

Some notes on morphology of *Echiniscus tessellatus* MURRAY, 1910 (Tardigrada)

HIERONYMUS DASTYCH

The paper is dedicated to Dr. GISELA RACK, a retired curator of the Zoological Museum Hamburg, on the anniversary of her 70th birthday.

ABSTRACT: The morphology of a rare tardigrade *Echiniscus tessellatus* MURRAY, 1910, a species new for the fauna of Hawaii, is described and illustrated. Hitherto unknown light microscopic and SEM images are presented.

KEYWORDS: Tardigrada, *Echiniscus tessellatus*, morphology, Hawaii.

Introduction

Dr. R. D. KATHMAN (Thompson St., Tennessee) recently donated to the Zoological Museum Hamburg her collection of tardigrades, on which several papers are based (KATHMAN 1990a, b, c, KATHMAN & CROSS 1991, KATHMAN & DASTYCH 1990, KATHMAN & NELSON 1989, KATHMAN & BEASLEY, in press). The collection comprises water-bears originating mainly from Canada and the U. S. A. and in part also consists of unidentified tardigrades from Hawaii, mounted either on slides or preserved in ethanol. The examination of the Hawaiian material revealed the presence of a rare tardigrade, *Echiniscus tessellatus* MURRAY, 1910, hitherto reported only from single localities in Australia (Eumundi: Queensland) and Indonesia (Bali) (MURRAY 1910, PILATO & BINDA 1990). The species is one of the most aberrant members of a very specious genus *Echiniscus*, when the sculpture of its dorsal plates is considered. This and other aspects of its morphology are presented below.

Material and Methods

The collection of tardigrades from Hawaii comprises more than 500 specimens mounted on microscope slides in Hoyer medium, including some individuals extracted newly from several soil and moss samples preserved in alcohol. These specimens were recently mounted in gum chloral (Faure's medium) for light microscope examination (Nomarski contrast, = DIC) or, for SEM studies, critical-point-dried and arranged on double sided sticky tape and coated with gold. *E. tessellatus* was represented in this material by only 15 individuals, including six specimens examined with SEM. Photo-micrographs were made using the light photo-microscope "Axiomat" or the scanning electron microscope "CamScan S4". All measurements are given in micrometers (μm).

Abbreviations used in in the text and micrographs are as follow: *A* = appendage *A*; *c* = clava; *cl* = claw; *e* = cirrus externus; *H* = head plate; *i* = cirrus internus; *ic* = internal claw; *it* = incision on terminal plate; *M1*, *M2*, *M3* = 1st, 2nd and 3rd median (intersegmental) plate, respectively; *P1*, *P2* = 1st and 2nd paired (= segmental) plate; *pc* = head papilla (= papilla cephalica); *S* =

shoulder plate; *T* = terminal plate. The species was found at the following localities in the Hawaiian archipelago:

(1) Hawaii Island, Kauai, Icalalau Valley, moss on boulders in native mixed mesic forest, 1600 feet above sea level, coll. S. M. GON III, June 1989, sample no. 103 (2 specimens);

(2) as above, Kipahohoe Natural Area Reserve, South Cona District, 5400 feet a.s.l., found on basaltic lava flow ("aa"), coll. S. M. GON III, June 1988, sample no. 101A (5 + 6 specimens);

(3) Oahu Island, Wai'anai Mts, Wai'anai Kai Valley, mesic gulch below Pu'u Kawiwi, from boulders in *Sapindus* forest, coll. S. M. GON III, 22 Feb. 1987, sample no. 42 (2 specimens).

Description

Length 147-198 μm . The body is short and dumpy, light-brown or yellowish-grey when preserved in ethanol. There are no (black) eye-spots. Dorsal plates are well developed (Fig. 1). The venter is smooth and without granulation, ventral plates are absent. On the dorsal plates occur numerous elongated cuticular ridges (bands), raised slightly above the surface of each plate (Figs. 1-6). The ridges are smooth (i.e. not or hardly sculptured), arranged in a characteristic pattern and they divide the surface of each plate into smaller, separate areas ("subplates") (Figs. 3-6, 8-11). Such a pattern occurs on all dorsal plates, except of the intersegmental plate I and III.

