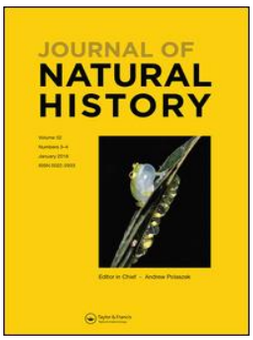

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A new species of *Friesea* (Collembola: Neanuridae) from the Antarctic Continent

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one' (Wise 1967, 1971). The same population was recorded by Bulavintsev (1995) as *Friesea* sp., and individuals are here found to have only five ocelli with 1 + 1 reduced on each side of the head, thus differing from all other Antarctic species. The specimens therefore unambiguously belong to a new species, which is described below.

Abbreviations

Mc – macrochaeta(e); me – mesochaeta(e); mi – microchaeta(e); s chaeta – sensillum, a; ant – antenna(e); th – thorax; abd – abdomen; PAO – postantennal organ.

Systematics

The species concept here used is that of morphology, as sufficient characters of this type distinguish the new species from other species in the genus. Moreover, the population has been isolated since glaciations of the continent. Greenslade (2018) noted characters that have been considered species specific for this genus, together with some of their variations. They are: number of ocelli, number of clavate tenent hairs, degree of reduction and form of the furca, number of teeth on the retinaculum, number and position of s chaetae on antennal segment IV, and form and number of anal spines (Smolis 2010). Additional characters useful in distinguishing species are: the relative lengths and form of the chaetae on the body, particularly on abdomen V and VI; the number of spines, spine-like or normal chaetae present on abdomen VI; the relative lengths of s chaetae; ordinary and macrochaetae on abdomen V; and the presence of dorsal cuticular granulation, body size, depth of pigmentation of adults and development of clavate tenent hairs and clavate macrochaetae.

Two systems of chaetotaxic nomenclature in the genus have been used by different authors; one is the system developed for Neanurinae by Deharveng and Bedos (1991) where species groups are named according to the position on tergites of the putative secondary tubercles. The other is the system developed by Yossi (1956) for poduromorphs which follows the primitive pattern of three rows of seven chaetae on each side of the thoracic and abdominal tergites. *Friesea* species often have a loss (reduction) in this pattern, as well as a displacement of some chaetae, making it difficult to confidently assign homologies (Grow and Christiansen 1974; Najt and Rubio 1978). Consequently, as the new species exhibits considerable reduction in chaetal numbers as well as asymmetries, the Deharveng and Bedos (1991) system is used here and recorded in a table. This system was also used by Potapov and Banasco (1985), Deharveng and Bedos (1991) and Weiner et al. (2011) for other species in the genus. It allows the species to be most easily compared to others in the genus and homologies to be identified with greater confidence. The ventral chaetotaxy of ant IV is not normally described or figured in descriptions of new *Friesea* species but is here shown to possess a significant specific character in that a distinct sensorial rasp is present (Figure 1). The only other species with such a structure appears to be *Friesea furculata* Deharveng and Bedos, 1991, where a sensorial rasp is figured comprising two to four chaetae. The new species here has a larger and conspicuous sensorial rasp, and is also distinguished by having 5 + 5

with 1 + 1 very reduced ocelli, a very reduced furca, one to four or five faintly clavate tenent hairs and six spines or spinose chaetae on abdomen VI.

Materials and methods

Five slides carrying a number of specimens of a *Friesea* species were received from M. Potapov, some with two cover slips with several specimens beneath them. Many specimens were in poor condition, being shrivelled and damaged. The mounting media of two of the slides had dried out leaving only a brown residue. The specimens on these slides were remounted in Berlese medium but one of the slides has only two specimens under one cover slip and numerous Prostigmata mites under the other. All specimens were examined under phase contrast; figures were drawn with a *camera lucida* and enhanced using Photoshop.

