotum instead of the five present on all other known hydraenid genera.

Meropatus larvae can also be distinguished from some hydraenid genera by the absence of a subprimary seta (DP) on the dorsopleural sclerites of the second instar and on the abdominal tergites of the third instar. The subprimary seta (DP) is additional to setae DP1 and DP2 in larvae of several genera and subgenera such as Ochthebius (Ochthebius) Leach (see Delgado & Soler 1997c) and Aulacoccephalus Kuwert (see Delgado & Soler in press).

The presence or absence of larval anal hooks is a variable condition in the family Hydraenidae. In some genera of the subfamily Hydraeninae, e.g. Hydraena Kugelmann (see Delgado & Soler 1996c) and Limnephilus Leach (see Delgado & Soler 1997a), these hooks are very well developed. However, in the subfamily Ochthebiinae there are different states for this character: anal hooks are absent in the genus Calobius Wollaston (see Delgado & Soler 1997b) and in the subgenus Ochthebius (Cobaltius) Rey (see Delgado & Soler 1996b) while they are well developed in the nominate subgenus Ochthebius (Ochthebius) Leach (see Delgado & Soler 1997c). Perkins (1997: 129) regards both Calobius and Cobaltius as junior synonyms of Ochthebius sensu stricto but, on the basis of larval morphology, we disagree with his proposed synonymy. In the subfamily Orchemontinae, larvae of the genus Podena have very well developed anal hooks (Delgado pers. obs.). At present we have no information regarding the larvae of any species from the remaining hydraenid subfamily, the Prosthetopinae.

Paulian (1941) mentioned that anal hooks were absent in the larvae of Meropatus chuni he studied, while Samuelson (1964) did not mention that feature when he described the larva of M. campbellensis. Our finding of anal hooks, albeit minute, in the larvae of M. zelandicus suggests that the ancestral Meropatus probably had anal hooks, which were subsequently lost in some species. The small sclerotised areas we observed in the anal vesicle of M. campbellensis larvae may be the vestiges of former anal hooks.

The phylogenetic significance of the anal hooks may be better understood when the larvae of several more hydraenid genera are known. However, the absence of anal hooks in some apparently not closely related generic groups may be the result of...
environmental selective pressures rather than an indication of phylogenetic relationships; for example, species of *Meroepthus, Calubius* and *Coballius* which are found in or close to marine environments have very short microglochi and very reduced or no anal hooks.

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