A NOTE ON PARATYLENCHUS IN THE NETHERLANDS WITH THE DESCRIPTION OF P. GOODEYI N. SP. (NEMATODA, CRICONEMATIDAE)

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INTRODUCTION

The eelworm genus *Paratylenchus* MICOLETZKI, 1922 (MICOLETZKI, 1922) comprises at present 9 described species. The generic characters were distinctly set out bij THORNE (1949) and by GOODEY (1951). Table 1 summarizes the morphological data of each species. The oldest is *Tylenchus macrophallus* DE MAN 1880, found in Dutch meadows and redescribed by GOODEY (1934) as *Paratylenchus macrophallus* (DE MAN, 1880) GOODEY, 1934, now based on an English population. Impressed by the great variability in body size and spear length encountered in his population, GOODEY synonymized the species *bukowinensis*, *nanus*, *anceps* and *besoekianus* with his *macrophallus*. Later on *anceps* was reestablished as a good species (THORNE & ALLEN, 1950), whereas *curvitata* VAN DER LINDE, 1938, *elachistus* STEINER, 1949, *minutus* LINFORD, 1949 and *hamatus* THORNE & ALLEN, 1950 were described as new. The genus deserves attention again since some of its species recently proved to be potential plant parasites (THORNE & ALLEN, 1950; LOWNSBERY, STODDARD & LOWNSBERY, 1952; OOSTENBRINK, 1953).

OBSERVATIONS

Since 1952 we have collected in the Netherlands several *Paratylenchus* populations, which were close to *P. hamatus*. Constant characters were a rather broad head with 4–5 lip annules, a strong stylet of 25–30 μ in the ♀♀ and an anal sheath with dorsal extension in the ♂♂ in all occasions that ♂♂ were found. Close examination, however, revealed, that at least three strains [1]) were involved, differing in habitat but also in shape of the head, shape and annulation of the tail, slenderness of the body, length of the stylet and presence of males and male spears. None of these strains seemed to fit *P. hamatus* exactly (THORNE & ALLEN, 1950). A few specimens of *P. hamatus*, kindly furnished by one of the authors of this species, however, also differed from the original description by greater α's, longer tails and a slightly offset head, so that more information is desirable to establish the systematic position of the Dutch strains. It was clear, however, that more species were involved. Shape and size of head and spear were remarkable consistent without much variation in all populations examined so far.

The question arose if one of these strains might be identical with *P. macrophallus*. Dr GOODEY was so kind to send freshly taken specimens from the field where he took his neo-type material of *P. macrophallus* in 1934. As the original meadow was ploughed up they could only be taken from the turf of an adjoining field road.

[1]) The word „strains" is used here to indicate morphologically distinguishable units, which are not yet described as species.

