

TRANSACTIONS OF THE SOCIETY.

XII.—Some South African Tardigrada.

By JAMES MURRAY.

(Read March 20, 1907.)

PLATES XVII. AND XVIII.

THE compilation of this short list of African Tardigrada has been rendered possible by the kindness of Mr. W. Milne, of Uitenhage, Cape Colony, formerly of Glasgow. Mr. Milne's work on Rotifera, extending over the past twenty years, and published from time to time in the Proceedings of the Philosophical Society of Glasgow, is well known.

While corresponding with him about the Bdelloid Rotifera, Mr. Milne sent to me from time to time, during the year 1906, moss from various parts of Cape Colony.

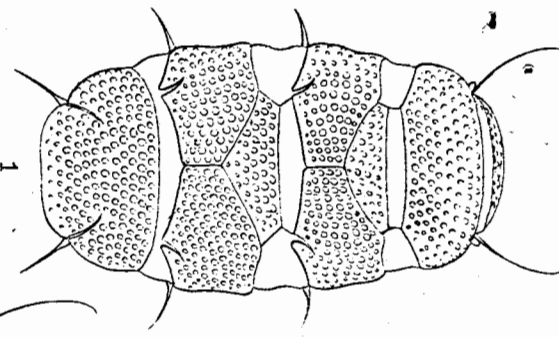
In addition to the Bdelloid Rotifers, which were abundant, and of which many peculiar species occurred, this moss yielded a good many Tardigrada.

EXPLANATION OF PLATE XVII.

- Fig. 1a.—*Echiniscus* sp. (?)
- 1b. " " " " Portion of dorsal surface.
- 2a.—*E. africanus* sp. n. Claw.
- 2b. " " " " "
- 3. —*E. longispinosus* sp. n. Portion of dorsal surface.
- 4a.—*E. perarnatus* sp. n. Outer and inner claws.
- 4b. " " " " "
- 5a.—*E. sp.* (?) Inner claw.
- 5b. " " " " "

Oct. 16th, 1907

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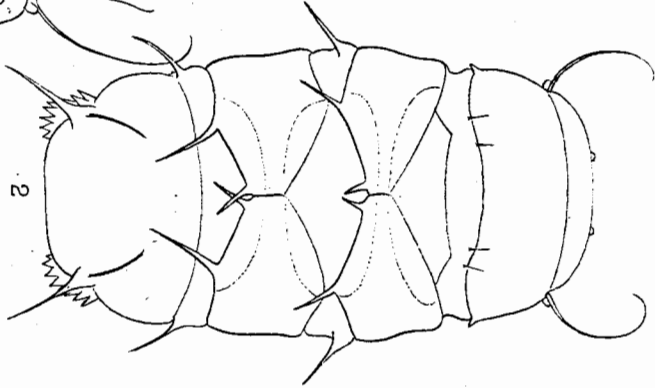
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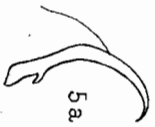
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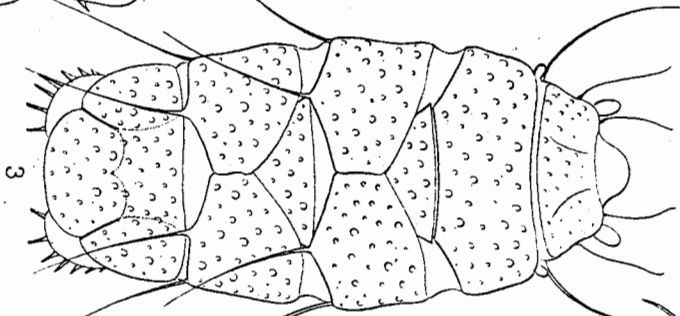
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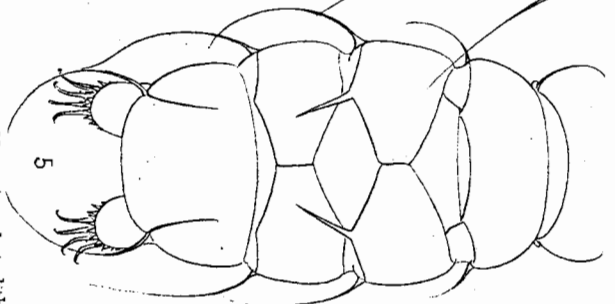
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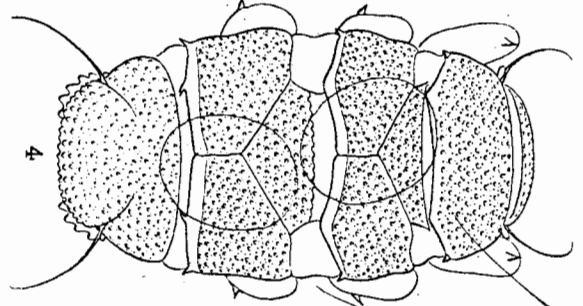
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4b



