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ANTARCTIC TARDIGRADA III. FILDES PENINSULA OF KING GEORGE ISLAND

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Abstract: In order to survey Antarctic tardigrade fauna, the authors examined the specimens from King George Island during the summer from December 1989 to February 1990. The samples composed of blue-green algae, mosses and lichens were collected from 17 sites around the Chinese Great Wall Station at the Fildes Peninsula of King George Island. Eleven species of tardigrades were found in 42 samples. Five of these species were obtained from the various sites in this study and have also been found in other antarctic areas such as Syowa Station, Molodezhnaya and Mt. Riiser-Larsen. However, the remaining 6 species (*Amphibolus volubilus*, *Isohypsibius asper*, *Isohypsibius papillifer*, *Hexapodibius* sp., *Hypsibius* sp. and *Echiniscus* sp.) were rare in the present samples.

1. Introduction

Various kinds of tardigrades have been reported from several areas of Antarctica since the early period of antarctic expeditions (MURRAY, 1906, 1910; RICHTERS, 1907, 1909; MORIKAWA, 1962; SUDZUKI, 1964; SUDZUKI and SHIMOIZUMI, 1967; JENNINGS, 1976a,b; DASTYCH, 1984, 1988; MILLER *et al.*, 1988). In previous papers, the authors reported 5 species of tardigrades in the Syowa Station area (UTSUGI and OHYAMA, 1989) and 9 species in the Molodezhnaya and Mt. Riiser-Larsen areas (UTSUGI and OHYAMA, 1991).

The present survey was carried out during the summer in the area around the Chinese Great Wall Station in the Fildes Peninsula of King George Island. Belonging to the maritime region, the study area is characterized by considerably different climate and flora from those of the continental area (INOUE, 1991).

The authors examine and compare the difference of tardigrade fauna between the areas.

2. Materials and Methods

Fourty two samples were collected from 17 sites around the Chinese Great Wall Station (58° 58'W, 62° 13'S) in the Fildes Peninsula of King George Island of Antarctica by Y. OHYAMA during the summer from December 1989 to February 1990. Although most of the samples consisted of either mosses or blue-green algae, some were mixture of mosses, blue-green algae and lichens (Table 1). The mosses were

mainly *Drepanocladus uncinatus*, *Bryum pseudotriquetrum*, *Polytrichum alpinum* and *Calliergidum* sp. Thread-like alga or *Nostoc* sp. was the most dominant species of blue-green algae. The lichens were not identifiable here.

Tardigrades were extracted after macerating these samples in water and fixed-stored in ethanol. To examine the details of the animals, the fixed tardigrades were mounted on slides with Gum-chloral for microscopic observation. A scanning electron microscope was also used to examine the surface structure of some species.

3. Results

The seventeen study sites are shown in Fig. 1. The occurrence of tardigrades at every site is summarized in Table 2. The characteristics of each species are described below.

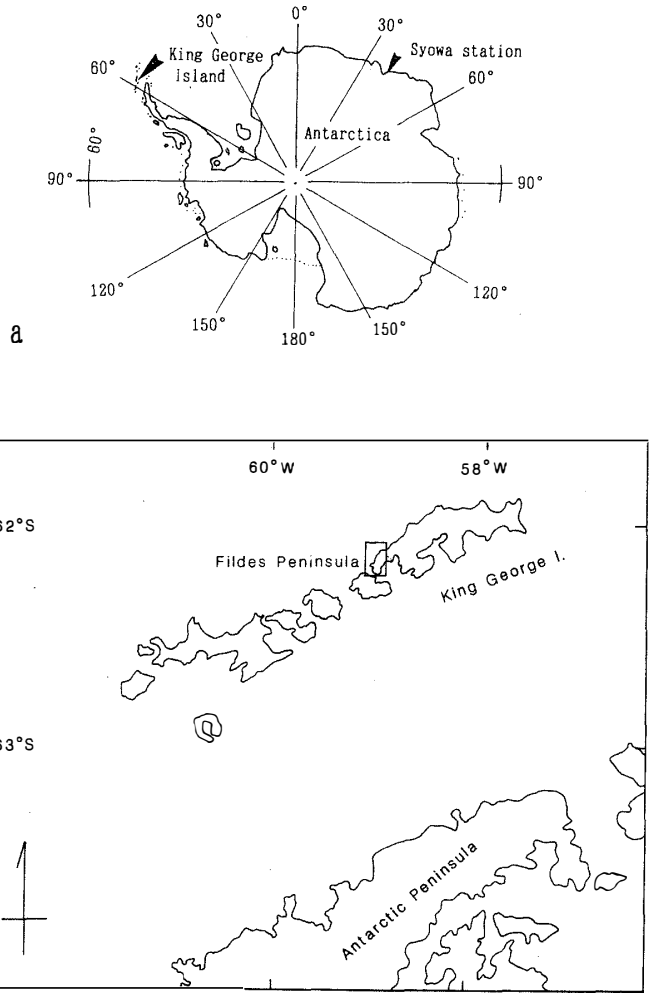

Fig. 1. Locations of sampling sites: a. Arrow indicates survey areas in Antarctica; b. place for the present study; c. (●) and (△) mean sampling sites (Nos. 1–17) and the Chinese Great Wall Station, respectively.

