On the genus *Ditylenchus* Filipjev, 1936 (Nematoda: Tylenchida)

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SUMMARY

Several populations of *Ditylenchus myceliophagus* from Ivory Coast and Upper-Volta were studied for variability of generic and specific taxonomic characters, which was found to be greater than generally accepted. *Ditylenchus* is redefined ; *Chitinotylenchus* is considered *genus inquirendum; Diptenchus* and *Safianema* are synonymized with *Ditylenchus* ; *Pseudhalenchus* is considered a valid genus under Tylenchinae ; *Pseudhalenchinae* is synonymized with *Tylenchinae. Ditylenchus geraerti* is synonymized with *D. myceliophagus.* The following new combinations are proposed : *Ditylenchus indicus* for *Pseudhalenchus indicus; Ditylenchus acutus* for *Pseudhalenchus acutus; Ditylenchus khani* for *Diptenchus indicus; Ditylenchus lutonensis* for *Safianema lutonense; D. anchilisposomus* for *S. anchilisposomum; D. damnatus* for *S. damnatum; S. hylobii* is transferred back to *Pseudhalenchus.* Four species are considered *species inquirendae : Ditylenchus bacillifer, D. intermedius, D. humuli* and *D. karakalpakensis. Chitinotylenchus paragracilis,* is considered *species incertae sedis.* A tabular key to the valid species of *Ditylenchus* is presented.

RÉSUMÉ

Le genre Ditylenchus *Filipjev, 1936 (Nematoda : Tylenchida)*

Plusieurs populations de *Ditylenchus myceliophagus* de Côte d'Ivoire et de Haute-Volta ont été étudiées ; la variabilité des caractères taxonomiques utilisés aux niveaux générique et spécifique s'est montrée plus grande que généralement admis. *Ditylenchus* est redéfini ; *Chitinotylenchus* est considéré comme *genus inquirendum; Diptenchus* et *Safianema* sont synonymisés avec *Ditylenchus; Pseudhalenchus* est considéré comme un genre valide appartenant aux Tylenchinae ; la sous-famille des Pseudhalenchinae est synonymisée avec celle des Tylenchinae. *Ditylenchus geraerti* est synonymisé avec *D. myceliophagus.* Les combinaisons nouvelles suivantes sont proposées : *Ditylenchus indicus* pour *Pseudhalenchus indicus; Ditylenchus acutus* pour *Pseudhalenchus acutus; Ditylenchus khani* pour *Diptenchus indicus; Ditylenchus lutonensis* pour *Safianema lutonense; D. anchilisposomus* pour *S. anchilisposomum; D. damnatus* for *S. damnatum; S. hylobii* est retransféré à *Pseudhalenchus.* Quatre espèces sont considérées comme *species inquirendae : Ditylenchus bacillifer, D. intermedius, D. humuli* et *D. karakalpakensis. Chitinotylenchus paragracilis* est considéré *species incertae sedis.* Une clé tabulaire est présentée pour la détermination des espèces valides de *Ditylenchus.*

Nematodes of the genus *Ditylenchus* were observed from diseased rice panicles in the Ivory Coast and it was thought, at first, that they might be responsible for the poor condition of the rice. However, a study of their morphology permitted their identification as *D. myceliiphagus* Goodey, 1958, a well known fungus feeder.

During these studies, it was observed that many morphometrical characters were highly variable and only a few were constant enough to be used for taxonomic purposes. A search of the literature revealed that similar variability exists in at least several other species of the genus.

This led the author to question the validity of the species described under *Ditylenchus* and also of the genera closely related to this taxon. As no recent review of the genus has been published, a tabular key to the valid species in

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Ditylenchus was constructed, using only the reliable characters. Brzeski (1981) recently proposed a revised classification of the family Anguinidae (including *Ditylenchus*) and his article was used as a framework for the present study.

Anguininae Paramonov, 1962 was raised to family rank by Siddiqi (1971) and to superfamily rank by Siddiqi (1980*b*). The status of this group will not be discussed here and its lowest rank (Anguininae) will be used.

Materials and Methods

The studied specimens were obtained from the following localities :

Sample 1 - Thirty females and twenty males from upland rice panicles (cv. Iguape Cateto) sent in 1976 by A. Pouzet (ORSTOM agronomist) from A.V.B. (Autorité pour l'Aménagement de la Vallée du Bandama) fields at Fitabro 1 (bloc C, plot 7.04), in the Ivory Coast.

Sample 2 - Six individuals from sample 1 were inoculated into a test tube containing the fungus *Colletotrichum gloeosporioides* Penz. on potato-dextrose agar. After three weeks, the tube was found to contain 120 specimens of *Ditylenchus* of which fifteen females and eight males were selected for morphological studies.

Sample 3 - Six females from an A.V.B. field at Assakra 1, a village close to Fitabro 1.

Sample 4 - Nine females and five males from soil around roots of sugarcane at Banfora (Upper-Volta) in the SOSUHV (Société Sucrière de Haute-Volta) fields collected by P. Cadet. Two females and one male were also observed from forest soil from Taï forest, in the Ivory Coast.

The specimens were killed by FP 4:1 (Netscher & Seinhorst, 1969), fixed in 4% formaldehyde and mounted in glycerin on Cobb slides. Orcein was added during the mounting process for coloring the nematodes. A few individuals from sample 2 were observed in pure water, just after being killed by gentle heat, to observe some inconspicuous features (median oesophageal bulb valve for instance). Some females were also observed in cross-section in glycerin.

The observations were made using a Leitz Ortholux II microscope at 1 000 × magnification, in bright field microscopy or with an interference contrast device of Nomarski. For measurement purposes, drawings were made of all specimens using a drawing attachment or a camera lucida, both systems set to give an additional enlargement factor of two.

Results

Observations made on the specimens

Table 1 (females) presents, for the four samples observed, the body length, stylet length, distance from anterior end to hemizonid and to excretory pore, length of oesophagus (to the oesophago-intestinal junction and to the end of glands), length of tail, anal and vulval body diameters, distance from head to vulva, length of anterior genital branch and of post uterine sac (P.U.S.), and distance between vulva and anus. Table 2 presents the same characters for males in samples 1, 2 and 4, with bursa, testis, spicule and gubernaculum lengths in place of the female genital characters. For every character, the mean is given with its confidence interval $\left(i = \frac{2\,\sigma}{\sqrt{n}}\right)$ the range and the coefficient of variability.

Figure 1 presents graphically the correlations between the constituents of the usual ratios (a, b, c, c′, and V) and post-uterine sac length in relation to vulva-anus distance for the females in samples 1 + 2. Some morphological features are illustrated in Figures 2 and 3.

Discussion on the variability of some morphometrical characters

General morphology

Habitus. In the present specimens, the body was almost straight or slighly C-shaped, usually with a bend located in the vicinity of the vulva (Fig. 2 A, B).

Body length. The body length was highly variable (Tab. 1) ; it ranged from 600 to 1 200 µm

