

Xiphinema israeliae n. sp. (Nematoda : Dorylaimoidea)

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SUMMARY

Xiphinema israeliae n.sp., is described from Israel. It is a bisexual species belonging to the group of didelphic, peg-tailed species with two complete female genital branches of the same length and structure, devoid of uterine Z differentiation. Populations were previously identified as *X. diversicaudatum* and were frequently found in association with citrus and avocado, and sometimes grapevines.

RÉSUMÉ

Xiphinema israeliae n.sp. (Nematoda : Dorylaimoidea)

Les auteurs décrivent *Xiphinema israeliae* n.sp., appartenant au groupe des espèces avec deux branches génitales femelles complètes de mêmes longueur et structure, sans différenciation Z et ayant une queue arrondie pourvue d'un mucron terminal. Cette espèce, signalée antérieurement en Israël sous le nom de *X. diversicaudatum*, est fréquemment rencontrée en association avec divers citrus et l'avocatier, plus rarement avec la vigne.

A survey of the genus *Xiphinema* occurring in Israel, carried out in 1964-65 (Cohn, 1969), revealed the presence of ten species, among them *X. diversicaudatum* (Micoletzky, 1923 & 1927) Thorne, 1939. This species differed from *X. index* Thorne & Allen, 1950 and *X. vuittenzei* Luc *et al.*, 1964, two other well-described peg-tailed *Xiphinema* species known at that time, primarily on account of its greater body length and its bisexual status. The biometrical characters of the Israeli population fell within the relatively broad range of the various populations of *X. diversicaudatum*, as redescribed by Goodey, Peacock and Pitcher (1960). However, additional species with pegged tails were described subsequently and detailed morphological descriptions of the female reproductive system were given. Flegg (1966) reported the presence of a Z-organ (in fact a pseudo-Z organ; see Luc and Dalmaso, 1975) in some English populations of *X. diversicaudatum*: however, since these nematodes were not from the type locality, Cohn and Sher (1972) considered that the species *X. diversicaudatum* did not possess a

«Z-organ». Later, in redescribing the species, Pitcher, Siddiqi and Brown (1974) confirmed the presence of a «Z-organ» in the females of other European populations of *X. diversicaudatum*.

Recently, reexamination of the Israeli specimens confirmed the lack of a pseudo-Z-organ or other Z-differentiation in all populations studied. Upon closer examination, additional differences between them and specimens of *X. diversicaudatum* from Europe were observed, and it became evident that we were dealing with a separate species. This paper describes these populations as *X. israeliae* n.sp., and discusses the relationship between this and other closely related species in the genus.

Materials and methods

All soil samples were processed within 30 h after sampling; the nematode extraction method used was a modification of that proposed by D'Herde and Van Den Brande (1964) for migratory dorylaimid

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Table 1
Xiphinema israeliae n.s. Morphometrics of females and males of three populations

	<i>Pop. Citrus Nes Ziona</i>		<i>Pop. Golf green</i>		<i>Pop. Citrus, Tel Mond</i>	
	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂
n =	20	20	12	13	10	5
L (mm)	3.93 (3.52-4.16)	3.80 (3.38-4.27)	3.94 (3.42-4.29)	3.75 (3.52-4.09)	3.78 (3.40-3.90)	3.54 (3.28-3.90)
a	91.0 (85.2-97.3)	94.8 (85.1-109.5)	92.6 (85-97.5)	96.2 (86.7-107.6)	90 (81-92)	92 (83-99)
b	8.7 (6.9-9.6)	8.3 (6.6-9.7)	8.4 (7.1-9.3)	8.0 (7.2-8.7)	8.6 (8.1-9.1)	8.2 (7.0-9.5)
tail (µm)	41 (36-48)	45 (39-50)	41 (35-46)	47 (38-53)	37 (34-41)	36 (34-38)
c	96.3 (76.7-106.7)	85.4 (70.4-99.3)	97.4 (85.2-107.5)	81.3 (71.5-98.9)	103 (97-109)	99 (91-109)
c'	1.3 (1.2-1.5)	1.3 (1.2-1.5)	1.4 (1.2-1.5)	1.4 (1.1-1.6)	1.2 (1.1-1.3)	1.1 (1.1-1.2)
V	49.0 (46.4-51.5)	—	48.5 (46.5-51.4)	—	49 (46-54)	—
od. style (µm)	123 (118-129)	126 (121-130)	125 (120-128)	126 (120-133)	116 (113-121)	117 (115-119)
od. phore (µm)	72 (69-76)	72 (68-75)	73 (70-77)	71 (68-75)	68 (65-70)	65 (63-67)
stylet (µm)	195 (189-202)	198 (191-204)	198 (190-204)	197 (192-205)	184 (178-191)	180 (170-186)
spicula (µm)	—	60 (54-68)	—	57 (53-60)	—	51 (46-54)
acc. pieces	—	12.5 (10-15)	—	12.5 (11-15)	—	—

nematodes. Specimens were mounted in dehydrated glycerine using Seinhorst's (1962) rapid technique.

