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**THE TARDIGRADA OF THE NETHERLANDS.  
A REVIEW OF RECORDS FROM LITERATURE AND A  
REVISION OF THE LOMAN COLLECTION**

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with 10 figures

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## INTRODUCTION

In the present paper an attempt is made to collect all records on Tardigrada from the Netherlands and to give a review of the Dutch literature on this group; "second-hand" information of little importance, however, has generally been omitted. Further a list is given of the species present in the small collection of J. C. C. Loman, now property of the Zoologisch Museum, Amsterdam.

## REVIEW OF THE LITERATURE

In a handbook by J. van der Hoeven (1846, pp. 236 and 666) the Tardigrada are called Colopoda, whilst the name Tardigrada is still used there for a group of mammals; in R. Leuckart's supplement to Van der Hoeven's book (1856, pp. 143-144) the name Colopoda is altered into Tardigrada. Van der Hoeven mentioned some species but he did not indicate any as having been found in the Netherlands. Schlegel (1858) cited the group as Arctisca and introduced the Dutch name "beerdertjes"; a figure of "*Macrobotus Hufelandii*" was given by him on pl. VI fig. 18. Snellen van Vollenhoven (1859, p. 79) introduced another Dutch name: "mosbeertjes", which is still in use at present. According to him "*Macrobotus ursellus* Müll." is found in the Netherlands and occurs in moss growing on roofs; he gave a figure (pl. VI fig. 12) of an exuvium with eggs from which it is clear that his

*Macrobotus ursellus* actually is a *Hypsibius*-species, the identity of which, however, is uncertain. Harting (1870, pp. 320, 354-357) mentioned a number of species but apparently his list was compiled from foreign literature and gives no data on Dutch animals. Lubach (1875, pp. 206-207) mentioned the occurrence of the "gewoon mosbeertje" (*Macrobotus ursellus*) in the Netherlands; he used a series of Dutch names for the group as a whole: "beertjes", "waterbeertjes", "traaglopers" and "stomppoten", all being translations of Latin and Greek names.

Hoek (1876) reported a single specimen of "*Echiniscus Sigismundi* Schultze" from the mantle-cavity of *Balanus balanoides* (L.); he demonstrated the animal in the meeting of the Netherlands Zoological Society of 10 July 1875. His record was the third of this well known marine species (Crisp & Hobart, 1954, showed that *Echiniscoides sigismundi* (M. Schultze) is not uncommonly found in *Balanus balanoides*). In 1878 Hoek published a list of Crustacea found near Den Helder (prov. of Noord-Holland); in this list he recorded "*Echiniscus Sigismundi* Schultze" as a rare animal living on algae and *Zostera* in the "Breewijd" and also stated that it had been found in *Balanus* near Katwijk (on the North Sea shore of the prov. of Zuid-Holland).

Maitland (1897) gave the following list of Tardigrada species found in the Netherlands and Belgium:

- "433 *Macrobotus ursellus* (Müll.) Sch. espèce commune
- 433a *Macrobotus Hufelandii* Schultze seulement observé en Belgique, esp. commune
- 433b *Macrobotus macronyx* Duj. seulement observé en Belgique, esp. commune
- 434 *Echiniscus Sigismundi* Schultze espèce commune
- 434a *Echiniscus testudo* Dug. rare
- 435 *Milnesium tardigradum* Doy. espèce commune
- 433 = Mosbeertje."

Richters (1908, p. 85), who examined samples of marine algae from Ierseke (prov. of Zeeland) could not find any tardigrade in them, but later when he examined similar samples from Scheveningen (near The Hague, prov. of Zuid-Holland) he found many *Echiniscoides sigismundi*. Another Dutch record of the last-mentioned species is that by Marcus (1927, p. 492), who found it in samples of algae collected by Miss Nora van Mastenbroek at Scheveningen "an den Pfählen vor dem Steindamm".