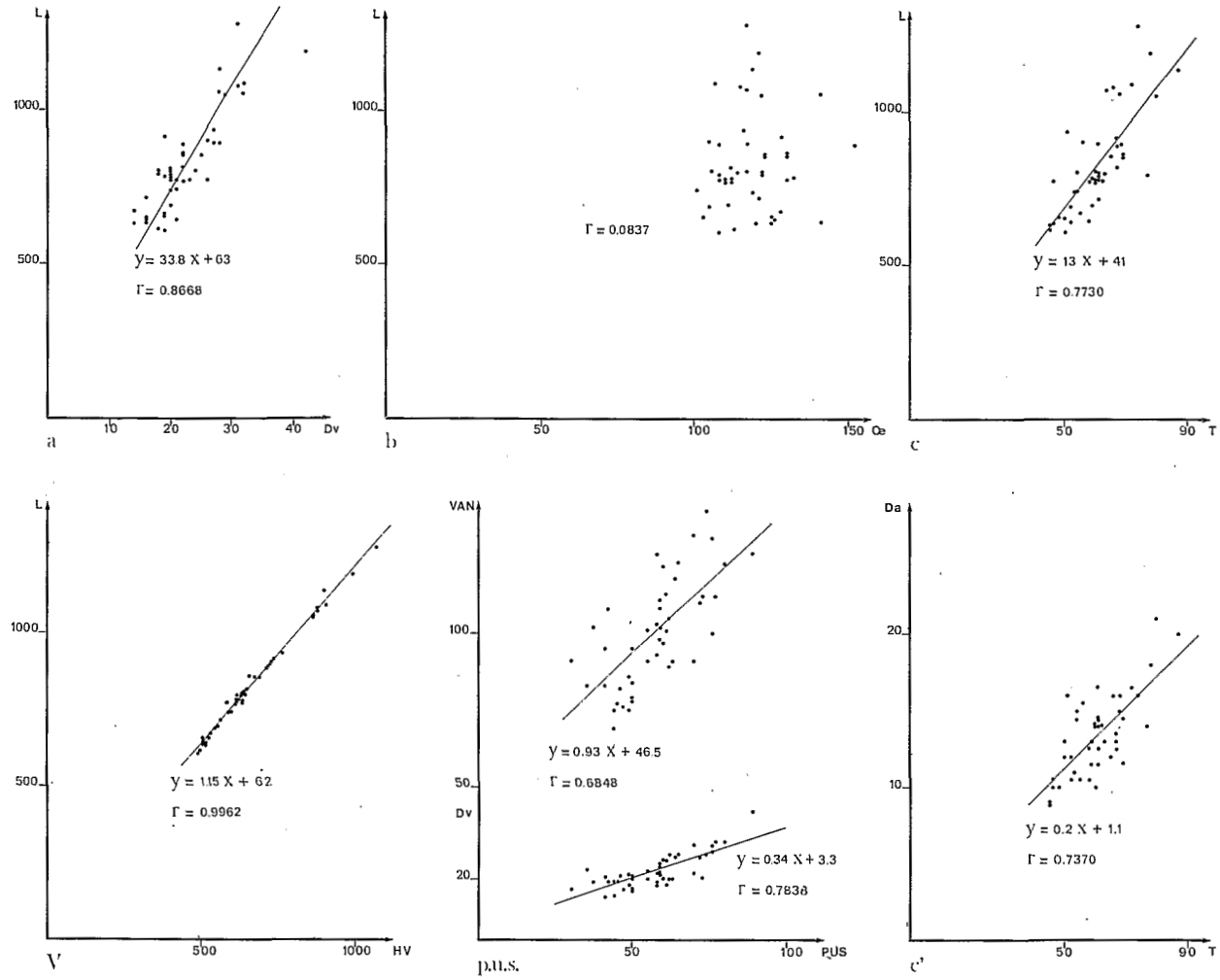

Fig. 1. *Ditylenchus myceliophagus*. Graphic representation of ratios a, b, c, c', V, and post-uterine sac in relation to vulva-anus distance and to body diameter. L : body length ; Dv : body diameter at level of vulva ; œ : length of oesophagus ; T : tail length ; HV : head to vulva distance ; VAN : vulva to anus distance ; Da : body diameter at level of anus ; PUS : length of post-uterine sac ; y = f(x) : equation of the regression lines ; r = coefficient of correlation (n = 45 ; r significant above 0.380 at 1 % level).

in sample 1, 700 to 1 400 µm in sample 4, with mean values of 800-850 µm. Sample 3 was smaller, with a mean value of only 546 µm. Brzeski (1967) and Evans and Fisher (1970) have shown that the body length of *D. myceliophagus* depends on the food supply and the nature of the fungus on which it feeds. Hesling (1974) gave a range for body length in *D. myceliophagus* of 600-1 380 µm. Goodey (1952), Thorne and Allen (1959), and Wu (1960*b*) observed that in *D. destructor* the body length varies greatly depending on the plant host. Differences in body size might also be caused by different ecological environment, individuals from rainforest (Taï) being smaller (400 and 575 µm) than those from savanna regions (A.V.B. fields and Upper-Volta, samples 1 to 4).

Body diameter. The body diameter also had a high variability in the present specimens (Tab. 1). Brzeski (1967) observed no statistical difference in width in specimens of *D. myceliophagus* but it should be noted that he measured this character only at pharynx and anus levels. Goodey (1952), while observing that in *D.*

Table 1

Ditylenchus myceliophagus : quantitative measurements of individuals from four origins
Females (measures in μm) : Mean ± confidence interval ; range ; coefficient of variability

Criteria	*Sample 1 (n = 30)*	*Sample 2 (n = 15)*	*Sample 3 (n = 6)*	*Sample 4 (n = 9)*
Length	816 ± 50 (608-1134), 17.1 %	856 ± 103 (616-1278), 23.8 %	546 ± 42 (480-604)	852 ± 141 (718-1414), 25.5 %
Stylet	7.7 ± 0.2 (7-8.5), 5.5 %	7.6 ± 0.2 (7-8), 5.1 %	7 ± 0.4 (6.5-7.5)	7.4 ± 0.3 (7-8), 6.2 %
Hemizonid	88 ± 3 (71-103), 9.6 %	86 ± 6 (71-105), 13.4 %	68 ± 2 (64-71)	95 ± 6 (75-108), 10.0 %
Pore exc.	93 ± 5 (74-107), 9.4 %	91 ± 6 (75-109), 13.4 %	71 ± 2 (66-74)	97 ± 7 (76-110), 10.3 %
Oes. (valve)	120 ± 5 (101-152), 10.1 %	115 ± 3 (107-125), 4.8 %	98 ± 6 (89-106)	137 ± 9 (122-126), 9.8 %
Oes. (gland)	134 ± 4 (103-155), 8.9 %	124 ± 5 (108-145), 8.6 %	105 ± 3 (100-109)	146 ± 8 (129-170), 8.0 %
Tail	60 ± 3 (46-87), 14.9 %	62 ± 6 (45-80), 18.3 %	46 ± 3 (41-51)	60 ± 5 (45-70), 12.0 %
Anal diam.	14 ± 2 (10-34), 31.3 %	13.5 ± 2 (9-21), 25.8 %	9.5 ± 0.5 (9-10.5)	13 ± 0.5 (11.5-14.5), 8.3 %
Head-vulva	652 ± 42 (490-898), 18.1 %	694 ± 91 (496-1070), 25.8 %	425 ± 34 (374-476)	696 ± 114 (578-1144), 25.2 %
Body diam.	22 ± 1.5 (14-32), 19.9 %	24 ± 4 (14.5-42), 31.1 %	17 ± 1.5 (15-19)	24.5 ± 2 (23-31), 11.1 %
Ovary	374 ± 45 (194-652), 35.0 %	311 ± 79 (154-588), 50.3 %	150 ± 14 (126-180)	333 ± 107 (243-757), 49.0 %
P.U.S.	55 ± 4 (30-80), 21.0 %	62 ± 7 (35-89), 23.4 %	47 ± 7 (30-55)	31 ± 1 (27-35), 7.4 %
Vulva-anus	100 ± 6 (69-140), 17.7 %	100 ± 9 (75-131), 18.3 %	72 ± 6 (59-80)	81 ± 4 (70-91), 6.0 %

destructor generally the longer the worm, the fatter it is, reported some variation related to the host. A population from mint was of the same length but much slimmer than a population from potato.

Ratio "a". The correlation of the two constituents of ratio "a" was studied from specimens from the two samples 1 and 2 (grouped). The correlation is good and the regression line almost passes through the origin (Fig. 1). Wu (1960*b*) showed that in *D. destructor*, although body length and diameter are highly significantly correlated, the regression line did not pass through the origin. The coefficient "a" cannot be used in all cases. Filipjev (1936*a*) differentiated *Ditylenchus* as being slimmer than *Anguina*. However, in view of the variability of this character under varying external conditions, it should not be used for taxonomic purposes.

Lips. Scanning electron microscope photographs of *D. dipsaci* and *Anguina* sp. in the photograph collection of the University of California, Riverside, kindly communicated by Arnold Bell, have lips as a round disc not separated into labial sectors. The character "lip separate" used in the key by Andrássy (1976) for differentiating Anguinidae from Tylenchidae and Psilenchidae is not supported by the present observations. The head of the present specimens was continuous with the body, anteriorly flattened and cap-like, and devoid of lip annulations when seen in bright field microscopy. Using an interference contrast device of Nomarsky, two or three very faint annules could be seen in some specimens (Fig. 2 C). Wu (1960*a*) observed at high magnification a few fine annules in the lips of *D. destructor*, a species originally described by Thorne (1945) as having smooth lips. Some species in *Ditylenchus* (*D. triformis* for example) have more marked lip annules, but this character is too difficult to observe to be used in routine identifications.

The absence of lip annulation was used by Thorne (1949) to differentiate *Ditylenchus* from *Tylenchus*. Lip annules are difficult to see in some *Tylenchus s.l.* (Wu, 1967*a*). They are present, even if very faint, in at least some species in *Ditylenchus*. This character should not be used at higher levels of the classification. The body annules were very faint in the present specimens, almost invisible in most of the body, more marked just below the lip region.

Phasmids. Phasmids were not observed in the present specimens as is generally the case in *Ditylenchus* and the Anguininae. Phasmids were reported in *D. nortoni* and in the males of *D. emus*.

Deirids. The deirids were present, slightly posterior to the level of the hemizonid.

Lateral field. The lateral field was composed of generally six (Fig. 2 E), more rarely seven (Fig. 2 F) or eight (Fig. 2 G) lines, best seen in cross section. In *D. destructor*, usually with six lines, five additional lines can sometimes be seen, formed by the crests of the cuticular folds, between the typical lines (Thorne & Allen, 1959 ; Wu, 1960*a*). Alternatively the lines can disappear completely in the stretched cuticule of stout egg-producing females (Thorne & Allen, 1959). The greater number of lines in *D. destructor* cannot be tied, through a wider girth, to the greater development of the genital branch in this species, because *D. dipsaci*, which also has enlarged ovary, possess only four lines. The number of lines is very constant in species like *D. dipsaci* with four lines, and, in spite of the variability of this character in species like *D. myceliophagus* or *D. destructor* with six to eleven lines, it can be used for identification of species.

Tail length. Tail length was highly variable (Tab. 1). The general shape of the tail was also variable. It was more or less conical with often a slimmer posterior part. It could be straight (Fig. 2 H), slightly bent (Fig. 2 I) or bent at an angle of 90° (Fig. 2 J) or more (Fig. 2 K).