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J. Murray del. ad nat.

South African Tardigrada.

West, Newman photolith.

pp. 515-524 + 2 pls.

Fourteen species have been found, belonging to the three genera, *Echiniscus*, *Milnesium*, and *Macrobiotus*.

There are eight species of *Echiniscus*, and five of *Macrobiotus*; of *Milnesium* there is only one well established species known.

It is remarkable that eight out of the fourteen species are distinct from any species previously known. The only known species of *Echiniscus* found is *E. arctomyx*; the known species of *Macrobiotus* are *M. echinogenitus* Richters, and *M. hufelandii* Richters; *M. arcticus* is a doubtful identification; *Milnesium* is of world-wide distribution.

Two of the species of *Echiniscus* were not sufficiently studied to justify me in naming them, but they are figured and described.

LIST OF SPECIES.

<i>Echiniscus arctomyx</i> Ehr.
" <i>bispinosus</i> sp. n.
" <i>afrikanus</i> sp. n.
" <i>perarmatus</i> sp. n.
" <i>longispinosus</i> sp. n.
" <i>crassispinosus</i> sp. n.
" sp. (?)
" sp. (?)
<i>Milnesium lardigradum</i> Doy.
<i>Macrobiotus hufelandii</i> Richters.
" <i>echinogenitus</i> Richters.
" <i>arcticus</i> Murray (?).
" <i>nodosus</i> sp. n.
" <i>crassidens</i> sp. n.

ECHINISCUS.

There are two well-marked groups within the genus. The first has segments v. and vi., as defined by Richters (8),* quite distinct. Segment v. is either a half-ring or forms a third pair of plates. Two African species belong to this group, *E. arctomyx* and *E. bispinosus*, and both have segment v. as a half-ring.

The second group has segments v. and vi. completely united, so that the junction cannot be distinguished. The common form thus formed is rendered trilobate by two lateral clefts, in the same way as plate vi. of the first group. This group includes six of the African species, and the great majority of known species.

In the descriptions of species of *Echiniscus* the body is regarded following Professor Richters (8), as consisting of six segments, which are distinguished by Roman numerals i.-vi. These numerals correspond with names I have used for the various plates, as

* The figures in brackets refer to the list of literature at end of paper.

follows: i. = the head; ii. = the shoulder; iii. = the first pair; iv. = the second pair; v. and vi. together = the lumbar plate. The five commonest lateral processes are distinguished by the letters a, b, c, d, e, consecutively from the head backwards. Any one of these, except a, may be absent, but the process in the corresponding position is always referred to by the same letter: a comes after segment i., b after segment ii., c after segment iii., d after segment iv., and e at the slit which separates the lateral and posterior lobes of vi.

The two commonest dorsal processes are over the lateral processes c and d, on the angles of the paired plates of segments iii. and iv. The median plates are intercalated between the segments—the first median between ii. and iii., the second between iii. and iv., the third (when there is a third) between iv. and v.

A. SEGMENTS V. AND VI. DISTINCT.

E. arctomyx Ehr. (?) plate XVIII. fig. 11.

This widely-distributed species was the most abundant in all the African collections.

The second median plate is separated from the pair of plates in front of it by a very obscure line, and the third median plate is separated by a similar line from the half-ring which follows it.

Examples with two and three small roundish eggs were found.

The largest African examples were unusually large for the species, measuring 260 μ in length, exclusive of the last legs, and were somewhat stout.

The pellucid dots on the plates are granules, and there are similar dots on the skin connecting the plates, and on the legs.

