

Species of *Trichodorus* (Nematoda : Trichodoridae) from Portugal

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SUMMARY

Soil samples collected in continental Portugal and the Açores, yielded *Trichodorus primitivus*, several populations of *T. lusitanicus* possessing two or three ventromedian cervical papillae and two new *Trichodorus* species, *T. beirensis* n. sp. from the Portuguese mainland and *T. azorensis* n. sp. from the Açores. The males of *T. lusitanicus*, *T. beirensis* n. sp. and *T. azorensis* n. sp. resemble very much the males of *T. viruliferus* and these four species form a closely related group of *Trichodorus* species. The females of these species can mainly be distinguished by the shape of the vulval sclerotizations in lateral view (large regular triangular pieces in *T. lusitanicus*, rounded triangular to almost oval shaped pieces in *T. beirensis* n. sp., conspicuous square shaped pieces in *T. azorensis* n. sp. and small oval shaped pieces in *T. viruliferus*) and by the absence of lateral body pores in *T. beirensis* n. sp., presence of one pair of lateral body pores in *T. azorensis* n. sp. and *T. viruliferus* and of one or two pairs of lateral body pores in *T. lusitanicus*. *T. azorensis* n. sp. probably represents an endemic species in the Açores, while *T. lusitanicus* and *T. beirensis* n. sp. have only been found in continental Portugal. *T. primitivus* is recorded for the first time associated with olive tree.

RÉSUMÉ

Espèces de Trichodorus (Nematoda : Trichodoridae) provenant du Portugal

Des échantillons de sol récoltés au Portugal continental et aux Açores contenaient *Trichodorus primitivus*, plusieurs populations de *T. lusitanicus* avec deux ou trois papilles cervicales et deux nouvelles espèces de *Trichodorus* : *T. beirensis* n. sp. provenant du Portugal continental et *T. azorensis* n. sp. provenant des Açores. Les mâles de *T. lusitanicus*, *T. beirensis* n. sp. et *T. azorensis* n. sp. ressemblent fortement à ceux de *T. viruliferus* et ces quatre espèces forment un groupe bien déterminé dans le genre *Trichodorus*. Les femelles de ces quatre espèces peuvent être différenciées par la morphologie de la sclérotisation vulvaire (large et régulièrement triangulaire chez *T. lusitanicus*; triangle arrondi jusqu'à ovale chez *T. beirensis* n. sp.; rectangulaire chez *T. azorensis* n. sp. et petite forme ovale chez *T. viruliferus*) et par l'absence de pores latéraux chez *T. beirensis* n. sp., la présence d'une paire de pores latéraux dans la région vulvaire chez *T. azorensis* n. sp. et *T. viruliferus* et celle d'une ou deux paires de pores latéraux chez *T. lusitanicus*. *T. azorensis* n. sp. est probablement endémique aux Açores, alors que *T. lusitanicus* et *T. beirensis* n. sp. n'ont été trouvés qu'au Portugal continental. *T. primitivus* a été trouvé, pour la première fois, associé à l'olivier.

The occurrence of *Trichodorus* species on the Iberian Peninsula has been little studied. *T. lusitanicus* Siddiqi, 1974 was described from Portugal. *T. primitivus* (de Man, 1880) Micoletzky, 1922 — originally described as *T. castellanensis* Arias, Jimenez & Lopez, 1965 (see Arias & Roca, 1986) — was reported from Spain. Recently, Santiago *et al.* (1987) recorded *T. aequalis* Allen, 1957 for Spain.

During a survey of plant-parasitic nematodes in Portugal, several *Trichodorus* populations were collected by the senior author (Fig. 1). Several soil samples, mostly from the northern part of the country, contained a new *Trichodorus* species which is described in this paper as

T. beirensis n. sp. In soil samples from the southern part of the country, a number of *trichodorus* populations were found identical to *T. lusitanicus*. However, while some of these populations possessed two ventral cervical papillae (as in the type population of *T. lusitanicus*) others possessed three ventral cervical papillae. Therefore, the type locality of *T. lusitanicus* was resampled (twice) by the senior author, however without success, while the available type material of *T. lusitanicus* was re-examined. Populations with two as well as with three ventral cervical papillae are reported in this paper as *T. lusitanicus*. A few soil samples from the central part of the country contained *T. primitivus*.

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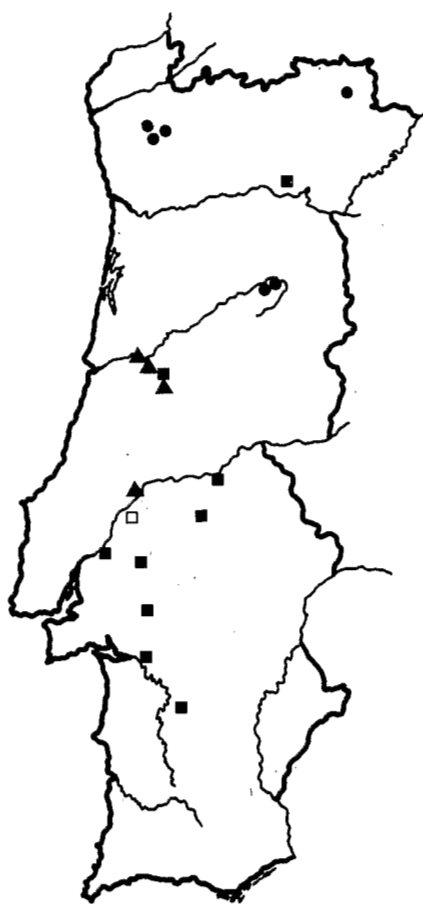


Fig. I. Geographical distribution of *T. beirensis* n. sp. (●), *T. lusitanicus* (■) and *T. primitivus* (▲) in Continental Portugal [□ : from Siddiqi, 1974].

In addition to the *Trichodorus* populations found on the Portuguese mainland, soil samples collected on six islands of the Açores by D. Sturhan in 1969 yielded another new *Trichodorus* species in two of the islands (São Miguel and Terceira) which is described in this paper as *T. azorensis* n. sp. Sturhan (1973) also reported *T. primitivus* from the Açores where this species was found on two islands (Terceira and Faial) in three out of 135 soil samples.

Materials and methods

The nematodes were extracted with the decanting and sieving technique (Alphrey & Boag, 1976), killed by gentle heat, fixed in TAF and processed to glycerol by the glycerol-ethanol method (Seinhorst, 1959).

Trichodorus beirensis * n. sp. (Figs 2 & 3)

MEASUREMENTS

See Tables 1-2

DESCRIPTION (based on specimens from the type population)

Female : Body slightly curved ventrally when killed by gentle heat. Lip region with distinct labial papillae; amphideal aperture sublateral, elliptical. Body cuticle about 2-2.5 μm thick in mid-body region, consisting of two layers : a thin outer one (about 0.8-1 μm) and a slightly thicker inner one (about 1-1.5 μm). Basis of inner cuticular layer with fine transverse striations. Excretory pore at 76-128 (102, n = 30) μm , i.e. about 1.9-2.9 times the onchiostyle length, from the anterior end of the body, situated usually at the level of the anterior part of the pharyngeal bulb. Pharyngeal bulb occupying about 1/3rd of the neck length. Five pharyngeal gland nuclei present. The posterior ventro-sublateral gland nuclei lie in the posterior third of the pharyngeal bulb. The anterior ventro-sublateral gland nuclei, usually rather indistinct, lie mostly in the anterior third of the pharyngeal bulb. The large dorsal gland nucleus usually lies in the middle of the pharyngeal bulb or just anterior to the posterior ventro-sublateral gland nuclei. Out of 30 females, 26 show no overlap while four show a short dorsal overlap of the pharyngeal bulb by the intestine. Nerve ring at about the level of the isthmus. Female reproductive system didelphic and amphidelphic. Ovaries reflexed. Oval spermatheca present at the junction of oviduct and uterus, filled with sperm (spermatheca visible only in some specimens). Sclerotizations at the junction of vulva and vagina rounded triangular to almost oval shaped (about 3 \times 5 μm) in lateral view, as shown in Figures 2 H & 3 A. Longitudinal axis of sclerotizations perpendicular to the body axis. Vulval opening a short transverse slit, about 2 μm long, in ventral view (Fig. 2 G). Vagina 6-12 μm long, extending inward over 34-53 % of the corresponding body-width, almost spherical to cylindrical in lateral view, surrounded by rather prominent muscles. In thirteen out of 30 females a distortion of the sclerotized pieces occurs due to the intrusion of a substance of unknown origin in the vagina (Figs 3 A : 4-5). Out of 30 females two have two intra-uterine eggs (24 \times 40 μm to 25 \times 70 μm) each. Lateral body pores absent. Anus subterminal. Tail hemispherical with one pair of subterminal subventral pores (Fig. 2 I).