Class Heterotardigrada MARCUS, 1927

Echiniscus kerguelensis RICHTERS, 1904

The characteristics of this species were described in a previous paper (UTSUGI and OHYAMA, 1991).

The present specimens were obtained from 7 sites (Nos. 1, 2, 3, 8, 11, 12 and 13).

Echiniscus sp.

(Fig. 2a–b)

Body 130 to 150 μm in length. Body color unknown because of fixed specimen. Eyespots dark brown. Surface sculpture of each plate small granules irregularly arranged. Cirrus A long (40 μm in 142 μm specimen). Internal and external peribuccal cirri present. Lateral appendages posterior to cirri A on C and E very long

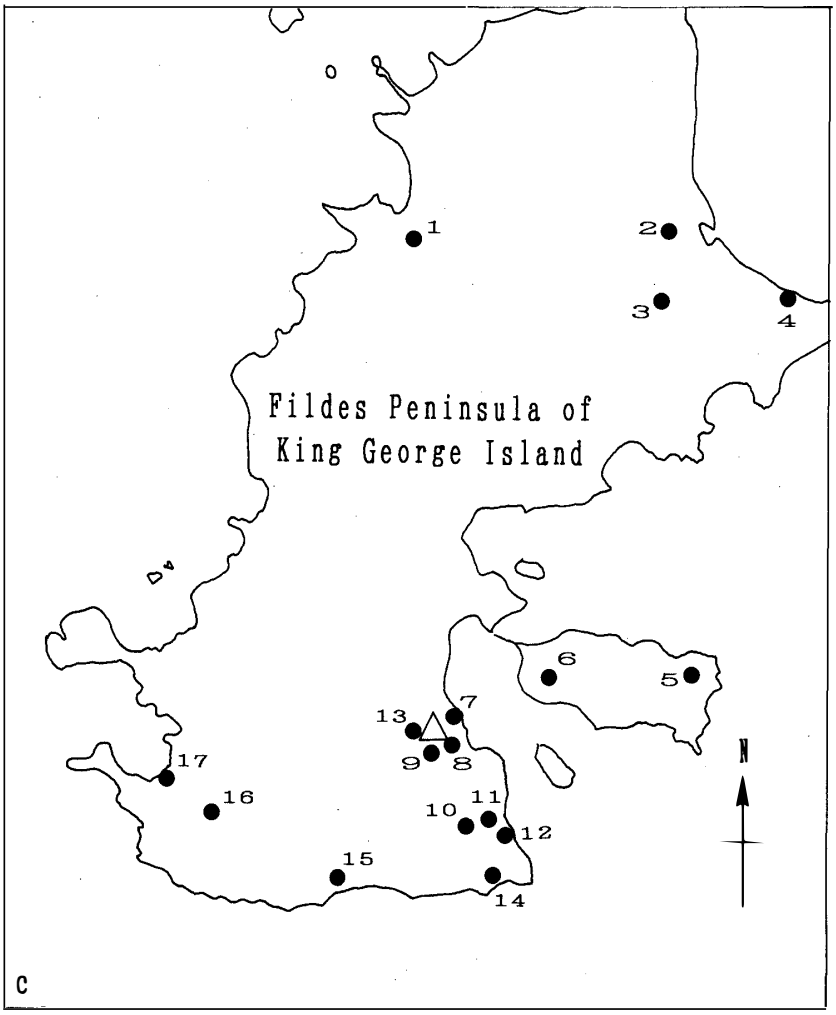

Fig. 1. (Continued).

Table 1. Collecting data in the Fildes Peninsula of King George Island.

Site number	Date	Altitude	Flora
1	'90.II.11.	<30 m	thread-like blue-green alga
2	'89.XII.29.	<30	*Nostoc commune* or lichens
3	'90.II.17.	100	*D. u.* + *C.* sp.
4	'90.I.8.	50	*D. u.* / *B. p.* or *D. u.* + *B. p.*
5	'90.I.1.	<30	*Nostoc commune*
6	'90.I.1.	<30	*Nostoc* sp.
7	'90.I.6.	<30	*D. u.* / *B. p.* / thread-like blue-green alga
8	'90.I.23.	<30	*P. a.* / *D. u.*
9	'90.I.25.	<30	*D. u.* + *B. p.* / *D. u.* + *C.* sp.
10	'90.I.17.	<30	thread-like blue-green algae
11	'90.I.26.	<30	thread-like blue-green algae
12	'90.I.26.	<30	*D. u.* / *B. p.* / thread-like blue-green alga
13	'90.I.29.	<30	*Nostoc commune* / *D. u.* + *Nostoc*
14	'90.I.14.	<30	*B. p.*
15	'90.I.14.	<30	*B. p.* + *Nostoc* / *Nostoc commune*
16	'90.I.14.	50	*P. a.* / thread-like blue-green alga
17	'90.I.14.	<30	*P. a.* / *D. u.* + *Nostoc*

Abbreviations indicate the following moss species.
B. p. = *Bryum pseudotriquetrum*, *C.* sp. = *Calliergidium* sp.
D. u. = *Drepanocladus uncinatus*, *P. a.* = *Polytrichum alpinum*

Table 2. Tardigrades from King George Island (Antarctica).