Taxonomy

Class **COLLEMBOLA** Lubbock
Order **PODUROMORPHA**
Family **NEANURIDAE**
Genus ***Friesea*** Dalla Torre, 1895
Friesea eureka sp. nov.
(Figures 1–3)

Type locality

Tereshkovoi Oasis, near Molodyezhnaya Station, Enderby Land, Eastern Antarctica, 67.66527778S, 45.8338333E, leg V. Bulavintsev, 6.i.1989, (SAMA).

Material examined

Holotype: Male, slide D. East Antarctica, Tereshkovoi Oasis, 6 January 1989, V. Bulavintsev (2 coverslips). Paratypes: Same data as holotype (2 coverslips), nspecimens mainly immatures (All SAMA).

Other material: Slide A Molodyezhnaya Station, January 1989, V. Bulavintsev; Slide B East Antarctica, Tereshkovoi Oasis, 6 January 1989, V. Bulavintsev; Slide C. East Antarctica, Tereshkovoi Oasis, 6 January 1989, V. Bulavintsev (2 coverslips), 10 specimens on this slide, one male is holotype, other 9 including female are paratypes. All material deposited in the South Australian Museum.

Description

Colour. Pale grey on slides.

Habitus. Small, elongate specimens.

Length. 0.72 to 0.96 mm (n = 10).

Ratio. Head length (lateral):antennal length:body length = 1.8:1:5.

