

## Larvae of the subfamily Trechinae from the Southern Hemisphere

(Insecta, Coleoptera, Carabidae)

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The larvae of *Trechisibus antarcticus* (Trechini) and *Ooapterus soledadinus* (Zolini), two carabid species introduced to the sub-Antarctic island South Georgia, are described and distinguished. The larva of *Trechisibus* is very similar to those of known *Trechus* but has a wider posterior part of frontale, larger and more distinctive stemmata, stronger sclerotized thoracic and abdominal sclerites, and longer urogomphi. The larval characters of *Ooapterus* come close to the ground plan of the subfamily Trechinae. A derived character of *Ooapterus* is the very thin and slender last maxillary palpomeres. *Ooapterus* has bulging, constricted sides of head as in larva of *Patrobini*. The larval ground plan characters of Trechinae are considered to be: (a) nasale serrate, protruding in the middle, adnasale angles more or less prominent; (b) lacinia absent; (c) only one claw with short seta at base present; (d) several pores of the carabid ground plan pattern reduced; (e) setae TA<sub>3</sub>, TA<sub>4</sub>, TA<sub>5</sub>, TA<sub>6</sub> on tarsus absent; (f) number of setae on urogomphi in second and third instars reduced, seta URβ always lacking.

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### Introduction

*Trechisibus antarcticus* (Dejean), a representative of the carabid tribe Trechini, and *Ooapterus soledadinus* (Guérin-Méneville), a species of the tribe Zolini, were introduced by man to the sub-Antarctic island South Georgia (Brandjes et al. 1999). Since their first recognition in 1963 and 1982 respectively, both species have been subject of many ecological studies which show that they have increased their colonized area on the island, are able to coexist, and were well adapted to the low temperature and extreme climate compared with their probable country of origin – the Falkland islands (Ernsting 1993, Ernsting et al. 1995, Block & Sømme 1983, Ottesen 1990, Todd & Block 1997). Despite these numerous works, the larva of *Trechisibus* has not been described previously, and that of *Ooapterus* indeed was described by Jeannel (1940), but this description is very cursory and quite unsatisfactory. However, larval knowledge of both genera would be important for several reasons.

Representatives of the tribes Trechini and Zolini are widespread in the Southern hemisphere. The Zolini, with eight described genera including about 50 species, are restricted to the southern part of South America, New Zealand, southeastern Australia, Tasmania and adjacent islands. The Trechini are distributed worldwide but a large number of endemic genera occur in the Australian and Neotropical regions. Whereas most of these genera include only a few species, the Neotropical genus *Trechisibus* Motschulsky with about 100 known species is one of the larger groups of the tribe. Only the works of Jeannel (1940), Johns (1974), May (1963) and Townsend (1978) regard larvae of Trechinae from these

regions, which means that larval knowledge is still basic.

The present study gives the first description of a larva of the genus *Trechisibus* and a detailed description of a larva of Zolini which makes phylogenetic interpretation of larval characters possible. A larval diagnosis of the subfamily Trechinae (= supertribe Trechitae in the sense of Kryzhanovsky 1976 and Erwin 1991 respectively) including Zolini is given. Larval differences of both carabids introduced on South Georgia are described which will allow the recognition and separation of the larval stages of these species in future ecological studies.

### Material and Methods

The description is based on the following material ( $L_2$ ,  $L_3$  refers to the second and third instars respectively):

Zolini:  $1L_2$ ,  $3L_3$  *Ooapterus soledadinus*, collected at Grytviken, King Edward Cove, Cumberland Bay, South Georgia, by W. Block, January/February 1982 together with adults. No other carabid species occurred at this collecting site.

Trechini:  $1L_2$ ,  $2L_3$  *Trechisibus antarcticus*, collected at Harbour Point, South Georgia, by G. Ernsting, February 23, 1994 in tussac litter together with adults. No other carabid species occurred at this collecting site.

