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TAXONOMIC STUDIES ON THE GENUS *PRATYLENCHUS (NEMATODA)*[1]

Met een samenvatting:

Taxonomische onderzoekingen aan het Nematodengeslacht Pratylenchus

DOOR

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PREFACE

The following studies on the nematode genus *Pratylenchus* form a review supplementary to the pioneer work by SHER & ALLEN (1953), who put the taxonomy of the genus on a sound basis. For information not contained in the following pages, the reader is referred to their paper.

Many nematologists have assisted the author with helpful criticism and suggestions, information on various points or with nematode material. Sincere thanks are offered to Prof. Dr. M. W. ALLEN (Berkeley, California, U.S.A.), Dr. P. BOVIEN (Lyngby, Denmark), Dr. J. R. CHRISTIE (Gainesville, Florida, U.S.A.), Dr. H. GOFFART (Münster, Germany), Dr. W. R. JENKINS (College Park, Maryland, U.S.A.), Mr. J. KRADEL (Kleinmachnow, Germany), Prof. Dr. H. A. KREIS (Bern, Switzerland), Dr. D. PAETZOLD (Halle, Germany), Prof. Dr. B. RENSCH (Münster, Germany), Drs. A. F. G. SLOOTWEG (Lisse, Netherlands), Dr. G. STEINER (Rio Piedras, Puerto Rico), Prof. G. THORNE (Madison, Wisconsin, U.S.A.) and Dr. T. YOKOO, (Saga, Japan). Thanks are also due to Dr. D. NOORDAM (Wageningen, Netherlands), Dr. Ir. T. VISSER (Talawakelle, Ceylon) and the officials of the Plantenziektenkundige Dienst, Wageningen, Netherlands.

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A. GENERAL AND EXPERIMENTAL SECTION

I. INTRODUCTION

§ 1. The nematode genus *Pratylenchus* is of great phytopathological and economic importance. Most of the species have a wide distribution; all are endoparasites of subterranean (exceptionally of aerial) parts of plants, where they may occur in considerable numbers. They cause dark necrotic spots (lesions) on the infested parts, or small pustules; in other cases, however, no visible symptoms are produced. They propagate in the roots, rhizomes and tubers, but there are some indications, that at least some of the species may also reproduce free in the soil (THORNE, 1939). Most species are polyphagous; a few, however, are known from only one host plant, e.g. *P. goodeyi* from banana.

The distribution of the *Pratylenchus* species seems to be chiefly determined by climate: some species occur in the tropics, others in the temperate zones. Soil type is known to influence the occurrence of a few species.

§ 2. Nematodes of this genus have been systematically collected and studied since 1952 at the Plantenziektenkundige Dienst (Wageningen, Netherlands). Some species prove to be of economic importance in the Netherlands, others are considered suspect; a synopsis was given by OOSTENBRINK (1954). In the course of time specimens have been found which did not fit too well the descriptions of known species, and it therefore seemed worth while to make a taxonomic study of this group, as a base for further phytopathological research and for advisory work.

§ 3. Since 1880, the year when the first species of *Pratylenchus* was described by DE MAN under the name *Tylenchus pratensis*, a fair number of species has been described. The taxonomy of the genus was extremely confused, chiefly because the identity of the type species *Pratylenchus pratensis* (DE MAN) was not unambiguously established. Numerous reports on *P. pratensis* really refer to other species; this fact lessens the value of a great part of the older literature, except of those publications that gave a description of the species under consideration.

In 1949 THORNE redescribed *P. pratensis*, and in 1953 the revision of the genus by SHER & ALLEN was published. This paper helped a great deal to create order. The authors recognized ten species, three of which were described as new. One species was not treated *(P. tumidiceps* MERZHEEVSKAYA, 1951); two were left species inquirendae *(P. sacchari* (SOLTWEDEL, 1888) and *Dolichodorus heterocercus* KREIS 1930).

Since 1953 six new species and two new varieties have been described, viz. *P. steineri* LORDELLO, ZAMITH & BOOCK, 1954; *P. hexincisus* TAYLOR & JENKINS, 1957; *P. subpenetrans* TAYLOR & JENKINS, 1957; *P. delattrei* LUC, 1958; *P. convallariae* SEINHORST, 1959; *P. helophilus* SEINHORST, 1959; *P. pratensis var. tenuistriatus* MEYL, 1953 and *P. pratensis var. bicaudatus* MEYL, 1954.

Thanks to the paper by SHER & ALLEN, a sound basis for further work existed. As their revision contains good historical, morphological and biological sections, and as it is easily accessible, most elementary questions and features need not be discussed here once more. Unless stated otherwise, the interpretation of names and descriptions, given by SHER & ALLEN, is followed hereafter.

§ 4. The genus *Pratylenchus* was erected by FILIPJEV in 1936. It is true that the name was already published in 1934, but at that time no generic diagnosis was given; only the type species was indicated. Article 25-c of the International Rules of Zoological Nomenclature states that „No generic name... published after December 31, 1930, shall have any status of availability (hence also of validity) under the Rules, unless and until it is published either

1. with a summary of characters (seu diagnosis; seu definition; seu condensed description) which differentiate or distinguish the genus... from other genera...;
2. or with a definite bibliographic reference to such summary ...;
   And further: 3. ...with the definite unambiguous designation of the type species..." (Cited after SCHENK & MCMASTERS, 1948).

Pratylenchus FILIPJEV, 1934 does not fulfill the requirements 1 and 2, and must therefore be regarded nomen nudum. In 1936 the name *Pratylenchus* was published almost simultaneously in two papers (FILIPJEV, 1936-A and 1936-B). It was not possible to find out which appeared earlier (See LOOF & OOSTENBRINK, 1958).

§ 5. The nematodes belonging to the genus *Pratylenchus* are of small size (300–900 μ, usually about 500 μ). Their chief morphological characters may be summarized as follows (The DE MAN system of measurements is used in the following sections; see DE MAN, 1880 and 1884):

a. Stylet short (11–22 μ) and stout, with strong basal knobs.
b. Oesophagus with distinct median bulb containing conspicuous valves; glands forming a rather short lobe which ventrally overlaps the intestine.
c. Lip region low, with well developed sclerotized framework.
d. Body stout to moderately slender (a = 15–40, usually about 25).
e. Body annulation not prominent; cuticle possessing but little rigidity.
f. One ovary, outstretched anteriorly; vulva situated far posteriorly (67–89 %). A short rudiment of the second gonad is present caudal of the vulva.
g. Female tail two to three times as long as anal body diameter, with more or less rounded tip.
h. Males with normally developed stylet and oesophagus; with one testis; bursa well developed, enveloping tail.

The nearest relative of *Pratylenchus* is probably *Pratylenchoides* WINSLOW, 1958, which genus differs from *Pratylenchus* chiefly in the following points:

a. Average size slightly larger.
b. Vulva placed about equatorially; two ovaries present.
c. No endoparasitic mode of life, as far is known.

II. Taxonomic characters

§ 1. The identification of *Pratylenchus* species is usually carried out with females. They possess more diagnostic characters than males, which, moreover, in several species are rare or unknown (and perhaps non-existent). The males will be discussed shortly in a later chapter; what follows now refers to females.

The species belonging to this genus are much alike. Morphological diversity is conspicuously less than in genera like *Tylenchorhynchus, Tylenchus, Ditylenchus* or *Psilenchus*. Spear length is about the same in all species; longitudinal striae on the cuticle do not occur; tail shape is in all species of the same gross type. The measurements differ only slightly. Intraspecific variability, on the other hand, may be very great.

§ 2. The chief diagnostic features established and used by Sher and Allen are the following:

a. The number of annules in the lip region. This is a good and comparatively easy character. The number may be two, three or four. When two, they are easily recognizable. In species with more, the annules may not be sharply discernible.
b. The shape of the tail. In some cases this is a good and reliable character, but in others it should be used with caution, because of the great intraspecific variability.
c. The position of the vulva. This is a good and relatively little variable feature. In many species the ranges of vulva position overlap, but even then the differences between the means may be statistically significant.
d. The length of the posterior uterine branch. Usually this part is short and undifferentiated; in a few cases, however, it is longer and carries a rudimentary ovary, which is a good character in these cases.
e. Size. This is extremely variable, being strongly influenced by external conditions. It may be a good character in a few cases. It should be kept in mind, that fixed and mounted specimens are 5–22% (usually 10–15%) shorter than fresh ones.
f. The presence or absence of males. This feature is more important than would appear from its use in Sher & Allen's key. When males occur frequently, the females possess a spermatheca, the shape of which often is taxonomically important. In species where males are rare or unknown, the spermatheca is lacking.
g. The shape of the spear knobs. This character can only be used in a few cases and should be handled with caution, especially when studying fixed and mounted specimens, in which the spear knobs often become indistinct and may disappear in the course of time.

§ 3. In 1957 TAYLOR & JENKINS published a paper containing a critical consideration of the taxonomic value of the coefficients L, V, a, b and c, and of the shape of the tail tip. They concluded that V varies very little and can be regarded as a reliable taxonomic character. The other coefficients and the tail shape have a much greater variability and should be used with caution.

§ 4. During the present investigations the possible taxonomic value of ovary length and lateral field was examined.

Ovary length is usually included in nemic measurements as percentage of body length. Sometimes it is used as a taxonomic character, e.g. in the Enoplida. SHER & ALLEN give for the relative length of the ovary lower values in *P. pratensis* (sensu THORNE), *P. zeae* and *P. thornei* than e.g. in *P. vulnus*. The author has observed the following data.

According to SHER & ALLEN, ovary length in *P. scribneri* is 31–45% and the gonad does not extend to the oesophagus. The writer examined material kindly supplied by Dr. CHRISTIE, from the same population that had been used by SHER & ALLEN, and found ovary length to be 31–66%, mean 53%; in most females the ovary originated in the region of the basal oesophageal lobe or even still further forward. These females either contained eggs or had the oviduct distended. Their bodies were long and thick, resulting in the lateral field being generally no longer visible. The population also contained a few smaller and more slender specimens. These had no eggs, the oviduct was not distended, the lateral field was easily visible and the gonad was short. This suggests that after the last moult the females continue to grow somewhat, but that the ovaries grow considerably.

A further striking point was that in most *Pratylenchus* populations studied most of the females were at about the same developmental stage. In the Florida population of *P. scribneri* and in the Japanese population of *P. coffeae* nearly all the females were in the egg-laying stage. In other populations not a single egg-bearing female occurred.

In *P. coffeae* the same differences between young and older females were observed. In *P. crenatus* on the other hand, the eggbearing females seen had as short an ovary as the younger ones. Thus it is possible that in some cases ovary length may be of taxonomic importance, but the life cycle of all *Pratylenchus* species must be more completely known before the value of this character can be decided.

§ 5. *Lateral field*

Literature data. Comparatively little attention has been paid so far to the structure of the lateral field in *Pratylenchus*. Most older authors (DE MAN, 1880 and 1884; COBB, 1919; GOODEY, 1932; FILIPJEV en SCHUURMANS STEKHOVEN, 1941) do not discuss the structure of this part of the body.

The presence of four longitudinal incisures was established by COBB (1917) in *P. scribneri* (illustration) and COBB (1920) in *P. mahogani* („... two wings consisting of two double lines").

The presence of more than four incisures was observed for the first time by STEINER (1927) in *P. penetrans* (called *Tylenchus pratensis* at that time). He wrote: „... the space between the wings also shows longitudinal striae, at least one on each side. In one specimen a much larger number was seen in the vulvar region".

SHER & ALLEN give many more details on the lateral field, although they do not consistently use it as a taxonomic character. In the general part they state that there are basically four incisures, but on some specimens of certain species four to six may be counted immediately before the vulva. The systematic section of their paper shows the following species to belong to this group: *P. pratensis* (sensu THORNE), *P. brachyurus* and *P. minyus* (see their plate 65, fig. N). In all other species treated they state the presence of four incisures, extending past the phasmid; the last mentioned statement being absent only in *P. scribneri*, the only species in which the presence of four incisures is given as a taxonomic character.

LORDELLO, ZAMITH & BOOCK (1954) distinguish their new species *P. steineri* from *P. minyus* among others by its lacking the oblique striae in the central zone of the lateral field in the vulvar region, which are present in *P. minyus*.

In 1957 TAYLOR & JENKINS described a new species *P. hexincisus*, which was stated to differ from all other species by the presence of six incisures.

Own observations. Usually the lateral field is difficult to observe in *Pratylenchus* species. In order to be able to distinguish details, one must use a very high magnification and light intensity. In stout specimens the lateral field may be not visible at all, owing to the cuticle being stretched (cf. § 4). Generally speaking, the stronger the cuticular annulation, the more easily seen is the lateral field.

Careful examination of large numbers of fresh and mounted specimens of all *Pratylenchus* species available showed that the following types may be recognized:

a. The lateral field contains four incisures and nothing more. This type is found predominantly in species with weak cuticular annulation, e.g. *P. penetrans*, *P. thornei*, *P. goodeyi*, *P. scribneri*. According to literature, it also occurs in *P. zeae*, *P. steineri* and other species. The outer incisures are smooth or at most weakly crenate (Fig. 1B). Usually the four incisures run at approximately equal distances from each other; sometimes the distance between the inner incisures is greater than that between these and the adjacent outer ones. In *P. vulnus* the reverse occurs.
b. There are four main lines; of the three zones between them the central one bears sculpture, which may extend from the level of the hind end of the oesophagus to just beyond the vulva. This sculpture may be distinguished as follows:

   1. Oblique striae, rather short and congested (Fig. 1A);
   2. Striae parallel to main incisures, forming two rows between the inner ones,

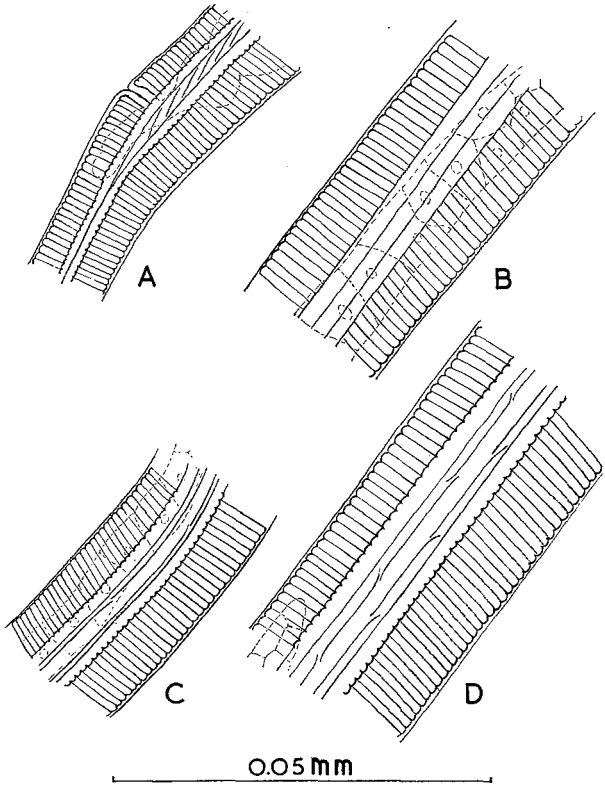

FIG. 1. A: *Pratylenchus neglectus*, lateral field in vulvar region. B: *P. penetrans*, lateral field in ovarial region. C-D: *P. crenatus*, lateral field in ovarial region.

thus giving the appearance that six lateral lines are present. Often the ends of these striae are somewhat bent outwards or inwards (Fig. 1D); the rows may, however, also appear uninterrupted (Fig. 1C). This form occurs in two variants:

2.1: six lines all over;

2.2: rows of striae broken up in vulvar region into oblique striae as in 1.

3. Striae parallel to main incisures, forming one row, so that five lateral lines appear to be present. Here again there are two variants:

3.1: five lines all over;

3.2: row broken up in vulvar region into oblique striae.

Within one and the same species several of these forms may be found. In b-1 and b-2 the outer incisures are usually strongly crenate; these forms occur in *P. crenatus* (predominantly b-2.1 and b-2.2), *P. neglectus* (b-1 and b-2.2) and *P. hexincisus* (b-2.1 and b-2.2). In *P. crenatus* the intervals between the six incisures are alternately wider and narrower; in *P. hexincisus* they are about equal in width. Thus the presence of six lateral incisures is not confined to the last mentioned species.

Now it is remarkable that occasionally specimens occur of species belonging to the first main type – four incisures only – that also show sculpture in the middle lateral zone, usually type b-1. As mentioned above, STEINER found this phenomenon in *P. penetrans*. The author has seen such specimens of *P. penetrans* (b-1), *P. thornei* (b-1), *P. loosi* (b-1) and *P. coffeae* (b-1 and b-2.2).

The reverse also occurs. In fat specimens of *P. crenatus*, *P. neglectus* and *P. hexincisus* sometimes only four lines are visible. This phenomenon proved important for the solution of a taxonomic problem: *P. neglectus* (4 incisures) was found to be conspecific with *P. minyus* (type b-1).

Variants b-3.1 and b-3.2 seem to occur only in specimens of the first main type. The writer has seen them in *P. penetrans* and in *P. scribneri*. SHER & ALLEN state that in *P. brachyurus* occasionally five lateral incisures may be seen in the prevulvar region. From the accounts of STEINER (1949) and LORDELLO, ZAMITH & BOOCK (1954) it is clear that this species belongs to type a (four incisures only), which supports this view.

The above data suggest that types a and b differ only in degree. Some sculpture may always be present between the inner incisures, but in species with weak body annulation it probably is visible only exceptionally, and chiefly in young females.

The structure of the lateral field is not known in *P. tumidiceps*, *P. sacchari*, *Dolichodorus heterocercus*, *P. pratensis var. tenuistriatus*, *P. pratensis var. bicaudatus* and *P. coffeae var. brevicaudatus*.

Discussion. In respect to the structure of the lateral field *Pratylenchus* differs notably from other genera such as *Tylenchorhynchus* (cf. ALLEN, 1955) or *Aphelenchoides* (cf. ALLEN, 1952, FRANKLIN, 1957 and HOOPER, 1958), within each of which occur several really distinct types (4–5–6 and 2–3–4 lateral incisures, respectively). In *Pratylenchus* such sharp distinctions are impossible; intraspecific variability, on the other hand, is very great in this genus. Thus the lateral field shows once more, that the *Pratylenchus* species are closely related to each other and possess only few sharply differentiated morphological characters.

Nevertheless, the occurrence of the different modifications discussed above has some taxonomic importance. Thus, among the species with three head annules and an annulated tail tip, *P. crenatus* is distinguished from *P. pratensis* and *P. convallariae* by the six incisures. The same character separates *P. hexincisus* from *P. scribneri*, while the shape of the sculpture distinguishes the former species from *P. neglectus*. It is, of course, desirable to study whole populations, not single individuals.

III. THE IDENTITY OF TYLENCHUS PRATENSIS DE MAN

§ 1. *Introduction*

The identity of the species described by DE MAN as *Tylenchus pratensis* has up to the present been uncertain. COBB (1927) and STEINER (1927) synonymized

it with *T. penetrans* COBB, 1917; T. GOODEY (1932) with several other *Pratylenchus* species. In 1949 THORNE redescribed it from what he assumed to be the type locality, viz. Sydenham, England („... Sydenham ... where DE MAN made his type collection"). His interpretation was accepted by SHER & ALLEN, who designated one of the specimens as neotype. THORNE remarks about this material: „These specimens so closely resemble the type description that there appears to be no doubt concerning their identity".