Site number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Number of samples taken	1	2	1	4	2	1	4	4	3	2	3	5	2	1	2	1	4
Heterotardigrada																	
Echiniscus kerguelensis	○	○	○					○			○	○	○				
Echiniscus sp.		○						○									
Eutardigrada																	
Macrobiotus harmsworthi		○					○		○			○		○	○		○
Amphibolus volubilus				○		○	○			○	○						○
Hypsibius arcticus		○	○	○	○	○	○	○	○	○	○	○	○		○	○	○
Hypsibius sp.				○													
Isohypsibius asper	○	○										○					
Isohypsibius papillifer												○	○				
Diphascon (D.) alpinum		○						○			○						
Diphascon (D.) higginsi							○	○						○			
Hexapodibius sp.								○									

and filamentous (C 60 μm and E 128 μm in 142 μm specimen). Dorsal appendages behind scapular plate on Cd long filamentous and that on Dd short spine (Cd 60 μm and Dd 7 μm in 142 μm specimen).

Internal claws of each leg with a spur curved toward base, but external claws without it. Fourth leg with a papilla and a dentate collar outside.

The present specimens were obtained from only 2 sites (Nos. 2 and 8).

Remarks: *Echiniscus* sp. is similar to *E. meridionalis* J. MURRAY, 1906, in the

number and positions of appendages. But the length of each appendage of the present specimen is longer than JENNINGS (1976a) as shown in the following ratio (present to JENNINGS): appendage C, 60 to 35 μm; Cd, 60 to 45 μm; Dd, 7 μm to vestige; E, 128 to 87 μm and further body length, 142 to 109 μm.

J. MURRAY (1906) suggested that the length of appendages may change during the development. But the present species resembles undetermined species *E.* sp. (J. MURRAY's plate I. Fig. 2) as well. Therefore, there still remains a possibility that this species may be new to science.

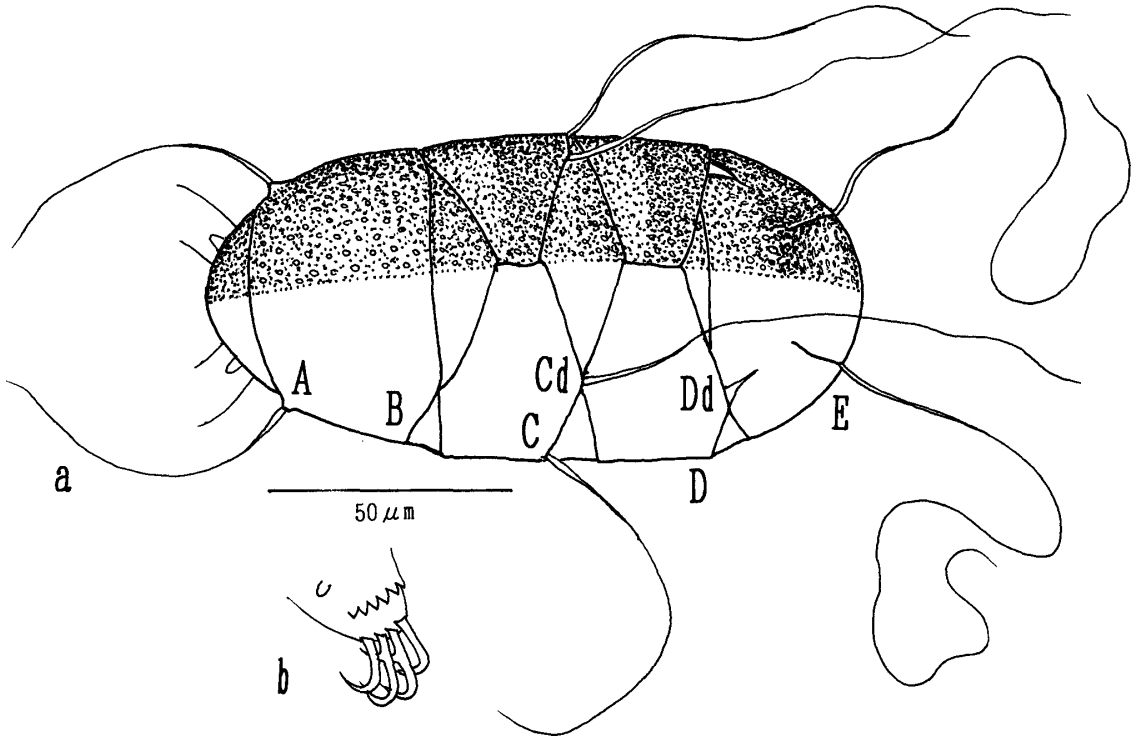

Fig. 2. Echiniscus *sp.: a. Dorsal view; cuticular sculptures shown only on for right half. A, B, C, Cd, D, Dd and E indicate positions of appendages; b. external view of leg IV, with single papilla, dentate collar and claws.*

Class Eutardigrada MARCUS, 1927

Macrobiotus harmsworthi J. MURRAY, 1907

The characteristics of this species were described in a previous paper (UTSUGI and OHYAMA, 1989). The present specimens were obtained from 7 sites (Nos. 2, 7, 9, 12, 14, 15 and 17).

