

**A NEW GENUS AND SPECIES OF ISOTOMINAE
(COLLEMBOLA: ISOTOMIDAE) FROM CUSHION PLANTS ON
SUB-ANTARCTIC MACQUARIE ISLAND**

Penelope Greenslade and Mikhail Potapov

Greenslade, Penelope and Potapov, M. 2008. A new genus and species of Isotominae (Collembola: Isotomidae) from cushion plants on sub-Antarctic Macquarie Island. *Kanunnah* 2: 87–97. ISSN 1832-536X. A new genus of a blind, white isotomid, *Azoritoma* n. gen. and new species *A. macquariensis*, is described from Macquarie Island. The species has only been found in association with the cushion plant, *Azorella macquariensis* Orchard, on the plateau of Macquarie Island at an altitude of 260 m. A table of characters is provided to distinguish the new genus from other, similar genera of blind, white Isotomidae and some ecological notes on the new species are included.

Penelope Greenslade, Department of Botany and Zoology, Australian National University, GPO Box, Australian Capital Territory, 0200, Australia.
email: Penny.Greenslade@anu.edu.au.

Mikhail Potapov, Department of Zoology and Ecology, Moscow Pedagogical State University, Kibalchicha St. 6, build. 5, Moscow 129164, Russia

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The collembolan fauna of sub-Antarctic Macquarie Island is well known in comparison with Australian islands with warmer climates. This is due, in part, to the fact that for nearly 100 years specimens have been collected and recorded from Macquarie Island, the first of those being *Hypogastrura viatica* (Tullberg 1872), which was collected by G. Hamilton during the Australian Expedition of 1911–13. In addition, the collembolan fauna of Macquarie Island consists of relatively few species compared to more temperate islands of a similar size; Greenslade (2006) recorded

only 34 species on Macquarie Island. Consequently cumulative species curves reach saturation after relatively few collections.

Endemism for Collembola and for other terrestrial animals is considered to be low on Macquarie Island (Greenslade 1990, 2006). Studies, however, which use molecular data to distinguish species, may uncover cryptic, endemic island species. Stevens *et al.* (2006) used molecular data to show that Collembola specimens from the island, previously identified as a single species, *Cryptopygus antarcticus* Willem, 1901, probably include three taxa.

The new species of Collembola was collected for the first time from the island by Rounsevell in 1972, and it was provisionally identified as *Isotoma (Pseudosorensia) atlantica* (Wise 1970) a species only known previously from South Georgia (Greenslade and Wise 1986). Some doubt was expressed by Greenslade and Wise (1986) as to its correct identification and a few details of its morphology, including several figures, were included in their published paper. Macquarie Island individuals were smaller, lacked ocelli or any pigmented eyespot compared to the described species. The specimens were subsequently referred to as *Isotoma (Pseudosorensia) sp. nr. atlantica* by Greenslade (1990) and *Pseudosorensia sp. nr.*

atlantica by Greenslade (2006). A detailed study of the species morphology has now been made on material collected in 1986–87 by the senior author, which shows that the sensorial chaetotaxy of the Macquarie Island species differs markedly from that of *Pseudosorensia atlantica* as redescribed by Potapov (1989) (as *Isotoma atlantica*) from South Georgian material. Moreover, based on this and other characters, the Macquarie Island species cannot be assigned to any existing genus and so a new genus is erected for it here. The species appears to have a restricted distribution on Macquarie Island; it has only been found, thus far, at one locality and in one habitat, the cushion plant, *Azorella macquariensis* Orchard.

Abbreviations

Abd.	Abdomen, abdominal segments.	PAO	Postantennal organ.
Ant.	Antenna, antennal segments.	MSPU	Moscow State Pedagogical University, Russia.
AO	Distal sensory organ on antennal segment III.	SAMA	South Australian Museum, Adelaide, South Australia.
Th.	Thorax, thoracic segments.	SMNG	Staatliches Museum für Naturkunde Görlitz.
ms	microsensillum.		
s	sensillum/a.		

