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TAXONOMY OF HEMICYCLIOPHORA
SPECIES FROM WEST AND CENTRAL EUROPE
(NEMATODA: CRICONEMATOIDEA)

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The present study is a review of all the Hemicycliophora species found in Western and Central Europe (the Netherlands, Belgium, Great Britain, Germany, Austria, Switzerland and Denmark). The total number of species found is eleven. Nine of these occur in the Netherlands, viz. H. typica, H. thornei, H. thienemanni, H. conida, and five new species which are described and illustrated. H. typica is redescribed from totopotypes and their progeny, and a neotype is selected. H. membranifer is synonymized with H. typica. Of the two remaining species H. aquatica is redescribed from the holotype; of H. microletzkyi totopotypes were available, from which a neotype is selected.

Unless otherwise stated, measurements were taken from specimens fixed in F.A.A. and mounted in glycerin. All females were measured along the inner cuticle. Because the body is contracted ventrally posterior to the vulva in most species and the degree of contraction varies from species to species, the shape of the postvulval body part is expressed by the ratio of its length to the anal body width rather than to maximum or vulva body width. The scale lines in the illustrations indicate 50 μ. The type slides marked WT are in the collection of the Plantenziektenkundige Dienst, Wageningen.

IDENTITY OF HEMICYCLIOPHORA TYPICA DE MAN, 1921
(Figs. 1 and 2; Plate 1, A-B-C)

In 1921 De Man described Hemicycliophora typica n. gen., n. sp. from a single male collected from a compost heap in the Municipal Park, Bergen-op-Zoom, The Netherlands. The taxonomic position of the genus remained uncertain for some time, until Loos (1948) showed that the corresponding females were those known already under the generic name of Procriconema Micoletzky, 1925. Loos regarded the type of this genus, P. membranifer Micoletzky, 1925 to be identical with H. typica. This view was accepted until Thorne (1955) redescribed H. typica from collections believed to have come from the type locality. Subsequently Meyl (1955) and Paetzold (1958) described specimens of H. typica which were conspecific with Thorne’s.
GOODEY (1963) noted that the descriptions of DE MAN (1921) and THORNE (1955) did not agree and renamed *H. typica* of THORNE, 1955, *H. thornei*. Consequently the status of *H. typica* DE MAN, 1921 still remains unsettled.

The holotype of *H. typica* is not among DE MAN'S collection. The possibility that it exists still is not wholly excluded, because all the specimens dealt with by DE MAN in his 1921 paper are missing, so that a small part of his collection may be unrediscovered. For the moment, however, the problem must be approached along two other lines: morphological study and search at the type locality.

DE MAN'S specimen had the following dimensions: \( L = 0.68 \text{ mm}; a = 30; c = 6.3; \) tail length = 108 \( \mu \); spicules = 28 \( \mu \) (straight distance between their extremities). The spicules were semicircular. The drawing indicates that the tail measures five anal body widths; the tail is elongate-conoid with a subacute tip. The head end is slightly expanded; inside the lip region there are two peculiar ovoid structures (Fig. 1).

![Fig. 1. *Hemicycliohora typica* DE MAN, holotype male. Redrawn from DE MAN, 1921; by courtesy of Martinus Nijhoff, Publishers.](image-url)
As the species was based upon one specimen, the intraspecific variation is unknown and we must collect data about the variation within *H. thornei* in order to see how De Man's data fit in. Unfortunately Thorne's paper does not give any indications of variations, but only the values of the demanian indices of single specimens. The present writer has collected *H. thornei* from three localities in the Netherlands, viz. the islands of Texel and Terschelling, and the Kreekrakdam, province of Zeeland (type locality). Dr. Paetzold, Halle, German Democratic Republic, kindly sent some soil samples from Artern, Germany, from which about 20 males and numerous females were collected. As was the practice of De Man, specimens were measured before they were mounted, in order to get a better comparison with De Man's numerical data.

Dimensions of the Artern males, freshly relaxed (n = 21):

- **L** = 1.07 mm (0.96–1.11);
- **a** = 36 (34–39);
- **b** = 6.4 (5.9–6.9).

Dimensions of males, mounted: See Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Texel</th>
<th>Artern</th>
<th>Kreekrakdam</th>
<th>Terschelling</th>
<th>Paetzold, 1958</th>
<th>Thorne, 1955</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>n</strong></td>
<td>13</td>
<td>23</td>
<td>4</td>
<td>10</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td><strong>L</strong></td>
<td>0.85–1.03 mm</td>
<td>0.81–1.06 mm</td>
<td>0.98–1.04 mm</td>
<td>0.86–1.06 mm</td>
<td>0.95–1.04 mm</td>
<td>1 mm</td>
</tr>
<tr>
<td><strong>a</strong></td>
<td>36–41</td>
<td>30–41</td>
<td>31–39</td>
<td>36–40</td>
<td>26–33</td>
<td>34</td>
</tr>
<tr>
<td><strong>b</strong></td>
<td>5.1–6.9</td>
<td>5.7–7.4</td>
<td>5.2–6.1</td>
<td>5.7–6.0</td>
<td>5.7–6.2</td>
<td>6.2</td>
</tr>
<tr>
<td><strong>c</strong></td>
<td>5.0–6.0</td>
<td>5.0–6.1</td>
<td>5.2–6.1</td>
<td>5.1–5.5</td>
<td>5.0–5.4</td>
<td>5.1</td>
</tr>
<tr>
<td><strong>tail</strong></td>
<td>142–199 μ</td>
<td>154–203 μ</td>
<td>170–193 μ</td>
<td>167–196 μ</td>
<td>196 μ</td>
<td>196 μ</td>
</tr>
<tr>
<td><strong>T/ABW</strong></td>
<td>7.8–10.9</td>
<td>8.0–9.9</td>
<td>8.2–8.8</td>
<td>8.4–9.2</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>spicules</td>
<td>29–35 μ</td>
<td>29–34 μ</td>
<td>32–35 μ</td>
<td>29–33 μ</td>
<td>35 μ</td>
<td></td>
</tr>
</tbody>
</table>

It is clear that there exist real differences in body length and relative and absolute tail length. In *H. thornei* the tail is nearly twice as long as in *H. typica*; T/ABW is also distinctly larger. Also the spicules are longer, and especially much thinner than illustrated by De Man; the tip of the tail appears more sharp, and the lip region is continuous in *H. thornei* while offset by expansion in *H. typica*. Moreover, both in the Netherlands and in Germany, *H. thornei* occurs only in brackish soils, whereas the soil at the Park in Bergen-op-Zoom is not brackish. Thus *H. thornei* must be regarded a good species, different from *H. typica*.

Soil samples from the Park in Bergen-op-Zoom yielded two species of *Hemicycliophora*. In the first place *H. thienemanni* (W. Schneider, 1925). Males of this species have been unknown so far, but they were collected from other localities in the country. They differ strongly from De Man's description, having about the same dimensions as those of *H. thornei* and being even more slender (see below). It is impossible to consider *H. thienemanni* as identical with *H. typica*.

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Of the second species also only females were found. Identical females had been collected earlier at Heinkenszand, where also two males were found. These agree well to De Man's description. Ten females from the Park were used for monocultures, reared in tubes with Lolium perenne L. After 13–15 weeks five tubes were positive; the total number of specimens recovered was: 10 males, 62 females and 163 juveniles. Again, these males well fitted De Man's description. One of the males has been selected as neotype.

Apart from H. typica, H. thornei and H. thienemanni, males are known, as far as the species occurring in the Netherlands are concerned, in H. conida Thorne, 1955. At first glance they also resemble the specimen described by De Man, but on closer examination relative tail length and structure of lip region were found to be distinctly different. For relative tail length of H. typica and H. conida see Fig. 2. Moreover, H. conida was not found at the Park. Thus the writer feels justified in interpreting H. typica as outlined above.

REDESCRIPTION OF H. TYPICA FROM TOPOTYPES AND THEIR PROGENY

Dimensions: See Table 2.

Female. – Body stout, nearly straight in death, the postvulval body part sometimes bent to ventral side. Outer cuticle fitting loosely, with distinct annulation. Lateral field marked externally by two longitudinal lines, between which the transverse striae show breaks suggesting a third irregular line. The cuticle also bears numerous longitudinal striae outside the lateral field. Head end broadly truncate, lips somewhat separate, the lateral lips slightly lower than the sub-
Table 2. *Hemicycliophora typica*. Dimensions of topotypes and their progeny. For the symbols Rep, RVan, RV and Ran see de Grisse (1964).