Amphibolus volubilus DURANTE PASA *et* MAUCCI, 1975

(Fig. 3a–d)

Body 470–660 μm in length. Eyespots present. Cuticle smooth. Mouth encircled by lamellae. Mouth tube short (70 μm), wide (6 μm). Pharyngeal bulb oval, with apophysis and two long rod-like macroplacoids. Microplacoid absent. First macroplacoid longer than second, with short projection at midpoint. Second macroplacoid with small node at posterior part. Doubleclaws of each leg large, of

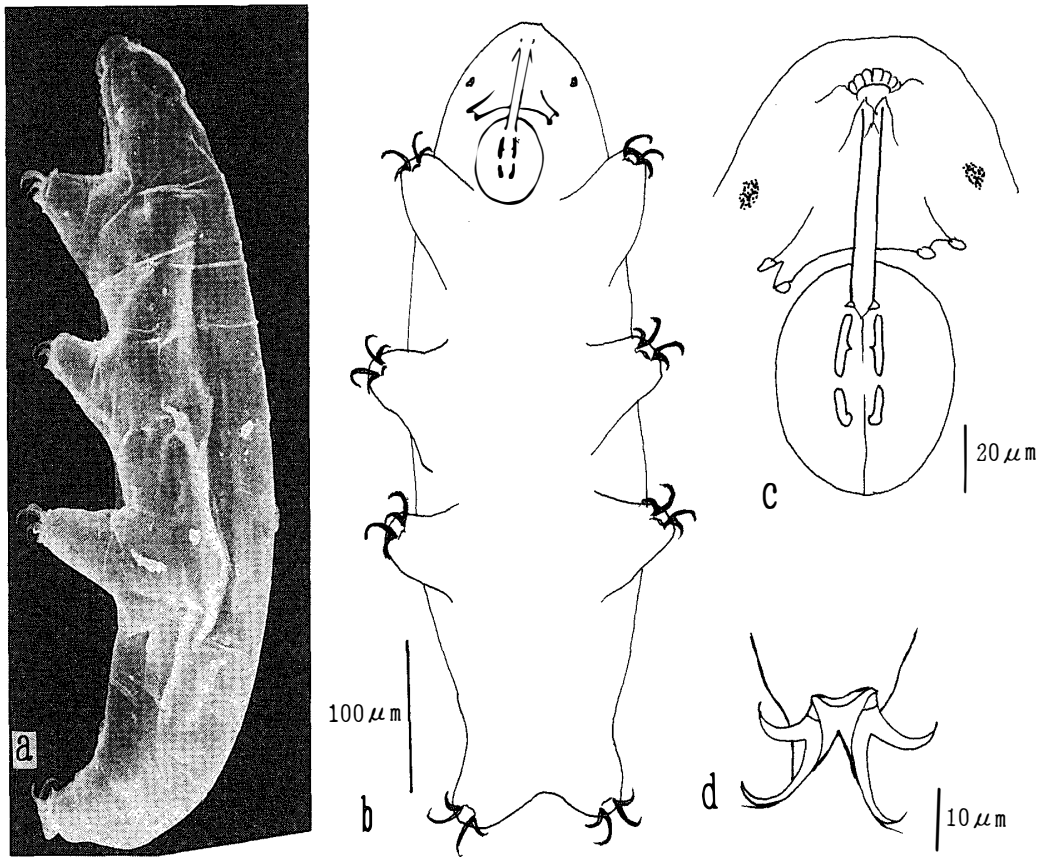

Fig. 3. Amphibolus volubilus*: a. Left lateral view by scanning electron microscope (SEM); b. ventral view; c. mouth apparatus; d. doubleclaws of leg III.*

almost the same shape. Both branches thick and curved, secondary branch at obtuse angle to primary one. At base of claws cuticular tract present. The present specimens were obtained from 6 sites (Nos. 4, 6, 7, 10, 11, and 17).

Hypsibius arcticus J. MURRAY, 1907

The characteristics of this species were described in a previous paper (UTSUGI and OHYAMA, 1989). The present specimens were widely obtained from 15 sites (except Nos. 1 and 14 of 17 sites).

Hypsibius sp.
(Fig. 4a–e)

Body 316 μm in length. Body color unknown but transparent in fixed specimens. Cuticle smooth. Eyespots present. Mouth tube straight, *ca.* 34 μm in length, 2 μm in diameter. Pharyngeal bulb round; apophysis present; macroplacoids two in number, rod-like in shape, of which first one has tiny constriction at midpoint and longer than second. Microplacoid absent.

Doubleclaws of each leg considerably different in shape; primary branch of outside claw straight, extraordinarily long and slender (*ca.* 30 μm in 316 μm specimen); secondary branch curved, thick, short (*ca.* 12 μm) and separated from primary one at base.

