

## *Longidorus israelensis* sp.n. (Nematoda: Dorylaimoidea), a parasite of carrot in Israel

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**Summary** – *Longidorus israelensis* sp.n., a parthenogenic species associated with diseased carrots in Israel, is described. This species is characterised by its long body (7.1-9.1 mm), slightly expanded and anteriorly flattened head region, amphidial pouches not bilobed, long odontostyle (125-135  $\mu$ m), and almost hemispherical short tail (36-46  $\mu$ m). Also, it has a somewhat unusual arrangement of the oesophageal gland nuclei. Carrots fed upon by *L. israelensis* sp.n. showed arrested root growth, alternative growth apices and root-tip galling, resulting in deformed and split carrots. The nematode is usually present at 20-40 cm depth in the soil profile but migrates to 40-100 cm depth to survive the hot dry summer period. © Orstom/Elsevier, Paris

**Résumé** – *Longidorus israelensis* sp. n. (Nematoda: Dorylaimoidea) parasite de la carotte en Israël – *Longidorus israelensis* sp. n, espèce parthénogénétique associée à des dégâts sur carotte en Israël, est décrite. Cette espèce est caractérisée par une grande longueur du corps (7,1-9,1 mm), une région labiale légèrement en relief et aplatie frontalement, des poches amphidiennes non bilobées, un long odontostyle (125-135  $\mu$ m) et une queue courte, sub-hémisphérique (36-46  $\mu$ m). Elle présente également une disposition inhabituelle des noyaux des glandes oesophagiennes. Les carottes attaquées par *L. israelensis* sp. n. voient la croissance de leurs racines stoppée, le départ de racines secondaires et l'apparition de renflements à l'extrémité des racines. Il en résulte des carottes déformées et divisées en plusieurs parties. Le nématode est généralement rencontré à des profondeurs du sol variant de 20 à 40 cm mais il peut migrer jusqu'à 40-100 cm de profondeur de façon à survivre pendant la période estivale chaude et sèche. © Orstom/Elsevier, Paris

**Keywords:** carrots, damage, Israel, *Longidorus*, nematode, new species.

Carrots (*Daucus carota* L.) growing in a field at Saad, Israel, had arrested root growth, alternative growth apices and root-tip galling. Specimens of a *Longidorus* species were recovered from soil collected from the rhizosphere of the diseased carrots. Examination of the nematodes revealed that they represented an undescribed species. This new *Longidorus* species is described here with information on its biology.

Soil samples were collected from an area of diseased carrots growing at Saad, Israel, at fortnightly intervals from November 1994 to April 1995. *Longidorus* nematodes were extracted by a decanting and sieving method from 100 g samples, heat killed, fixed in FA 4:1, processed to anhydrous glycerol and mounted on microscope slides.