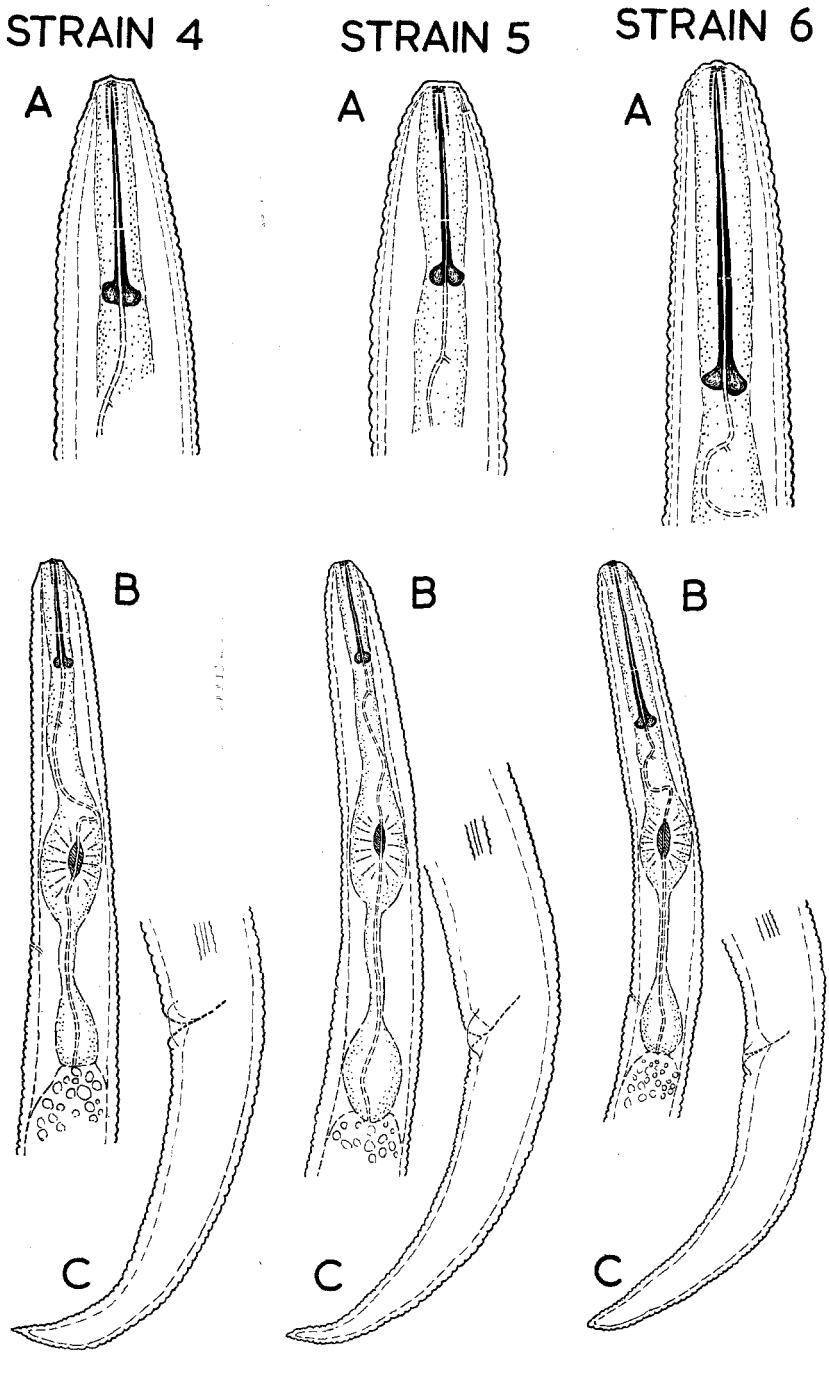

Fig. 1. 3 different *Paratylenchus* strains from the lawn, where also *P. goodeyi* n.sp. was collected. A – ♀ heads, 1500 ×; B – ♀ heads, 750 ×; C – ♀ tails, 750 ×.

