

A Survey of the Nematodes Attacking Crops in Thailand
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A Survey of the Nematodes Attacking Crops in Thailand

I. Genus *Helicotylenchus* STEINER, 1945*

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Eight species of the genus *Helicotylenchus* found from crop fields in Thailand are measured, described and illustrated as follows: *H. abunaamai*, *H. certus*, *H. crenacauda*, *H. dihystra*, *H. egyptiensis*, *H. indicus*, and 2 unidentified species. Variability of the characters observed in the Thai specimens are remarked. This is the first record for *H. certus* in Thailand. *Jpn. J. Nematol.* 22: 26-36 (1992).

Key words: spiral nematode, identification, morphology, variability.

This is a partial report on the preliminary survey of the plant parasitic nematodes in Thailand, which has been conducted as a subsidiary research of the "Prevention of crop damage caused by nematodes in Thailand" carried out under the joint research program between Japan and Thailand. Partial results of this report were obtained in the Department of Agriculture, Ministry of Agriculture and Cooperative, Thailand, during a period from March 18 to April 30, 1990.

This part of the report deals with the genus *Helicotylenchus* STEINER, 1945. Since the early survey of the genus in Thailand²²⁾, 16 species have been identified so far by the Thai nematologists, i.e., *H. abunaamai*^{2, 11, 12, 13)}, *H. cavenessi*^{11, 12, 13)}, *H. crenacauda*¹⁰⁾, *H. densibulatus*¹³⁾, *H. digitatus*^{2, 12, 13)}, *H. digonicus*^{11, 13)}, *H. dihystra*^{11, 12, 13)}, *H. egyptiensis*^{10, 12)}, *H. exallus*¹³⁾, *H. indicus*²⁾, *H. microdorus*²⁾, *H. microcephalus*¹³⁾, *H. multicinctus*^{12, 13)}, *H. pseudorobustus*¹⁰⁾, *H. retusus*^{12, 13)} and *H. rotundicauda*^{12, 13)}, along with 3 unidentified species^{7, 10)}. All these species were those identified according to the either keys devised by SHER¹⁵⁾ or SIDDIQI¹⁷⁾.

Specimens in this survey were identified by accepting the FORTUNER's selection of reliable characters⁶⁾. This genus is large enough to have 176 nominal species as listed by FORTUNER⁶⁾ and the species show vast variability of the characters^{5, 6)}, resulting in one of the difficult genus to be identified at species level. However, FORTUNER found that only 10 characters were usable to identify the *Helicotylenchus* spp.⁶⁾, and 9 characters of them were adopted by BOAG & JAIRAJPURI to produce compendium of 154 nominal species¹⁾.

Specimens from Thailand identified as nominal species have shown some deviation even in those reliable characters. No taxonomic consideration on such species are attempted herein, but are left for another report. Measurements, descriptions and partial illustrations of the species found in Thailand are given as follows.

*Cooperative investigation by the Tropical Agriculture Research Center (TARC), Japan, and Department of Agriculture (DOA), Thailand.

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MATERIALS AND METHODS

Field sampling was made mainly in the crop fields at such locations as Bangkok, Chiagn Mai, Chiagn Rai, Saraburi and Nakhon Ratchasima. A soil sample taken from Nakhon Sawan and maintained in the greenhouse to culture nematodes was also examined. Sixty-nine soil samples were collected from the rhizosphere of various plants of economic importance, including ornamental crops and medical herbs. Nematodes were extracted by the sieving and centrifugal flotation using sucrose, killed by gentle heating (at 60°C), fixed by cold TAF, processed in lactophenol and mounted in lactophenol for observation and measurement.