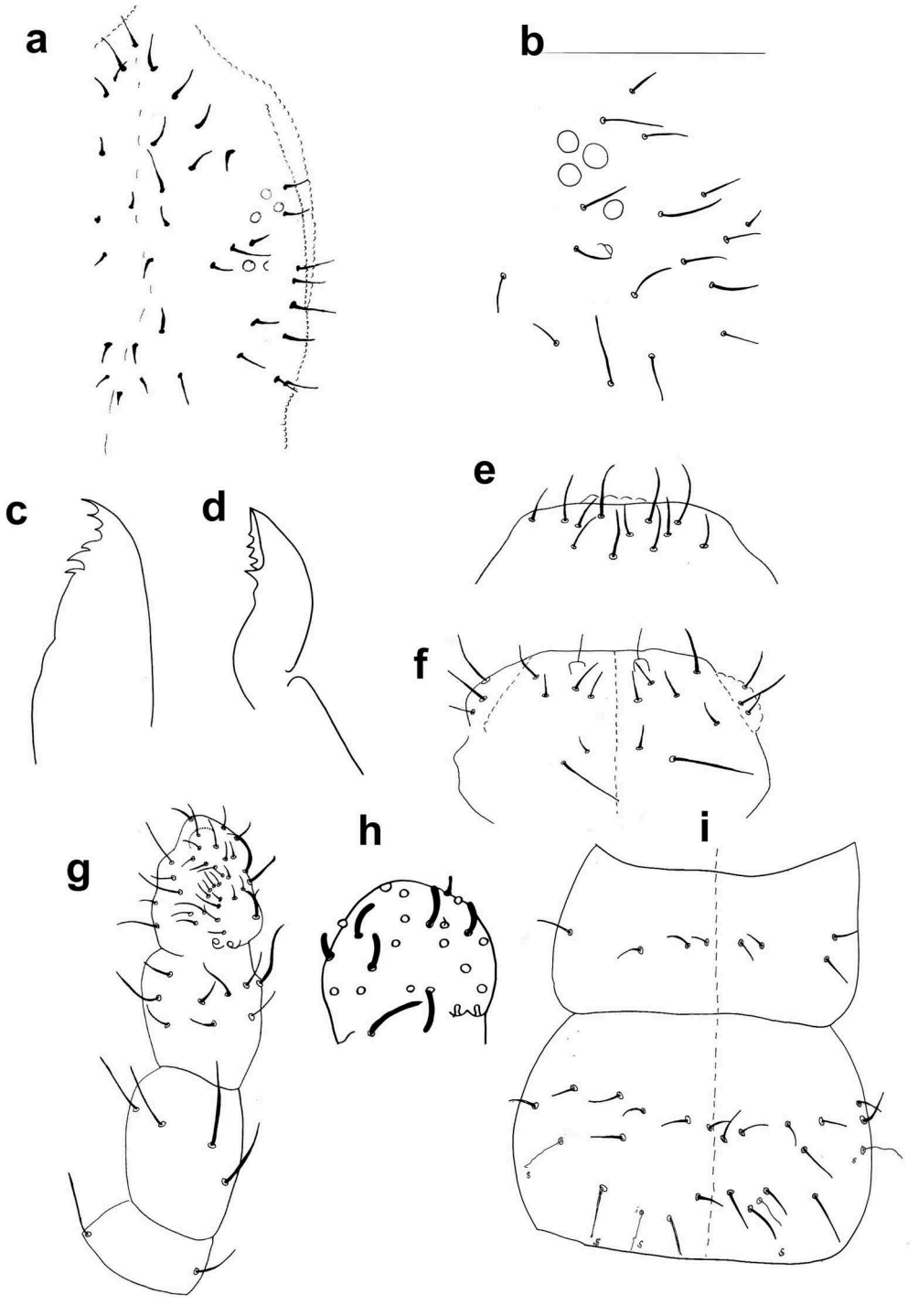

Figure 1. *Friesea eureka* sp. nov. (a) Right side of dorsal head chaetotaxy; (b) enlargement of ocellus patch and chaetae on left side of head; (c) lateral view of mandible; (d) lateral view of maxilla; (e) labrum; (f) labium and ventral head chaetotaxy; (g) ventral antennal segments; (h) dorsal antennal IV chaetotaxy, ordinary chaetae indicated by open circles; (i), dorsal chaetotaxy of thorax I, II.