* From the name of the province where the type specimens were found.

Table 1
Morphometric data of females of *Trichodorus beirensis* n. sp.

	Holotype	Paratypes	Insua do Pontao	Povoa de Lanhoso	Barcelos	Vila Verde	Bragança
n		30	14	4	7	2	2
L (µm)	750	692-925 (787 ± 62)	660-1 050 (894)	829-910 (873)	709-930 (844)	890-980 (935)	871-1 010 (941)
Body width (µm)	30	25-40 (32 ± 3)	25-37 (33)	24-34 (29)	25-29 (27)	28-31 (30)	31-35 (33)
Neck length (µm)	161	114-195 (145 ± 17)	150-187 (164)	120-156 (145)	140-160 (151)	150-160 (155)	164-179 (172)
Onchiostyle length (µm)	43	39-52 (43 ± 3)	41-54 (48)	42-56 (49)	40-45 (43)	54-55 (55)	44-45 (45)
Ant. end to EP (µm)	103	76-128 (102 ± 13)	88-106 (96)	97-111 (103)	87-118 (100)	98-103 (101)	88-116 (102)
Ant. genital branch (µm)	170	126-234 (173 ± 30)	108-198 (169)	117-141 (126)	80-173 (139)	132-154 (143)	160-225 (193)
Post. genital branch (µm)	182	111-228 (151 ± 26)	120-189 (160)	120-160 (138)	100-175 (140)	129-151 (140)	130-165 (148)
a	25	20.2-30.6 (24.4 ± 2.3)	22.2-32.3 (27.5)	24.4-37.9 (30.4)	27.3-33.2 (31.2)	31.6-31.8 (31.7)	28.1-28.9 (28.5)
b	4.7	4.7-6.4 (5.5 ± 0.4)	3.8-6.6 (5.5)	5.4-7.4 (6.1)	4.7-6.2 (5.6)	5.6-6.5 (6.1)	4.9-6.2 (5.6)
V	57.3	46.9-61.7 (56.4 ± 2.6)	51.6-59.1 (55.9)	54-58.8 (55.6)	52.8-56.5 (55.2)	57.3-59.2 (58.3)	53-60.7 (56.9)
G ₁	34.7	26.3-40.1 (34.5 ± 4)	31.7-40.7 (37)	38.5-43.8 (40.9)	33.3-45.1 (38.9)	40-45.7 (42.9)	30.7-42.4 (36.6)
G ₂	33.1	29.3-45.1 (37.3 ± 4)	35.2-41.1 (35.6)	35.7-44.9 (39.8)	35.1-42.3 (38.9)	42.8-43.8 (43.3)	36.6-45.8 (41.2)
Ant. end to EP Neck length (%)	64	59.5-83.7 (70.7 ± 6.3)	48.1-69.7 (58.8)	63-92.5 (72.2)	58.7-78.1 (66.3)	61.3-68.7 (65)	53.7-64.8 (59.3)
Onchiostyle length Neck length (%)	26.7	26.3-37.7 (29.8 ± 2.6)	23.5-34 (29.4)	26.9-46.7 (34.4)	26.3-31 (28.3)	33.8-36.7 (35.3)	25.1-26.8 (26)

Male : General appearance similar to female, but posterior end more ventrally curved. Excretory pore at 77-118 (98) µm (n = 30), i.e. 1.8-3.1 times the onchiostyle length, from the anterior end of the body, situated always posterior to the ventromedian cervical papillae. Usually three conspicuous ventromedian cervical papillae present, almost equally spaced (Fig. 2 E). The anterior papilla (CP 1) usually situated opposite the middle of the onchiostyle region, exceptionally opposite the basis of the onchiostyle; the median papilla (CP 2) usually situated a short distance behind the nerve ring. One out of 50 males with four ventromedian cervical papillae, all situated anterior to the excretory pore. A pair of lateral cervical pores present slightly anterior or posterior to the basis of the onchiostyle (Fig. 2 E). Out of 30 males, 24 show no overlap while six show a short dorsal overlap of the pharyngeal bulb by the intestine. In all specimens three preloacal ventromedian supple-

ments present (Fig. 2 C). The posterior one (SP 1) lies at about 52-71 % of the spiculum length anterior to the cloacal aperture, i.e. usually within reach of the retracted spicules, exceptionally opposite the heads of the retracted spicules. The distance between the anterior (SP 3) and the median (SP 2) supplement is always larger (1.4-1.9 times) than between the median (SP 2) and the posterior (SP 1) supplement. The anterior supplement (SP 3) always less prominent than the other two (Fig. 2 C). Testis single, outstretched. Spicules paired, 27-33 (30, n = 30) µm, not striated. Proximal part of the spicule wide (about 4 µm diameter), gradually tapering towards the middle part where a distinct irregular constriction is present. Behind the constriction, the spicule widens again and gradually tapers distally. Setae present on the surface of the narrow middle part of the spicules (Figs 2 D & 3 B). Gubernaculum spatulated and slightly curved, 9-12 µm long (Fig. 2 C). Tail

Table 2
Morphometric data of males of *Trichodorus beirensis* n. sp.

	Paratypes	Insua do Pontao	Povoa de Lanhoso	Barcelos
n	30	10	7	4
L (µm)	671-891 (767 ± 52)	642-971 (794)	820-930 (863)	842-982 (914)
Body width (µm)	24-35 (29 ± 2)	25-35 (31)	26-34 (31)	24-28 (25)
Neck length (µm)	125-153 (143 ± 8)	122-174 (140)	131-188 (158)	140-151 (147)
Onchiostyle length (µm)	32-47 (41 ± 3)	41-50 (44)	42-57 (54)	41-46 (43)
Ant. end to EP (µm)	77-118 (98 ± 9)	85-112 (105)	89-106 (99)	99-112 (107)
Ant. end to CP 1 (µm)	19-41 (27 ± 4)	25-40 (29)	30-48 (39)	31-35 (36)
CP 1 to CP 2 (µm)	15-42 (30 ± 5)	26-36 (32)	14-25 (21)	17-60 (37)
CP 2 to CP 3 (µm)	23-35 (29 ± 3)	22-32 (27)	18-30 (23)	24-27 (26)
CP 3 to EP (µm)	4-23 (30 ± 2)	9-22 (15)	8-24 (16)	6-40 (20)
Spicule (µm)	27-33 (30 ± 2)	28-36 (31)	28-37 (35)	30-34 (33)
Gubernaculum (µm)	9-12 (11 ± 1)	9-12 (11)	10-16 (14)	10-11 (10)
Cloaca to SP 1 (µm)	15-20 (18 ± 1)	18-27 (21)	23-36 (31)	23-25 (24)
SP 1 to SP 2 (µm)	32-46 (39 ± 4)	33-47 (40)	33-38 (35)	30-35 (33)
SP 2 to SP 3 (µm)	56-88 (66 ± 7)	40-85 (61)	36-46 (43)	45-57 (51)
a	22.8-30.6 (26.6 ± 1.8)	23.7-28.9 (26)	25.1-33.1 (27.9)	33.7-38.3 (36.3)
b	4.8-6.7 (5.4 ± 0.4)	4.7-6.4 (5.7)	4.5-6.3 (5.5)	6-6.5 (6.2)
T	56-80.2 (64 ± 5.3)	53.1-75.7 (61.2)	61.9-68.7 (65)	56.1-66.5 (61.7)
$\frac{\text{Ant. end to EP}}{\text{Neck length}}$ (%)	54.6-92.8 (69 ± 7.1)	64.4-85.2 (75.2)	53.2-75.7 (63.3)	65.6-75.2 (72.5)
$\frac{\text{Onchiostyle length}}{\text{Neck length}}$ (%)	22-35.2 (29.2 ± 2.6)	28.7-33.6 (31.3)	24.6-43.5 (34.5)	27.7-32.9 (29.3)
$\frac{\text{Cloaca to SP 1}}{\text{Spicule length}}$ (%)	51.6-71.4 (60.5 ± 4.7)	58.1-89.3 (67.4)	73.5-97.3 (88.1)	69.7-76.7 (73.2)
$\frac{\text{Cloaca to SP 2}}{\text{Spicule length}}$ (%)	166.7-232.1 (192.9 ± 16.9)	172.2-216.1 (196.4)	185.3-200 (189.6)	166.7-186.7 (175.7)
$\frac{\text{Cloaca to SP 3}}{\text{Spicule length}}$ (%)	360-524.1 (417.4 ± 37.7)	283.3-471 (391.8)	291.4-364.3 (314.9)	257.6-348.5 (313)