<table>
<thead>
<tr>
<th>Females</th>
<th>Males</th>
<th>Neotype male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshly relaxed</td>
<td>Mounted</td>
<td>Freshly relaxed</td>
</tr>
<tr>
<td>n</td>
<td>19</td>
<td>26</td>
</tr>
<tr>
<td>L</td>
<td>0.70–0.88 mm</td>
<td>0.68–0.85 mm</td>
</tr>
<tr>
<td>a</td>
<td>21–27</td>
<td>21–26</td>
</tr>
<tr>
<td>b</td>
<td>5.2–6.2</td>
<td>5.1–5.7</td>
</tr>
<tr>
<td>c</td>
<td>8.9–10.6</td>
<td>8.8–10.9</td>
</tr>
<tr>
<td>Spear</td>
<td>64–74 μ</td>
<td>63–74 μ</td>
</tr>
<tr>
<td>Tail</td>
<td>101–126 μ</td>
<td>98–114 μ</td>
</tr>
</tbody>
</table>

Median ones; the labial disc in line with the apices of the submedian lips; with two distinct annules on both cuticles. Spear slender, with basal knobs directed backward. Oesophagus with short isthmus, terminal bulb well developed, about as long as isthmus. Hemizonid near base of oesophagus, slightly bulging out, two annules long. Excretory pore about two annules behind the hemizonid. Vulva a conspicuous irregularity in the ventral body wall; its lips modified, elongate. There is a distinct vulva sleeve which sometimes is so long that—at least in mounted specimens—the fold of the outer cuticle completely surrounds the body. Uterus with round spermatheca containing sperm. Gonad single, anterior, outstretched. Dimensions of eight intra-uterine eggs: 74–87 × 20–27 μ; the eggs are 2.9–3.8 × as long as wide. The postvulval body part is subcylindroid, about five anal body widths long; the tail narrows distally to a slender spike; this part is not offset so strongly as in *H. thienemanni* or *H. thornei*. On the tail the annules are distinct till the terminus; in the distal part they even become more coarse. The body cavity extends almost to the terminus. The vulva-anus distance is 52% (34–60) of tail length.

Male. — Body moderately slender, subcylindroid. Cuticle with distinct annulation 1.7 μ wide on middle of body, till 2 μ on the tail. Lateral field with three longitudinal lines. Lip region somewhat trapezoid, slightly expanded; this expanded appearance is more strong under low magnification than with oil immersion. No annules visible in the lip region. In medial view the amphid apertures and labial disc are distinct. The two oval markings illustrated by de MAN are conspicuous in most specimens, but their nature is not clear. Sometimes a few compound annules, composed of two normal ones, occur on the ventral side of the body anterior to the cloacal opening. Oesophagus degenerate, with indistinct outline. Walls of mouth cavity somewhat sclerotized.

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Fig. 3. *Hemicycliophora typica* DE MAN, neotype population. A: Female, neck region; B: female, posterior part of body; C: female, cuticle sculpture; D: female, end-on view of head; E: male, end-on view of head; F: male, head end; G: male, region of oesophagointestinal junction; H: male tail.
Hemizonid marked by a slight elevation of the cuticle, two annules long, located about four annules anterior to the excretory pore. Testis single, outstretched, occupying about one-third of total body length. Spicules semicircular, slightly cephalated proximally, the tip bent outward. Gubernaculum linear, 8.5 μ long. Bursa annulated, broad, extending from nearly two anal body widths anterior to the cloacal opening to one behind it. A thin anal sheath surrounds part of the spicules; at the base of this sheath, on the caudal side, the cuticle forms a characteristic knob in all specimens (less distinct in some specimens from other localities). On the caudal side the apex of the sheath is drawn out into a short acute process which is also indicated in de Man's drawing. Body wall on the ventral side strongly curved inward anterior to the cloacal opening (this feature, too, agrees with de Man's drawing). Tail slightly bent ventrad shortly behind its base, then straight; tapering to blunt or subacute tip; its posterior half with irregular outline.


**DISCUSSION OF H. MEMBRANIFER (MICOLETZKY, 1925) LOOS, 1948**

(Fig. 4; Plate 1, D)

Through the courtesy of Dr. G. Hartwich, Berlin, I was able to study the type material of *H. membranifer* (MICOLETZKY, 1925). There are four slides, numbered (by the Berlin Museum) 9333–9336 and bearing the original labels. On the right labels is the name *Procriconema membranifer*; on the left ones: 'Danmark, Tjustrupsø, Carex-Uferwiese, VI. 1924. LXXXVI. Formol. Glyz.' These data agree with those in the publication. The total number of specimens is five adult females and eight juveniles. Most specimens are flattened.

Dimensions of the adult females:

$L = 0.76–0.89$ mm; $a = 17–21$; $b = 5.3–5.8$; $c = 8.6–9.3$; $V = 83–85$;

$G = 67–71$ (n = 2); spear $= 68–76$ μ; Rex $= 37–43$; RVan $= 10–15$; RV $= 41–47$; Ran $= 30–33$; $R = 200–219$.1 These measurements are from the inner cuticle. MICOLETZKY measured the specimens along the outer cuticle; the dimensions are then: $L = 0.79–0.91$ mm; $a = 16–20$; $b = 5.4–5.9$; $c = 8.3–8.8$; $V = 81–83$.

These females agree with those of *H. typica* in dimensions, shape and structure of lip region, shape of tail with coarse annulation on its distal part, shape of vulva lips, loose outer cuticle and longitudinal sculpture of the cuticle; here too, the body cavity extends almost to the terminus. The vulva sleeve is long, so that in some specimens the fold in the outer cuticle extends all round the body, as in *H. typica*.

MICOLETZKY expressly stated that he could not find a spermatheca. This statement has some weight, because in the same publication he mentioned the presence of this organ in *H. aquatica*.

1 For the meaning of the symbols R, Rex, RV, RVan, Ran see de Grisse (1964).

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Two circumstances suggest that he examined the specimens after mounting: in the first place he gave the total number of adult specimens as four, whereas the slides contain five, but one was concealed under the ring and only came to light during remounting. Secondly, the relative body width given by Micoletzky agrees with that in the specimens in their present flattened condition.

Flattening may obscure several internal details. In these specimens the anterior end of the uterus is very broad, even bulging, and in two of them a
spermatheca filled with sperm is definitely present. Recent topotypes could not be obtained, the type locality now being spoilt by industry (LINDHARDT, in litt.).

_H. typica_ occurs in moist meadows in the Netherlands.

One female on slide 9336 is herewith designated lectotype. Dimensions: Along inner cuticle: \( L = 0.76 \text{ mm}; a = 20; b = 5.6; c = 9.3; V = 85; \text{ spear} = 71 \mu; \text{ Rex} = 41; \text{ RVan} = 10; \text{ RV} = 41; \text{ Ran} = 31; R = 205. \) Along outer cuticle: \( L = 0.79 \text{ mm}; a = 20; b = 5.8; c = 8.3; V = 83. \) This is the specimen which best shows the spermatheca and therefore it is selected, even though in general it is not the best preserved specimen.

In all populations of _H. typica_ studied the spermatheca is distinct, though in a population from Terschelling it was rather indistinct in a few specimens. Populations agreeing with _typica_ but without spermatheca have never been found in the Netherlands. It appears improbable that _H. membranifer_ should not occur in this country.

For all these reasons I prefer to regard _membranifer_ and _typica_ as one and the same species.

_H. membranifer_ has been redescribed by several authors. The descriptions of TAYLOR (1936) and TARJAN (1952) are copies of MICOLETZKY'S description; these authors did not study specimens themselves. LOOS (1948) found males, but he did not state whether the females had a spermatheca. Though he expressly stated the presence of three lateral lines in the females, specimens studied by me (slide indicated: ‘patna soil, June 1945’) have only one lateral line and therefore belong to a different species, perhaps _H. labiata_ COLBRAN, 1960. LUC (1958—a) did not find males, but his females possessed a well-defined spermatheca. WILLIAMS (1960) and COOMANS (1966) found females without spermatheca. A species much resembling _H. typica_, but monosexual, was recently described from Africa by WOLFF SCHOEMAKER (1968) as _H. nyanzae_, and the specimens of WILLIAMS and COOMANS might rather belong to that species.

_H. typica_ apud GOODEY (1951), considered by him conspecific with _H. membranifer_, does not belong here, but, in view of tail shape, spear length and absence of distinct lateral lines, rather represents _H. conida_ THORNE, 1955.

**HEMICYCLIOPHORA ROBUSTA** N. SP.
(Fig. 5–6; Plate 2, A-B)

**Dimensions:**

_Females (n = 17): L = 0.87–1.11 mm; a = 24–28; b = 4.8–5.8; c = 10–15; V = 48–85–89; spear = 93–108 \( \mu \); Rex = 39–45; RVan = 10–19; RV = 33–49; Ran = 22–33; R = 217–244. Holotype: L = 1.02 \text{ mm}; a = 27; b = 5.4; c = 12; V = 4986; spear = 99 \mu; Rep = 39; RVan = 13; RV = 41; Ran = 28; R = 224.