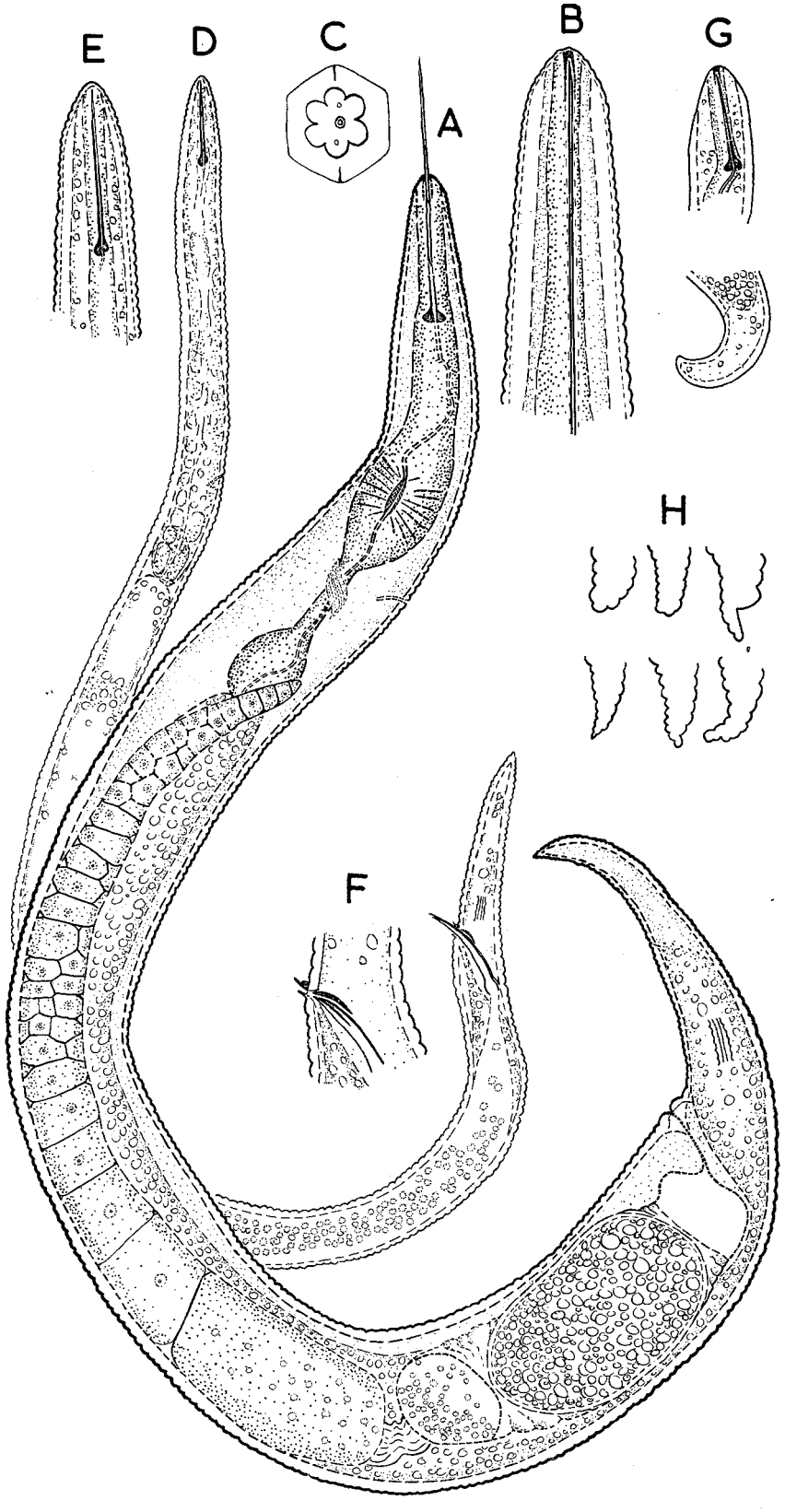

Fig. 2. *Paratylenchus goodeyi* n.sp. A – ♀, 750 ×; B – ♀ head, 1500 ×; C – ♀ face view, 1500 ×. D – ♂, 750 ×; E – ♂ head, 1500 ×; F – ♂ anal sheath, 1500 ×; G – larval

This population of about 20 females and larvae proved to be homogenous and differed distinctly from our *hamatus*-like populations by its coneshaped head with a somewhat protruding labial front and by its short spear of 17–19 μ. It fitted GOODEY's former description (1934) fairly well except that no great variability in body size and spear length did appear, as a comparison of the strains 2 and 3 of table 1 shows.