### *Longidorus israelensis* sp.n. (Figs 1, 2)

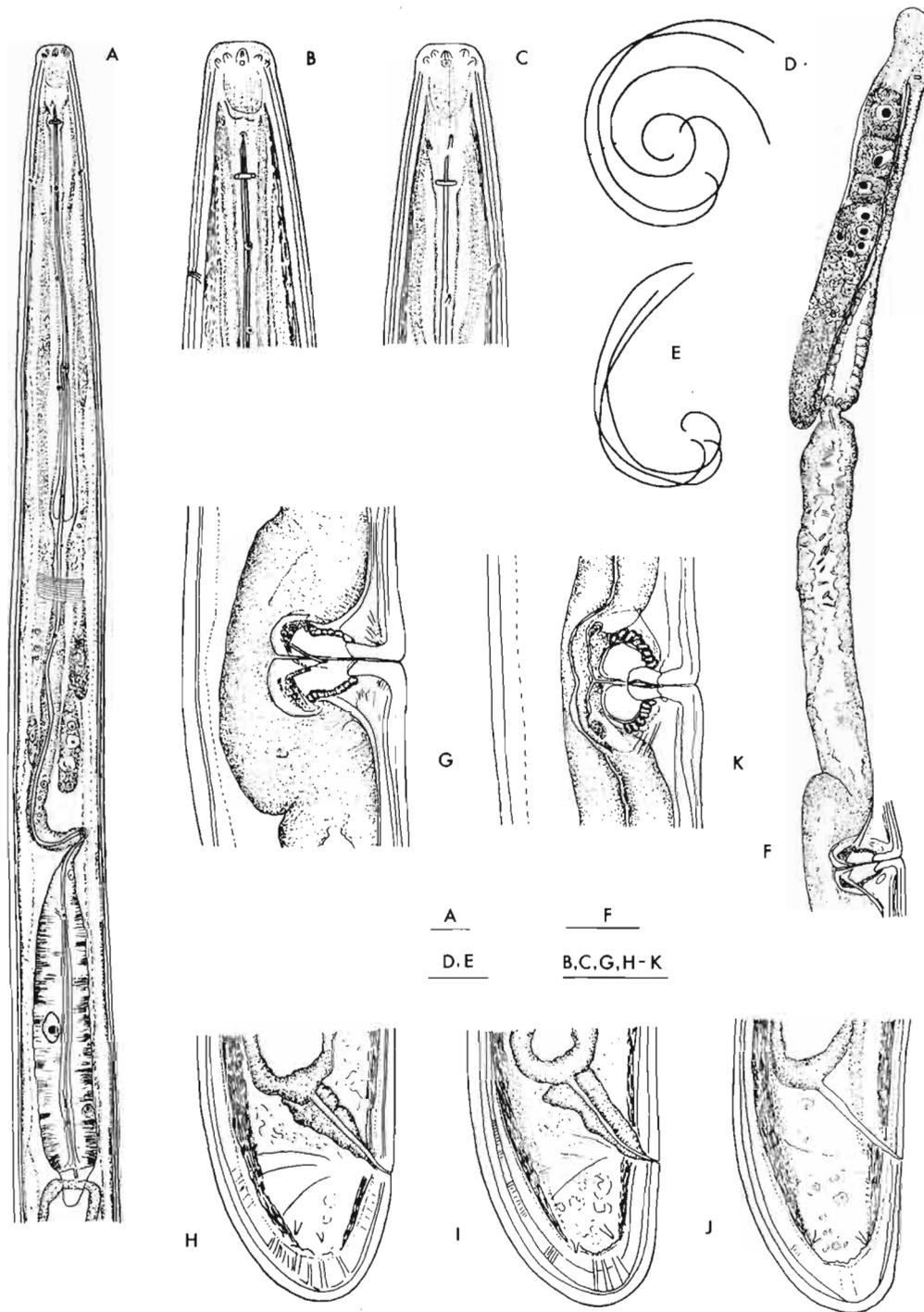
#### MEASUREMENTS

See Table 1.