However, Sydenham is not the type locality. As will be shown below, *Tylenchus pratensis* was described from Holland. This means that the neotype designated by SHER & ALLEN is invalid.

Also there appear to be some discrepancies between the description and illustration by THORNE 1949 – SHER & ALLEN 1953 on the one hand, and by DE MAN on the other.

For all these reasons it seemed necessary to examine once more the problem of the identity of DE MAN's species.

§ 2. *Type locality*

The original description of *Tylenchus pratensis* was published in 1880, in a paper called „Die einheimischen, frei in der reinen Erde und im süssen Wasser lebenden Nematoden".[1] Only females were known at that time. In 1881 DE MAN described the male. In the book of 1884 the species was again treated, and also figured. This book is entitled: „Die frei in der reinen Erde und im süssen Wasser lebenden Nematoden der niederländischen Fauna".[2]

In 1880 DE MAN said of this species: „Eine nicht häufige Art, welche die feuchte oder sandige Erde unserer Wiesen und Marschgründe bewohnt".[3] In 1884 this statement was modified as follows: „Dieses Thier ist gar nicht häufig und bewohnt die feuchte reine oder mehr sandige Erde der Wiesen und Marschgründe".[4] It is followed by the indication: „Geographische Verbreitung: England (Sydenham)." These statements are to be interpreted as follows.

The titles of the 1880 and 1884 publications clearly show that DE MAN is dealing with the Dutch nematode fauna. On page 19 of the 1884 book he explains, that, in order to gain information on the geographical distribution of the nematodes, he had asked several colleagues from foreign countries to send him soil samples. In this way he received soil from Sydenham, sent to him by OERLEY in September 1881. This sample contained several nematode species, among them *Tylenchus pratensis*. Thus it is clear that the original description was made from Dutch specimens and that the type locality must lie in the Netherlands. Wherever in the systematic part of the 1884 book the phrase „Geographical Distribution" occurs, it signifies that the species in question has

[1] The free-living soil and freshwater nematodes of our country.

[2] The free-living soil and freshwater nematodes of the Dutch fauna.

[3] An uncommon species, which inhabits the moist or sandy soil of our meadows and marshes. (Note the word *our*).

[4] This animal is not at all common and inhabits the moist, pure or more sandy soil of the meadows and marshes. (Note the word *the*).

also been found in other countries besides Holland. This is stated plainly in a footnote on page 30.

Comparison of the 1880 and 1884 descriptions shows that these foreign specimens were not used for morphological purposes. Now DE MAN found no females of *T. pratensis* after 1879 (see below), so that the 1884 description and illustrations were based on the same female specimens as the 1880 description and have to be regarded as the first valid emendation of the latter.

§ 3. *Type specimens*

In 1880 no special record is given of specimens. In 1884 DE MAN states: „Ein erwachsenes Weibchen traf ich in Februar, ein jüngeres in April an, während das einzige beobachtete Männchen in September aufgefunden wurde".[1]

As mentioned above, the male was found after the 1880 paper had gone to press. Several passages of the 1880 paper (two values given for each of the coefficients a and b; species stated to have been found in two types of soil) indicate that both females mentioned above were found before 1880. So there are two type specimens. However, one of them was full-grown, the other younger. It is known that DE MAN based his species descriptions mainly on full-grown specimens. The length given for *T. pratensis* (0.6 mm) is obviously that of the larger specimen. So we may conveniently temporarily distinguish the two females as holotype and paratype, and confine our attention to the former, thus obviating the danger of discussing a species mixture.

In a notebook with data, used by DE MAN for the 1884 book, four localities are given for *T. pratensis*, viz. Leiden, Scheveningen, Walcheren (three localities in The Netherlands) and Sydenham. Walcheren was the locality of the male (see DE MAN, 1881), thus the type specimens came from Leiden and Scheveningen. Happily we can determine the holotype locality, for the legend to the 1884 illustration contains the statement: „... ein 0.6 mm langes Weibchen aus feuchter Erde unweit Leiden."[2] So we may conclude that the holotype locality is moist meadow, Leiden; the paratype came from sandy soil, Scheveningen.

As the Sydenham nematodes were not collected until 1881, specimens of *T. pratensis* originating from this locality have no type status.

§ 4. Comparison of the descriptions of THORNE 1949 – SHER & ALLEN 1953 with those of DE MAN (1880 and 1884).

The following points call for comment:

1. Vulva position. DE MAN says: „slightly over 3/4"; the illustration shows 78%. THORNE gives 82%, SHER & ALLEN 80–85%. The present author found in *pratensis* of THORNE (determined bij Prof. ALLEN) 80–86%, usually 81–84%. Out of many hundreds of specimens studied, only two small ones were found to have the vulva slightly before 80%. The difference from DE MAN's

[1] I found a full-grown female in February, a younger one in April, while the only male observed was met with in September.

[2] A female, 0.6 mm long, from moist soil near Leiden.

value is small, but the work of TAYLOR & JENKINS (1957) has shown that vulva position is a reliable and relatively little variable character.

2. Body length is given bij DE MAN as 0.6 mm and the same value was computed from his figure. THORNE's species is usually much smaller, only the largest specimens attaining a length of about 600 μ. DE MAN's measurements were computed from fresh specimens (see DE MAN, 1884, p. 6), but even the largest fresh specimens of THORNE's species seen by the author measured 587 μ, the majority being under 500 μ.
3. Connected with points 1 and 2 is the large distance between vulva and anus in DE MAN's holotype, viz. 103 μ. In THORNE's species the author never found a value larger than 85 μ, neither in fresh nor in fixed and mounted specimens. Theoretically, a female combining the three extreme values given by SHER & ALLEN (L 600 μ, V 80 %, c 24) might reach 95 μ.
4. DE MAN drew a smooth tail tip. In THORNE's species it is distinctly and coarsely annulated, which feature can be established even at a magnification of 450, the tip annulation being at least as strong as the body annulation.

   Comparing DE MAN's drawings of *Tylenchus robustus* (Fig. 92) with those of *T. lamelliferus* (Fig. 94), we find that in the former species the tail tip is drawn as striated, in the latter smooth. (Fig. 2). Actually, however, it is annulated in both species, but in *T. lamelliferus* the tip annulation is much less distinct than that on other body parts. Thus DE MAN's holotype might have had a striated tail tip, but in that case the annulation was probably weaker than elsewhere on the body.
5. DE MAN drew a conical tail with rather narrowly rounded tip. THORNE's species has a broadly rounded, often even spatulate tip. The position of the anus in DE MAN's Fig. 95-B is against the supposition that this drawing represents a subdorsal view. It must be remarked that there seems to be a slight difference in shape between the two female tails of Fig. 95 and Fig. 95-B, but it is difficult to be sure because of the small size of Fig. 95. Even assuming that Fig. 95-B represents the tail of the paratype, it is logical to assume that the holotype did not have a broadly rounded and coarsely annulated tail tip.
6. DE MAN's holotype came from a moist meadow near the town of Leiden. In this neighbourhood three soil types occur, viz. dune sand, submerged peat and river clay. It was in the last type that the nematode fauna was found to resemble most closely the species list given by DE MAN. THORNE's species is partial to light sandy soils and was found only rarely around Leiden. That DE MAN found only one female here, is obviously connected with the fact that he only examined soil samples, not roots.
7. DE MAN figured the ovary as rather short, with an abrupt anterior ending. There is nothing in THORNE's species that might explain this.

§ 5. *Material in the collection*

The nematode specimens on which DE MAN based his papers of 1880, 1881 and 1884, are gathered into a separate part of his collection, the so-called

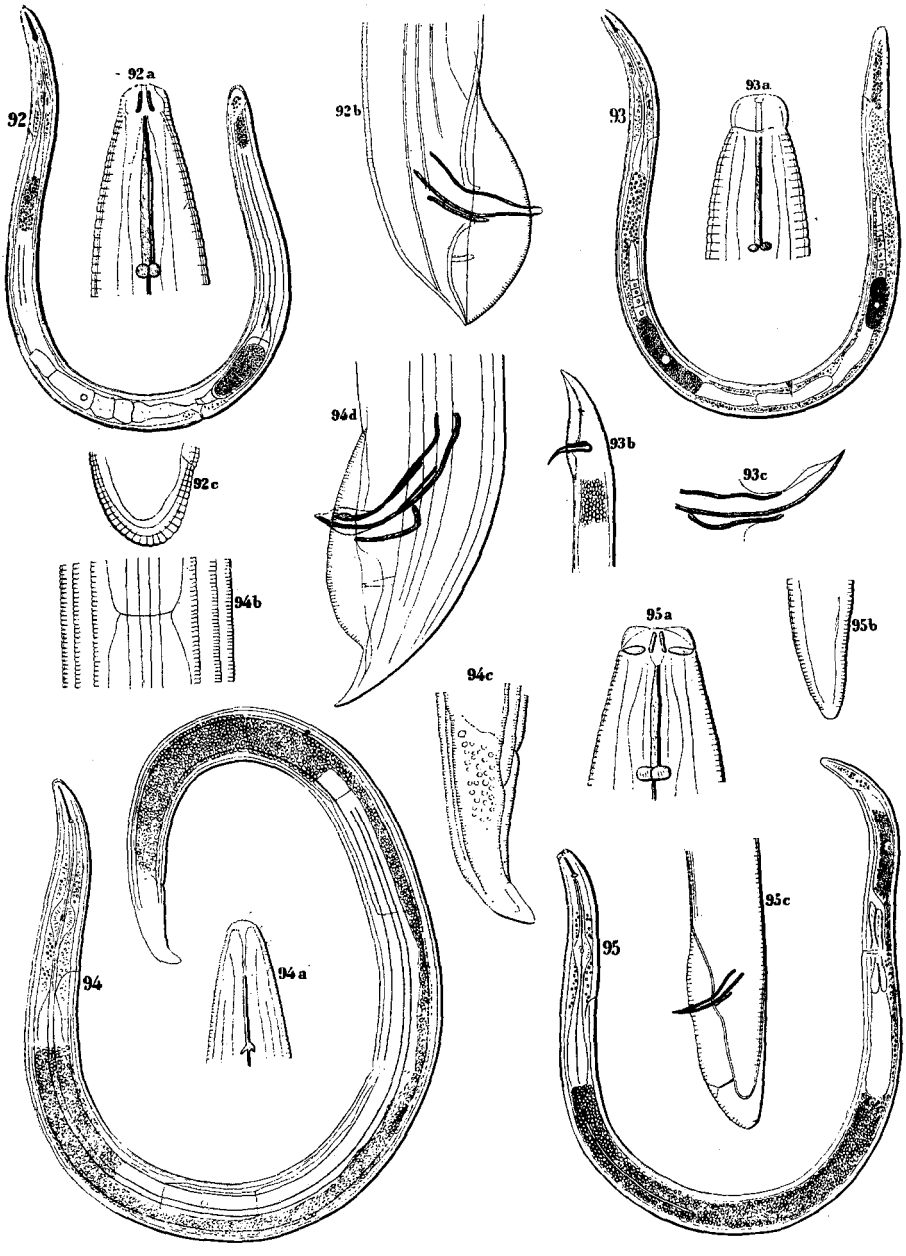

FIG. 2. Page of illustrations from DE MAN, 1884 (By courtesy of E. J. Brill, Publishers, Leiden).

„Hollandsche Collectie" (See LOOF & OOSTENBRINK, 1958). This collection, catalogued by DE MAN himself, contains one slide labelled *Tylenchus pratensis* by DE MAN. It does not bear indications of date or locality. The one female it carries is in good condition, owing to its having been surrounded by the „Judaic bitumen" with which DE MAN sealed his slides and which had here penetrated rather far under the coverglass.

Practically all the specimens in the collection of species which DE MAN described in 1880 are labelled n. sp., but the slide bearing the female of *T. pratensis* is labelled „*Tylenchus pratensis* DE MAN". All slides bearing specimens originally described in 1876 are similarly labelled with the author indication DE MAN. The inference from this state of affairs is that the slide bearing *T. pratensis* is not the type specimen, because that should bear the indication n.sp. It seems reasonable to suggest that the specimen may be one of the Sydenham ones. Its identity will be discussed later as we are here only concerned with the type specimens.

§ 6. *Identity of De Man's „holotype"*

Many features of DE MAN's description have already been mentioned in § 4. Some others that are of importance are the very short tail (c = 25) and the shape of the lip region, which is rather high and thus suggests that it may be composed of three annules. The measurements given in both the 1880 and the 1884 papers are: L = 0.6 mm; a = 25–30; b'[1] = 4–4 1/3; c = 25; stylet 1/9 of oesophagus. Calculated from the figure: L = 593 μ; V = 78,5%; a = 25,2; b' = 4,3; c = 24.

A large number of soil and root samples from many meadows round Leiden were examined. Four *Pratylenchus* species were found to occur here:

1. *P. pratensis* (sensu THORNE): very rare, in the drier parts;
2. *P. penetrans:* same;
3. *P. thornei:* rather common, especially in the more moist localities;
4. *P. helophilus:* very common, also in moist places.

Thus these four species deserve our special attention, though of course the others cannot a priori be excluded. These latter will be considered briefly first:

P. brachyurus: Never found here. Has V = 82–89%.
P. loosi: Never found here. Has V = 80–85%.
P. coffeae: Never found here. Tail with very broad tip.
P. neglectus: Smaller than 0.6 mm. V generally 80–84%.
P. hexincisus: Never found here. Smaller than 0.6 mm.
P. scribneri: Found here only once in a nursery. Excluded by its long tail.
P. vulnus: Possibly does not occur here as a native; found only in a few localities in Holland. Has a very slender body.

[1] In *Tylenchus robustus, T. pratensis* and *T. gracilis* DE MAN, when calculating the index b, included the terminal lobe into the oesophagus. Thus his values for b are too low; they will here be referred to as b'.

P. subpenetrans: Never found here. Does not reach a size of 0.6 mm.

P. zeae: Never found here. V 68–76%; smaller than 0.6 mm.

P. goodeyi: Never found here. Excluded by its long, dorsally sinuate tail.

P. convallariae: Has a truncate tail. Found so far only in *Convallaria* roots, never in meadows.

P. irregularis: Excluded by its irregularly mucronate tail. Not known from the Netherlands.

P. tumidiceps: Never found here. Excluded by small size and shape of head end.

P. delattrei: Never found here. Smaller than 0.6 mm.

Of the four species found near Leiden, *P. pratensis* sensu THORNE has been discussed already. It is excluded by vulva position, tail shape, size and habitat (See table on p. 20).

P. penetrans: Practically excluded by its long tail, though very large specimens may have c = 24. Does normally not occur in marshy meadows.

P. thornei: Measurements agree well those given by DE MAN. This species might be indicated by DE MAN's statement about the head end: „Auf jeder der lateralen Seiten beobachtet man zwei chitinisirte Längsstreifen (wie ungefähr beim *robustus)* und vier submediane gebogene Linien."[1] It is, however, more probable, especially when comparing this with the description of *T. robustus*, that the words „lateral" and „submedian" do not refer to the picture as it presents itself under the microscope, the nematode lying on its side, but to the orientation in the nemic body itself. In this case the „chitinisirte Längsstreifen" are the forward arching central parts of the framework. Points against *thornei:* tail truncate, and no explanation for abrupt anterior end of ovary.

P. helophilus: Measurements fit well to DE MAN's. Tail tip annulated, but in most specimens more weakly than remainder of body; appearing smooth at 450x, whereas the body annulation is visible at this magnification. Males are common; the females possess a conspicuous spermatheca, appearing in live specimens under 20 × as a light rectangle set off sharply against the dark intestine, just about the level where DE MAN drew the beginning of the ovary. This seems an unexpectedly good solution of the puzzle presented by DE MAN's illustration. The tail shape is also in accordance with DE MAN's figure, and lastly *P. helophilus* is known to occur in meadows. Thus it is reasonable to say that this is the true *pratensis* of DE MAN.

§ 7. *Comparison of Pratylenchus pratensis* (DE MAN) with *P. pratensis* of THORNE nec (DE MAN).

Pratylenchus pratensis (DE MAN) differs from *P. pratensis* of THORNE nec (DE MAN) in the following points:

[1] On each lateral side one observes two chitinous longitudinal streaks (about the same as in *robustus*) and four submedian curved lines.

	De Man	Thorne
1. Size (fresh)	400–700 μ, usually over 500 μ	330–600 μ, usually under 500 μ
2. Vulva position	75–80%	80–86%
3. Tail shape	conical	broadly rounded or even spatulate
4. Lateral incisures	4	6
5. Annulation	not prominent	prominent
6. Males	common	lacking
7. Spermatheca	oblong	lacking
8. Habitat	meadows	sandy soils

It is not impossible that SHER & ALLEN had both species before them, since they state that in some populations males occurred and that not all females had 6 lateral incisures. Their description, however, unambiguously refers to THORNE's species, to which *pratensis* DE MAN keys out, using their key.

§ 8. *Identity and status of the female in De Man's collection*

Identity. The measurements are: L = 464 μ; V = 77,2%; a = 27,6; b′ = 3,6; c = 20,3; stylet 15 μ; vulva-anus distance 83 μ.

The tail tip is annulated, conical in shape. This feature, in connection with vulva position and the presence of 3 annules on the lips, suggests that it belongs to the true *pratensis*. The structure of the lateral field could no longer be made out; here and there very faint traces of four incisures were visible.

It must be remarked, however, that a spermatheca could not be distinguished with certainty. But on examination of specimens from the Hollandsche Collectie of species possessing a spermatheca (*Tylenchorhynchus dubius, Rotylenchus robustus)* it was found that the organ was no longer visible there either; also, there is always the possibility of an unfertilized specimen.

Vulva position and tail shape preclude the possibility that this female belongs to *pratensis* sensu THORNE.

Status. The values for b′ and c are obviously different from those given by DE MAN. This would seem to support the hypothesis that this specimen is from Sydenham. However, this need not be the case. The author found a female of *pratensis* in a meadow at Hillegersberg, which had almost exactly the measurements of DE MAN, viz. L = 597 μ; V = 78.9%; a = 29.0; b′ = 4.5; c = 24.7; vulva-anus distance 102 μ. After fixation and mounting, however, its measurements had changed to the following: L = 466 μ; V = 79,0%; a = 32.1; b′ = 3.9; c = 21.4; vulva-anus distance 76 μ, i.e. approaching those of the specimen in the collection. But the author indication in DE MAN's catalogue might again point to Sydenham. Thus date, locality and consequently status of this specimen cannot be determined with certainty, so that it cannot be designated lecto- or metatype.

§ 9. *Neotype*

For this reason a female from a meadow near Leiden was designated neotype. Measurements (Fresh): L 601 μ; V 78.0%; a = 29.2; b = 7.2; b′ = 4.6; c = 23.6; stylet = 15 μ; vulva-anus distance = 107 μ. Measurements (mounted): L = 535 μ; V = 78.9%; a = 29.4; b = 6.9; b′ = 4.5; c = 24.5; vulva-anus distance = 92 μ.