At this time a single exceptional *Paratylenchus* ♀ was remembered, collected from a lawn at Arnhem. The thick body and the narrow, tapered head differed conspicuously from all species in literature and it had a very long spear. A second sample from the same grass sod gave 10 ♀♀ with the same characters and also 1 *Paratylenchus* ♂ which was characterized by a thick anal sheath with dorsal extension and a head, nearly tapering to a point. This remarkable species is described hereafter as *P. goodeyi.*

A third sample of another spot in the same lawn however furnished a mixture of *P. goodeyi* and two short-speared strains. One of them closely fitted the English population sent by *Goodey*; the other differed in the more convex head without protruding labial front. Intensive sampling finally also revealed a few specimens of a strain close to *P. hamatus*, but differing from all *hamatus* strains mentioned before. The 4 strains of this mixture are provisionally headed in table 1 under *P. macrophallus* for comparison (strains 4 to 7, figures 1 and 2).

Thus this lawn contained, though irregularly distributed, several species together, as is known to be common with *Tylenchorhynchus, Pratylenchus* and *Heterodera species* in meadows. The *Paratylenchus* species in this mixed population were distinguishable on the shape of head, tail and body. In addition to these characters they proved to have their own fixed and rather constant spear length. It is evident from this study that spear length should be rehabilitated as a good specific character with low variability in *Paratylenchus.* This suggestion is strengthened by the literature data in table 1, which show a constant spear length in all species for which limits are recorded, except GOODEY's *macrophallus.*

Now it is very probable, that the population on which GOODEY based his redescription of *P. macrophallus* in 1934 was a similar mixture of species. Besides the English population GOODEY sent us (strain No. 3) possibly *P. goodeyi* was present, to account for the long spear, great body length and high β of some of his specimens, and probably also strains with a median spear like *P. hamatus*, for his description stresses the frequence of ♀♀ with spear length of 27–30 μ.

TYLENCHUS MACROPHALLUS DE MAN, 1880

In DE MAN's old collection, kindly made available to us by the keeper, Professor Dr H. ENGEL of the Zoological Museum at Amsterdam, no *T. macrophallus* slides proved to be present. Though DE MAN's descriptions and illustrations (1880, 1884) are not very elaborate for our circumstances, they reveal several conclusive data. He probably dealt with a *Paratylenchus*, as GOODEY (1934) already concluded, though it remains remarkable that he did not give an adequate drawing of the oesophagus of the ♀ notwithstanding the fact that he had several specimens. The ♀ and ♂ evidently belonged together considering the uniform shape of the heads. ♀♀ were rather slender with a flat head, a stout spear of about 28 μ (or possibly somewhat shorter as the tip is not drawn) and a slender, pointed tail. ♂♂ were probably not rare and had a distinct spear. The small bursa observed by DE MAN may have been the edge of the concave ventral

side of the tail, as THORNE (1950) indicated. But the high number of tail annules has probably been concrete, for DE MAN consciously mentions that this ♂ had a tail which was longer than the tail of the ♀, which character differs from other *Paratylenchus* species.

None of the 7 *Paratylenchus* strains met with up to now in the Netherlands fits the above mentioned characters of DE MAN's *macrophallus*, also not when the ♂ is left out of consideration. Also GOODEY's population (strain No. 3) does not fit it, though it still remains possible that his mixed population used for the redescription of *P. macrophallus* has comprised DE MAN's original species. It is probable though, that DE MAN's *macrophallus* has not been collected .

PARATYLENCHUS GOODEYI N. SP. [1]) (Nematoda, Criconematidae)

Female

Mean of 25: Length 408 (260–500) μ. Breadth [2]) 26 (11–46) μ. α = 17,2 (10,9–25,8). β = 4,2 (2,6–6,2). γ = 15,5 (11,1–21). V = 83 (78–88) %. Spear length = 51 (48–56) μ. Number of annules posterior to vulva 55 (44–64).