As far as I know, Loman, a specialist on Pycnogonida, is the only investigator who gave a more important contribution to the knowledge of the Dutch Tardigrada. From 1918 to 1926 he studied a number of Tardigrada and prepared a small collection. It appears from his 1919 publication, dealing with the problem of the relationship of the Tardigrada with other groups,

that he found *Macrobiotus intermedius* Plate and *M. hufelandii* S. Schultze in the Amsterdam Zoo. A second record is that of *M. hufelandii* from Groningen (Loman, 1920a). One year after the beginning of his study Loman listed nine species from the Netherlands (Loman, 1920b):

1. *Arctiscon tardigradum* Schrank
2. *Macrobiotus Hufelandii* S. Schultze
3. *Macrobiotus intermedius* Plate
4. *Macrobiotus Dujardin* Doyère
5. *Macrobiotus Oberhäuser* Doyère
6. *Macrobiotus chilensis* Plate
7. *Macrobiotus tetradactylus* Greef
8. *Macrobiotus echinogenitus* Richters
9. *Echiniscoides Sigismundi* (M. Schultze)"

According to Loman *Macrobiotus hufelandii* is the most common species; he found it in 64% of his samples. Because the greater part of the Loman slides that are still extant, contains animals that have been collected after the publication of his 1920 paper, the identifications published in this paper can not be checked. So it is impossible to say whether his no. 7 refers to *Hypsibius (Isohypsibius) prosostomus* (Thulin) or to *Hypsibius (Hypsibius) convergens* Urbanowicz (cf. Marcus, 1936, pp. 249, 268).

In a publication of 1922 Loman mentioned that he found smooth eggs in the exuviae of "*Macrobiotus Oberhäuser*" from Bergen (prov. Noord-Holland). On account of this, Marcus (1936) supposed that Loman had to do with a mixed population of *Hypsibius oberhaeuseri* (Doy.) and *Hypsibius novemcinctus* Marcus and that Loman's "winter eggs" of *H. oberhaeuseri* actually were eggs of *H. novemcinctus*. Although this may be true, there are no specimens in the collection to prove this supposition.

Loman (1924) also found *Echiniscoides sigismundi* near Den Helder. A paper in French (Loman, 1927) mainly deals with historical and nomenclatorial problems. Loman also contributed to the "Leerboek der Bijzondere Dierkunde" by Ihle & Nierstrasz (1928).

Teunissen (1938) investigated material from the Parc National Albert in the Congo. It appears from his paper that he had found *Macrobiotus hufelandii* C. A. S. Schultze and *Macrobiotus macronyx* Dujardin in the Netherlands. He gave a length frequency-curve of 240 specimens of *M. hufelandii* from Nijmegen and listed the sex ratio in *M. macronyx*. Teunissen announced in this paper his intention to publish the results of histological investigations but, as far as I know, this second paper has not actually been published.

Van der Drift (1949, 1950) investigated the soil fauna of an 80 years old beach forest without undergrowth near Hoenderlo (prov. Gelderland). He used Baermann's method for collecting Nematoda, Enchytraeida, Tardigrada

and Rotifera. However, according to Ramazzotti (1959) this and similar methods are not suitable for quantitative investigations on Tardigrada. In January and February 1947 Van der Drift collected 12 samples of 40 cm<sup>3</sup> of soil with the following results:

| Date       | Layer   | Number of Tardigrada |
|------------|---|----------------------|
| 20-I-1947  | H (= humus)                                     | 8                    |
|            | H   | 100                  |
|            | H   | 12                   |
|            | H   | —                    |
|            | H   | 13                   |
|            | H   | 81                   |
|            | H   | 65                   |
| 21-II-1947 | F <sub>0</sub> (= litter, upper layer)          | 81                   |
|            | F <sub>1</sub> (= litter, 1 year old)           | 17                   |
|            | F <sub>1</sub>                                  | 17                   |
|            | F <sub>x</sub> (= litter, more than 1 year old) | 4                    |
|            | F <sub>x</sub> -H                               | 2                    |

It is probable that Van der Drift actually obtained only a small percentage of the animals present in the samples. From his results we can therefore only arrive at the conclusion that Tardigrada can be abundant among the hemiedaphic fauna; other investigators have arrived at the same conclusion.

During hydrobiological investigations in and near a little lake, „de Geritsflesch” near Kootwijk (Veluwe, prov. Gelderland), H. F. de Vries found Tardigrada in *Sphagnum* in vegetations both of *Eriophorum angustifolium* Honckeny and of *Carex rostrata* Stokes (Dresscher et al., 1952). He identified the animals as *Macrobiotus macronyx*.