Neotype: Female on slide e 21.

Neotype habitat: Moist meadow.

Neotype locality: Meadow between Valkenburg and Leiden, The Netherlands.

Neotype in collection of the Plantenziektenkundige Dienst, Wageningen, The Netherlands.

§ 10. *Renaming of P. pratensis sensu Thorne*

Pratylenchus pratensis of THORNE, 1949 nec (DE MAN, 1880) must consequently be renamed. In view of the strong cuticular annulation, resulting in the outer lateral incisures and the outline of the tail tip being crenate, the specific trivial name *crenatus* nom. nov. is proposed here. The neotype, selected by SHER & ALLEN for *P. pratensis*, from the Sydenham material, now becomes holotype of *P. crenatus*.

IV. THE IDENTITY OF TYLENCHUS GULOSUS KÜHN

§ 1. *History*

Tylenchus gulosus was described in 1890 by J.KÜHN as noxious to sugarbeets. His description was so extremely short and insufficient that it hardly deserves the name.

In 1894 FISCHER described a disease of *Clematis jackmani* MOORE, caused presumably by two nematode species, viz. *Aphelenchoides kühnii* n.g., n.sp. and *Tylenchus gulosus* KÜHN. He had his material of the latter species checked by KÜHN, who confirmed the determination. In the light of our present distinctions in the genus *Pratylenchus*, however, this does not amount to much.

In 1932 STEINER published a short note containing the statement that *Tylenchus gulosus* KÜHN was identical with *T. pratensis* DE MAN 1880. Prior to 1953 there was considerable confusion as to the identity of the latter species; STEINER understood by *T. pratensis* DE MAN the species now known as *Pratylenchus penetrans* (COBB, 1917) (STEINER, *in litt.;* cf. also STEINER, 1927).

In 1953 SHER & ALLEN again separated *pratensis* and *penetrans*, but left *T. gulosus* as synonym with the former species, in the interpretation of which they followed THORNE (1949).

§ 2. *Description*

The whole original description by KÜHN consists of the following statements: „... *Tylenchus gulosus* ...In seiner Bildung nähert er sich dem Stockälchen *Tylenchus devastatrix*, erreicht aber nur die halbe Grösse desselben... Beachtenswert ist aber, dass dieser Schmarotzer leicht verwechselt werden kann mit

jugendlichen Formen der gewöhnlichen Rübennematoden."[1] This tells nothing more than that *T. gulosus* is a tylenchid nematode with posterior vulva position. Even taking into account the time at which the description was composed, it is extremely poor, especially as several monodelphic tylenchids were already known then *(Tylenchus davainei, T. filiformis, T. leptosoma, Ditylenchus intermedius* and others). The reference to the stem nematode *(Ditylenchus dipsaci* (KÜHN, 1858)) and to the larva of the beet eelworm *(Heterodera schachtii* SCHMIDT, 1871) suggest that the tail was more or less pointed, while actually it was probably broadly rounded (see below). Therefore we may reasonably declare *Tylenchus gulosus* KÜHN 1890 a nomen nudum. FISCHER (1894) should be regarded as the first publication in which the name *Tylenchus gulosus* occurs as nomenclatorially available.

FISCHER's description says: Females length 680 μ (665–700 μ); a = 27–28; V about 80%. Males, length 520 μ (424–590 μ); a = 27–28. Stylet in both sexes 18 μ. The illustration shows that the female tail is broadly rounded, not spatulate.

The length of the females and the apparently normal occurrence of males preclude the possibility that *T. gulosus* could be conspecific with *P. pratensis* of THORNE, 1949. Identity of *gulosus* with *P. penetrans* is, on the other hand, quite possible. The chief objection is the length of the females. Measurements of 50 females of this species from the P. D. Collection showed the range of length to be 343–643 μ; SHER & ALLEN give 430–650 μ. The original description by COBB stated the length to be 700 μ, but his description of the female refers to *P. scribneri* (SHER & ALLEN, 1953; CHRISTIE & BIRCHFIELD, 1958). During experiments with *P. minyus* it was found that the length of these nematodes may vary with external conditions. *P. penetrans* therefore was reared on *Clematis jackmani* to test its behaviour in this respect.

§ 3. *Experimental*

Six plants of *Clematis jackmani* were planted in six pots of 10 litres capacity each, which had been filled with soil from the experimental field at Overloon, where *P. penetrans* occurred in large numbers. Three pots received sterilized soil, the others untreated soil. Plenty of artificial manure was added to all pots so as to superimpose manurial effects on differences that might be the result of the treatment.

The experiment was started on May 25, 1957. In both the untreated and the treated series one plant died within a few weeks. This was probably not due to nematodes, but to a fungus, to which *Clematis* seems to be highly sensitive.

In the course of the summer considerable differences in growth between the treated and the untreated series became manifest; the plants in the untreated soil developed very slowly, the controls much more quickly.

At the end of September the root systems were examined. Those from un-

[1] In its organization *Tylenchus gulosus* resembles the stem nematode *T. devastatrix*, but reaches no more than half the size of this species... It should be kept in mind that this parasite may be easily confused with larval stages of the ordinary beet eelworm.

treated soil weighed 4,5 g and 5,5 g. The central parts were poorly developed and had a dark brown colour; lesions were present, typical of *Pratylenchus* infestation in susceptible plants.

The root systems of the controls weighed 22 and 27 g; they looked quite healthy, showing no lesions or dark brown parts.

All four root systems were washed for six days. The plants from untreated soil were calculated to harbour, per 10 g roots, 293 and 965 *P. penetrans* respectively. The corresponding figures for the controls were 3 and 24.

Forty females of *P. penetrans*, extracted from the *Clematis* roots, were measured. Their average length was 646 μ; the range 541–811 μ. 26 specimens were smaller than 655 μ; 8 between 655 and 700, and 6 over 700.

§ 4. *Discussion and conclusions*

This experiment shows that *Pratylenchus penetrans* infests *Clematis jackmani*. The root lesions indicate that *Clematis* is susceptible to damage by this nematode. This is the more probable since *P. penetrans* is known to be a widespread pest of woody perennials in Western Europe.

The nematodes reared on this plant were still somewhat smaller than FISCHER's specimens, but distinctly longer than the average for *P. penetrans*. From the trial field at Overloon a population of *P. penetrans* was obtained, from a plot where barley had been grown. The mean length of these specimens was 520 μ, the range 449–569 μ. It appears therefore that the host plant is the factor affecting length in this case.

Thus all the evidence indicates that *Tylenchus gulosus* FISCHER 1894 is indeed identical with *T. penetrans* COBB, 1917, as STEINER (1932) supposed. Other *Pratylenchus* species hardly come into consideration for taxonomic as well as for etiological reasons.

A nomenclatorial problem now presents itself. The name *gulosus* FISCHER, 1894 antedates *penetrans* COBB, 1917. The latter name is widely used, whereas the former has fallen completely into oblivion; in fact, as far as the writer knows, it was never used again for more than sixty years. Although it is very likely that *gulosus* is the same species as *penetrans*, strict proof is, of course, impossible, FISCHER's specimens apparently no longer existing. For all these reasons the writer has sent an application to the Nomenclature Commission, requesting the name *penetrans* COBB, 1917 to be put on the Official List. Pending the Commission's decision, *penetrans* remains the valid name.

V. THE IDENTITY OF APHELENCHUS NEGLECTUS RENSCH [1]

§ 1. *Introduction and history*

In the year 1924 RENSCH described and illustrated under the name *Aphelenchus neglectus* n.sp. a nematode which, in many parts of Germany, did serious

[1] A preliminary report on these investigations was given in Nematologica 2, Supplement, p. 348.

damage to various cereals and other crops. In 1927 GOFFART published more details on this species.

In this same year 1927 STEINER showed that *Aphelenchus neglectus* did not belong to *Aphelenchus*, but to Tylenchidae. He declared it identical with *Tylenchus pratensis* DE MAN. The date is important; COBB (1927) had, shortly before, synonymized his *T. penetrans* 1917 with *T. pratensis* too. Thus at the time *T. pratensis* was the only recognized species of root lesion nematode from the Northern Temperate Zone; it had been reported from Europe and North America. STEINER's description makes it probable that the specimens studied by him belonged to *P. penetrans* („Of all the descriptions given, that of COBB is undoubtedly the most complete and accurate, and the specimens used in this study could easily be identified as his form"), so that it was *P. penetrans* with which *A. neglectus* was actually synonymized.

Thus, since 1927, the name *A. neglectus* has disappeared from the literature, except that it was quoted now and then in synonymies of *P. pratensis*, e.g. by SHER & ALLEN (1953). These authors re-erected *P. penetrans* as a good species, but left *neglectus* as a synonym of *pratensis*.

As there were some points in RENSCH's description which did not fit too well either to *pratensis* or to *penetrans*, it seemed worth while to reinvestigate the matter.

§ 2. *Material and methods*

Dr. RENSCH informed the author that his original material no longer existed. Dr. GOFFART possessed no more specimens either. He stated that neither he nor RENSCH had seen each other's specimens, but assumed that they had worked with the same species. This means that we have to fall back entirely on RENSCH's description.

The bulk of RENSCH's original material came from two localities in Germany, viz. the estate Theessen near Magdeburg, and the seedfarm Salzmünde near Halle.[1] The nematodes had been obtained from roots of winter rye in the first case, and from barley, wheat and poppy in the second. Mr. KRADEL, Kleinmachnow, Germany, kindly sent the author some root systems of rye from Theessen and of barley and wheat from Salzmünde. From these roots a sufficient number of *Pratylenchus* specimens were extracted.

In such a case as this, where the identity of a nominal species has to be ascertained from topotypes, great caution is necessary. It is essential to compare the specimens very carefully with the description, and it is inadmissible to declare them to be the species sought merely because they occur in the locality and on the host plant indicated by the original author. Such practice could lead to great confusion, because species mixtures often occur.

§ 3. *The original description*

The original description of *Aphelenchus neglectus* is rather short, but for-

[1] Dr. GOFFART (personal communication) has informed the writer that the specimens on which his 1927 paper was based, came from Salzmünde too.

tunately it is accompanied by an illustration which provides useful information.

Although RENSCH saw numerous specimens, he found only females. He gave the following measurements: L = 430–504 μ; body width 21–25 μ; a = 21; V about 75%; stylet 18μ. An important diagnostic characteristic is indicated as follows: „Ohne Messungen kann diese Art schon daran erkannt werden, dass die Kopfbreite in der Höhe des Stachelknopfes gleich der Stachellänge (also 0.018 mm) ist."[1] This statement calls forth two comments:

1. By „stylet length" RENSCH most probably understood the distance from the stylet knobs to the anterior body end. The real apex of the stylet is usually difficult to detect amid the labial framework. It is therefore quite possible that the length of the stylet in *A. neglectus* is actually 16 or 17 μ.

2. RENSCH consigned the species to *Aphelenchus*, which genus at that time comprised both *Aphelenchus* and *Aphelenchoides*. The diagnostic characters given serve to distinguish *A. neglectus* from *Aphelenchoides fragariae* (then known as *Aphelenchus ormerodis*), as is shown by the context. The latter species and its relatives have much more slender bodies than *A. neglectus*, resulting in the head width being much less than stylet length. Therefore we may interpret RENSCH's statement in this manner, that the two measurements in question are *about* equal. This is the more probable as RENSCH says the ratio may be determined without measuring.

The accompanying illustration (Fig. 3) leaves no doubt that *A. neglectus* is a *Pratylenchus*. The specimen figured was calculated to be 498 μ in length; a = 19,7; the stylet about 16 μ. The vulva is situated at 72%, but is probably inaccurately drawn, as the posterior uterine branch is much longer than is usual in *Pratylenchus*. It is possible that the specimen had not completed its last moult, as there is no break drawn in the ventral body wall at the level of the vulva, but not too much importance should be attached to this detail. The completely developed ovary, combined with the easily visible hind part of the spear, as well as the length of the specimen, which is near the upper margin given by RENSCH, are against this supposition.

The anus is not indicated. The most conspicuous feature of the drawing is the convex-conoid, obtusely pointed tail.

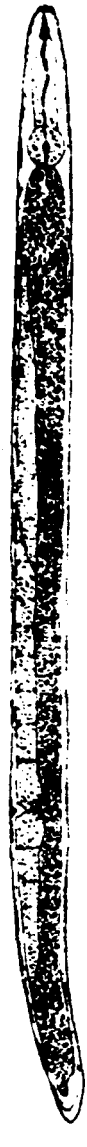

FIG. 3. *Aphelenchus neglectus*, original illustration (From RENSCH, Zool. Anz. 59, 1924, p. 279; by courtesy of publishers, Akademische Verlagsgesellschaft Geest & Portig K. G., Leipzig).

[1] Without measuring one can recognize the species from the fact that the head width at the level of the stylet knobs is equal to the stylet length (0.018 mm).

§ 4. *Comparison with* P. crenatus *and* P. penetrans.

The measurements of *Aphelenchus neglectus* agree to a certain extent with those of *P. pratensis* sensu THORNE = *P. crenatus*, but the latter species is distinctly more slender (a = 22–32 after SHER & ALLEN). Moreover, the tail tip is different in shape: it is always broadly rounded, and in many specimens even spatulate (Fig. 4 A-D).

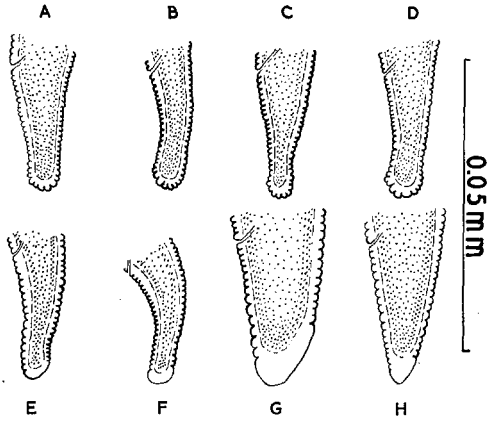

FIG. 4. A-D: Female tails of *Pratylenchus crenatus*. E-F: Same of *P. minyus*. G-H: Same of *P.g.*

P. penetrans is also more slender than *A. neglectus*, and has, in addition, a greater body length (450–700 μ). It has also a broadly rounded tail tip. Finally, in *P. penetrans* males are numerous, and it seems unlikely that RENSCH, had he seen this species, should not have found them among his abundant material.

Thus it is improbable that *Aphelenchus neglectus* is synonymous with either of these two *Pratylenchus* species.

§ 5. *Examination of topotypes.*

Examination of root samples from the type localities yielded mixtures of four or five *Pratylenchus* species. Such species mixtures are very common with free-living nematodes (OOSTENBRINK, 1957).

The results are shown in Tables 1 and 2.

TABLE 1. Theessen – Rye roots

Plot	Cren.	Pen.	Minyus	G	Total
Hustig II . . .	14	4	22	31	71
Hustig III . . .	7	2	1	18	28
Räckendorf . .	–	–	9	14	23
Total	21	6	32	63	122

TABLE 2. Salzmünde

Plant	Cren.	Pen.	Thornei	Minyus	G	Total
Wheat	–	–	–	34	58	101
Barley	–	1	1	28	24	54
Total	–	1	1	71	82	155

Thus representatives of five species were present. *Pratylenchus G* is a species similar to *P. minyus*, known already from the Netherlands (see next chapter, § 1).

It is probable that RENSCH had a similar species mixture, but we are not concerned with what he may have seen, but with what he actually described.

From the tables it is clear that *crenatus*, *penetrans* and *thornei* can be dismissed, as these species occur in too low numbers. The morphological objections against *crenatus* and *penetrans* have already been discussed. *P. thornei* is also too large (450–750 μ) and too slender (a = 25–36).

This leaves *minyus* and *G*. The former species has a spatulate tail with broadly rounded tip (Fig. 4 E and F) and is, moreover, too slender (a = 23–32) (these characters from specimens from The Netherlands, determined as *P. minyus* by Prof. ALLEN). The latter, however, fits excellently. It has a plump body (a = 17–23); length 400–550 μ (the greater range compared with RENSCH's is probably due to a larger number of specimens having been measured). The tail tip is variable (Fig. 4 G–H; Fig. 6 lower half), but on the whole fits the illustration. The ratio head width: stylet length varies from 0,9 to 1,2, but this is the case in other *Pratylenchus* species too.

§ 6. *Discussion and conclusions*

At the localities mentioned by RENSCH a *Pratylenchus* species was found to occur in large numbers, which fitted his description, so it is reasonable to assume that it is the true *Aphelenchus neglectus*. It keys out, according to SHER & ALLEN's key, with *P. minyus*, but it differs from this species in being stouter, possessing a differently shaped tail and less distinct body annulation. Some specimens were found, however, that were more or less intermediate between *minyus* and *neglectus*. The relation between these species is further discussed in the next chapter.

The biological data supplied by RENSCH agree with the opinion, that *Aphelenchus neglectus* is identical with the Dutch form *Pratylenchus g*. *A. neglectus* was found in loamy sand, in medium loam and in sandy loam. *Pratylenchus g* is known to occur in the same type of soil in the Netherlands, normally together with *P. minyus*, while *crenatus* and *penetrans* prefer lighter soils, *thornei* heavier.

Aphelenchus neglectus was found in Germany to cause serious damage to rye, barley, wheat and possibly to more crops. In the Netherlands too it occurs on cereals, although it has not yet been fully established whether damage occurs. This is, however, not very important, since the diagnostic value of these observations is not great and the circumstances in Germany in 1923 were probably different from the present situation in the Netherlands.

The measurements and especially the illustration of GOFFART show that he was dealing with the same species. His material came from Salzmünde too, and he found males very rarely (oral communication). This fits perfectly; the tables show that the sole species present in the mixture with numerous males, viz. *P. penetrans*, only occurred in low numbers.

Thus *Aphelenchus neglectus* was actually a good, valid species, not identical

with either *crenatus* or *penetrans*. CHITWOOD & OTEIFA (1952) transferred *A. neglectus* to *Pratylenchus*, so the correct name is *Pratylenchus neglectus* (RENSCH 1924) CHITWOOD & OTEIFA 1952. A female from rye roots, THEESSEN, has been selected as neotype. Data see systematic section.

VI. TAXONOMY OF PRATYLENCHUS MINYUS

§ 1. *Introduction*

OOSTENBRINK (1954) gave a review of the occurence of *Pratylenchus* species in the Netherlands. He reported the presence of several forms keying out to *P. minyus* SHER & ALLEN, but differring more or less distinctly from that species. In the nematode collection of the Plantenziektenkundige Dienst at Wageningen material of these forms had been preserved. OOSTENBRINK (l.c.) made the following comments:

„*Pratylenchus minyus* komt soms in grote getale voor in lesies in de wortels van kool *(Brassica oleracea* L.*)* en koolraap *(Brassica napus* var. *napobrassica* (L.) RCHB.) op zavelgrond. Het is niet zeker of dit gepaard gaat met schade."[1]

„Een afwijkende soort, die in de determinatietabel op *minyus* uitkomt, doch morfologisch toch duidelijke verschillen vertoont, gaat samen met ernstige schade bij koolraap in de Maasstreek".[2]

This form was provisionally listed as *Pratylenchus g*.