SYSTEMATICS**Family Isotomidae**
Subfamily Isotominae
***Azoritoma* n. gen.**

Diagnosis: Isotominae with all abdominal segments separate including abdomen V and VI, no abdominal segments fused, dens crenulated, longer than manubrium, ocelli absent, pigment absent, postantennal organ present and well developed, antenna IV with 6 thick sensilla, the most distal thicker than the others, labial palp bifurcated with 2 sublobal hairs, maxilla with reduced teeth on capitulum, manubrium lacking distal medial setae anteriorly, anterior chaetotaxy of dens with more than 30 setae, mucro with 4 teeth, sensorial chaetotaxy of abdomen V with 1 + 1 broad anterior and 4 + 4 medial thinner s setae.

Type species: *Azoritoma macquariensis* n. sp.

Systematic discussion

The new genus belongs to the subfamily Isotominae Schäffer, 1896 *sensu* Potapov (2001) because of the numerous setae on the anterior side of manubrium. *Azoritoma* n. gen. is clearly distinct from other genera of Isotominae based on three characters: 1) a characteristic modification of the outer and inner mouthparts (the maxillary head and outer maxillary lobe are particularly unusual); 2) a strongly reduced and differentiated sensillary chaetotaxy; and 3) a loss of setae from the anteriomedial face of the manubrium.

Firstly, the reduction of the maxillary claws (teeth) in *Azoritoma* is otherwise

unknown in the family. Secondly, in Isotominae, there are normally 4 sublobal hairs on the maxillary outer lobe and they are always shorter than the maxillary palp, not two and longer as in *Azoritoma*. Thirdly, the small number of sensilla on body is rare in Isotominae except for *Sericeotoma* Potapov, 1991, a Palaearctic genus known from the Ural Mountains and *Isotoma atlantica* (Wise 1970) *s.l.* from South Georgia, the generic placement of which is still uncertain. Thickened sensilla on body are sometimes present in unrelated taxa of Isotominae, for instance *Heteroisotoma stebaevae* (Rusek 1991) and *Isotoma mackenziana* (Hammer 1953), but are so far unknown in genera of small sized animals such as *Parisotoma* Bagnall, 1940 and *Pseudosorensia* Izarra, 1972. Species in the genus *Arlea* Womersley, 1939 from South America and South Africa, have a similar sensillary pattern on Abd V (Abrantes and Mendonça 2005; Mendonça *et al.* 2006) but the genus belongs to subfamily Anurophorinae Börner, 1906 *s.l.* because it has only one pair of anterior manubrial setae. Finally, the loss of setae from the anteriomedial group on the manubrium of *A. macquariensis* distinguishes it from all other small, blind members of the genera *Parisotoma* and *Pseudosorensia*. The same condition is only found in *I. atlantica*. *Isotoma atlantica* does not belong to the genus *Isotoma* due to the presence of 1 + 1 ocelli and a pigmented eye patch. Although a mucro with 4 teeth is found very occasionally in *Parisotoma*, the arrangement of the teeth is different from that of *Azoritoma*.

Azoritoma macquariensis* n. sp.*Material Examined**

Holotype: Adult Female, in *Azorella macquariensis* plants, at junction of Bauer Bay and Doctors Tracks, on plateau, Macquarie Island, 260 m a.s.l., 14.xii.1986, collected by P. Greenslade. Reg. no. SAMA I22626.

Paratypes: 11 Females, same data as holotype, reg. no. SAMA I22627; 20 Females, in alcohol, same data as holotype, SMNG; 2 Females on slide, MSPU.

Additional material: Collections 4/1, 4/2, on plateau, Macquarie Island, xi.1972, collected by D. Rounsevell, SAMA.

External Morphology

Body length: 0.48–0.53 mm. White, totally lacking pigmentation.