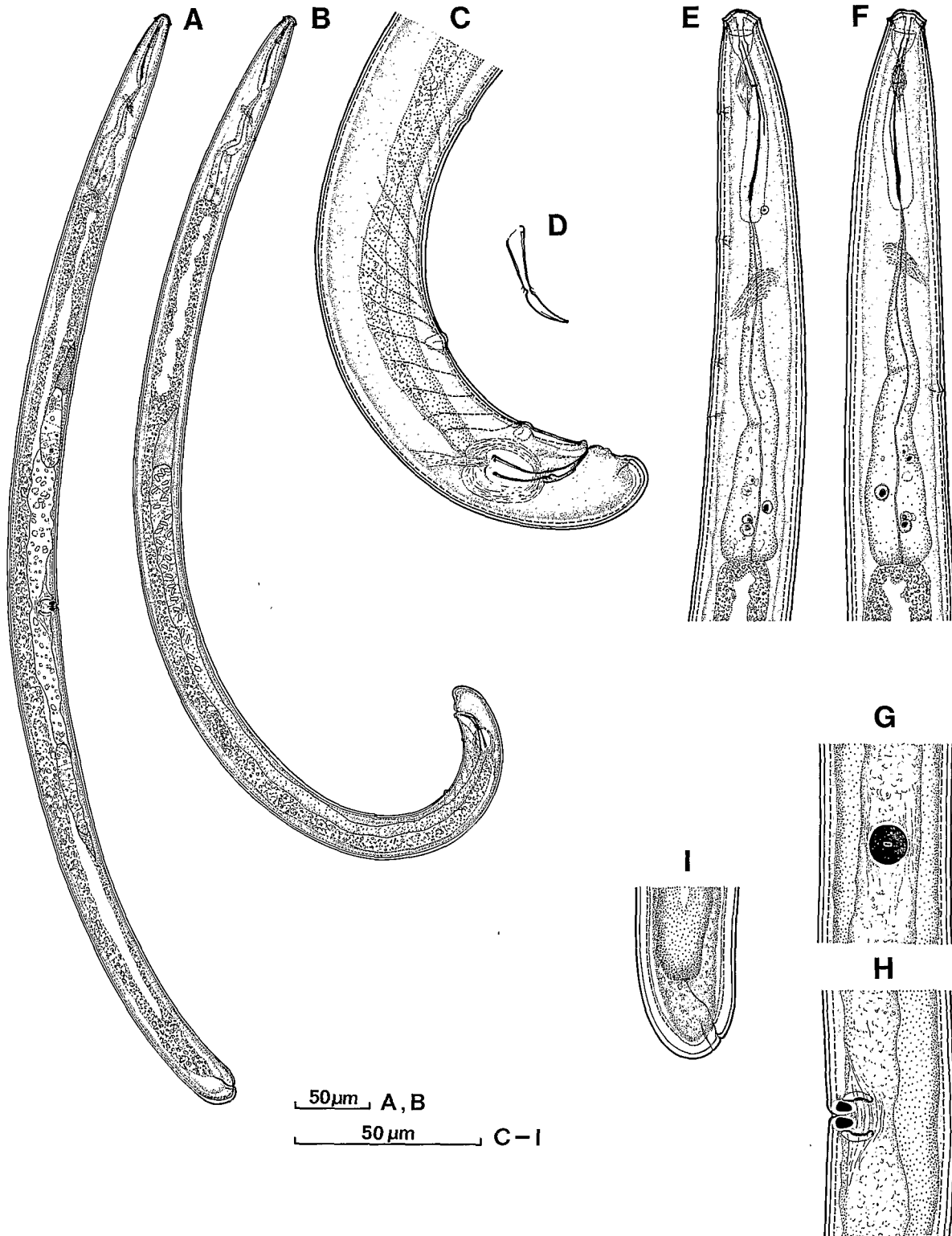


Fig. 2. *Trichodorus beirensis* n. sp. — A : Female, entire; B : Male, entire; C : Male, posterior region; D : Spicule (lateral view); E : Male, anterior region; F : Female, anterior region; G : Vulval region (ventral view); H : Vagina and vulval region (lateral view); I : Female, tail region.

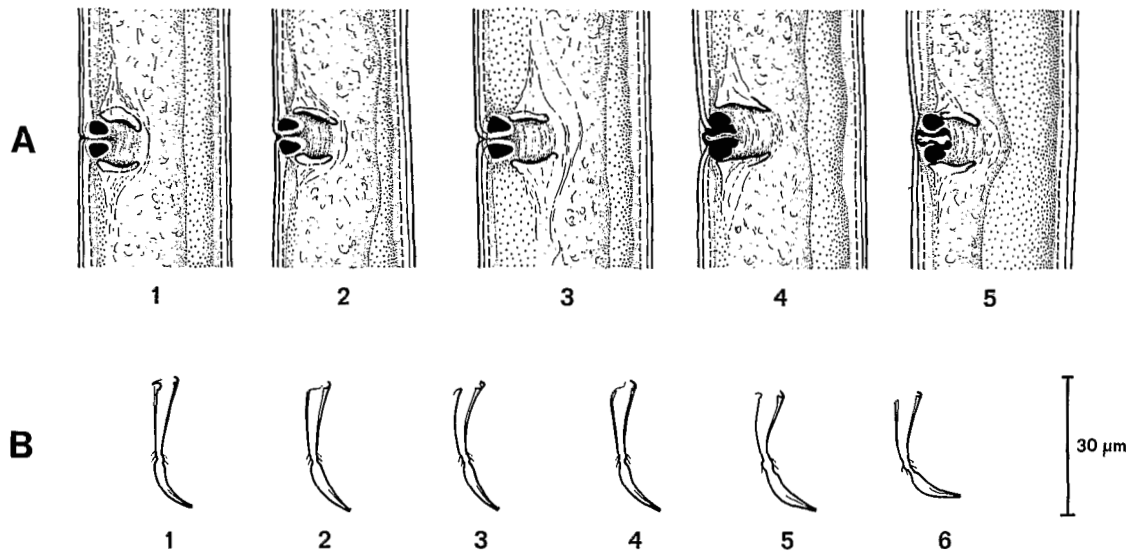


Fig. 3. *Trichodorus beirensis* n. sp. — A : Vagina and vulval region (lateral view); B : Spicules (lateral view).

asymmetrical, with one pair of postcloacal subventral papillae and one pair of subterminal subventral pores (Fig. 2 C).

TYPE HABITAT AND LOCALITY

Sandy loam soil, around the roots of rye (*Secale cereale* L.) and rye-grass (*Lolium multiflorum* Lam.), from an irrigated field, Tapada do Salgueiro, Celorico da Beira, 410 m altitude, collected by M. Teresa M. Almeida on 20-5-1982.

OTHER HABITATS AND LOCALITIES

Sandy-loam soil around the roots of rye and rye-grass, Insua do Pontao, Celorico da Beira, 410 m altitude (30-10-1983); soil around the roots of hop (*Humulus lupulus* L.) at several localities in northern Portugal, from 60 to 210 m altitude : Pova de Lanhoso (28-10-1983), Barcelos (25-4-1984), Vila Verde (25-4-1984); soil from an uncultivated field in Bragança, at about 700 m altitude (12-4-1984). Samples collected by M. Teresa M. Almeida, Isabel M. de O. Abrantes and Serafim Andrade.

DIAGNOSIS AND RELATIONSHIPS

Trichodorus beirensis n. sp. is characterized by the shape of the vaginal sclerotizations in lateral view and the absence of lateral body pores in the females, and by the presence of three conspicuous ventral cervical papillae anterior to the excretory pore, the anterior one usually situated opposite the onchiostyle region, spicule shape and length, and the position of the three ventro-

median, precloacal supplements, the posterior one lying slightly anterior, opposite or slightly posterior to the heads of the retracted spicules in the males.

T. beirensis n. sp. is distinguished from *T. viruliferus*, *T. lusitanicus* and *T. azorensis* n. sp. by the characteristic shape of the vaginal sclerotizations in lateral view (two rounded triangular to almost oval shaped pieces in *T. beirensis* n. sp. vs two small oval shaped pieces in *T. viruliferus*, two large regular triangular pieces in *T. lusitanicus* and two conspicuous square shaped pieces in *T. azorensis* n. sp.) and by the absence of lateral body pores (one pair of lateral body pores present in *T. viruliferus* and *T. azorensis* n. sp.; one or two pairs of lateral body pores present in *T. lusitanicus*) in the females. Furthermore, *T. beirensis* n. sp. differs from *T. azorensis* n. sp. in the onchiostyle length (less than 55 μm in *T. beirensis* n. sp. vs more than 55 μm in *T. azorensis* n. sp.).