RESULTS

Helicotylenchus abunaamai SIDDIQI, 1972

(Fig. 1 A-J)

Measurements (females): Col. no. 5 (n=4): L=469-622 μm (561 ± 68 ; mean \pm SD); a=21.0-24.6 (23.3 ± 1.64); b=5.4-6.9 (6.2 ± 0.71); b'=3.7-4.9 (4.3 ± 0.55); c=35.5-40.9 (38.7 ± 2.55); c'=1.0-1.2 (1.1 ± 0.06); V=61.6-64.6% (63.7 ± 1.38); spear=22.8-24.0 μm (23.3 ± 0.56); m=47.4-51.7% (48.9 ± 1.90); dorsal gland orifice from spear knob base (DGO)=8.8-10.4 μm (9.6 ± 0.7); O=38.6-44.8% (41.2 ± 2.7); excretory pore from anterior end (EXPORE)=94-99 μm (97 ± 3.3); esophagus=87-95 μm (91 ± 3.3); length of basal esophageal gland overlapping intestine (OVLBEG)=36-41 μm (39 ± 2.1); VL=303-385 μm (357 ± 38.1); vulva-anus=153-223 μm (190 ± 2.99); tail=13.2-16.0 μm (14.5 ± 1.32); Tail/V-a=6.8-8.6% (7.7 ± 0.77); annule width at mid-body (annule)=1.0-1.7 μm (1.4 ± 0.33).

Measurements (females): Col. no. 8 (n=5): L=568-605 μm (585 ± 13); a=21.0-27.0 (24.5 ± 2.16); b=5.2-6.3 (5.9: n=3); b'=4.4-4.6 (4.5: n=3); c=36.8-42.0 (38.8 ± 2.29); c'=1.0-1.3 (1.2 ± 0.11); V=61.9-63.2% (62.5 ± 0.60); spear=22.0-23.2 μm (23.0 ± 0.54); m=44.8-49.1% (46.7 ± 1.95); DGO=8.8-10.4 μm (9.5 ± 0.8); O=36.2-44.8% (41.5 ± 3.8); EXPORE=94-102 μm (97 ± 3.3); esophagus=94-109 μm (100: n=3); OVLBEG=18-40 μm (31: n=3); VL=352-382 μm (366 ± 11.4); vulva-anus=201-208 μm (204 ± 3.1); tail=14.4-16.0 μm (15.1 ± 0.72); Tail/V-a=6.9-7.9% (7.4 ± 0.41); annule=1.3-1.4 μm (n=2).

Col. no. 11 (n=3: most measurements are based on 2 females unless otherwise stated): L=549-573 μm ; a=21.7-23.7; b=5.7-5.9; b'=4.4-4.6; c=39.8-42.9; c'=1.1; V=63.0-63.8%; spear=22.4-23.2 μm (22.9: n=3); m=46.4-48.3% (47.7: n=3); DGO=9.6-10.4 μm (9.9: n=3); O=41.4-44.8% (43.0: n=3); EXPORE=97-98 μm ; esophagus=94-100 μm ; OVLBEG=25-32 μm ; VL=346-366 μm ; vulva-anus=190-193 μm ; tail=12.8-14.4 μm ; Tail/V-a=6.7-7.5%; annule=1.2-1.3 μm .

Col. no. 12 (n=3: most measurements are based on 2 females unless otherwise stated): L=531-550 μm ; a=24.6-25.0; b=5.5 (n=1); b'=4.5 (n=1); c=37.2-37.9; c'=1.1-1.3; V=62.2-63.0%; spear=21.6-24.0 μm (22.7: n=3); m=46.6-48.3% (47.7: n=3); DGO=7.6-10.4 μm (8.9: n=3); O=32.8-44.8% (38.5: n=3); EXPORE=95 μm (n=1); esophagus=96 μm (n=1); OVLBEG=21 μm (n=1); VL=330-346 μm ; vulva-anus=186-189 μm ; tail=14.0-14.8 μm ; Tail/V-a=7.5-7.8%; annule=1.2-1.3 μm .

Col. no. 24 (n=4): L=517-651 μm (594 ± 61.6); a=19.6-27.5 (25.0 ± 3.68); b=5.6-7.5 (6.6 ± 0.92); b'=4.4-4.9 (4.7 ± 0.19); c=37.0-44.2 (39.2 ± 3.33); c'=0.9-1.3 (1.1 ± 0.15); V=61.9-63.8% (63.1 ± 0.83); spear=21.6-24.8 μm (23.0 ± 1.37); m=48.1-53.2% (50.3 ± 2.11); DGO=7.6-9.2 μm (8.4 ± 0.7); O=35.2-37.9% (36.5 ± 1.3); EXPORE=94-109 μm (99 ± 6.9); esophagus=85-94 μm (90 ± 4.2); OVLBEG=25-48 μm (37 ± 11.7); VL=328-412 μm (375 ± 40.3); vulva-anus=176-221 μm (204 ± 20.3); tail=13.6-17.6 μm (15.2 ± 1.73); Tail/V-a=6.7-7.9% (7.5 ± 0.56); annule=1.0-1.4 μm (1.2 ± 0.17).