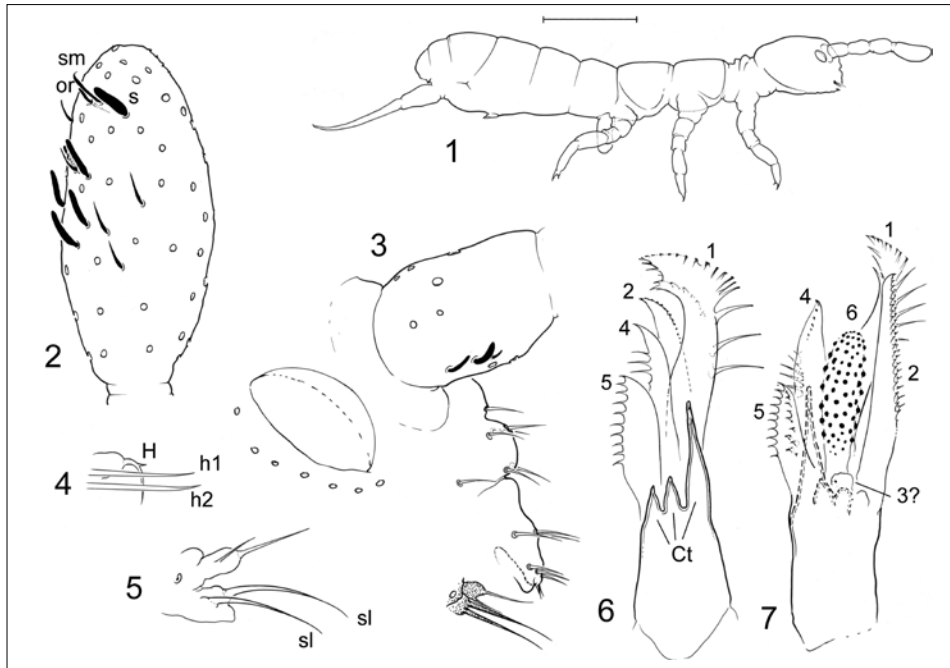
Antennae: Ant.I with 3 sensilla dorsally (1 moderately thickened, almost seta-like, 1 thickened and large, and 1 short (Fig. 3)) and with 1 or 2 (variable) microsensilla ventrally. Inner sensilla of AO of Ant.III broad, almost spherical, outer sensilla rather short (see Greenslade and Wise 1986; Fig. 1). Ant.IV with 5 sensilla moderately thickened, 1 thicker and positioned more distally and some thin sensilla (Fig. 2). Subapical microsensillum long, organite stick-like.

Head: Ocelli absent. PAO about as long as width of Ant.I (Fig. 3). Labral formula 2/554, in prelabral area 2 additional setae present, possibly prelabral (if so, labral formula 4/554) but frontal setae appear to be positioned ventrally (Fig. 16). Apical labral setae half length of rest, inserted near to distal margin, so area of apical folds

and apical folds entirely absent (Fig. 3). Maxillary outer lobe with 2 thick, long sublobal hairs and bifurcate apical palp (Figs 3, 5). Labial palp generally normal for family with 5 papillae (A–E) and full set of guards (16, incl. e7), lateral process as for family. Hypostomal setae h1 and h2 well developed, seta H weaker, curved and armed with denticle on outer side (Fig. 4). Labium with 4 + 4 basomedian, 5 + 5 basolateral, and 3 + 3 proximal setae. 3 + 3 postlabial setae (Fig. 16). Mouthparts considerably modified. Mandibles distally more slender than in most Isotomidae. Five elongate lamellae on maxillary head (1, 2, 4–6) (Fig. 7), lamella 3 probably lost or present as a small swelling (denticle) at the base (sometimes visible) (Fig. 7). Maxillary teeth on capitulum strongly reduced, only 1 clearly visible, but rather thin, appears to have 2 blunt teeth at the tip, 2 other teeth small, slightly pointed or variably blunt, inconspicuous (Fig. 6).

