

## *Trichodorus philipi* n. sp. from South Africa, with Notes on *Paratrichodorus lobatus* and *P. acutus*

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**Abstract:** A new species in the family Trichodoridae, from the rhizosphere of native plants of the Cape Fynbos in the western Cape, Republic of South Africa, is described and illustrated. *Trichodorus philipi* n. sp. resembles *T. cottieri* Clark, 1963 and *T. elegans* Allen, 1957, from which both sexes are distinguished by a shorter body and onchiostyle. The females differ by the more posterior position of excretory pore, presence of two pairs of lateral body pores, and shape and sclerotization of vulval-vaginal region in lateral view. Males differ by the more posterior position of excretory pore and ventromedian cervical papilla and length and shape of the spicules. Additional morphological details and morphometrics are given for *Paratrichodorus lobatus* (Colbran, 1965) Siddiqi, 1974 and *P. acutus* (Bird, 1967) Siddiqi, 1974.

**Key words:** Cape Fynbos, leatherleaf fern, morphology, rice, South Africa, stubby-root nematode, taxonomy.

The Cape Fynbos is an ancient part of the vegetation of the Cape Floral Kingdom, one of the six floral kingdoms of the world. Fynbos is an Afrikaans term meaning fine bush, alluding to the fine-leaved form of many of the sclerophyllous shrubs and their bushy habits. Soil samples were collected in the Cape Fynbos on the mountain slopes of the Hottentots-Holland Nature Reserve in the western Cape, Republic of South Africa, by the second author at the summit of a narrow ravine called Landdroskloof, at 1,350 m altitude. This locality is covered with mist or rain clouds for most of the year resulting in low temperatures and an average annual rainfall exceeding 3,500 mm. The soil samples were rich in organic matter and their moisture content was near saturation. One sample contained specimens considered to be a new species of *Trichodorus* Cobb, 1913 described herein as *T. philipi* n. sp.

Soil samples collected by the first author from the rhizosphere of rice (*Oryza sativa* L.) in a rice pilot project in North Natal, Republic of South Africa, contained *Paratrichodorus lobatus* (Colbran, 1965) Siddiqi, 1974; those collected by the third author

from the rhizosphere of leatherleaf fern (*Rumohra adiantiformis* (Forst) Ching) in a nursery in Krugersdorp near Johannesburg, contained *P. acutus* (Bird, 1967) Siddiqi, 1974. Examination of these specimens revealed additional specific morphological information reported here.

### MATERIALS AND METHODS

Nematodes were extracted from soil by sugar centrifugal-flotation (6). Specimens were killed and fixed with hot 4% formalin, processed to pure glycerin by a modified Seinhorst method (5), and mounted in glycerin on glass slides. Unless otherwise indicated, all measurements are in micrometers ( $\mu\text{m}$ ).

### SYSTEMATICS

#### *Trichodorus philipi* n. sp. (Fig. 1)

**Males (Fig. 1B, D):** Morphometric data of the holotype and paratypes ( $n = 9$ ) are given in Table 1. General appearance typical of Trichodoridae. Posterior end curved ventrally. After fixation cuticle swollen or not swollen. Swollen cuticle at mid-body about 2.5–3 thick, not swollen about 1.5–2. Swollen cuticle with two distinct layers, not swollen with three. Esophageal bulb 25–30% esophagus length. Five esophageal gland nuclei present (Fig. 1B): anterior ventro-sublateral nuclei small, indistinct, in anterior third of bulb; posterior ventro-sublateral nuclei in posterior third

Received for publication 4 November 1988.

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of bulb; dorsal nucleus position variable. No esophageal or intestinal overlap. Nerve ring about mid-esophagus. One distinct ventromedian cervical papilla (CP) present (Fig. 1B), posterior to onchiostyle region, opposite anterior part of esophageal bulb. Excretory pore 82–101% esophagus length from anterior end, posterior to CP, opposite posterior part of esophageal bulb. One pair of lateral cervical pores present (Fig. 1B), positioned at level of CP, 69–89 (81) from anterior end. Testis single, outstretched. Spicules proximally cephalated, manubrium and calamus arcuate, lamina straight, faintly striated (Fig. 1D). Gubernaculum keel thickened. Three preanal supplements: posterior one (SP1) within range of retracted spicules; median one (SP2) 49–64 anterior to anus, anterior to retracted spicules; anterior one (SP3) 89–123 anterior to anus. Distances between SP1, SP2, and SP3 in Table 1. One small pair postanal subventral papillae and one pair subterminal caudal pores present. Tail terminus cuticle thickened slightly on specimens without swollen cuticle, more thickened on specimens with swollen cuticle.