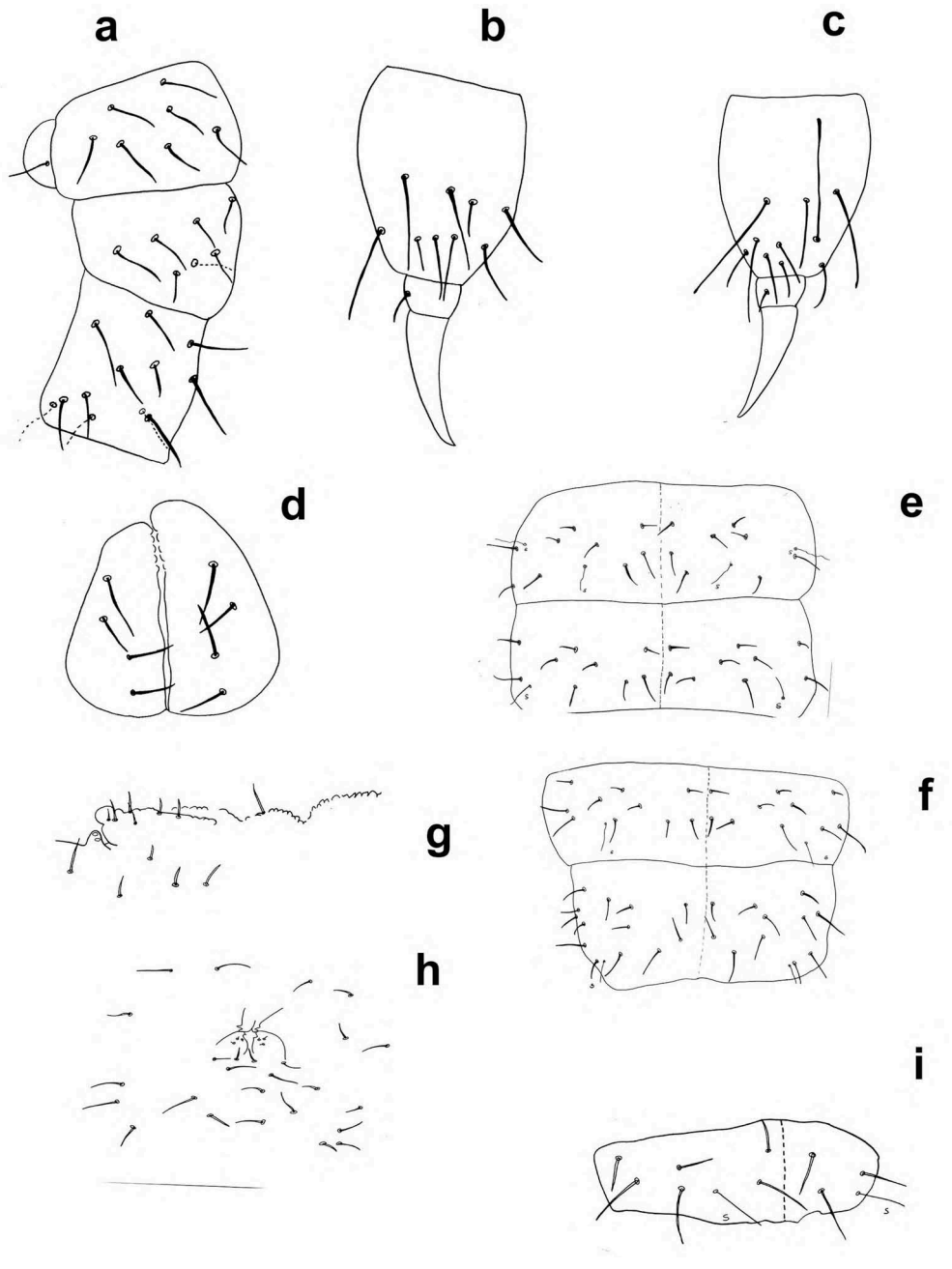

Figure 2. *Friesea eureka* sp. nov. (a) Leg III coxa, trochanter and femur; (b) ventral chaetotaxy of tibiotarsus III; (c) dorsal chaetotaxy of tibiotarsus III; (d) ventral tube; (e) chaetotaxy of abdominal segments I and II; (f), chaetotaxy of abdomen III and IV; (g) furcal region lateral view; (h) ventral chaetotaxy of abdomen III showing furca and manubrial chaetae; (i) dorsal chaetotaxy of abdomen V.

Chaetotaxy and cuticle. Most specimens received were juveniles with a reduced and asymmetric chaeotaxy. Chaetal asymmetries present mid-dorsally. Even in adults, chaetotaxy is not stable. For instance, one male has a pair of deeply bifurcate p1 on abd V. All Mc