Largest species known. Fullgrown ♀♀ very stout, broad just before and suddenly narrowing behind the vulva (fig. 2 A). Tail gradually tapering to a convex cone. The shape of the tip may show much variation and may even be truncate just behind the anus, thus influencing the body length and γ considerably (fig. 2 H). Anteriorly the body tapers rapidly in the oesophageal region, ending without constriction in a narrow head with sloping sides and a slight elevation on top (fig. 2 B). Hexagonal symmetry seen in face view (fig. 2 C). Old, exhausted ♀♀ generally folded and transparent. Young ♀♀ slender and with the same general body shape as most other *Paratylenchus* species.

Cuticle striae distinct but very fine near head and tail tip. Coarser on the rest of the body, varying from 1 μ in young to 2 μ in swollen specimens, eventually quite straightened in the latters. Sloping head with several faint annules, also on the central head elevation according to face view. Lateral field on each side running from head to tail tip, taking about 1/5 of the body width in young and less in swollen ♀♀. It begins with one line on top of the head and splits on the neck into 4 bright lines. It is broadest near the vulva and then suddenly narrows posteriorly.

Buccal cavity about 4 μ deep with thickened ring on top, serving as a spear guide. Spear constantly very long and slender, sharply pointed, flexible and occasionally twisted. Is sometimes protruded very far and then easily breaks in handling the specimens. Spear knobs broad, but not massive, sometimes reaching into median bulb. Oesophagus as in fig. 2 A. Dorsal gland orifice $\pm$ 8 μ behind spear knobs. Glandular basal bulb distinctly separated from the intestine. Intestine well stocked with fat globules, unless in old, exhausted ♀♀. Anus scarcely visible, on about 2/5th distance from tail tip to vulva.

Vulva conspicuous with thick, somewhat protruding lips. Lateral vulva membranes present, but lower than lips and therefore hardly visible. No post-

[1]) The species is named after the late Dr T. GOODEY, who probably was the first who handled specimens of this species when he studied his neo-type material of *P. macrophallus* in 1934.

[2]) Specimens with a body width of more than 30 μ may be somewhat flattened, as some supports in the slides had this size. If for all thicker specimens the minimum width of 30 μ is calculated, the breadth becomes 24 (11–30) μ and the α 18.1 (13.8–25.8), whereas extremes of β remain the same. So the general picture is not influenced by eventual flattening.

Table 1. Summarized morphological data of described *Paratylenchus*-
α = length: breadth, β = length: length of oesophagus, γ =
Figures in italics are calculated or taken by the

Paratylenchus species and strains, consecutively numbered	♀							
	Specimens measured	Length in u	α	β	γ	V in %	Number of postvulvar annules	Spear length in u
1. *P. macrophallus* (DE MAN, 1880) GOODEY, 1934. After DE MAN		370	23–25	3,5–3,8	12,5–13,5	*83*		*27?*
2. After GOODEY		311–497	16,0–24.4	*4*–7,4	10,5–12	79–85	±*40*	15–56
3. English strain (loc. cit.)		313–359	17,7–23,6	3,6–4,2		84–85	42–48	17–19
4. Dutch strain from mixture Arnhem (loc. cit.)	10	300–390	20,3–28,4	3,4–4,4	±11	81–84	±55	17–19
5. Dutch strain from mixture Arnhem (loc. cit.)	15	315–375	18,8–25,5	3,7–4,9	10,3–14,3	81–84	±55	15–19
6. Dutch strain from mixture Arnhem (loc. cit.)	5	290–370	21,7–27,3	3,5–4,3	±13	83–85	±50	27–30
7. *P. goodeyi* n.sp. from mixture Arnhem (loc. cit.)	25	260–500	10,9–25,8	2,6–6,2	11,1–21	78–88	44–64	48–56
8. *P. bukowinensis* MICOLETZKI, 1922	1	390	20,5	4,3	16,8	84	±*60*	±*26*
9. *P. nanus* COBB, 1923	2	360–410	*17,9–22,2*	*3,2–4,2*	*14,3–23,8*	*82–83*	±*20?*	*34–36*
10. *P. anceps* COBB, 1923	1	280	*18,9*	*2,94*	*13,5?*			*67*
11. *P. besoekianus* BALLY & REYDON, 1931	6	242–269	17,5–19,4	3,3–3,9	12,0–18,6	81–87		±*19*
12. *P. curvitata* VAN DER LINDE, 1938		330	23,8	3,7	16,4	81–87	±42	24
13. *P. elachistus* STEINER, 1949		234–304	16,9–23,5	3,6–4,2	10,5–15	82–87		21–22
14. *P. minutus* LINFORD, 1949		240–310	16–24	3,4–4,1	12–18	80–84		16–21
15. *P. hamatus* THORNE & ALLEN, 1950		350–400	17	4,3	15	84	±*40*	28