„Een derde, op *minyus* uitkomende soort, die van beide bovengenoemden verschilt, werd op verschillende plaatsen in grondmonsters gevonden."[3] Listed provisionally under letter *l*.

„Een op *P. scribneri* uitkomende soort gaat op enkele plaatsen samen met zich geleidelijk uitbreidende slechte plekken in stamboon *(Phaseolus vulgaris* L.) en aardappelen *(Solanum tuberosum* L.*)*. Of aardappelknollen worden aangetast, is nog niet zeker."[4]

This species was listed as *Pratylenchus j*. On examination, however, it was found that in this form the vulva was located at more than 80%. Thus *Pratylenchus j* does not belong to *P. scribneri*, but to the *minyus*-group.

In addition, the collection contained specimens of:
Pratylenchus h, collected from lettuce near Leiden;
Pratylenchus i, from beetroots at Wageningen.

An attempt was made to clarify the taxonomic position of these closely related forms.

[1] *P. minyus* may be found in large numbers in lesions in roots of cabbage and turnips in sandy clay soil. It is uncertain whether the plants are damaged by it.

[2] A species keying out to *minyus* but morphologically differring distinctly from that species, is associated with serious damage to turnips in the Meuse district.

[3] A third species keying out to *minyus*, differring from both the preceding ones, was found in several places in soil samples.

[4] A species keying out to *P. scribneri* occurs in some places associated with slowly spreading poor patches in bush beans and potatoes. Whether potato tubers are infested, is yet uncertain.

§ 2. *Morphological character of the forms studied*

Pratylenchus minyus. This species was originally described from soil, California, U.S.A. A slide containing six paratypes (females), kindly sent by Prof. ALLEN, was available for study.

The following condensed description is based on this material and on 20 females from the Netherlands (Friesian clay district), which ALLEN also considered to belong to *P. minyus.*

A small, rather slender form. Most specimens in the slides lay more or less irregularly coiled. Body annulation distinct. Lateral field distinct; the central zone bears distinct oblique striae. Tail coarsely annulated, with large, round, or more trapezoid, smooth tip. The dorsal and ventral contours are bent inwards, giving the tail a concave-conoid shape. The tail is rather slender and at least twice as long as the anal body diameter (Fig. 5 A and B).

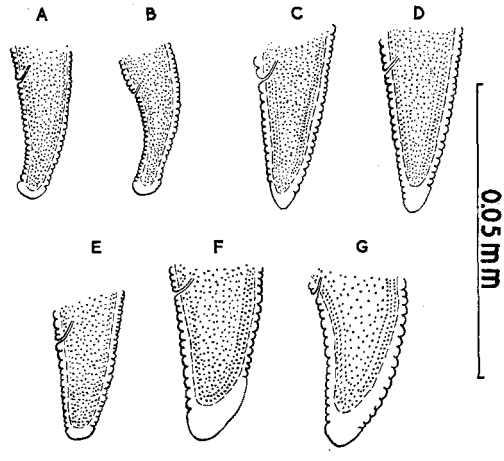

FIG. 5. A-B: Female tails of *Pratylenchus minyus.* C-D: Same of *P.g.* E: Same of *P.h.* F-G: Same of *P.l.*

Measurements:

	Paratypes	Dutch specimens
L	428 μ(328–486)	405 μ (334–454);
V	83,3 % (81,6–83,8)	81,8 % (79,3–83,5)
a	22,5 (20,5–26,4)[1]	26,6 (19,4–30,3)
b	6,0 (5,7– 6,1)	. . . . . .[2]
c	20,5 (17,7–22,9)	19,0 (16,4–21,8)
stylet	16–17 μ	15–17 μ

Pratylenchus g. A stout form with rather pointed tail (Fig. 5 C and D). As the specimens in the collection had been mounted in lactophenol, the lateral field and body annulation had become obscure. Measurements (based on 27 females): L = 443 μ (407–478); V = 80,9 % (77,1–83,2); a = 20,0 (17,3–22,8); c = 19,4 (16,6–21,8); stylet 16–17 μ. The average length of this form is larger than that of *minyus.*

[1] Specimens somewhat flattened.

[2] During these investigations the index *b* was not constantly computed, as the exact point where the oesophageal lumen joins that of the intestine is often difficult to determine. Moreover, in *Pratylenchus* the index *b* has hardly any taxonomic value.

Pratylenchus h. A small and rather stout form. Tail short and plump, tapering only little (Fig. 5 E). In the collection seven specimens were present. Measurements: L = 380 μ (351–422); V = 81,6% (79,8–83,8); a = 21,0 (17,8–23,9); c = 20,5 (17,8–23,9); stylet 16–17 μ.

Of *Pratylenchus i* only three adult specimens were available, which did not seem to differ morphologically from other forms. At the type locality this form could no longer be found, so it was not possible to study it further.

Pratylenchus j. Under this letter three populations were present in the collection:

j-1 from bush bean, Blerick: 16 adult specimens;
j-2 from potato, Wolder; 5 specimens, rather flattened;
j-3 from carrots, Beilen, 10 specimens, all more or less collapsed. When fresh material of this form had been studied, it proved to be identical with *P. minyus.*

The morphological peculiarities of j-1 and j-2 were not clear. The structure of the lateral field was rather obscure.

Measurements:

	j-1	j-2
L	458 μ (403–485)	431 μ (414–471)
V	81,8% (78,8–84,1)	81,3% (80,3–83,0)
a	24,8 (21,0–28,2)	19,1 (17,4–21,0; see above)
c	20,5 (17,4–26,6)	18,0 (17,0–19,1)
stylet	16–18 μ	16–17 μ

Pratylenchus l. Thirteen adult specimens available, mounted in lactophenol. Annulation and lateral field could not be studied: the cuticle of all the specimens was more or less swollen. A large stout form with rather broadly rounded tail (Fig. 5 F and G). The specimens came from cereals, Noordoostpolder. Measurements: L = 490 μ (418–580); V = 82,1% (79,6–83,8); a = 20,3 (18,7–22,2); c = 20,4 (15,7–23,6); stylet 15–18 μ.

Most of the populations in the collection were too small for a clear picture of the morphological character of each form. The differences, however, did not seem to be very distinct, the variability was relatively great, and the measurements overlapped. Generally speaking, the forms *g* and *l* differred from *P. minyus* through larger size, stouter body, indistinct annulation and lateral field, and convex-conical tail, which was less than twice the anal body diameter in length. These differences might suggest that *g* and *l* represented a further stage of development than *P. minyus;* cf. what has been said about *P. scribneri* on p. 10. Thus *P. minyus* would consist of young females, *g* and *l* of older. There were some differences in ovary length present, but they were only slight: ovary length ranged in *minyus* from 29–46%, mean 38%; in *g* the ovary measured 42% (29–51%) and in *l* 44% (29–55%).

It was clear that many more specimens needed studying.

§ 3. *First rearing test*

To investigate the variability of these forms, they were reared on different plants and in different soils. The forms studied in this way were *g*, *h*, *j*-1, *j*-2 and *l*. Of *h* only little fresh material could be obtained; this form will be discussed in § 5.

The tests were carried out in glass tubes as described by OOSTENBRINK (1952) and lasted four months. Five plant-soil combinations were used:

1. wheat in heavy loam (type host and locality of *l*);
2. bush bean in coarse river sand (same of *j*-1);
3. turnip in loamy sand (same of *g*);
4. lettuce in fine dune sand (same of *h*);
5. Beetroots in old dark sandy culture soil (same of *i*).

The forms *g*, *j*-1, *j*-2 and *l* were reared in each of these five combinations in tenfold replication. Twenty nematodes were inoculated into each tube, as it was known that heavy mortality might occur in inoculation tests with *Pratylenchus* (cf. OOSTENBRINK, 1958). The possibility was kept in mind, that the inocula might contain a mixture of species.

After four months nematodes of the *minyus*-group were found in 182 out of 200 tubes. The four forms tested all gave the same picture: no multiplication in series 2 and 4; strong multiplication in 1 and 5, and very strong multiplication in 3. These differences were probably connected with soil types (moisture contents) rather than with host plants.

The progeny obtained could be divided into two groups:

1. A slender form with concave-conical tail and distinct annulation. The lateral field showed oblique striae in the central zone. This form agreed completely with *P. minyus* and will be referred to as the minyus form.

2. A plump form, generally somewhat larger; annulation and lateral field indistinct; tail more or less convex-conical; ovary on the average slightly longer than in the minyus form. During the experiment this form was found to be

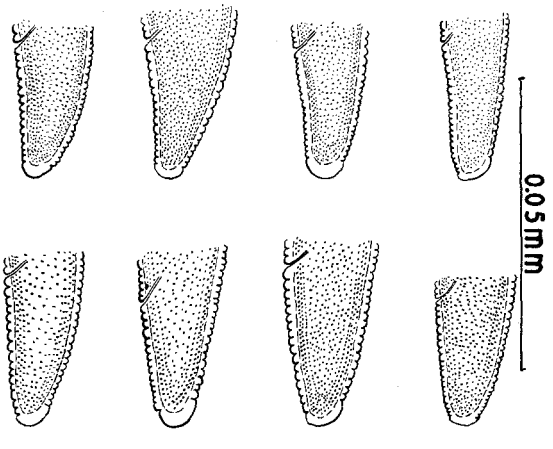

FIG. 6. Upper half: Variation in shape of female tail of *Pratylenchus l*, obtained from first rearing test. Lower half: Same of *Pratylenchus* g.

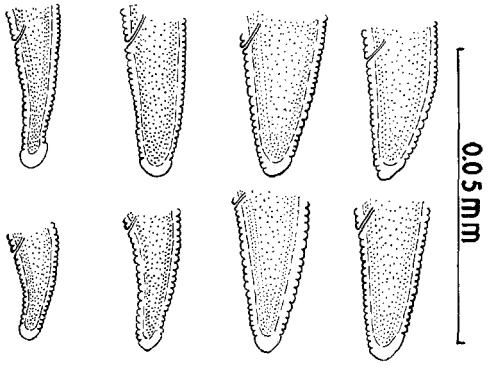

FIG. 7. Upper half: Variation in shape of female tail of *Pratylenchus j-1*, obtained from first rearing test. Lower half: Same of *Pratylenchus j-2*.

identical with *Aphelenchus neglectus* RENSCH (see the preceding chapter). It will be referred to as the neglectus form.

Within the minyus form variability was rather low, within the neglectus form on the other hand very high. Fig. 6 and 7 give illustrations of the variability in the neglectus form. Separation into distinct groups was not possible. There were some with more pointed tails („g"), and others with more rounded ones („l" or even „h"). There were, however, also some specimens (though a minority) that were more or less intermediate. The egg-bearing individuals belonged predominantly, though not exclusively, to the neglectus form.

The proportion of the minyus form and the neglectus form in these five series showed some regularity. In 1, 2 and 4 the minyusform was dominant, in 3 and to a minor degree in 5, the neglectus form. In series 2 and 4 no egg-bearing females were found, while these were abundant in 3. This supports the view that the minyus form and the neglectus form are conspecific, and that the latter represents the egg-laying stage, comparable to the thick, indistinctly annulated individuals of *P. scribneri.* Nevertheless, the possibility that the minyusform and the neglectus form represented two different species, could not at that stage be discarded. Even the occurrence of intermediate individuals is not decisive, while the taxonomic value of the differentiating characters remains poorly known.

§ 4. *Second rearing test*

To decide between the two possibilities mentioned above, a second test was set up using the same method, but now only a single female was inoculated into each tube. After four months it was found that in some tubes pure minuys form and pure neglectus form occurred side by side in the progeny of one and the same parent (Fig. 8). This was good proof that *minyus* and *neglectus* are conspecific. Again it was found that the neglectus form had slightly longer ovaries than the minyus form but the difference seemed smaller than in *P. scribneri.* Thus the minyus form contains most probably young females, the neglectus form the older ones. The morphological differences between these forms in this and in other species *(P. scribneri, P. penetrans)* suggest that a certain „matura-

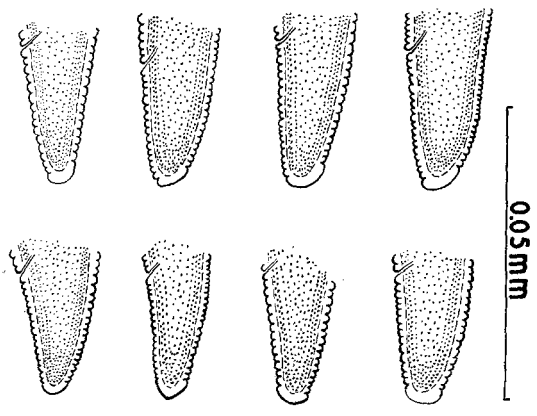

FIG. 8. Upper half: Variation in shape of female tail among progeny of a single female of *P. minyus*, obtained from second rearing test. Lower half: Same, progeny of another female.

tion period" is undergone by the females after the last moult, before egg-laying is started.

Thus all forms treated above belong to one species, which must bear the name *Pratylenchus neglectus* (RENSCH 1924) CHITWOOD & OTEIFA 1952.

§ 5. *Pratylenchus* h

This form could not be tested as completely as the others, its type locality having just been treated with a nematicide. Progeny was obtained only from a few tubes of series 3, 4 and 5, the total number of females found being eleven. In series 3 they were large and fat, generally with convex-conical tails (neglectus form). The only female from series 5 resembled the minyus form. Of the larvae some were inoculated again and twelve more females were obtained. The total of twenty-three females, now available, was on the whole characterized by a short and plump tail. From each of the forms *g*, *j*-1, *j*-2 and *l*, twenty-three females were selected, agreeing as nearly as possible in length with the *h* females (to avoid allometrical effects). The value of c was found to be:

Population	Range of c	Mean of c
h	20,4–26,8	23,1
g	17,4–24,0	19,1
j-1	17,8–23,9	21,0
j-2	17,1–25,7	20,1
l	16,8–22,6	19,9

Thus it is seen that *h* is indeed characterized by its short tail, which is also remarkably broadly rounded. But for both characters a large overlap with the other forms is seen. No differences in behaviour could be detected either (*h* also showing the neglectus form in series 3). Thus *Pratylenchus h* must be regarded as a very short-tailed population of *P. neglectus*.

The conclusion is clearly that *P. neglectus* is a most variable species, younger and older females differing strongly, much more so than in other species, e.g. *P. penetrans*.

VII. The taxonomic status of Pratylenchus coffeae (Zimmermann)

§ 1. *Introduction*

In 1956 Yokoo published a paper stating that *Pratylenchus pratensis* (De Man) (sensu Thorne) damaged potato tubers in Japan. In Europe, where this nematode species is very numerous, no damage to this crop is known. Moreover, Yokoo's description and illustrations showed clearly that he was dealing with a different species. On request he had the kindness to send the writer some infested parts of potato tubers, fixed in formalin. These yielded large numbers of the nematode in question.

§ 2. *Morphology of the nematode*

The chief features of Yokoo's description are:

a. Males were rather common;
b. Females had L = 530–700 μ; V = 78–80%; a = 21–24;
c. Lip region composed of three annules. The drawings, however, suggested there might be really only two;
d. Tail tip of female annulated. The tail shape was distinctly different from that of *pratensis* sensu Thorne, and the striation on the tip was very weak.

The material received agreed in every respect with the description. There were only two head annules; the slightly raised central part of the anterior one had evidently suggested the presence of a third annule. In some specimens the tail tip was smooth, in others weakly and irregularly striated. Its shape was variable: broadly rounded, truncate or indented.

§ 3. *Identification*

With Sher & Allen's key Yokoo's species was found to key out with *P. coffeae* (Zimmermann, 1898). Judging from the description, it was not sure whether it was really that species: Sher & Allen said *P. coffeae* to be very slender (♀ a = 25–35) and to possess a tapering female tail with rounded terminus, whereas Yokoo's females were stout (a = 21–24), and in many of them the tail tip was not rounded.

A population of *Pratylenchus* from tea roots, Ceylon, which had been identified as *P. coffeae* (see Loos, 1953), was available for study. This material agreed well with Sher & Allen's description, except for the slightly more posterior vulva position; it differred, however, evidently from the Japanese specimens. The chief points of difference are tabulated below.

The difference in ovary length indicated that the Ceylonese specimens might be younger than the Japanese ones. The differences in relative and absolute body width might at least partly be due to this factor. On the other hand, the differences in vulva position and tail shape seemed real. Also, if the Ceylonese and Japanese populations were conspecific, the latter might have been expected to be more indistinctly annulated than the former. Lastly, the young Ceylonese

(All specimens fixed and mounted)

Ceylon	Japan
1. ♀ a = 28–36, mean 31,7	♀ a = 17–24, mean 21,3
2. V = 80–85%, mean 82,6	V = 76–84%, mean 80,3
3. ♀ tail length 2,5–3 × anal body diameter	♀ tail length 1,5–2,5 × anal body diameter
4. ♀ tail length 34–57% of vulva-anus distance, mean 42	♀ tail length 25–41% of vulva-anus distance, mean 34
5. ♀ Tail with narrowly rounded or subacute tip (Fig. 9 F–J)	♀ tail with tip broadly rounded, truncate or indented (Fig. 9 A–E)
6. ♀ body width 16–22μ	♀ body width 22–29μ
7. Annulation of cuticle very fine, rather indistinct	Annulation of cuticle distinct
8. Ovary length 20–40% of body length, mean 28%	Ovary length 30–63% of body length, mean 50%
9. Posterior uterine branch short, without rudimentary ovary	Posterior uterine branch in about 20% of females elongate with distinct rudimentary ovary

females showed the same body length as the old Japanese ones, thus it is possible that length differences exist between specimens of the same stage. Thus there were indications that *P. coffeae* comprised at least two species.

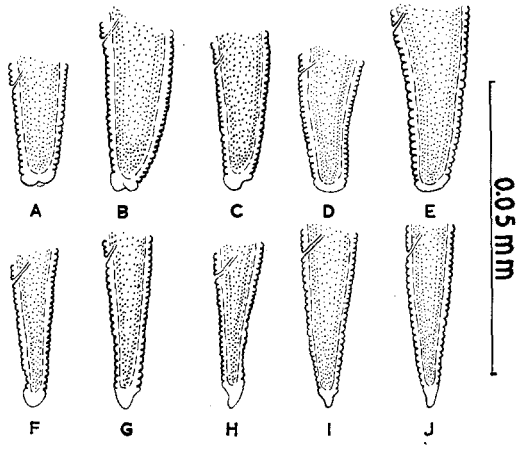

FIG. 9. A-E: Variation in shape of female tail of *Pratylenchus coffeae* from Japan (C aberrant, others normal). F–J: Same of *P. loosi* (F aberrant, others normal).

§ 4. *Descriptions of* P. coffeae

The original description by ZIMMERMANN stated that „*Tylenchus coffeae*" was very fat, the mean value of a being 20,8. Since the specimen figured had an ovary length of over 70%, he obviously dealt with a population of old females, which explains the low value of a and the great average length (0,66 mm). He gave the mean vulva position as 81,2%, which might fit either of the two forms discussed above. Since the illustration showed the female tail rather stout and broadly rounded, *P. coffeae* seems to be closer to the Japanese than to the Ceylonese form. ZIMMERMANN found the species in East Java only (1898, p. 35 and 41).