Col. no. 40 (n=1): L=600 μm ; a=19.2; b=4.6; b'=3.9; c=38.5; c'=1.0; V=62.7%; spear=23.2 μm ; m=50.0%; DGO=9.6 μm ; O=41.4%; EXPORE=104 μm ; esophagus=130 μm ; OVL-

BEG=26 μm ; VL=376 μm ; vulva-anus=208 μm ; tail=15.6 μm ; Tail/V-a=7.5%; annule=1.2 μm .

Morphology: *Females* ($n=22$: 4, 5, 6, 6, 4 & 2 females in col. nos. 5, 8, 11, 12, 24 & 40, respectively): Body forming 1 to 1.5 spirals (1-1.5, 1-1.5, 1-1.25, 1.25-1.5, 1.5 and 1 in col. nos. 5, 8, 11, 12, 24 and 40, respectively) when killed by gentle heating. Head hemispherical and continuous to body contour with 4-5 annuli. Anterior margin of spear knobs flattened or concave, very rarely sloping posteriorly (col. no. 5: 1 female). Hemizonid 2 annuli long, level with or 0-1.5 annuli anterior to excretory pore; hemizonion 12 annuli (col. no. 5: 1 female) or 6-11 annuli (col. no. 24) posterior to excretory pore. Lateral vulval membranes inconspicuous (col. no. 5), when observed, 2.4-4.3 μm (col. no. 12) or 3 μm (col. no. 24) long. Spermatheca empty, rounded, offset from ovary. Tails generally less convex dorsally, nearly straight ventrally (col. nos. 5 & 12); they even taper ventrally as well as dorsally to the tips (col. no. 24: Fig. 1F, G); tips bluntly rounded or pointed (col. no. 5), more or less broadly protruded (col. no. 12), or pointed and annulated (col. no. 24), no sharply pointed small projection observed; ventral surface with 8-11 annuli (8-11, 9-11, 8-10, 8-10, 9-11 and 10 in col. nos. 5, 8, 11, 12, 24 and 40, respectively). Inner incisures of lateral fields fuse between anterior 1/3 the length of tail and the end of the fields. In specimens from col. no. 24, lateral fields at tail region, closely approaching at the dorsal edge of tail (Fig. 1F, G). Caudalid not seen. Phasmids 8-0 annuli (6-2, 8-2, 7-2, 8-0 (mostly 5-2), 4-1 and 6-3 in col. nos. 5, 8, 11, 12, 24 and 40, respectively) anterior to anus.

Male: Not found.

Host plants and localities: Clove tree (*Eugenia caryophyllus* BULLOEK et HARRISON), Bangkok (col. no. 5); *Ptyrocarpus indicus* WILLD, Bangkok (col. no. 8); Indian Brasil Wood (*Caesalpinia sappan* L.), Bangkok (col. no. 11); Mulberry (*Morus alba* L.), Bangkok (col. no. 12); Mango (*Mangifera indica* L.), Nakhon Ratchasima (col. no. 24); Maize (*Zea mays* L.), Chiagn Mai (col. no. 40).

Remarks: All the specimens observed can also be taken as *H. dihystra* (COBB, 1893), considering the wide variability in the many characters of the latter⁶⁾. Nevertheless, these are identified as *H. abunaamai*, since there exist distinct gaps in the spear length, c-value and tail morphology between populations identified as *H. abunaamai* and those identified as *H. dihystra*.