**Females** (Fig. 1A, C, E): Morphometric data of the allotype and paratypes ( $n = 10$ ) are given in Table 2. Similar to males. Posterior end straight. No esophageal or intestinal overlap. Excretory pore 3–4 times onchiostyle length from anterior end, about level of esophago-intestinal junction (Fig. 1A). Female reproductive system didelphic, amphidelphic. Ovaries reflexed, large spermathecae present. Vaginal sclerotizations well developed (Fig. 1C). Vagina length 10–13.5, extends inward 37–48% corresponding body width. Two pairs lateral body pores present: one pair 7–26 posterior to vulva, within one body width (Fig. 1C); one pair 69–133 anterior to vulva, 2.3–4.2 times corresponding body width. Anus subterminal. One pair subventral subterminal caudal pores present (Fig. 1E).

**Diagnosis:** *Trichodorus philipi* n. sp. resembles *T. cottieri* Clark, 1963 and *T. elegans* Allen, 1957 in having males with one conspicuous ventromedian cervical papilla posterior to the onchiostyle and anterior

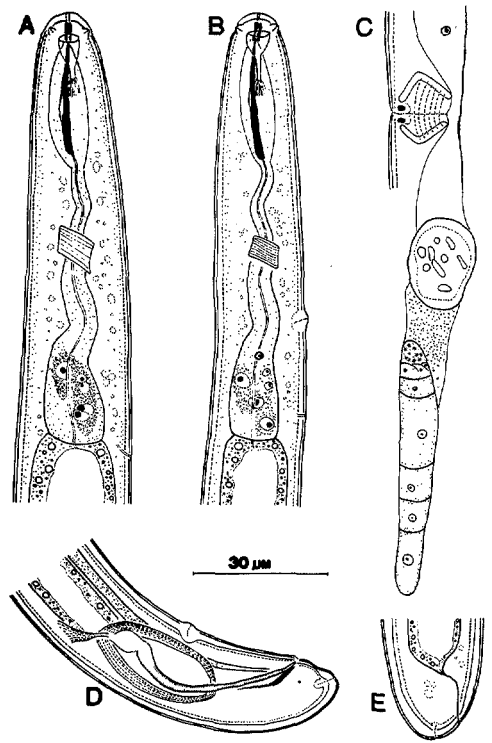


FIG. 1. *Trichodorus philipi* n. sp. A) Anterior region of female (allotype). B) Anterior region of male (holotype). C) Anterior reproductive branch of female (allotype). D) Posterior region of male (paratype). E) Tail of female (allotype).

to the excretory pore; and three ventromedian preanal supplements, the posterior one within range of the retracted spicules and the median one anterior to retracted spicules. Males of *T. philipi* n. sp. differ from the males of *T. cottieri* and *T. elegans* by the more posterior position of the ventromedian cervical papilla and excretory pore, shorter spicules (39–45 vs. 44–53 in *T. cottieri*, and 55–62 in *T. elegans*), and characteristic shape of the spicules (Fig. 1D). Both sexes of *T. philipi* n. sp. can be distinguished from these two species by the shorter body length (504–666 vs. 700–1,030 in *T. cottieri*, and 860–1,230 in *T. elegans*), and shorter onchiostyle (26–30.5 vs. 53–68 in *T. cottieri*, and 140–155 in *T. elegans*). Females of *T. philipi* n. sp. differ from those of *T. cottieri* and *T. elegans* in having two pairs of lateral body pores instead of one, characteristic shape (large,

TABLE 1. Morphometric data of 10 males of *Trichodorus philipi* n. sp.