TYPE SPECIMENS

Holotype female and allotype male on slides no. 56/1 and no. 56/2 deposited in the Nematode Collection of the Museu e Laboratorio Zoologico, Departamento de Zoologia, Universidade de Coimbra, Portugal. One paratype female and one paratype male deposited with each of the following Nematode Collections : Museu e Laboratorio Zoologico, Departamento de Zoologia, Universidade de Coimbra, Portugal; Rothamsted Experimental Station, Harpenden, England; Instituut voor Dierkunde, Rijksuniversiteit Gent, Belgium. Remaining specimens with M. Teresa M. Almeida, Area de Biologia, Universidade do Minho, Portugal.

Trichodorus azorensis n. sp.
(Fig. 4)

MEASUREMENTS

See Tables 3-4

DESCRIPTION (based on specimens from the type population).

Female : General appearance typical for the genus. Body cuticle about 3 μm thick in mid-body region, consisting of two layers : a thin outer one (somewhat less than 1 μm) and a thicker inner one (about 2 μm). Basis of inner cuticular layer with very fine transverse striations. Excretory pore at 72-103 (93) μm (n = 22), i.e. 1.2-1.9 times the onchiostyle length, from the anterior end of the body, sometimes situated near the basis of the onchiostyle region but mostly at the level of the isthmus or the anterior part of the pharyngeal bulb (Fig. 4 E).

Pharyngeal bulb occupying 1/3rd to 1/4th of the neck length. Five pharyngeal gland nuclei present. The posterior ventro-sublateral gland nuclei lie in the posterior third of the pharyngeal bulb. The anterior ventro-sublateral gland nuclei, usually rather indistinct, lie in the anterior third of the pharyngeal bulb. The large dorsal gland nucleus usually lies in the middle or the posterior third of the pharyngeal bulb, exceptionally in the anterior third; always between the anterior and the posterior ventro-sublateral gland nuclei. No overlap, nor by the pharyngeal bulb or the intestine, present. Nerve ring about halfway along the pharynx. Female reproductive system didelphic and amphidelphic. Ovaries reflexed, large spermatheca present at the junction of oviduct and uterus. Sclerotizations at the junction of vulva and vagina more or less square-shaped in lateral view with rounded edges (Figs 4 A & B). In ten out of 22 females a distortion of these sclerotizations occurs due to the intrusion of a substance of unknown origin in the vagina (Figs 4 C & D). Vagina 14-17 μm , extending inwards

Table 3

Morphometric data of females of *Trichodorus azorensis* n. sp. and *T. primitivus*

	<i>Trichodorus azorensis</i> n. sp.		<i>Trichodorus primitivus</i>				
	Holotype	Paratypes	Bencanta	Miranda do Corvo	Condeixa	Golega	Horta, Faial
n		22	25	3	3	2	5
L (μm)	706	601-769 (690 \pm 50)	645-939 (780)	737-822 (774)	615-671 (652)	680-920 (800)	680-756 (712)
Body width (μm)	29	25-32 (29 \pm 2)	28-38 (33)	28-30 (29)	27-33 (29)	27-33 (30)	32-37 (34)
Neck length (μm)	151	123-159 (141 \pm 10)	126-182 (151)	143-162 (156)	145-165 (155)	163 (163)	138-150 (143)
Onchiostyle length (μm)	63	55-63 (59 \pm 2)	45-53 (49)	49-52 (50)	45-48 (46)	49-52 (51)	40-49 (46)
Ant. end to EP (μm)	93	72-103 (93 \pm 9)	75-106 (90)	91-103 (98)	85-108 (94)	94-97 (96)	81-100 (90)
Ant. genital branch (μm)	139	103-179 (138 \pm 23)	89-266 (164)	113-146 (133)	122-168 (152)	152-175 (164)	138-188 (158)
Post. genital branch (μm)	136	92-179 (137 \pm 19)	98-234 (166)	134-143 (140)	114-178 (146)	130-160 (145)	153-183 (169)
a	24.3	19.1-28.7 (23.7 \pm 2.3)	19.8-27.1 (23.6)	25.4-27.4 (26.7)	20.3-24.9 (22.4)	25.2-27.9 (26.6)	19.6-22.2 (20.9)
b	4.7	4.2-5.8 (5 \pm 0.4)	4.1-6.5 (5.2)	4.5-5.7 (5)	3.7-4.6 (4.2)	4.2-5.6 (4.9)	4.8-5.1 (5)
V	58.9	53.1-61.5 (57 \pm 2)	48.9-61.9 (56.6)	57.2-59 (57.7)	56.9-58.5 (57.5)	58.8-59.2 (59)	43.4-57.7 (53.9)
G ₁	19.7	14.4-25.9 (19.9 \pm 2.7)	30.1-41.4 (35.6)	39.4-42.1 (40.5)	31.9-38.7 (34.7)	36.5-40.2 (38.4)	22.6-36.4 (32)
G ₂	19.3	15-26.2 (19.7 \pm 2.8)	26-46.8 (35.1)	38.2-40.8 (39.6)	31.6-40 (35.6)	39.7-41.8 (40.8)	20.9-34 (30.2)
<u>Ant. end to EP</u> (%)	16.6	55.7-77.7 (65.9 \pm 6.9)	46.6-76.9 (60.5)	56.2-72 (63.1)	51.5-62.1 (57.6)	57.7-59.5 (58.6)	58.3-68 (63)
<u>Onchiostyle length</u> (%)	41.7	35.8-49.6 (41.8 \pm 3.2)	26.4-38.5 (32.5)	30.2-36.4 (32.3)	28.8-31.7 (29.9)	30.1-31.9 (31)	26.7-34.5 (32.5)

Table 4
Morphometric data of males of *Trichodorus azorensis* n. sp. and *T. primitivus*

	<i>Trichodorus azorensis</i> n. sp.		<i>Trichodorus primitivus</i>			
	Paratypes	Bencanta	Miranda do Corvo	Condeixa	Golega	Horta, Faial
n	13	24	2	2	4	8
L (µm)	647-807 (706 ± 50)	672-970 (805)	746-868 (807)	707-895 (801)	660-873 (763)	655-825 (749)
Body width (µm)	27-32 (30 ± 2)	25-37 (32)	28-34 (31)	23-27 (25)	24-35 (30)	26-36 (32)
Neck length (µm)	121-152 (139 ± 9)	112-173 (151)	137-159 (148)	143-146 (145)	135-154 (147)	130-158 (144)
Onchiostyle length (µm)	55-66 (60 ± 3)	45-52 (49)	42-47 (45)	46-49 (48)	44-48 (46)	44-53 (49)
Ant. end to EP (µm)	75-117 (98 ± 11)	82-108 (94)	95-99 (97)	91-92 (92)	83-101 (93)	88-105 (97)
Ant. end to CP 1 (µm)	21-33 (28 ± 4)	27-35 (31)	25-29 (27)	26-28 (27)	30-34 (32)	25-34 (30)
CP 1 to CP 2 (µm)	16-37 (27 ± 6)	21-39 (31)	31-35 (33)	29 (29)	23-35 (29)	28-35 (30)
CP 2 to CP 3 (µm)	21-34 (27 ± 4)	18-33 (22)	13-29 (21)	23-24 (24)	16-23 (21)	18-28** (22)
CP 3 to EP (µm)	11-22* (15 ± 4)	6-17 (11)	14-18 (16)	10-14 (12)	10-13 (11)	10-25** (16)
Spicule (µm)	29-34 (31 ± 1)	34-43 (39)	32-38 (35)	37 (37)	39-43 (41)	38-43 (42)
Gubernaculum (µm)	13-15 (14 ± 1)	14-18 (16)	15-17 (16)	15 (15)	16-19 (18)	16-19 (18)
Cloaca to SP 1 (µm)	17-31 (21 ± 4)	21-28 (24)	22-24 (23)	20-23 (22)	22-26 (25)	20-26 (23)
SP 1 to SP 2 (µm)	20-37 (30 ± 4)	32-45 (38)	31-37 (34)	33-38 (36)	22-38 (32)	31-39 (34)
SP 2 to SP 3 (µm)	23-51 (35 ± 7)	34-54 (44)	39-62 (51)	41-43 (42)	40-46 (43)	30-44 (40)
a	20.8-28.8 (22.3 ± 7)	20.4-29.4 (25.5)	25.5-26.6 (26.1)	26.2-38.9 (32.6)	22.2-28.8 (26)	21.9-25.2 (23.3)
b	4.4-5.8 (5.1 ± 0.5)	4-7.4 (5.4)	4.7-6.3 (5.5)	4.9-6.1 (5.5)	4.9-5.4 (5.2)	4.7-5.9 (5.2)
T	57.9-67.2 (61.8 ± 3.2)	48.5-76.8 (62.9)	—	51.1-63.1 (57.1)	58.2-62.4 (61)	36-65.7 (61.5)
Ant. end to EP (%)	54.3-83.5	49.1-87.5	62.3-69.3	63-63.6	55.3-74.8	62.5-73.1
Neck length (%)	(70.7 ± 9.5)	(63.6)	(65.8)	(63.3)	(63)	(67.1)
Onchiostyle length (%)	39.5-47.3	27.7-43.8	29.6-30.7	32.3-33.6	30.5-32.6	31-35.4
Neck length (%)	(43 ± 2.4)	(32.9)	(30.2)	(32.9)	(31.5)	(33.5)
Cloaca to SP 1 (%)	56-107	53.8-73.5	63.2-68.8	54.1-62.2	55-66.7	45.5-65
Spicule length (%)	(69 ± 14)	(61.6)	(66)	(58.2)	(60.2)	(55.7)
Cloaca to SP 2 (%)	138-210	135.9-200	160.5-165.6	143.2-164.9	123.1-156.1	120.5-148.8
Spicule length (%)	(164 ± 20)	(158.1)	(163.1)	(154.1)	(139.2)	(137.1)
Cloaca to SP 3 (%)	213-386	148.7-341.2	263.2-359.4	254.1-281.1	241.9-261	215.9-252.5
Spicule length (%)	(276 ± 42)	(267.5)	(311.3)	(267.6)	(248.5)	(234.3)

