

## Trichodoridae from Israel, with a description of *Trichodorus minzi* n. sp.

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**Summary** — Identification of Trichodoridae populations collected in Israel yielded *Paratrichodorus minor*, *P. allius*, *Trichodorus orientalis* and a new species, *T. minzi* n. sp. *T. minzi* n. sp. is characterized by the presence of a dorsal overlap of the pharyngeal bulb by the intestine; onchiostyle length in males (53-62 µm) and females (53-64 µm); presence of two cervical papillae; excretory pore situated posterior to the cervical papillae; length (63-71 µm) and shape of the spicules; posterior precloacal ventromedian papilla situated well within reach of the retracted spicules in the males; presence of two lateral body pores; vagina length (23-32 µm) and shape of the vaginal sclerotizations in the females. In several localities in the coastal plain of Israel, high population densities of *T. minzi* n. sp. were associated with stunted and unthrifty wheat. *P. minor* is also considered a pest of economic dimensions, especially on maize in central Israel

**Résumé** — *Trichodoridae* provenant d'Israël et description de *Trichodorus minzi* n. sp. — L'identification de populations de Trichodorides récoltées en Israël révèle la présence de *Paratrichodorus minor*, *P. allius*, *Trichodorus orientalis* et d'une nouvelle espèce, *T. minzi* n. sp. *T. minzi* n. sp. est caractérisé par la présence d'un recouvrement dorsal du bulbe œsophagien par l'intestin; la longueur du stylet chez mâles (53-62 µm) et femelles (53-64 µm); la présence de deux papilles cervicales; la position du pore excréteur postérieure aux papilles cervicales; la longueur (63-71 µm) et la forme des spicules; la position du troisième supplément ventromédian au niveau des spicules; la présence de deux paires de pores latéraux; la longueur (23-32 µm) du vagin et la forme de la sclérotisation vaginale.

**Key-words** : *Trichodorus*.

Trichodoridae were first identified in Israel by Minz (1957) who reported the occurrence of two species in the rhizosphere of several cultivated plants. Economic damage by an unspecified trichodorid species to maize in southern Israel was reported six years later (Minz *et al.*, 1963). Cohn *et al.* (1973) positively identified the presence of *P. minor* (= *T. christiei*) in Israel and found trichodorids in 6 % of all samples collected in a country-wide survey conducted during 1970-1972. By the mid-seventies, *P. minor* was recognized as an important species of the plant-parasitic nematode fauna in Israel and a population originating from the rhizosphere of citrus plants in central Israel was used in a comprehensive pathogenic and ecological study (Schilt & Cohn, 1975). During the early eighties, an increasing number of wheat and maize fields in central Israel were found infested with two trichodorid species (Spiegel *et al.*, 1983) causing severe damage and stubby-root symptoms. Nematicidal treatments were effective in increasing crop yields (Orion & Chefer, 1983; Chefer *et al.*, 1984). These two trichodorid species (one of which is a new species) as well as the trichodorid populations collected during the 1970-1972 survey mentioned above, form the basis of the present paper.

### *Trichodorus minzi* \* n. sp. (Fig. 1)

#### MEASUREMENTS

See Tables 1 and 2.

#### DESCRIPTION

*Female* : General appearance typical for the genus. Lip region with distinct labial papillae; amphideal aperture sublabial, elliptical. Body cuticle swollen after fixation, about 5-6.5 µm thick in mid-body region, consisting of two optically different layers : a thick outer one (about 3.5-4.5 µm) and a thin inner one (about 1.5-2 µm). Excretory pore at 89-133 (111 µm), i.e. about 1.5-2.5 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 1/3 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 smaller anterior ventro-sublateral gland nu-

\* After the late Prof. G. Minz, founder and former Head, Department of Nematology, ARO, The Volcani Center, Israel.