Male unknown.

Body moderately slender, slightly curved in death. Outer cuticle fitting rather tightly, distinctly annulated all over the body. Lateral field marked only by discontinuities in the transverse striae. Outside the lateral field a few isolated
Fig. 5. *Hemicyclophora robusta* n. sp., female from type population. A: neck region; B: lateral field; C: posterior end of body.
Fig. 6. *Hemicycliophora robusta* n. sp., second population, female. A: neck region; B: lateral field; C: posterior part of body.
longitudinal scratches are present. Lip region with two distinct annules on both cuticles; its sides tapering, anterior margin truncate. Lips distinct, the lateral ones slightly lower than the submedian ones; labial disc raised, protruding beyond the apices of the submedian lips. Spear with large round knobs. Oesophagus with short isthmus and well developed, relatively large terminal bulb. Excretory pore at level of base of oesophagus. Hemizonid two annules anterior to excretory pore, marked by a cuticular elevation two annules long, on the inner cuticle only; weakly developed, in some specimens not distinguishable. Vulva a not very conspicuous discontinuity in the ventral body wall; its lips thick, round, not modified in shape. Vulva sleeve short. Body contracted slightly ventrally behind the vulva. Gonad single, anterior, outstretched, oocytes in single row except for a short zone near the anterior end. A large (33–35 × 22–24 µ) spermatheca containing sperm is present at the anterior end of the uterus. Behind the vulva the body is subcylindroid till the distal third of the tail which is broadly triangular with bluntly rounded tip; the two parts of the tail are not separated by a constriction, but nevertheless they are well-marked. The post-vulval body part measures 3.5–4.5 anal body widths; the tail length is equal to 2.2–2.8 anal body diameters. The distance vulva-anus is 42–69% of tail length.


On this same island a second population was found resembling the one described above, but differing by the more anterior vulva and longer vulva-anus distance relative to tail length. This population occurred in soil near roots of cranberry (*Oxyccoccus macrocarpus* (Ait.) Pers.) on the Studentenplak. One female with double flexure in the gonad. Dimensions of nine females: L = 0.80–1.01 mm; a = 23–30; b = 4.7–5.9; c = 10–12; V = 43–53; 82–85; spear = 95–107 µ; Rex = 42–47; RVan = 15–21; RV = 40–49; Ran = 22–28; R = 206–232.

This species strongly resembles *H. epicharoides* n. sp. through general body shape, tail shape and the presence of a full spermatheca. It differs from *epicharoides* in having round, unmodified vulva lips; the very short vulva sleeve; the labial disc being raised and protruding beyond the lips; the much longer spear; the finer and more numerous body annules; the absence of lateral lines. In vulval characters *H. robusta* resembles *H. thienemanni*, from which it differs by the shape of the tail, the full spermatheca, the shape of the lip region, the nearly straight posture in death, the more posterior vulva and the much lower annule number.

**HEMICYCLIOPHORA TRIANGULUM N. SP.**

(Fig. 7; Plate 2, C–D)

Dimensions:

Females (*n* = 50): L = 0.77 mm (0.70–0.85); a = 26 (23–28); b = 5.2 (4.7–5.7); c = 11.2 (9.8–12.8); V = 86 (83–87); G = 35–50; spear = 73 µ (70–79); Rex = 49 (44–54); RVan = 16 (11–21); RV = 47 (40–54); Ran
Population from Overloon (n = 20): L = 0.69–0.88 mm; a = 24–30; b = 4.6–5.7; c = 9.3–13.0; V = 83–86; G = 36–55; spear = 73–81 μ; Rex = 44–52; RVan = 13–21; RV = 43–51; Ran = 27–34; R = 223–252.

Holotype: L = 0.77 mm; a = 28; b = 5.2; c = 10.6; V = 3985; spear = 73 μ; Rex = 53; RVan = 16; RV = 50; Ran = 33; R = 259.

Male unknown.

Body moderately slender, straight or slightly curved in death. Outer cuticle closely adpressed all over the body, nearly wholly smooth in the posterior part, traces of transverse striae being visible on the inside only. On the inner cuticle the annulation grows more coarse towards the head end. Lateral field marked externally by two longitudinal lines which extend from the median oesophageal bulb till a short distance anterior to the vulva; between them anastomoses or breaks in the annules may suggest a third, irregular line. There is no longitudinal striaion outside the lateral field, only a few irregular scratches here and there. Lip region truncate, lateral lips distinctly lower than submedian ones; the labial disc lies in line with the apices of the submedian lips. Lip region with two distinct annules on both cuticles. End-on view shows that the submedian lips each bear a papilla. Labial framework hexaradiate, the median prongs are duplex. Spear slender, basal knobs round with slightly concave anterior margins. Isthmus of oesophagus short, terminal bulb generally well developed, about as long as isthmus. Hemizonid marked by a slight bulging of the inner cuticle, two to three annules long, located one to three annules anterior to the excretory pore; the latter lies two to ten annules behind the base of the oesophagus.

Gonad single, outstretched, with oocytes in single row except over a short distance near the anterior end. Uterus with empty spermatheca. The discontinuity in the ventral body wall caused by the vulva is less conspicuous than in most other Hemicycliophora species. Vulva lips modified, elongate. Vulva sleeve practically absent, the vulva opens almost directly outward. Postvulval body part plump, about five anal body diameters long. The vulva-anus distance is 60% (44–78) of tail length. Tail about three anal body widths long, the tip slightly offset to form a triangle twice as long as wide at the base. The annulation is on the distal part of the tail not coarser than elsewhere.

Holotype: Female on slide WT 558. Paratypes: 49 females on slides WT 559–571; three females with end-on view of head end on slides WT 764–766.

Type habitat and locality: Grass field in the Grebbe Valley, west of Bennekom, The Netherlands.

The species has also been found at the following localities in the Netherlands: Overloon, grass-clover field; Denekamp, orchard soil; Havelte, sandy soil; Aalten, meadow soil; Bakel, sandy soil (the three paratypes with end-on view from this locality); Uden, soil from pear orchard; Mill, sandy soil; Noordbroek soil from rose nursery; Oosterhout, soil from sugarbeet field; Leiden, meadow soil; Eelde, soil near Drosera spec.; Breda, grass soil; Bergen-op-Zoom, soil; Lunteren, sandy soil from corn field. Most of these localities consist of light
Fig. 7. *Hemicycliophora triangulum* n. sp., female. A: neck region; B: end-on view of head; C: basal plate of labial framework; D: lateral field; E: posterior part of body.
sandy soil and lie in the eastern part of the country; the species, however, is also found in heavier soils (Leiden, Bennekom) and more close to the shore (Leiden, Bergen-op-Zoom).

A. de Grisse found this species in Western Belgium (Aalter, Merendree, Huise) and Germany (Rumphorst, Osnabrück).

A population from Airolo, Switzerland, collected by Dr. Y. Tencalla, differs by its lower annule number. Dimensions of 50 females: L = 0.78 mm (0.71-0.88); a = 28 (24-32); b = 4.9 (4.4-5.3); c = 11.1 (9.8-12.5); V = 85 (83-87); G = 32-50; spear = 77 μ (69-81); Rex = 43 (40-47); RVan = 14 (11-23); RV = 43 (39-50); Ran = 28 (25-36); R = 217 (202-227).

HEMICYCLIOPHORA EPICHAROIDES N. SP.
(Fig. 8; Plate 3, A)

Dimensions:
Females (n = 50): L = 0.81 mm (0.66-0.93); a = 24 (21-27); b = 5.1 (4.7-5.7); c = 11.6 (10.1-13.6); V = 86 (84-87); G = 41-65; spear = 81 μ (76-87); Rex = 35 (32-39); RVan = 11 (9-13); RV = 37 (31-42); Ran = 24 (20-30); R = 183 (165-202).

Holotype: L = 0.81 mm; a = 24; b = 5.2; c = 11.9; V = 4187; spear = 80 μ; Rex = 34; RVan = 11; RV = 34; Ran = 22; R = 173.

Male unknown.