For comparative purpose, larvae of 40 carabid tribes including following representatives of Trechinae were studied: Trechini: *Trechus* Clairville; Bembidiini: *Bembidion* Latreille s. l., *Asaphidion* Des Gozis, *Tachys* Dejean, *Elaphropus* Motschulsky, *Meotachys* Erwin, *Typhlocharis* Dieck; Pogonini: *Pogonus* Dejean. All larvae are deposited in the collection of the author.

The larvae were mounted in Euparal or Canada balsam on microscope slides and studied at magnifications up to 400 $\times$ . The notation of setae and pores follows Bousquet & Goulet (1984) and Bousquet (1985). Following Bousquet & Goulet (1984), "primary" setae and pores are ground plan structures of the first larval instar and their homologous structures in the later instars, "secondary" setae (coded with Greek letters) and pores are ground plan structures of second and third instars.

### Description of second and third instar larvae

#### *Trechisibus antarcticus* (Dejean)

Fig. 1

#### Description

Colouration. Head and urogomphi reddish brown, other sclerites brown, comparatively strong sclerotized.

Head width.  $L_2$  - 0.60 mm (n=1),  $L_3$  - 0.90, 093 mm (n=2).

Microsculpture. Sides of head capsule (parietale) with transverse meshes, abdominal tergite IX isolated multipointed, urogomphi basally and mesally pointed, pygopod pointed. Other sclerites without regular microsculpture.

Chaetotaxy. Primary setae present except  $TA_3$ ,  $TA_4$ ,  $TA_5$  and  $TA_6$  apically on tarsus. Frontale, parietale, prementum, thoracic and abdominal sclerites, in part pro-, meso-, and metathorax as well as abdominal tergites I-VIII with many additional setae. Antenna with all pores and setae of the ground plan, including five pores  $AN_{a-c}$  on antennomere I. Maxilla with group gMX consisting of about 15-20 setae; setae  $MX_5$  and  $MX_6$  long, subequal in length; setae  $MX_{11}$  and  $MX_{12}$  pore-like. Ligula with a pair of one long ( $LA_6$ ) and one short ( $LA_4$  or  $LA_7$  respectively) setae. Seta  $UN_1$  of single claw shorter than basal diameter of claw; seta  $TA_1$  in middle of tarsus; tibia with  $TI_2$ ,  $TI_3$ ,  $TI_4$ ,  $TI_5$ ,  $TI_6$  and  $TI_7$  bristle shaped; a ring of secondary setae in the middle of tibia and femur, in the course of this ring ventrally on tibia two setae, ventrally on femur four setae. Abdominal tergite IX with long secondary seta  $UR_a$ ; urogomphi with seven long setae  $UR_{4-8}$ ,  $UR_\beta$  and  $UR_e$ .

Head. Head capsule (Fig. 1) with sides parallel. Cervical groove indicated but not distinctive. Frontale slender, V-shaped posteriorly (=pars), coronal suture about as long as antennomere I. Six stemmata present, ocular groove absent. Nasale serrate, protruded in the middle. Antenna four-segmented, about as long as mandible; antennomeres I and II subequal in length; penultimate antennomere about 1.2 times longer than basal with bulb-like sensorial appendage, ultimate antennomere