BALLY & REYDON (1931) again described *T. coffeae* from Java. They found slightly larger values for a (21,3–31,3, mean 26,8) and said that the ovary was shorter than indicated by ZIMMERMANN. Probably they worked with younger females. The range of vulva position was given as 78,7–85,4%. The illustrations show they had certainly ZIMMERMANN's species before them, but it is possible that some specimens of the Ceylonese form were also present.

§ 5. *Examination of topotypes*

The author succeeded in getting some coffee roots from East Java (Djember). The *Pratylenchus*, extracted from them, fitted ZIMMERMANN's description, but again were evidently in a younger developmental stage. Measurements of 28 fixed and mounted females:

L = 451 μ (374–551); V = 79,9% (75,8–83,4%); a = 27,0 (23,0–30,5);
b = 6,5 (5,0–7,3); c = 17,9 (13,7–22,4); G_1 = 33,3% (25,7–43,9).

The body annulation was fairly distinct. Most of the specimens had the tail tip broadly rounded, but truncate and indented forms also occurred. Therefore the writer is of opinion that YOKOO's specimens belong to *P. coffeae*.

It remains now to check the status of 1) the neotype of *P. coffeae*, designated by SHER & ALLEN, 2) the Ceylonese form, 3) *Tylenchus musicola*, COBB, 1919, and 4) *T. mahogani* COBB, 1920.

§ 6. *Identity of the neotype*

Prof. Dr. ALLEN had the great kindness to lend the author some type specimens, among which the neotype. These specimens, although being still slenderer than those seen by BALLY & REYDON, proved yet to be conspecific with the Javanese material seen by the writer. This means that body width in *P. coffeae* ranges from a = 35 in young specimens to a = 17 in older ones.

§ 7. *Status of the Ceylonese specimens*

The Ceylon population seemed morphologically so much different from *P. coffeae* as to justify considering them a separate species.

Some living material being available, it was tried to find out whether this species would cause those symptoms on potato tubers that were described by YOKOO for *P. coffeae*. In two flowerpots of 3 litres capacity each, potato tubers were planted. As soon as the stems came above ground, about 2500 specimens of *Pratylenchus*, extracted from tea roots, were inoculated into each pot. The pots were kept in a greenhouse during the summer.

Both plants died after $3\frac{1}{2}$ months. On examination six new tubers were found to have been formed, but none showed any lesions. They were kept in plastic bags (to avoid desiccation) for seven weeks, at the end of which they still looked quite sound. They were then cut into slices and placed in a root washing apparatus for a fortnight, but not a single *Pratylenchus* was washed out.

From each pot 100 cc soil were sampled, but no *Pratylenchus* were found.

The two root systems were washed out for two weeks. They yielded 45 and 4

specimens of *Pratylenchus*, respectively, which, on morphological examination, were found to have retained their original characters.

As it was not possible to rear the species on any other known good host, one should not immediately conclude from this test that the potato is not a good host plant for this species of *Pratylenchus*. Conditions of soil, humidity and temperature may also have played a part. Moreover, OOSTENBRINK (1958) has shown that *P. penetrans*, after inoculation, decreases considerably in numbers before multiplying again; probably a large percentage of the nematodes do not survive the inoculation or cannot propagate for other reasons. This effect may also have been of importance here. However, it must be observed that the decrease of the *Pratylenchus* population was in this test much greater than that found by OOSTENBRINK. Moreover, the *Pratylenchus* obviously did not assemble in the tubers, and, when reared on potato, remained morphologically different from *P. coffeae*. Thus this experiment also seems to suggest that the Ceylonese population represents a separate species.

Finally, young females of the Ceylonese form were found to be distinctly longer than those of *P. coffeae*, though it cannot yet be said whether this difference is genotypical or not.

For the Ceylonese species the name *Pratylenchus loosi* nom. nov. is proposed, in honour of Dr. C. A. LOOS, who carried out many investigations on *Pratylenchus* on Ceylon.

§ 8. *Tylenchus musicola and T. mahogani*

The original description of *T. musicola* states: L 0,66 mm; V = 81 %; a = 31,3; c = 14,3; G_1 = 48 %. The values of L, a and c are rather extreme, but they still fall within the range of variation for *P. coffeae*. The shape of the female tail tip is somewhat irregular, but on the whole fits rather well to that of *coffeae*. The shape of the bursa is aberrant, leaving the tail tip free, but this point seems doubtful, since in all *Pratylenchus* species the tail tip is enclosed. *T. musicola* was described from the Bluggoe Banana, Grenada, West Indies.

TAYLOR & LOEGERING (1953) also studied *P. musicola*, from abacá (*Musa textilis* Née) in some Central American states and the Philippines. Their specimens were slightly smaller than COBB's (L ♀ = 475–540 μ) and stouter, the specimen figured having a = 21; the female tail was indented to truncate and the bursa enclosed the tail tip. Assuming they had indeed COBB's species before them, their data support the idea that *P. musicola* might be identical with *P. coffeae*.

Of *T. mahogani* COBB gave the following dimensions: L = 0,56 mm; V = 83 %; a = 20,8; c = 27,0; G_1 = 50 %. The shape of the female tail was stated to be subtruncate or rounded. Material from the type host and locality was studied by T. GOODEY (1937). Dr. J. B. GOODEY very kindly lent some specimens to the author. The tail tip was found to show the same variation as *P. coffeae*, and particularly as the Japanese population. The chief differences between *musicola* and *mahogani* are: relative tail length, body width, annulation. GOODEY gave c = 18–25 in his redescription of *mahogani*, thus the values 14,3

(musicola) and 27,0 *(mahogani)* might be extremes of a single variation pattern. The differences in body width and annulation night perhaps be due to differences in developmental stages. COBB also mentions differences in spear length and shape of bursa, but the author thinks these, if at all real, hardly sufficient for specific separation, and thus prefers to regard both *musicola* and *mahogani* as synonyms of *coffeae*, in accordance with the opinion of SHER & ALLEN, though some doubt remains, especially with regard to *mahogani*.

VIII. SOME REMARKS CONCERNING THE DETERMINATION OF MALES

§ 1. Contrary to those of Rhabditids and Dorylaimids, the males of Tylenchids are difficult to determine. The sexual apparatus is usually uniform. Preanal ventral papillae, very helpful in taxonomy, are lacking. Typical secondary sexual characters are present in some instances, e.g. the gubernaculum in *Tylenchorhynchus claytoni* and the shape of the bursa in *T. lamelliferus*. Therefore the keys are, as a rule, based on females, the more so, as in many species males are rare or unknown.

This is also the state of affairs in *Pratylenchus*. SHER & ALLEN base their species identifications exclusively on females. In those species where males are known, they are briefly described. Nevertheless, determination of *Pratylenchus* males is possible to a certain extent. The characters that can be used are largely somatic ones, although in a few cases sexual characters were found to be useful. There are, however, some species that are so closely related that the males do not appear to be distinguishable.

§ 2. *Pratylenchus* males possess, like practically all male phasmidians, one testis, which, as a rule, is outstretched anteriorly. Exceptionally is it reflexed near the anterior end. This feature was observed in *P. coffeae* by ZIMMERMANN (1898) and in *P. penetrans* by T. GOODEY (1932). The testis consists of a multiple row of cells.

The vas deferens often contains a „packet" of spermatozoa. The junction between testis and vas deferens is generally not very distinctly marked; it is indicated by the loosening of the tissue into separate cells.

Spicula, gubernaculum, bursa and phasmids are, on the whole, remarkably uniform; only *P. thornei* seems to possess much longer spicula than the other species. The bursal edge may be coarsely or finely crenate. The phasmid extends into the bursa, but does not lie in the same plane (THORNE, 1949; GOODEY, 1951).

It seems that, in this genus, the males possess a higher and more rounded lip region than the females. The phenomenon is distinct e.g. in *P. neglectus*. This seems of interest, as the same is known in some other Tylenchids, e.g. *Rotylenchus robustus* (DE MAN) and *Radopholus similis* (COBB).

§ 3. The following provisional key may be set up. An asterisk denotes that males of this species were not seen by the author, the characters having been taken from the literature.

1. Body parallel until lip region . . . . . *tumidiceps*+.
   Body tapering into lip region . . . . . 2.
2. Lip region with 2 annules . . . . . 3.
   Lip region with 3 annules . . . . . 9.
   Lip region with 4 annules . . . . . 7.
3. Lateral margin of lip region angular . . . . . *brachyurus*+.
   Lateral margin of lip region rounded . . . . . 4.
4. Bursal edge distinctly crenate . . . . . 5.
   Bursal edge faintly crenate . . . . . 6.
5. Centrale zone of lateral field with oblique striae . . . . . *neglectus*
   Central zone of lateral field without oblique striae . . . . . *scribneri.*
6. Body very slender (a = 30–42), annulation of cuticle very fine . . . . . *loosi.*
   Body less slender (a = 23–31), annulation of cuticle fairly distinct . . . . . *coffeae.*
7. Central zone of lateral field usually narrower than marginal ones . . . . . *vulnus.*
   Central zone of lateral field as wide as marginal ones . . . . . 8.
8. Spicula at junction of shaft and blade with distinct projection, shaft dorsally strongly concave[1] . . . . . *goodeyi.*
   Spicula without distinct dorsal projection, shaft not strongly concave . . *irregularis*
9. Lip region high, conical; framework extended backwards laterally . . . . . *thornei.*
   Lip region lower, not distinctly conical; framework not extended backwards . . . 10.
10. Bursal edge finely crenate. Tail usually 2,5–3 × anal body diameter in length *irregularis. pratensis.*
    Bursal edge coarsely and distinctly crenate. Tail length 1,5–2 × anal body diameter 11.
11. Testis as long as, or longer than, vas deferens (80–125%). Central zone of lateral field usually narrower than marginal ones. Body long, very slender . . . . . *vulnus*
    Testis usually shorter than vas deferens (20–80%). Central zone of lateral field not narrower than marginal ones. Body less slender . . . . . *penetrans. convallariae.*

P. crenatus has not been included in the key, although males of this species have been described by THORNE (1949) and SHER & ALLEN (1953). The writer has never found a male of this very common species and is of the opinion that the males found probably belonged either to *P. penetrans* or to *P. pratensis.*

Size of the spermatozoa might perhaps prove to be useful for diagnostic purposes. The spermatozoa of *P. vulnus* seemed to be larger than those of *P. penetrans,* while those of *P. goodeyi* gave the impression of being still larger. There were, however, not enough males of *P. vulnus* and *P. goodeyi* available to decide this point.

[1] This feature was noted by T. GOODEY, see his illustration (1928).

B. SYSTEMATIC SECTION

IX. VALID SPECIES

Genus *Pratylenchus* FILIPJEV, 1936

FILIPJEV, Smithson. Misc. Coll. 63, 1934, 32, nomen nudum.
FILIPJEV, Proc. Helm. Soc. Wash. 3, 1936, 81.
FILIPJEV, Trudy Zool. Inst. Akad. Nauk SSSR 3, 1936, 538; 543[1].

Type species: *Pratylenchus pratensis* (DE MAN, 1880) FILIPJEV, 1936, syn. *Tylenchus pratensis* DE MAN, 1880 (Type by original designation).

Key to females

1. Body parallel until lip region, there narrowing suddenly. Body length under 600 μ *tumidiceps* MERZHEEVSKAYA.
   Body tapering toward lip region . . . . . 2.
2. Lip region composed of 2 annules . . . . . 3.
   Lip region composed of 3 annules . . . . . 10.
   Lip region composed of 4 annules . . . . . 9.
3. Vulva at 72%. Tail conical, with narrowly rounded tip . . . *coffeae* subsp. *brasiliensis* LORDELLO.
   Vulva at more than 80%; sometimes at 75–80%, but then tail tip more broadly rounded . . . . . 4.
4. Spermatheca present; males common . . . . . 5.
   Spermatheca absent; males rare or unknown . . . . . 6.
5. Body slender (a 25–36), body annulation very fine; tail tip narrowly rounded or subacute . . . . . *loosi* n. sp.
   Body stouter (a usually = 17–27); body annulation more distinct; tail tip broadly rounded, truncate or indented . . . . . *coffeae* (ZIMMERMANN).
6. Lip region angular; stylet length 17–22μ . . . . . *brachyurus* (GODFREY).
   Lip region rounded; stylet length under 20μ . . . . . 7.
7. Vulva at 74–82%, usually at less than 80%; anterior margin of lip region straight, sides „stepped" . . . . . 8.
   Vulva at 76–88%, usually at more than 80%; anterior margin of lip region convex, sides not „stepped" . . . . . *neglectus* (RENSCH).
8. Large species (L 450–700 μ); lateral field with 4 incisures (sometimes 5 in vulvar region) *scribneri* STEINER.
   Small species (L 280–550 μ); lateral field with 6 incisures *hexincisus* TAYLOR & JENKINS.
9. Vulva at 67–76%; dorsal contour of tail sinuate near tip; posterior uterine branch short and undifferentiated . . . . . *goodeyi* SHER & ALLEN.
   Vulva at 78–82%; tail tapering regularly to narrowly rounded tip; posterior uterine branch with rudimentary ovary . . . . . *vulnus* ALLEN & JENSEN (cf under 15).
10. Spermatheca absent; males rare or unknown . . . . . 11.
    Spermatheca present; males common . . . . . 14.
11. Labial framework extended backwards laterally . . . . . 12.
    Labial framework not extended backwards laterally . . . . . 13.

[1] In the German summary of this paper *Pratylenchus* is said on p. 543 to possess a „tylenchoid" oesophagus (i.e. with terminal bulb). This is a printer's error; the sentence „3 (2) Oesophagus tylenchoid" should come, not before, but after the paragraph on *Pratylenchus*. In the Russian part (p. 538) *Paratylenchus* (lapsus for *Pratylenchus*) stands under the correct heading „Oesophagus aphelenchoid".

12. Body long (L = 450–770 μ) and slender (a = 25–37); tail tip usually truncate . . *thornei* SHER & ALLEN.
Body small (L = 386–470 μ) and stout (a = 20–26); tail tapering with rounded tip *delattrei* LUC.
13. Vulva at 68–76%; tail tip smooth, narrowly rounded . . . . . *zeae* GRAHAM
Vulva at 80–86%; tail tip broadly rounded and coarsely annulated . . *crenatus* nom. nov.
14. Spermatheca distinctly longer than wide . . . . . 15.
Spermatheca not longer than wide . . . . . 17.
15. Vulva at 78–82%; posterior uterine branch with rudimentary ovary *vulnus* ALLEN & JENSEN (cf. under 9).
Vulva at 73–79%; posterior uterine branch short and undifferentiated . . . . . 16.
16. Tail tip very irregular, with more or less distinct mucro . . . . . *irregularis* n. sp.
Tail tip regularly rounded and annulated . . . . . *pratensis* (DE MAN).
17. Posterior uterine branch with rudimentary ovary . . *subpenetrans* TAYLOR & JENKINS
Posterior uterine branch short and undifferentiated . . . . . 18.
18. Tail tip smooth, rounded; V usually at 78–84% . . . . . *penetrans* (COBB). .
Tail tip annulated, usually truncate; V at 75–81% . . . . . *convallariae* SEINHORST.

1. *Pratylenchus pratensis* (DE MAN, 1880) FILIPJEV, 1936.

Syn. *Tylenchus pratensis* DE MAN, 1880; 1884 ♀.
Pratylenchus pratensis in COOMANS, 1958 partim; PAETZOLD, 1958.
Pratylenchus helophilus SEINHORST, 1959.

Nec *Tylenchus pratensis* DE MAN, 1881; 1884 ♂.
Tylenchus pratensis in VAN POETEREN, 1920; STEINER, 1927; BOVIEN, 1927.
Anguillulina pratensis in GOFFART, 1929; GOODEY, 1932; GADD & LOOS, 1941.
Pratylenchus pratensis in THORNE, 1934; THORNE, 1940; FILIPJEV & SCHUURMANS STEKHOVEN, 1941; THORNE, 1949; GOODEY, 1951; OOSTENBRINK, 1954; MEYL, 1955; PAETZOLD, 1955; OOSTENBRINK, 1956; SLOOTWEG, 1956; YOKOO, 1956.

Measurements:

Females (freshly relaxed specimens; n = 52):
L = 509 μ (402–632); V = 76,0–80,2%; a = 21,8–30,3; b = 5,5–7,6; c = 13,7–26,8; G = 24–54%; stylet = 12–16 μ.

Females (fixed in F.A.A. and mounted in glycerine; n = 27):
L = 485 μ (386–614); V = 75,5–80,0%; a = 22,3–33,0; b = 5,0–6,4; c = 12,8–22,0.

Males (fixed in F.A.A. and mounted in glycerine; n = 12):
L = 447 μ (379–535); a = 24,3–32,8; b = 4,7–6,5; c = 15,6–20,1; T = 39–50%; stylet = 12–15 μ.

Female (neotype freshly relaxed): L = 601 μ; V = 78,0%; a = 29,2; b = 7,2; b′ = 4,6; c = 23,6; stylet = 16 μ.
Fixed in F.A.A. and mounted in glycerine: L = 535 μ; V = 78,9%; a = 29,4; b = 6,9; b′ = 4,5; c = 24,5; G = 36%.

Male (neoallotype; fixed in F.A.A. and mounted in glycerine):
L = 424 μ; a = 29,2; b = 5,6; c = 15,9; T = 39%; stylet = 12 μ.

Body straight or nearly so when killed by gentle heat. Cuticle with fine striations. Lateral field with four incisures, the outer ones smooth or weakly

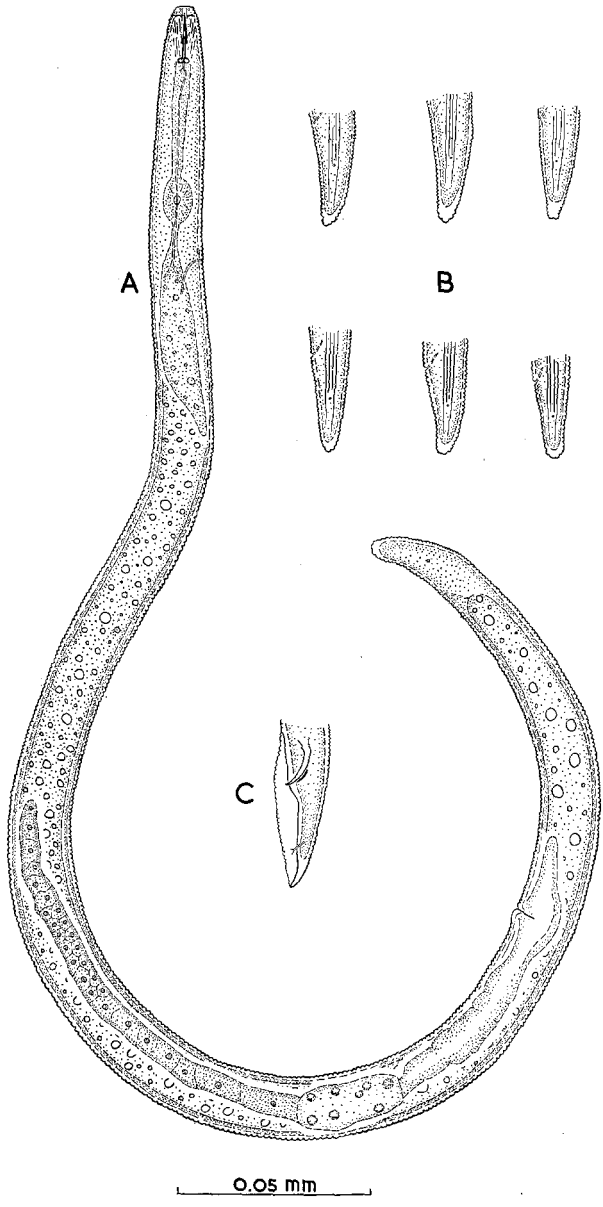

FIG. 10. *Pratylenchus pratensis* (DE MAN): A: Adult female; B: Variation in shape of female tail; C: Male tail.

crenate. Hemizonid immediately anterior to excretory pore, not very distinct. Stylet knobs well separated. Orifice of dorsal oesophageal gland 2,5 μ behind spear base.