Body nearly straight in death. Outer cuticle rather closely adpressed, more loosely between vulva and anus; its annulation conspicuous till the distal half of the tail. Lateral field marked by breaks in the annules which may suggest an irregular lateral line. Occasionally, mostly in the prevulvar region, two weakly developed and irregular sublateral lines like those of H. triangulum are visible over a short distance. Outside the lateral field there are no longitudinal striae but short scratches. Lip region somewhat rounded, with six lips, the lateral ones low, the labial disc protruding only very little beyond the apices of the submedian lips; with two distinct annules on both cuticles. Spear with round, backwardly directed basal knobs which in some specimens appear to be slightly asymmetrical. Oesophagus with short isthmus; terminal bulb distinct, about as long as isthmus. Excretory pore located near the base of the oesophagus. Hemizonid very weakly developed, practically not bulging, marked only by a less distinct groove between two annules.

Vulva conspicuous, its lips modified, elongate. Vulva sleeve short but distinct. Gonad single, anterior, outstretched, oocytes in single row except for a short zone near the anterior end. Uterus with distinct round spermatheca filled with sperm. Dimensions of an intra-uterine egg 68 × 24 μ. The postvulval body part measures 4.3 (3.8-5.0) anal body widths. Rectum relatively conspicuous. Tail cylindroid first, bluntly triangular distally, without sharp demarcation between the two parts; its length 2.1-2.7 anal body diameters. Length of vulva-anus distance 61 % (42-92) of tail.

Holotype: Female on slide WT 841. Paratypes: 49 females on slides WT
Fig. 8. *Hemicycliophora epicharoides* n. sp., female. A: neck region; B: lateral field in mid-body; C: lateral field in prevulvar region; D: posterior part of body.
Fig. 9. *Hemicycliophora epicharis* Raski, female, posterior part of body (paratype).


This species resembles *H. triangulum* n.sp., but it has much coarser annules and much lower annule number; a full spermatheca; and its lateral lines are much weaker and shorter. It also is close to *H. epicharis* Raski, 1958, (Fig. 9; Plate 3, B) from which it differs chiefly by the cuticular sculpture, shorter vulva sleeve and by the fact, that among about one hundred females not a single male was found. In addition, in *H. epicharis* the annulation on the distal part of the tail is conspicuously coarser than in *H. epicharoides*.

*HEMICYCLIOPHORA MACRISTHMUS N. SP.*
(Fig. 10; Plate 3, C)

Dimensions:

Females (*n* = 3): L = 0.89–0.99 mm; a = 25–27; b = 4.9–5.3; c = 9.0–9.8; V = 37–83–84; spear = 110–114 μ; Rex = 56–57; RVan = 16–19; RV = 56–59; Ran = 40–41; R = 261–277.

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Fig. 10. Hemicycliophora macristhmus n. sp., female. A: neck region; B: cuticle sculpture; C: uterus; D: posterior part of body.
Holotype: L = 0.94 mm; a = 27; b = 5.3; c = 9.1; V = 4083; spear = 114 μ; Rex = 57; RVan = 18; RV = 59; Ran = 40; R = 274.

Body moderately slender, slightly curved in death. Outer cuticle fitting loosely, with distinct annulation except on the distal part of the tail. Lateral field marked externally only by occasional irregularities or breaks in the transverse striae. Two rows of fine elongate dots on each annule. Lip region truncate, with two distinct annules on both cuticles; lateral lips slightly lower than submedian ones. The labial disc protrudes distinctly beyond the apices of the submedian lips. Spear slightly curved, with round basal knobs which are directed obliquely backward. Oesophagus with conspicuously long isthmus (hence the specific name) and broadly oval, well set off, terminal bulb which is much shorter than the isthmus. Hemizonid two to three annules long, indicated by bulging of the inner cuticle; located two to three annules anterior to the excretory pore; the latter lies about two annules posterior to the base of the oesophagus. Vulva a conspicuous discontinuity in the ventral body wall; its lips modified, elongate. There is a distinct vulva sleeve. Gonad single, anterior, outstretched; oocytes in single row except for a short zone near the anterior end. Uterus without distinct spermatheca; no sperm. The postvulval body part is 5–6 anal body widths long. The distance vulva-anus is about half as long as the tail. Tail slender, 3.5–4 anal body widths long, the distal part slightly offset, four times as long as wide at the base.

Male unknown. Juvenile cuticle with numerous short irregular longitudinal scratches.

Holotype: Female on slide WT 767. Paratypes: two females on slides WT 768–769. Type habitat and locality: Moist soil around roots of Ulmus sp., Baarn, The Netherlands. Also one female from moist soil, La Promenthouse, near Lake Leman, Switzerland. Dimensions: L = 0.91 mm; a = 24; b = 4.6; c = 10.3; V = 4085; spear = 111 μ; Rex = 54; RVan = 15; RV = 53; Ran = 37; R = 257. In this specimen the isthmus is slightly less elongate than in the type specimens; the rows of dots on the annules are distinct.

This species is most similar to H. aquatica (MICOLETZKY, 1913) and H. micoletzkyi Goffart, 1951 in shape of lip region and cuticular ornamentation. It differs from both by the shorter spear and by the absence of a distinct spermatheca; from H. micoletzkyi also by the much lower annule number. H. macristhmus is a terrestrial species, whereas H. aquatica and H. micoletzkyi are aquatic. From H. tenuis Thorne, 1955 H. macristhmus differs chiefly by the shape of the lip region, by the modified vulva lips and by the much lower annule number (410 in H. tenuis); it also is smaller (against 1.4 mm) and stouter (a = 36 in H. tenuis).

HEMICYCLIOPHORA NUCLEATA N. SP.

(Fig. 11; Plate 3, D)

Dimensions:

Females (n = 41): L = 1.45 mm (1.24–1.55); a = 33 (30–38); b = 6.0 (5.5–6.7); c = 9.0 (7.7–11.1); V = 82 (79–85); G = 29–62; spear = 138 μ

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Fig. 11. *Hemicycliophora nucleata* n. sp., female. A: neck region; B: end-on view of head; C: lateral field; D: detail of intestine; E: anterior part of uterus; F: posterior part of body.
Body slender, straight or slightly curved ventrad in death. Outer cuticle closely adpressed all over the body; its annulation is distinct except on the middle part of the tail. Lateral field marked externally only by breaks in the annules. There are no longitudinal striae. Lip region conoid, the lateral lips being higher than the submedian ones; the lips are less distinctly separated than in the species dealt with so far. The lip region bears two annules on the outer cuticle, none on the inner. Spear slender, basal knobs round. Oesophagus with very large median bulb, the valves measuring 14 μ. Isthmus thick, terminal bulb well developed. Hemizonid weakly developed, two annules long; cuticle not bulging. Excretory pore two to four annules behind the hemizonid and zero to five annules behind the base of the oesophagus. The nuclei of the mid-intestine are conspicuously large and prominent, hence the specific name.

Gonad single, anterior, outstretched, oocytes in single row except for a short zone near the anterior end; uterus with indistinct empty spermatheca. Vulva a conspicuous discontinuity in the ventral body wall, the body being contracted markedly behind it on the ventral side. Vulva lips modified, though not much elongate; vulva sleeve practically absent. The postvulval body part measures 7.2 (5.6–8.5) anal body widths; the vulva-anus distance is 65% (52–85) of tail length. The tail measures 4.4 (3.3–5.5) anal body widths; it is subcylindroid first, distally spicate; the distal part is offset sharply. On the spicate part the outer cuticle sometimes bears fine irregular striae. Dimensions of four intrauterine eggs: 128–147 × 30–36 μ.

Holotype: Female on slide WT 947. Paratypes: 42 females (two with end-on view of head) on slides WT 948–963.

Type habitat and locality: Ditch bottom, Oosterbeek, The Netherlands; collected by A. Schoemaker.

This species strongly resembles *H. thienemannii* (W. Schneider, 1925) by the shape of head and tail. It is, however, much longer, more slender, the spear is much longer, the annule number is higher; the vulva is much more conspicuous and the vulva lips are modified. It differs from *H. aquatica* by the conoid lip region and much higher annule number; from *H. micoletzkyi* by the conoid lip region and spicate tail.

Husmann (1956) recorded *H. thienemannii* from bottom water near the Weser, south of Hameln, Germany. His numerical data are: L = 1.03–1.48 mm; a = 24–34; b = 5.1–7.7; c = 16–23; V = 79–82. The value of c is obviously incorrect. The value of L suggests that he may have had a mixture of *H. thienemannii* and *H. nucleata*.
HEMICYCLIOPHORA THIENEMANNI (W. SCHNEIDER, 1925) LOOS, 1948

Syn. H. similis apud LOOF, 1961; H. typica apud KRALL, 1958

(Fig. 12–13; Plate 4, A-B-C)

**Dimensions:**

Population from Ens, The Netherlands (21 females): L = 0.72–1.14 mm; a = 26–33; b = 5.2–6.2; c = 7.8–9.7; V = 81–84; G = 28–44; spear = 85–99 μ; Rex = 44–61; RVan = 19–30; RV = 58–78; Ran = 39–48; R = 256–325.