species and of the strains in a natural mixture discussed in this paper.
length: length of tail, V = vulva position in % of the body length.
present author from original data or drawings.

Additional data on ♀ and ♂ and host or habitat
Head truncated conical; tail slender, acute. ♂♂ probably not rare, 330 μ, slender (α = 27–28), with distinct spear and long tail with many annules ($\pm$ *50*) and probably with small bursa. In meadows (DE MAN, 1880, 1884).
Head truncated conical; tail slender, acute with generally a fine process; spear very variable in length. Eggs (50–60) × (18–20) μ. ♂♂ rare, 320–420 μ, stout (α = 21–23.5), with faded spear, with $\pm$ *21* tail annules, without a bursa. In, on and around grass roots (GOODEY, 1934, 1951).
Head truncated conical with protruded labial front; tail generally acute, sometimes with fine process; spear length constant. No ♂♂ found. In soil around grass roots.
Head truncated conical with protruded labial front; tail generally acute, sometimes with fine process; spear length constant (fig. 1). No ♂♂ found. In soil around grass roots.
Head continuous with body contour, convex with broad, flat labial front; tail with slender tip, subacute to very sharp; spear length constant (fig. 1). Eggs long and slender: (43–64) × (12–19) μ. No ♂♂ found. In soil around grass roots.
Head continuous with body contour, round and with distinct lip annules; tail clumsy, blunt. Spear length constant (fig. 1). No ♂♂ found. In soil around grass roots.
Head rapidly tapering to narrow, rounded lip with central elevation; tail with varying tip, body very stout, spear contantly long, reproductive system typical (fig. 2). Eggs stout (38–55) × (22–25) μ. ♂♂ rare, slender (α = 32.8); with tapering head, distinct spear and thick anal sheath with dorsal extension. In soil around grass roots.
Head truncated conical; tail clumsy, subacute; postvulvar uterine sac perhaps present. Eggs probably slender. No ♂♂ found. On grass roots (MICOLETZKI, 1922).
Head convex-conoid and gradually tapering with narrow, rounded labial front; tail conoid, blunt; spear firm with stout, round knobs. Egg 60 × 20 μ. No ♂♂ found. Around grass roots and in roots of *Zinnia elegans* (COBB, 1923; STEINER, 1924).
Head truncated with broad labial front; tail very blunt; oesophagus and spear very long. This concerns a young ♀ and larvae. No ♂♂ found. On roots of *Umbellularia californica* NUTT. (COBB, 1923; THORNE & ALLEN, 1950).
Head truncated; tail subacute, small postvulvar uterine sac recorded. ♂♂ not rare, 220 μ, slender (α = 29,4), with faded spear. In and around roots of *Coffea* sp. (BALLY & REYDON, 1931).
Head steeper than tapering neck, distinctly set off as a truncated cone; tail clumsy, subacute. ♂♂ unknown. On roots of *Phlox* and other plants (VAN DER LINDE, 1938).
Head smooth, somewhat rounded; tail subacute; ovary sometimes reaching to nerve ring. ♂♂ not rare, 228–248 μ; α = 23,6–30,5; with clumsy tail and faded spear. On roots of *Boehmeria nivea* (L.) GAUD. (STEINER, 1949).
Head probably rounded; tail slender, subacute. ♂♂ not rare, 220–270 μ; α = 22–27; with faded spear and with thick anal sheath. In, on and around roots of *Ananas comosus* (L.) MERZ and many other plants (LINFORD, OLIVIERA & ISHII MAMORU, 1949).
Head rounded; tail gradually tapering to blunt terminus. Eggs (40–53) × (12–16) μ. ♂♂ not rare, 350–400 μ, rather stout (α = 24); with distinct spear, with $\pm$ *25* tail annules and with an anal sheath with dorsal extension. On and around roots of *Ficus carica* L. (THORNE & ALLEN, 1950).