Tail shape was used by Thorne (1949) to separate *Tylenchus s.l.* with tail filiform, greatly elongated, from *Ditylenchus* with tail conoid. In fact, the variability of this character, both within species like *D. myceliophagus* or *D. destructor* and among species of the various genera under Tylenchinae, precludes its use for differentiation of the higher taxa. Wu (1967*a*) recognized *Ditylenchus* with tail conoid to elongate-conoid and *Tylenchus s.l.* with tail elongate-conoid to filiform. Tail extremity (used by Hesling, 1974, as a discriminating criterion for *D. myceliophagus*) was more constant, being rounded in every individual observed. Wu (1960*b*) observed the shape of tail of *D. destructor*

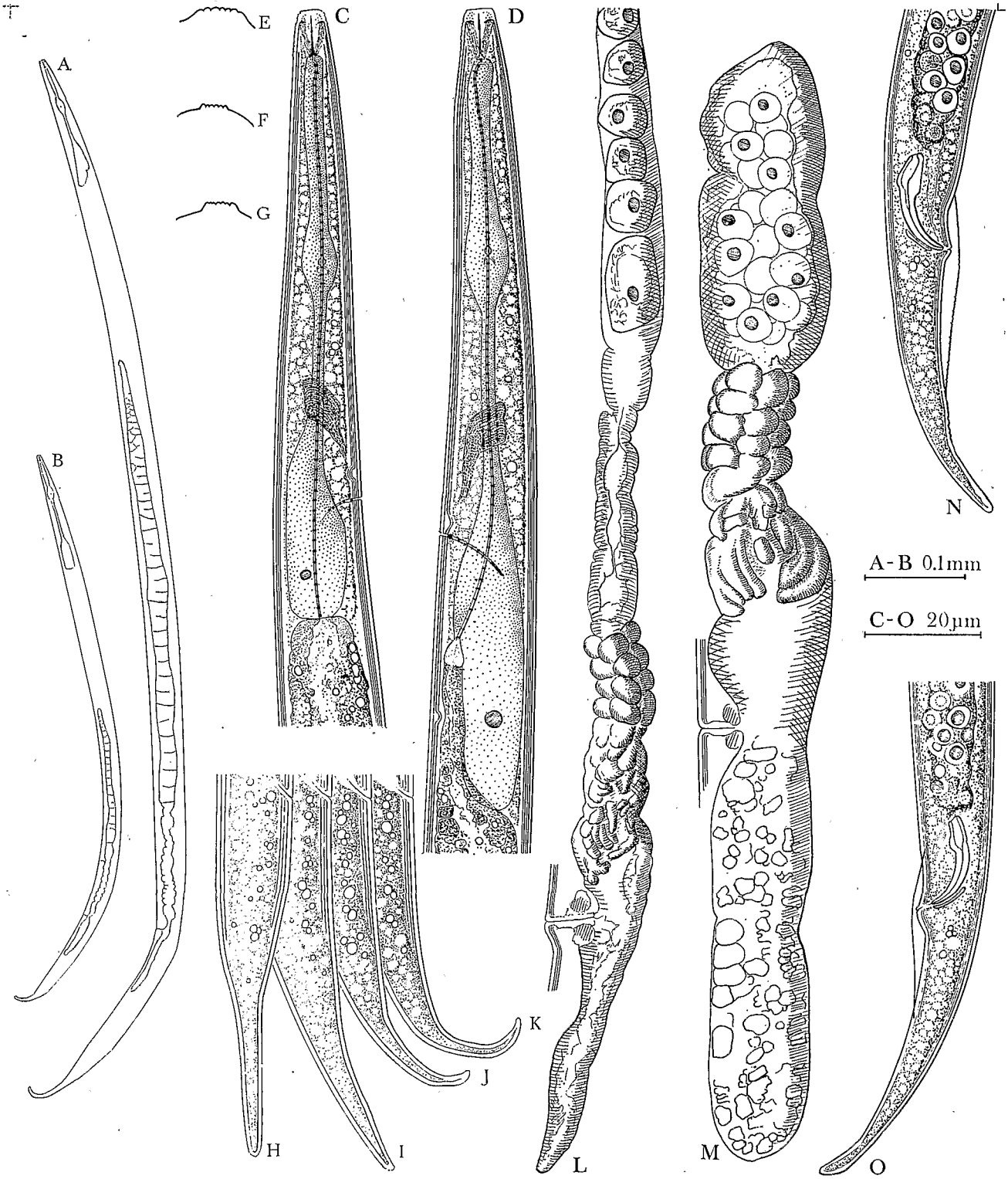

Fig. 2. *Ditylenchus myceliophagus*. A-M : females ; N-O : males ; population 1. A. Large female, L = 1.3 mm ; B. Small female, L = 0.680 mm ; C. Anterior end, abutting oesophageal glands ; D. Anterior end, dorsal oesophageal gland overlapping intestine ; E-G. Lateral field, E : 6 lines, F : 7 lines, G : 8 lines ; H-K. Posterior ends, H : tail straight, I : tail slightly bent, J : tail bent, K : tail sharply bent ; L-M. Ovaries, L : spermatheca and post-uterine sac empty, M : spermatheca with sperms, post-uterine sac filled with granular material. N-O : male tails.

to be somewhat variable depending on the host. However, all tails illustrated in Fig. 1 of Wu (1960*b*) have a narrowly rounded extremity. Kheiri (1972) gave illustrations of tails of eleven specimens of *D. destructor*. Ten have the rounded end typical of the species, one is pointed.

Pointed tails seems a constant feature of some other species (for example *D. dipsaci*). Broadly rounded or sickle-shaped extremities are characteristic of other species. Very few species are described with intermediate tail ends (*i.e.* pointed to minutely rounded) and, those excepted, shape of tail terminus is both reliable and useful for specific differentiation.

In the present specimens, the tail length was correlated both with the body length (coefficient c) and the anal diameter (coefficient c') and the regression lines passed through the origin (Fig. 1).

Wu (1960*b*) observed that, in females of *D. destructor*, the correlation between body and tail lengths was not significant. The coefficient c cannot be used in all cases.

The digestive system

Stylet. The stylet is weak (character of the sub-family), with small knobs rounded and well separated (Fig. 2 C, D). In the present specimens, the mean stylet length was 7 to 7.5 µm (the range was 6.5 to 8.5 µm), with very little variation (Tab. 1). Brzeski (1967) observed similar values, and no variation, in stylet lengths of *D. myceliophagus* reared on two different fungi. Hesling (1974) indicates that stylet length does vary a little in *D. myceliophagus* but it never reaches 10 µm.

Some other *Ditylenchus* spp. also have small stylet, less than 9 µm long (Tab. 3), while other have stylet 10 µm or longer (and among these, *D. dipsaci* and *D. destructor*). Very few species present intermediate values (Tab. 3). This constant character is very useful for species identification.

Cephalic framework. Filipjev (1936*a*) noted "head without chitinization" for *Ditylenchus*. In fact the cephalic framework is always present and sclerified in this genus, but rather weak. The protractor muscles of the stylet are attached to the basal plate of the framework, as in all members of Anguininae (Fig. 2 C, D). As pointed out by Paramonov (1970), many species in Tylenchinae have protractors attached directly to the subcuticle of the cephalic capsule.

Oesophagus. The oesophagus length was not correlated to the body length (Fig. 1). Wu (1960*b*) noted the same phenomenon for *D. destructor*. Coefficient b must not be calculated. In the present specimens, the procorpus was thin, the median bulb fusiform, the isthmus long and thin and there were no thickenings or constrictions either between procorpus and median bulb or between isthmus and glandular bulb (constrictions appear in several genera of Anguininae, see Brzeski, 1981).

Median bulb. The median bulb was situated not at mid-length of the oesophagus but closer to the anterior end (Fig. 2 C, D). In the median bulb, weak thickenings were present but impossible to observe in some fixed specimens. For a casual observer the present specimens of *D. myceliophagus* would appear to belong to the genus *Nothotylenchus*, which differs from *Ditylenchus* only by the absence of refractive thickenings in the median bulb. The study of individuals freshly killed and temporarily mounted in water was necessary to decide of the true identity of the nematode. The present specimens are intermediate between the species in *Ditylenchus* with strong thickenings (for example *D. dipsaci*) and the species in the genus *Nothotylenchus*. Several workers (Sumenkova, 1975 and Geraert, 1976 in Brzeski, 1981) suggested that *Nothotylenchus* is probably synonymous to *Ditylenchus*. The above observations tends to support this opinion, but the genus *Nothotylenchus* will have to be reviewed before any definite move can be done.

Oesophageal glands. The shape of oesophageal glands was very variable. Individuals were observed with an abutting basal bulb, others with overlapping glandular lobes. In the latter case, position of overlap was either lateral, ventral or dorsal and its length varied greatly, up to 44 µm (Fig. 2 C, D and Fig. 3).