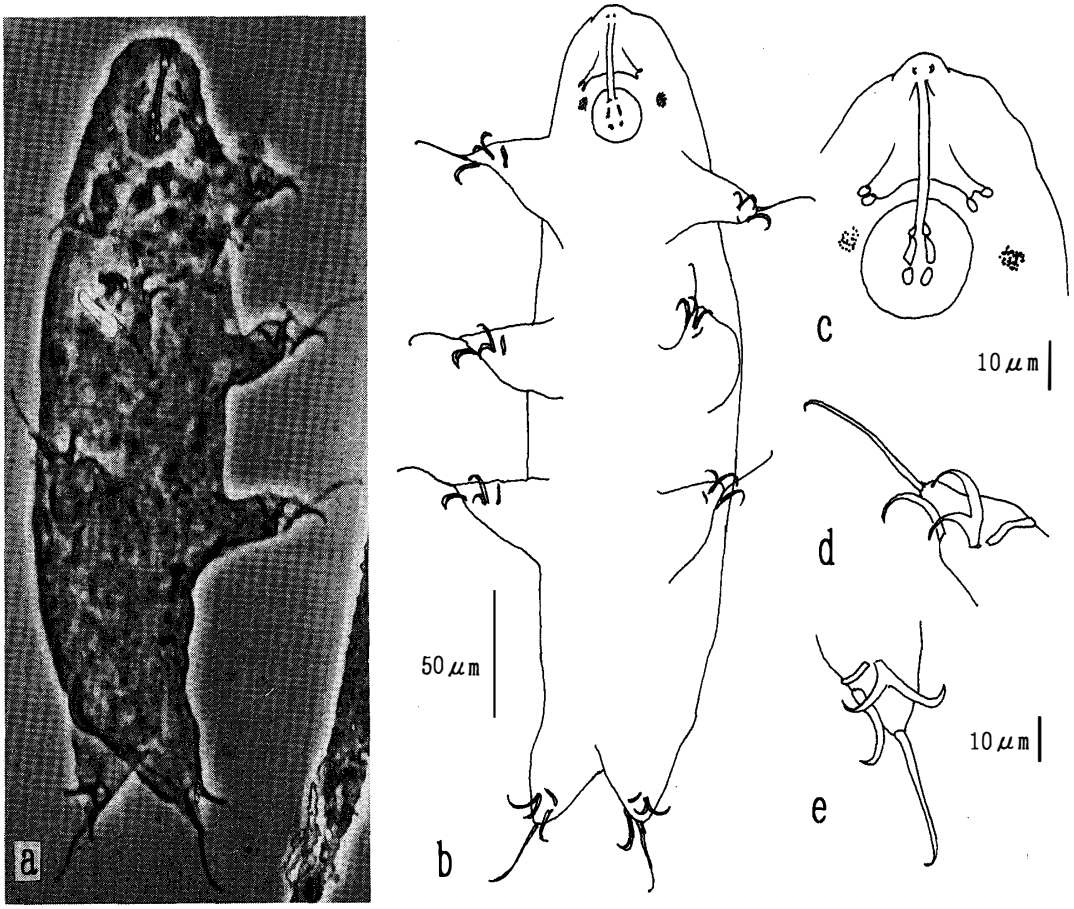

Fig. 4. Hypsibius *sp.: a and b. Ventral view; c. mouth apparatus; d. doubleclaws of leg III; e. doubleclaws of leg IV.*

Secondary branch of inside claw not separated, short at base and at obtuse angle to primary one. Thick cuticular bar present at base of each of doubleclaws.

For this species, only one specimen was obtained from a *Drepanocladus uncinatus* moss sample collected at site No. 4.

Remarks: *Hypsibius* sp. is similar to *H. cataphractus* MAUCCI, 1974. The former is, however, different from the latter in regard of the following two characteristics; *H.* sp. with a pair of eyespots and with cuticular surface being smooth, whereas *H. cataphractus* without eyespots and with fine granular structures on the cuticular surface. This species is probably new to science, but it remains undescribed here, because of the deficient number of specimens.

Isohypsibius asper J. MURRAY, 1905
(Fig. 5a–d)

Body 306–490 μm in length. Eyespots present. Dense small hemispherical projections irregularly dispersed on dorsal and lateral surfaces of cuticle. Mouth tube narrow, short. Pharyngeal bulb oval. Apophysis small. Three macroplacoids