E. bispinosus sp. n., plate XVIII. fig. 7.

Specific Characters.—Small, red. Plates, 11: 3 median, 2 pairs, v. and vi. separate, vi. 3-lobed, all finely punctate. Lateral processes, on each side a spine with bulbous base after segment iii. (c, Richters). Head setae or horns (a, Richters) short. No dorsal processes, fringe on 4th leg, or barbs on the claws.

Length 130 μ . Very like *E. arctomyx*, and distinguished chiefly by the lateral spines. The second median plate seems more sharply separated from the pair in front. The median plates could not be seen to be transversely divided, as is the case with most species of this section of the genus, but those plates change greatly in appearance with the point of view and attitude of the animal. The pellucid dots, as in *E. arctomyx*, extend on to the membrane connecting the plates.

Rare, and no eggs seen.

B. SEGMENTS V. AND VI. COMPLETELY UNITED.

E. africanus sp. n., plate XVIII. figs. 2a, 2b.

Specific Characters.—Small. Plates, 10: arrangement normal—2 pairs, 3 median, vi. trilobate. Lateral processes, *a* a seta, *b* a spicule, *c*, *d*, and *e* short spines with expanded bases. Dorsal processes, 4 acicular points on the interspace behind ii., 2 short spines on the posterior border of each plate of the first pair—one on the angle, and one near the median line—2 similar spines on the plates of the second pair. Plates regularly dotted. Fringe of sharp teeth on 4th leg.

Length 150 μ . The paired plates are each sub-divided by obscure curved transverse lines into three parts. This division may be of the same kind as that which gives rise to many small plates in Professor Richter's two species, *E. quadrispinosus* and *E. scrofa* (8).

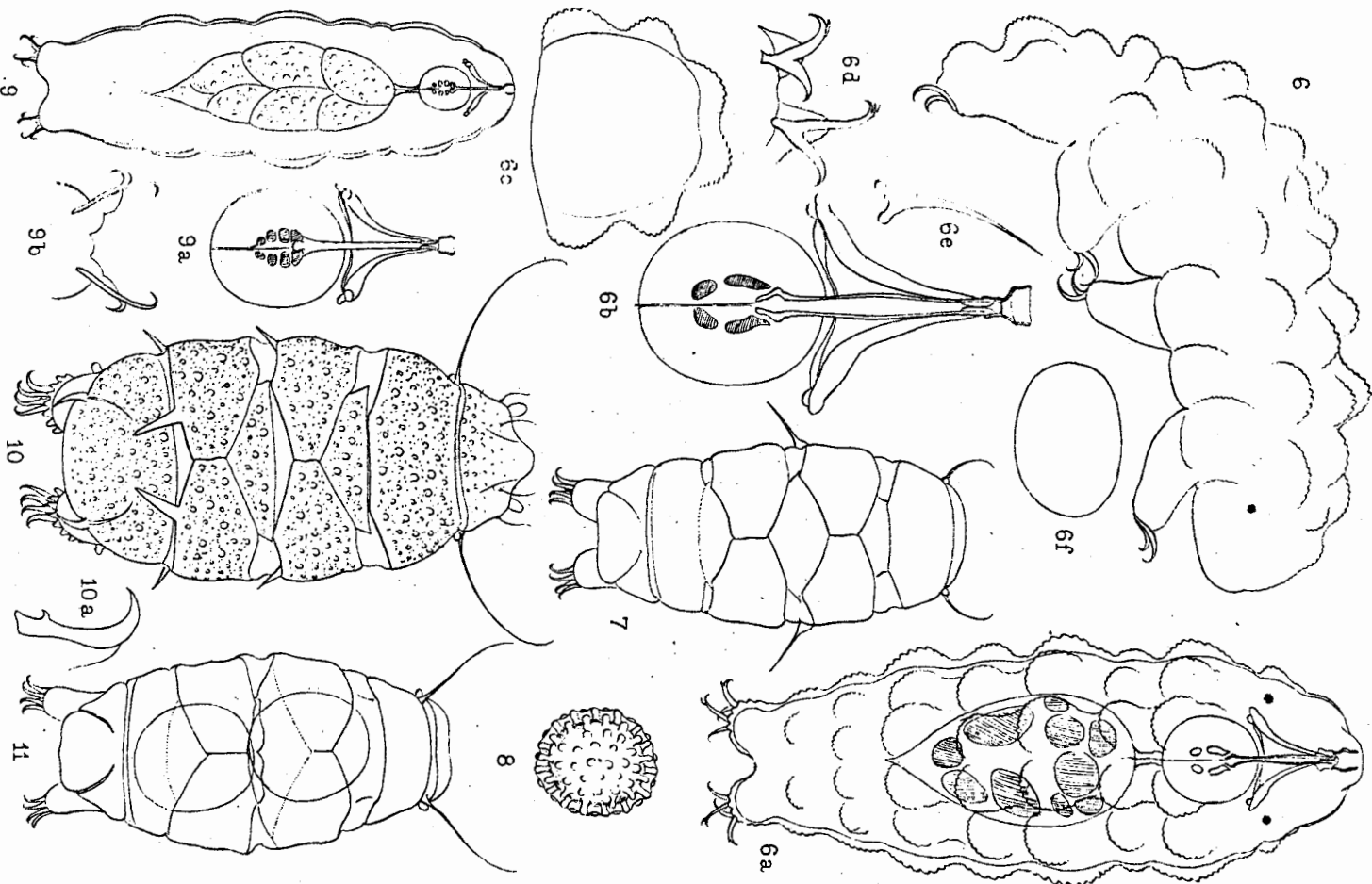
The first and second median plates are each crossed by a transverse line, which appears to separate two distinct parts. The part posterior to the line is certainly punctate, but it is doubtful if the anterior part is punctate, and I am uncertain whether it forms a plate of equal value with the other, as it does in several species (*E. islandicus*, etc.), or if it is merely a connecting membrane.