uterine sac. Vagina heavily walled, enlarging to a spacious, firm, rather square chamber. Uterus massive, anteriorly ending in a solid, probably non-muscular, round spermatheca which is normally filled with sperms. Uterus may contain one egg at a time. Sperms also seen at other side of oviduct in first oogonium and may also be ample in exhausted females. Ovary single, prodelphic, normally outstretched, but may be reflexed or double reflexed or looped. Sometimes even passing the median bulb. In swollen females the ovary may push ahead the oesophagus, thus strongly influencing the β and relative position of excretory pore. The region of multiplication in the ovary may be 2–5 cells broad.

Excretory pore has an anterior position and is generally next to or just behind median bulb in undisturbed ♀♀. Phasmids not seen with certainty. Amphids observed in face view (fig. 2 C). Deirids distinct opposite excretory pore.

Male

One single specimen: Length 364 μ. α = 32,8. β = 3,9. γ = 10,5. Spear = 15 μ. Spicules = 21 μ. Gubernaculum = 4 μ. Number of tail annules = 26.

Comparatively large and slender. Spear distinctly visible. Oesophageal structure faint and degenerate. Thick anal sheath with dorsal extension, which is conspicuous in living specimen with retained spicules. Numerous sperms of about 1 μ in body. Tail pointed, with 26 annules. Intestine poorly stocked with fat globules. Comparable with ♂♂ of *P. macrophallus* and *P. hamatus*, but differing by its narrow head which nearly tapers to a cone. ♂♂ are probably rare and only one specimen was found against many ♀♀. It was evident that this ♂ belonged to *P. goodeyi* on account of the adequate head and the absence of other species in the sample, though other *Paratylenchus* species were present in the same field. (Fig. 2 D, E and F.)

Egg

(38–55) × (22–25) μ. Thicker and less oblong than known with other species. A well defined larva with 4 flexures may be present in egg in the uterus; first moult observed in egg.

Larva

l_2 in egg showed spear of 12 μ with knobs of the same shape as with fullgrown ♀♀. Latter stages from soil samples, which probably belonged to this species on account of the typical shape of the head, all had a short spear below 20 μ (fig. 2 G).

Type specimens: Holotype female C 3; allotype male C 8; paratypes ± 50 ♀♀, in Plantenziektenkundige Dienst collection at Wageningen, the Netherlands.

Type habitat and locality: Grass turf under a pear tree in a lawn at Arnhem, the Netherlands.

Diagnosis: This species shows the generic characters of *Paratylenchus*, as indicated by MICOLETZKI (1922), THORNE (1949) and GOODEY (1951). It is, however, intermediate with the related genus *Cacopaurus* THORNE, 1943 (THORNE, 1943, ALLEN & JENSEN, 1950) in some characters, viz. the stout, sometimes nearly saccate body, the occasionally reflexed ovary, the presence of a broad chamber at one side and a spermatheca at the other side of the uterus.

The ♀♀ differ from other *Paratylenchus* species by the very narrow, tapering head and by the long flexible spear. Confer table 1. Only *P. anceps* seems to have a spear of comparable size. Of this species only one immature female and three

young larvae are known. They differ, however, conspicuously from specimens of about the same stage of our *P. goodeyi* in shape of head, tail, spear and lateral field. THORNE (1950) even suggests that *P. anceps* may be a *Cacopaurus*. ♂♂ of *P. goodeyi* are rare, have a distinct spear and an anal sheath with extension and are distinguishable on the narrow, tapering head.