**Table 1.** Morphometric data of females of *Trichodorus minzi* n. sp., *T. orientalis* and *Paratrichodorus allius*.

	<i>Trichodorus minzi</i> n. sp.		<i>Trichodorus orientalis</i>		<i>Paratrichodorus allius</i>
	Holotype	Paratypes	Tal forest (Galilee)	Avocado	Avocado (Kubeiba)
n		13	6	5	5
L (µm)	1053	822-973 (937 ± 60)	697-941 (820 ± 109)	730-789 (754 ± 25)	472-666 (580 ± 61)
Body width (µm)	53	48-61 (54 ± 4)	34-39 (37 ± 2)	37-45 (39 ± 3)	37-43 (40 ± 2)
Neck length (µm)	164	154-211 (179 ± 16)	136-159 (146 ± 10)	139-152 (145 ± 6)	108-134 (123 ± 10)
Onchiostyle length (µm)	60	53-64 (58 ± 3)	51-55 (53 ± 2)	49-54 (52 ± 2)	45-49 (47 ± 2)
Anterior end to EP (µm)	129	89-133 (111 ± 11)	99-117 (107 ± 7)	97-109 (104 ± 6)	80-92 (88 ± 5)
Anterior genital branch (µm)	193	144-207 (181 ± 17)	120-213 (145 ± 35)	123-157 (120 ± 59)	62-127 (95 ± 23)
Posterior genital branch (µm)	197	161-234 (195 ± 17)	107-211 (150 ± 40)	162-187 (177 ± 11)	63-115 (85 ± 19)
a	19.9	14.4-19.2 (17.4 ± 1.9)	17.9-24.1 (21.5 ± 3)	17.5-20.5 (19.3 ± 1.2)	11.8-16 (14.5 ± 1.4)
b	6.4	4.1-6.1 (5.3 ± 0.6)	4.9-6.3 (5.6 ± 0.5)	4.8-5.5 (5.2 ± 0.3)	4.5-5 (4.7 ± 0.3)
V	51.9	49.6-55.3 (52.3 ± 1.6)	53.7-59.4 (56 ± 2)	53.3-56.9 (55.4 ± 1.5)	45.8-52.8 (50 ± 2.2)
G <sub>1</sub>	18.3	17-26.7 (19.9 ± 2.5)	14.5-23.5 (17.7 ± 3.2)	16.8-21.5 (19.4 ± 1.8)	13.1-21.4 (16.4 ± 3.3)
G <sub>2</sub>	18.7	17.9-24.2 (20.9 ± 1.8)	15.2-23.2 (18.1 ± 3.2)	21.2-25.3 (23.4 ± 1.7)	11.3-19.4 (14.6 ± 2.9)
Ant. end to EP (% neck length)	78.7	51.7-78.3 (62.2 ± 8.6)	67.3-83 (73.5 ± 5.2)	66.4-77.7 (71.9 ± 4.9)	62.5-79.6 (71.2 ± 7)
Onchiostyle length (% neck length)	36.6	27.5-38.3 (32.9 ± 3.6)	34.4-38.4 (36.4 ± 1.7)	35.3-38.8 (35.9 ± 1.7)	33.6-44.4 (38.3 ± 3.8)

clei lie in the anterior third of the pharyngeal bulb. The large dorsal gland nucleus lies in the middle of the pharyngeal bulb or just anterior to the posterior ventro-sublateral gland nuclei. Out of fourteen females, eight show a short dorsal overlap [5-23 (14) µm] of the pharyngeal bulb by the intestine. Nerve ring at 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. Vulval lips protruding in some specimens. Vaginal sclerotizations large, round to almost oval shaped in lateral view (see Fig. 1 C-F). Vagina 23-32 (29) µm long, extending inward over 38-62 (51) % of the corresponding body-width. Shape of vagina in lateral view as shown in Figure 1 C-F. In most females objects of unknown origin were observed in the uterus. In one female one of these objects was protruding from the vulva (Fig. 1 E). Two pairs of lateral body pores present in thirteen females. The anterior pair situated 109-248