Helicotylenchus certus EROSHENKO & THANH, 1981

(Fig. 1 K-T)

Measurements (females): Col. no. 68 ($n=8$): L=621-743 μm (696 \pm 39.9); a=22.7-25.0 (23.8 \pm 0.83); b=4.9-6.0 (5.6 \pm 0.36); b'=4.0-4.7 (4.4 \pm 0.20); c=34.4-45.3 (39.7 \pm 3.84); c'=1.1-1.5 (1.3 \pm 0.12); V=60.3-62.9% (61.5 \pm 0.86); spear=24.4-28.4 μm (25.7 \pm 1.22); m=47.6-53.5% (49.3 \pm 1.81); DGO=11.2-14.8 μm (13.3 \pm 1.3); O=44.4-57.8% (51.5 \pm 5.3); G1=17.9-21.5% (19.7 \pm 1.45); G2=16.8-19.5% (18.4 \pm 1.0); EXPORE=110-120 μm (115 \pm 3.5); esophagus=121-131 μm (125 \pm 3.5); OVL-BEG=24-46 μm (34 \pm 7.9); VL=384-449 μm (428 \pm 21.9); vulva-anus=222-278 μm (251 \pm 19.0); tail=15.2-20.0 μm (17.7 \pm 1.66); Tail/V-a=5.9-8.3% (7.1 \pm 0.78); annule=1.3-1.8 μm (1.5 \pm 0.17).

Col. no. 69 ($n=8$): L=644-734 μm (696 \pm 33.4); a=21.8-27.5 (24.3 \pm 2.11); b=5.5-6.6 (6.1 \pm 0.41); b'=4.3-4.8 (4.6 \pm 0.21); c=29.8-51.6 (41.7 \pm 7.07); c'=0.9-1.5 (1.1 \pm 0.19); V=59.1-62.4% (60.9 \pm 1.18); spear=25.6-28.0 μm (26.7 \pm 0.74); m=46.2-48.6% (47.3 \pm 0.92); DGO=10.0-12.0 μm (10.9 \pm 0.8); O=37.1-46.9% (41.0 \pm 3.6); EXPORE=105-119 μm (113 \pm 3.9); esophagus=107-126 μm (114 \pm 5.81); OVL-BEG=32-48 μm (37 \pm 5.1); VL=393-444 μm (424 \pm 19.9); vulva-anus=230-281 μm (255 \pm 17.3); tail=13.6-21.6 μm (17.1 \pm 2.87); Tail/V-a=5.4-9.4% (6.7 \pm 1.32); annule=1.4-1.9 μm (1.6 \pm 0.15).

Morphology: *Females* ($n=16$): Body forming 1 to 1.25 spirals in col. no. 68 and generally 1.5 spirals in col. no. 69 (varying from 1.25 to 2) spirals when killed by gentle heating. Lip region truncate, continuous to the body contour (in col. no. 68) or slightly offset (in col. no. 69), with 4 (varying from 3 to 5) indistinct annuli. Anterior margin of spear knobs sloping backward.

Hemizonid 1-2 annuli long, 0-1 annuli anterior to excretory pore; hemizonion 4-7 annuli (in col. no. 68) or 6-8 annuli (in col. no. 69) posterior to excretory pore. Vulval slit fringed with lateral membranes of 4-6 μm (in col. no. 68) or 3-5 μm (in col. no. 69) long. Spermatheca empty, offset. Tail convex dorsally, ventral surface with 8-11 annuli ending exclusively in sharply pointed, short (2 μm long) projection in specimens from col. no. 68 (Fig. 1M, N), though much variation occurs in the specimens from col. no. 69, where the small rounded lobes (3 females: Fig. 1R), sharp and long projection (2 females: Fig. 1O), sharp and short projection (3 females: Fig. 1P) and entirely rounded tail (1 female: Fig. 1Q) are observed. Inner incisures of lateral fields completely separated up to the end of the lateral field. Caudalid not seen. Phasmids from 5 annuli anterior to 1 annule posterior to anus (4-2 annuli anterior to anus in col. no. 68).

Male: Unknown.

Host plants and localities: Maize (*Zea mays* L.), Phuraphattabad (Saraburi Province) (col. no. 68); Cotton (*Gossypium* sp.), Nakhon Sawan (col. no. 69).

Remarks: The present specimens differ from the Vietnamese population⁴⁾ in the longer body (621-743 μm vs. 590-650 μm), longer spear (24.4-28.4 μm vs. 23-25 μm) and somewhat anterior vulva (V=59-63% vs. 61-65%), but are consistent in other characters.