Thorax: Legs with few setae. Tibiotarsus I and II with 21 setae each, III with approximately 25 setae; all legs with only 7 setae in apical whorl (Fig. 13). Pretarsus with 2 small setae. Claw without lateral or internal teeth. Empodial appendage with broad lamellae. Ratio of length of claw III (measured internally): length of empodial appendage III = 1.3. Ratio of length of PAO: length of claw of leg III (measured internally) = 1.80

Abdomen: Ventral tube with 2+2 lateral, 2+2 anterior, and usually 3 posterior setae (see Greenslade and Wise 1986; Fig. 3). Retinaculum with 4+4 teeth and 1 seta (1 specimen with 2 setae). Anterior furcal subcoxa with 17–20 setae, posterior subcoxa partly fused with tergite as in

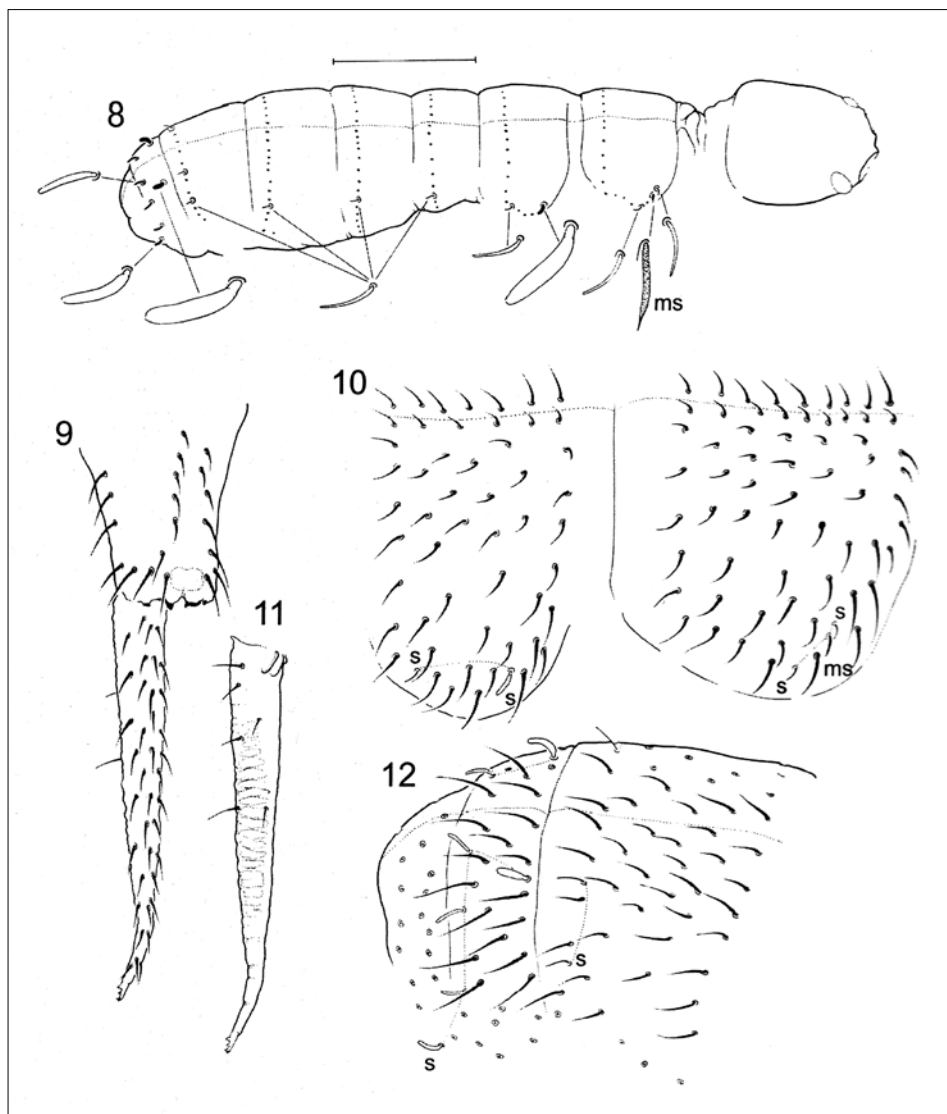


Figs 1–7. *Azoritoma macquariensis* adult female.