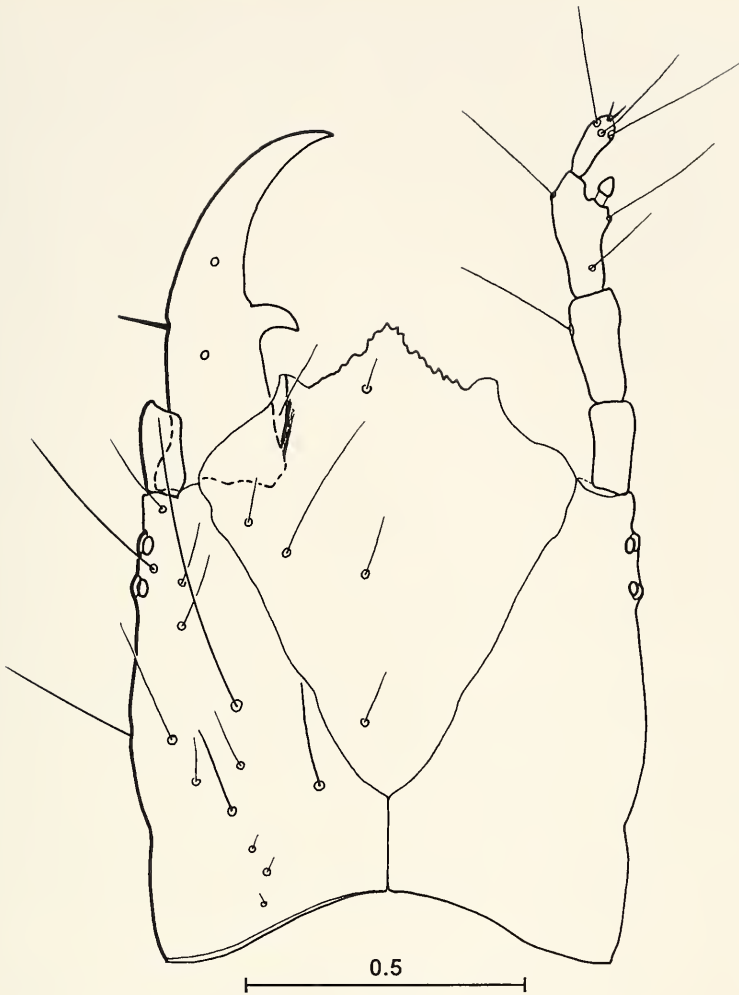
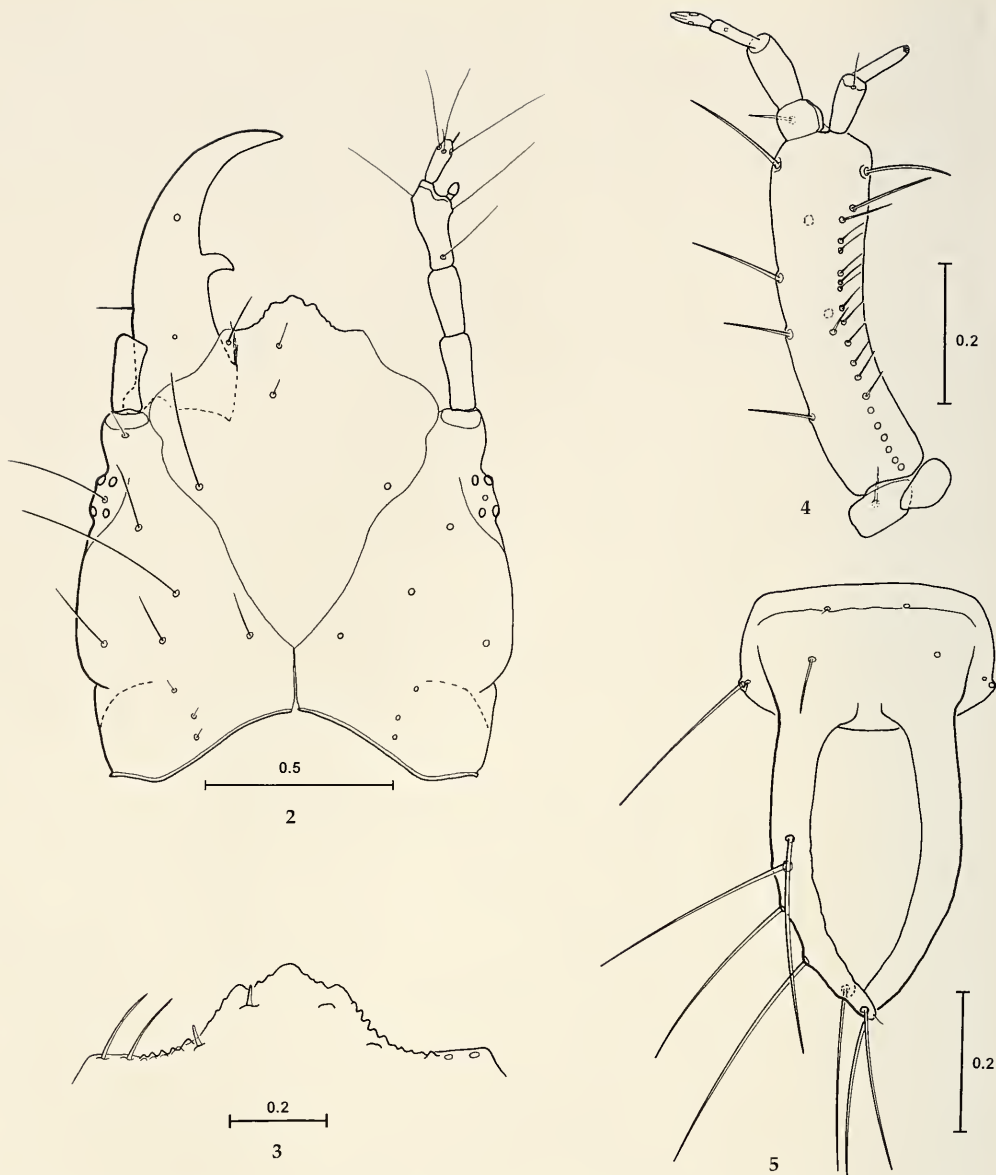