Helicotylenchus crenacauda SHER, 1966

(Fig. 1 U-Y)

Measurements (females): Col. no. 7 ($n=1$): L=608 μm ; a=19.0; b=5.8; b'=4.7; c=33.1; c'=1.2; V=64.5%; spear=25.6 μm ; m=46.9%; DGO=8.0 μm ; O=31.3%; EXPORE=98 μm ; esophagus=105 μm ; OVLBEG=25 μm ; VL=393 μm ; vulva-anus=198 μm ; tail=18.4 μm ; Tail/V-a=9.3%; annule=1.4 μm .

Col. no. 19 ($n=3$): L=588-681 μm (629); a=20.9-21.8 (21.2); b=5.2-6.1 (5.8); b'=4.1-4.9 (4.6); c=40.5-42.9 (41.4); c'=1.0-1.1 (1.0); V=63.3-64.8% (64.2); spear=24.8-27.2 μm (25.6); m=42.6-45.2% (43.8); DGO=7.6-8.8 μm (8.1); O=27.9-35.5% (31.9); EXPORE=94-98 μm (96); esophagus=104-113 μm (109); OVLBEG=26-31 μm (28); VL=379-431 μm (404); vulva-anus=194-233 μm (210); tail=14.4-16.8 μm (15.2); Tail/V-a=7.1-7.4% (7.2); annule=1.3-1.4 μm (1.4).

Col. no. 40 ($n=2$): L=641-679 μm ; a=19.5-20.2; b=5.7 ($n=1$); b'=4.7 ($n=1$); c=41.4-42.2; c'=1.0; V=62.4-62.7%; spear=26.0-26.8 μm ; m=46.3-49.2%; DGO=8.0-9.6 μm ; O=30.8-36.9%; EXPORE=98-106 μm ; esophagus=113 μm ($n=1$); OVLBEG=24 μm ($n=1$); VL=402-424 μm ; vulva-anus=224-239 μm ; tail=15.2-16.4 μm ; Tail/V-a=6.8-6.9%; annule=1.1-1.4 μm .

Morphology: Females ($n=8$): Body forming 1.5 to 1.75 spirals when killed by gentle heating. Lip region hemispherical, slightly continuous with or offset from body contour, with 4-5 annuli. Anterior margin of spear knobs slightly sloping backward or flattened anteriorly. Hemizonid 2 annuli long, level with or immediately anterior to excretory pore; hemizonion 0.5 annule long, 9 annuli posterior to excretory pore (2 females). Lateral vulval membrane inconspicuous. Spermatheca empty, rounded and offset from ovary. Tail convex dorsally, concave at middle, protruded ventrally by a narrow outgrowth, which has tapering and dorsally serrated tip; cuticular folds on tip in varying development (Fig. 1W-Y); 8-10 annuli present on ventral surface excluding serrated outgrowth. Inner incisures of lateral fields fuse in a posterior third of tail. Caudalid not seen. Phasmids 5-12 annuli anterior to anus.

Male: Not found.

Host plants and localities: Mangosteen (*Garcinia mangostana* (L.)), Bangkok (col. no. 19); *Hydrocarpus anthelminthica* PIERRE, Bangkok (col. no. 7); Maize (*Zea mays* L.), Chiagn Mai (col. no. 40).

Remarks: General measurements of the specimens are consistent with those given by SHER¹⁵⁾ for an Indonesian population. However, a difference exists on tail end: presence of the cuticular fold, which was described in *H. pteracercus* S. D. SINGH, 1971¹⁹⁾ and *H. parafteracercus* SULTAN,