Thorne and Allen (1959) observed an overlapping lobe in *D. destructor*. In the specimens from potato the overlap was dorsal, but it was ventral in the specimens from bulbous iris. Brzeski (1967) found that the size of the oesophageal lobe depended on the fungus host upon which *D.*

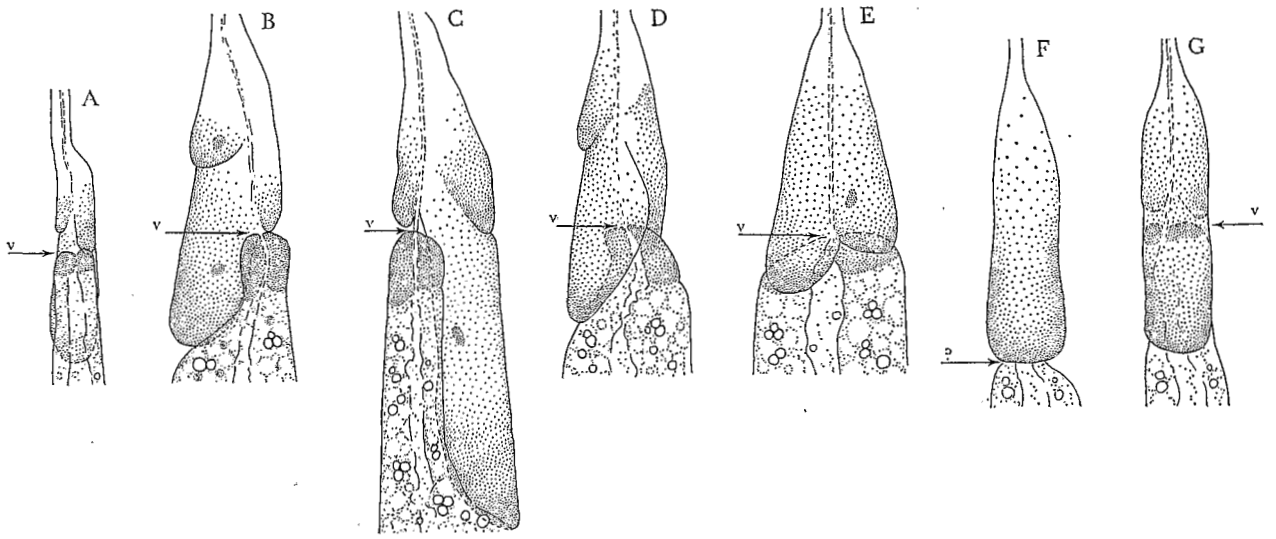

Fig. 3. *Ditylenchus myceliophagus*. Variability of oesophageal glandular lobe. A : Juvenile, second stage, six day-old, with lateral overlap, B : Female fourteen day-old, ventral overlap ; C : Female fourteen day-old, dorsal overlap ; D : Female nine day-old, very reduced overlap ; F & G : two views of the same specimen, female eight day-old ; F : appearance of an abutting oesophageal bulb ; G : actual lateral overlap, V : oesophago-intestinal junction. All arrows from ventral side.

myceliopaghus was feeding. The overlap was either dorsal or ventral. In Iran, *D. destructor* had glands overlapping the intestine slightly to considerably, on dorsal, ventral or lateral sides of the body (Kheiri, 1972). This considerable variation of the oesophageal glands in *D. destructor* was used by Kheiri (1972) and Geraert and Kheiri (1970) to point out the similitude between this species and *Pseudhalenchus anchilisposomus* Tarjan, 1958.

In the present specimens, in order to clarify the arrangement of the oesophageal glands, 70 individuals (fourteen juveniles, fourteen males, five young females (less than ten-day-old), 37 older females) were observed from test tubes inoculated with two juveniles each and extracted one to 49 days after inoculation. It was found that : (*i*) In young specimens, the basic pattern is a long lateral overlap (Fig. 3 A). This was observed in twelve juveniles, eight males, and four young females. (*ii*) This pattern is often modified by a ventral shift of the overlap, (Fig. 3 B) observed in older individuals : two juveniles, fifteen older females, and three males. (*iii*) More rarely, the overlap was shifted dorsally (Fig. 3 C). This never appears in juveniles nor in young females, but only in two males and eleven older females. (*iv*) A shortened overlap (Fig. 3 D) was seen in seven older females. (*v*) Very rarely, the shortening was so pronounced that the overlap disappeared altogether (Fig. 3 E). This was never seen in juveniles or young females, but in two older females and one male. Sometimes the gland appeared to lie in an abutting bulb, but examination from the opposite side revealed the oesophago-intestinal valve lying hidden behind a long lateral overlap (Fig. 3 F, G).

Intestine. No cardia was observed between oesophagus and intestine in the present specimens, but the anterior intestinal cells were hyaline as described by Brzeski (1981) for members of Anguininae. In individuals with a long oesophageal overlap, the intestine along the overlap was sometimes thinner, probably to make room for this structure, and then the lumen of the intestine was indistinct and difficult to see (Fig. 2 D). A similar condition was described by Siddiqi (1980*a*) for his new genus *Safianema*.

The genital apparatus

The ovary. In the anterior genital branch of present female individuals (whether young or old) the ovary was always straight and never reached the base of oesophagus (Fig. 2 A, B). One specimen of *D. myceliophagus* from fungus culture from Antibes (France) had a long, reflexed ovary. It can be noted that long and reflexed ovaries reaching past the end of the oesophagus are found in several plant parasitic species *(D. dipsaci, D. angustus, D. destructor)*, whereas the mycophagous (*D. myceliophagus* and others) have shorter, straight ovaries. Paramonov (1970) also links the long reflexed ovaries of some *Ditylenchus* to their pathogenicity to plants. The relationship may prove to be constant but, for the moment, the hypothesis must rest until more is known about the feeding habits of a majority of species of *Ditylenchus*. Whatever the cause of the greater length of the ovary in the plant parasitic species of *Ditylenchus*, this character is highly variable. Goodey (1952) noted that in *D. destructor*, the size of the gonads of both sexes was influenced by the host. Thorne and Allen (1959) observed that the number of oocytes in the ovary of *D. destructor* varied with the host, from a dozen in specimens from sugar beet to "scores" of oocytes in specimens from potato and sweet potato. Wu (1960*b*) noted that reflexion of the tip of the ovary in *D. destructor* occurred "in a few cases" in specimens from bulbous iris and only once in 25 specimens from dahlia.

In the present specimens, the oocytes were arranged in the ovary in one or two rows. *D. destructor* has oocytes paired or in single file depending on the host (Wu, 1960*b*). No taxonomic value should be placed, at specific or generic levels, to this character. However, the oocytes were never arranged in several rows, and this disposition never appears in *Ditylenchus* spp. Three genera in Anguininae have oocytes in several rows (1) : *Anguina*, *Nothanguina* and *Afrina* (Brzeski, 1981).

Spermatheca. The spermathecae of the present specimens were elongate, tubular, in line with the genital tract, and usually full of sperm cells (Fig. 2 L, M). The shape of the spermatheca was used by Wu (1967*a*) to differentiate *Ditylenchus* (with spermatheca a tubular structure between uterus and oviduct) from *Tylenchus s.l.* (spermatheca, when present, a diverticulum at the junction of the uterus and the oviduct). Some species (*D. brassicae, D. cyperi, D. deiridus)* have short, rounded spermatheca, in line with the genital tract.

Columella.(2) The columella was short (Fig. 2 N, O) and composed of four rows of four cells as typical in *Ditylenchus*. Brzeski (1981) placed great emphasis on the structure of the columella for separating the genera within Anguininae.

The columella was followed by a group of closely packed cells. This structure was called a sphincter by Brzeski (1981). Its function is unknown.

Post uterine sac. The posterior genital branch was reduced to a post-uterine sac (P.U.S.). The length of this structure is variable (Tab. 1). It is correlated to the vulva-anus distance but the regression line does not pass through the origin (Fig. 1). The ratio P.U.S./vulva-anus distance cannot be used. It is also correlated to the body diameter at vulva, and here the regression line passes through the origin (Fig. 1). It is not known whether this is also the case for other species in *Ditylenchus*. In the present specimens, the P.U.S. was about three body diameters long. Studying the influence of the host on the dimensions of *D. destructor*, Goodey (1952) noted the "relative constancy" of the length of the P.U.S. Contrarywise, Thorne and Allen (1959) observed that, in the same species, the host induced "marked variations" in length of the P.U.S. Kheiri (1972) found variations to occur in the length of the P.U.S. of *D. destructor*. Evans and Fisher (1970) showed the length of the P.U.S. to be independent of the food supply in *D. myceliophagus*. In view of these conflicting observations, it is best not to use the actual length of the P.U.S. for species identification. Ratios relating this length to other dimensions

(1) The rachis described by Thorne (1949) for *Anguina tritici* was believed by Nagamine and Maggenti (1980) to be an oocyte surrounded by the epithelium of the oviduct.

(2) See Fortuner, Merny and Roux (1980) for discussion on the name "columella".

such as vulval diameter or vulva-anus distance sometimes have no mathematical meaning and must be used with caution. However, the P.U.S. length can be used in a very broad sense for separating species with short P.U.S. from those with long P.U.S. The P.U.S. illustrated for *D. destructor* either in Goodey (1952) or in Kheiri (1972) are rather long structures, reaching far from the vulva level. *D. myceliophagus* also has a long P.U.S. Both species can be separated from others with short P.U.S. as for example *D. triformis*.

The absence of any P.U.S. in some species in *Ditylenchus* will be discussed below. In the present specimens, the P.U.S. was either an empty, flattened structure (Fig. 2 L), or a broad sac, filled with a granular substance (Fig. 2 M). This substance may be degenerating sperm cells which had entered this dead end after the spermatheca was filled. It could also be a degenerating egg. An egg was seen in a specimen of *D. myceliophagus* from France, halfway engaged into the P.U.S.

Vulva. The distance from head to vulva is very strongly correlated with the body length (Fig. 1) and the regression line passes very near the origin. A similar result was obtained for *D. destructor* by Wu (1960*b*). The coefficient V is mathematically correct. It is also very efficient in reducing the variability of its morphometric constituents : its coefficient of variability is only about 2% compared with C.V.s of 20 to 25% for body length and head to vulva distance. Goodey (1952) remarked that, in *D. destructor*, "the relative position of the vulva, which is a structural feature, is however, practically unaffected [by the host]".