Population from Ramspol, The Netherlands (24 females): L = 0.78–1.11 mm; a = 25–34; b = 5.2–6.7; c = 7.4–9.9; V = 80–83; spear = 90–101 μ; Rex = 45–57; RVan = 18–27; RV = 64–78; Ran = 41–54; R = 263–321.

Population from a ditch bottom, Wageningen, The Netherlands (20 females): L = 0.91–1.19 mm; a = 25–33; b = 5.2–6.3; c = 7.8–10.6; V = 78–84; G = 32–53; spear = 87–106 μ; Rex = 48–57; RVan = 22–31; RV = 65–80; Ran = 40–54; R = 271–327.

Males (n = 21, from Ens): L = 0.79–0.93 mm; a = 40–51; b = 6.1–7.3; c = 5.0–6.3; spicules (straight distance between extremities) = 24–27 μ; T = 19–35.

**Description of Dutch populations:**

**Female.** - Body slender, curved into open C-shape in death. Outer cuticle very closely adpressed all over the body; its annulation mostly indistinct on the postvulval body part. Lateral field marked only by occasional irregularities and breaks in the annules. Irregular longitudinal scratches on the cuticle may here and there suggest two longitudinal lines over short distances. No longitudinal striae outside the lateral field. Lip region conoid, the lateral lips higher than the submedian ones; the lips not distinctly separate. The outer cuticle of the lip region shows two annules, the inner none. Spear slender, with round basal knobs which are not clearly directed backward. Oesophagus with rather long isthmus; terminal bulb variable in size, but distinct. Excretory pore located one to seven annules posterior to the base of the oesophagus. Hemizonid two annules long, indicated in most specimens by a slight bulging of the inner cuticle; located one to three annules anterior to the excretory pore. Intestinal nuclei not particularly large or conspicuous. Vulva inconspicuous, the discontinuity in the ventral body wall very slight; vulva lips not modified, round as in H. robusta. Vulva sleeve absent, the vulva opens directly outward. Gonad single, anterior, outstretched; oocytes in single row except for a short zone near the anterior end. An empty spermatheca at the anterior end of the uterus. Distal part of vagina almost perpendicular to the body axis. The postvulval body part is 6.4 (4.7–8.4) anal body diameters long. The vulva-anus distance is 55% (39–77) of tail length. Tail subcylindroid first; the distal part spicate, distinctly offset. The tail measures four (3.4–5.0) anal body widths.

**Male.** - The male has not been reported so far, and is indeed very rare. Body very slender, straight in death, with a sharp bend ventrad at the base of the tail. Annulation of cuticle relatively fine, 1.5 μ on middle of body. Lateral field with
Fig. 12. *Hemicycliophora thienemanni* (SCHNEIDER), specimens from the Netherlands. A: female, neck region; B: female, lateral field; C: female, posterior part of body; D: female, end-on view of head; E: female, uterus; F: male, head end; G: male tail.
three longitudinal lines. Head end conoid, somewhat similar in shape to that of
the male of H. conida, but not offset distinctly. Four conspicuous ovoid organs
in the lip region. Oesophagus degenerate, without distinct contours. Hemizonid
conspicuous, two annules long, located a short distance behind the base of the
oesophagus. Excretory pore about three annules behind the hemizonid. Testis
short, outstretched. Bursa relatively narrow. Spicules curved only to about 90°.
Anal tubercle very weakly developed; no conspicuous discontinuity in the
ventral body wall at the anus. Tail very long (130–184 μ), 10–12 anal body
widths, with acute tip.

Through the courtesy of Dr. F. Schemer, Vienna, the author could study a
slide from W. Schneider's collection containing this species. The slide bears
the data 'Cric. th.' and an undecipherable word, inscribed with black ink on the
slide. It contains two females and one juvenile. Although the slide does not bear
any further indications, I consider it justified to regard it as the type slide, for the
following reasons:

1. Schneider collected the types prior to 1922, whereas the generic name
Procriconema was not erected until 1925. Prior to 1925 the generic names
Hoplolaimus and Criconema were used for Hemicycliophora. In 1925 the
species was published under the generic name Hoplolaimus. So the specimens
on this slide were certainly collected prior to 1925.

2. The females show the following dimensions: L = 1.13 mm; a = 26–27;
b = 6.2; c = 8.5–9.3; V = 82; spear = 105–107 μ; Rex = 55; RVan =
24–25; RV = 78–80; Ran = 52–55; R = 308–324. The juvenile has L =
0.82 mm; a = 24. These data well fit those given by Schneider, except c (c =
18 after Schneider), but nearly all the older authors did not see the anus at
all, or located it incorrectly.

3. Schneider described tail shape as: 'very characteristic: constricted shortly1)
behind the anus, then narrowed rather uniformly, with acute tip.' The
drawing is at variance with this, but the tail shape of the specimens wholly
fits the description. Schneider commented on the differences between
H. thienemanni and H. aquatica, but did not mention a difference in tail
shape. Indeed, the tail shape of H. aquatica (Fig. 17, Plate 6, C) is similar to
that of the thienemanni specimens on the slide, indicating that Schneider's
description, not his drawing, is correct.

A difficulty is that Schneider mentioned only two type specimens, a female
and a juvenile. Now the juvenile and one female lie close together, the other
female lies on the other side of the slide. In 1939 Schneider described this
species again, but his numerical data are identical to those of 1925, and it is
difficult to assume that the two females had the same dimensions up to one
decimal. So it is apparent that he overlooked one female; the other (Fig. 13;
Plate 4, C) can be regarded the holotype.

De Coninck (1930) described Hoplolaimus spec. which he later (1939) iden-
tified with H. thienemanni. Though the description is based upon juveniles, his
drawings indicate that this determination is probably correct.

1 Indication that the anus was located incorrectly.
Fig. 13. *Hemicycliophora thienemanni* (SCHNEIDER), type specimen, female. A: neck region; B: uterus; C: lateral field; D: distal part of tail.
Fig. 14. *Hemicycliophora similis* THORNE, type specimens (female). A: neck region; B: lateral field; C: posterior part of body.
Goffart (1949) recorded *H. thienemanni* from springs at Aschaffenburg and Erlangen, Germany, but did not give a description. Husmann (1956) found the species near Hameln, Germany, but, as indicated above, the record may partly refer to *H. nucleata*.

Krall (1958) described *H. typica* from the sandy bottom near the shore of a lake in Estonia. His measurements and illustrations clearly indicate that he had *H. thienemanni*.

The species has been found in several localities in Belgium (Balegem, Maldegem, Merendree, Melsele, Oostakker, Hockai, collected by De Grisse); Germany (Waltrop, Rumphorst, coll. De Grisse; strawberry plantation at Nienhagen, coll. U. Wyss) and Switzerland (Airolo, coll. Y. Tencalla; Dischmatal, coll. J. K. Maksymov; numerous in nearly all samples of wet soil near the Morges River, coll. A. Savary). Dalmasso found it in the south of France.

*H. thienemanni* is the most widespread Hemicycliophora species in the Netherlands. It has been found by us in all provinces except Limburg. It occurs in orchard soils, in scrub nurseries, in strawberry plantations, in flower nurseries and agricultural crops; at ditch banks and even in the bottom soil of shallow ditches. It occurs in heavy as well as in light soils. From culture experiments I get the impression that this species requires a high moisture.

In this species females are found regularly with abnormal tails: the distal spicate part may be shortened, so that the tail becomes conoid and in extreme cases even broadly rounded, showing the shape that is normal for *H. arenaria* Raski, 1958. The same phenomenon has been reported in *H. zuckermani* Brzeski, 1963 (Brzeski & Zuckerman, 1965).

Originally I had identified this species as *H. similis* Thorne, 1955, chiefly because it closely resembles *H. thornei*. Examination of type specimens of *H. similis* showed that this is a different species (Fig. 14; Plate 4, D). In *H. similis* the lip region shows two distinct annules on both cuticles; the labial disc is raised, the lateral lips are lower than the submedian ones. The vulva lips are modified, elongate; the distal part of the tail is offset much less distinctly. Dimensions of five females: L = 1.03–1.12 mm; a = 29–32; b = 5.6–6.3; c = 7.7–9.9; V = 38–56; spear = 97–107 μ; Rex = 56–64; RVan = 23–30; RV = 70–83; Ran = 44–54; R = 320–346; vulva-anus distance 59–79% of tail length; the postvulval body part measures 6.5–7.8, the tail 3.7–4.9 anal body diameters. *H. similis* apparently does not occur in the Netherlands; the records of Klinkenberg (e.g. 1964) also refer to *H. thienemanni*.