* Male with four cervical papillae omitted : CP 3 to CP 4 13 µm, CP 4 to EP 16 µm

** n = 7 (one male with two cervical papillae : CP 2 to EP 33 µm)

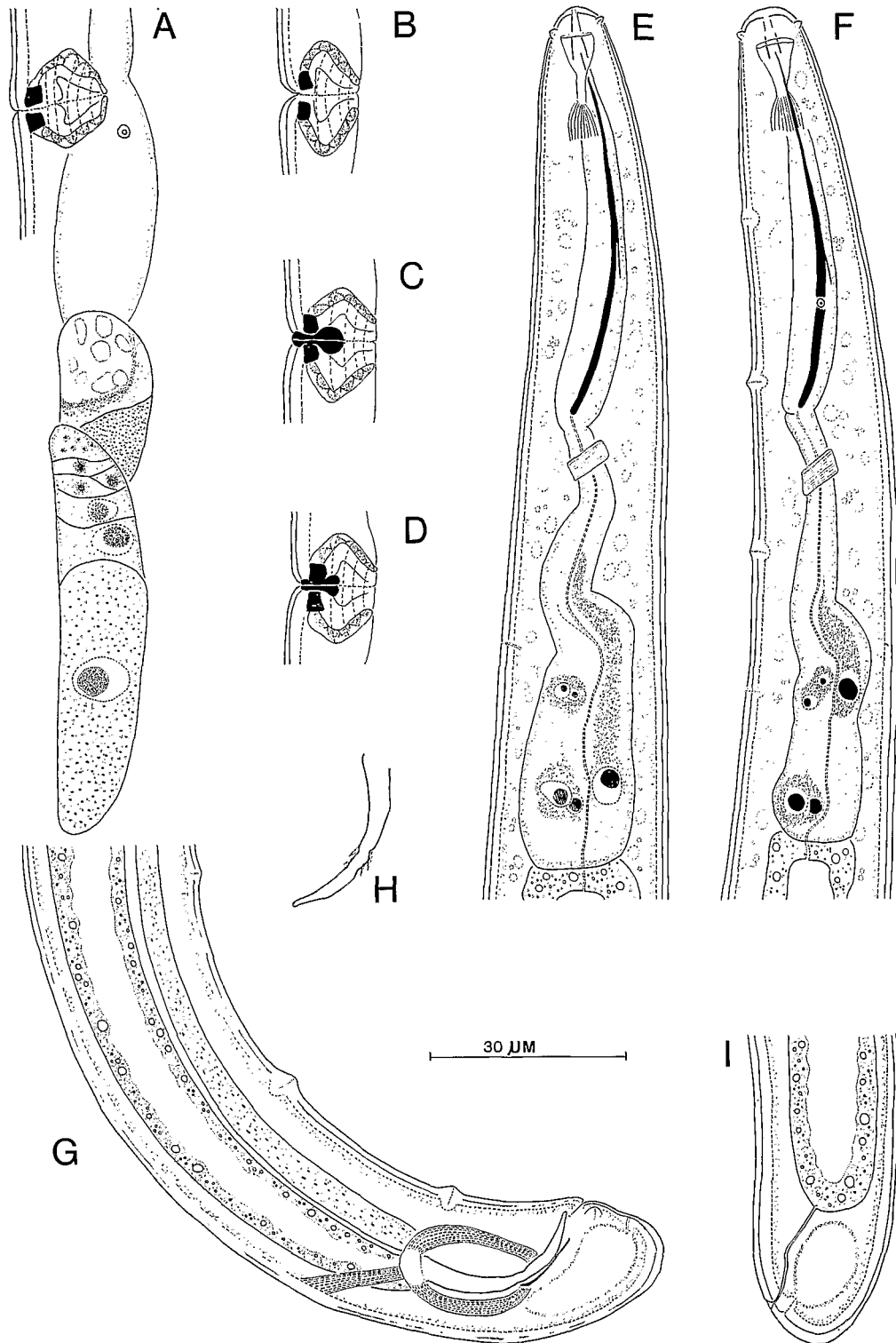


Fig. 4. *Trichodorus azorensis* n. sp. — A : Posterior branch of reproductive system of mature female (holotype); B : Vagina and vulval region (Terceira population), lateral view; C : Vagina and vulval region (type population), lateral view; D : Vagina and vulval region (Terceira population), lateral view; E : Female, anterior region (holotype); F : Male, anterior region; G : Male, tail region; H : Spicule (lateral view); I : Female, tail region (holotype).

over 50-60 % of the corresponding body-width. No intra-uterine eggs present. One pair of lateral body pores present in seventeen females, situated within 10 μm behind the vulva. In four females only one body pore was present, also situated just posterior to the vulva, while in one female lateral body pores were absent. Anus subterminal. Tail hemispherical with one pair of subterminal subventral pores (Fig. 4 I).

Male : General appearance similar to female, but posterior end more curved ventrally. Excretory pore at 75-117 (98) μm ($n = 13$), i.e. 1.2-2 times the onchiostyle length, from the anterior end of the body, always posterior to the ventromedian cervical papillae. Usually three conspicuous ventromedian cervical papillae present (Fig. 4 F). The most anterior papilla (CP 1) situated near to the middle of the onchiostyle region; the median papilla (CP 2) opposite the posterior half or the basis of the onchiostyle region or a short distance behind it; the posterior papilla (CP 3) at the level of the isthmus or the anterior half of the pharyngeal bulb. Only one out of thirteen males possesses four ventromedian cervical papillae. A pair of lateral cervical pores occurs at about the level of the basis of the onchiostyle region. No overlap, nor by the pharyngeal bulb of the intestine present. In all specimens three precloacal ventromedian supplements present (Fig. 4 G). The posterior one (SP 1) lies at about 56-107 % of the spiculum length anterior to the cloacal aperture, i.e. within, opposite or just out of range of the heads of the retracted spicules. The distance between the anterior (SP 3) and the median (SP 2) supplement is always larger than between the median (SP 2) and the posterior supplement (SP 1). Testis single, outstretched. Spicules paired, 29-34 (31) μm , not striated, ventrally curved (Fig. 4 H). Proximal spicule end is wide and gradually tapers to about halfway along the spicule length where a constriction is present; behind this constriction the shaft widens somewhat before gradually tapering towards the distal end. Delicate setae occur on the surface of the middle part of the spicules. Gubernaculum 13-15 μm long. Tail with one pair of postcloacal subventral papillae and one pair of subterminal subventral pores (Fig. 4 G).