While the coefficient can be used with confidence for specific identification, unfortunately most of the described species in *Ditylenchus* share similar values for this character : about 80%.

The vulval lips are slightly elevated or not at all (Fig. 2 L, M). The vulval slit is oriented at a straight angle from the body axis. Some species in *Ditylenchus* have vulva slits more obliquely oriented (*D. angustus* for example) but in fact this character was not described for most species in *Ditylenchus* and cannot be used for the moment in taxonomy.

Taxonomic characters in males

Table 2 presents some measurements for males in the present populations. The demanian ratios were also studied. The ratios a, b, and c have constituent measurements significantly correlated but the regression lines do not pass through the origin. These ratios must not be used.

Spicules. The spicule length is a reasonably constant character in the present specimens (Tab. 2) and this character can be used for species identification.

The spicules were ventrally arcuate, with an anterior head slightly offset (*i.e.* slightly "cephalated"). This head was about twice as long as wide (*i.e.* "anteriorly expanded") (Fig. 2 N, O).

The shape of the spicules was used by Siddiqi (1980*a*) to assign his new genus *Safianema* to Anguininae. *Safianema* was said to be close to *Ditylenchus* in, among other characters, the structure of the spicules "ventrally arcuate, anteriorly expanded". In the same article, Siddiqi redefined *Pseudhalenchus* Tarjan, 1958 and placed this genus under Tylenchidae. The spicules in *Pseudhalenchus* (*sensu* Siddiqi, 1980*a*) are "slender, arcuate, cephalated but not prominently expanded anteriorly".

The shape of the spicules seems variable among species of *Ditylenchus*. *D. angustus*, as figured by Seshadri and Dasgupta (1975) has spicules strongly cephalated but not expanded anteriorly. Contrarywise, the spicules of *D. dipsaci* and *D. destructor* (in Thorne, 1945) are not cephalated but markedly expanded anteriorly. *D. equalis*, as described by Heyns (1964) has spicules not cephalated and not expanded. In view of this variability this character should not be used for taxonomic purposes.

Bursa. The bursa length (measured from the level of anus to the posterior end of the bursa) is very variable (Tab. 2). This length is not correlated to the tail length ($r = 0.1780$ with 26 d.f.). Bursa in *Ditylenchus* is always leptoderan. This character was used by Meyl (1961) to differentiate *Neoditylenchus*, a new genus, with bursa peloderan, from *Ditylenchus*. (*D. virtudesae* has a bursa reaching to tail tip but not enveloping it, so it is not a true peloderan bursa). Filipjev (1936*b*) described the bursa of *Ditylenchus* has "bis oder fast bis zur Schwanz-

Table 2

Ditylenchus myceliophagus : Quantitative measurements of individuals from three origins Males (measures in µm) : Mean ± confidence interval ; range ; coefficient of variability.

Criteria	*Sample 1 (n = 20)*	*Sample 2 (n = 8)*	*Sample 4 (n = 5)*
Length	664 ± 26 (568-792), 8.9%	734 ± 50 (636-846), 9.8%	646 ± 17 (614-664)
Stylet	7.1 ± 0.1 (6.5-8) 4.3%	7.3 ± 0.2 (7-7.5), 3.5%	7.0
Hemizonid	82 ± 3 (72-97), 7.6%	83 ± 4 (77-89), 6.6%	81 ± 3 (75-85)
Excre. pore	85 ± 3 (76-101), 7.2%	87 ± 3 (82-93), 5.7%	84 ± 3 (78-88)
Oes. (valve)	116 ± 4 (100-133), 8.0%	116 ± 8 (103-130), 9.7%	123 ± 8 (111-133)
Oes. (gland)	123 ± 3 (108-136), 5.7%	130 ± 4 (119-138), 4.9%	127 ± 8 (116-136)
Tail	49 ± 2 (43-60), 10.3%	51 ± 2 (47-56), 6.9%	62 ± 4 (57-68)
Bursa	25 ± 2 (17-33), 18.7%	27 ± 2 (22-30), 12.1%	42 ± 4 (36-46)
Body diameter	16 ± 0.7 (13.5-18), 9.5%	18 ± 1 (15-20), 10.3%	22 ± 1 (19.5-24)
Testis	321 ± 31 (192-434), 22.0%	412 ± 47 (321-517), 16.6%	244 ± 43 (182-304)
Spicules	19.2 ± 0.5 (17-21), 6.2%	20.1 ± 0.8 (19-22), 5.6%	20 ± 0.9 (19-21)
Gubernaculum	5.8 ± 0.2 (5-7), 9.4%	7.1 ± 0.3 (6.5-8), 6.2%	7.5

spitze reichend" [Transl. : "Reaching to, or almost to, the tail tip"]. Thorne (1949) distinguished *Tylenchus s.l.* with "bursa short, adanal" from *Ditylenchus* with "bursa enveloping one-fourth of tail or more". Andrássy (1976) separated Anguinidae with "bursa relatively large, reaching to 2/3 of tail length or more" from Tylenchidae and Psilenchinae with "bursa short, adanal, not reaching to 1/2 of tail length".

Original descriptions of 25 species of *Ditylenchus* were studied. For eight of these species, the bursa reach to about 1/3 of the tail length, the shortest being the bursa in *D. solani* "enveloping slightly less than 1/5 of tail length" (Husain & Khan, 1976). I think it is misleading not to call adanal a bursa reaching only to 1/5 or 1/3 of the tail length. It may be that in some Tylenchinae with filiform tails the relative length of the bursa is even shorter, but this character should be further studied before being used in classification and then a different terminology must be used. For identification of species of *Ditylenchus* it is possible to separate species with short and long bursae but, as said above, the ratio bursa length/tail length must not be used.

Sperm cells. In the present specimens, the sperm cells, either in the *receptaculum seminalis* of males (Fig. 2 N, O) or in the spermathecae of females (Fig. 2 M) were composed of a dark nucleus, 2 µm in diameter enclosed in a translucent vesicle 5-6 µm in diameter. Such a structure was described by Wu (1967*a*) as typical of *Ditylenchus* whereas *Tylenchus s.l.* had small sperm cells without prominent vesicle.

The genus *Ditylenchus* Filipjev, 1936 [3]

Definition (emended)

Anguininae. Lips usually with no obvious striations, faint annulations visible in some species. Cephalic framework sclerotized. Spear with basal knobs, its protractor muscles attached to basal plate of the framework. Four or more lines in the lateral field. Median bulb fusiform, with refractive thickenings. Isthmus not separated from glandular bulb by a constriction. Basal glandular bulb arranged symmetrically around the intestine, with glands either of

[3] *Ditylenchus* in Filipjev, 1934 is a *nomen nudum* (Goodey, 1963). A more complete description of the genus was given by Filipjev in two articles (1936*a* and 1936*b*). Loof and Oostenbrink (1958) stated that Filipjev (1936*a*) was published on July 22, 1936 and Filipjev (1936*b*) also in July 1936, at an unknown date. Actually, the letter of Dr. Sveshnikova from which was obtained the information about the second article was mistranslated. The correct date for Filipjev, 1936*b* is October, 1936 (Loof, pers. comm.). Filipjev 1936*a* is the correct reference for the original description of *Ditylenchus* and also for *Pratylenchus*, *Rotylenchus* and *Tetylenchus*.

equal length or with one gland longer, overlapping the intestine for a very variable length. Anterior ovary straight or with one or two flexures, with oocytes in one or two rows. Spermatheca in line with the genital tract, generally a tubular elongated structure. Columella with four rows of four cells, no longer than spermatheca. Post uterine sac present or absent. Male with bursa of variable length but never enveloping the tail end.

Ditylenchus is distinctive among Anguininae in having oocytes in one or two rows, median bulb with refractive thickenings and columella with four rows of four cells.

List of species of *Ditylenchus*

The reader may refer to the book of Tarjan and Hopper (1974) for the taxonomic avatars and list of synonyms of the cited species through 1971.

Valid species

Type species

Ditylenchus dipsaci (Kühn, 1857) Filipjev, 1936.

Other species :