Character	Holotype	Range	Mean	Standard deviation	Coefficient of variation (%)
Length	534.0	534.0-666.0	610.0	37.9	6.2
Body width	25.5	22.5-31.5	26.0	2.6	10.1
Esophagus length	99.0	97.0-127.0	106.0	9.3	8.8
Onchiostyle length	28.5	27.5-30.5	28.5	0.9	3.2
Anterior end to CP1	77.0	72.0-88.0	79.0	5.4	6.9
CP1 to EP	16.0	14.0-23.0	19.0	3.3	17.2
Anterior end to EP	93.0	89.0-106.0	99.0	5.1	5.1
Spicule length	42.5	39.0-45.0	42.5	2.1	5.0
Gubernaculum length	14.5	10.5-15.0	13.0	1.7	12.8
Anus to SP1	21.0	20.0-25.0	23.0	1.9	8.4
SP1 to SP2	33.0	25.0-39.0	31.0	3.6	11.4
SP2 to SP3	48.0	39.0-59.0	47.0	6.6	14.1
a	20.9	19.2-29.4	23.6	3.3	13.8
b	5.4	5.2-6.4	5.8	0.4	7.5
T	72.4	64.8-72.4	67.2	2.4	3.6
Anterior end to EP/total esophagus length (%)	93.9	81.9-101.0	93.3	5.8	6.2
Onchiostyle length/total esophagus length (%)	28.8	23.9-29.0	27.2	2.1	7.5
Anus to SP1/spicule length (%)	49.4	46.0-59.5	53.3	4.2	7.8
Anus to SP2/spicule length (%)	127.1	114.9-142.2	127.4	8.7	6.8
Anus to SP3/spicule length (%)	240.0	204.6-273.3	238.8	21.7	9.1

All measurements are in micrometers ( $\mu\text{m}$ ) unless otherwise indicated.

square-shaped with rounded edges) of the vaginal sclerotizations (small in *T. cotti*, and elongate-rounded in *T. elegans*) and more posterior position of excretory pore.

*Type host and locality*: Collected by A. J. Meyer on 14 October 1986 from wet soil around the roots of native plants of the Cape Fynbos on the summit of the Landdroeskloof, 1,350 m altitude, Hottentots-Holland Nature Reserve, Republic of South Africa.

*Type designations*: Holotype male (the uppermost specimen on slide no. 23942), allotype female (the upper left-hand specimen on slide no. 23943), five paratype males and five paratype females (slides nos. 23942-23945) deposited in the National Collection of Nematodes, Plant Protection Research Institute, Pretoria, Republic of South Africa. Four paratype males and five paratype females (slides nos. 805-806) deposited in the Nematode Collection, Insti-

TABLE 2. Morphometric data of 11 females of *Trichodorus philipi* n. sp.

Character	Allotype	Range	Mean	Standard deviation	Coefficient of variation (%)
Length	592.0	504.0-643.0	572.0	49.5	8.7
Body width	30.5	26.0-30.5	28.5	5.3	18.7
Esophagus length	104.0	87.0-124.0	103.0	9.6	9.3
Onchiostyle length	26.0	26.0-28.5	27.0	0.9	3.2
Anterior end to EP	108.0	89.0-108.0	97.0	7.3	7.5
Anterior genital branch	113.0	81.0-141.0	111.0	15.1	13.5
Posterior genital branch	116.0	107.0-152.0	122.0	14.2	11.6
a	19.4	18.2-23.0	20.0	1.6	8.2
b	5.7	4.5-6.3	5.6	0.5	9.4
V	52.5	50.0-56.7	52.9	2.0	3.9
G <sub>1</sub>	19.1	14.7-23.3	19.4	2.4	12.6
G <sub>2</sub>	19.6	17.6-25.8	21.5	2.6	12.1
Anterior end to EP/total esophagus length (%)	103.8	88.1-105.7	97.5	6.6	6.7
Onchiostyle length/total esophagus length (%)	25.0	21.8-31.0	26.4	2.5	9.6

All measurements are in micrometers ( $\mu\text{m}$ ) unless otherwise indicated.

TABLE 3. Morphometric data of 11 females of *Paratrichodorus lobatus*.

Character	Range	Mean	Standard deviation	Coefficient of variation (%)
Length	618.0-967.0	793.0	115.4	14.5
Body width	48.5-61.5	52.6	4.4	8.4
Esophagus length	127.0-220.0	167.0	29.5	17.7
Onchiostyle length	44.5-58.0	50.0	5.1	10.2
Anterior end to EP	62.0-107.0	93.0	16.8	18.0
Anterior genital branch	116.0-239.0	176.0	37.2	21.1
Posterior genital branch	110.0-231.0	183.0	35.9	19.7
a	12.7-19.9	15.1	2.3	15.4
b	3.7-6.0	4.8	0.7	13.5
V	47.7-60.1	52.0	3.1	5.9
G <sub>1</sub>	18.3-30.5	22.2	3.6	16.1
G <sub>2</sub>	17.8-26.9	22.9	2.8	12.3
Anterior end to EP/total esophagus length (%)	45.8-69.9	57.7	7.8	13.4
Onchiostyle length/total esophagus length (%)	24.3-35.0	30.5	3.3	11.0

All measurements are in micrometers (µm) unless otherwise indicated.

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This new species is named in memory of the senior author's youngest brother, Philip De Waele.