TYPE HABITAT AND LOCALITY

Bushland with *Ulex europaeus* L., *Rubus* sp., *Plantago lanceolata* L., Leguminosae, grasses and moss, moist stony soil, Lagõa das Furnas, São Miguel, Açores, close to the northern shore of the lake. Collected by D. Sturhan on 6-6-1969.

OTHER HABITAT AND LOCALITY

Slope in forest with *Myrica faia* Ait., *Pittosporum* sp., *Senecio* sp., grass, *Pteridium aquilinum* (L.) Kühn and *Selaginella kraussiana* (G. Kunze) A. Braun, moist

sandy to humous soil, with stones, Mata da Serreta, Terceira, Açores. Collected by D. Sturhan on 8-6-1969.

DIAGNOSIS AND RELATIONSHIPS

Trichodorus azorensis n. sp. is characterized by the shape of the vaginal sclerotizations in lateral view and the presence of one pair of lateral body pores in the females, and by the presence of three conspicuous ventral cervical papillae anterior to the excretory pore, the anterior one usually situated opposite the onchiostyle region, spicule shape and length, the position of the three ventromedian, precloacal supplements, the posterior one lying slightly anterior, opposite or slightly posterior to the heads of the retracted spicules in the males.

T. azorensis n. sp. is distinguished from these three species by the characteristic shape of the vaginal sclerotizations in lateral view (two conspicuous square shaped pieces in *T. azorensis* n. sp. vs two small oval pieces in *T. viruliferus*, two large regular triangular pieces in *T. lusitanicus* and two large rounded triangular to oval pieces in *T. beirensis* n. sp.) and also in the onchiostyle length (more than 55 μm in *T. azorensis* n. sp. vs usually less than 55 μm in the other three species mentioned). The females of *T. azorensis* n. sp. are also distinguished from the females of *T. beirensis* n. sp. in having usually one pair of lateral body pores (no lateral body pores present in *T. beirensis* n. sp.) and by the shape of the vagina.

TYPE SPECIMENS

Holotype female, allotype male, fifteen paratype females and twelve paratype males deposited at the German Nematode Collection, Institute for Nematology and Vertebrate Research, Münster, Germany. Paratypes deposited in the following Nematode Collections : Museu e Laboratorio Zoologico, Departamento de Zoologia, Universidade de Coimbra, Portugal and Instituut voor Dierkunde, Rijksuniversiteit Gent, Belgium.

Trichodorus lusitanicus Siddiqi, 1974

(Fig. 5)

MEASUREMENTS

See Tables 5-6

DESCRIPTION (based on specimens from Cadaixo, Miranda do Corvo).

Female : Body slightly curved ventrally when killed by gentle heat. Lip region with distinct labial papillae; amphideal aperture sublateral, elliptical. Body cuticle about 2-2.5 μm thick in mid-body region, consisting of two layers : a thin outer one (about 1 μm) and a slightly

thicker inner one (about 1.5 μm). Basis of inner cuticular layer with fine transverse striations. Excretory pore at 70-119 (94) μm ($n = 30$), i.e. about 1.8 times the onchiostyle length, from the anterior end of the body, usually at the level of the posterior part of the isthmus or the anterior part of the pharyngeal bulb (Fig. 5 E). Pharyngeal bulb occupying about 1/3rd of the neck length. Five pharyngeal gland nuclei present. The posterior ventro-sublateral gland nuclei lie in the posterior third of the pharyngeal bulb. The anterior ventro-sublateral gland nuclei, usually rather indistinct, lie in the anterior third of the pharyngeal bulb. The large dorsal gland nucleus usually lies in the middle of the pharyngeal bulb between the anterior and the posterior ventro-sublateral gland nuclei. Out of 30 females, 21 show no overlap while nine show a short dorsal overlap of the pharyngeal bulb by the intestine. Nerve ring at about the

level of the isthmus. Female reproductive system didelphic and amphidelphic. Ovaries reflexed. Roundish spermatheca filled with sperm (Figs 5 F & G; spermatheca not visible in all specimens). Sclerotizations at the junction of vulva and vagina regular triangular shaped ($3 \times 3 \mu\text{m}$) in lateral view (Figs 5 G & H). Vulval opening pore-like in ventral view. Vagina 8-13 μm , extending inward over 36-56 % of the corresponding body-width, more or less mushroom shaped in lateral view (outer half hemispherical, inner half cylindrical). In seven out of 30 females, a distortion of the sclerotizations occurs due to the intrusion of a substance of unknown origin in the vagina. Out of 30 females, twenty show two lateral body pores on each body side : one pair situated just posterior to the vulva and one pair situated at the level of the distal part of the anterior genital branch. In ten females only one lateral body pore present

Table 5
Morphometric data of females of *Trichodorus lusitanicus*

	<i>Cadaixo Miranda do Corvo</i>	<i>Pinhal do Norte</i>	<i>Coruche</i>	<i>Alcacer do Sal</i>	<i>Gaviao</i>	<i>Figueira dos Cavaleiros</i>	<i>Ponte de Sor</i>	<i>Vendas Novas</i>
n	30	8	16	7	4	2	2	2
L (μm)	668-945 (804 \pm 76)	670-862 (771)	770-998 (866)	724-975 (859)	870-922 (896)	770-840 (805)	906-950 (928)	810-960 (885)
Body width (μm)	25-40 (30 \pm 4)	32-38 (34)	25-32 (28)	25-35 (31)	25-30 (27)	30-35 (33)	33 (33)	26-29 (28)
Neck length (μm)	133-185 (162 \pm 11)	139-208 (163)	141-1791 (151)	132-194 (150)	130-148 (140)	150-155 (153)	140-150 (145)	150 (150)
Onchiostyle length (μm)	48-56 (52 \pm 2)	50-55 (53)	49-55 (52)	35-58 (49)	50-53 (52)	52 (52)	52 (52)	51-54 (53)
Ant. end to EP (μm)	70-119 (94 \pm 11)	88-118 (104)	80-105 (91)	90-126 (100)	90-104 (97)	88-92 (90)	93-96 (95)	90 (90)
Ant. genital branch (μm)	111-216 (165 \pm 29)	121-188 (149)	123-201 (176)	155-221 (172)	105-173 (148)	185-210 (198)	165-187 (176)	160-190 (175)
Post. genital branch (μm)	110-250 (170 \pm 35)	106-200 (147)	130-224 (167)	152-209 (185)	100-167 (142)	152-190 (171)	165-189 (177)	136-174 (155)
a	21.5-32.9 (26.7 \pm 3)	20.9-25 (22.8)	24.7-38 (30.8)	24.1-36 (28.1)	30.7-34.8 (33)	24-26.5 (25.3)	27.5-28.8 (28.2)	31.2-33.1 (32.2)
b	3.8-6 (5 \pm 0.6)	3.5-5.5 (4.8)	4.3-6.7 (5.7)	4.5-6.8 (5.8)	5.9-6.9 (6.4)	5.1-5.4 (5.3)	5-6.8 (6.4)	5.4-6.4 (5.9)
V	50.5-59.9 (56.6 \pm 2)	53.5-58.6 (56.9)	53.7-59.5 (57)	54.2-64.5 (58.1)	54.7-57 (56.2)	56.1-57.8 (57)	54.7-55.7 (55.2)	55.6-56.8 (56.2)
G ₁	29.8-42 (36.1 \pm 3.2)	31.7-43 (37.6)	31.6-43.4 (36.6)	32.7-42.6 (37.8)	35.4-45.6 (39.6)	31-33.8 (32.4)	35.1-37.5 (36.3)	35.8-37.1 (36.4)
G ₂	25.9-43.7 (35 \pm 4.5)	30.3-45.1 (37.7)	28.7-43 (37.7)	228.6-41.9 (36.4)	37.1-46.1 (40.3)	33.4-38.1 (35.8)	34.8-37.5 (36.1)	34.1-42.6 (38.4)
$\frac{\text{Ant. end to EP}}{\text{Neck length}} (\%)$	42.7-74.8 (58.2 \pm 8.8)	52.1-73.9 (64.3)	50.3-72.4 (60.4)	46.4-90 (68.3)	65-71.4 (69)	56.8-61.3 (59.1)	64-66.4 (65.2)	60 (60)
$\frac{\text{Onchiostyle length}}{\text{Neck length}} (\%)$	27.8-38.3 (32.3 \pm 2.4)	25.5-38.8 (32.7)	28.5-36.2 (34.3)	24.1-39.3 (33.1)	35.8-38.5 (37.1)	33.5-34.7 (34.1)	34.7-37.1 (35.9)	34-36 (35)