Professor Richters calls attention to the correspondence of the 4 acicular points with the spicules occupying the same position in *E. islandicus*.

There is, indeed, a considerable superficial resemblance between this species and *E. islandicus* (12) and *E. borealis* (6), especially the latter. Those are the only two species previously described which have processes on the paired plates between the angle and the median line of the body. The lateral processes correspond, except in relative size; the processes near the middle line agree with those of *E. borealis*; and the transverse division of the median

EXPLANATION OF PLATE XVIII.

Fig. 6a.—	<i>Macrobolus nodosus</i> sp. n.	Side view.
" 6b.	"	Dorsal view.
" 6c.	"	Teeth and pharynx.
" 6d.	"	Optical section.
" 6e.	"	Claws.
" 6f.	"	Side view of tooth.
" 6g.	"	Figg.
" 7.	<i>Echiniscus bispinosus</i> sp. n.	
" 8.	<i>M. archicus</i> Murray (?)	
" 9a.	<i>M. crassidens</i> sp. n.	Teeth and pharynx.
" 9b.	"	Claws.
" 9c.	"	Teeth and pharynx.
" 10a.	<i>E. crassispinosus</i> sp. n.	Claws.
" 10b.	"	Inner claw.
" 11.	<i>E. arcidomys</i> Ehr.	



J. Murray del. ad nat.

South African Tardigrada.

West, Newman photo-lith.

plates increases the resemblance. Notwithstanding all those points of agreement, *E. africanus* is not even in the same section of the genus, for segments v. and vi. are completely fused, without a trace of the line of junction.

The dots on the plates look like pits. The little spines on the paired plates are so near the median line that they usually overlap, and look like pairs of scissors.

The head setae or horns (*a*, Richers) are of moderate length, and curved forward and inward in the normal fashion.

Whether there are barbs on the inner claws I have been unable to see, owing to the position of the legs in the few examples studied.

Three examples seen, and none with eggs.

E. perarmatus sp. n., plate XVIII. figs. 4a to 4c.

Specific Characters.—Size, moderate. Plates, 9: 2 median, 2 pairs, vi trilobate. Pattern of two kinds, coarse dots, regularly arranged, and very fine pellucid dots. Lateral processes, *a* a short curved seta, *b*, *c*, and *d* spicules, *e* a long curved spine or seta. Dorsal processes, on each side a spicule on each plate of the second pair, above *d*. Spicules on 1st, 2nd, and 3rd legs. Fringe of longish obtuse processes on the 4th leg. Inner claws with small barbs.