D. acutus (Khan & Nanjappa, 1972) comb. nov.
syn. *Pseudhalenchus acutus* Khan & Nanjappa, 1972
D. anchilisposomus (Tarjan, 1958) comb. nov.
syn. *Pseudhalenchus anchilisposmus* Tarjan, 1958
Safianema anchilisposomum (Tarjan, 1958) Siddiqi, 1980
D. angustus (Butler, 1913) Filipjev, 1936
D. ausafi Husain & Khan, 1967
D. brassicae Husain & Khan, 1976
D. caudatus Thorne & Malek, 1968
D. clarus Thorne & Malek, 1968
D. convallariae Sturhan & Friedman, 1965
D. cyperi Husain & Khan, 1967
D. damnatus (Massey, 1966) comb. nov.
syn. *Pseudhalenchus damnatus* Massey, 1966
Safianema damnatum (Massey, 1966) Siddiqi, 1980
D. deiridus Thorne & Malek, 1968
D. destructor Thorne, 1945
D. dipsaci falcariae Poghossian, 1967
D. dipsacoideus (Andrássy, 1952) Andrássy, 1956
D. drepanocercus, Goodey, 1953
D. emus Khan, Chawla, & Prasad, 1969
D. equalis Heyns, 1964
D. galeopsidis Teploukhova 1968
D. indicus (Sethi & Swarup, 1967) comb. nov.
syn. *Pseudhalenchus indicus* Sethi & Swarup, 1967
D. inobservabilis (Kirjanova, 1938) Kirjanova, 1961
D. istatae Samibaeva, 1966
D. khani nom. nov.
syn. *Diptenchus indicus* Khan, Chawla & Seshadri, 1969
D. lutonensis (Siddiqi, 1980) comb. nov.
syn. *Safianema lutonense* Siddiqi, 1980
D. medicaginis Wasilewska, 1965
D. melongena Bhatnagar & Kadyan, 1969
D. microdens Thorne & Malek, 1968
D. minutus Husain & Khan, 1967
D. mirus Siddiqi, 1963
D. myceliophagus Goodey, 1958
syn. *D. geraerti* (Paramonov, 1970) Bello & Geraert, 1972, n. syn.
D. nanus Siddiqi, 1963
D. nortoni (Elmiligy, 1971) Bello & Geraert, 1972
syn. *Basiroides nortoni* Elmiligy, 1971
nec Basiroides nortoni (Thorne & Malek, 1968) Fotedar & Mahajan, 1973, syn. *Basiria nortoni* Thorne & Malek, 1968.
D. obesus Thorne & Malek, 1968
D. sibiricus German, 1969
D. solani Husain & Khan, 1976
D. sonchophila Kirjanova, 1958 (cited in Paramonov, 1970)
D. taleolus (Kirjanova, 1938) Kirjanova, 1961
D. tausaghyzatus (Kirjanova, 1938) Kirjanova, 1961
D. tenuidens Gritsenko, 1971
D. triformis Hirschmann & Sasser, 1955
D. valveus Thorne & Malek, 1968
D. virtudesae Tobar Jimenez, 1964

Species of the genus Ditylenchus *considered as imperfectly described (species inquirendae)* seven species [4] :

By Meyl (1961) :
D. darbouxi (Cotte, 1912) Filipjev, 1936
D. sycobius (Cotte, 1920) Filipjev, 1936

By Goodey (1963) :
D. brevicauda (Micoletzky, 1925) Filipjev, 1936

[4] *Chitinotylenchus boevii* Izatullaeva, 1967, *Anguillulina incognata* Van der Linde, 1938, *C. sedatus* Kirjanova, 1951 and *Tylopharynx annulatus* Cassidy, 1930 are listed in Tarjan and Hopper (1974) under *Ditylenchus*. In fact, Sher (1970) considered these species as *species inquirendae* under the name *Chitinotylenchus*. The last one was transferred by Golden (1971) to *Tylenchorhynchus*.

To this group of imperfectly described species, it seems necessary to add the following :

D. bacillifer (Micoletzky, 1922) Filipjev, 1936
D. humuli Skarbilovich, 1972
D. intermedius (De Man, 1880) Filipjev, 1936
D. karakalpakensis Erzhanova, 1964

Species considered of doubtful position (species incertae sedis), eight species ([5]) :

By Paramonov (1970) :
D. beljaevae Karimova, 1957
D. eurycephalus (De Man, 1921) Filipjev, 1936
D. procerus (Bally & Reydon, 1931) Filipjev, 1936
D. pumilus Karimova, 1957
D. sapari Atakhanov, 1958
D. tulaganovi Karimova, 1957
By Brzeski (1981) :
D. pustulicola (Thorne, 1934) Filipjev & Schuurmans Stekhoven, 1941

To this group of species of doubtful position is now added :

D. paragracilis (Micoletzky, 1922) Sher, 1970

Species of Ditylenchus *later transfered to other genera*

— To *Neoditylenchus* (fourteen species)
By Meyl (1961) :
D. abieticolus, Rühm, 1956
D. autographi Rühm, 1956
D. dendrophilus (Marcinowski, 1909) Filipjev & Schuurmans Stekhoven, 1941
D. eremus Rühm, 1956
D. gallicus (Steiner, 1935) Filipjev, 1956
D. glischrus Rühm, 1956
D. major (Fuchs, 1915) Filipjev, 1936
D. ortus (Fuchs, 1938) Filipjev & Schuurmans Stekhoven, 1941
D. panurgus Rühm, 1956
D. petithi (Fuchs, 1938) Rühm, 1956
D. pityokteinophilus Rühm, 1956
D. striatus (Fuchs, 1918) Rühm, 1954
By Goodey (1963) :
D. pinophilus (Thorne, 1935) Filipjev, 1936
D. rarus Meyl, 1954
— To *Anguina* (two species)
By Filipjev (1936*a*) :
D. balsamophilus (Thorne, 1926) Filipjev & Schuurmans Stekhoven, 1941
By Thorne (1961) :
D. amsinckiae Filipjev & Schuurmans Stekhoven, 1941
— To *Orrina* (one species)
By Brzeski (1981) :
D. phyllobius (Thorne, 1934) Filipjev, 1936
— To *Subanguina* (four species)
By Paramonov (1967) :
D. radicicola (Greef, 1872) Filipjev, 1936
By Brzeski (1981) :
D. askenasyi (Bütschli, 1873) Goodey, 1951
D. brenani (Goodey, 1945) Goodey, 1951
D. graminophilus (Goodey, 1933) Filipjev, 1936
— To *Deladenus* (two species)
By Goodey and Franklin (in Goodey, 1956) :
D. arboricolus (Cobb, 1922) Filipjev & Schuurmans Stekhoven, 1941
By Thorne (1941) :
D. durus (Cobb, 1922) Filipjev, 1936
— To *Tylenchus* one species
By Bello and Geraert (1972) :
D. misellus Andrássy, 1958

Related and synonym genera

The genus Chitinotylenchus

Chitinotylenchus paragracilis (Micoletzky, 1922) Filipjev, 1936 was redescribed by Sher (1970) from the only known specimen, the female holotype. Sher transferred *C. paragracilis* to *Ditylenchus* and proposed to consider *Chitinotylenchus* Micoletzky, 1922 and *Ditylenchus* Filipjev, 1936 as synonyms. To preserve the well known name *Ditylenchus*, Loof and Sher (1971) requested from the International Commission of Zoological Nomenclature to supress the name *Chitinotylenchus* and to place *Ditylenchus* on the Official List of Generic Names in Zoology. Dr. Lemche latter suggested to also place the name *Chitinotylenchus* on the Official

([5]) *Tylenchus cafeicola* Schuurmans Steckhoven, 1951 was believed by Goodey (1963) to be a *Ditylenchus* but too meagerly described to be attributed to this genus with confidence.

Index of Rejected and Invalid Names in Zoology and Dr. Loof gave a list of references with the name *Ditylenchus* to implement his earlier proposal (Lemche ; Loof, 1974).

In June 1975, the Commission supported the application by nineteen votes to one. Dr. Dupuis voted for postponing the decision because the synonymization of the two genera was the opinion of a single scientist. Three specialists were consulted. Luc accepted the conclusion of Sher while Andrássy and Siddiqi questioned it (Siddiqi (1971) had accepted the synonymization in an earlier article) because some generic characters are not visible in the flattened and cleared female holotype and the male is not known for *C. paragracilis* (Melville, 1977). The commission was then asked to choose whether to suppress *Chitinotylenchus* as originally decided or to give *Ditylenchus* precedence over *Chitinotylenchus* whenever the two names are considered synonyms. This means that whoever considers the two genera as two different valid taxa would be entitled to use both names but when they are held to apply to the name genus, *Ditylenchus* is the name to be used. The final decision of the Commission is expected to be published soon (Melville, pers. comm.).

I consider that because some important features relevant at generic level are not known for *Chitinotylenchus paragracilis* (namely arrangement of oocytes in the ovary and structure and size of spermatheca, columella, male bursae and sperm cells), it is not possible to consider it as a species of *Ditylenchus*, neither is it possible to assign *Chitinotylenchus* a place among other genera in the Anguininae. Following the opinion of Andrássy (in Melville, 1977), I regard *Chitinotylenchus* a *genus inquirendum* and *C. paragracilis* a *species inquirenda.*

The genus Diptenchus

Diptenchus was proposed to accomodate *Diptenchus indicus* Khan, Chawla & Seshadri, 1969, type and so far only species in the genus. *Diptenchus* was differentiated from *Ditylenchus* by : *i*) the shape of the glandular bulb (pyriform, set off from the intestine in *Diptenchus*, clavate to variously expanded, sometimes lobed in *Ditylenchus*) ; *ii*) the absence of a post uterine sac (P.U.S. present in *Ditylenchus*) (Khan Chawla & Seshadri, 1969).

Another differentiating character was proposed by Brzeski (1981) : the vagina was said to be oblique to the body axis in *Diptenchus*, perpendicular to body axis in *Ditylenchus*. In fact the orientation of the vulva is not described or figured for most species in *Ditylenchus*. In the present specimens the vulva was mostly perpendicular but sometimes made a slight angle with the body axis. A wider angle can be seen in illustrations of *D. caudatus*, *D. deiridus* and *D. valveus* (Thorne & Malek, 1968), *D. angustus* (Filipjev & Schuurmans Stekhoven, 1941 ; Seshadri & Dasgupta, 1975) and *D. nortoni* (Bello & Geraert, 1972). The use of this character is questionable at generic level.

The pyriform bulb illustrated for *Diptenchus indicus* (Khan, 1969) is not different from the corresponding structure in *Ditylenchus clarus* (with a long P.U.S.), *D. emus* (P.U.S. of medium length), *D. nortoni* and *D. obesus* (P.U.S. about one body diameter long). The first character used in the original diagnosis of *Diptenchus* does not differentiate this genus from *Ditylenchus*.