Female: Ovary prodelphic, outstretched, oocytes in single row except for short zone near anterior end. Spermatheca oblong, as in *P. goodeyi;* in living

specimens it is visible at a magnification of 20 ×, appearing as a conspicuous light rectangle, anteriorly set off sharply against the dark intestine. Posterior uterine branch short, slightly longer than body diameter, undifferentiated. Tail tapering, 2,5–3 times as long as anal body diameter; tip varying in shape from obliquely and narrowly rounded to rather broadly rounded; annulated, but not so regularly and distinctly as the other body parts. Sometimes there are only two annules on the tip, giving it a bifid appearance (Fig. 10 B).

Male: Similar to that of *P. irregularis*.

Diagnosis: This species resembles *P. crenatus*, *P. convallariae* and *P. irregularis*. From the first it is differentiated by the weaker annulation, the presence of only 4 lateral incisures, the presence of a spermatheca and males, and by the more anterior vulva position. *P. convallariae* has a round spermatheca and a more truncate tail, while the non-mucronate tail tip distinguishes *P. pratensis* from *P. irregularis;* the latter species appears also to be slightly larger in size and to have longer gonads in both sexes, but the material available was too little to be sure on this point.

The male described by DE MAN in 1881 and figured in 1884, might rather belong to *P. penetrans*, since the drawing shows a coarsely annulated bursal edge and a short tail. Males of *P. pratensis* have a more slender tail and a very finely annulated bursal edge. De MAN's male was stated to have been found in dry clay soil on the Island of Walcheren, together with *Tylenchorhynchus dubius*, which species prefers the same type of soil as *P. penetrans*.

Neotype: Female on slide e 21.

Neoallotype: Male on slide e 3.

Neotype locality: Between Leiden and Valkenburg.

Neotype habitat: Moist meadow.

Neotypes in collection of the Plantenziektenkundige Dienst, Wageningen.

Geographical distribution: *P. pratensis* is known from The Netherlands; from Belgium (meadow near Drongen; the statement of COOMANS 1958 clearly shows that he had a mixture of *P. pratensis* and *P. crenatus*) and from Germany (PAETZOLD, 1958). The majority of literature references of *P. pratensis* relates to other *Pratylenchus* species.

2. *Pratylenchus thornei* SHER & ALLEN, 1953.

Measurements:

Females (fixed in F.A.A. and mounted in glycerine; n = 37):

L = 408–708 μ; V = 74,4–79,0%; a = 25,3–36,4; b = 5,4–8,3; c = 18,6–25,1; G = 24–38%; stylet = 15–19 μ.

Male (fixed in F.A.A. and mounted in glycerine):

L = 492 μ; a = 29,0; b = 6,2; c = 20,3; stylet = 16 μ; anterior end of testis indistinct.

A large and slender species. When killed by gentle heat the body assumes an open C-shape, unlike most other *Pratylenchus* species, which lie either quite or almost straight, or coiled. Lip region high, conical, consisting of three annules. Body annulation fine, not conspicuous. Lateral field with 4 incisures, the outer

ones straight or weakly crenate. In one specimen oblique striae were observed in the central zone in the prevulvar region. Tail tip broadly rounded or (more commonly) truncate.

Male: Shape of lip region as in female. Spicules very long (21 μ). Only two males are known.

Distribution and host plants: This species seems to be confined to the Northern Temperate Zone. Known from the Netherlands, where it occurs on heavy clay soils; reported from *Iberis* sp., corn and several fruit trees (red currant, apple, pear, plum, cherry) (OOSTENBRINK, 1954). Found by author in soil near Halle, Germany. Also known from the U.S.A. (California and Utah). In Utah damage to wheat was observed (SHER & ALLEN, 1953).

3. *Pratylenchus delattrei* LUC, 1958.

Measurements (after LUC, 1958).

Females (n = 13): L 386–470 μ; V = 75,3 % (72,7–80,5); a = 20,4–25,8; b = 3,7–4,8[1]; c = 18,0–22,3; stylet 16,5–18 μ.

Male: unknown.

A small and stout species. Lateral field with four incisures, extending past phasmid. Labial sclerotization well developed; basal plate convex anteriorly; laterally the framework extends into body about 1,5 annule. Stylet knobs well developed, with flat anterior margins. Ovary as in *P. pratensis;* spermatheca absent. Posterior uterine branch undifferentiated, slightly longer than body diameter. Tail tapering, with smooth, regularly rounded tip.

This species is known from Madagascar only. It was found in cotton, corn, *Sorghum vulgare* PERS., *Abutilon asiaticum* D. DON and *Corchorus acutangulus* LAM.

4. *Pratylenchus irregularis* nov. sp.

Syn. *Pratylenchus pratensis* in PAETZOLD, 1955; perhaps in MEYL, 1955.
Pratylenchus spec. in PAETZOLD, 1958.

Measurements after PAETZOLD (1955 and 1958):

Females (n = 15): L = 481–685 μ; V = 75–81 %; a = 24,1–32,2; b = 4,2–6,9; c = 16,2–19,9.

Males (n = 15): L = 471–580 μ; a = 26,8–32,6; b = 3,9–5,1; c = 15,5–19,9.

Own measurements (specimens fixed and mounted):

Females (n = 8): L = 570 μ (529–615); V = 76,6–79,6 %; a = 24,1–28,8; b = 5,3–7,0; c = 15,1–19,5; G = 37,8–51,0 %; stylet = 16–17 μ.

Males (n = 12): L = 511 μ (434–599); a = 25,6–33,2; b = 5,7–6,9; c = 15,2–19,7; T = 45–57 %; stylet = 15–16 μ.

Female (holotype): L = 535 μ; V = 77,4 %; a = 26,0; b = 6,6; c = 18,2; G = 44 %; stylet = 16 μ.

Male (allotype): L = 510 μ; a = 29,1; b = 6,5; c = 17,5; T = 45 %; stylet = 15 μ.

[1] Oesophagus obviously measured until end of terminal lobe, like DE MAN did.

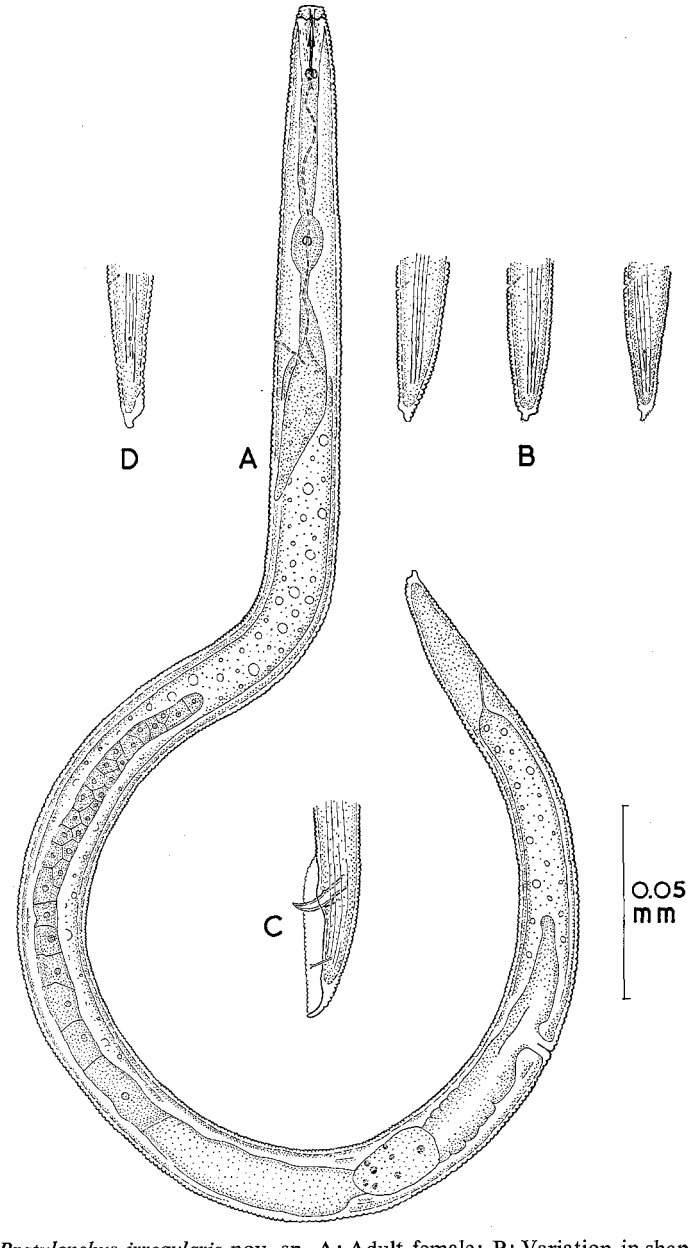

FIG. 11. *Pratylenchus irregularis* nov. sp. A: Adult female; B: Variation in shape of female tail; C: Male tail. *P. goodeyi* SHER & ALLEN: D: Female tail.

Cuticle with fine striations. Lateral field with 4 incisures. Lip region with 3 annules[1]. Hemizonid distinct, just anterior to excretory pore, which is situated somewhat more than one body width behind the posterior edge of the median

[1] 3 or 4 annules according to PAETZOLD (1958).

bulb. Orifice of dorsal oesophageal gland 3–3,5 μ behind spear base. Basal knobs of spear well separated.

Female: Ovary outstretched, oocytes in single row except for a short zone near anterior end. Spermatheca broadly oval. Posterior uterine branch short, undifferentiated. Tail 2–3 times as long as anal body diameter. Shortly before the tip annulation suddenly becomes more coarse; the tip carries an irregularly shaped, more or less pointed projection.

Male: Gonad and spicules typical of genus. Testis about half (47–58 %) as long as vas deferens. Bursal edge finely crenate. Phasmid extends into bursa.

Holotype: Female on slide f 5.

Allotype: Male on slide f 5.

Paratypes: 7 females and 11 males on slides f 1, f 2, f 3, f 4 and f 6. All types in collection of Plantenziektenkundige Dienst, Wageningen.

Type locality: Aseleben, Germany.

Type habitat: Silt meadow, chlorid content of soil 1,524 %.

Diagnosis: This species resembles *Pratylenchus pratensis* and *P. goodeyi*. From the former it is differentiated by the irregular shape of the female tail, and perhaps by slightly larger size and longer gonads; from the latter by the number of lip annules and by the irregular shape of the female tail, the outline of the tail being much more smooth and regular in *P. goodeyi* (See Fig. 11D).

MEYL (1955) states to have found *P. pratensis* in a very similar habitat, in two localities in Germany, with 0,5 % and 1,9 % NaCl respectively. He did not give a description of his specimens, but states the proportion males: females to be 1:3 and 1:2 respectively, which might point to *P. irregularis*. MEYL's material was not available for study.

There is a third reference in the literature to *P. pratensis* being found in brackish soils, viz. in Iceland (DE CONINCK, 1943), but these specimens could also no longer be examined.

Thus *P. irregularis* is known only from Central Germany.

5. *Pratylenchus crenatus* nom. nov.

Syn. *Anguillulina pratensis* in GOFFART 1929, partim.

- *Pratylenchus pratensis* in THORNE, 1949; SHER & ALLEN, 1953; OOSTENBRINK, 1954; COOMANS, 1958 partim.

Nec *Tylenchus pratensis* DE MAN 1880; 1881; 1884.

- *Tylenchus pratensis* in VAN POETEREN, 1920; STEINER, 1927; BOVIEN, 1927; STEINER, 1932.
- *Anguillulina pratensis* in GOODEY, 1932; GADD & LOOS, 1941.
- *Pratylenchus pratensis* in THORNE, 1934; THORNE, 1940; HASTINGS, 1939; W. SCHNEIDER, 1939; FILIPJEV & SCHUURMANS STEKHOVEN, 1941; GOODEY, 1951; MEYL, 1955; PAETZOLD, 1955; YOKOO, 1956; SLOOTWEG, 1956.

Measurements:

Females (fixed and mounted; n = 131):

L = 323–596 μ; V = 78,2–86,3 %; a = 19,7–29,9; b = 4,9–7,9; c = 16,4–26,8; G = 26–48 %; stylet = 14–18 μ; distance vulva-anus 39–84 μ.

Females (freshly relaxed; n = 33):

L = 359–587 μ; V = 80,5–86,2%; a = 20,1–32,3; b = 4,3–6,0; c = 18,1–26,6; distance vulva-anus 36–79 μ.

Males not seen.

A moderately slender, small species, most specimens being smaller than 500 μ. Body usually coiled when killed by gentle heat. Lip region with 3 annules. Body annulation prominent. Lateral field with 4 main incisures, the outer ones strongly crenate; the central zone with sculpture forming normally two somewhat irregular additional lateral lines close to the inner incisures. Vulva usually at 81–84%; only very exceptionally at 78–80%. Tail broadly rounded; tip often spatulate, coarsely and distinctly annulated. Ovary with oocytes in single row, except for a short zone near anterior end. Spermatheca absent. Posterior uterine branch short, undifferentiated.

Males of this species have been described several times (THORNE, 1949; SHER & ALLEN, 1953. The latter authors wrote: Males of this species are infrequent, being absent in some collections). Although *P. crenatus* is extremely common in Europe, not a single male has yet been found by us. The females do not possess a spermatheca, which indicates that males are either extremely rare or do not occur at all. The males referred to above might have belonged to *P. pratensis*, with which species *P. crenatus* has sometimes been confused, or to *P. penetrans*, which often occurs together with *P. crenatus*.

In 1929 GOFFART published a paper on *Anguillulina pratensis*. It seems probable that he dealt mainly with *P. crenatus*. His specimens had L = 425–633 μ; V = 81,1–82,5%; c = 20–23,6. Since he found males too, the population might also have contained *P. penetrans*. He stated *A. pratensis* to be harmful to wheat, oats and barley, and to a minor degree to rye, sugar beet and cabbage, while potato was hardly attacked. These data might also point to *P. neglectus*, but this species does not normally occur together with *P. penetrans* and is, moreover, more harmful to cabbage. In pot experiments GOFFART found rapid multiplication on barley in pure sand, whereas the present author found that *P. neglectus* did not thrive in this soil type. Thus the evidence is in favour of the supposition that GOFFART worked mainly with *P. crenatus*.

Diagnosis: This species resembles *P. pratensis* and *P. convallariae*, which also have 3 lip annules and an annulated tail tip. Both species have, however, numerous males and the females possess a spermatheca. In addition, these species have a much weaker body annulation, the vulva position is more anterior, and there are only 4 incisures in the lateral field. From occasional specimens of *P. coffeae* showing annulation round the tail tip *P. crenatus* may be distinguished by the 3 lip annules, the absence of a spermatheca in the females, and the lack of males.

Distribution and host plants: This species is very polyphagous. An account of its host plants is given by OOSTENBRINK (1954). It has been reported from the Netherlands (very common on sandy soils), Germany (GOFFART, 1929; found by author together with *P. penetrans* near MAGDEBURG and HALLE), England (Sydenham: THORNE, 1949) and the U.S.A. (SHER & ALLEN, 1953).

The neotype, designated by SHER & ALLEN for *P. pratensis*, becomes the holotype of *P. crenatus*. Measurements: L = 0,45 mm; V = 81%; a = 25; b = 6; c = 21; stylet = 17 μ. Collected from soil around grass, Sydenham, England.

6. *Pratylenchus zeae* GRAHAM 1951.

For descriptions of this species see GRAHAM, 1951; SHER & ALLEN 1953 and TAYLOR & JENKINS, 1957.

Distribution and hosts: A mainly subtropical species. Known from the south-eastern states of the U.S.A. (Georgia: corn; South Carolina: corn; Florida: *Hibiscus cannabinus*) and Australia (sugarcane and peach, COLBRAN, 1955).

7. *Pratylenchus subpenetrans* TAYLOR & JENKINS, 1957.

Measurements see TAYLOR & JENKINS, 1957.

This species is said to differ from *P. penetrans* by its smaller body length, longer posterior uterine branch carrying some ovarian tissue, and shape of the labial framework, which resembles that of *P. thornei*. Material of *P. subpenetrans* was kindly lent to the author by Prof. JENKINS. No differences could be seen between the labial framework of *P. subpenetrans* and *P. penetrans*, neither is the difference in size real (see under *P. penetrans*). The structure of the posterior uterine branch could not be made out with certainty. Thus the possibility cannot be excluded that *P. subpenetrans* is identical with *P. penetrans*, but the author is at present not in a position to decide this.

P. subpenetrans is known only from pasture grass. Maryland, U.S.A.

8. *Pratylenchus penetrans* (COBB, 1917) CHITWOOD & OTEIFA, 1952.

Syn. *Tylenchus gulosus* KÜHN, 1890; FISCHER, 1894.
- *Tylenchus penetrans* COBB, 1917 ♂.
- *Tylenchus pratensis* in STEINER, 1927; BOVIEN, 1927; STEINER, 1932.
- *Tylenchus (Chitinotylenchus) penetrans* in RAHM, 1928 and 1929 (somewhat doubtful).
- *Anguillulina pratensis* in GOODEY, 1932 and 1933; W. SCHNEIDER, 1939.
- *Pratylenchus pratensis* in FILIPJEV & SCHUURMANS STEKHOVEN, 1941; GOODEY, 1951.
- *Pratylenchus penetrans* in SHER & ALLEN, 1953.
- (possibly) *Tylenchus pratensis* DE MAN 1881; 1884 ♂; nec 1880, 1884 ♀.

Nec *Tylenchus penetrans* COBB, 1917 ♀.

Measurements:

Females (freshly relaxed, and mounted specimens; n = 84):
L = 343–811 μ; V = 75,1–84,3%; a = 18,9–31,9; b = 5,3–7,9; c = 15,3–23,8; G = 24–54%; stylet = 15–17 μ.

Females (freshly relaxed specimens; n = 16):
L = 455–630 μ; V = 77,6–82,5%; a = 20,0–28,1; b = 5,7–7,7; c = 15,7–25,7.

Males (specimens fixed and mounted; n = 34):

L = 305–574 μ; a = 22,9–33,8; b = 5,4–7,3; c = 15,8–21,5; T = 36–58%; stylet = 13–16 μ.