Length, 260 μ . Eggs oval, red, 66 μ long. Larva, with two claws, length 96 μ . The larva has all the processes of the adult, but the lateral seta *e* is shorter. The paired plates have, along the posterior border, a broad plain marginal band, without dots.

Among the external characters of Tardigrada there is nothing so puzzling as the nature of the dots on the plates, usually referred to as granulation. Plate (*7*, p. 294) regards those dots as "dimples," and in my experience they also most commonly appear as depressions, but there is no doubt that the nature of the surface-texture varies in different species. Plate (*7*, p. 294) supposes that Doyère regarded the dots as really papillae, since he named a species *E. granulatus*, but I would suppose that his naming one species thus might be to emphasise a contrast between it and the others. Certainly a species closely agreeing with *E. granulatus* Doy. (*1*) is the only one in which I have seen granules, unmistakable and large. Some others, as *E. arcuatus*, I believe to be granular, but the condition is less obvious.

In no species are the dots so puzzling as in *E. perarmatus*. The larger dots, which are arranged in regular rows, appear over the general surface of all the plates as pits, but the rows can be traced without interruption from the centre of the lumbar plate (*v*. and *vi*.) to the posterior border of the middle lobe (fall-piece), and there they are certainly papillae. On the second median plate,

on the other hand, the anterior margin appears as though the plate were there bent over, showing the dots in profile, as "dimples."

Dots of two kinds are also found in a Scottish species which I identify as *E. oihonmæ*. In that case the dots are all of equal length, and the darker ones look as though one here and there of the pellucid dots had been punched out, leaving a hole. Though Professor Richters makes no reference to the texture in "Nordische Tardigraden" (9), nor in "Arktische Tardigraden" (10), his figure in the latter work (plate xv. fig. 4) gives colour to the belief that his animal had also two kinds of dots.

Skins with two and three eggs were seen.

Cape Colony. One of the most abundant species. The name is given in reference to the protection of the legs, as well as the back, by spines. I know no other species with such spines on the 2nd and 3rd legs, though the spine on the 1st leg is common to nearly all Echinisci.

E. longispinosus sp. n., plate XVII. fig. 3.

Specific Characters.—Size, moderate. Plates, 9: 2 median, 2 pairs, v. and vi. united, 3-lobed, 5 faceted. Lateral processes, *a*, *c*, and *d*, long fine seta. Dorsal processes, a long fine seta on the angle of each plate of the first and second pairs (segments iii. and iv.). Four setæ round mouth, long, and palps large. Coarsely punctate, dots distant. Fringe of long peg-like processes, standing apart, on the fourth leg.

Length, 200 μ . Eyes red. Fringe hyaline. No barbs could be detected on the inner claws. In such cases minute barbs may be present, as in *E. multibitis* (3) but they may be readily overlooked. The eight posterior setæ (on the paired plates) are equal and very slender.

The dots are of unequal size and very widely spaced. They look like depressions. The eggs were not seen.

The name refers not only to the principal setæ, which are, however, not so long as in some other species (*E. merolensis*, *E. oihonmæ*, etc.), but to the elongation of all the lesser processes. The mouth-bristles and the teeth of the fringe are relatively longer than in any other species known to me.

Cape Colony. One example seen. Though no eggs were found to indicate maturity, the species is sufficiently distinct from all other known species.

The facing of the plate formed by the union of segments v. and vi. is shared by several species. *E. reticulatus* Murray (3) has only 4 facets, *E. meridionalis* Murray (4), and another (unnamed) species from the South Orkneys have 5 facets just like *E. longispinosus*.

E. crassispinosus sp. n., plate XVIII. figs. 10a, 10b.

Specific Characters.—Size, moderate. Plates, 9: 2 median, 2 pairs, v. and vi. united, 3-lobed. Dots of two kinds: large, distant, and small, pellucid. Lateral processes, *a* long seta; *c*, *d*, and *e*, short spines. Dorsal processes, a broad flat spine on each plate of the second pair, nearer the median line than the angle. Fringe of blunt processes on the 4th leg. Blunt palp at base of 4th leg. Small barbs on the inner claws of all legs.