Three populations were studied :

— pop. 1 (type population) : rhizosphere of *Citrus* sp., Nes-Ziona, Israel,

— pop. 2 : golf green, Caesarea, Israel,

— pop. 3 : rhizosphere of *Citrus* sp. (lemon), Tel-Mond, Israel.

***Xiphinema israeliae* n.sp.**

= *X. diversicaudatum* apud Cohn, 1969 ;
 Cohn & Mordechai, 1969.

MEASUREMENTS

Morphometrics of females and males of the three populations studied are given in Table 1 and morphometrics of the four larval stages on Table 2.

Holotype: female : L = 3.52 mm ; a = 88 ; b = 6.9 ; tail length = 40 µm ; c = 88 ; c' = 1.3 ; V = 47.7 ; odontostyle = 124 µm ; odontophore = 69 µm.

DESCRIPTION

Female: When heat-relaxed, body habitus from slightly ventrally curved to open shape. Cuticle apparently composed of two layers, 2.5-3 µm thick at mid-body and slightly reinforced in the neck region (3-4 µm). Lateral chord 14 µm (10-17) wide at mid-body, or 30% (23-38) of the corresponding diameter. Cervical pores in four rows, few in number and spaced : 2-4 dorsal, 2-4 ventral and 3-5 lateral ; lateral cervical pore line prolonged as a subdorsal line of pores, rare and irregularly spaced on the anterior three quarters of the body, more numerous and regularly disposed on the posterior part of