**Hemicycliophora conida** Thorne, 1955

(Fig. 15; Plate 5, A-D)

Dimensions:

**Form I:** Females (n = 100): L = 0.84 mm (0.66–0.99); a = 23 (18–27); b = 5.2 (4.5–6.0); c = 11.1 (8.7–14.4); V = 86 (84–88); G = 32–68; spear = 87 μ (78–96); Rex = 48 (42–53); RVan = 15 (11–21); RV = 49 (38–57); Ran = 33 (24–39); R = 245 (227–274).

Males (n = 51): L = 0.66 mm (0.53–0.84); a = 30 (22–39); b = 6.1 (5.1–7.0);
Form I: Males (n = 5): L = 0.62-0.68 mm; a = 29-33; b = 5.0-6.0; c = 7.0-8.0; 
tail = 81-88 μ; spicules (as above) = 18-20 μ; tail/ABW = 4.9-5.2.

Female. - Body plump, tapering hardly anteriorly, markedly posteriorly to 
the narrowly rounded terminus. Outer cuticle fitting fairly close, though less so 
than in e.g. H. thienemanni or H. triangulum; more loosely on the tail. In the 
postvulval body part the outer surface of the outer cuticle appears almost smooth, 
the annulation being indicated on the inside only; on the distal portion of the 
tail, however, a very fine but distinct annulation is visible, each annule corres­
ponding to one-half of a normal annule. Lateral field indicated by occasional 
irregularities and breaks in the transverse striae. On each annule there are four 
vague ovate markings as described by THORNE; their outer sides suggest the 
presence of two indistinct lateral lines; no clear ovate markings outside these 
lines were found. There are no longitudinal striae outside the lateral field, but 
there are two rows of very fine scratches on each annule. Lip region broad, 
truncate, with two distinct annules on both cuticles; with six distinct lips, the 
lateral ones lower than the submedian ones. Labial disc elevated distinctly, best 
visible in medial view. Spear slender with basal knobs directed conspicuously 
backward. Oesophagus with short, thick isthmus and well developed terminal 
bulb. Excretory pore located from five annules anterior, to seven posterior to 
the base of the oesophagus. Hemizonid weakly developed, in many specimens 
not visible, but sometimes bulging conspicuously in poorly mounted specimens; 
two annules long, located two annules anterior to the excretory pore. Vulva a 
conspicuous discontinuity in the ventral body wall; its lips modified, elongate. 
Vulva sleeve very short or absent. Gonad single, anterior, outstretched; oocytes 
in single row except for a short zone near the anterior end. Uterus long and thin, 
with empty spermatheca. Dimensions of intra-uterine eggs: form I 69-118 × 
23-34 μ (n = 6); form II 73-79 × 22-24 μ (n = 3). The postvulval body part 
measures 4.6 (3.6-5.0) anal body widths. Tail first convex-conoid, tapering 
markedly towards the slightly offset conoid distal part with narrowly rounded 
tip. Characteristic is the very fine annulation of the inner cuticle in this region. 
Tail length is equal to 3.0 (2.6-3.4) anal body widths in form I, 2.6 (2.1-3.0) in 
form II. The vulva-anus distance is 52% (35-67) of the tail length in form I, 
58% (36-87) in form II.

Male. - Head markedly trapezoid, offset by distinct expansion. Lateral field 
marked by three longitudinal lines. Cuticle with rather fine annulation (1.5 μ on 
middle of body); in the precloacal region larger annules occur owing to fusion of 
annules two by two. There appears to be a relatively large mouth cavity with 
somewhat sclerotized walls. Oesophagus degenerate, with indistinct outline. 
Hemizonid three to four annules long, located six to ten annules behind the
Fig. 15. *Hemicycliophora conida* THORNE, specimens from the Netherlands. A: Female, neck region; B: female, head end in medial view; C: female, end-on view of head; D: female, basal plate of labial framework; E: female, posterior part of body; F: female, cuticle sculpture; G: male, end-on view of head; H: male, head end; I: male tail.
base of the oesophagus. Excretory pore three to six annules behind the hemizonid. Testis single, outstretched. Spicules semicircular, the tip slightly recurved. Gubernaculum linear, slightly thickened proximally, about 10 μ long. Bursa with crenate edge. Anal sheath distinctly longer than in *H. typica*, often longer than the greatest width of the bursa. The tail is irregularly annulated in the posterior half, the tip is subacute. The tail is distinctly shorter than that of *H. typica*; individuals with \( L = 0.68 \text{ mm} \) always have tails shorter than 100 μ.

The numerous populations studied fall into two morphological forms. In Form I the females have about 230 annules or more; the excretory pore lies about 50 annules from the head end; spear length is on the average about 90 μ; diameter of spicules about 23 μ. In Form II the females have 180–220 annules, the excretory pore lies about 40 annules from the head end, the average spear length is 80 μ and the spicules are about 19 μ in diameter. Form I tends to be slightly larger than Form II. Qualitative differences could not be found, so that these forms are regarded as conspecific.

The type population from Ireland belongs to Form II. Seven females were available for study. Dimensions: \( L = 0.70-0.78 \text{ mm} \); \( a = 18-23 \); \( b = 4.9-5.2 \); \( c = 9.5-11.4 \); \( \varphi = 45°-58° \); spear = 73–82 μ; Rex = 38–42; RVan = 8–15; RV = 31–41; Ran = 20–29; R = 180–201. Dimensions of the holotype: \( L = 0.78 \text{ mm} \); \( a = 23 \); \( b = 5.2 \); \( c = 10.7 \); \( \varphi = 45° \); spear = 82 μ; Rex = 41; RVan = 11; RV = 41; Ran = 29; R = 201; intra-uterine egg 74 × 24 μ.

In the Netherlands this species is common and widespread; it is, however, found chiefly in the western districts. It is particularly common in the Zuiderzeepolders and often occurs together with *H. thienemanni*. A few inland localities are known: Huissen, Wageningen, Twello, St. Michielsgestel. The Twello population is a mixture: every single individual can be brought without doubt to either Form I or Form II. In this population the variation coefficients of annule number, Rex and spear length are conspicuously higher than in the 'pure' populations. The populations from the Braakman, in the extreme southwest, and of Scheveningen are form II. All other Dutch populations are form I. Males are generally extremely rare and in many populations they are apparently absent altogether. However, they may spasmodically turn up in large numbers.

Belgium: Several populations from the coastal districts were examined. Here Form II is dominant (Koksyde, de Panne, Westende), though Form I occurs also (Koksyde).

Ireland: The type population is Form II, as said above.

England: Populations from Herringwell and Docking are Form I.

Germany: Populations from Rodenkirchen am Rhein, Halle an der Saale, Marburg, Rumphorst, Waltrop and Euren are all Form I.

Switzerland: Along the Morges River Form II is numerous. At Airolo a mixed population occurs; what was said above about the Twello population applies here as well.

Italy: One female from Pozza, Dolomites is Form II.

Poland: A population from Skierniewice is Form I.

In the Netherlands this species prefers sandy soils, though it is occasionally

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found in heavier soils. As in *H. thienemanni*, females with short-conoid to broadly rounded tails are found regularly. On the island of Terschelling this species was found, though very rare, in brackish soils in company of *H. typica* and *H. thornei*.

**HEMICYCLIOPHORA THORNEI GOODEY, 1963**

Syn. *H. typica* apud Thorne, 1955; apud Meyl, 1955; apud Paetzold,

(Fig. 16; Plate 6, A-B)

Four populations were studied. The dimensions of the males have been given above (Table 1). Females:

Kreekrakdam (type locality, n = 30): L = 1.02 mm (0.88-1.18); a = 25 (22-30); b = 5.9 (5.2-6.5); c = 9.8 (8.4-11.6); V = 85 (83-87); G = 32-58; spear = 91 μ (85-101); Rex = 44 (40-49); RVan = 15 (10-18); RV = 53 (47-60); Ran = 38 (31-42); R = 243 (230-260).

Texel (n = 30): L = 1.11 mm (0.96-1.28); a = 29 (25-32); b = 6.1 (5.4-6.6); c = 9.9 (8.9-11.3); V = 84 (82-86); G = 42-69; spear = 92 μ (88-98); Rex = 44 (38-47); RVan = 15 (11-19); RV = 56 (50-63); Ran = 40 (36-46); R = 247 (223-263).

Terschelling (n = 30): L = 1.11 mm (0.85-1.38); a = 29 (23-33); b = 6.1 (4.9-7.0); c = 10.0 (9.1-10.9); V = 85 (83-88); G = 34-62; spear = 94 μ (82-103); Rex = 44 (39-47); RVan = 15 (9-18); RV = 56 (46-61); Ran = 40 (33-45); R = 246 (219-260).