The dorsal plates are covered with large, slightly flattened and almost hemispherical, cuticular knobs (granules), which can be up to 4 μm in diameter (usually about 3 μm). The knobs are confined to surface between the ridges, regularly distributed on the plate surface and located close to each other. Smaller knobs (up to 2 μm) and less regular in shape occur laterally between the segmental plates. The ridges separating the subplates are, to a large degree, composed of such more or less distinctly fused knobs (Figs. 4, 6). On some ridges, particularly those on the shoulder plate, occur several tiny, irregularly distributed (?) pore-like structures (Fig. 6: arrows).

Cirri interni and *c. externi* are relatively long (13-17 and 15-19 μm , respectively; 17 and 19 μm in a specimen of 198 μm in length), head papilla (= secondary clava: Fig. 10, *pc*) is positioned slightly closer to *c. externus* than to *c. internus*. Only setae *A* are present. Their length is 25-34% of the body length (39-64 μm ; 64 μm in a specimen 198 μm long). The tips of the setae were often broken off.

Head segment dorsally consists of two small oval, transversally elongated concave plates, covered densely with knobs (Fig. 2, 3). The shoulder plate is large. The anterior edge of the shoulder plate is formed as a thickened, relatively wide, distinctly raised and smooth rim (belt), without cuticular knobs (Figs. 1, 3). The posterior rim of the plate is similar, though not raised quite as much above the plate surface. This rim is more or less covered with knobs. The shoulder plate is symmetrically divided into 12-14 subplates which are separated by well formed ridges (Figs. 1, 8-10). The subplates are densely covered with knobs (Figs. 6, 8-10). There are eight dorso-medial subplates and two or three dorso-lateral ones (Figs. 1, 10). The second pair of dorsal subplates is often provided with a short oblique ridge, dividing each subplate into two smaller, almost triangular areas of unequal size (Figs. 1; 3, 9, 10: arrowheads). That latter pattern is characteristic for almost all specimens examined. However, the separation within the second subplates is sometimes poorly marked (Fig. 8: arrowhead) and is thus a subject to variation.

The segmental (paired) plates I and II are similarly sculptured with cuticular ridges (Figs. 1, 9, 10), which are long and transversal in the plate middle, short and longitudinal at the plate edges. Depending on the development of the ridges, each single plate is divided into five or six smaller areas, and the resulting separation into subplates also being dependent of the development of the ridge. The terminal plate is distinctly faceted, with four smaller subplates arranged in a wide band in anterior part of the plate. Furthermore, there are at least three larger subplates located posteriorly

(Figs. 7, 11). The lateral posterior subplates are slightly smaller than the median one. The latter subplate is often divided into two or even three separate areas. As a result, up to nine such subplates can occur on the terminal plate. Their number, however, depends on the degree of development of the ridges. The incisions on the terminal plate are relatively wide at their base and are of median length (Figs. 7, 11: *it*). The intersegmental (median) plates I and III carry only knobs, ridges being absent. The second (II) has thin, but distinct transverse furrow. The intersegmental plate III often not distinctly formed, i.e. it is poorly separated from the surrounding plates (the segmental plate II and the terminal one: see Figs. 7, 11).

Leg I with a small spine-like sensory organ (Fig. 10: arrow), leg IV with small sensory papilla. Spine fringe smooth, without granulation (knobs), but with four to eight more or less regularly shaped teeth of medium size. Some teeth are bidentated at their tips. External claws are smooth, internal ones each with a small but distinct spine (spur) directed towards the base. On the claws of legs IV the spur is located slightly above the claw base (Fig. 5: arrowhead). On legs I-III the spur is distinctly smaller, hardly discernible and located closer to the claw base. The claws on the IVth pair of legs are 10-15 μm long (15 μm in a 198 μm long specimen).