Length, 260 μ , exclusive of last legs. The four mouth-bristles are small. The head setæ or horns (*h*) are very long, and widely spreading, like the horns of Highland cattle. The double pattern on the plates is like that of *E. perarmatus*—the larger dots look like depressions, and the smaller like fine pellucid granules. The larger dots are not in this species arranged in regular rows, but scattered, more widely separated, and of unequal sizes. The colour is red.

The palp on the 4th leg is common to most species. The claws are somewhat broad, and the minute decurved barbs are near their bases.

Cape Colony. Several examples. Though no eggs were seen, the animal has too many peculiarities to be united with any known species.

Echiniscus sp., plate XVII. figs. 1a, 1b.

Description.—Small. Plates, 9: 2 median, transversely subdivided. Lateral processes, *a* seta, *c*, *d*, *e*, short spines. Dorsal processes, short curved spines on each plate of the pairs. Dots very large and close. Fringe and barbs not seen. Colour, yellow. Claws, four.

Length 120–150 μ . Dots appear to be depressions, obscurely polygonal, by reason of contiguity.

Professor Richters suggests that this may be the young of *E. quadrispinosus* Richters, with which the processes agree. The pattern is, however, quite different, more regular, and closer, and is not interrupted by bands as in that species.

Very probably a distinct species, but as yet insufficiently studied.

Cape Colony. Two examples.

Echiniscus sp., plate XVII. figs. 5a, 5b.

Small, pale red, finely dotted. Plates, 9 or 10 (3rd median doubtful), arrangement normal. Lateral processes, *a*, *b*, *c*, *d*, *e*, all incurved setæ. Dorsal process, a spine of moderate length over *c*. Fringe of small acute teeth. Inner claws with small barbs. Length 190 μ . Only one skin seen, without eggs.

The pattern of the plates is close and regular, and the dots appear to be depressions. The five lateral processes agree with *M. victor* Ehr. (?), but the proportional sizes of the processes are different, and there is only one dorsal process on each side instead of two. Professor Richters (11) describes, without naming or figuring, an almost exactly similar species.

MINNESUM.

M. lardigradum Doy. (1).

In Scotland the shorter claws of this species are variable, having from one to three points on each. All the African examples seen had three points on the shorter claws of all legs.

One skin contained three eggs.
Cape Colony. Only a few examples.

MACROBIOTUS.

The genus is divided into sections according to the characters of the eggs, which are either spiny, in which case they are laid free, or smooth, and are then laid several together in the skin when it is cast. A few of the spiny eggs have the rods imbedded in a clear matrix. Examples of all three kinds are among the African species.

The pharynx contains several rows of hard bodies (3 double rows) referred to as *rods* or *nuts*. The number of these free rods is always either two or three, exclusive of a short process at the anterior end of each row, which appears to be joined to the gullet, and another small nut at the posterior end of each row, which Professor Richters calls a "comma." The anterior nut is rarely or never absent, but many species have no "comma."

A. EGGS SPINY, LAID FREE.

M. hufelandtii (Richters) (9) (10).

Diverse animals have been identified by various authors as Schultz's *M. hufelandtii* (13). The species found in South Africa is that referred to under this name in Professor Richters's various works, and which I have followed him in recording from different parts of the world under the same name. It has the claws of each pair united about half-way up, the pharynx with a nut, a long double rod, a shorter rod, and a "comma" in each row of thickenings. The egg has processes which are conical in the lower portion, and expanded above into a disk. It is a well-marked species, accurately characterised by Professor Richters, though its identity with Schultz's species may be questioned, the description of that species being, like most of the early descriptions, rather inadequate.

M. echinogenitus Richters (9).

The animal found is Richters' type as found in Spitzbergen, with the pairs of claws divergent like the letter V, three short rods in each row of pharyngeal thickenings, and the spines of the egg without areolation in the interspaces. The well-developed young was squeezed out of the egg. The pharynx has a "comma" in each row of thickenings, besides the three principal rods.

M. arcticus ? Murray (5), plate XVIII. fig. 8.

This doubtful identification depends on the finding of an egg of the peculiar type of structure of which *M. hastatus* Murray (5) is the best known example. The rods on the egg surface are most like those of *M. arcticus*, but are larger and thicker.