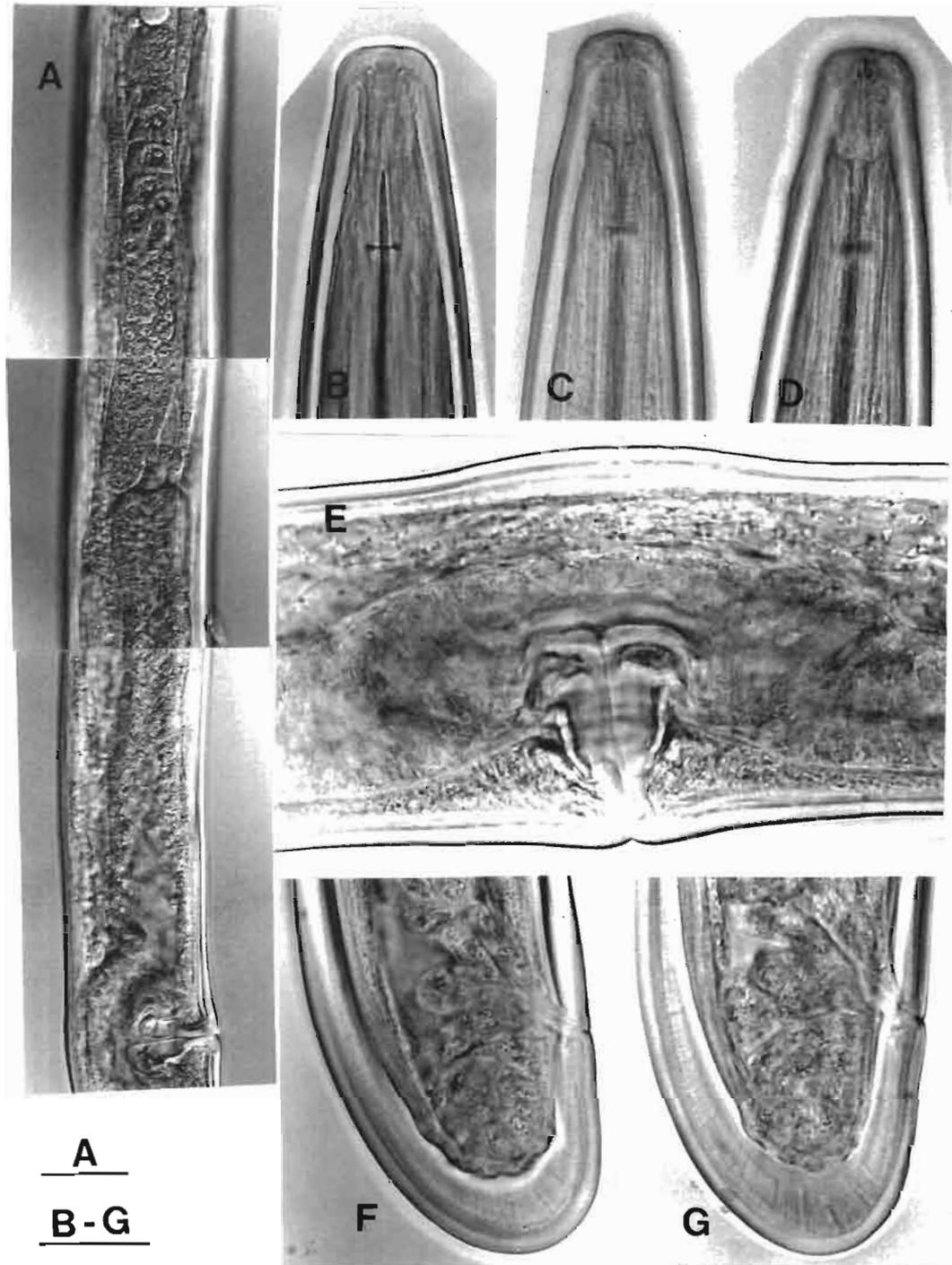
Corresponding author: D.J.F. Brown.

#### DESCRIPTION

*Female:* When heat relaxed, body assuming a C or spiral shape. Head region slightly expanded, anteriorly flat, rounded laterally, set-off by a shallow depression. Labial papillae prominent. Cuticle along the body 4-5  $\mu$ m thick. Hypodermal chord  $22.8 \pm 0.8$  (20-26)  $\mu$ m wide (n = 10). One lateral pore anterior to guide ring, two or three in the odontostyle and the odontophore regions; one dorsal and two ventral body pores posterior to the guide ring. Amphidial pouches large, extending to half the distance between anterior end and guide ring, not bilobed, occasionally a ventral enlargement observed. Muscular bulb slender, measuring  $26.1 \pm 1.8$  (23-29)  $\times$   $147.8 \pm 9.6$  (126-162)  $\mu$ m; oesophago-intestinal valve elongate, bluntly conoid. Nuclei of dorsal and subventral glands situated at 52 (49-54) % and 78 (75-80) % (n = 12); opening of the dorsal gland (DO) at 17-19 % (n = 5) and opening of the subventral glands (SVO) at 82-89 % (n = 6) of the distance from anterior end of oesophageal bulb, respectively. Dorsal gland nuclei 3  $\mu$ m diam. and subventral glands nuclei 2  $\mu$ m diam. Vulva a transverse slit, vagina extending to ca 1/2 corresponding body