Neotype see SHER & ALLEN, 1953.

A moderately slender species. Body almost straight when killed by gentle heat. Cuticular annulation not prominent. Lip region with rounded outer angles, composed of three annules. Median oesophageal bulb usually broadly oval or even circular. Lateral field with four incisures, the outer ones straight or weakly crenate. Occasionally specimens may be found with oblique striae in the central zone.

Female: Ovary with oocytes in single row, except for a short zone near anterior end; ovary usually not extending to oesophageal glands. Spermatheca round, sometimes more square. Posterior uterine branch short and undifferentiated. Tail generally broadly rounded, the dorsal contour often slightly concave. Tip smooth.

Male: Testis shorter than vas deferens. Bursal edge coarsely crenate. Tail about twice as long as anal body diameter.

This species has often been mentioned in the literature as *Tylenchus* (or *Anguillulina) pratensis*. Thus BOVIEN (1927) mentioned *Tylenchus pratensis* as a parasite of barley in Denmark. He reported males to be present. Microphotographs, which he kindly put at the writer's disposal, indicated that the species concerned was *P. penetrans*.

The paper by STEINER (1927) has been commented upon in Chapter V. STEINER (in litt.) confirmed that his papers of 1927 and 1932 referred to *P. penetrans*.

In 1881 DE MAN described the male of *T. pratensis*. The tail of his only specimen is figured in the 1884 book; it is short (not more than twice the anal body diameter) and shows a coarsely crenate bursal edge, agreeing well with *penetrans* in these respects. It would serve no purpose to look again at the locality where it was found (the island of Walcheren), because this has since twice been flooded by the sea.

GOODEY (1932) synonymized *pratensis* with *penetrans*, *coffeae*, *brachyurus* and *neglectus*. The text shows that he had not seen the three last mentioned species. He had not seen DE MAN's material either, so that the specimens he actually studied most probably belonged to *P. penetrans*. This is confirmed by the description and the list of host plants. GOODEY (1933) and W. SCHNEIDER (1939), as well as FILIPJEV & SCHUURMANS STEKHOVEN (1941), followed GOODEY (1932).

GOODEY (1951) again treats *brachyurus* and *coffeae* as good species, does not mention *penetrans* and *neglectus*, and copies the illustrations from the 1932 paper. So the section on *P. pratensis* in the 1951 book also refers to *P. penetrans*.

RAHM (1928, 1929) reported to have found *P. penetrans* in Brasil in roots of *Citrus* sp. and *Dianthus caryophyllus* L. He gives, however, rather aberrant measurements (length of male 800 μ, of females 879 and 1360 μ) and it appears unlikely that he made a measuring error, because he commented on the measurements himself. Some doubt remains, therefore, as to the identity of his specimens.

SLOOTWEG (1956) suggested that physiological races might occur within this species. He had found that *P. penetrans* attacking narcissus did not damage lilies, and vice versa. On examining a population from lily, the present writer could detect no differences from the common *penetrans*. From narcissus two populations were available for study. One proved morphologically similar to *penetrans*, but had only few males; the females of the other population (only fixed specimens available) were characterized by the very long ovary. Measurements (n = 15): L = 550–673 μ; V = 77,2–83,5%; a = 19,3–26,6; b = 6,6–8,6; c = 16,4–24,5; G = 45–75%; stylet = 16–17 μ. In these specimens the ovary usually extended past the oesophageal glands and not infrequently even past the median bulb (mean ovary length 63%). Most females of this population bore eggs; five egg-bearing specimens of the normal *penetrans* had ovary length 44% (35–54%). The narcissus population had been collected at a spot where the plants showed a typical disease („van de wortel gaan").

Distribution and hosts: Lists of host plants were given by JENSEN (1953) and OOSTENBRINK (1954). The species seems to be widely spread in the temperate zone of the Northern Hemisphere. It has been reported from many states of the U.S.A. (SHER & ALLEN, 1953), Canada (SHER & ALLEN, 1953), ? HASTINGS, 1939), Brasil (?; RAHM, 1928, 1929), the Netherlands (OOSTENBRINK, 1954), England (GOODEY, 1932), Germany (found by author near Magdeburg, Halle and Hamburg) and Denmark (BOVIEN, 1927). See also GOODEY & FRANKLIN, 1956.

9. *Pratylenchus convallariae* SEINHORST, 1959.

Syn. *Pratylenchus pratensis* in SLOOTWEG, 1956, p. 196.

(prob.) *Tylenchus pratensis* in VAN POETEREN, 1920, p. 44; COBB, 1921, p. 95.

Measurements (specimens fixed and mounted):

Females (n = 51): L = 389–597 μ; V = 75,6–81,2%; a = 20,6–30,4; b = 5,6–7,6; c = 17,1–22,7; G = 30–47%; stylet = 14–17 μ.

Males (n = 14): L = 380–521 μ; a = 23,5–33,8; b = 5,1–6,4; c = 17,1–21,5; T = 36–55%; stylet = 14–16 μ.

Body moderately slender; long specimens were found to be more slender than short ones. Body almost straight when killed by gentle heat. Annulation of cuticle fine. Lateral field with 4 incisures, the outer ones weakly crenate, the inner ones amalgamating at about level of phasmid. Lip region with 3 annules; outer angles rounded. Labial framework as in *P. penetrans*. Stylet knobs high and rather narrow, Hemizonid distinct.

Female: Ovary with oocytes in single row, except for short zone near anterior end. Spermatheca round. Posterior uterine branch a little over one body width long. Phasmid about middle of tail, rather inconspicuous. Tail with coarsely, irregularly annulated posterior edge, truncate in most specimens.

Male: Very similar to that of *P. penetrans*. In some specimens the tail tip appeared bifid, in others the bursal edge was slightly irregular immediately before the tail tip. Bursal edge coarsely crenate. Testis shorter than vas deferens;

in the specimens studied the demarcation between these two parts was more distinct than in other species of *Pratylenchus*.

Diagnosis: *P. convallariae* resembles *P. pratensis*, *P. crenatus* and *P. penetrans*. From *pratensis* it may be distinguished by the truncate tail and round spermatheca, from the second by the presence of a spermatheca and numerous males, by the weaker body annulation, 4 incisures in lateral field, more anterior position of vulva, and tail shape; from *P. penetrans* by the annulated tail tip and position of vulva. This last difference is small, but on examination of 50 females of both species was found to be highly significant (difference 6 times its standard error).

Distribution and hosts: *P. convallariae* is known only from *Convallaria*, where it causes severe damage (VAN POETEREN, 1920). It has been reported from the Netherlands and from Germany.

10. *Pratylenchus vulnus* ALLEN & JENSEN, 1951.

For synonymy, lectotype and illustrations see SHER & ALLEN, 1953. Measurements (specimens fixed and mounted):

Females (n = 14): L = 470–718 μ; V = 77,3–82,2%; a = 27,8–37,6; b = 5,7–7,7; c = 18,4–24,7; G = 22–44%; stylet = 13–16 μ.
Males (n = 9): L = 489–606 μ; a = 32,1–38,5; b = 6,3–7,2; c = 20,5–23,6; T = 34–53%; stylet = 13–15 μ.

A very slender species. Body nearly straight when killed by gentle heat. Cuticular annulation fine, not conspicuous. Lateral field with 4 incisures, the outer ones smooth or weakly crenate. The inner incisures frequently run closer to each other than to the adjacent outer ones. Lip region composed of 3–4 annules, higher than in *P. penetrans* and in shape somewhat reminiscent of *Tylenchorhynchus brevidens* ALLEN, 1955. This difference is indicated in the illustrations by SHER & ALLEN (plates 66 and 67). The median oesophageal bulb is generally rather narrow and oblong, narrower than in most other *Pratylenchus* species.

Female: Ovary with oocytes in single row, except for short zone near anterior end. Spermatheca oblong. Posterior uterine branch with rudimentary ovary. Tail tapering to narrowly rounded tip.

Male: Testis usually longer than vas deferens. A typical „packet" of spermatids was not observed.

The Dutch specimens studied were smaller than the Californian ones and possessed a slightly shorter stylet and a much shorter ovary; probably they were young ones.

Distribution and host plants: An extensive list of host plants was published by JENSEN (1953). This species seems to be the predominant *Pratylenchus* species in California (SHER & ALLEN, 1953). It is also known from Maryland, Arkansas and Oregon. In the Netherlands it occurs too, but is apparently very rare, being found in two localities only, viz. in a tree nursery at Boskoop (thus possibly imported) and at Tegelen.

11. *Pratylenchus goodeyi* SHER & ALLEN, 1953.

Syn. *Tylenchus musicola* in GOODEY, 1928; FILIPJEV & SCHUURMANS STEKHOVEN, 1941.

Anguillulina musicola in GOODEY, 1932.

Nec *Tylenchus musicola* COBB, 1919; *Pratylenchus musicola* in TAYLOR & LOEGERING, 1953.

For measurements and description see SHER & ALLEN (1953) and GOODEY (1928). Part of T. GOODEY's material was examined by the author (kindly sent to him by Dr. J. B. GOODEY), who found the vulva position to vary from 71,7–76,7% (SHER & ALLEN: 73–75%; GOODEY (1932); about 2/3 of body length from head and; GOODEY (1933): 69–75%). Lateral field with four incisures, running about equidistant from each other.

Female: Tail resembles that of *P. irregularis* in shape, but the outline is much more smooth and regular than in that species (Fig. 11D); its sides are slightly concave. Spermatheca oblong, often nearly rectangular. In the fixed specimens the spermatozoa gave the impression of being larger than in other *Pratylenchus* species. Ovary with oocytes in single row, except for short zone near anterior end. Posterior uterine branch short and undifferentiated.

Male: Spicula with dorsally strongly concave shaft.

The home country of this species is unknown. It has only once been found, in banana roots, Kew Gardens, England, by T. GOODEY.

12. *Pratylenchus tumidiceps* MERZHEEVSKAYA, 1951.

Measurements (After MERZHEEVSKAYA, 1953):

Females: L = 325–500 μ; V = 75–77%; a = 27,9–28,8; b = 3,8–5,1 (probably measured until end of terminal oesophageal lobe); c = 19,8–30,6; stylet = 14–15 μ.

Males: L = 315–430 μ; a = 27–30; b = 3,8–5,1; c = 14–15; stylet = 14–15 μ.

Of this species no material was available for study. It is said to be characterized by the shape of the body, which is parallel as far as the lip region, there narrowing suddenly. This character is occasionally found in other species as well, especially in *P. crenatus* and *P. neglectus*, probably as a fixation artefact. However, the large number (188) of specimens of *P. tumidiceps* known suggests the phenomenon may be natural here. The number of annules on the lip region is not given; the illustration shows that this body part is low, so that the number may well be two. If this is so, the species resembles *P. scribneri* and especially *P. hexincisus*, but differs in the occurrence of males and the more slender body and shorter tail. No mention is made of a spermatheca, but the fact that males were found suggests that this organ is probably present.

Distribution and hosts: Known only from White Russia, chiefly occurring in roots of wheat and rye, but found also in flax.

13. *Pratylenchus scribneri* STEINER 1943.

Syn. *Tylenchus penetrans* COBB 1917, female.

Measurements:

Females from Holland (freshly relaxed, n = 18):
L = 613 μ (481–731); V = 77,3 % (75,1–79,3); a = 21,0–30,7; b = 5,0–7,3; c = 14,2–20,6; stylet = 15–17 μ; intra-uterine eggs 64–73 × 23–25 μ.
Females from Florida (fixed and mounted; n = 37): L = 523 μ (409–616); V = 73,3–79,2 %; a = 20,0–29,3; b = 5,7–7,7; c = 13,3–18,4; G = 31–66 %; stylet = 14–17 μ; intra-uterine eggs 43–69 × 18–22 μ.
Male (Florida, fixed and mounted): L = 469 μ; a = 27,6; b = 6,6; c = 17,6; T = 53 %; stylet = 12 μ.

A large and rather stout species. Body nearly straight when killed by gentle heat. Cuticular annulation fine. Lateral field with four incisures; in young females sometimes a fifth was observed in the pre-vulvar region. Lip region with straight anterior margin; second annule distinctly wider than first, so that the sides of the lip region are „stepped". (Fig. 12A).

Female: Ovary with oocytes in single row, except for short zone near anterior end. In egg-laying females it originates in oesophageal region. Spermatheca absent. Tail with broadly rounded tip.

Male: Lip region with slightly convex anterior margin; apical annule not higher than second. Spicula slender, curved. Outer lateral incisures strongly crenate on tail. Bursal edge moderately distinctly crenate. Testis about as long as vas deferens.

This species is related to *P. hexincisus*, but differs from it by its larger size, longer tail (both relatively and absolutely) and the presence of four incisures in the lateral field.

The above description from specimens from *Hippeastrum* sp. This is undoubtedly the species described by SHER & ALLEN. Whether it is the true *scribneri* of STEINER, remains to be shown by further investigations. STEINER gave slightly different measurements (L = 278–592 μ; c = 16,9–22,7) and his specimens were obtained from potato.

Distribution and hosts: *P. scribneri* is known from the Northern Temperate Zone, occurring in the U.S.A. (Tennessee, potato: STEINER, 1943; Florida, *Hippeastrum* (recorded as *Amaryllis)*: SHER & ALLEN, 1953; CHRISTIE & BIRCHFIELD, 1958) and recently found in the Netherlands on *Hippeastrum*. The author found two females in a sample of garden soil from Yugoslavia, but it was not possible to determine whether they belonged to *scribneri* or to *hexincisus*.

14. *Pratylenchus hexincisus* TAYLOR & JENKINS 1957.

Measurements (After TAYLOR & JENKINS, 1957):
Females: L = 436 μ (342–540); V = 78,0 % (75,3–82,2); a = 22,6 (18,2–28,8); b = 7,2 (5,9–8,4); c = 18,6 (16,1–22,7); stylet 14,5–15,4 μ.
Male: Unknown.

A small and rather stout species. Cuticular annulation not very distinct. Lip region similar in shape to that of *P. scribneri*. The shape was accurately drawn by TAYLOR and JENKINS, but not used as a diagnostic character. Lateral field with six incisures, about equidistant from each other. Near the vulva the inner two may break up into oblique striae; further forward they appear as regular as

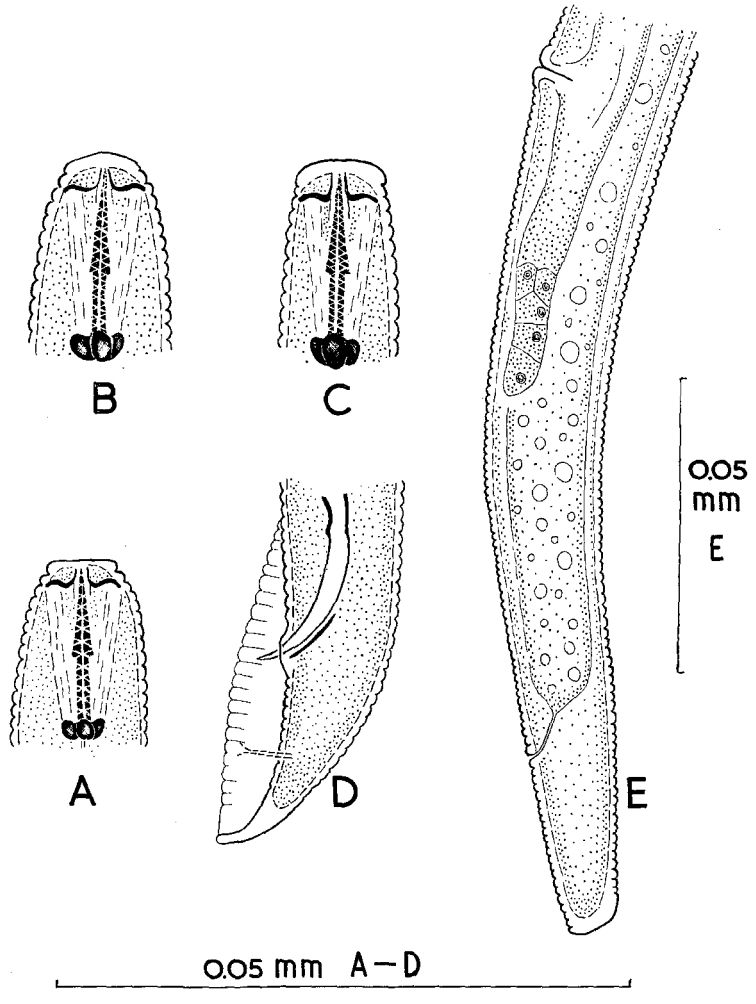

FIG. 12. *Pratylenchus scribneri* STEINER. A: Head end of female. *P. neglectus* (RENSCH). B: Head end of female; C: Head end of male; D: Tail of male. *P. coffeae* (ZIMMERMANN): E: Posterior body end of female, showing elongate posterior uterine branch with rudimentary ovary.

the four others. Ovary with oocytes in single row except for short zone near anterior end. Posterior uterine branch short, undifferentiated. Tail with smooth, rounded tip. Phasmids anterior to middle of tail.

This species resembles *P. scribneri*, but is smaller and has six incisures in the lateral field. It should be pointed out, however, that the length indications of *P. hexincisus* agree fairly well with those given by STEINER for *P. scribneri*.

Distribution and hosts: Known only from Maryland, U.S.A., on corn (TAYLOR & JENKINS, 1957).

15. *Pratylenchus neglectus* (RENSCH, 1924) CHITWOOD & OTEIFA, 1952.
Syn. *Aphelenchus neglectus* RENSCH, 1924; GOFFART, 1927.
– *Pratylenchus minyus* SHER & ALLEN, 1953.

Measurements:

Females (specimens fixed and mounted; n = 900):
L = 461 μ (312–588); V = 81,6% (75,5–86,6); a = 16,5–32,2; b = 4,9–7,8; c = 20,0 (13,8–26,8); G = 25–60%; stylet = 15–19 μ; intra-uterine eggs 42–67 × 16–24 μ.

Males (fixed and mounted; n = 2):
L = 420–524 μ; a = 25,5–28,9; b = 6,2–6,3; c = 17,3–21,7; T = 42–56%; stylet = 15–17 μ.

Female (neotype; fixed and mounted): L = 513 μ; V = 79,2%; a = 21,2; b = 6,2; c = 22,3; G = 41%; stylet = 16 μ.

A small and rather stout species. When killed by gentle heat, young females lie coiled, whereas older ones assume an almost straight position. Cuticular annulation prominent on young specimens; on older ones it may become very obscure. Lateral field with four incisures; the central zone bears numerous oblique striae. Lip region composed of two annules; anterior margin of apical annule convex. The second annule is wider than the first, but the sides of the lip region are not distinctly „stepped" (Fig. 12B).

Female: Ovary with oocytes in single row, except for short zone near anterior end. Spermatheca absent. Ovary does not, as a rule, extend as far as the oesophagus, even in egg-bearing females. Posterior uterine branch short, undifferentiated. Tail length equal to 1,5–2,5 times the anal body diameter; tail more or less conical, with rounded or trapezoid, smooth tip.