B. EGGS SMOOTH, LAID IN THE CAST SKIN.

M. nodosus sp. n., plate XVIII. 6a to 6g.

Specific Characters.—Large, yellow, with large papillose dorsal tubercles in transverse rows, 6 on each segment (see fig. 6d) and 6 on each intermediate false segment. Pharynx with two thick rods in each row, the first twice as long as the second, and no "comma." Claws united for a short distance above the base, then divergent, one of each pair longer, and the long claw of one pair longer than that of the other; long claws with supplementary points. Eggs, elliptical, reddish brown, smooth. Dark eyes.

Length up to 500 μ , pharynx 50 μ long. Superficially resembling *M. tuberculatus* Plate (7), this species differs in nearly all details of structure. It is much larger, and highly coloured, while *M. tuberculatus* is colourless. The claws of *M. tuberculatus* are widely divergent from the very base, and there are three short equal rods in each row of pharyngeal thickenings.

The pharynx is of the same type as *M. hufelandtii* Richters, but the longer rod is not so clearly double, or formed by the joining end to end of two shorter rods. The basal thickening at the end of the gullet looks more like an expansion of the gullet than separate nuts, and there is no comma.

The longest claw of each foot has two supplementary points, but two points were not distinguished on the long claw of the lesser pair.

The stomach is pear-shaped, of few large cells enclosing sienna-brown matter. The coloration of the whole animal is distinctive: yellow skin, salmon-coloured eggs, and brown stomach.

Cape Colony. Very abundant. Many skins were found with eggs, up to 6 in number, the skins retaining the characteristic tubercles.

C. EGGS UNKNOWN.

M. crassidens sp. n., plate XVIII. figs. 9a to 9c.

Specific Characters.—Small, hyaline. Teeth strongly bent in middle. Pharynx with two free nuts in each row, besides large nut at end of gullet, and large comma; nuts very short and broad, often as broad as, or broader than, long. Claws very slender, each pair united more than half way.

Length 250 μ . No eyes. Stomach walls of few large cells, only about 6 visible in one view. No supplementary points could be seen on the longer claws.

This appears to be the African representative of *M. intermedius* Plate (?), as more fully described by Professor Richters (10). Compared with examples of that species sent to me by Professor Richters, *M. crassidens* has broader teeth, and more slender claws, united for a greater proportion of their length.

No eggs were found.

The first nut in the pharynx is unusually large, and seems to be more closely united to the gullet than in most species. It gives the end of the gullet the appearance of being expanded into a funnel. Similar expanded cuneate processes at the end of the gullet are found in several species not at all closely related to *M. crassidens*, as *M. coronifer*, *M. granulatus*, and *M. zetlandicus*.

Cape Colony. Fairly abundant.

LITERATURE.

1. DOYÈRE—Ann. d. Sci. Nat., ser. 2, xiv., 1840.
2. EHRENBURG—Mikrogeologie, 1854. Atlas, plate 35b.
3. MURRAY, J.—Tardigrada of the Scottish Lochs. Trans. Roy. Soc. Edin. xli. (1905) pp. 677-98.
4. " Tardigrada of the South Orkneys. Op. cit., xlv. (1906) pp. 323-34.
5. " Scottish Tardigrada. Op. cit., 1907.
6. " Arctic Tardigrada. Loc. cit.
7. PLATE, L. H.—Naturgeschichte der Tardigraden. Zool. Jahrb., iii. Morph. Abt., 1888, pp. 487-550.
8. RICHTERS, F.—Fauna der Umgebung von Frankfurt-a-M. Ber. Senckenbg. Natf. Ges., 1902, pp. 8-14.
9. " Nordische Tardigraden. Zool. Anz., xxvii. (1903) pp. 168-72.
10. " Arktische Tardigraden. Fauna Arctica, iii. (1904) pp. 495-508.
11. " Verbreitung der Tardigraden. Zool. Anz. xviii. (1904) p. 347.
12. " Islandische Tardigraden. Tom. cit., p. 313.
13. SCHULTZE, C. A. S.—*Macrobiotus hufelandi*. Okens Isis, 1834, p. 708.