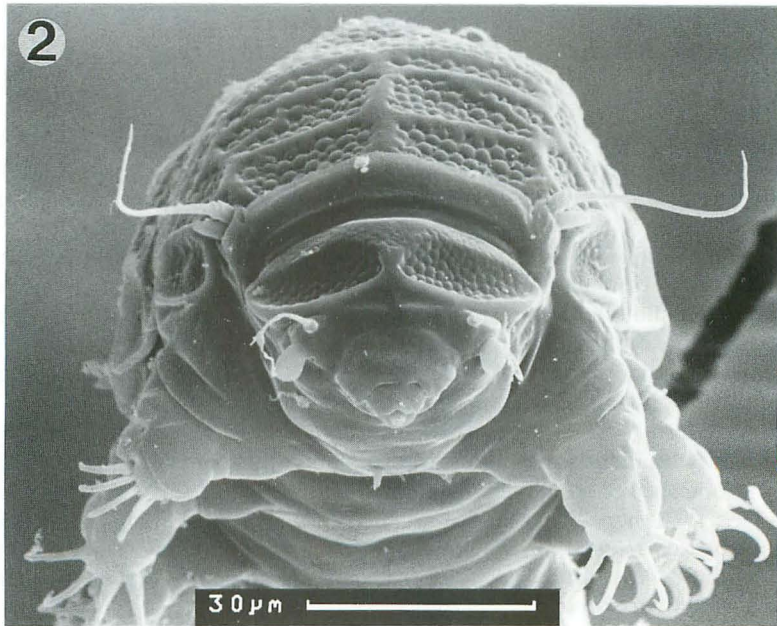
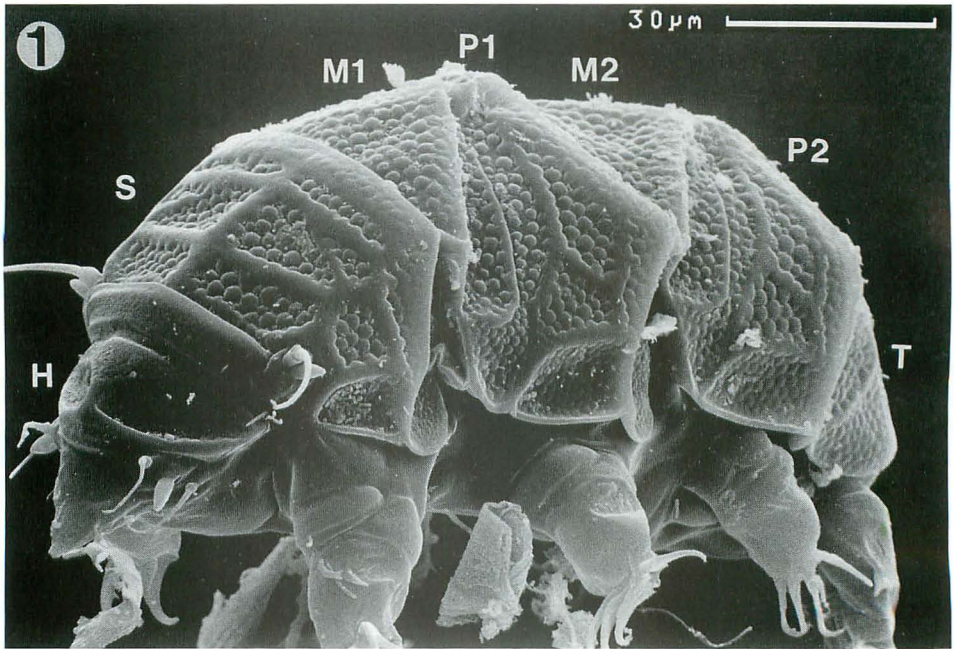
Comments

Some characters described by MURRAY (1910) in the protologue of *E. tessellatus* disagree with those found in the recent description of the species (PILATO & BINDA 1990) and the present study. The differences concern mainly the length of the setae *A*, the number of subplates on the dorsum and the presence of a spur on the internal claws.