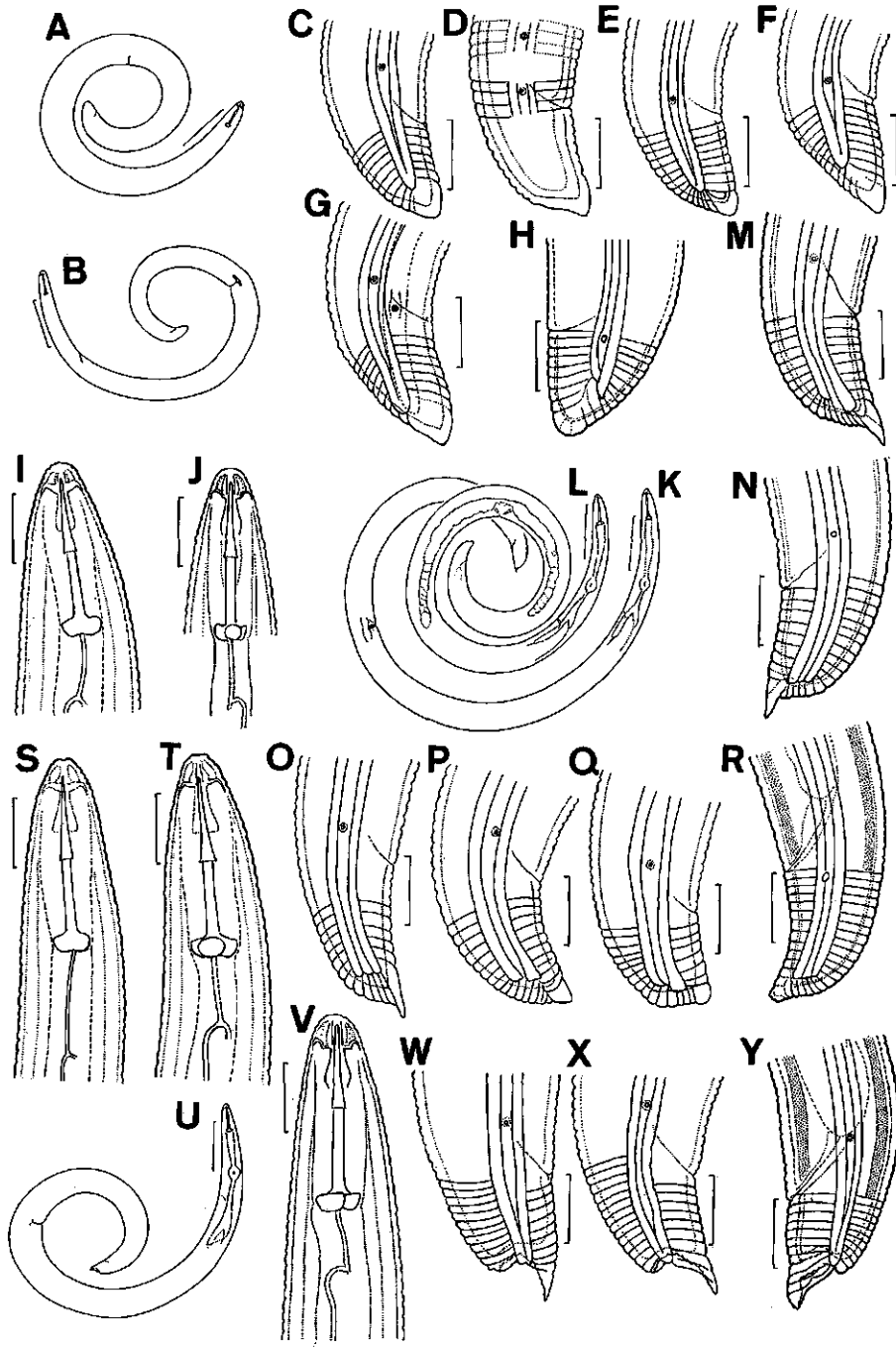


Fig. 1. A-J: *Helicotylenchus abunaamai* SIDDIQI, females; B-D: col. no. 5; E: col. no. 12; A, F-J: col. no. 24. K-T: *H. certus* EROSHENKO & THANH, females; K, M, N & S: col. no. 68; L, O-R & T: col. no. 69. U-Y: *H. crenacauda* SHER, females; U-W & Y: col. no. 19; X: col. no. 7. Scale bars: general views: 50 μ m; parts: 10 μ m.