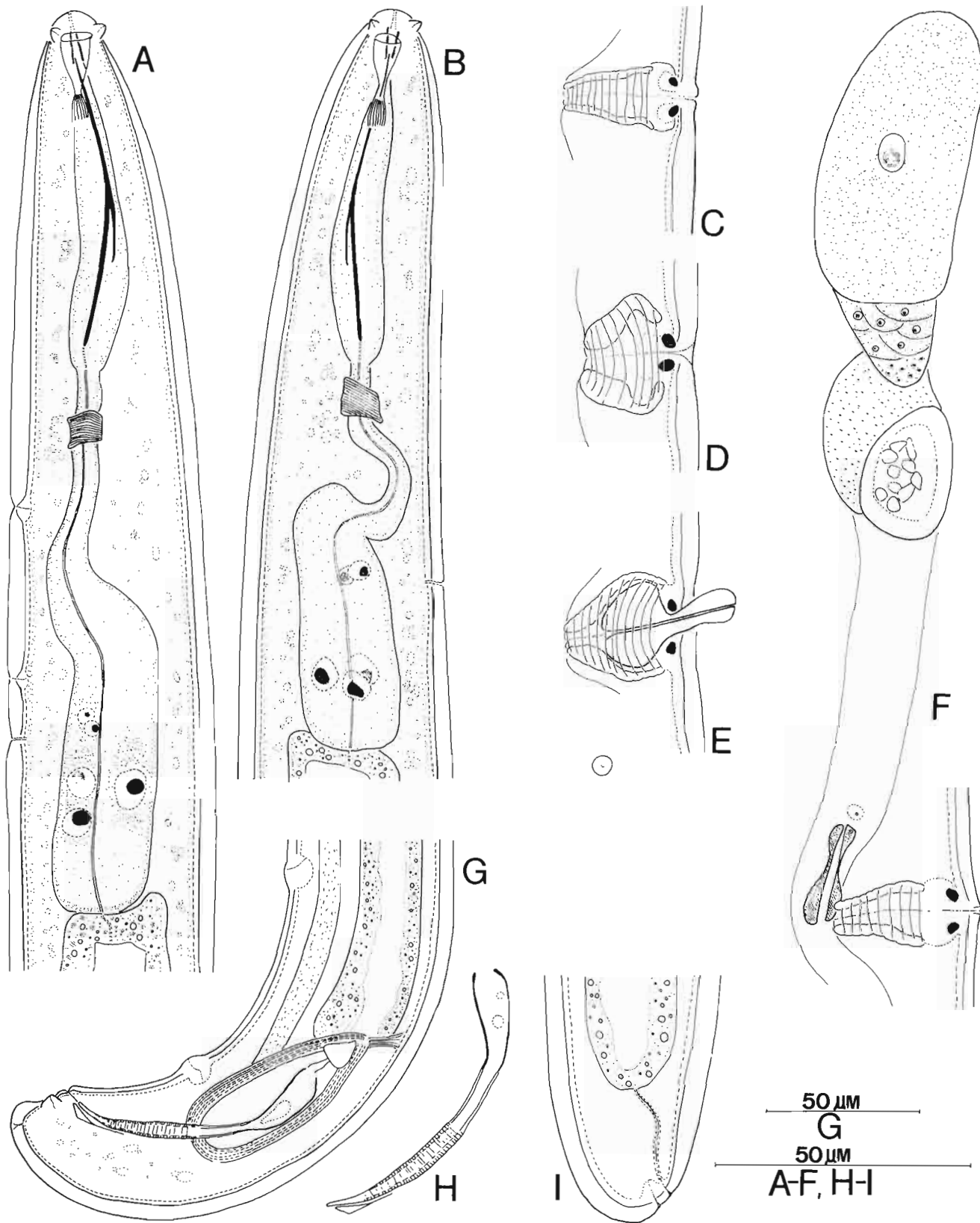
(179) µm anterior to the vulva. The posterior pair situated 9-43 (25) µm, i.e. within one body-width, behind the vulva. In one female the anterior pair was not observed. Anus subterminal. Tail with one pair of subterminal subventral pores.