MURRAY recorded setae *A* as "very long" (150 μm in a specimen 200 μm long, i.e. 75% of the body length). They are, however, distinctly shorter in the Hawaiian material (up to 34%; 32% in PILATO & BINDA, *l. c.*). The author overlooked also the spurs on the internal claws ("claws without barbs") and interpreted the sculpturing of the head and the ridge pattern on paired plates differently (see MURRAY, *l. c.*: Fig. 15). The "projecting flange" (= "nimbus") on the lateral margins of animal body mentioned by MURRAY has later not been observed (probably an artifact), while the body colour of his specimens ("yellow") differs from that reported recently by PILATO & BINDA, *l. c.* (red: "rosso" in original). Additionally MURRAY noted a lower number of dorsal subplates on the shoulder and terminal plate (ten and six, respectively), either due to variability of those characters or because of the lower quality of his microscope, compared with modern ones. All the same, his description of *E. tessellatus* was excellent for those days and is still very useful today.

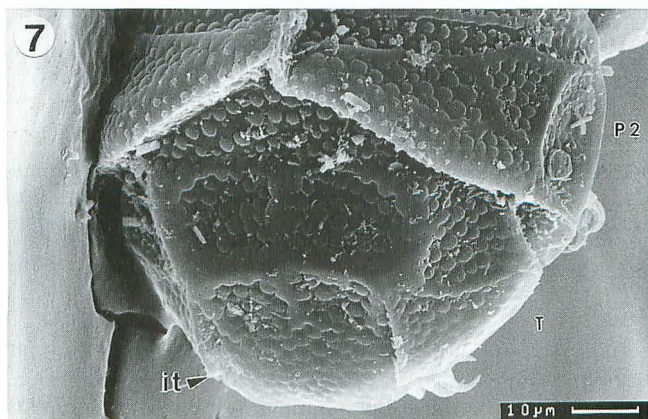
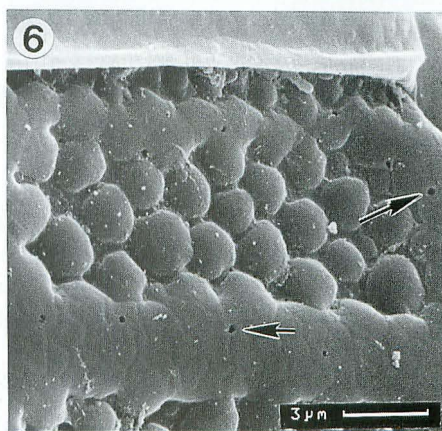
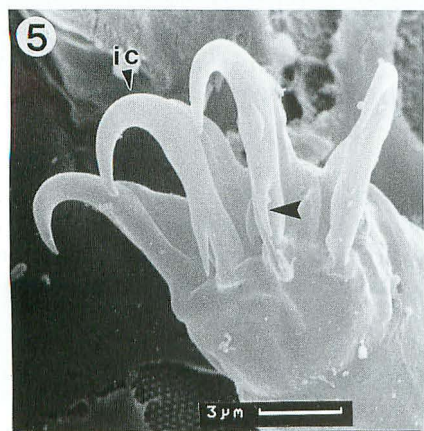
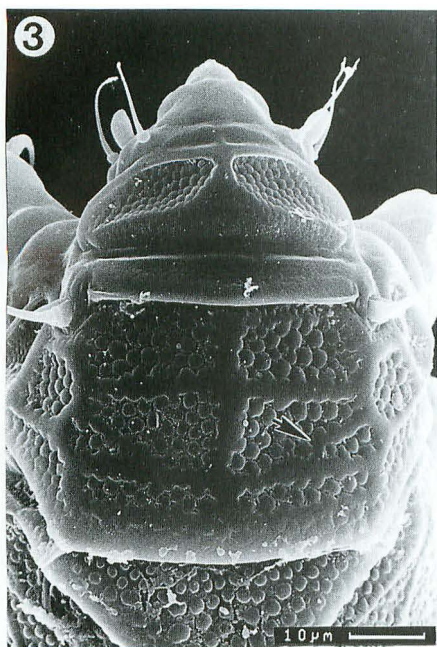
The type material of *E. tessellatus* is most probably lost or, as a such, has never been designated or permanently mounted. Unfortunately, this concerns also the majority of other tardigrade species from the SHACKELTON expedition (see also VAN DER LAND 1966, GRAEVES 1996). The here discussed Hawaiian material is almost identical with specimens redescribed by PILATO & BINDA (*l. c.*). On the other hand, their material also corresponds perfectly with the Australian specimens rediscovered recently at the type locality and provided for comparison to these authors by S. CLAXTON.