Table 6

Morphometric data of males of *Trichodorus lusitanicus*

	<i>Cadaixo Miranda do Corvo</i>	<i>Pinhal do Norte</i>	<i>Coruche</i>	<i>Alcacer do Sal</i>	<i>Gaviao</i>	<i>Figueira dos Cavaleiros</i>	<i>Ponte de Sor</i>	<i>Vendas Novas</i>	<i>Salvaterra de Magos</i>
n	30	4	4	5	2	1	3	1	2
L (μm)	730-997 (850 \pm 63)	690-838 (765)	830-976 (892)	795-1 020 (870)	945-970 (958)	960	830-1 006 (929)	900	690-955 (823)
Body width (μm)	25-45 (33 \pm 6)	27-32 (30)	22-28 (25)	25-33 (28)	26-30 (28)	31	31-33 (32)	24	23-33 (28)
Neck length (μm)	135-182 (162 \pm 12)	146-170 (157)	140-155 (148)	130-210 (109)	140-149 (145)	161	150-170 (160)	159	108-168 (138)
Onchiostyle length (μm)	49-59 (53 \pm 3)	51-52 (52)	51-52 (52)	33-58 (50)	46-53 (50)	52	53-54 (54)	51	50-52 (51)
Ant. end to EP (μm)	76-135 (98 \pm 10)	93-108 (104)	88-98 (93)	78-100 (89)	95-98 (97)	99	86-105 (93)	103	87-93 (90)
Ant. end to CP 1 (μm)	26-48 (36 \pm 5)	23-38 (32)	38-45 (43)	32-44 (39)	39-45 (42)	50	37-42 (39)	51	38-39 (39)
CP 1 to CP 2 (μm)	14-45 (24 \pm 6)	26-28 (27)	30-43 (38)	26-43 (34)	40-44 (42)	41	27-53 (37)	40	25-33 (29)
CP 2 to CP 3 (μm)	16-34 (22 \pm 4)	26-32 (28)	—	—	—	—	—	—	—
CP 3 to EP* (μm)	4-32 (15 \pm 5)	10-20 (15)	8-12 (10)	8-23 (15)	11-14 (13)	9	15-17 (16)	18	16-28 (22)
Spicule (m)	30-41 (36 \pm 3)	29-33 (31)	32-35 (34)	30-38 (33)	32-35 (34)	34	29-36 (33)	34	33-36 (35)
Gubernaculum (μm)	11-18 (14 \pm 2)	10-12 (11)	12-15 (13)	9-16 (13)	12 (13)	11	13-14 (14)	13	11-12 (12)
Cloaca to SP 1 (μm)	25-36 (31 \pm 2)	11-17 (21)	26-32 (28)	28-37 (32)	28-30 (29)	33	30-34 (32)	33	28-29 (29)
SP 1 to SP 2 (μm)	23-39 (30 \pm 3)	33-46 (41)	24-31 (28)	29-36 (33)	30-33 (32)	36	33-42 (37)	33	30-32 (31)
SP 2 to SP 3 (μm)	33-56 (41 \pm 4)	32-60 (53)	36-41 (38)	40-53 (46)	43-48 (46)	48	33-44 (39)	40	38-39 (39)
a	19.2-32 (26 \pm 3.5)	23.8-31 (25.9)	34.9-38.6 (36.5)	30.9-32 (31.5)	32.3-36.3 (34.3)	31	25.2-32.5 (28.8)	38	28.9-30 (29.5)
b	4.4-6.5 (5.3 \pm 0.5)	4.5-5.7 (4.9)	5.5-6.5 (6)	3.8-6.5 (5.6)	6.5-6.8 (6.7)	6	5.2-6.3 (5.8)	5.6	4.1-8.8 (6.5)
T	47.6-74.4 (63.9 \pm 6.6)	55.5-61 (58.6)	55.2-63.7 (59.7)	56.5-61.8 (58.9)	42.3-55.7 (48)	62.5	57.7-61.5 (59.5)	52.2	58-73 (65.5)
$\frac{\text{Ant. end to EP}}{\text{Neck length}} (^{\circ}\%)$	42.2-85 (60.5 \pm 7.8)	63.5-72.8 (66.1)	60-65.3 (62.4)	37.1-67.7 (56.6)	65.8-67.8 (66.9)	61.4	54.4-61.8 (57.8)	64.8	51.8-86.1 (69)
$\frac{\text{Onchiostyle length}}{\text{Neck length}} (^{\circ}\%)$	28.7-38.1 (33 \pm 2.3)	30.3-35.4 (33)	32.9-37.1 (34.8)	25.4-36.3 (31.1)	30.9-37.9 (34.3)	32.3	31.8-35.3 (35.3)	32.1	32-46.3 (38.7)
$\frac{\text{Cloaca to SP 1}}{\text{Spicule length}} (^{\circ}\%)$	64.1-110 (85.9 \pm 9)	33.3-3.1 (68.6)	76.5-91.4 (83.7)	84.2-123.3 (98.4)	85.7-87.5 (86.6)	97.1	94.4-103.4	97.1	77.8-87.9 (82.9)
$\frac{\text{Cloaca to SP 2}}{\text{Spicule length}} (^{\circ}\%)$	135.9-223.3 (171.3 \pm 19.7)	160.1-201 (210)	156.3-180 (166.7)	178.9-233.3 (200.4)	171.4-190.6 (181)	202.9	191.7-220.6 (209.8)	194.1	161.1-184.8 (173)
$\frac{\text{Cloaca to SP 3}}{\text{Spicule length}} (^{\circ}\%)$	230.8-359.4 (285.1 \pm 30.9)	315.2-444.8 (372.1)	268.8-285.7 (277.7)	300-383.3 (346.7)	294.3-340.6 (317.7)	344.1	283.3-358.6 (330.6)	311.8	269.4-300 (284.7)