All species in *Ditylenchus* have a P.U.S. except *Ditylenchus deiridus*. This species also has a pyriform glandular bulb resembling *Diptenchus indicus*. However, the recognition of *Diptenchus* as a valid genus and the transfer of *Ditylenchus deiridus* to *Diptenchus* is not advocated here for the following reasons :

— *Diptenchus* differs from *Ditylenchus* in one character only. All other features are remarkably similar in males and females of species of these two genera.

— Presence or absence of P.U.S. is a character useful for specific identification (see Tab. 3). Identification is different from taxonomy and the erection of a new genus for identification purposes is unwarranted and unnecessary.

— The post uterine sac represents the relict of a posterior genital branch. The modern forms of nematodes possessing this structure probably evolved from ancestral forms with two genital branches equally developed (in some genera, modern species present different states of the regression of the posterior branch : for example, many *Helicotylenchus* have two equal branches, *H. multicinctus* has a shorter posterior branch, *H. neoformis* and *Rotylenchoides intermedius* have vestigial posterior branches and typical species in *Rotylenchoides* possess short P.U.S.).

No modern form exists resembling the hypothetical ancestral form of *Ditylenchus* with two genital branches. In that genus, the P.U.S. varies from a long structure to a short sac or disappears completely (see Tab. 3). Grouping in a separate genus the forms completely lacking this structure would put an unnecessary emphasis upon what is only the logic end of the regression.

— Species with no or very reduced P.U.S. are present in the related genus *Subanguina* : *S. moxae*, *S. calamagrostis*, *S. graminophila*, *S. millefolii*, while other *Subanguina* species have long P.U.S. To be consistent with the diagnosis of *Diptenchus*, a new genus would have to be provided for these species. Species without P.U.S. exist perhaps in other genera in Anguininae (I have observed a *Nothotylenchus* sp. without P.U.S.). The creation of new genera based on this character, and the acceptance of *Diptenchus*, would confuse the relationships existing between the genera in Anguininae because emphasizing a regressed structure (Mayr 1969, cautions against using regressed organs for classification purposes).

Diptenchus Khan, Chawla & Seshadri, 1969 is here proposed as a junior synonym of *Ditylenchus* Filipjev, 1936. *Diptenchus indicus* Khan. Chawla & Seshadri, 1969 is transferred to the genus *Ditylenchus*. As the name *Ditylenchus indicus* is preoccupied by a species described earlier (*Pseudhalenchus indicus* Sethi & Swarup, 1967, transferred to *Ditylenchus* in the present article), a new name is here proposed for *Diptenchus indicus* : *Ditylenchus khani* nom. nov.

The genus Safianema

Siddiqi (1980*a*) proposed *Safianema* n. gen. to accommodate a new species, *S. lutonense* and those species in *Pseudhalenchus* Tarjan, 1958 which show close affinities with the Anguininae (through similarities in lip region, spear, gonads, spicules and absence of a cardia). The new genus was differentiated from *Ditylenchus* by : *i*) the oesophageal glands extending as an elongated lobe over the intestine and *ii*) the intestine narrower at level of the oesophageal glands.

The taxonomic position of one of the species transferred by Siddiqi to his new genus, *P. anchilisposomus* (= *S. anchilisposomum*) was questioned by Geraert and Kheiri (1970). These authors concluded that "the differences between *P. anchilisposomus* and *D. destructor* are apparrently only quantitative (...) so this species could probably be transferred to the genus *Ditylenchus*".

The narrowness of the intestine at the level of the oesophageal glands is most probably a consequence of the very presence of the glandular lobe and the necessity to make room for this structure. A similarly narrow intestine was observed in the specimens of *D. myceliophagus* with a long oesophageal lobe (Fig. 2, D). There is no difference in structure between narrower or larger intestines and this character has no value for generic differentiation.

Observations of *D. myceliophagus* from the Ivory Coast, as explained above, have shown that the length of the oesophageal overlap varies greatly during the life of any particular individual. Young West African specimens are remarkably similar to the description of *Safianema* while older individuals fit well into the diagnosis of *Ditylenchus*.

Could it be that this similarity was only apparent and that it was nevertheless possible to differentiate *Safianema*, with glands lying free over the intestine, from *Ditylenchus*, with glands enclosed in a basal bulb ? The ultrastructure of the glandular region of the oesophagus of *D. myceliophagus* could not be studied for material reasons, but interesting conclusions can be drawn from two studies published, the first on *D. dipsaci* (Yuen, 1968) which is supposed to have "a clavate posterior oesophageal bulb that butts onto or slightly overlaps the intestine" (Hooper, 1972), and the second on *Heterodera glycines* (Baldwin, Hirschmann & Triantaphyllou, 1977) which, like all *Heterodera* species, has glands lying free over the intestine.

Yuen (1968) described the postcorpus of *D. dipsaci* as a "thinwalled elastic sac" containing the glands. At the anterior end the wall is thicker, containing large pockets of nuclei and mitochondria (Fig. 16 of Yuen, 1968). In middle portion the wall is reduced to the "basement membrane" (Fig. 17 of Yuen, 1968).

In *Heterodera glycines*, Baldwin, Hirschmann & Triantaphyllou (1977) described at the anterior end of the oesophageal lobe, peripheral nuclei associated with narrow bands of tissue

of the oesophagus. Fig. 23 of Baldwin, Hirschmann & Triantaphyllou (1977) is quite similar to Fig. 16 of Yuen (1968). More posteriorly, the gland lobe is sheathed by the basal lamina (= basement membrane of Yuen) only, and Fig. 26 of Baldwin, Hirschmann & Triantaphyllou (1977) resembles Fig. 17 of Yuen (1968).

From these two studies, no difference appears to exist in the structure of the glandular part of the oesophagus in *D. dipsaci* and in a species described with glands free, overlapping the intestine. It is probably that in *Ditylenchus* there exists no such structure as a "basal bulb" : in some species of this genus the oesophageal glands stop short of the oesophago-intestinal junction, while in others they extend posterior to it.

Because there appears to be no structural differences in the glandular oesophageal lobe in *Ditylenchus* and *Safianema*, and because this structure was observed to vary during the life of individual specimens, it is considered to be unfit for diagnostic purposes. *Safianema* Siddiqi, 1980 is here proposed as a junior synonym of *Ditylenchus* Filipjev, 1936. Four species were included in the genus *Safianema* by Siddiqi (1980) :

S. lutonense Siddiqi, 1980, type species
S. anchilisposomum (Tarjan, 1958) Siddiqi, 1980
syn. *Pseudhalenchus anchilisposomus* Tarjan, 1958
S. damnatum (Massey, 1966) Siddiqi, 1980
syn. *P. damnatus* Massey, 1966
S. hylobii (Massey, 1967) Siddiqi, 1980
syn. *P. hylobii* Massey, 1967

S. lutonense fits well the diagnosis of *Ditylenchus* as given above. The oesophageal overlap is 45 to 59 µm long, of the same magnitude that the corresponding structure in some of the present specimens. Paratypes were examined. Structure of oesophagus and intestine showed no difference with *Ditylenchus*. The new combination *Ditylenchus lutonensis* (Siddiqi, 1980) *comb. nov.* is here proposed.

Examination of paratypes of *S. anchilisposomum* support the opinion of Geraert and Kheiri (1970) and this species is here transferred to *Ditylenchus* as *D. anchilisposomus* (Tarjan, 1958) *comb. nov.* It differs from *D. destructor* in several characters as seen in Table 3. *P. anchilisposomus* identified in Japan by Dr. Yamamoto was also examined and its identity as *D. anchilisposomus* was confirmed.

Paratypes of *S. damnatum* also presented every characteristic of *Ditylenchus*. The genital branch has the typical structure of *Ditylenchus*, (columella, spermatheca, ovary). Stylet length in female (not indicated in original description) was 12 µm, lateral incisures were not absent as mentioned, but very difficult to observe. Three lines were seen on tail. The number of lines on the body could not be determined. The tail was more pointed than originally described. This species is here transferred to *Ditylenchus* as *D. damnatus* (Massey, 1966) *comb. nov.*

Paratypes of *S. hylobii* proved this species to be quite different from the preceeding ones, with protractor muscles of stylet attached to cephalic cuticle, spermatheca oblong, as a diverticulum offset from uterus, packed with small rounded sperms lacking translucent vesicle, crustaformeria with cells irregularly disposed, tail filiform and male bursa very small. The structure of the female gonad and male sperm cells fit the definition of *Pseudhalenchus* (*sensu* Siddiqi, 1980) better, and it is transferred back to this genus.

Siddiqi (1980*a*) proposed to leave *P. indicus* and *P. acutus* in the genus *Pseudhalenchus*, which he redefined as a member of Tylenchinae (see discussion below). Female paratypes of both species were examined and were found to have every characteristic of the genus *Ditylenchus* as redefined here. Male paratypes could not be obtained, but sperm cells present in the spermathecae of all the female specimens were of the Anguininae-type.

Pseudhalenchus indicus and *P. acutus* are here transferred to the genus *Ditylenchus* under the names *Ditylenchus indicus* (Sethi & Swarup, 1967) comb. nov. and *Ditylenchus acutus* (Khan & Nanjappa, 1972) comb. nov.

Paratypes of *D. indicus* have a shorter stylet (8 µm) and a more rounded tail than originally described (Sethi & Swarup, 1967).

The genus Pseudhalenchus

Pseudhalenchus Tarjan, 1958, was redefined by Siddiqi (1980) to include the species which, because of the structure of male and female gonads, are related to Tylenchinae.