**Fig. 1.** *Longidorus israelensis* sp.n. A-f: Female: A: Oesophageal region; B, C: Head region; D: Habitus; F: Anterior genital branch; C: Vaginal region; H, I: Tail ends; Juveniles, pre-adult stage: E: Habitus; f: Tail end. — *Longidorus proximus* Sturhan & Argo, 1983. Female: K: Vaginal region. (Scale bars: D, E = 1 mm; F = 40 μm; B, C, G, H-K = 30 μm; A = 20 μm).



**Fig. 2.** *Longidorus israelensis* sp.n. A: Genital branch; B-D: Female head region; E: Vulval region; F, G: Female tail end. (Scale bars: A = 40  $\mu$ m; B-G = 20  $\mu$ m).

**Table 1.** Measurements of the holotype and paratype females and pre-adult juveniles of *Longidorus israelensis* sp.n. from Israel (all measurements in  $\mu\text{m}$ , except L in mm).

	Holotype	Females	Pre-adult juveniles
n		15	6
L	9.07	8.17 $\pm$ 0.69 (7.07-9.07)	6.24 $\pm$ 0.52 (5.5-7.0)
a	120.9	115.4 $\pm$ 7.4 (99.1-124.7)	114.5 $\pm$ 7.1 (101.9-123.4)
b	16.0	14.1 $\pm$ 1.5 (12.2-16.8)	11.8 $\pm$ 1.1 (10.3-13.4)
c	227.7	199.3 $\pm$ 21.3 (163.4-228.7)	137.9 $\pm$ 1.1 (120.9-146.5)
c'	0.81	0.85 $\pm$ 0.07 (0.73-0.96)	1.0 $\pm$ 0.04 (0.93-1.06)
d*	2.92	2.8 $\pm$ 0.25 (2.22-3.38)	2.91 $\pm$ 0.08 (2.81-3.03)
d'***	1.62	1.53 $\pm$ 0.06 (1.41-1.62)	1.58 $\pm$ 0.07 (1.5-1.69)
V	51.5	50.3 $\pm$ 1.6 (48.2-54.1)	-
Odontostyle	132	129.6 $\pm$ 2.6 (125-135)	116.2 $\pm$ 3.9 (111-121)
Odontophore	76	76.3 $\pm$ 3.7 (67-82)	76.3 $\pm$ 2.02 (72.5-78)
Repl. odontostyle	-	-	131.8 $\pm$ 3.9 (127-135)
Tail	40	41.2 $\pm$ 2.7 (36-46)	45.3 $\pm$ 2.1 (41.5-47.5)
h	16	15.4 $\pm$ 1.2 (13-17)	13.8 $\pm$ 0.7 (13-14.5)
Anterior - guide ring	38	37.2 $\pm$ 0.8 (36-38)	33.5 $\pm$ 1.2 (32-35)
Oesophagus length	568	581.6 $\pm$ 46.2 (473-650)	530.7 $\pm$ 28.5 (499-574)
Anterior- nerve ring	273	251.8 $\pm$ 12.0 (232-273)	233.2 $\pm$ 5.6 (224-239)
Diam. in lip region	18.5	18.6 $\pm$ 0.3 (18-19)	16.2 $\pm$ 0.3 (16-16.5)
Diam. at guide ring	30	28.6 $\pm$ 0.99 (26-30)	25.5 $\pm$ 1.05 (24-27)
Diam. at oes. base	54	52.2 $\pm$ 4.4 (41-56)	47.1 $\pm$ 1.7 (45-50)
Diam. at mid-body	75	70.9 $\pm$ 4.7 (58-76)	50.1 $\pm$ 4.4 (53-59)
Diam. at anus	49.5	48.2 $\pm$ 3.0 (43.5-53)	45.3 $\pm$ 1.64 (43-48)
Diam. at beginning of J	37.6	35.3 $\pm$ 2.6 (31-39)	30.7 $\pm$ 1.9 (27-32)

\*d = Dist. ant. end to guide ring length / body diameter at lip region.