*Male* : General appearance similar to female, but posterior end more ventrally curved. Excretory pore at 101-141 (117) µm, i.e. 1.6-2.6 times the onchiostyle length, from the anterior end of the body, situated always posterior to the ventromedian cervical papillae. Usually two conspicuous ventromedian cervical papillae present. The anterior papilla (CP 1) situated posterior to the basis of the onchiostyle at level of the isthmus. The posterior papilla (CP 2) situated opposite the anterior part of the pharyngeal bulb. One male with only one ventromedian cervical papilla situated 80 µm from the anterior end of the body and 33 µm anterior to the excretory pore. A pair of lateral cervical pores present slightly anterior to the level of CP 1 or halfway between

**Table 2.** Morphometric data of males of *Trichodorus minzi* n. sp. and *T. orientalis*

	<i>Trichodorus minzi</i> n. sp.		<i>Trichodorus orientalis</i>	
	Allotype	Paratypes	Tal forest (Galilee)	Avocado
n		32	3	5
L (µm)	963	783-1072 (919 ± 90)	829-888 (866)	625-834 (756 ± 78)
Body width (µm)	50	46-57 (51 ± 3)	31-34 (33)	31-36 (33 ± 2)
Neck length (µm)	162	138-185 (162 ± 12)	130-154 (141)	111-149 (140 ± 16)
Onchiostyle length (µm)	53	53-62 (57 ± 2)	50-53 (52)	50-53 (51 ± 1)
Ant. end to EP (µm)	119	101-141 (117 ± 13)	108-115 (112)	89-103 (100 ± 6)
Ant. end to CP 1 (µm)	91	64-96 (80 ± 9)	67-69 (68)	59-65 (61 ± 3)
CP 1 to CP 2 (µm)	21	16-36 (25 ± 6)	27-35 (30)	*25-33 (28 ± 4)
CP 2 to EP (µm)	7	5-45 (13 ± 8)	12-15 (13)	*5-13 (8 ± 4)
Spicule (µm)	64	63-71 (66 ± 2)	39-43 (41)	39-42 (40 ± 1)
Gubernaculum length (µm)	33	30-37 (33 ± 2)	6 (6)	4-7 (5 ± 1)
Cloaca to SP 1 (µm)	35	25-40 (32 ± 3)	31-35 (32)	27-31 (29 ± 2)
SP 1 to SP 2 (µm)	51	37-58 (49 ± 7)	36-49 (44)	35-49 (44 ± 6)
SP 2 to SP 3 (µm)	58	37-59 (54 ± 7)	53-63 (58)	39-51 (46 ± 5)
a	19.3	14.5-23.2 (18.1 ± 2.3)	25.1-28.6 (26.5)	20.2-24.3 (22.8 ± 1.5)
b	5.9	4.5-6.7 (5.7 ± 0.5)	5.8-6.4 (6.2)	4.4-7.5 (5.5 ± 1.2)
T	64.9	49.3-84.6 (65.1 ± 6.6)	61.5-65.9 (64.4)	63.2-75.5 (69.1 ± 4.9)
Ant. end to EP (% neck length)	73.5	57.1-91 (74 ± 8.7)	74.7-86.2 (79.5)	60.1-92.8 (72.3 ± 12.2)
Onchiostyle length (% neck length)	32.7	30-41.3 (35.4 ± 2.6)	33.8-40.8 (36.9)	33.8-46.8 (37.1 ± 5.6)
Cloaca to SP 1 (% spicule length)	54.7	38.2-59.7 (49.1 ± 5.4)	72.1-89.7 (79.8)	67.5-77.5 (73 ± 3.7)
Cloaca to SP 2 (% spicule length)	134.4	96.9-140 (123.2 ± 14)	167.5-215.4 (188.1)	155-197.5 (182.5 ± 163)
Cloaca to SP 3 (% spicule length)	225	164.3-231 (209.4 ± 20.6)	304.7-376.5 (330.5)	252.5-325 (297.1 ± 27)

\* Male with one cervical papilla omitted : CP 1 to EP 37 µm.



**Fig. 1.** *T. minzi* n. sp. — A : Anterior region of male (allotype); B : Anterior region of female (holotype); C-E : Females, vulva and vagina region, lateral view; F : Posterior reproductive branch of female; G : Posterior region of male (allotype); H : Male, spicule and gubernaculum, lateral view; I : Female tail (holotype).