1981²⁰⁾. From *H. pteracercus* in the original description¹⁹⁾, the present specimens differ by the longer spear (25-28 μm vs. 23-25 μm), fewer tail annuli (8-10 vs. 10-15) and anterior phasmids (5-12 annuli anterior to anus vs. 2 annuli anterior to and 3 annuli posterior to anus). However, from *H. parapteracercus*²⁰⁾, the present specimens are not specifically separated but are distinguished only by such uncritical characters as the number of lip annuli (4-5 vs. 5-6), shape of spear knobs (sloping posteriorly vs. indented), manner of termination of inner lateral lines (fused at posterior third of tail vs. fused at the very end of lateral fields). Further, SULTAN's illustration of a tail (in his Fig. 2G) did not show any trace of cuticular fold²⁰⁾, which suggests that cuticular folds in his population showed variable developmental degrees as in Thai populations. These suggest that SULTAN's population and our population are conspecific and both can be identified as *H. crenacauda*.

Helicotylenchus dihystra (COBB, 1893) SHER, 1961

(Fig. 2 A-D)

Measurements (females): Col. no. 9 (n=3): L=617-646 μm (636); a=20.3-25.6 (23.2); b=6.2 (n=1); b'=4.1 (n=1); c=44.7-47.5 (45.9); c'=0.9-1.0 (1.0); V=61.9-64.8% (63.1); spear=25.6-27.2 μm (26.0 \pm 0.62; n=6); m=50.0% (n=1); DGO=10.4-10.8 μm (10.5); O=38.8-41.9% (40.8); EXPORE=98-105 μm (102); esophagus=100 μm (n=1); OVLBEG=50 μm (n=1); VL=382-418 μm (401); vulva-anus=212-228 μm (221); tail=13.6-14.4 μm (13.9); Tail/V-a=6.0-6.8% (6.3); annule=1.4 μm (n=1).

Col. no. 31 (n=1): L=673 μm ; a=19.1; b=6.0; b'=4.6; c=49.5; c'=0.8; V=61.6%; spear=26.0 μm ; m=49.2% (n=3); DGO=13.2 μm ; O=50.8%; EXPORE=110 μm ; esophagus=113 μm ; OVLBEG=24-43 μm ; VL=414 μm ; vulva-anus=245 μm ; tail=13.6 μm ; Tail/V-a=5.6%; annule=1.6 μm .

Col. no. 59 (n=3; most measurements are based on 2 females unless otherwise stated): L=753-823 μm ; a=21.4-22.4; b=6.0-6.2; b'=5.0-5.3; c=44.7-49.5; c'=0.8-1.1; V=64.0-64.4%; spear=26.0-26.8 μm (26.4; n=3); m=46.3-48.5%; DGO=13.6-15.2 μm ; O=51.5-58.5%; EXPORE=113-126 μm ; esophagus=125-133 μm ; OVLBEG=22-26 μm ; VL=482-530 μm ; vulva-anus=256-274 μm ; tail=15.2-18.4 μm ; Tail/V-a=5.9-6.7%; annule=1.7-1.8 μm .

Morphology: Females (n=9): Body forming 1.25 to 2.25 (1.75 in 4 females) spirals when killed by gentle heating. Lip region hemispherical continuous to body contour with 4-5 annuli. Anterior margin of spear knobs more or less concave. Hemizonion 2 annuli long, 1 annule anterior or immediately anterior to excretory pore; hemizonid inconspicuous. Lateral vulval membrane 3.2-4.0 μm long. Spermatheca empty, rounded and offset from ovary. Tail convex dorsally, nearly straight ventrally, with 8-11 annuli; variations are observed in ventral tip, which is not protruded or protruded as a short rounded lobe or a sharply pointed short projection. Inner incisures of lateral fields fuse at posterior third of tail or fuse at only distal margin of the fields. Caudalid not seen. Phasmids 6-13 (mostly 8-11) annuli anterior to anus.

Male: Not found.

Host plants and localities: Egg plant (*Solanum melongana* L.), Chiagn Rai (col. no. 59); *Stemona tuberos* LOUR, Bangkok (col. no. 9); *Canna generalis* BAILEY, Nakhon Ratchasima (col. no. 31).

Remarks: Populations described above show typical character-states of *H. dihystra* in the spear of 26-27 μm long and phasmids at 6-13 annuli anterior to anus, although these characters would have more wide range in this species⁶⁾.