Artern (Germany) (n = 30): L = 1.14 mm (0.94-1.31); a = 24 (22-29); b = 6.4 (5.9-7.0); c = 10.1 (8.8-11.1); V = 85 (83-86); G = 28-55; spear = 91 μ (84-97); Rex = 46 (43-49); RVan = 16 (12-18); RV = 58 (50-66); Ran = 41 (33-47); R = 257 (238-273).

Female. - Body moderately slender, slightly curved when killed. Outer cuticle fitting loosely, with distinct annulation all over the body. On the distal half of the tail the annules of the outer cuticle are subdivided into two small annules each. Lateral field marked only by breaks and irregularities in the transverse striae. Outside the lateral field the annules bear some weak and irregular longitudinal markings and here and there a few short longitudinal striae. No true longitudinal striae such as found in *H. typica*. Lip region conoid, the lateral lips higher than the submedian ones, with two indistinct annules visible on the outer cuticle only. Spear slender with round basal knobs. Isthmus of oesophagus as long as terminal bulb, the latter in most specimens well developed. Hemizonid weakly developed, in many specimens not bulging at all; two annules long, located at the level of the base of the oesophagus. Excretory pore opening usually one to three annules behind the hemizonid, but in some specimens through the second hemizonid annule. Vulva a conspicuous discontinuity in the ventral body wall; its lips modified, slightly elongate. Gonad single, anterior, outstretched; oocytes in single row except for a short zone near the anterior end. Uterus with distinct spermatheca (15–24 × 14–17 μ) containing sperm. The postvulval body part measures 5.3 (4.5-6.0) anal body widths. The
Fig. 16. *Hemicycliophora thornei* GOODEY. A: female, neck region; B: female, posterior part of body; C: female, lateral field; D: male, head end; E: male, region of oesophago-intestinal junction; F: male, tail.
Tail is subcylindroid first, the distal part spicate, offset distinctly; its length is equal to 3.6 (3.1–4.1) anal body diameters. The vulva-anus distance is 53% (27–73) of tail length.

Male. – Tail mostly curved to ventral side. Body rather slender, width of annules 1.5 μ on middle of body; towards the tip of the tail the annules become more coarse, till 2.4 μ. Lateral field with three longitudinal lines. Lip region round, not offset from the body. Mouth cavity less distinct than in H. conida, its walls hardly sclerotized. Oesophagus degenerate, with indistinct outline. Hemizonid two to three annules long, located at the level of the base of the oesophagus, or a short distance behind it. Excretory pore three to six annules behind the hemizonid. Testis single, outstretched; the gonad occupies 31% (22–37) of body length. Bursa with strongly crenate edge. Spicules semicircular, the tip slightly recurved. Gubernaculum linear, about 12 μ long. The anal tubercle is 12 μ long, slightly less than the anal body width. The ventral body wall curves inward distinctly before the anal tubercle. Posteriorly the tip of the anal tubercle bears a distinct transverse spine. Tail regularly annulated.

The neotype of H. typica, designated by Therne (1955) is the holotype of H. thornei, because H. thornei is nom. nov. for H. typica of Therne, 1955 nec Deman, 1921. Type locality: brackish soil, Kreekrakdam, Island of Zuid-Beveland, province of Zeeland, The Netherlands.

This species occurs in brackish soils only. Apart from the type locality it has been found in the Netherlands on the Wadden Islands of Texel and Terschelling; on the latter in mixed populations with H. typica and (very rare) H. conida.

Paetzold (1958–b) reported this species from inland brackish meadows at Artern and Langenbogen, Germany. From Artern Meyl (1955) also reported and described 'H. typica'. His description indicates that he must have had H. thornei, but curiously he mentioned that the lateral field of the female was marked by three longitudinal lines. This must be a lapsus, since the specimens from this locality examined by me did not show such lines. Meyl's specimens certainly do not come closer to H. membranifer as suggested by Luc (1958–b).

According to Therne, the females of H. thornei are practically identical to those of H. similis Therne, 1955, except for the presence of sperm in the uterus. However, on examination of type specimens of H. similis it was found that head shape of this species is different (lips well separate, distinct annulation on both cuticles), the vulva lies more anterior (79–82% against 82–88), and the annule number is much greater; this can be determined most quickly by counting RVan which in H. thornei is under 20 and in H. similis over 20. H. thornei is much more similar to H. thienameanni through shape of lip region and tail; H. thienameanni has a much higher annule number (RVan over 20), the vulva is much less conspicuous, has unmodified lips and lies more anterior (79–84); the outer cuticle fits very closely. Males of H. thornei are common in all populations; they differ from those of H. thienameanni, with which they share the continuous lip region and the long tail, by the semicircular spicules, distinct anal tubercle and less slender body.

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Fig. 17. *Hemicycliophora aquatica* (Micoletzky), female holotype. A: neck region; B: cuticle sculpture; C: uterus; D: posterior part of body.
HEMICYCLIOPHORA TYPICA DE MAN, 1921

In the Netherlands this species occurs chiefly in the western districts. It has been found at Bergen-op-Zoom (type locality), Oegstgeest (moist meadow), Voorschoten, Wassenaar, Warmond, Zoeterwoude (same), Wageningen (ditch bank), Akersloot (soil from Lilium spec.). In addition, on the islands of Texel and Terschelling it occurs in brackish soils together with *H. thornei*.

In England we found a population in a narcissus field at Braunton.

HEMICYCLIOPHORA AQUATICA (MICOLETZKY, 1913) LOOS, 1948

(Fig. 17; Plate 5, E)

The holotype was available for study. Dimensions:

Along inner cuticle: \( L = 1.15 \text{ mm}; \ a = 22; \ b = 5.3; \ c = 10.5; \ V = 35.84; \) spear = 136 \( \mu \); Rex = 57; RVan about 20; RV = 57; Ran about 36; R = 277.

Along outer cuticle (for comparison with MICOLETZKY's data): \( L = 1.21 \text{ mm}; \ a = 18; b = 5.5; c = 7.1; \ V = 34.79. \)

MICOLETZKY's data: \( L = 1.2 \text{ mm}; a = 22.2; b = 6.6; c = 5.1; V = 70 \) (c is incorrect; in 1925 MICOLETZKY stated that he could not find the anus and corrected V to 79\%).

The body is flattened and twisted somewhat, so that the posterior part lies in submedian position. Outer cuticle fitting loosely, with distinct annulation except on the distal part of the tail. Margins of annules slightly crenate or wavy. Each annule bears two rows of fine elongate dots. Lateral field marked only by irregularities in the transverse striae. Lip region truncate, lips well separate, the lateral ones not higher than the submedian ones; labial disc protruding distinctly; both cuticles with distinct annules. Oesophagus with rather long isthmus and well developed terminal bulb. Excretory pore near the base of the oesophagus; hemizonid two annules anterior to it, not bulging, two annules long. Gonad single, anterior; uterus with spermatheca containing sperm. Shape of vulva lips not determinable, but probably modified. Tail convex-conoid first, the distal part spicate, offset distinctly. The postvulval body part measures 4.5, the tail 2.8 anal body widths; vulva-anus distance is 61% of tail length.

Holotype: On slide 9332 of the Zoological Museum of Humboldt University, Berlin. The slide bears the original labels; the left one bears the data: 'Lunz, Untersee, 13 M tief. Reg. 20. VIII. 1912.' The right one is inscribed: 'Pro Cri-conema aquaticum miih' in ink; through it traces of the generic names *Hoplo-laimus* and *Tylencholaimus*, written in pencil, are visible.

This species seems close to *H. macristhmus*; it has a much longer spear, and the spermatheca is distinct and contains sperm. From *H. micoletzkyi* it differs by the much lower annule number. *H. aquatica* was recorded from Waldaschaff, Germany, by NOLL & STAMMER (1953), but no description was given.
HEMICYCLIOPHORA MICOLETZKYI GOFFART, 1951
(Prociconema micoletzkyi GOFFART, 1949, nomen nudum)
(Fig. 18 and 19; Plate 6, C-D)

In 1949 GOFFART, in giving a review of some collections of subterranean aquatic nematodes, mentioned Prociconema micoletzkyi n. sp., without giving a description. In 1951 he described it under the generic name of Hemicycliophora. Prociconema micoletzkyi GOFFART, 1949 therefore is a nomen nudum; the valid name of the species is Hemicycliophora micoletzkyi GOFFART, 1951.

The type specimen is lost (WEISCHER, in litt). The description is short, the illustration insufficient for recognition. Through the kind cooperation of Dr. R. DERN, Frankfurt am Main, I received some samples from the pump of the swimming pool at Aschaffenburg, Germany, the type locality (though the holotype came from a different point of the same water-system, NOLL & STAMMER, 1953). These samples contained five females, two males and some juveniles. One male was lost during processing.