#### REVISION OF THE LOMAN COLLECTION

Between 1919 and 1927 Loman prepared a small collection of Tardigrada of which 48 slides are still preserved in the Zoologisch Museum, Amsterdam. Many of the specimens are misidentified, whilst some slides bear no identification at all; this is not surprising because, though identifying of Tardigrada is still not easy at present, it was certainly more difficult at the time when Loman studied the group. I do not know what mounting media Loman did use; the condition of the slides is sometimes quite poor and then does not permit a definitive identification, so that a part of the material had to be left unidentified. In the following list a revision of the Loman collection is given.

#### *Echiniscoides sigismundi* M. Schultze, 1865

Material: Scheveningen, VIII-1919.-27 specimens (slide no. 1). Nieuwe Diep, harbour of Den Helder, algae on piling, VI-1921.-1 specimen (slide no. 2). Den Helder, harbour, algae on piling, VI-1921.-1 specimen (slide no. 3).

**Macrobotus areolatus** James Murray, 1907

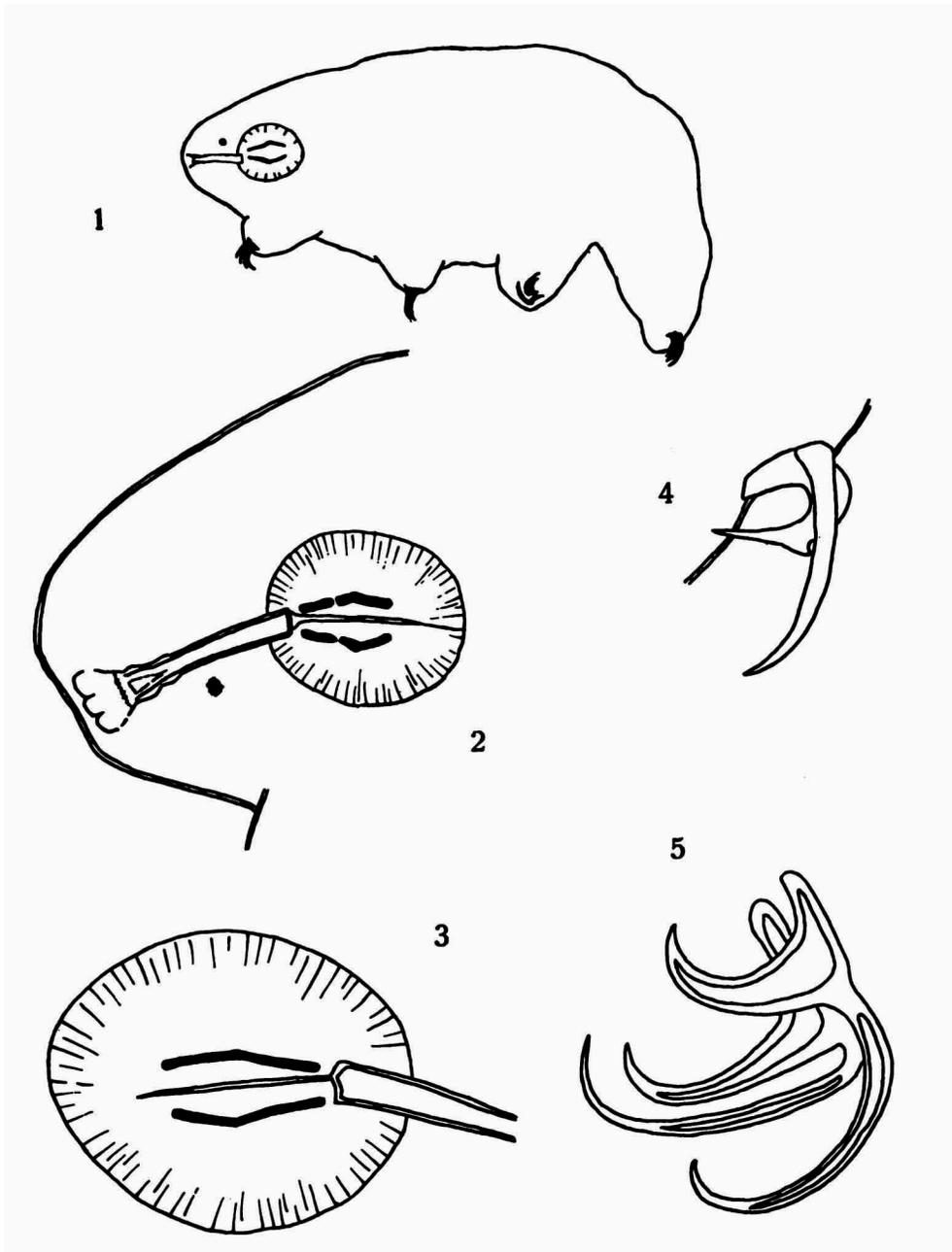
Material: Locality unknown, moss, III-1927.-8 specimens, 4 eggs (slides nos. 24-27).  
Locality unknown, IX-1927.-10 specimens, 4 eggs (slides nos. 31, 32).