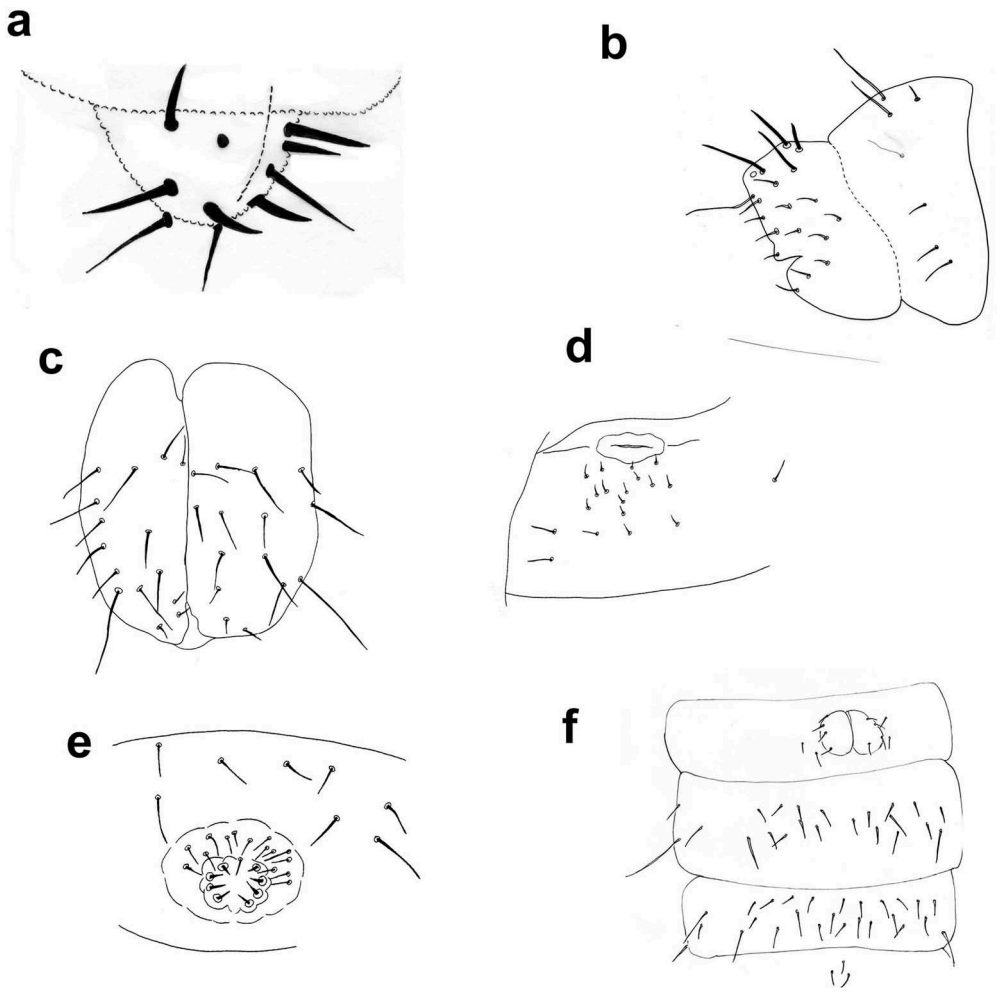

Figure 3. *Friesea eureka* sp. nov. (a) Dorsal chaetotaxy of abdomen VI showing spines and spine-like chaetae; (b) lateral view abdomen V, VI; (c) anal lobes; (d) female genital opening; (e) male genital opening; (f) ventral chaetotaxy abdomen I to III.

and me chaetae are smooth and pointed, becoming longer posteriorly. Mc chaetae stoutish. S chaetae very fine, thin, not particularly long relative to segment length. Broad S chaetae on antennal segment III (2) and IV (6). Number and arrangement of S chaetae as for genus but because of losses and asymmetries of some chaetae, position not always clear. For instance, S chaeta appears in position of m2 on abd V and not m3 as m2 is absent.

Head and antennae. Antennal segments III and IV partially fused dorsally; ant I with 7 chaetae, no mi seen; ant II with 11 chaetae; ant III organ with 2 broad clubs in cuticular groove, 1 very long, curved S chaeta dorsally and 1 ventrally; ant III with 16 chaetae with 3 mi ventrally; 6 thick curved S chaetae on ant IV, no others distinct, S1 thinner than others; S7 and 8 thicker; less developed in some individuals; apical bulb on ant IV

conspicuous and single; organite and mi present. Antennal IV ventrally with small sensorial rasp consisting of about 9–10 short, bluntish chaetae; L chaeta present on labium but seta A or B absent in juveniles and D displaced laterally also in juveniles, sometimes asymmetrically present; labrum with 5, 4, 4 chaetae from posterior to anterior, most posterior central ao chaeta longer than adjacent chaetae; ocelli 4 + 4 lenses, plus 1 + 1 reduced and hardly visible, but six pigmented eye spots on head; 3 interocular chaetae; head with chaetae Do present, p1, p2, c1, c2 present; v1, v2 absent; ventral head with 2 + 2 chaetae.

Ratio. Antennal segments: I:II:III = 1:1.5:1.5.1.6.