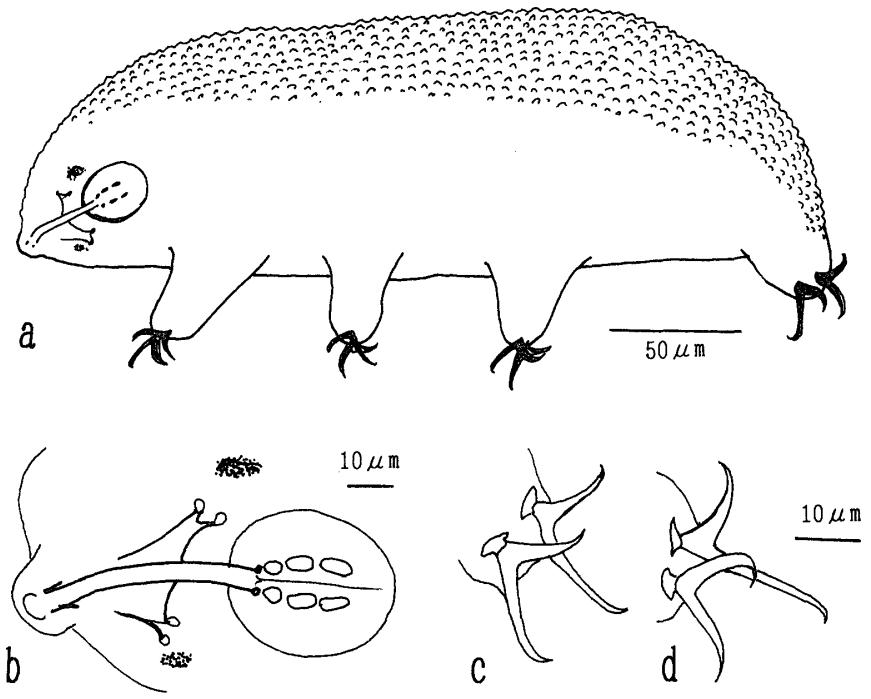

Fig. 5. Isohypsibius asper*: a. Left lateral view; b. mouth apparatus; c and d. doubleclaws of legs II and IV, respectively.*

short, rod-like, of which first one rather round. Microplacoid absent. Doubleclaws of each leg large. Size of claws increases gradually from anterior to posterior legs. Secondary branch at obtuse angle with primary one. Each claw with lunule at base.

The present specimens were obtained from 3 sites (Nos. 1, 2 and 12).

Isohypsibius papillifer J. MURRAY, 1905
(Fig. 6a–e)

Body 170 μm in length. Eyespots present. Many conical papillae arranged in 10 transverse bands of cuticle. Number of papillae on each band in order from cephalic to caudal part; 2, 6, 6, 6, 6, 6, 2, 6, 4 and 4. Mouth tube narrow, pharyngeal bulb oval. Apophysis present. Three macroplacoids short, rod-like and almost in the same size. Microplacoid absent. Both shape and size of doubleclaws similar among legs. Secondary branch at obtuse angle with primary one.

The present specimens were obtained from 2 sites (Nos. 12 and 13).

Diphascon (*D.*) *alpinum* J. MURRAY, 1906
(Fig. 7a–d)

Body 240 μm in length. Cuticle smooth. Eyespots absent. Mouth tube straight and narrow, (1 μm in diameter, 20 μm in length) with drop-shaped structure at dorsal posterior edge. Pharyngeal tube long and curved, also narrow, 1 μm in diameter, 44 μm in length. Pharyngeal bulb short oval (28 × 22 μm in 240 μm specimen). Small apophysis and three macroplacoids present. Macroplacoid short rod-like of

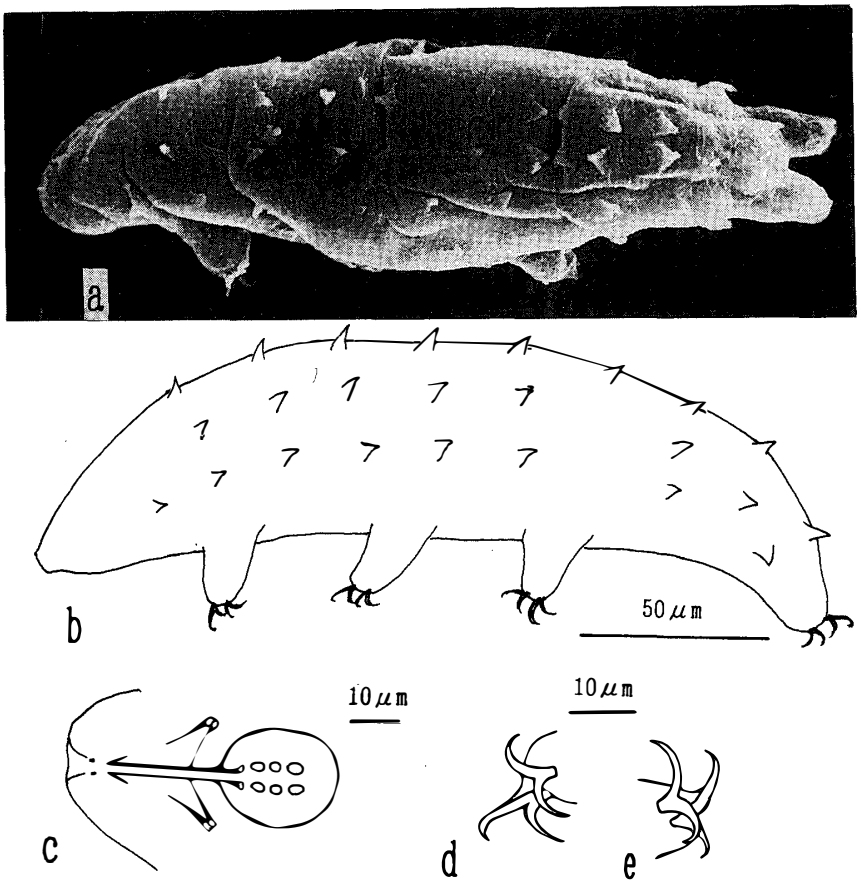

Fig. 6. Isohypsibius papillifer*: a. Dorsal view showing conical papillae, by scanning electron microscope (SEM); b. left lateral view; c. mouth apparatus; d and e. doubleclaws of legs III and IV.*

which first is shortest (2 μm), and other two equal (3 μm). Microplacoid and septulum present. External and internal doubleclaws of each leg different in shape, being "*Hypsibius* type".