Loman identified this material as *Macrobotus echinogenitus* Richters. He apparently overlooked the areolation of the eggs, which is indeed not always visible, especially when the eggs are flattened by the coverglass. The animals themselves can be recognized as specimens of *Macrobotus* with claws of the *hufelandii*-type, but other important characters are invisible. The eggs can be distinguished from those of *Macrobotus richtersi* James Murray by the pointed processes (those of *M. richtersi* being truncate) and perhaps by the greater size. In the following table measurements are given of a number of eggs of both species. The eggs of *M. richtersi* are from southern Germany (from two populations near Regensburg, Bavaria, in moss, leg. L. van der Hammen, 17-VI-1961).

| Species             | slide no. | Ø egg without processes | Ø egg with processes | processes in % of egg Ø |
|---------------------|-----------|-------------------------|----------------------|-------------------------|
| <i>M. richtersi</i> | 20 ML     | 60 µ                    | 95 µ                 | 29%                     |
|                     |           | 60                      | 98                   | 32                      |
|                     | 21 ML     | 65                      | 105                  | 31                      |
|                     |           | 65                      | 100                  | 27                      |
|                     |           | 65                      | 90                   | 19                      |
| <i>M. areolatus</i> | 22 ML     | 65                      | 85                   | 15                      |
|                     |           | 60                      | 87                   | 23                      |
|                     | 24        | 90                      | 145                  | 39                      |
|                     | 26        | 105                     | 170                  | 31                      |
|                     | 27        | 100                     | 160                  | 30                      |
|                     | 31        | 100                     | 165                  | 33                      |
|                     | 32        | 105                     | 170                  | 34                      |
|                     |           | 100                     | 155                  | 28                      |

The measurements given by other authors are not always in accordance with my data as is shown in the following table.

| author                     | <i>M. richtersi</i> |                 | <i>M. areolatus</i> |                 |
|----------------------------|---------------------|-----------------|---------------------|-----------------|
|                            | egg                 | egg + processes | egg                 | egg + processes |
| Cuénot (1932)              | ± 65 µ              | ± 92 µ          |                     |                 |
| Marcus (1936)              | 65-75               | 92-120          | —100 µ              | —200 µ          |
| Ramazzotti (1945)          | 45-65               | 65-85           |                     |                 |
|                            | 62-75               | 84-97           |                     |                 |
| Ramazzotti (1962)          | 60-80               | 80-140          |                     | 80-100          |
| Petersen (1951)            |                     | 130-140         |                     | 130-140         |
| Węglarska (1959)<br>(1962) | ± 60                | 84-111          |                     | -200            |
|                            | 53-73               | 69-90           |                     |                 |
| Higgins (1960)             |                     | 96-100          |                     | 78-91           |
| Own data                   | 60-65               | 85-105          | 90-105              | 145-170         |



Figs. 1-5. *Hysibius (Isohysibius) augusti* (James Murray). 1, ♀, habitus,  $\times 136$ .  
 2, subadult ♀, head,  $\times 545$ . 3, ♀, bulbus,  $\times 680$ . 4, ♂, foremost claw of leg I,  $\times 1360$ .  
 5, ♀, claws of leg IV,  $\times 1360$ .

Generally the oval processes of *M. areolatus* appear to be a little higher. Further it is my experience that in *M. areolatus* the oval processes do not look granulate as they do in *M. richtersi*. The "granulation" of the processes in *M. richtersi* is caused by many minute pores, that are not present in the areolated part of the eggs.