* Males with only two cervical papillae : distance CP 2 to EP

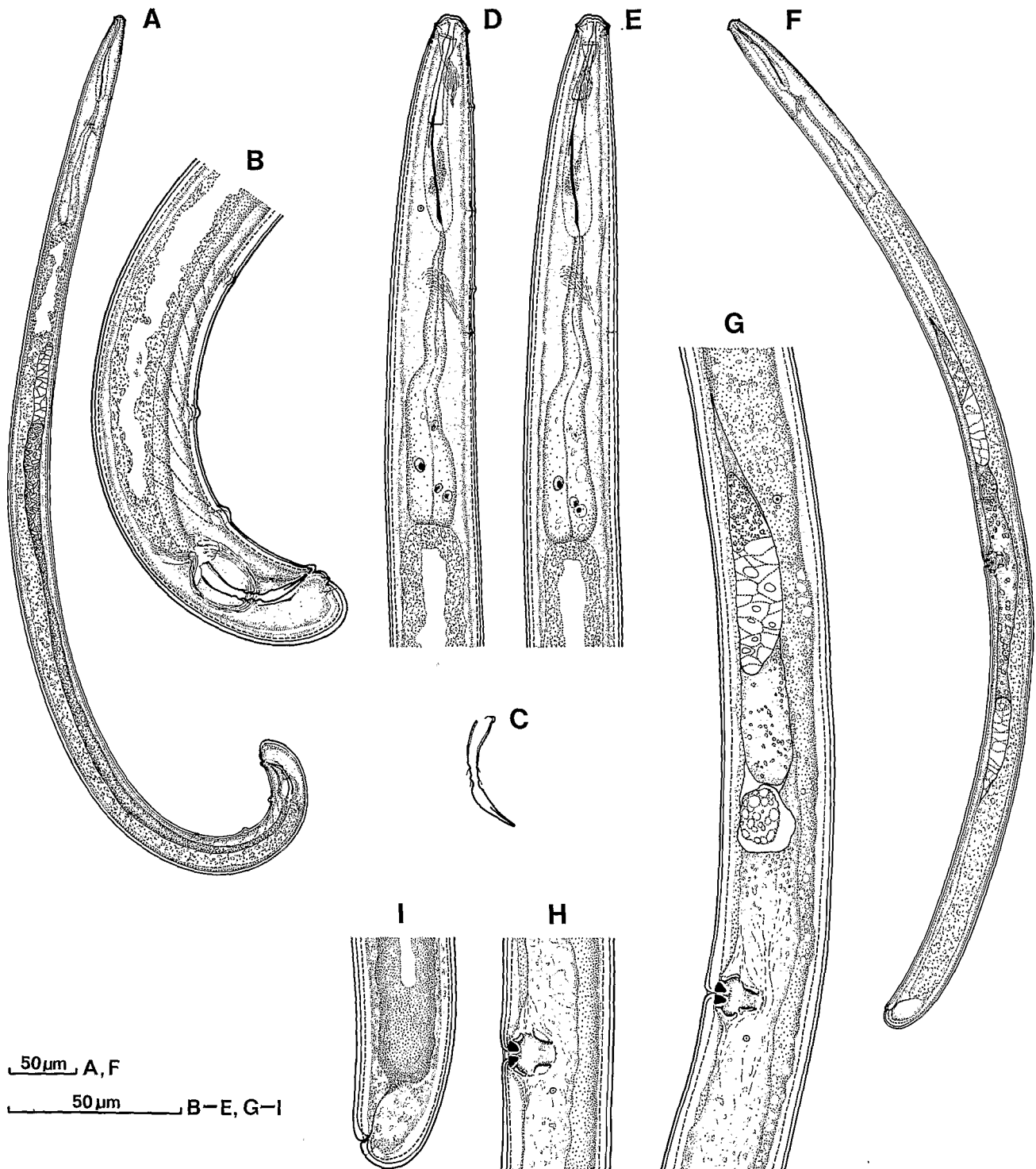


Fig. 5. *Trichodorus lusitanicus* Siddiqi, 1974. — A : Male, entire; B : Male, posterior region; C : Spicule, lateral view; D : Male, anterior region; E : Female, anterior region; F : Female entire; G : Anterior branch of reproductive system of mature female; H : Vagina and vulval region (lateral view); I : Female, tail region.

on each body side, situated immediately posterior to the vulva. Anus subterminal. Tail hemispherical with one pair of subterminal subventral pores (Fig. 5 I).

Male : General appearance similar to female but posterior end more ventrally curved. Excretory pore at 76-135 (98) μm ($n = 30$), i.e. 1.4-2.6 times the onchiostyle length, from the anterior end of the body, always situated posterior to the ventromedian cervical papillae (Fig. 5 D). Three ventromedian cervical papillae present. The most anterior papilla (CP 1) situated opposite the middle or the anterior half of the onchiostyle. The median papilla (CP 2) usually situated opposite the posterior half or the basis of the onchiostyle (in eight out of 30 males CP 2 situated just posterior to the basis of the onchiostyle). The posterior papilla (CP 3) usually situated opposite the nerve ring. A pair of lateral cervical pores present slightly anterior or posterior to the basis of the onchiostyle (Fig. 5 D). Out of 30 males, twenty show no overlap while ten show a slight dorsal overlap of the pharyngeal bulb by the intestine. In all specimens three precloacal ventromedian supplements present. The posterior one (SP 1) lies at about 64-110 % of the spiculum length anterior to the cloacal aperture, slightly anterior, opposite or slightly posterior to the heads of the retracted spicules (Fig. 5 B). Testis single, outstretched. Spicules paired, 30-41 (36) μm ($n = 30$), not striated, ventrally curved. Proximal part of the spicule wide, gradually tapering towards the middle part which is irregularly narrowed. Behind this constriction, the spicule widens again and gradually tapers distally. Setae present on the surface of the narrow middle part of the spicules. Gubernaculum thickened distally, 11-18 μm long. Tail asymmetrical, with one pair of postcloacal subventral papillae and one pair of subterminal subventral pores (Fig. 5 B).

COMPARISON WITH THE TYPE POPULATION

The populations of *T. lusitanicus*, with two and three ventromedian cervical papillae, reported in the present study, are similar in morphological and morphometrical characters with the type population (possessing two ventromedian cervical papillae) except in onchiostyle length which is somewhat larger in our populations (Tab. 5-6) and in the presence of setae on the surface of the spicules (no setae were observed in the type population).

Although Loof (1973) considered the setosity of spicules a good and constant character in the genus *Trichodorus*, De Waele (1983) examined 48 males of *T. sparsus* Szczygiel, 1968 from Belgium and found that 28 males had setae on the surface of the spicules, six males had no setae while fourteen males only had an irregular thickening of the surface of the spicules. De Waele (1983) considered the taxonomic value of this character therefore unreliable.

De Waele (1983) calculated, based upon published data and own observations, that about 4 % of the specimens of *Trichodorus* species possessing usually two ventromedian cervical papillae had one or three cervical papillae, while about 5 % of the specimens of *Trichodorus* species possessing usually three ventromedian cervical papillae had one, two or four cervical papillae. Hooper (1972) described *T. variopapillatus* based upon a population in which half of the specimens examined had three ventromedian cervical papillae while the other specimens had only two cervical papillae. However, De Waele (1983) examined 44 males of *T. variopapillatus* from Belgium and found that about 10 % of the specimens had two ventromedian cervical papillae while the rest of the specimens had three cervical papillae. All these findings suggest that the number of ventromedian cervical papillae is rather constant in most *Trichodorus* species but can vary between populations of *T. lusitanicus* and within populations of *T. variopapillatus*.

HABITATS AND LOCALITIES

Loamy soil around the roots of *Olea europaea* L., Miranda do Corvo, 150 m altitude; soil around the roots of cork trees (*Quercus suber* L.) at several localities in Portugal, from 15 to 480 m altitude : Alcacer do Sal, Coruche, Gaviao, Figueira dos Cavaleiros, Pinhal do Norte, Ponte de Sor, Salvaterra de Magos and Vendas Novas. Samples collected by M. Teresa M. Almeida and Isabel M. de O. Abrantes (1982-1986).

Trichodorus primitivus (de Man, 1880) Micoletzky, 1922

MEASUREMENTS

See Tables 3-4

COMPARISON WITH THE TYPE POPULATION

The populations of *T. primitivus* from the Portuguese mainland and the Açores are similar in morphological and morphometrical characters with the type population (de Man, 1884) and the population redescribed by Seinhorst (1963). Some of the specimens from Portugal possessed a slight ventral overlap of the intestine by the pharynx.

HABITATS AND LOCALITIES

Soil around the roots of *Olea europaea* L. at Bencanta (28-1-1983), Miranda do Corvo (6-6-1983), Condeixa (2-2-1986) and Golega (23-11-1986) on the Portuguese mainland (all samples collected by M. Teresa M. Almeida). Moist loamy soil from a meadow (*Poa trivialis* L., *Plantago lanceolata* L., *Mentha* sp., *Trifolium pratense* L. *Rumex* sp., etc.), Serreta, Terceira; moist sandy

soil from a grassy vegetation with *Ulmus procera* Salisb. along a road, Capelo, Faial and moist light stony soil around the roots of potatoes and *Citrus* sp. in a garden, Horta, Faial on the Açores (all samples collected by D. Sturhan in June 1969).

DISCUSSION

T. lusitanicus, *T. beirensis* n. sp., *T. azorensis* n. sp. and *T. viruliferus* are closely related species. The males of these four species have a similar spicule shape (proximal end wide, gradually tapering of the middle of the spicule where a distinct constriction is present; behind this constriction the shaft widens before gradually tapering again to the distal end) which is very characteristic and unique in comparison with all other *Trichodorus* species. The only other species having a somewhat similar spicule shape is *T. velatus* Hooper, 1972, but the spicules of this species are stouter and possess a velum.

While the males of *T. lusitanicus*, *T. beirensis* n. sp., *T. azorensis* n. sp. and *T. viruliferus* differ only in minor morphometrical characters, their females are clearly different from each other, the most important differentiating morphological character being the shape of the vulval sclerotizations in lateral view.

The suggestion, on morphological grounds, that these four *Trichodorus* species are closely related is strengthened by their geographical distribution which is concentrated in central to western Mediterranean countries: *T. viruliferus* is the most common trichodorid species in Italy (Roca & Lamberti, 1985) and the Mediterranean region of France (Scotto La Massese, 1985); *T. lusitanicus* and *T. beirensis* n. sp. occur in continental Portugal while *T. azorensis* n. sp. occurs in the Açores where this species is probably endemic.

T. primitivus is a very common *Trichodorus* species in North-, West- and East-Europe but rarely occurs in South-Europe (De Waele, 1983; Alphey & Taylor, 1986). In Italy, it was not found during the national survey of Trichodoridae, out of 4 000 soil samples (Roca & Lamberti, 1984). The present study shows that *T. primitivus* is also rare in continental Portugal where it was found in only four out of 300 soil samples. Although these soil samples were collected from various vegetation types distributed throughout the country, *T. primitivus* was only found around the roots of olive trees at localities situated in more temperate regions. Further investigations will be needed to establish if *T. primitivus* occurs more frequently in the cooler regions of continental Portugal. The vegetation types in which *T. primitivus* was found on the Açores suggest that this species has been introduced at least on two of these islands with imported plant material.

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