The present specimens were obtained from 3 sites (Nos. 2, 8 and 11).

Diphascon (*D.*) *higginsi* BINDA, 1971
(Fig. 8a–d)

Body 143–382 μm in length. Cuticle smooth. Eyespots absent. Mouth tube straight, *ca.* 20 μm long, and pharyngeal tube slightly curved, *ca.* 30 μm long, narrow. Pharyngeal bulb elliptical (32 × 22 μm in 248 μm specimen), with a small apophysis, three elongated macroplacoids, a microplacoid and septulum. Length of macroplacoids in order from first to third one 4, 5 and 6 μm. Shape of external and internal doubleclaws different from each other, being "*Hypsibius* type". At base of internal claw of anterior three pairs of leg, thin cuticular bar present.

The present specimens were obtained from 3 sites (Nos. 7, 8, and 14).

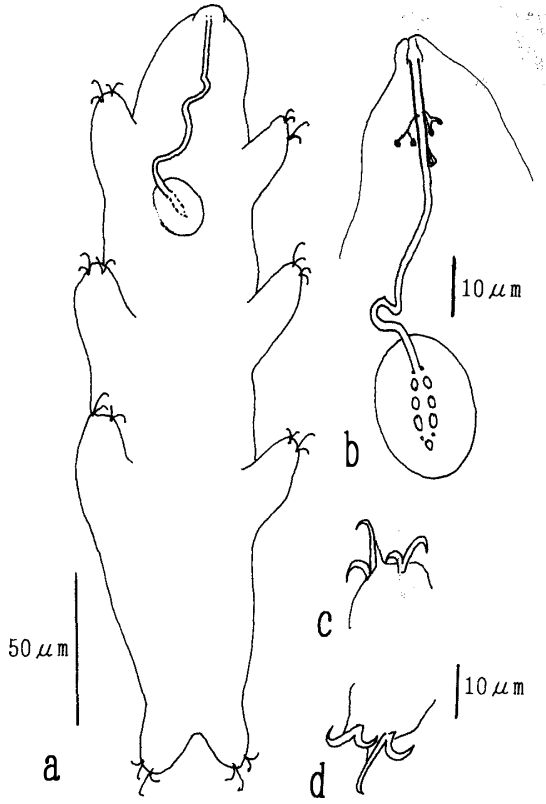

Fig. 7. Diphascon (D.) alpinum*: a. Ventral view; b. mouth apparatus (lateral view); c and d. doubleclaws of legs III and IV, respectively.*

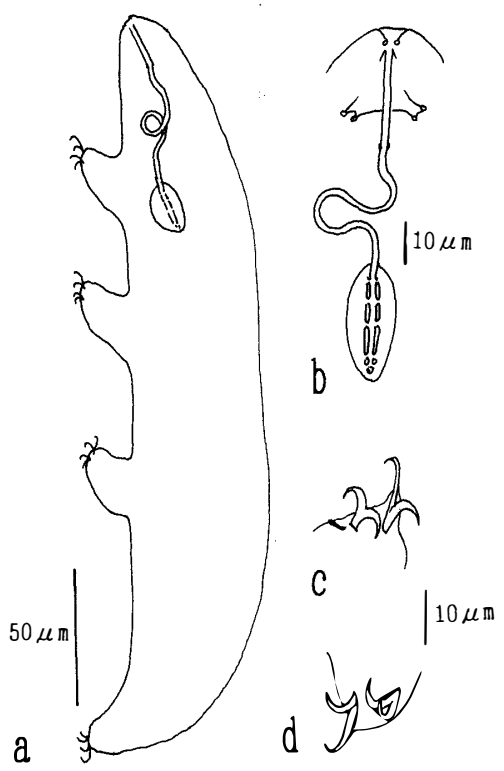

Fig. 8. Diphascon (D.) higginsi*: a. Left lateral view; b. mouth apparatus; c and d. doubleclaws of legs III and IV, respectively.*

Hexapodibius sp.
(Fig. 9a–f)

Body 420 to 607 μm in length. Eyespots present. Small conical papillae arranged in several transverse bands of cuticle. Number of papillae on a band 2-12, varying with band. Papillae developed dorso-laterally, but reaching to ventral side in some bands. Anterior part of mouth tube curved ventrally. Pharyngeal bulb round, with apophysis and three macroplacoid. Microplacoid absent. First and second macroplacoids short, rod-like (6 and 5 μm in length), third one longest (8 μm in 607 μm specimen) and with a tiny constriction at posterior end. Internal and external claws developed on anterior three pairs of legs are the same shape. Primary branch long, secondary branch short, at obtuse angle with primary one. Fourth pair of legs very short; claws considerably vestigeal, short hook-like or absent.

The present specimens were obtained from only one site (No. 8) close to the Chinese Great Wall Station.