Thorax and legs. Dorsal chaetotaxy of thorax and legs as in Tables 1 & 2 and Figures 1i, 2a,b,c respectively. No ventral thoracic chaetae; number of tenent hairs up to 5 in adults, variable and only lightly clavate; claw moderately narrow, lacking teeth (Table 2 and Figure 2b,c). Internal length of claw and anal spines at m1 variable with maturity, sometimes approximately equal in length varying from: 1:1.5 to 1:1.1.

Abdomen and appendages. Ventral tube with 3 + 3 (4 + 4) chaetae in adult (Figure 2d); two minute teeth on the remnant of retinaculum; manubrium with 8 + 8 chaetae; dens reduced, with 3 + 3 mi and slight indication of mucro as minute pimple (Figure 2g,h); anal lobes with 12 (11) chaetae, macrochaetae not always seen; m1 missing on abd IV; S chaetae thin, pointed, longish on abd; on abd IV S chaeta at p4; at p3 on abd V but p2 absent; nearly as long as Mc on abd V and three-quarters as long as segment (Figure 2e,f); abd VI a1 longer than on abd V in female. Abd VI with 2 + 2 spines in adult and macrochaetae longer, thick and spine-like; on Abd VI po is unpaired, m1 as a slightly curved long thick spine, a1 with shorter straight spine; a2 long spinose chaeta; m2 long, spinose chaeta; po on abd VI as short fine chaeta (Figure 3a,b). Progression of spinal development: m1 to a1 to a2 (long) to m2. Spines not fully

Table 1. Dorsal chaetotaxy of half tergites for *Friesea eureka* sp. nov. Variations are indicated by brackets.

	Di	De	DL	L
Th 1		4(3)		
Th II	4 (3)	3(4) + s	3 + s + ms	
Th III	4 (3)	3(4) + s	4 3? + s	
Abd I	3	3 + s	4	
Abd II	3	4 + s	4	2
Abd III	3	4 + s	3	2
Abd IV	3	4 + s	3	2
Abd V	2	3 + s	3	

Table 2. Chaetotaxy of legs of *Friesea eureka* sp. nov.

	Precoxa I	Precoxa II	Coxa	Trochanter	Femur	Tibiotarsus
Leg I	0	0	1	6	12	8/11
Leg II	0	2	8	6	10	8/11
Leg III	1	1	7	6	11	7/11

developed in immatures, with abd VI becoming longer with greater spine development in adult. Ventral chaetotaxy: abd II 5 + 5, abd III 7 + 7, abd IV 3 + 3 (Figure 3f).
Abd V ratios length of segment: Mc:me:s = 2:1.8:1:1.5. abd v S 22, Mc p122, me a1 13.
Abd VI ratios length of anal spines on abd VI: a1:a2:m1:m2 = 2:1:1:2.4
Abd VI ratios claw: me:a1 spine: m1 spines, M p2 = 1:1: 1.3: 1.8: 2.6.
Abd VI ratios claw: po = 2.5:1.

Genital apertures. Male with 18 circum-aperture chaetae, 4 + 4 internal strong chaetae on in sexual phase. Female with 10 chaetae, 3 + 3 mi internally (Figure 3d,f).

Diagnosis

This species differs from all other *Friesea* species on the Antarctic continent in having 4 + 4 ocelli + 1 + 1 regressed, a small sensorial rasp ventrally on ant IV, 4 straight spines on abdomen VI not inserted into papillae, 2 + 2 spine-like chaetae on abd. VI and S chaetae long, nearly as long as Mc on abd V.

Biology

Several specimens had tardigrade claws and rotifer trophi (mouthparts) in their alimentary canals. The genus has been known to feed in micro-invertebrates since Cassagnau's (1958) publication. Ten species of Tardigrada are known from aquatic habitats near Molodyezhnaya Station and at the Tereshkovoi oasis (Opaliński 1972; Tsujimoto et al. 2014). The rotifer fauna has also been described.