Dimensions:

Females (n = 4): L = 1.40–1.78 mm; a = 32–39; b = 6.3–7.4; c = 8.5–9.3; V = 30–53; spear = 119–142 μ; Rex = 60–74; RVan = 15–22; RV = 77–90; Ran = 61–68; R = 366–461.

One female with abnormal tail: L = 1.48 mm; a = 34; b = 6.7; c = 12.3; V = 50–87; spear = 133 μ; Rex = 66; RVan = 21; RV = 65; Ran = 43; R = 370.

Female neotype: L = 1.73 mm; a = 39; b = 6.8; c = 8.9; V = 30–85; spear = 142 μ; Rex = 74; RVan = 21; RV = 90; Ran = 68; R = 461.

Male: L = 1.38 mm; a = 53; b = 6.2; c = 5.8; T = 22; tail = 237 μ; diameter of spicules = 42 μ.

Female. - Body slender, nearly straight in death. Outer cuticle fitting loosely, with distinct transverse striation. Lateral field marked externally by two longitudinal lines, between which breaks in the striae may suggest a third. Outside the lateral field each annule bears two series of conspicuous longitudinal scratches like those of H. aquatica; the edges of the annules are undulate. Lip region truncate, lips well separate, the lateral ones as high as the submedian ones. Labial disc protruding strongly. Lip region with three distinct annules on both cuticles. Spear slender, basal knobs directed somewhat backward. Oesophagus with large median bulb containing valves, short isthmus and large, well-developed terminal bulb. Hemizonid weakly developed, two annules long, located three to five annules anterior to the excretory pore; the latter lies one to thirteen annules behind the base of the oesophagus. Vulva a conspicuous discontinuity in the ventral body wall; vulva lips modified, elongate. A distinct vulva sleeve is present. Gonad single, anterior, outstretched, oocytes in single row except for a zone, longer than in most other species, near the anterior end. Uterus with large spermatheca (22–27 × 16–21 μ) filled with sperm. Oviduct very long. Tail in most specimens tapering uniformly, the distal part slightly offset, spicate; in some specimens the distal part is offset more distinctly, so that tail
Fig. 18. *Hemicyclophora micoletzkyi* Goffart, female neotype. A: neck region; B: prevulvar part of body; C: tail; D: cuticle sculpture.
Fig. 19. *Hemicycliaphora micoletzkyi* Goffart, male. A: head end; B: region of oesophago-intestinal junction; C: lateral field; D: tail.
shape approaches that of *H. aquatica*. The postvulval body part measures 7.4–7.7 anal body widths; tail length is 4.6–5.6 anal diameters; vulva-anus distance is 32–43% of tail length (the four normal specimens).

Male. – Body very slender, width of annules 1.8 µ on middle of body. On the ventral side there are some compound annules consisting of two normal ones. Lateral field with two longitudinal lines, originating about five annules behind the lip region. Head end somewhat trapezoid, but not so distinct as in *H. conida*. Lips apparently relatively distinct. Excretory pore located on 129th annule behind the lip region; five annules behind the hemizonid. The latter is three annules long and lies just before the – indistinct – oesophago-intestinal junction.

Spicules semicircular, slender, not cephalate proximally, the tip slightly bent outward. Cloacal aperture a conspicuous irregularity in the ventral body wall. There is a long anal sheath (19 µ), its tip bears a small spine on the posterior side. Bursa broad, relatively long. Tail length equal to ten anal body diameters; tail tapering regularly to the acute terminus; annulation regular, disappearing towards terminus.

Neotype: Female on slide WT 1039. Neoparatypes: Four females and one male on slides WT 1040–1044.

*H. micoletzkyi* is very close to *H. aquatica*, from which it differs by slenderer body and higher annule number. Whereas in the holotype of *H. aquatica* the distal part of the tail is offset distinctly, this is not, or much less distinctly the case in *H. micoletzkyi*. More material of *H. aquatica* must be examined in order to evaluate properly the differences between these species. The male of *H. micoletzkyi* is unique in having only two lateral lines.

*H. micoletzkyi* also resembles *H. tenuis* THORNE, 1955, through spear length, dimensions of body and annule number. *H. tenuis*, however, has no distinct spermatheca, the shape of the lip region is as in *H. thienemanni, H. thornei* and *H. nucleata*; the vulva is inconspicuous and its lips are not modified, as in *H. thienemanni*.

In Dr. Goffart’s collection at Münster, Germany, one juvenile specimen is present, collected at the type locality on May 19, 1950. It is in poor condition, the outer cuticle being very irregularly plicated. Anus and excretory pore are invisible. Dimensions: L = 0.98 mm; a = 38; b = 6.5; spear = 107 µ; annule number about 420. Shape of lip region and tail, as well as the presence of lateral lines, indicate that this specimen is conspecific with the ones described above.

**KEY TO HEMICYCLIOPHORA SPECIES OCCURRING IN WESTERN AND CENTRAL EUROPE**

(Based upon females)

1. Lip region conoid, lips somewhat connate; lateral lips higher than submedian ones; annulation in lip region indistinct on the inner cuticle . . . . . 2.

2. Lip region truncate, lips well separate; lateral lips not higher than submedian ones; annulation in lip region distinct on both cuticles . . . . . 4.

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2. Bisexual species, females with spermatheca containing sperm; outer cuticle fitting loosely; RVan under 20; V = 83–87. *H. thornei.*

Monosexual species, spermatheca empty; outer cuticle fitting tightly; RVan over 20; V = 78–84. 3.

3. Spear length 130 μ or more; vulva lips modified; intestinal nuclei very large and conspicuous. *H. nucleata.*

Spear length 80–108 μ; vulva very inconspicuous, lips not modified; intestinal nuclei not particularly large. *H. thienemanni.*

4. Each annule with numerous longitudinal scratches; labial disc protruding distinctly. 5.

Annules without conspicuous longitudinal scratches. 8.

5. Spear length 120–142 μ, spermatheca with sperm. 6.

Spear length 70–120 μ, spermatheca empty. 7.

6. Annule number 366–461; body slender (a = over 30); tail mostly tapering uniformly. *H. micoletzkyi.*

Annule number under 300; body stout (a = under 30); distal part of tail offset distinctly, spicate. *H. aquatica.*

7. Spear length over 110 μ; distal part of tail offset. *H. macristhmus.*

Spear length under 100 μ; distal part of tail hardly offset. *H. conida.*

8. Lateral field marked by two distinct lateral lines extending from neck till near vulva; between them breaks in the transverse striae suggest a third line. 9.

Lateral field marked by breaks only; if there are longitudinal lines, they are indistinct or extend over short distances only. 10.

9. Bisexual species; outer cuticle fitting loosely; cuticle with prominent longitudinal striae; distal part of tail elongate-conoid, with coarse annulation. *H. typica.*

Monosexual species, spermatheca empty; no longitudinal striae; distal part of tail triangular, its annulation not conspicuously coarse. *H. triangulum.*

10. Uterus with empty spermatheca; annules with vague ovate markings laterally. *H. conida*.

Uterus with spermatheca containing sperm; no ovate markings on cuticle. 11.

11. Spear length 93 μ or more; annules over 200; vulva lips not modified. *H. robusta.*

Spear length 90 μ or less; annules under 200; vulva lips modified. *H. epicharoides.*

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1 Because the longitudinal scratches on the annules are in this species less distinct than in *H. micoletzkyi, H. aquatica* and *H. macristhmus,* I have inserted *H. conida* in the key twice.

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Plate 2. A: *Hemicycliophora robusta* n.sp., female from type population; B: *H. robusta* n. sp., female from second population; C: *H. triangulum* n. sp., females from type population; D: *H. triangulum* n. sp., females from Airolo. Photos Plantenziektenkundige Dienst, Wageningen.
Plate 3. A: *Hemicycliophora epicharoides* n. sp., females; B: *H. epicharis* RASKY, paratype female; C: *H. macristhmas* n. sp., female; D: *H. nucleata* n. sp., female. Photos Plantenziektenkundige Dienst, Wageningen.
Plate 4. A: Hemicycliophora thienemanni (W. Schneider), females from the Netherlands; B: H. thienemanni (W. Schneider), male; C: H. thienemanni (W. Schneider), type specimens; D: H. similis Thorne, type specimens. Photos Plantenziektkenkundige Dienst, Wageningen.
Plate 5. A-D: *Hemicycliophora conida* THORNE. A: Females, form I; B: Females, form II; 
C: Male, form I; D: Male, form II. E: *H. aquatica* (MICOLETZKY), female holotype. 
Photos Plantenziektenkundige Dienst, Wageningen.