#### **Macrobiotus hufelandii** C. A. S. Schultze, 1834

Material: Vogelenzang (near Haarlem, prov. of Noord-Holland), X-1919. — 1 specimen (slide no. 18). Locality unknown, III-1920. — 5 specimens (slide no. 21). Sloterdijk (near Amsterdam, prov. of Noord-Holland), V-1924. — 8 specimens (slide no. 17). Putten (prov. of Gelderland), IX-1924, moss on roof. — 80 specimens (slides nos. 6-15). Putten, V-1925, moss. — 4 specimens (slide no. 16). Putten, VI-1925, moss on roof. — 2 specimens (slide no. 23). Locality unknown. — 4 specimens (slide no. 4).

#### **Macrobiotus echinogenitus** Richters, 1904

As mentioned above Loman identified many specimens as *Macrobiotus echinogenitus* Richters, while most of them (slides nos. 24-27, 31, 32) appear to belong to *Macrobiotus areolatus* James Murray. I am not certain as to the other slides (nos. 29, 30, 46-48), but I believe that they do not belong to *M. echinogenitus* either; their condition is too poor, however, to permit of a specific identification.

#### **Hypsibius (Isophypsibius) augusti** (James Murray, 1907)

Material: Leiden (prov. of Zuid-Holland), IX-1921, in water, G. Romijn leg. — 5 specimens (slide no. 19).

Loman prepared one very good slide of this species: adult and subadult ♀♀ as well as eggs and a ♂ are present. He erroneously identified the specimens as *Macrobiotus macronyx* Duj. *Hypsibius augusti* is one of the most variable species of Tardigrada and it would lead to a valuable contribution to the taxonomy of the Macrobiotidae if this variability (and that of other species) would be studied in rich populations from different places. Figure 1 gives the typical habitus of the species with the long hind legs. The bulbus of *H. augusti* has very often two placoids, the second being longer than the first and very often broken, as is the case in the present material (fig. 2). The placoids become more and more rod-like and in adults they touch each other; in that case they sometimes look like one long placoid (fig. 3). *H. augusti* is one of the few Tardigrada showing sexual dimorphism. The secondary branch of the foremost claw of leg I of the male forms a typical hook (fig. 4). The function of this hook is unknown but perhaps it is used during copulation. The aspect of the claws is often variable, which is caused by the flexibility of the proximal part of the primary branch (figs. 5, 6).