*Paratrichodorus lobatus*  
(Colbran, 1965) Siddiqi, 1974  
(Fig. 2H-M)

*Females* (n = 11): Morphometric data are given in Table 3. General appearance typical of Trichodoridae. Cuticle swollen after

fixation, 3.5-5.5 thick at mid-body. Excretory pore 62-107 from anterior end. Esophageal bulb 25-33% esophagus length. Five esophageal gland nuclei present. Esophageal bulb with distinct, posteriorly directed, overlap of intestine, overlap 16.5-70.5 long. In nine out of thirteen females, esophageal overlap less than one body width, 0.4-0.8 (Fig. 2M). In four females, esophageal overlap 1-1.5 times corresponding body width (Fig. 2L). Vaginal shape and sclerotizations as shown in Fig. 2H, I. Vagina extends inward 25-33% cor-

TABLE 4. Morphometric data of 14 males of *Paratrichodorus lobatus*.

Character	Range	Mean	Standard deviation	Coefficient of variation (%)
Length	579.0-967.0	719.0	102.9	14.3
Body width	39.0-51.0	44.5	4.1	9.1
Esophagus length	115.0-208.0	150.0	25.3	16.8
Onchiostyle length	44.0-56.0	57.5	3.0	6.4
Anterior end to EP	60.0-129.0	96.0	16.5	17.3
Spicule length	48.5-67.5	60.5	5.5	9.0
Gubernaculum length	9.0-14.5	12.0	1.6	13.6
Anus to SP1	12.0-19.0	15.0	2.1	14.2
SP1 to SP2	11.5-21.0	18.0	3.4	18.8
a	12.1-23.0	16.3	2.9	17.5
b	3.6-6.6	4.9	0.8	16.2
T	59.2-71.5	65.0	4.0	6.2
Anterior end to EP/total esophagus length (%)	46.2-87.0	64.5	10.6	16.4
Onchiostyle length/total esophagus length (%)	25.7-39.1	32.2	3.9	12.2
Anus to SP1/spicule length (%)	19.0-33.0	24.8	3.7	14.7
Anus to SP2/spicule length (%)	45.2-82.5	55.1	9.7	17.5

All measurements are in micrometers (µm) unless otherwise indicated.

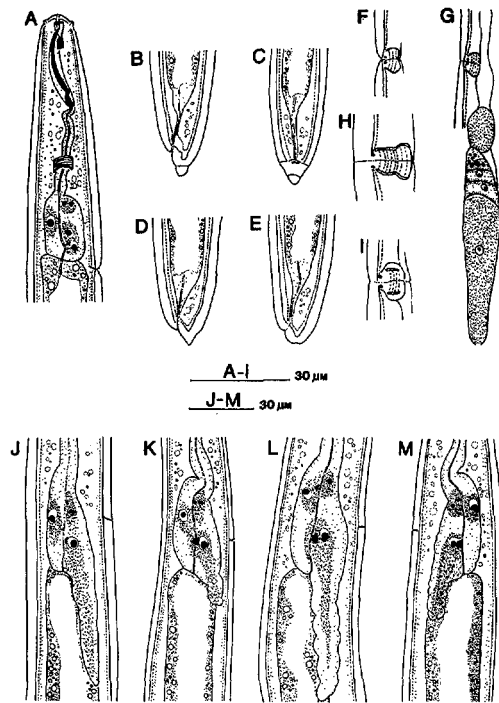


FIG. 2. *Paratrichodorus acutus* and *P. lobatus*. A-G) Females of *P. acutus*. A) Anterior region. B, D, E) Tail (lateral). C) Tail (ventral). F) Vulva and vagina region (lateral). G) Posterior reproductive branch. H-M) Males and females of *P. lobatus*. H, I) Female, vulva and vagina region (lateral). J, K) Male, esophago-intestinal junction. L, M) Female, esophago-intestinal junction.

responding body width. In ten out of thirteen females, two pairs of lateral body pores present: one pair 100–200 from anterior end, and one pair 96–223 posterior to vulva. Four females with only the posterior pair. Tail with one pair subterminal caudal pores.

*Males* ( $n = 14$ ): Morphometric data are given in Table 4. Similar to females. Excretory pore 60–129 from anterior end. Ventromedian cervical papillae and lateral cervical papillae absent. Esophageal bulb with distinct, posteriorly directed, overlap of intestine, overlap 13–55 long. In eleven out of fourteen males, esophageal overlap less than one body width, 0.3–0.9 (Fig. 2K). In three males, esophageal overlap 1–1.4 times corresponding body width (Fig. 2J). Spicules striated, proximally cephalated. Gubernaculum keel not thickened. Two preanal supplements within range of retracted spicules. One pair postanal subventral papillae and one pair subterminal caudal pores present. Bursa present. Tail convex-conoid.