Remarks: *Hexapodibius* sp. has peculiar small conical papillae in the transverse bands on the dorsal to lateral cuticular body surface, whereas the other six congeneric species lack any papillae or projections on body surface. It is, therefore, possibly new species of this genus. But it is not described here, until the additional specimens will

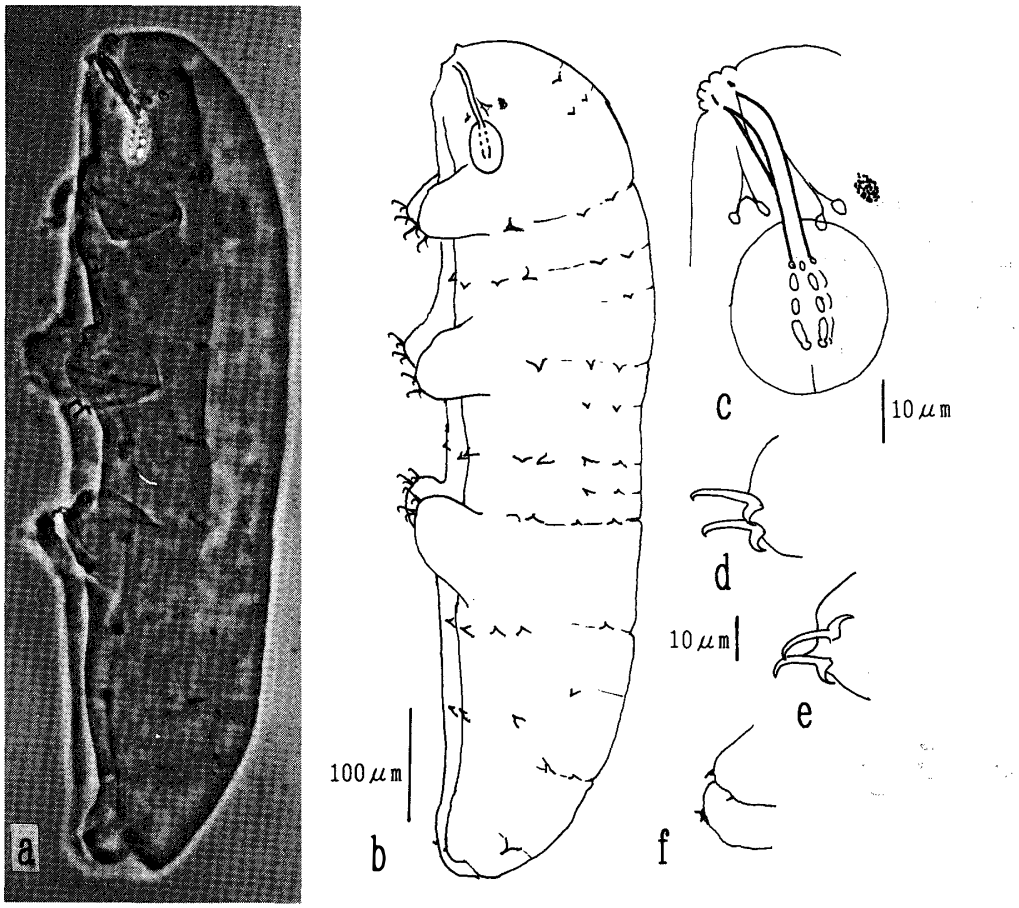

Fig. 9. Hexapodibius *sp.: a. Left lateral view, by phase contrast microscope; b. left lateral view showing conical papillae on cuticular surface; c. mouth apparatus; d and e. doubleclaws of legs II and III, respectively; f. vestigial doubleclaws of leg IV.*

be available.

4. Discussion

In the present survey, the tardigrade fauna was examined in some places in King George Island, the places consisting of different kinds of environmental conditions. It is conceivable that King George Island is more fruitful in flora than the other areas of Antarctica, because of its maritime climate (INOUE, 1991). Comparison of the present results with those of previous reports, indicates that King George Island possesses the richest fauna (Table 3).

The authors found 11 species of tardigrades in this study (Table 2), of which 5 species (*Hypsibius arcticus*, *Diphascon* (*D.*) *alpinum*, *Diphascon* (*D*) *higginsi*, *Macrobiotus harmsworthi* and *Echiniscus kerguelensis*) are distributed widely in Antarctica and other areas of the world. However, the other 6 species (*Amphibolus volubilus*, *Isohypsibius asper*, *Isohypsibius papillifer*, *Hypsibius* sp., *Hexapodibius* sp. and *Echiniscus* sp.) were rarely found in this study, of which the later 3 species have sever-

Table 3. Tardigrade fauna in four Antarctic areas.

Tardigrades	Syowa Station	Molodezh-naya	Mt. Riiser-Larsen	King George Island
Heterotardigrada				
Echiniscus kerguelensis		○	○	○
E. sp.				○
Pseudechiniscus sp.	○			
Eutardigrada				
Macrobiotus harmsworthi	○			○
M. harmsworthi coronatus		○	○	
M. montanus		○		
Amphibolus volubilus				○
Hypsibius antarcticus		○		
H. arcticus	○	○	○	○
H. sp.				○
Isohypsibius asper				○
I. papillifer				○
I. saracenus			○	
Diphascon (D.) alpinum				○
D. chilenensis		○	○	
D. conjungens		○	○	
D. ongulensis	○			
D. higginsi				○
Hexapodibius sp.				○
Milnesium tardigradum		○		

al different characteristics from those of the congeneric other species.

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