1. Habitus; lateral view. Scale line represents 0.1 mm. **2.** Ant. IV showing sensorial setae with thicker distal sensillum. **3.** Lateral view of head and Ant. I showing PAO, Ant. I sensilla, maxillary palp (shaded), labral and preclypeal (frontal) setae. **4.** Hypostomal setae with small barbed H seta, and long h1 and h2 setae. **5.** Maxillary palp, bifurcate with two long sublobal hairs. **6.** Maxillary head, Ct-reduced teeth of the capitulum and five lamellae 1–2, 4–6. **7.** Maxillary head, alternate view, showing five well-developed lamellae, lamella 3 possibly rudimentary. sm – subapical microsensillum; or – organite; sl – sublobal hair.

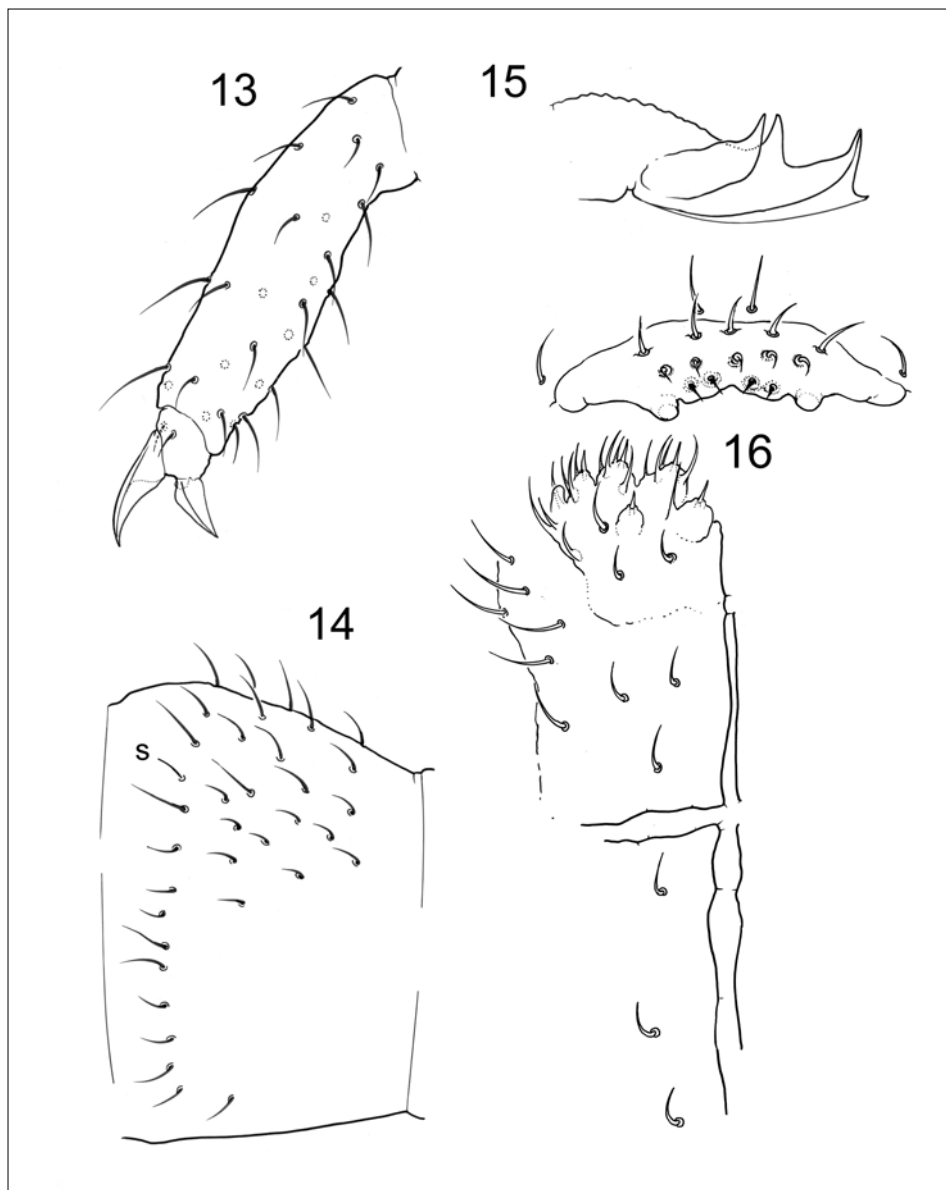
related genera. Manubrial thickening simple as for family. Anterior manubrium with approx. 18 setae. Medial setae in apical part of anterior face of manubrium absent (Fig. 9). Dens with 36–39 setae on anterior and 6 setae on posterior side (2 basal, 2 inner and 2 outer) (Figs 9, 11). Mucro with 4 teeth (3 is usual for most species of *Parisotoma*), fourth tooth minute, anteriodistal in position and obscure in dorsoventral view (Fig. 15). Ratio of length of manubrium: length of dens = 0.49 (measured laterally).