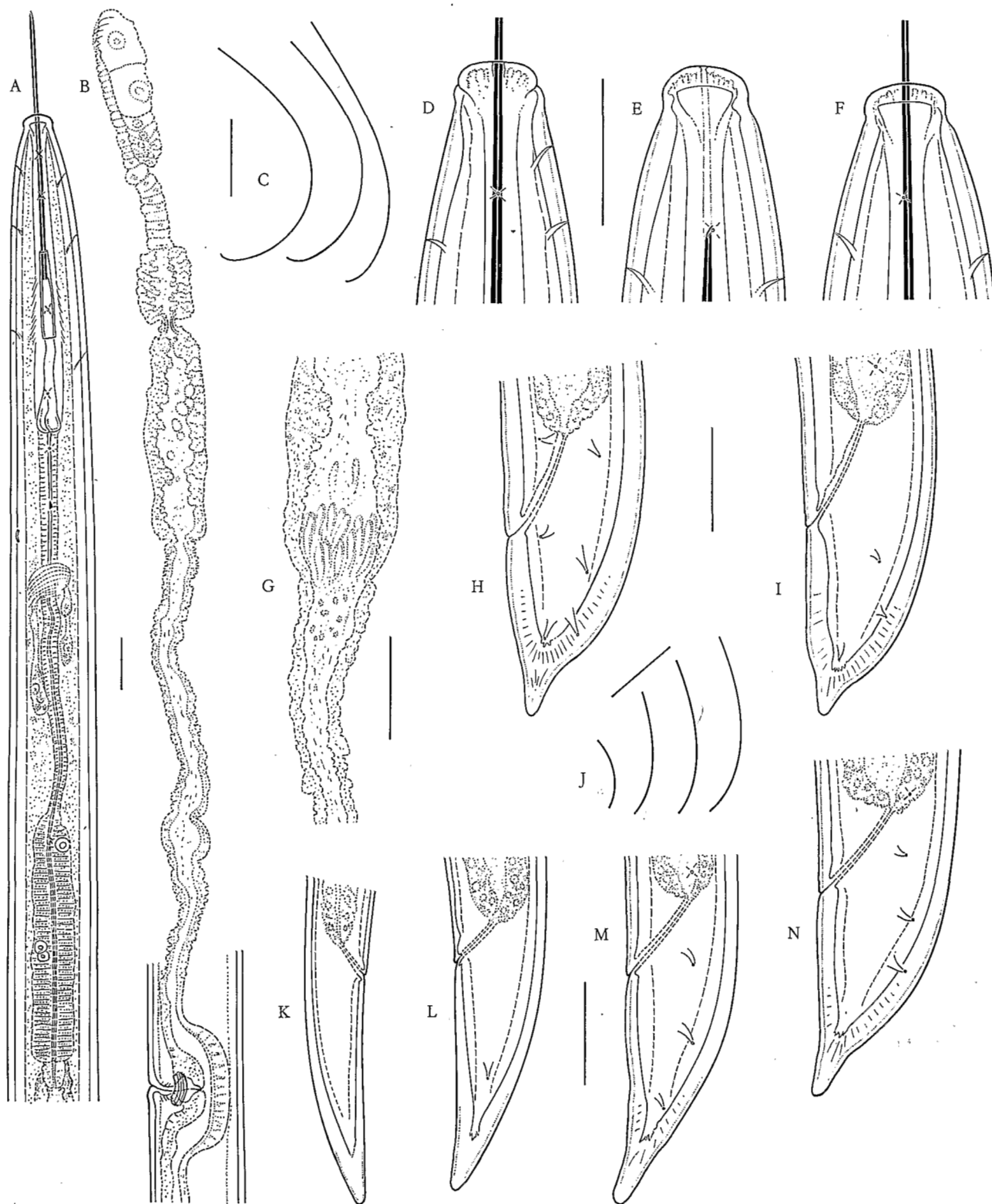


Fig. 1. *Xiphinema israeliae* n.sp. Female. A : oesophageal part. B : anterior genital branch. C : habitus. D, E, F : anterior part (D : dorso-ventral ; E : lateral, stylet exserted ; E : lateral, stylet retracted). G : portion of uterus showing spermatozoa in uterine pouch. H, I : tails. — Juveniles. J : habitus of the four stages. K : tail J 1. L : tail J 2. M : tail J 3. N : tail J 4. (Bars represent : C and J : 1 mm ; others : 25 μ m).

Table 2
Xiphinema israeliae p.sp. Morphometrics of juveniles
 (Pop. Citrus, Nes-Ziona and Golf Green)

	J 1	J 2	J 3	J 4
n	4	7	13	20
L (mm)	1.10 (1.02-1.30)	1.42 (1.28-1.67)	2.01 (1.65-2.35)	2.87 (2.55-3.05)
a	47.0 (43.3-54.2)	51.7 (43.4-59.6)	64.1 (53.2-72.4)	73.9 (69.8-83.3)
b	4.1 (3.5-4.8)	4.4 (3.9-5.3)	5.3 (4.7-6.5)	6.8 (5.8-8.5)
Tail (μm)	58 (54-64)	59 (55-63)	52.5 (47-58)	47 (36-56)
c	19.5 (18.9-20.3)	25.6 (22.1-28.2)	38.2 (34.4-42)	61.2 (52.1-77.8)
c'	3.7 (3.4-4.0)	3.4 (3.2-3.5)	2.2 (1.9-2.4)	1.6 (1.3-1.9)
Od. style (μm)	57 (53-61)	70.5 (68-78)	88 (83-92)	104 (99-111)
Od. phore (μm)	42 (39-44)	48 (45-50)	58 (54-65)	65 (61-68)
Stylet (μm)	99 (96-104)	118.5 (113-127)	146 (139-153)	169 (160-178)
Repl od.	69 (66-72)	86 (82-90)	106.5 (102-113)	125.5 (118-134)

body; no latero-subventral pores; ventral pores regularly disposed along the body. Lip region rounded in front, 14-16 μm wide, separated from the rest of the body by a weak, smooth constriction. Amphid stirrup-shaped; amphidial aperture a large, straight, transverse slit (65-72% of the corresponding diameter) situated in front of the constriction. Hemizonid flat, 5-8 μm wide, situated at 210 μm (190-225) from anterior end; hemizonion lenticular, 2-4 μm wide, situated at 272 μm (251-304) from anterior end. Nerve ring 11-18 μm wide, at variable distance from base of stylet (10-85 μm); no second posterior nerve ring. Stylet conforms to genus; flanges of odontophore 11-14 μm wide, reinforced at their margins. Stylet guiding apparatus appearing tubular; basal annule at 111 μm (96-122) from anterior end; length of the « tube » very variable, depending on whether the stylet is retracted or protracted (3-43 μm). Oesophagus conforms to genus; « mucro » situated in oesophageal wall, very variable in length (2-7 μm) and in position (10-82 μm from base of stylet). Oesophageal bulb clearly set off at anterior end, measuring 124 \times 22 μm (114-135 \times 20-25); position and size of the dorsal oesophageal gland nucleus and of the subventral oesophageal gland nuclei conform to genus. Vaginal