Discussion

The new species is unlike any other *Friesea* species known in its unique combination of ocelli, reduced furca and number of anal spines, and spinose chaetae and so is also distinct from other species in the southern polar region. *Friesea flava* Salmon 1949 from Campbell Island has the same number of ocelli and anal spines, but it has a well-developed furca. *Friesea woyciechowskii* from the South Shetlands has five ocelli and a reduced furca, but it only has two anal spines and a single, more distinct clavate tenent hair. It is also larger at over 1 mm, its chaetae are shorter, ant IV only has four S chaetae, and the macrochaetae are not spine-like. A possible sensorial rasp was described by Weiner (1980) for *F. woyciechowskii*, consisting of 11 blunt chaetae compared to a slightly smaller one in *F. eureka*. The new species is likely to be closely related to *F. woyciekowski* but selection pressures on it, because of the shorter growing season in Enderby Land compared to the South Shetlands, would have been towards earlier maturity so the smaller size and increase in spines and clavate tenent chaetae might be expected. A key to continental Antarctic species of *Friesea* is given in Greenslade (2018).

Friesea eureka sp. nov. is a short-range endemic based on current records. It is found quite commonly in ice-free areas in and around the Russian station Molodyezhnaya. Concern has been expressed in the literature regarding the threat to the locally endemic species on the continent imposed by climate warming, as their distributions are likely to expand and they may come in contact with congenerics (Lee et al. 2017). The nearest other *Friesea* species on the continent is probably *F.* sp. cf. *grisea*, at a distance of approximately

Table 3. Checklist and distribution of *Friesea* species from the Antarctic continent and Antarctic Peninsula. Type locality in bold.

Genus	Species	Authority	Distribution
Friesea	*antarctica*	(Willem, 1901)	**Harry Island, Gerlache Straits, Antarctic Peninsula**
Friesea	*eureka*	This paper	**Tereshkovoi Oasis, Enderby Land**
Friesea	*grisea*	(Schäffer 1891)	**South Georgia**; various doubtful localities Antarctic continent
Friesea	*topo*	Greenslade, 1985	**Alexander Island, Marguerite Bay;** ?South Orkneys
Friesea	*tilbrooki*	Wise, 1970	Bouvetoya Island, also Subantarctic Islands
Friesea	*wyciechowskii*	Weiner, 1980	**King George Island**, **Keller Peninsula**, Livingston Island, King George Island; Deception Island, **South Shetland Island**; South Orkneys

2500 km, so the likelihood of contact is low. However, *Cryptopygus sverdrupi* Lawrence, 1978 has been shown to comprise two genetically distinct lineages separated by only 15 km in nunataks in Dronning Maud Land (Stevens and D'Haese 2014), and, as no sequence data is available for *F. eureka*, it is possible that different lineages exist for this species too. If it shows a similar pattern to *C. sverdrupi*, there would be an increased risk of hybridisation and mingling of genotypes under a climate warming scenario. A measure of the 'biodiversity outlook' of the Antarctic fauna, taking into consideration the effect of future threats and impacts, concluded it would be the same there as for the rest of the world (Chown et al. 2017). This assessment failed to take into consideration the much higher percentage of endemic species, even genera and their isolated distributions, present in the region compared to the rest of the world. Because of this, impacts would have a relatively greater deleterious effect on the Antarctic fauna.

Revised international conservation legislation for Antarctica has recently been adopted (Antarctic Treaty (Environment Protection) Amendment Act 2010). It allows listing of specially protected invertebrate species and controls on collecting native invertebrates. It is likely that the new species described here would fulfil the criteria for listing because of its restricted distribution. As no Antarctic Collembola are listed as specially protected species so far, *F. eureka* sp. nov. appears to be an ideal candidate to list and would emphasise the importance of this group of organisms for ecosystem integrity, especially as there are now five described Friesea species known from the Antarctic Continent and Peninsula (Table 3).

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