Chaetotaxy: Ordinary setae slightly thickened, smooth and short. A range of anterior and lateral ordinary setae on abdomen II absent (as in *Isotomiella symmetricumucronata* Najt and Massoud, 1987) (Fig. 14). Axial chaetotaxy for Th. II–Abd. III normally 9, 6–7/3, 3, 4 respectively. Macrochaetae hardly differentiated, smooth, shorter on Abd. V than length of tergite (Fig. 12). Ratio of length of Abd. V macrochaetae: length of Abd. V (measured laterally) = 0.59. Sensillary chaetotaxy as 2, 2/1, 1, 1, 2(1), 5 (s) and



Figs 8–12. *Azoritoma macquariensis* adult female.

- 8.** Dorsolateral view of body showing position and form of sensilla. Scale line represents 0.1 mm.
9. Anterior view of manubrium and dens, distal apical area of manubrium lacking setae indicated with dotted line (only in adult). **10.** Dorsolateral view of Th. II and III showing full chaetotaxy.
11. Posterior view of dens. **12.** Laterodorsal view of Abd. IV, V and VI showing ordinary setae and sensilla. ms – microsensillum; s – sensillum.



Figs 13–16. *Azoritoma macquariensis* adult female.

13. Anterior view of distal portion of tibiotarsus and claw of leg III. **14.** Lateral view of Abd. II showing chaetotaxy and area of missing setae. **15.** Mucro, lateral view. **16.** Ventral view of head showing labrum and right labium, ventral groove and post labial setae.

1, 0/0, 0, 0 (ms) on Th.II–Abd.V and on Th.II–Abd.IV respectively. Lateral sensilla sometimes absent on Abd.IV. Lateral sensilla on Th.III and all sensilla on Abd.V considerably thickened (Fig. 8). Following the notation of Potapov (1985) the number of ordinary setae between median line and sensilla on Abd.I–IV as 6_s , $6-8_s$, $8-9_s$, 2_s+2_s . Microsensilla on Th.II somewhat longer than sensilla on this segment.

Ecology

Azoritoma macquariensis shows adaptations to an euedaphic way of life with loss of ocelli and pigment, as well as development of particular sensilla on Ant.I and Abd.V. Species of other genera of Isotomidae that live in below-ground habitats, such as *Folsomotoma* Bagnall, 1949, *Folsomina* Denis, 1931, *Arlea* Womersley, 1939 and *Isotomiella* Bagnall, 1939 also have enlarged sensilla on antennae and/or abdomen V. The unusual modification of mouthparts in this species is likely to be related to the specialised habitat in which it is found.