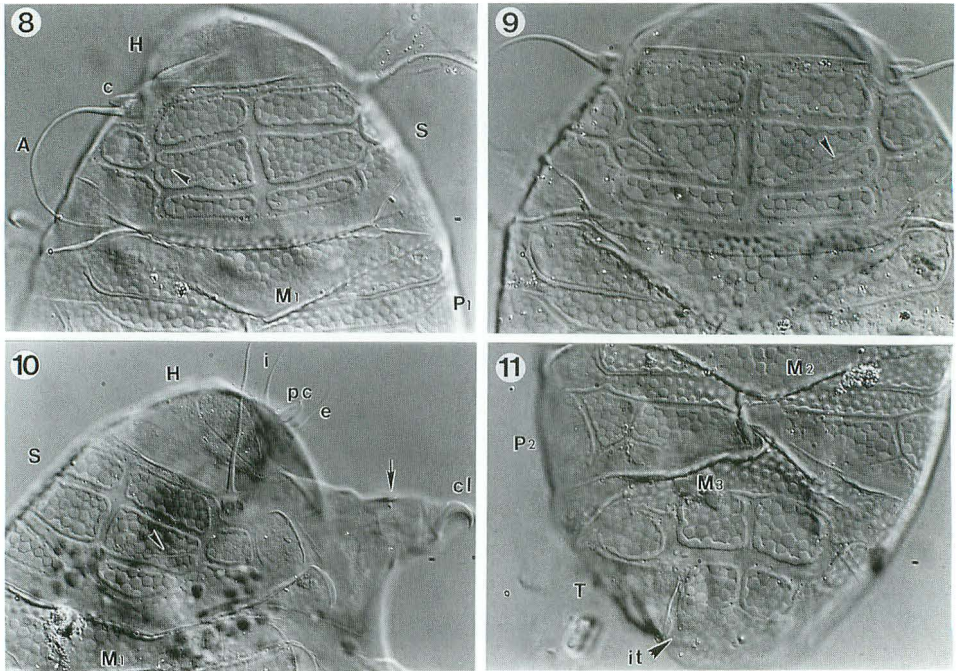
The granules on dorsal plates in *E. tessellatus* are among the largest within the genus, as already mentioned by MURRAY, who described them as "...coarsest known on an *Echiniscus*". The species is also characterized by the highest number of facets on dorsal plates. To some degree, a somewhat similar pattern of arrangement of the subplates on the shoulder plate occurs in *E. quadrispinosus* f. *cribrosa* MURRAY, 1907 (*sensu* PETERSEN 1951), a not related taxon of unclear status. However, the latter has differently formed sculpturing of the plates, i.e. there are small cavities instead of knobs on the surface, as well as other diverging features.



Figs 1-2 *Echiniscus tessellatus* MURRAY, 1910: lateral and frontal view, respectively (see text for abbreviations).

Figs 3-7 (opposite). *Echiniscus tessellatus* MURRAY, 1910: **3** - dorsal view of anterior of body; **4** - part of the IInd paired plate; **5** - claws on the IVth leg; **6** - part of shoulder plate; **7** - dorsal view of posterior of body.