Fig. 1. *Trechisibus antarcticus* (Dejean),  $L_{3/4}$  head.

shortest. Mandible straight with smooth terebrum; penicillus present; retinaculum about in the middle of inner side of mandible. Maxilla without lacinia; stipes long and slender, palpifer wider than maxillary palpomeres, about as wide as long; palpomere I largest, ultimate palpomere divided in two segments, therefore maxillary palpus (without palpifer) apparently four-segmented. First galeomere about 1.3 times longer than second, palpus including palpifer about 2.1 times longer than galea. Hypopharynx large with lateral sides bearing numerous long setae. Labium with short ligula; apical palpomere about as long as basal, divided in two segments.

Thorax and abdomen. Legs with single, simple claw; relation of femur:tibia:tarsus about 1.5:1:1.2. Anterior keel and median suture of mesothorax, metathorax, and abdominal tergites present. Urogomphi with branches almost parallel, about 1.3 times longer than pygopod.

**Remarks.** The larva of *Trechisibus* is very similar to those of known *Trechus* Clairville. Compared with that of *Trechus*, the larva of *Trechisibus* has a wider posterior part of frontale, larger and more distinctive stemmata, more strongly sclerotized thoracic and abdominal sclerites, and longer urogomphi. The increased numbers of setae on the parietale, thorax and abdomen are characteristic not only of second and third instar larvae of *Trechisibus* but also for some species of *Trechus*.



Figs 2-5. *Oopterus soledadinus* (Guérin-Méneville), L<sub>3</sub>. 2. Head. 3. Nasale and adnasale. 4. Maxilla. 5. Urogomphi. All scales in mm.

*Oopterus soledadinus* (Guérin-Méneville)

Figs 2-5

**Description**

Colouration. Sclerites reddish brown to brown with head slightly darker than other sclerites.

Head width. L<sub>2</sub> - 0.72 mm (n=1), L<sub>3</sub> - 1.05-1.19 (aver. 1.13) mm (n=3).

Microsculpture. Sides of head capsule (parietale) with transverse to isodiametral meshes, abdominal tergite IX pointed to multipointed, urogomphi and pygopod pointed. Other sclerites without regular microsculpture.