General discussion

Azorella macquariensis is a plant endemic to Macquarie Island. A closely related species, *Azorella selago* Hook.f., occurs widely in the sub-Antarctic, as well as being found outside the sub-Antarctic region *sensu stricto* on Amsterdam Island, the Falkland Islands, the Kerguelen group, Marion and Heard Islands, but, so far, both the plant and the collembolan, *A. macquariensis*, have only been found on Macquarie Island. *Azorella* species are slow growing and have a compact form. Old leaves are retained under the green compact surface forming a moist, humus-like mass of organic matter

in which an array of Collembola and Acarina species can be found (Hugo *et al.* 2005; P. Greenslade unpublished results). The plant, *A. selago*, is considered a 'keystone' species in fellfield communities since it can act as a sentinel for climate change and thus its responses to increased temperatures and shading have been studied (Le Roux *et al.* 2005; McGeoch *et al.* 2006). The experimental manipulation led to less compact plants with a resultant loss of surface integrity. For a species such as *Azoritoma macquariensis*, which appears to require an edaphic-like habitat protected from wind, rain and extreme temperatures, warming climates are therefore likely to be detrimental to its survival. The other threats to the integrity of the Macquarie Island plant community that contains *Azorella* are damage caused by a large and growing population of rabbits, as well as attack from a fungal disease similar to *Rhizoctonia* (D. Bergstrom pers. comm. 2006). Isotomid Collembola have been shown to graze on *Rhizoctonia* on wheat roots in Europe (Sabatini and Innocenti 1995) but they may also aid in the dispersal of the disease. So whether *Azoritoma macquariensis* has a beneficial or deleterious effect on *Azorella* by feeding on the fungus is unknown and likely to depend on the density of both plants and animals.

Although *A. macquariensis* has so far only been found within *Azorella* plants, it is also likely to occur, but at lower densities, below the ground surface in the matrix surrounding the plants, as do other Collembola species that are found within *Azorella* cushions (Barendse and Chown 2001; Barendse *et al.* 2002). Obligatory, or even less rigid, associations of Collembola species with particular plant species are

Character	GENERA			
	<i>Azoritoma</i>	<i>Parisotoma</i>	<i>Pseudosorensia</i>	<i>Arlea</i>
Reference	This work	Potapov 2001	Izarra 1972; Wise 1970; Potapov 1991	Abrantes & Mendonça 2005; Mendonça <i>et al.</i> 2006
Abd V and VI	separate	separate	fused	fused
Mucronal teeth	4	3 (4 rare)	3	1
Anterior setae on manubrium	>15	>15	>15	1 + 1
Ant.IV sensilla	6 distal one thicker	5	unknown	7–10
Maxillary palp	bifurcate	trifurcate	unknown	unknown
Sublobal setae	2	4	unknown	unknown
Sensilla on Abd.V	1 + 4 thickened	2 + 5 not thickened	unknown	1 + 3 thickened
Distal medial setae on anterior face of manubrium	absent	2 + 2	2 + 2	absent
Ciliated macrochaetae	absent	present or absent	present or absent	absent

Table 1. Differentiating characters for three genera of Isotominae and one of Proisotominae that include white species with reduced ocelli.

rare but have been recorded twice before in Australia (Rodgers 1997; Driessen and Greenslade 2004). Further sampling on the island is needed to establish the true habitat range of the new species.

Endemism in terrestrial plants and animals is generally considered to be low on Macquarie Island, although deep soil species and freshwater aquatics seem to have a higher proportion of endemics than epigeic species (Greenslade 2006).

There is only one other endemic genus on Macquarie: an aquatic worm, *Macquaridrilus bennettiae* Jamieson, 1968 which is a tubificid oligochaete. Among the 30 species of Collembola found on Macquarie Island, only *Katianna banzareii* Salmon, 1964 and a possible undescribed marine littoral *Archisotoma* species are currently considered endemic. The new genus is therefore a significant addition to the uniqueness of the fauna of the island.

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