Paratypes of *P. minutus* Tarjan, 1958, the type species, were young females with inconspicuous spermathecae. As far as could be observed, this structure was axial, but certainly smaller than in most *Ditylenchus* spp. No sperm cells were observed in the spermathecae of the females but two male paratypes had sperm cells small and without translucent vesicle.

The structure of the sperm cells, which is a very significant character, oblige to assign *P. minutus* to Tylenchinae. As pointed out by Siddiqi (1980) it is unique among Tylenchinae in having elongated gland lobe. No intermediate form exists between typical genera in Tylenchinae with small "bulb" and *P. minutus*. Consequently, *Pseudhalenchus* appears to be distinct from all genera in Tylenchindae and is considered a valid genus.

It does not seem necessary to assign *Pseudhalenchus* to a separate sub-family because it presents only quantitative and not structural difference with other genera in Tylenchinae (see discussion above on the nature of the "basal bulb"). The sub-family Pseudhalenchinae Siddiqi, 1971 ([6]) is considered synonym of Tylenchinae Oerley, 1880.

As said above, *P. hylobii* Massey, 1967 is a valid species of the genus *Pseudhalenchus sensu* Siddiqi (1980).

On the status of some species of *Ditylenchus*

Synonym species

The validity of some species is doubtful. For example, *D. sonchophila*, and *D. dipsaci falcariae* are morphologically very close to *D. dipsaci* and are probable synonyms of this species.

No significant difference could be found between *D. geraerti* and *D. myceliophagus*. *D. geraerti* is smaller (400-455 µm) than *D. myceliophagus* (600-1 380 µm), but body length was proven to be dependent on food supply (Evans & Fisher, 1970). Some West African individuals of *D. myceliophagus* (sample 3 and specimens from Taï forest) were also very small (less than 600 µm), whereas other West African populations (samples 1, 2 and 4) were of the same size as typical *D. myceliophagus* (600-1 380 µm in Hesling, 1974). No males were found and spermathecae of *D. geraerti* are empty. However, if we suppose that the three individuals observed by Geraert (1962) were young, immature females, this could explain their small size, short ovary, and absence of sperms in spermathecae. Examination of a paralectotype of *D. geraerti* failed to show any difference with West African specimens and with description of *D. myceliophagus*. Therefore, *D. geraerti* is synonymized with the latter species.

D. phloxidis, listed as synonym of *D. dipsaci* in Tarjan and Hopper (1974), actually presents genetic incompatibility with some populations of that species and the suggestion was made that it was in a state of active speciation (Ladygina, 1974). Another species is excluded from Tarjan and Hopper's list of synonyms of *D. dipsaci* : *D. destructor* is not considered synonymous with *D. dipsaci* because of greater number (six) of lines in lateral field (Thorne, 1961).

Imperfectly described species

Thorne (1961) expressed the gravest doubts about the identity of *D. intermedius* : "Actually, this name appears to have been used as a dumping ground to accommodate a number of closely related forms". Loof (1961) studying the nematode collection of De Man found only one male. (Another specimen of *D. intermedius*, a female, was lost during remounting). He could not determine the exact length of the bursa, and the tail was much longer and slenderer than the original description.

The number of lines in the lateral field was not indicated in these two works nor in Paramonov (1970) or in Goodey (1932). The value of V was given as 70% by Thorne (1961), 76-82% by Paramonov (1970) and 68.5-82.5% by Goodey (1932). Because so many diagnostic characters are unknown, it seems best to consider *D. intermedius* a *species inquirenda.*

([6]) Siddiqi mentioned the new subfamily at the E.S.N. symposium at Pescara in September 1970. This does not constitute a publication (Art. 9 (4) of the Code of Zoological Nomenclature). In the published abstracts (Siddiqi, 1970), the name Pseudhalenchinae is not accompanied by a statement giving the characters differentiating the new taxon. The dispositions of Art. 13 (a) of the Code are not fulfilled.

Table 3
Tabular Key to Species of *Ditylenchus*

Groups	*Stylet length* 1 : →9 µm 2 : 10 µm→	*Tail Pointed* *Rounded* *Broad* *Sickle*	*Lateral lines* 4 *6* *(= more than 4)*	*P.U.S. Short* *Long* *0 : no P.U.S.*	*V%* 1 →70% *2* →77% 3 →84% 4	*Bursa Short* *Long*	*Spicule length* 1 →12 µm *2* →16 µm *3* →21 µm 4	*Species*
1	1	P	4	0	4	—	—	*D. deiridus*
				S	3	S	2	*D. sibiricus*
				S	3	S	2	*D. equalis*
				S	3	L	(3 ?)	*D. microdens*
				S-L	3	S	4	*D. nortoni*
2	1	P	6	0	3-4	L	4	*D. khani*
				S	3	L	2	*D. tenuidens*
1/3	1	?	4	L	2-3	?	1	*D. minutus*
				S	2	—	—	*D. brassicae*
	1	P-R	4	S	3	—	—	*D. acutus*
2/4	1	P-R	6	L	2	S	2-3	*D. lutonensis*
				L	2-3	S-L	2-3	*D. medicaginis*
3	1	R	4	S	1	S	2-3	*D. emus*
				S	3	S	2	*D. indicus*
3/4	1	R	?	L	2-3	L	2-3	*D. dipsacoideus*
				L	3-4	L	2	*D. nanus*
4	1	R	6	S	2-3	S-L	2	*D. triformis*
				L	3-(4 ?)	L	3	*D. myceliophagus*
A	1	B	?	L	3-4	L	3	*D. mirus*
	1	B	6	L	3	L	1	*D. virtudesae*
	1	S	?	S	2-3	L	1	*D. drepanocercus*
3/7	1-2	R	4	L	3	S	3	*D. solani*
4/8	1-2	R	6	L	3	L	3	*D. anchilisposomus*
5	2	P	4	S	2	S	2	*D. ausafi*
				L	2-3	L	3	*D. angustus*
				L	3	L	4	*D. dipsaci*
				L	3	L	4	*D. dipsaci falcariae*
				L	3-4	L	4	*D. sonchophila*
5/6	2	P	4-6	L	3	—	4	*D. galeopsidis*
6	2	P	6	L	2-3	L	4	*D. convallariae*
6/8	2	P-R	6	S	3	S	—	*D. valveus*
		?		L	2-3	L	2-3	*D. cyperi*
6/7/8	2	P-R	?	S	2	L	—	*D. damnatus*
7/8	2	R	?	S-L	3	—	—	*D. obesus*
				L	3	—	—	*D. clarus*
8	2	R	6	S	2	S	4?	*D. caudatus*
				L	3	L	—	*D. destructor*

Note : *D. inobservabilis, D. istatae, D. melongena, D. taleolus* and *D. tausaghyzatus* are not included in this key.

D. bacillifer was described by Micoletzky (1922) as *Tylenchus bacillifer* from a single female. Some important features were not mentioned (number of incisures), the stylet length of 18 µm was probably over-estimated (in the same paper, Micoletzky described *Tylenchus dipsaci* with a 10-18 µm spear, *T. paragracilis* with a 13 µm spear : Sher (1970) redescribing the latter species measured a 8 µm spear) : tail was figured pointed, but described "... mit leicht abgerundeter Spitze" [Transl. : "with a slightly rounded end"] ; the description of cephalic framework does not fit with any known feature : "Im Innern des Vorderendes finden sich (vermutlich 3) chitinige Stäbchen (...) von kommaartiger Gestalt und veränderlicher Stellung" [Transl. : "inside the anterior end are found (probably 3) chitinous rods (...) in the shape of a comma and of a variable position"]. *D. bacillifer* has apparently never been found since the original description and was not referred to either in Throne (1961), Goodey (1963), or Paramonov (1970).

The description of *D. humuli* is very meager. Only some measurements (but not stylet length and V-value) and relationships (with *D. dipsaci* and *D. destructor*), but no morphological description and no figure, were given.

The description of *D. karakalpakensis* was more complete, but some essential information (on genital system and lines in lateral field) is missing and the figure presents a flattened specimen.

D. pustulicola was considered as *Anguina pustulicola* by Choi and Loof (1973) and Hooper and Southey (1978), but these latter authors suggest that the original description of the species is unsound. Brzeski (1981) said that it may belong to *Subanguina*. For the moment, it seems preferable to consider this species as *species incertae sedis*.

Tabular key to species of *Ditylenchus*

From the present observations, and from similar studies by various authors, it is evident that most morphometrical characters cannot be used for identification of the species of *Ditylenchus* because they are unreliable (*i.e.* varying in a given species) or useless (appearing in identical state in all species of the genus).

Only a few characters could be retained and were used in Table 3.

The first three characters (stylet length, tail end, and number of lines) can usually be determined for every population and without ambiguity. They were used to define eight groups of species, numbered 1 to 8. Group 7 is not represented. An additional group (Group A) includes the species with abnormal tail ends, broadly rounded or sickle-shaped. Because some characters are unknown or overlapping for some species, some intermediate groups (1/3, 2/4 and so on) had to be delimited.

When the group to which an unknown population belongs has been determined, it must be compared to all the species in that group, as well as to the species of the adjacent intermediate groups. For example, if an unknown population is found to belong to group 4, it must be compared to the two species in group 4, the two species in group 2/4, the two species in group 3/4 and the species of group 4/8.

These comparisons are made using the other four characters. The final decision on the identity of the unknown population must use the original description (or reliable redescriptions) of the more closely related species.

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