Figs 8-11 *Echiniscus tessellatus* MURRAY, 1910: **8, 9** - anterior part of body in dorsal view; **10** - the same viewed laterally; **11** - posterior part of body, dorsal view (all DIC contrast).

The observed slight variability of some characters within *E. tessellatus* is limited mainly to the different degree of development of some ridges on the shoulder and terminal plate. Consequently, this results in variation of clarity in the separation of these plates, i.e. the second pair of the median subplates on the shoulder plate and the median posterior subplate on the terminal plate.

Zusammenfassung

Die Morphologie einer wenig bekannten Tardigradenart, *Echiniscus tessellatus* MURRAY, 1910, wurde im Rasterelektronen- und Lichtmikroskop untersucht und nachbeschrieben. Die Art war bisher nur aus Australien (Eumundi: Queensland) und Indonesien (Bali) gemeldet und ist neu für die Fauna von Hawaii.

ACKNOWLEDGEMENTS: I thank Dr. R. D. KATHMAN (Thomson St., Tennessee) for her help with locality data, Mrs. R. Walter for her assistance in obtaining SEM micrographs and Dr. D. L. BÜRKEL (both Universität Hamburg) for linguistic corrections in the English manuscript.

Literature

- GRAEVES, P. M., 1996: The ill-fated JAMES MURRAY. - *Quekett J. Microsc.*, 37: 606-620.
 KATHMAN, R. D., 1990a: Some tardigrades from Colorado, with a description of a new species of *Macrobiotus* (Macrobiotidae: Eutardigrada). - *Proc. Biol. Soc. Wash.*, 103 (2): 300-303.

- KATHMAN, R. D., 1990bc: *Isohypsibius woodsae*, a new species of Eutardigrada (Tardigrada) from British Columbia. - Can. Field Naturalist, 104 (2): 293-294.
- , 1990c: Eutardigrada from Vancouver Island, British Columbia, Canada, including a description of *Platicrista cheleusis* n. sp. - Can. J. Zool., 68: 1880-1895.
- KATHMAN, R. D. & BEASLEY, C.: Synonymy of *Platicrista cheleusis* (Tardigrada: Eutardigrada). - Can. J. Zool. (in press).
- KATHMAN, R. D. & CROSS, S. F., 1991: Ecological distribution of moos-dwelling tardigrades on Vancouver Island, British Columbia, Canada. - Can. J. Zool., 69: 122-129.
- KATHMAN, R. D. & DASTYCH, H., 1990: Some Echiniscidae (Tardigrada: Heterotardigrada) from Vancouver Island, British Columbia, Canada. - Can. J. Zool., 68: 699-706.
- KATHMAN, R. D. & NELSON, D. R., 1989: *Pseudodiphascon arrowsmithi*, a new species of tardigrade from British Columbia, Canada (Macrobiotidae: Eutardigrada: Tardigrada). - J. Entomol. Soc. Brit. Columbia, 86: 66-70.
- MURRAY, J., 191: Tardigrada. - In: British Antarctic Expedition 1907-9, Reports on the Scientific Investigations, 1 (5): 1-185.
- PETERSEN, B., 1951: The tardigrade fauna of Greenland. - Meddel. Gronland, 150 (5): 1-94.
- PILATO, G. & BINDA, M. G., 1990: Notizie sui Tardigradi muscicoli di Bali (Indonesia). - Animalia, 17: 209-218.
- VAN DER LAND, J., 1966: The Tardigrada of the Scottish Lake Survey described as new species by James Murray. - Proc. Roy. Soc. Edinburgh, 69 (3-4): 298-320.

Accepted: 13 June 1997

Address: Zoologisches Institut und Zoologisches Museum der Universität Hamburg,
Martin-Luther-King-Platz 3, D-20146 Hamburg, Bundesrepublik Deutschland.