\*\*\* d' = Body diam. at guide ring / body diam. at lip region (Brown *et al.*, 1994).

diameter, or slightly more; *pars distalis vaginae* and moderately thick walled *pars proximalis vaginae* 16.5-20 and 17-22  $\mu\text{m}$  long, respectively. Uteri 228-294  $\mu\text{m}$  long, differentiated (ovjector present), thick walled, conspicuous lumen, filled with fusiform cells (possibly sperm ?), well developed sphincter between uterus and *pars dilatata* of oviduct. Prerectum  $439.5 \pm 121.5$  (271-683)  $\mu\text{m}$ , rectum about 0.7 (0.5-0.9) of body diameter at anus. Tail bluntly rounded, almost hemispherical, ventrally straight; two pairs of lateral pores present.

*Male*: Not found

*Juveniles*: Only pre-adult stage juvenile present. Similar to females except for the absence of developed reproductive system. Muscular bulb measuring  $137.3 \pm 7.0$  (126-144)  $\times$   $23.5 \pm 2.2$  (21-27)  $\mu\text{m}$  (n = 6). Nuclei of dorsal and subventral glands situated at 50.34 (47-54) % and 77.1 (73-81) % (n = 6); opening of the dorsal gland at 12-17% (n = 5); opening of the subventral glands at 84-89% (n = 6) of the distance from anterior end of oesophageal bulb, respectively. Prerectum  $365.2 \pm 51.0$  (308-427)  $\mu\text{m}$ , rectum about 0.7 (0.6-0.8) of body diameter at anus.

#### DIAGNOSIS AND RELATIONSHIPS

*Longidorus israelensis* sp.n. is characterised by its large body length, slightly expanded and anteriorly flattened head region, long odontostyle and short, almost hemispherical, tail, a somewhat unusual arrangement of the dorsal gland nuclei, and smaller size of the nucleoli.

These two latter features have previously been reported only for *L. closelongatus* Stoyanov 1964, *L. cohni* Heyns, 1969, *L. iranicus* Sturhan & Barooti, 1983 and *L. proximus* Sturhan & Argo, 1983. *Longidorus israelensis* sp.n. is readily distinguished from these four species by having a longer odontostyle 130 (125-135  $\mu\text{m}$ ) vs 114 (107-120)  $\mu\text{m}$  in *L. closelongatus*; vs 114 (102-112)  $\mu\text{m}$  in *L. cohni*; vs 112 (106-108)  $\mu\text{m}$  in *L. iranicus*; and vs 107 (102-117)  $\mu\text{m}$  in *L. proximus*.

Within this group, the new species is most similar to *L. proximus*, from which it can be distinguished by having a somewhat less expanded head region, differently shaped vagina (Fig. 1 G, K), thicker uterus, and no caecum-like extension of the oviduct (Robbins & Brown, 1996), here observed in all four *L. proximus* paratype specimens available for study, and previously referred to as the 'blind part of oviduct' by Sturhan and Argo (1983); higher d' value (1.53 [1.41-1.62] vs 1.2-1.4). From *L. closelongatus* and *L. cohni* the new species differs by tail shape and c' values (0.85 [0.73-0.95] vs 1.28-1.45 and 1.2-1.5, respectively); from *L. iranicus* it differs by the head region shape not being conical and by having a wider lip region (18-19 vs 15  $\mu\text{m}$ ). Also, the general morphology of *L. israelensis* sp.n. is similar to *L. paraelongatus* Altherr, 1974,

which was described from one female specimen and in which the oesophageal glands are not visible. However, *L. israelensis* sp.n. can be distinguished from *L. paraelongatus* by having a shorter odontostyle (140  $\mu\text{m}$  in *L. paraelongatus*) and lacking the peculiar woven-like striations on the neck and tail regions.