Chaetotaxy. Primary setae present except TA<sub>3</sub>, TA<sub>4</sub>, TA<sub>5</sub> and TA<sub>6</sub> apically on tarsus. Parietale and frontale without additional setae even in last instar. Antenna with all pores and setae of the ground plan, including five pores AN<sub>ae</sub> on antennomere I. Maxilla with group gMX consisting of 20-35 setae, setae arranged in a simple row (see Fig. 4) or in a double row; setae MX<sub>5</sub> and MX<sub>6</sub> long, subequal in length; setae MX<sub>9</sub>, MX<sub>11</sub> and MX<sub>12</sub> apically on galeomere I and palpomere II pore-like. Ligula with only one pair of long setae (LA<sub>6</sub>), LA<sub>4</sub> (or LA<sub>7</sub>, respectively) pore-like. Seta UN<sub>1</sub> of single claw small, much shorter than basal diameter of claw; seta TA<sub>1</sub> in middle of tarsus; tibia with TI<sub>1-7</sub> bristle shaped; no secondary setae ventrally on tibia and femur. Abdominal tergites I-VIII with ground plan pattern of setae plus two small additional setae (additional setae between ground plan setae TE<sub>1/6</sub> and TE<sub>9/10</sub>). Abdominal tergite IX with long seta UR<sub>2</sub>, very small seta UR<sub>3</sub> and long secondary seta UR<sub>α</sub>; urogomphi (Fig. 5) with seven long setae UR<sub>1-8</sub>, UR<sub>β</sub> and UR<sub>ε</sub>.

Head. Head capsule (Fig. 2) with sides bulging. Cervical groove lacking, but head at level of cervical groove constricted. Frontale slender, V-shaped posteriorly (=pars), coronal suture slightly longer than antennomere IV. Six stemmata present in two rows, the stemmata of anterior row larger than those of posterior row; ocular groove present. Nasale serrate, protruded in the middle (Fig. 3.). Antenna four-segmented, about as long as mandible; antennomeres I and II subequal in length; penultimate antennomere about 1.2 times longer than basal with bulb-like sensorial appendage, ultimate antennomere shortest. Mandible straight with smooth terebrum; penicillus present; retinaculum about in the middle of inner side of mandible. Maxilla (Fig. 4) without lacinia; stipes long and slender, 3.8 times longer than wide; palpifer wider than long and wider than maxillary palpomeres; palpomere I largest, nearly as long as palpomeres II and III together; last two palpomeres remarkably thin and slender; last palpomere not divided into two segments. Segments of galea subequal in length, palpus including palpifer about 1.7 times longer than galea. Hypopharynx large with lateral sides bearing numerous long setae. Labium with short ligula; labial palpomere I about 1.75 times longer than palpomere II, the latter not divided in two segments.

Thorax and abdomen. Legs with single claw; femur, tibia, and tarsus of about equal length. Anterior keel and median suture of mesothorax, metathorax, and abdominal tergites present. Urogomphi (Fig. 5) with branches curved, about 1.3 times longer than pygopod.

**Remarks.** The larva of *O. soledadinus* (as *Merizodus*) was described first by Jeannel (1940). Jeannel's verbal description is very short but his figure of the head capsule remembers a larva of *Trechini*. It does not show the constricted head capsule with bulging sides as the larva here described. The first instar larva of *Oopterus* spec. according to Johns (1974) has one pointed egg-burster on the parietale on each side of the coronal suture near the posterior margin of the head capsule.

Tab. 1. Morphological differences between larvae of *Trechisibus antarcticus* and *Oopterus soledadinus*.