CP 1 and CP 2. Out of 33 males, 28 show a short dorsal overlap of the pharyngeal bulb by the intestine. In all males three precloacal ventromedian supplements present. The posterior one (SP 1) lies at about 38-60 % of the spiculum length anterior to the cloacal aperture, i.e. within reach of the retracted spicules. The two other ones (SP 2 and SP 3) lie out of reach of the retracted spicules. The distance between SP 2 and SP 3 is slightly larger than between SP 1 and SP 2. Testis single, outstretched. Spicules paired, 63-71 (66)  $\mu\text{m}$ , proximal third cephalated, separated from the shaft by a constriction, 14-16  $\mu\text{m}$ . Behind the constriction, the spicule widens again and then gradually tapers distally. Proximal half with striae. No setae were observed. Gubernaculum 12.5-15.5 (15)  $\mu\text{m}$  long. Terminal cuticle of tail usually slightly thickened, with one pair of postcloacal subventral papillae and one pair of subterminal subventral pores.

#### TYPE HABITAT AND LOCALITY

Wheat. Givat Haim, central Israel. Stunted plants.

#### OTHER HABITATS AND LOCALITIES

Wheat fields throughout the coastal plain of Israel.

#### TYPE SPECIMENS

Holotype female, allotype male, four paratype females and ten paratype males deposited at the Collection of the Instituut voor Dierkunde, Rijksuniversiteit Gent, Belgium. Six paratype females and five paratype males deposited with the Muséum national d'Histoire naturelle, Laboratoire des Vers, Paris, France.

#### DIAGNOSIS AND RELATIONSHIPS

*T. minzi* n. sp. can be separated from all species in the genus by the combination of the following characters : dorsal overlap of the pharyngeal bulb by the intestine, two ventromedian cervical papillae, onchiostyle length, spicule length, excretory pore situated posterior to the ventromedian cervical papillae, posterior precloacal ventromedian supplement within reach of the retracted spicules, shape of the spicules, vagina length, two pairs of lateral body pores and shape of the vaginal sclerotizations.

*T. minzi* n. sp. resembles *T. taylori* De Waele, Mancini, Roca & Lamberti, 1982, *T. coomansi* De Waele & Carbonell, 1982, *T. persicus* De Waele & Sturhan, 1987, *T. rinae* Vermeulen & Heyns, 1985 and *T. petrusalberti* De Waele, 1988 in having a dorsal overlap of the pharyngeal bulb by the intestine, two ventromedian cervical papillae and the posterior precloacal ventromedian supplement (SP 1) within reach of the retracted spicules. The males of *T. minzi* n. sp. are easily distinguished from the males of *T. coomansi*, *T. persicus*, *T. rinae* and *T. petrusalberti* by the characteristic shape of the spicules. The spicules of *T. minzi* n. sp. resemble those of *T. taylori* but the constriction which separates the cephalated shaft from the rest of the spicule is

relatively shorter in *T. taylori* than in *T. minzi* n. sp. Males of *T. minzi* n. sp. also differ from those of *T. coomansi* and *T. rinae* by the position of the excretory pore (EP posterior to CP 2 vs EP between CP 1 and CP 2 in *T. coomansi* and *T. rinae*). Males of *T. minzi* n. sp. furthermore differ from the males of *T. taylori*, *T. persicus* and *T. petrusalberti* by the shorter onchiostyle (53-62  $\mu\text{m}$  vs 66-70  $\mu\text{m}$  in *T. taylori*, 65-72  $\mu\text{m}$  in *T. persicus* and 67-73  $\mu\text{m}$  in *T. petrusalberti*), from *T. taylori*, *T. coomansi*, *T. persicus* and *T. rinae* in the longer spicules (63-71  $\mu\text{m}$  vs 57-64  $\mu\text{m}$  in *T. taylori*, 40-54  $\mu\text{m}$  in *T. coomansi*, 51-61  $\mu\text{m}$  in *T. persicus* and 40-55  $\mu\text{m}$  in *T. rinae*) and from *T. persicus* in the position of the posterior precloacal ventromedian supplement (SP 1 at 38-60 % of spiculum length anterior to cloacal aperture vs SP 1 at 60-85 % in *T. persicus*). The females of *T. minzi* n. sp. are distinguished from the females of *T. taylori*, *T. coomansi*, *T. persicus*, *T. rinae* and *T. petrusalberti* by the characteristic shape of the vaginal sclerotizations. They also differ from the females of *T. taylori* and *T. rinae* in having two pairs of lateral body pores instead of only one pair of pores. Furthermore, females of *T. minzi* n. sp. differ from those of *T. taylori*, *T. persicus* and *T. petrusalberti* in the shorter onchiostyle (53-64  $\mu\text{m}$  vs 64-72  $\mu\text{m}$  in *T. taylori*, 63-71  $\mu\text{m}$  in *T. persicus* and 68-73  $\mu\text{m}$  in *T. petrusalberti*) and from those of *T. coomansi* and *T. rinae* in the longer vagina (23-32  $\mu\text{m}$  vs 14-16  $\mu\text{m}$  in *T. coomansi* and 16-17  $\mu\text{m}$  in *T. rinae*). 16-17  $\mu\text{m}$  in *T. rinae*).