The code for identifying the new species when using the identification key of Chen *et al.* (1997) is: A-5, B-3, C-3, D-3, E-1, F-4, G-2, 3, H-1, I-1.

#### TYPE HOST AND LOCALITY

Specimens collected from the rhizosphere of carrots (*Daucus carota* L.) growing at Saad (31.28' N; 34.32'), Israel, May 1996, by D. Orion. Soil a sandy loess type (sand 49%; silt 32%; clay 19.5%).

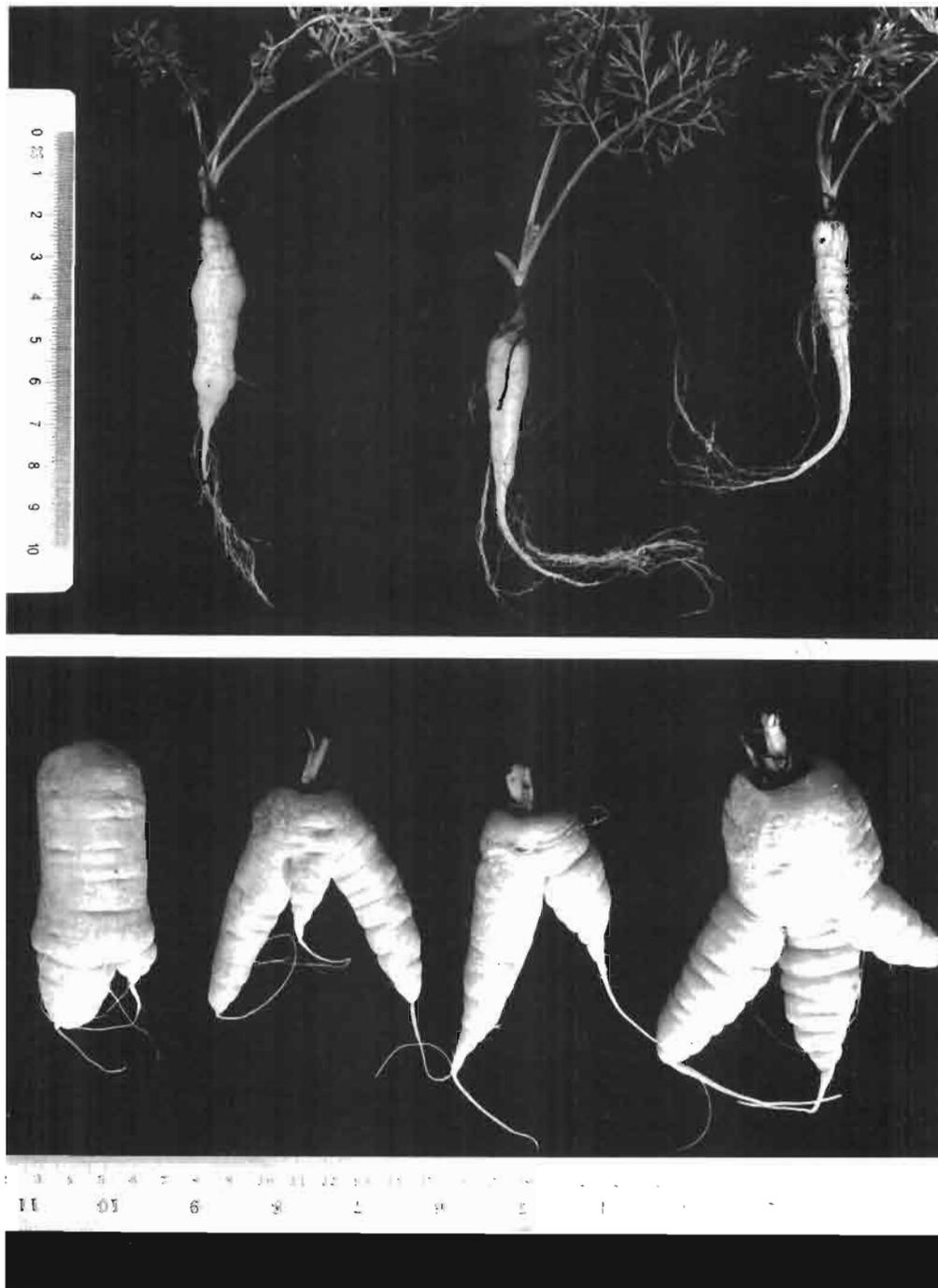
#### TYPE MATERIAL

Holotype and paratype females (two specimens) and juveniles (two specimens) deposited in the nematode collection of the International Institute of Parasitology, St. Albans, UK; one female and one juvenile paratype in the collection at the Muséum National d'Histoire Naturelle, Paris, France; one paratype female in the German Nematode Collection at the Nematology Institute, Münster, Germany; one female and one juvenile paratype in the collection at the Instituut for Dierkunde, Rijksuniversiteit, Gent, Belgium; two paratype females in the USDA Nematode Collection, Beltsville, Maryland; two paratype females in the Department of Nematology, University of California, Davis, USA; one paratype female and one juvenile in the collection of the Agricultural University, Wageningen, The Netherlands; two paratype females in the Department of Nematology, A.R.O., The Volcani Centre, Bet-Dagan, Israel; two paratype females and two paratype juveniles at the Central Laboratory of General Ecology, Sofia, Bulgaria.

#### Biology

Patches of stunted carrots growing in a field at Saad, Israel, exhibited short roots, alternative growth apices and root-tip galls resulting in deformed and split carrots (Fig. 3). Soil samples collected from the rhizosphere of the diseased carrots contained numerous plant parasitic nematodes, including specimens of a *Longidorus* species, here described as *L. israelensis* sp.n. The population dynamics of *L. israelensis* sp.n. was studied during the growing period of the carrots from November 1994 to April 1995. Samples from 20-60 cm depth were collected at fortnightly intervals during this period and the nematode population density was determined by counting the number of individuals recovered from 100 g soil samples.