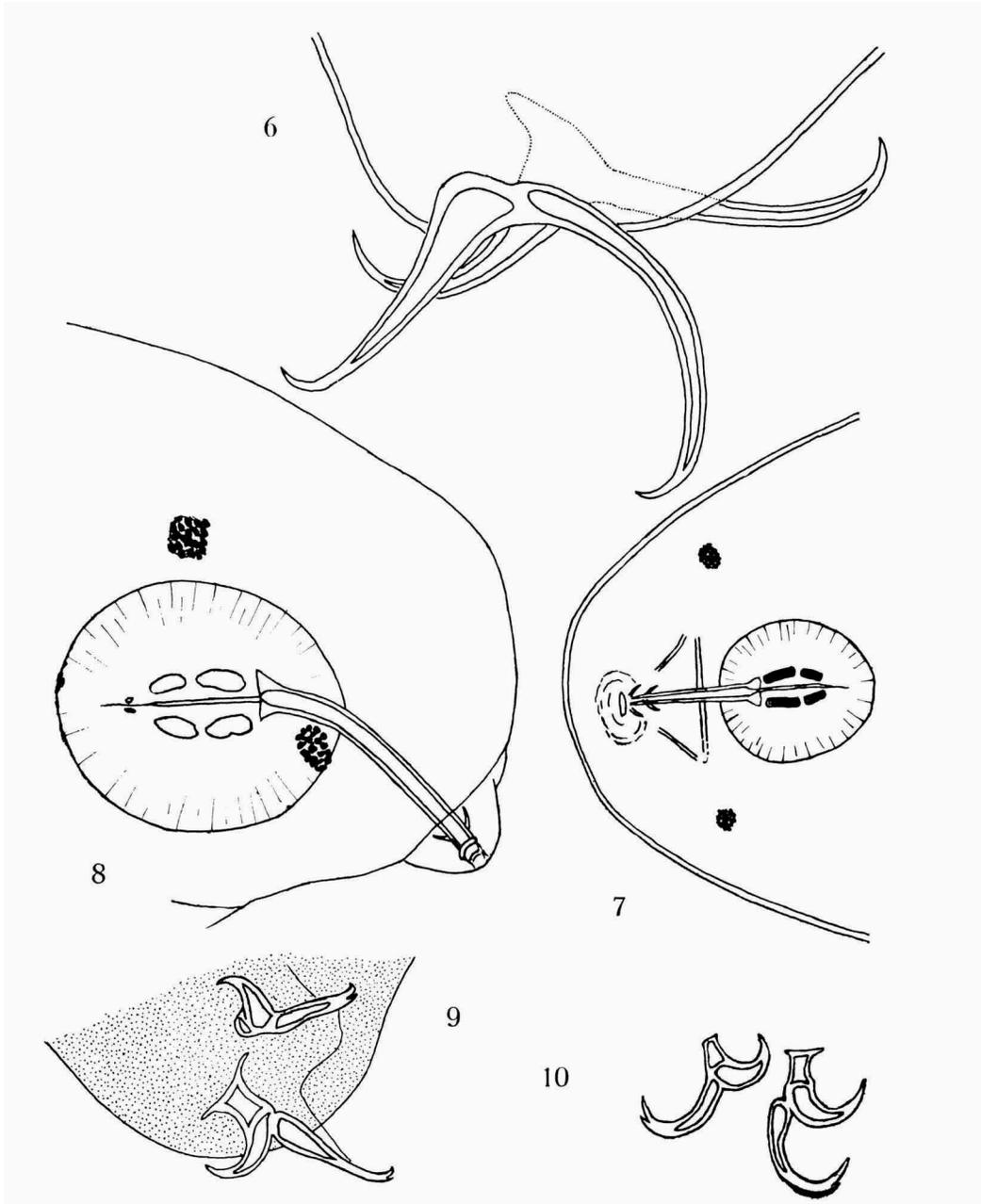


Fig. 6. *Hypsibius (Isohypsibius) augusti* (James Murray), ♀, claws of leg III,  $\times 1360$ .  
 Figs. 7-10. *Hypsibius (Hypsibius) convergens* Urbanowicz. 7, head of  $450 \mu$  animal, lateral,  $\times 680$ . 8, head of  $315 \mu$  animal, dorsal,  $\times 1360$ . 9, claws of leg IV of  $415 \mu$  animal,  $\times 1360$ . 10, claws of leg III of  $415 \mu$  animal,  $\times 1360$ .

**Hypsibius (Isohypsibius) spec.**

Material: Middachten (near Arnhem, prov. of Gelderland), 18-III-1924, from ditch. — exuvium with 10 eggs (slide no. 20).

Loman identified the present specimen as *Macrobiotus macronyx*, which is undoubtedly incorrect. It is a *Hypsibius* of the subgenus *Isohypsibius* but it is necessary to have the complete animal for an accurate identification.

**Hypsibius (Hypsibius) convergens Urbanowicz, 1924**

Material: Locality unknown, III-1920. — 3 specimens (slide no. 21).

Eight specimens are mounted on slide no. 21; Loman identified all as "*Macrobiotus Hufelandii* S.S."; three specimens, however, appear to belong to *Hypsibius convergens*. Loman mentioned no locality, but undoubtedly he had found the specimens in terrestrial mosses, as he considered this to be the most normal habitat. This species can be easily confused with *Hypsibius dujardini* (Doy). The last mentioned species has more narrow macroplacoids but in my opinion this does not apply to young specimens. The presence or absence of the microplacoids is also an unreliable character. In the present material the largest specimen has no microplacoids (fig. 7); if they were present, they certainly would be visible because the other parts of the bulbus are very distinct. The two smaller specimens have tiny microplacoids (fig. 8); Cuénot (1932, p. 73) also observed these microplacoids in part of his material. The measurements of the specimens are given in the following table.

|                    | Animals in the Loman collection |           |           | Marcus (1936) |
|--------------------|---------------------------------|-----------|-----------|---------------|
|                    | 415 $\mu$                       | 315 $\mu$ | 300 $\mu$ | 400 $\mu$     |
| Body length        | 27                              | 24        | 24        | 26            |
| Mouth tube, length | 1,8                             | 1,5       | 1,5       | 1,5-1,7       |
| width              | 33                              | 30        | 28        | 24            |
| Bulbus, length     | 24                              | 24        | 24        | 18            |
| width              | 6                               | 4         |           |               |
| Placoids I         | 4                               | 3         |           |               |
| II                 | 1,5                             | 2         |           |               |
| Width of placoids  |                                 |           |           |               |