#### *Trichodorus orientalis* De Waele & Hashim, 1984

##### MEASUREMENTS

See Tables 1 and 2.

##### DESCRIPTION

*Female* : General appearance typical of family. Cuticle 2.5-4  $\mu\text{m}$  thick in mid-body region consisting usually of the three layers; the thin outer one sometimes indistinct when the cuticle is 3.5-4  $\mu\text{m}$  thick. Excretory pore 97-117 (106)  $\mu\text{m}$ , i.e. 1.9-2.2 times the onchiostyle length, from the anterior end of the body. Eight out of eleven females show a clear dorsal overlap of the pharyngeal bulb by the intestine. Overlap 6-16 (12)  $\mu\text{m}$ , i.e. 17-48 (34) % of the corresponding body-width. Three females without overlap. Vaginal shape and sclerotizations as described earlier (De Waele & Hashim, 1984). Vagina 15-17 (17)  $\mu\text{m}$ , extending inward 37-47 (43) % of the corresponding body-width. One pair of lateral body pores situated 10-33 (20)  $\mu\text{m}$  posterior to the vulval region, within one body-width.

*Male* : General appearance similar to females but posterior end of body strongly curved ventrally. In seven out of eight males two conspicuous ventromedian cervical papillae (CP) situated just posterior to the onchiostyle region; the posterior papilla (CP 2) at the level of the isthmus. In one male only one cervical papilla

present, 63  $\mu\text{m}$  from the anterior end of the body and 37  $\mu\text{m}$  anterior to the EP. Excretory pore 89-115 (104)  $\mu\text{m}$ , i.e. 1.8-2.2 times the onchiostyle length, from the anterior end of the body. One pair of lateral cervical pores present, positioned between CP 1 and CP 2. All males show dorsal overlap of the pharyngeal bulb by the intestine. Overlap 3-25 (15)  $\mu\text{m}$ , i.e. 11-73 (48) % of the corresponding body-width. Shape of spicules and gubernaculum as described by De Waele and Hashim (1984).

#### REMARKS

The morphological characters and morphometrics of the two populations from Israel of *T. orientalis* agree with the type population (De Waele & Hashim, 1984) except that the specimens from Israel are somewhat longer.

In Israel, *T. orientalis* was found associated with avocado in Kabri, western Galilee and natural vegetation in the Tal forest, Upper Galilee.

#### *Paratrichodorus minor* (Colbran, 1956) Siddiqi, 1974

The populations of *P. minor* from Israel are similar in morphological and morphometrical characters with the descriptions and measurements presented by Heyns (1975).

In Israel, *P. minor* was found associated with unthrifty maize (Givat Haim, Betyitzhak, various sites in central Israel); pea (Kfar Bilu); lawn (Petah Tikva).

#### *Paratrichodorus allius* (Jensen, 1963) Siddiqi, 1974

##### MEASUREMENTS

See Table 1.