*Paratrichodorus acutus*  
(Bird, 1967) Siddiqi, 1974  
(Fig. 2A–G)

*Females* ( $n = 23$ ): Morphometric data are given in Table 5. Body straight when fixed.

TABLE 5. Morphometric data of 23 females of *Paratrichodorus acutus*.

Character	Range	Mean	Standard deviation	Coefficient of variation (%)
Length	338.0–439.0	395.0	29.6	7.5
Body width	22.0–26.5	24.0	1.0	4.3
Esophagus length	72.0–84.0	77.0	3.4	4.4
Onchiostyle length	24.0–27.0	26.0	0.9	3.3
Anterior end to EP	68.0–78.0	73.0	2.9	4.0
Anterior genital branch	55.0–93.0	70.0	11.0	15.7
Posterior genital branch	57.0–87.0	75.0	8.8	11.8
a	14.1–17.7	16.4	1.0	6.3
b	4.3–6.0	5.1	8.9	0.5
V	52.3–55.8	54.0	1.1	2.1
G <sub>1</sub>	23.8–24.2	17.8	2.6	14.5
G <sub>2</sub>	14.5–21.8	19.0	1.9	10.2
Anterior end to EP/total esophagus length (%)	84.1–102.7	94.4	5.0	5.3
Onchiostyle length/total esophagus length (%)	31.1–36.5	33.7	1.5	4.5

All measurements are in micrometers ( $\mu\text{m}$ ) unless otherwise indicated.

Cuticle 2.5–3.5 thick at mid-body, with two distinct layers: thick outer (2–3), and thin inner layer (0.5–1). Lip region hemispherical to slightly conical, one-third body width at esophago-intestinal junction, almost continuous with body contour. Labial papillae slightly raised. Amphidial aperture at level of labial papillae, ellipsoidal, 2.5 wide; sensilla sac 7–8 from anterior end. Excretory pore usually at level of esophago-intestinal junction. Stoma tubular, 3.5–4, walls distinctly sclerotized. Posterior part of onchiostyle irregularly twisted (Fig. 2A). Esophageal bulb 25–33% esophagus length. Five esophageal gland nuclei present (Fig. 2A): anterior ventro-sublateral nuclei small, indistinct, in anterior third of bulb; posterior ventro-sublateral nuclei in posterior third of bulb; dorsal nucleus near mid-bulb. Nerve ring about mid-esophagus. Without esophageal and intestinal overlap. Reproductive system didelphic, amphidelphic. Ovaries reflexed, empty spermathecae present (Fig. 2G). Vagina length 6–8.5, extends inward 25–36% corresponding body width. Vaginal sclerotizations well developed, round (Fig. 2F). Vulva short transverse slit in ventral view. Lateral body pores absent. Rectum 16–22 long. Anus subterminal. Tail usually 7–8 long (Fig. 2B, C), sometimes shorter, 3.5–5 (Fig. 2D, E). Tail usually anteriorly conoid, then digitate with rounded terminus (Fig. 2B, C). Caudal pores absent.

*Males:* Unknown; sperm not observed in mature females.

#### DISCUSSION

The morphological characters and morphometrics of the rice population of *P. lobatus* agree with previous reports (2,9,10), except for the length of the esophageal overlap and the number of lateral body pores in the females. The esophageal overlap was originally described as about one body width long (2), and this character has been used in all diagnostic keys to differentiate *P. lobatus* from related species (3,7,8). Although a large esophageal overlap was present in some specimens from rice, most overlaps were shorter than one

body width. Decraemer and De Waele (4) also reported differences in the length of esophageal overlaps within the same species, between specimens from the same locality, and between specimens from different localities. The observations presented in our study support their conclusion that the taxonomic value of the length of the esophageal overlap is questionable. Females of *P. lobatus* have been described as having only one pair of lateral body pores situated between vulva and anus (2,9), a character which has also been used to differentiate *P. lobatus* from closely related species (3). In most specimens from rice, however, two lateral body pores were present.

The morphological characters and morphometrics of the South African population of *P. acutus* agree with those reported by Bird (1). The tail shape of this species is unique among all species of the Trichodoridae. *Paratrichodorus acutus* was described from the rhizosphere of gloxinia (*Sinningia speciosa*) in Ithaca, New York (1), and not reported again until the present study.

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