There is little variability in the claws, but as far as I can make out there is no difference between the two species in this respect. Marcus (1936) found rather short basal parts in the claws of *H. dujardini*, but Węglarska (1959) and Cuénot (1932) found longer basal parts. In the present material the claws have rather long basal parts, often with proximal extensions (figs. 9, 10).

**Hypsibius (Hypsibius) spec.**

Material: Putten, V-1922. — exuvium with 7 eggs (slide no. 33). Putten, V-1925. — exuvium with 3 eggs (slide no. 34).

The complete animals not being available, it is impossible to identify the material of the two slides with certainty; they represent two different species.

**Hypsibius (Hypsibius) oberhaeuseri (Doyère, 1840)**

Material: Velp (near Arnhem, prov. of Gelderland), X-1920. — 8 ♀♀ (slide no. 22). Putten, VI-1925, moss on roof. — 1 ♀ (slide no. 23).

**Milnesium tardigradum Doyère, 1840**

Material: Veluwe, IX-1923, moss on roof. — 2 specimens and one exuvium with 4 eggs (slides nos. 36, 37). Putten, IX-1924, 3 ♀♀ (slides nos. 13, 35). Locality unknown, I-1925. — 3 ♀♀ (slide no. 38). Putten, V-1925. — 2 ♂♂, 6 ♀♀ (slide no. 39). Putten, VI-1925, moss on roof. — 8 specimens (slides nos. 23, 41). Locality unknown. — 4 ♀♀, 1 exuvium with 2 juveniles and 5 eggs (slide no. 40).

REVISED LIST OF THE KNOWN DUTCH SPECIES OF  
TARDIGRADA

As a result of the present study, the following species of Tardigrada are known to occur in the Netherlands. Species new to our fauna are marked with an asterisk. In comparison with other countries, the total number of species is still very low, so that it is to be expected that in the future many species will be added to this list.

1. *Echiniscoides sigismundi* (M. Schultze, 1865)  
Localities: Katwijk (Hoek), Scheveningen (Richters, Marcus, Loman), Den Helder (Hoek, Loman).
2. *Echiniscus (Echiniscus) testudo* (Doyère, 1840)  
Locality unknown (Maitland).
- \*3. *Macrobotus areolatus* James Murray, 1907  
Localities unknown (Loman collection).
4. *Macrobotus intermedius* Plate, 1888  
Locality: Amsterdam (Loman).
5. *Macrobotus macronyx* Dujardin, 1851  
Locality: Kootwijk (Dresscher).
6. *Macrobotus hufelandii* C. A. S. Schultze, 1834  
Localities: Groningen (Loman), Amsterdam (Loman), Sloterdijk (Loman collection), Putten (Loman collection), Nijmegen (Teunissen).
7. *Macrobotus echinogenitus* Richters, 1904  
Locality unknown (Loman).
- \*8. *Hypsibius (Isohypsibius) augusti* (James Murray, 1907)  
Locality: Leiden (Loman collection).
- \*9. *Hypsibius (Hypsibius) convergens* Urbanowicz, 1924

- Locality unknown (Loman collection).
10. *Hypsibius (Hypsibius) oberhaeuseri* (Doyère, 1840)  
Localities: Velp (Loman collection), Putten (Loman collection) Bergen (Loman).
  11. *Hypsibius (Hypsibius) dujardini* (Doyère, 1840)  
Locality unknown (Loman).
  12. *Hypsibius (Hypsibius) novemcinctus* Marcus, 1936  
Locality: Bergen (Loman).
  13. *Hypsibius (Diphascos) chilensis* (Plate, 1888)  
Locality unknown (Loman).
  14. *Milnesium tardigradum* Doyère, 1840  
Localities: Putten (Loman collection), unknown localities (Loman, Maitland).
- Macrobiotus ursellus* (Müller, 1785) and *Macrobiotus tetradactylus* Greeff, 1866, were insufficiently defined, so that their identity can not be fixed.

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