SUMMARY AND CONCLUSIONS

1. In the Netherlands already seven different *Paratylenchus* strains resp. species have been found, but probably none of them is identical with the original *P. macrophallus* (DE MAN, 1880).
   One remarkable strain is described as *P. goodeyi* n. sp.; the others are provisionally headed under known species.
2. Spear length proved to be a useful specific character in addition to shape of head and tail in all strains encountered so far in this country. The presence of ♂♂ and the presence of a spear in ♂♂ also varied consistently between strains. α and β may show great variation when maturing ♀♀ swell considerably, as in *P. goodeyi*. Lateral vulva membranes, as indicated by THORNE & ALLEN (1950), were always present with the ♀♀ and a thick, anal sheath with dorsal extension with the ♂♂, so that these characters may be generic. The same was true for the presence of lip annules and of a lateral field with 4 lines.
3. GOODEY's redescription of *P. macrophallus* in 1934 is probably based on a mixture of species. A similar mixture is met with in the Netherlands and analysed in this paper.
4. Some described species of *Paratylenchus* may be synonyms of others, but in the case of *P. macrophallus* the present synonymy has probably gone too far. The genus evidently needs an over all revision, including the description of several commonly occurring new species.

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ACTUALITEITEN EN VOORLOPIGE MEDEDELINGEN

PHYTOPHTHORAROT VAN APPELBOMEN – Dr J. G. TEN HOUTEN. Sinds enkele jaren treden in Nederland rottingsverschijnselen aan de stambasis van ± 10 jaar oude appelbomen, speciaal van het ras Cox Orange pippin op, waarvan de oorzaak niet met zekerheid viel vast te stellen. Sommigen dachten aan een bacterieziekte, omdat bacteriën dikwijls uit de zieke bast geïsoleerd werden, anderen meenden met een virusaantasting te doen te hebben. Tijdens een bezoek aan Duitsland in Juli van dit jaar vertelde Prof. BRAUN te Bonn mij, dat men ook in de Rijnvlakte sinds 1945 appelbomen, vooral van ± 10 jaar oude Cox, vond, die een ernstig stambasisrot vertoonden. Hij had hieruit *Phytophthora cactorum* geïsoleerd, die bij infectieproeven dezelfde verschijnselen teweeg bracht. De foto's, die hij mij toonde, leken veel op het door ons in Nederland waargenomen aantastingsbeeld. Deze ziekte was reeds in de Verenigde Staten, Canada en Nieuw Zeeland beschreven resp. in 1939, 1942 en 1950, maar tot nu toe niet in Europa gevonden. Typisch is, dat in Plant Pathology van September j.l. vermeld wordt, dat deze ziekte ook in Engeland is geconstateerd. Onmiddellijk na terugkeer in Wageningen heb ik toen isolaties gemaakt uit de bast van zieke Cox-stammen uit een boomgaard te Maasbracht (L.) en uit een te Meerlo (L.). In beide gevallen gelukte het met bepaalde technieken een Phycomyceet te isoleren, die bij determinatie door het Centraal Bureau voor Schimmelcultures *Phytophthora cactorum* (LEB. & COHN) SCHROET. bleek te zijn. Hoewel nog infectieproeven genomen moeten worden, kan op grond van de buitenlandse ervaringen nu reeds als practisch zeker worden aangenomen, dat deze schimmel de oorzaak van de genoemde ernstige stambasisaantasting bij 10-jarige Cox is. Ik hoop hierover te zijner tijd een meer uitvoerig artikel te publiceren, waarin dan meteen de tot nu toe bekende bestrijdingswijzen zullen worden aangegeven.