slit transverse; vagina reaching half the corresponding diameter; vaginal sphincter flat; ovejector muscularized; two genital branches, approximately the same length and of similar structure; uterus in two parts, a tubular portion connected with the ovejector, composed of globular cells, with no muscularized part, no Z-differentiation or spines; wide uterine pouch, composed of large cells with internal wall convoluted; sphincter between uterus and oviduct well developed; oviduct with a large pouch at contact with sphincter and a thin part composed of closely packed small cells; ovary without any particular characteristic⁽¹⁾. Spermatozoa present in some females, aggregated in the lower part of the uterine pouch. Tail short, rounded, with curvature essentially dorsal, and ventral profile

⁽¹⁾ All females examined apparently had recently completed egg-laying; this was assumed from several characters evident in the genital tracts: lumen of the tubular part of the uterus wide with granules and presenting occasional swellings; oviduct pouch often vacuolated; thin part of oviduct with distended cells; ovary reduced in size and with no clearly formed oocytes (Fig. 1B); thus such structures probably are physiological and cannot be reported as specific.

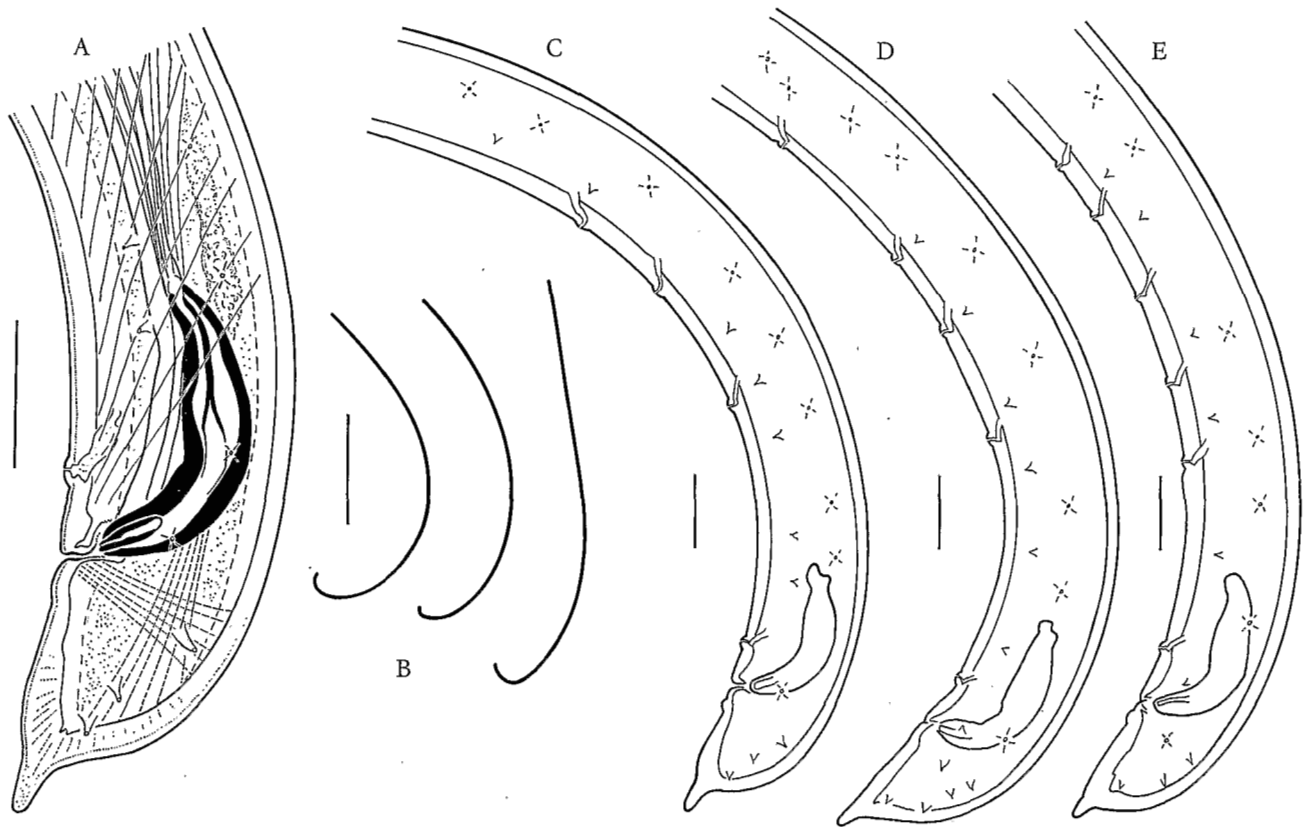


Fig. 2. *Xiphinema israeliae* n.sp. Male. A : tail and spicules. B : habitus. C, D, E : posterior part of males showing distribution of ventral supplements and of pores. (Bars represent : B : 1 mm ; others : 25 μ m).