##### DESCRIPTION

Body straight after fixation. Cuticle swollen, sometimes slightly detached from the body but not at the head, vulva and tail. Excretory pore 80-92 (88)  $\mu\text{m}$ , i.e. 1.7-2 times the onchiostyle length, from the anterior end of the body, at the level of the anterior part of the pharyngeal bulb. Pharyngeal bulb with five gland nuclei. Dorsal nucleus and nuclei of the posterior ventro-sublateral glands large, similar in size. Nuclei of the anterior ventro-sublateral glands small but distinct. Dorsal nucleus always situated in the anterior third of the pharyngeal bulb at level of the anterior ventro-sublateral nuclei. Dorsal overlap of the pharyngeal bulb by the intestine and ventral overlap of the intestine by the posterior ventro-sublateral glands present in all females. Dorsal overlap short, 4-11 (8)  $\mu\text{m}$ , less distinct than pharyngeal overlap. Pharyngeal overlap 7-15 (11)  $\mu\text{m}$ , i.e. less than 0.5 times the corresponding body-width. Female reproductive system didelphic and amphidelphic. Ovaries reflexed. No spermatheca ob-

served. Vagina 6.5-9 (7.5)  $\mu\text{m}$ , extending inward over 15.2-23.4 (19.3) % of the corresponding body-width. Vaginal sclerotization 0.8  $\mu\text{m}$  in diameter, 1.7-2.3  $\mu\text{m}$  apart, more or less round in lateral view. Vulva opening a longitudinal slit. In six out of eight females, an accumulation of spermlike bodies was present in both uteri. In the distal parts of the gonads, oogonia and oocytes at various stages of development were observed. No spermlike bodies were seen outside the uteri. In one of the remaining females, an accumulation of spermlike bodies was present at the tip of both genital tracts where the gonads reflex but no spermlike bodies were seen in the uteri. Lateral body pores absent. Anus subterminal. Tail with one pair of subterminal subventral pores.

##### COMPARISON WITH THE TYPE AND OTHER POPULATIONS

The morphological characters and morphometrics of the population from Israel of *P. allius* agree with the populations of *P. allius* from the USA, Madeira Archipelago, continental Portugal, Tanzania and South Africa (Jensen, 1963; Siddiqi, 1974; Vermeulen & Heyns, 1983; Sturhan, 1989a) except that in the female specimens from Israel no lateral body pores were observed and that both a dorsal and ventral overlap are present. Lateral body pores were also not mentioned in the original description of *P. allius* (Jensen, 1963) but Sturhan (1989a) observed faint lateral body pores between the vulva and anus of a few specimens of the Washington State and Madeira Archipelago populations. Only a ventral overlap was described in the original description of *P. allius* by Jensen (1963) and the populations from Tanzania (Siddiqi, 1974) and Washington State (Sturhan, 1989a). Unusual sperm location was observed previously in *P. allius* (Decraemer 1988, 1989) and hermaphroditism of the syngonic type (both types of gametes produced in the same gonad) is strongly suspected for this species (Sturhan, 1989b).

##### HABITATS AND LOCALITIES

In Israel, *P. allius* was found associated with avocado in Kubeiba, central Israel.

##### Discussion

Two *Trichodorus* species have been found in Israel. One of these, *T. minzi* n. sp., has only been recorded from Israel while the other, *T. orientalis*, was described from the rhizosphere of tomato and dry beans in Jordan and from the rhizosphere of grapevine in Iran (De Waele & Hashim, 1984). It was not reported again until the present study. This information suggests that *T. orientalis* may be widespread in the Middle East. It also seems possible that the record of "*Trichodorus* probably *primitivus*" by Minz (1957), later cited by Cohn *et al.* (1973), might refer to *T. orientalis*, to which it bears some resemblance. In any event, *T. primitivus* was not identified in the present study, and it seems rather unlikely

that this species would occur in a subtropical climate.

Of the four Trichodoridae species reported herein, two are evidently pests of economic importance. *P. minor* is recognized as such on various crops and is worldwide in occurrence (Heyns, 1975) whereas *T. minzi* n. sp. is so far known to damage primarily wheat in the coastal plain of Israel.