Twenty days after germination of the carrot seed, the *L. israelensis* sp.n. population density was 30 specimens/100 g soil and increased steadily for a further



**Fig. 3.** Carrots grown at Saad, Israel, damaged by the feeding of *Longidorus israelensis* sp.n. Upper: Young carrots showing deformity, splitting and alternative growth apices; Down: Mature carrots showing major deformity resulting from the formation of alternative growth apices.

60 days when the population density reached its maximum, 70 specimens/100 g. Thereafter, the population density steadily declined to a minimum of 10 specimens/100 g at the harvesting of the carrots in April 1995. As only female and juvenile specimens were recovered from the samples it may be concluded that *L. israelensis* sp.n. probably has a parthenogenetic mode of reproduction. The ratio of juveniles to females increased steadily whilst the carrots were growing and reached a maximum of 3.6:1.0 at 80 days after carrot seed germination. Thereafter, the juvenile to female ratio declined steadily and reached 1.0:1.0 at the time of the carrot harvest.

The vertical distribution of *L. israelensis* sp.n. was examined by collecting soil samples from 0-20, 21-40, 41-60, 61-80 and 81-100 cm depths on three occasions: 13th August, 7th September, and 8th November 1994. On the first sampling date the nematodes were recovered from 21-60 cm depth, whereas, on the other two sampling dates, the nematodes were present only in samples from 21-100 cm depth. Therefore, it is concluded that *L. israelensis* sp.n. actively migrate to deeper, cooler, more moist, soil layers during the hot, dry period and return to the upper soil layers during the wetter and cooler period of the year.

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