Male: Apical lip annule conspicuously high (Fig. 12C). Spicules rather slender, the shaft not set off as sharply as in *P. coffeae* (Fig 12D). Bursal edge coarsely and distinctly crenate. Phasmids extend into bursa. Three males are known of this species; two from the Netherlands, one from the U.S.A. This last specimen, described by SHER & ALLEN, was rather smaller than the Dutch ones (L = 340 μ).

Younger females of this species differ strongly from older ones, the younger being smaller and more slender, showing distinct body annulation and lateral field with oblique striae, and having a slender, concave-conoid tail; while the latter are larger and stouter, the body annulation and lateral field are rather indistinct, and the tail is convex-conoid and plump.

There are some indications that in the Netherlands some physiological races may occur. Also there seem to be differences in host range between the American populations and the Dutch ones. Although the present writer was unable to detect morphological differences, future investigations might establish the presence of several races or even species, in which case the specific name *minyus* would again become valid.

P. neglectus can be distinguished from *P. hexincisus* and *P. scribneri* by the location of the vulva (usually 80–84%, in American specimens up to 88%) and

the shape of the lip region; from *P. scribneri* also by smaller size and the structure of the lateral field.

Distribution and hosts: A widespread species from the Northern Temperate Zone; very polyphagous. Reported from the U.S.A. (California, Nevada, Colorado, from a large number of crops and weeds, SHER & ALLEN), Canada (tobacco, MOUNTAIN), The Netherlands (see OOSTENBRINK 1954 for host plants), Germany (on cereals, sugarbeet, poppy, also on the indigenous grass *Weingaertneria canescens*, see RENSCH, 1924; GOFFART, 1927); also known from Denmark (grass roots, Lyngby; specimens kindly sent by Dr. BOVIEN).

Neotype: Female collected October 1956, by Mr. J. KRADEL, on slide L 273.

Neotype host: Roots of rye.

Neotype locality: Former estate of Theessen, near Magdeburg, Germany.

Neotype in collection Plantenziektenkundige Dienst, Wageningen.

16. *Pratylenchus brachyurus* (GODFREY, 1929) GOODEY, 1951.

Syn. *Tylenchus brachyurus* GODFREY, 1929.

– *Pratylenchus pratensis* in THORNE, 1940.

– *Pratylenchus leiocephalus* STEINER, 1949.

Pratylenchus steineri LORDELLO, ZAMITH & BOOCK, 1954.

Measurements (compiled from GODFREY, 1929, STEINER, 1949, SHER & ALLEN, 1953, LORDELLO, ZAMITH & BOOCK, 1954, and LORDELLO, ZAMITH & DE ARRUDAS, 1958):

Females: L = 393–750 μ; V = 82–89%; a = 15–29; b = 5–10; c = 13–28; stylet = 17–22 μ; egg 70–80 × 20–28 μ.

Males: L = 0,46–0,56 mm; a = 27–29; b = 6; c = 21; stylet = 19 μ.

For detailed descriptions of this species see GODFREY, 1929, STEINER, 1949 and SHER & ALLEN, 1953. Here only the taxonomic position of *P. steineri* is discussed. No material of this species was available for study.

LORDELLO, ZAMITH & BOOCK (1954) state that the lateral margins of the lip region in *P. steineri* are rounded. However, their illustration 1B shows a rather angular lip region; in fact, the picture is strikingly similar to the illustration given by STEINER (1949, fig. 27B). This fact once established, *P. steineri* was found to agree with *P. brachyurus* in all respects: the long stylet; the four lateral incisures; the far posterior position of the vulva; the shape of the tail tip, the variability of *P. steineri* agreeing completely with that of *Tylenchus brachyurus* as illustrated by GODFREY; the size of the eggs (GODFREY: 80 × 25 μ, used as a diagnostic character; *steineri* 70–75 × 24–28 μ; *leiocephalus* 72×20 μ); and lastly, the structure of the ovary. According to LORDELLO, ZAMITH & BOOCK, two types of ovary occur in *P. steineri:* 1. the ovary consists of a single row of oocytes throughout its length; 2. near the anterior end there is a short zone with more rows. For *P. leiocephalus* STEINER described and figured a single row of oocytes, while SHER & ALLEN remarked that occasionally some oocytes may be doubled. In view of these striking similarities and the absence of clear differences the present writer considers *P. steineri* as identical with *P. brachyurus*.

P. steineri was described as a parasite of the potato. STEINER also reported *P. leiocephalus* from this host.

Distribution and hosts: A mainly tropical and subtropical species. Reported from Hawaii (pineapple, GODFREY, 1929); the southern parts of the U.S.A. (peanut, lespedeza, cotton, corn, tobacco, potato, strawberry, okra and kenaf: STEINER, 1949; SHER & ALLEN, 1953); Brasil (potato, LORDELLO, ZAMITH & BOOCK, 1954; cotton and soya, LORDELLO, ZAMITH & DE ARRUDAS, 1958); South Africa (potato, SHER & ALLEN, 1953); Australia (pineapple, white and red clover, *Araucaria*, *Phaseolus mungo* L., *Persea americana* Mill., COLBRAN, 1955).

17. *Pratylenchus coffeae* (ZIMMERMANN, 1898) GOODEY, 1951.

Syn. *Tylenchus coffeae* ZIMMERMANN, 1898; BALLY & REYDON, 1931.
- *Tylenchus musicola* COBB, 1919; RAHM, 1928, 1929.
- *Tylenchus mahogani* COBB, 1920.
- *Pratylenchus musicola* (COBB, 1919) FILIPJEV, 1936; TAYLOR & LOEGERING, 1953.
- *Pratylenchus mahogani* (COBB, 1920) FILIPJEV, 1936.
- *Anguillulina mahogani* (COBB, 1920) in GOODEY, 1937.
- *Tylenchus (Chitinotylenchus)* sp. W. SCHNEIDER, 1938.
- *Pratylenchus coffeae* (ZIMMERMANN, 1898) in SHER & ALLEN, 1953.
- *Pratylenchus pratensis* (DE MAN, 1880) in YOKOO, 1956.

Nec *Tylenchus musicola* (COBB, 1919) in GOODEY, 1928.
- *Anguillulina musicola* (COBB, 1919) in GOODEY, 1932.

Measurements (specimens fixed in F.A.A. and mounted in glycerine):

Females (n = 69): L = 529 μ (374–698); V = 80,1 % (75,8–84,2); a = 23,7 (17,7–30,5); b = 6,8 (5,0–7,8); c = 19,0 (13,7–23,9); G = 44 % (26–63); stylet = 14–17 μ.

Males (n = 10): L = 480 μ (407–564); a = 27,4 (23,8–31,4); b = 6,5 (5,9–7,7); c = 19,1 (17,6–23,3); T = 48 % (37–58); stylet = 14–15 μ.

Female (neotype designated by SHER & ALLEN): L = 0,59 mm; V = 81,9 %; a = 34; b = 6,3; c = 21; G = 32 %; stylet = 18 μ.

Body rather slender in young females, fat in old ones. Cuticular annulation fairly conspicuous. Lateral field distinct, normally with 4–5, occasionally with 6 incisures.

Female: In young specimens the ovary extends over one-quarter of body length, in old ones over more than one-half. Spermatheca broadly oval to nearly round. Posterior uterine branch variable in length, sometimes reaching 50 μ. In about 20 % of the females examined (especially older ones) it carried a distinct rudimentary ovary (Fig. 12E). Tail tapering slightly, its length in young specimens 2–2,5 ×, in old ones 1,5–2 × anal body diameter; tip broadly rounded, truncate or indented; in some specimens appearing weakly and irregularly annulated (Fig. 9A–B).

Intra-uterine eggs often contain embryos, as was noted already by COBB (1920).

Male: Spicula very slender, shaft ventrally concave. Gonad extends over about one-half body length. Testis shorter than vas deferens. Bursal edge faintly crenate.

This species may be distinguished from *P. loosi* by the more prominent cuticular annulation, the slightly more anterior position of the vulva, the shape of the female tail, and perhaps by its shorter oesophagus and the length of the posterior uterine branch.

Tylenchus (Chitinotylenchus) sp. W. SCHNEIDER, 1938, is probably identical with this species, as SCHNEIDER himself has already suggested

Distribution and host plants: A mainly tropical and subtropical species. Reported from Indonesia (Java: coffee, ZIMMERMANN, 1898; BALLY & REYDON, 1931; bamboo, BALLY & REYDON, 1931; *Indigofera endecaphylla*, BALLY & REYDON(?); Sumatra: *Potamogeton* sp. and *Nitella* sp., W. SCHNEIDER, 1938); West Indies (bluggoe banana, COBB, 1919; mahogany, COBB, 1920); Central America (abacá, TAYLOR & LOEGERING, 1953); California *(Vitis vinifera*, STEINER, 1927); Brasil *(Musa* sp., RAHM, 1928 and 1929); Philippines (abacá, TAYLOR & LOEGERING, 1953) and Japan (potato and sweet potato, YOKOO, 1956).

There are more literature reports on *P. coffeae*, but the species may have been confused with *P. loosi.*

18. *Pratylenchus loosi* nov. sp.

Syn. (prob.): *Anguillulina pratensis* in GADD & LOOS, 1941.

– *Pratylenchus coffeae* in LOOS, 1953.

Measurements (specimens fixed in F.A.A. and mounted in glycerine):

Females (n = 34): L = 575 µ (481–639); V = 82,5 % (78,8–85,4); a = 31,9 (27,7–36,1); b = 6,4 (5,7–7,1); c = 19,9 (17,7–25,1); G = 28 % (20–40); stylet = 14–18 µ.

Males (n = 15): L = 464 µ (380–584); a = 35,3 (28,4–41,4); b = 5,9 (5,4–6,7); c = 20,8 (18,5–23,2); T = 42 % (36–52); stylet = 12–16 µ.

Female (holotype): L = 604 µ; V = 82,0 %; a = 27,7; b = 6,8; c = 17,8; G = 27 %; stylet = 16 µ.

Male (allotype): L = 552 µ; a = 38,0; b = 6,7; c = 22,8; T = 41 %; stylet = 12 µ.

A very slender species. Body almost straight after killing by gentle heat. Cuticular annulation fine and indistinct. Lateral field broad, with 4 (occasionally 5 or even 6) incisures.

Female: In the specimens observed (no egg-bearing ones) the ovary extended over about one-third of body length. Spermatheca oval. Posterior uterine branch short, in some specimens with faint traces of ovarial tissue. Tail 2,5–3 × as long as anal body diameter; tapering, very slender in distal half, with projecting smooth terminus, which is narrowly rounded or even subacute.

Male: Spicula as in *P. coffeae*; gonad generally somewhat shorter than in that species. Testis shorter than vas deferens. Bursal edge faintly crenate.

This species may be distinguished from the preceding by its more slender body, fine annulation, slightly more posterior vulva position and shape of the female tail.

Distribution and hosts: Known only from Ceylon, on tea roots, but it is possible that this species may have been confused with *P. coffeae*. Perhaps this is the species GADD & LOOS (1941) worked with; cf. LOOS (1953).

Holotype: Female on slide m 4.

Allotype: Male on slide m 11.

Paratypes: 33 females and 14 males on slides m 1, m 2, m 3, m 4, m 5, m 6, m 7, m 9, m 10 and m 11.

All types in collection of Plantenziektenkundige Dienst, Wageningen, Netherlands.

19. *Pratylenchus coffeae subsp. brasiliensis* LORDELLO 1956.

Measurements after LORDELLO:

Females (n = 2): L = 392–400 μ; V = 71,7%; a = 23,3–23,5; b1 (b?) = 7,2–7,5; c = 17,3. Male unknown.

Of this form no material was available for study. The description was based on two females from onion, Brasil. The tail tapers to a rather narrowly rounded terminus. A spermatheca is not mentioned. This form ought not to be regarded as a subspecies of *P. coffeae*, because the nominate form, according to RAHM (1928) also occurs in Brasil. The tail shape of this form seems to resemble that of *P. loosi*, which species is, however, much more slender. Whether *P. coffeae subsp. brasiliensis* should be regarded as a valid species, or as a form of either *P. coffeae* or *P. loosi*, cannot be determined on the basis of the data available.

X. SPECIES INQUIRENDAE

1. *Pratylenchus sacchari* (SOLTWEDEL 1888) FILIPJEV 1936.

The writer has nothing to add to the comment by SHER & ALLEN (1953).

2. *Dolichodorus heterocercus* KREIS 1930.

This species was described from China and later reported by RAHM from Hainan. KREIS' figure shows the lip region to be rather high, so that it is probable that it consists of 3 or 4 annules. Should this be the case the species could be inserted into the system here presented without great difficulties. *D. heterocercus* is characterized by the extremely short tail (c = 25–31 (KREIS); c = 28–31 (RAHM)). It is uncertain whether RAHM's specimens are conspecific with those of KREIS, in view of the differences in position of vulva (KREIS: 76–77%; RAHM: 66–69%). It should be noted that KREIS draws and describes a distinct, triangular cardia. KREIS (in litt.) has reported his specimens to be lost.

3. *Pratylenchus pratensis* var. *tenuistriatus* MEYL 1953.

Measurements (partly after MEYL, 1954):

Females (n = 4): L = 400–432 μ; V = 77–78,2%; a = 16,3–20,5; b = 8,7–9,1 (obviously measured from head end to posterior edge of median bulb); c = 18,1–18,8; G = 39%; eggs 52–59 × 18–21 μ.

This variety, described from fumaroles in Ischia, Italy, is characterized by the

short stylet (11–12 μ) and the body annulation, which is so fine as to be nearly imperceptible. However, it is uncertain first, what MEYL understood by *P. pratensis*, and second, whether this variety indeed belongs to that species. It might as well be a good species. For eggbearing females the size is extremely small. Until the material is examined once more the taxonomic position cannot be determined.

4. *Pratylenchus pratensis* var. *bicaudatus* MEYL 1954.

Measurements:

Females (n = 2): L = 0,40–0,42 mm; V = 76,3–75,2%; a = 27,0–29,3; b = 9,0 (see above); c = 17,1–18,4.

This form was described from two females found in moist humus in Ischia, Italy. It differs from the nominate form, the identity of which is in this case as uncertain as in the preceding, by the forward position of the excretory pore (almost at level of hind end of median bulb) and the bilobed, smooth tail tip. MEYL considered it was closely related or even identical with *P. musicola* (COBB, 1919), by which species he undoubtedly meant *P. goodeyi*. It should be observed that *P. goodeyi* is much larger. It is not impossible that the variety is a valid species. Since, however, the characters given are the only data available, this question must be left undecided until the material has been studied again.

5. *Tylenchus (Chitinotylenchus) coffeae* var. *brevicauda* RAHM 1928.

Measurements:

Females (n = 3): L = 600–711 μ; V = 70–80%; (mean 78%); a = 23–26; b = 5–6; c = 37.

This form was described from three females found in *Citrus* roots, Limeira, Brasil. The outstanding feature of this variety is the extremely short tail. As it is impossible to decide, whether the form belongs to *P. loosi* or *P. coffeae*, or should be regarded as a distinct species, or as a local or even individual aberration, its status must at present moment be regarded as uncertain.

XI. SYNONYMIZED AND TRANSFERRED SPECIES

1. Species synonymized with other *Pratylenchus* species.

P. gulosus (KÜHN 1890) CHITWOOD & OTEIFA 1952.

Synonym of *P. penetrans* (COBB 1917) CHITWOOD & OTEIFA 1952; synonymized by STEINER (1932).

P. helophilus SEINHORST 1959.

Synonym of *P. pratensis* (DE MAN 1880) FILIPJEV 1936; new synonymy.

P. leiocephalus STEINER 1949.

Synonym of *P. brachyurus* (GODFREY 1929) GOODEY 1951; synonymized by SHER & ALLEN (1953).

P. mahogani (COBB 1920) FILIPJEV 1936.

Synonym of *P. coffeae* (ZIMMERMANN 1898) GOODEY 1951. Synonymized by SHER & ALLEN (1953).

P. minyus SHER & ALLEN 1953.
Synonym of *P. neglectus* (RENSCH 1924) CHITWOOD & OTEIFA 1952; new synonymy.
P. musicola (COBB 1919) FILIPJEV 1936.
Synonym of *P. coffeae* (ZIMMERMANN 1898) GOODEY 1951; synonymized by SHER & ALLEN (1953).
P. steineri LORDELLO, ZAMITH & BOOCK 1954.
Synonym of *P. brachyurus* (GODFREY 1929) GOODEY 1951; new synonymy.

2. Species transferred to other genera.
P. aberrans (THORNE 1935) FILIPJEV 1936.
Transferred to *Nacobbus* by THORNE & ALLEN (1944).
P. dendrophilus (MARCINOWSKI 1909) FILIPJEV 1936.
Transferred to *Ditylenchus* by FILIPJEV & SCHUURMANS STEKHOVEN (1941).
P. obtusus (BASTIAN 1865) GOODEY 1951 (doubtfully included). Transferred to *Pratylenchoides* and renamed *crenicauda* by WINSLOW (1958); *Tylenchus obtusus* BASTIAN 1865 being regarded nomen dubium.
P. tumefaciens (COBB 1932) FILIPJEV 1936 (doubtfully included). Transferred to *Anguina* by FILIPJEV & SCHUURMANS STEKHOVEN (1941).

SAMENVATTING

TAXONOMISCHE ONDERZOEKINGEN AAN HET NEMATODENGESLACHT *Pratylenchus*

In aansluiting op de revisie van SHER & ALLEN (1953) zijn aanvullende taxonomische onderzoekingen verricht aan het geslacht *Pratylenchus*. Achttien goede soorten worden erkend, vijf als *species inquirendae* beschouwd, terwijl van één vorm *(P. coffeae subsp. brasiliensis* LORDELLO, 1956) de relatie tot verwante soorten nog onzeker is,

Gebleken is, dat de structuur van het zijveld een zekere, hoewel geringe, waarde als taxonomisch kenmerk heeft (Fig. 1). Determinatie van mannetjes is tot op zekere hoogte mogelijk.

Een volledige determinatietabel voor wijfjes wordt gegeven. Als nieuwe soorten worden beschreven *P. irregularis* (Fig. 11) en *P. loosi* (Fig. 9). Door critisch onderzoek van de literatuurgegevens konden de synonymieën op een aantal punten worden gecorrigeerd. *P. pratensis* (DE MAN, 1880) wordt aan de hand van in de oorspronkelijke beschrijving voorhanden gegevens herbeschreven (Fig. 2 en 10); *P. helophilus* SEINHORST, 1959 is synonym met deze soort; *P. pratensis* THORNE, 1949 nec (DE MAN, 1880) wordt herdoopt in *P. crenatus* (Fig. 4). *Tylenchus gulosus* KÜHN, 1890 resp. FISCHER, 1894 wordt als synonym van *P. penetrans* (COBB, 1917) beschouwd, *Aphelenchus neglectus* RENSCH, 1924 als synonym van *P. minyus* SHER & ALLEN, 1953; deze laatste soort blijkt zeer variabel te zijn (Fig. 3, 5–8, 12). *P. steineri* LORDELLO, ZAMITH & BOOCK, 1954 wordt gesynonymiseerd met *P. brachyurus* (GODFREY, 1929).

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