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#### References

- CHEFER, Y., SPIEGEL, Y. & ORION, D. (1984). [Recommendation for controlling migratory nematodes during sowing of wheat or maize for silage.] *Hassadeh*, 64 : 888-890.
- COHN, E., SHER, S. A., BELL, A. H. & MINZ, G. (1973). Soil nematodes occurring in Israel. *Agric. Res. Org., Bet Dagan, Israel Spec. Public.*, No. 22, 12 p.
- DECRAEMER, W. (1988). Identification of trichodorids. In : Fortuner, R. (Ed.). *Nematode Identification and Expert-System Technology*. New York. Plenum Publication Corporation : 157-170.
- DECRAEMER, W. (1989). Morphologic variability and value of the characters used for species identification in *Paratrichodorus* Siddiqi, 1974 (Nematoda : Trichodoridae). *Nematologica*, 35 : 37-61.
- DE WAELE, D. (1988). *Trichodorus petrusalberti* n. sp. (Nematoda : Trichodoridae) from rice with additional notes on the morphology of *T. sanniae* and *T. rinae*. *J. Nematol.*, 20 : 85-90.
- DE WAELE, D. & CARBONELL, E. (1982). Two new species of *Trichodorus* (Nematoda : Diphtherophorina) from Africa. *Nematologica*, 28 : 387-397.
- DE WAELE, D. & HASHIM, Z. (1984). *Trichodorus orientalis* n. sp. (Nematoda : Trichodoridae) from Jordan and Iran. *Syst. Parasitol.*, 6 : 63-67.
- DE WAELE, D. & STURHAN, D. (1987). *Trichodorus persicus* n. sp. (Nematoda : Trichodoridae) from Iran. *Syst. Parasitol.*, 10 : 79-83.
- DE WAELE, D., MANCINI, G., ROCA, F. & LAMBERTI, F. (1982). *Trichodorus taylora* n. sp. (Nematoda : Dorylaimida) from Italy. *Nematol. mediterr.*, 10 : 27-37.
- HEYNS, J. (1975). *Paratrichodorus christiei*. *C.I.H. Descript. Pl.-paras. Nematodes*, Set 5, No. 69 : 4 p.
- JENSEN, H. J. (1963). *Trichodorus allius*, a new species of stubby-root nematode from Oregon (Nemata : Dorylaimoidea). *Proc. helminth. Soc. Wash.*, 30 : 157-159.
- MINZ, G. (1957). Free-living plant-parasitic and possible plant parasitic nematodes in Israel. *Pl. Dis. Repr.*, 41 : 92-94.
- MINZ, G., STRICH-HARARI, D. & COHN, E. (1963). [Plant parasitic nematodes in Israel and their control.] *Sifriat Hassadeh, Tel Aviv*. 84 p.
- ORION, D. & CHEFER, Y. (1983). [Controlling migratory nematodes increases the yield of corn for silage.] *Hassadeh*, 53 : 446-447, 454.
- ROCA, F. & LAMBERTI, F. (1984). Trichodorids (Nematoda) from Italy. *Nematol. mediterr.*, 12 : 95-118.
- SCHILT, H. G. & COHN, E. (1975). Pathogenicity and population increase of *Paratrichodorus minor* as influenced by some environmental factors. *Nematologica*, 21 : 71-80.
- SIDDIQI, M. R. (1974). Systematics of the genus *Trichodorus* Cobb, 1913 (Nematoda : Dorylaimida), with descriptions of three new species. *Nematologica*, 19 : 259-278.
- SPIEGEL, Y., ORION, D. & MORDECHAI, M. (1983). [Distribution of nematodes attacking winter cereals in Israel.] *Hassadeh*, 53 : 1780-1781.
- STURHAN, D. (1989a). On the species status of *Paratrichodorus allius* (Jensen, 1963) and *P. tansaniensis* Siddiqi, 1974 (Nematoda, Trichodoridae). *Nematologica*, 35 : 62-68.
- STURHAN, D. (1989b). Hermaphroditism in *Paratrichodorus* species (Nemata : Dorylaimida). *Revue Nématol.*, 12 : 273-276.
- VERMEULEN, W. & HEYNS, J. (1983). Studies on Trichodoridae (Nematoda : Dorylaimida) from South Africa. *Phytophylactica*, 15 : 17-34.
- VERMEULEN, W. & HEYNS, J. (1985). Further studies on southern African Trichodoridae (Nematoda : Dorylaimida). *Phytophylactica*, 16 : 301-305.