on the same line as body profile, with a conical smooth terminal peg slightly ventral to the body axis and not clearly separated from the rest of the tail ; cuticle at tail thick and about the same thickness on the ventral and dorsal sides (5.7-7 μ m) ; radial striations clearly visible in internal layer(s) of tail cuticle ; no blind canal at tail extremity ; three to four pairs of caudal pores, the posterior median, the anterior at level of anus, generally latero-dorsal, as were the intermediate one(s).

Male: Bisexual species ; male : female ratio approximately 50 : 50. Curvature of posterior part of male body more pronounced than in female. Morphology and anatomy are similar to those of the female except the genital apparatus and somatic structures linked to it (see below) and the narrower lateral chord (7-8 μ m, or 15-19% of body diameter, at mid-body). Spicules massive, curved in open C, not cephalated, with conspicuous median reinforcement ; accessory piece straight, rounded posteriorly. Preloacal double papillae present ; generally four

to five ventral single supplements (exceptionally three or six) ; very rarely (three of 33 males observed) the most anterior supplement is slightly atrophied ; six to nine pairs of ventro-sublateral pores, well developed, in the area of the supplements ; position of the double papilla and of the single supplements are given in Table 3. Tail having the same shape and structure as in the female ; three to five pairs of caudal pores.

Juveniles: In the four juvenile stages, body curvature was less pronounced than in adult forms and no significant differences were observed within the different stages. Lip area shape identical to that of adults. J1 tail regularly elongate-conical with slight dorsal curvature and only one, inconspicuous, pair of caudal pores ; J2 tail similar to that of J1, but less elongated ; one pair of caudal pores present ; J3 tail conoid-elongated, with curvature mainly dorsal, but extremity with a weak but conspicuous digitation ; J4 tail very similar to that of female ; two or three pairs of caudal pores in J3 and J4.

Table 3
Xiphinema israeliae n. sp.
 Position of ventral male supplements, in μm
 (No. 1-13 : pop. golf green
 No. 14-33 : Pop. Citrus, Nes-Ziona)

No.	Cloaca- double pap.	Double pap.- S_1	S_1 - S_2	S_2 - S_3	S_3 - S_4	S_4 - S_5	S_5 - S_6
1	17	106	30	25			
2	16	62	24	49	(58)		
3	17	94	26	25	34		
4	15	79	24	31	29		
5	15	65	31	35	23		
6	15	74	36	25	23		
7	16	63	26	40	27		
8	17	55	28	33	37		
9	15	62	24	39	35	(57)	
10	13	69	26	30	36	(41)	
11	19	72	22	31	25	23	
12	16	57	41	27	25	23	
13	15	57	26	22	19	24	
14	14	78	43	33			
15	13	84	42	35			
16	17	76	25	22	31		
17	16	63	30	40	33		
18	15	55	35	21	21		
19	19	90	40	12	30		
20	18	70	31	45	30		
21	18	71	43	28	26		
22	18	80	27	25	31		
23	19	65	22	41	24		
24	11	67	27	33	28		
25	19	83	38	29	54		
26	16	70	28	32	28	30	
27	20	65	26	33	32	20	
28	18	71	22	25	25	24	
29	15	64	34	27	35	32	
30	18	56	30	24	25	29	
31	20	55	31	41	33	23	
32	17	66	22	28	24	18	
33	17	57	22	23	20	30	40

Number between brackets indicates an atrophied supplement.

TYPE DATA

Holotype: Female, slide n° 15053, deposited in Muséum national d'Histoire naturelle, Laboratoire des Vers, Paris.

Paratypes: One female and one male deposited in each of the following institutions : The Volcani Center, Bet-Dagan, Israël; Rothamsted Experimental Station, Harpenden, Herts., U.K.; Laboratorium

voor Nematologie, Wageningen, Nederland ; USDA Collection, Beltsville, Md, USA ; University of California, Davis, USA ; Scottish Crop Research Institute Invergowrie, Dundee, U.K. ; Rands Afrikaans University, Johannesburg, South Africa. Remaining type material in the Paris Muséum collection.