Character	<i>Trechisibus antarcticus</i>	<i>Oopterus soledadinus</i>
Last segments of palpomeres	Divided in two segments: labial palpomere apparently 3-segmented, maxillary palpomere (incl. palpifer) apparently 5-segmented.	Not divided, labial palpomere consisting of 2 segments, maxillary palpomere (incl. palpifer) of 4 segments.
Sides of head capsule	Parallel, not constricted; ocular groove absent.	Bulging, constricted at level of cervical groove; ocular groove present.
Number of setae on parietale (second and third instars only)	Parietale dorso-posteriorly of eyes with more than 6 long setae.	Parietale dorso-posteriorly of eyes with 5 long setae.
Setae on tibia (second and third instars only)	6 bristles apically, 1 bristle dorso-basally AND a row of setae in the middle.	6 bristles apically, 1 bristle dorso-basally.
Number of setae on abdominal tergites I-VIII (second and third instars only)	Tergite halves with 5 long and much more than 10 middle long or short setae.	Tergite halves with 5 long and at most 9 short setae.

### Discussion of general characters of larvae of the subfamily Trechinae (including Trechini, Zolini, Bembidiini and Pogonini)

Larvae of Trechinae are characterized by the following character states (see also Arndt 1991, pp. 80-84, Arndt et al. 1999, Grebennikov 1996):

1. nasale serrate, protruding in the middle, adnasale angles more or less prominent
2. lacinia absent
3. only one claw with short seta at base present
4. pores  $PR_{\gamma}$ ,  $PR_{\delta}$ ,  $PR_{\epsilon}$ ,  $PR_{\zeta}$  on prothorax, pores  $ME_d$  and  $ME_e$  on meso- and metathorax, pore  $TE_b$  on abdominal tergites I-VIII absent
5. setae  $TA_{3-6}$  on tarsus absent
6. number of setae on urogomphi in second and third instars reduced, seta  $UR\beta$  always lacking.

Only (5) the absence of setae  $TA_{3-6}$  is an autapomorphic character state of Trechinae in present knowledge. The larvae of Trechinae share characters (1, 2, and 6) with those of Patrobini. The possible sister-group relationship between Trechinae and Patrobini was already mentioned in Arndt (1993: 32) based on larval and adult characters. Character (4), the reduction of ground plan pores, is difficult to examine and data on these pores are lacking from the majority of carabid groups. Possibly this character supports the relationship between Patrobini and Trechinae too, as the pores could not be found in larvae of *Patrobis* Stephens. This result has to be confirmed with further patrobine taxa however.

The serration of nasale region is lacking in known Anillini (Arndt et al. 1999) with extremely adapted cephalic characters. The majority of larvae of Trechinae have only one claw on each leg, however the presence of two claws is known from three peculiar genera of Trechini (all representatives of the subtribes Perileptina and Trechodina known in the larval stage). Two claws are described from larvae of *Perileptus* Schaum (Luff 1985), *Amblystogenium* Enderlein (Womersley 1937) and *Thalassophilus* Wollaston (Grebennikov 1996). This character state can be interpreted as plesiomorphic. Two claws are the ground plan state of Carabidae (Arndt 1993), reduced to one claw in carabids several times independently.

The tribes Trechini, Zolini, and Pogonini as well as the subtribe Bembidiina of the tribe Bembidiini have seven long urogomphi setae in second and third instars, their secondary setae  $UR\beta$  and  $UR\gamma$  are reduced. The subtribe Tachyina (Bembidiini) has six setae,  $UR\beta, \gamma, \epsilon$  being reduced, whereas in Anillina with seven setae,  $UR\beta$  and  $UR\epsilon$  seem to be reduced (Arndt et al. 1999). The phylogenetic interpretation of these reductions is difficult.

The described larva of *Oopterus* (Zolini) fits well the characters of Trechinae. The larval characters of *Oopterus* come probably very close to the ground plan of the subfamily or to a monophyletic unit comprising Trechinae without Perileptina and Trechodina respectively. A derived (autapomorphic) character of *Oopterus* is probably only the small last maxillary palpomeres. The bulging, constricted sides of head are very similar to Patrobini.

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