TYPE LOCALITY

Rhizosphere of *Citrus* sp., Nes-Ziona, Israel.

DIAGNOSIS AND RELATIONSHIPS

Xiphinema israeliae n. sp. may be classified in the group of species having two complete female genital branches of the same length and structure which are devoid of any uterine Z-differentiation and uterine spines, and a female tail rounded with a terminal peg or bulge. Besides the new species, this group comprises the following species : *X. basilgoodeyi* Coomans, 1964 ; *X. index* Thorne & Allen, 1950 ; *X. mammillatum* Schuurmans Stekhoven & Teunissen, 1938 ; *X. neovuittenezi* Dalmasso, 1969 ; *X. pyrenaicum* Dalmasso, 1969 ; *X. seredouense* Luc, 1975 ; *X. tarjani* Luc, 1975 and *X. vuittenezi* Luc, Lima, Weischer & Flegg, 1964.

X. israeliae n. sp. may be immediately separated *i)* from *X. index* and *X. mammillatum* (as redescribed by Luc and Tarjan, 1963) in which the vulva is more anteriorly situated ($V = 38-40$ for both species); *ii)* from *X. tarjani* which is much shorter ($L = 1.6-2.4$ mm) and has a lip area continuous with the rest of body.

The new species differs from *X. neovuittenezi*, *X. pyrenaicum* and *X. vuittenezi*, besides other characters, mainly by the tail shape and the shape and development of the tail terminal peg. In the three species cited, the tail is of general hemispherical shape and the terminal bulge is very weakly developed, being even absent in some specimens ; in addition, in *X. neovuittenezi* a blind canal is present in the terminal cuticle of the tail. In *X. pyrenaicum* males are unknown and in *X. vuittenezi* extremely rare.

Apart from having a shorter body (female, $L = 2.5-3.3$ mm), *X. basilgoodeyi* differs from *X. israeliae* n.sp. mainly in the shape of the tail and the peg. In the former species, the tail has a more pronounced dorsal curvature and the peg is clearly set-off from the rest of the tail ; in addition a conspicuous blind canal is present. Tail shape also differs between the different larval stages of the two species.

Several characters separate *X. israeliae* n. sp.

from *X. seredouense*. In the latter species the habitus of the female is a loose spiral or more rarely a rather closed C; lip area is continuous with the rest of the body; tail is longer (41-61 μm) and a blind canal is present.

X. israeliae n. sp. shows resemblance to *X. diversicaudatum* (Micoletzky, 1923 & 1927) Thorne, 1939, but in the latter species, the vulva is somewhat more anterior ($V = 39-46$), the tail has a more pronounced dorsal curvature and the peg is shorter and clearly set-off from the rest of the tail. Also the female genital tracts in *X. diversicaudatum* contain the characteristic pseudo Z-organ with numerous globular bodies.

X. paraelongatum Altherr, 1958 was considered by Luc and Tarjan (1963) to be a minor synonym of *X. diversicaudatum*. Syntypes (one female, one male; kindly supplied by Dr. R. Vallotton) were re-examined. Although the specimens, particularly the female, were flattened, the pseudo Z-organ was observed; this finding confirms the synonymy with *X. diversicaudatum* and the distinction from *X. israeliae* n. sp.

BIONOMICS

Some biological data concerning this species are available from earlier studies. During the survey carried out in the mid-sixties, *X. israeliae* n. sp. occurred in 41% of all citrus samples ($n = 32$), in 30% of avocado samples ($n = 10$) and 8% of the grapevine samples ($n = 26$). Only traces were observed in soil sampled from around rose plants. Most population levels were relatively low (15-38 nematodes per 200 g. soil), although a maximum of 81 specimens per 200 g soil (around citrus) was recorded (Cohn, 1969). Almost all populations encountered were found in soils classified as « sandy » and were concentrated in the approximate depth range of 20-40 cm.

Hand-picked specimens multiplied slightly on grapevine and citrus in greenhouse culture, but failed to build up around strawberry, mint, bur marigold and nettle. The life cycle was not completed during a nine-month observation period on any host tested, but this could be due to unfavourable culturing conditions (Cohn & Mordechai, 1969).

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Field and pot experiments to investigate any possible implication of the nematode in the transmission of several citrus virus diseases and avocado sunblotch were inconclusive.

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