Helicotylenchus egyptiensis TARJAN, 1964

(Fig. 2 E-I)

Measurements (females): Col. no. 29 (n=6): L=608-702 μm (642 \pm 34.1); a=21.7-28.3 (25.1

± 2.42); $b=4.8-6.9$ (5.9 ± 0.80); $b'=4.0-4.6$ (4.4 ± 0.20); $c=34.4-44.3$ (39.7 ± 3.27); $c'=0.9-1.4$ (1.2 ± 0.15); $V=61.1-62.5\%$ (62.0 ± 0.57); $spear=25.6-27.2 \mu m$ (26.5 ± 0.60); $m=47.7-50.0\%$ (49.2 ± 0.84); $DGO=10.4-12.8 \mu m$ (12.0 ± 1.0); $O=38.2-49.2\%$ (45.4 ± 4.3); $EXPORE=96-112 \mu m$ (104 ± 5.6); $esophagus=92-132 \mu m$ (110 ± 13.1); $OVLBEG=21-52 \mu m$ (37 ± 12.9); $VL=380-437 \mu m$ (398 ± 20.8); $vulva-anus=213-246 \mu m$ (228 ± 13.0); $tail=14.4-18.4 \mu m$ (16.3 ± 1.73); $Tail/V-a=6.3-8.2\%$ (7.1 ± 0.63); $annule=1.4-1.8 \mu m$ (1.6 ± 0.15).

Morphology: Females ($n=6$): Body forming 1.25-1.5 (5 females) to 2.0 (1 female: Fig. 2E) spirals when killed by gentle heating. Lip region truncate, continuous to body contour, with 5 annuli. Anterior margin of spear knobs flattened (5 females) or sloping posteriorly (1 female). Hemizonid not seen; hemizonion 8 annuli posterior to excretory pore (1 female). Vulval slit fringed laterally with 3-4 μm membranes. Spermatheca oval, filled with irregular bodies (spermatozoa?) (4 females). Tail convex dorsally, with a short bluntly pointed projection ventrally; ventral surface with 9-12 annuli. Inner incisures of lateral fields fuse at the end of lateral fields. Caudalid not seen. Phasmids between 3 annuli anterior to anus and 2 annuli posterior to anus.

Males: Not found.

Host plant and locality: Cassava (*Manihot esculenta* CRENTZ), Bangkok.

Remarks: Present specimens differ from the original description of the species²¹⁾ in the shorter body (608-702 μm vs. 690-850 μm), shorter tail ($c=34-44$ vs. 25-33), slightly posterior vulva ($V=61-63\%$ vs. 59-62%) and slightly posterior position of phasmids (between 3 annuli anterior and 2 annuli posterior to anus vs. 5-0 annuli anterior to anus). However, VAN DEN BERG & KIRBY²³⁾ and BOAG & JAIRAJPURI¹⁾ bestowed the wide variability of the characters to this species, which encompasses the dimensions of the present specimens.

Helicotylenchus indicus SIDDIQI, 1963

(Fig. 2 J-O)

Measurements (females): Col. no. 2 ($n=5$): $L=585-628 \mu m$ (602 ± 21.3); $a=23.1-25.4$ (24.0 ± 0.95); $b=6.0-7.4$ (6.5 ± 0.64); $b'=4.5-5.3$ (4.9 ± 0.40); $c=30.6-35.7$ (32.8 ± 2.53); $c'=1.3-1.5$ (1.4 ± 0.07); $V=61.5-63.6\%$ (62.7 ± 0.84); $spear=20.8-21.6 \mu m$ (21.3 ± 0.44); $m=46.3-50.0\%$ (48.1 ± 2.62); $DGO=10.4-11.2 \mu m$ (10.9 ; $n=3$); $O=50-52\%$ (50 ; $n=3$); $G1=18.2-19.4\%$ ($n=2$); $G2=16.7-16.9\%$ ($n=2$); $EXPORE=79-98 \mu m$ (90 ± 7.7); $esophagus=79-102 \mu m$ (93 ± 9.8); $OVLBEG=18-36 \mu m$ (30 ± 7.8); $VL=367-388 \mu m$ (378 ± 9.1); $vulva-anus=194-224 \mu m$ (206 ± 13.5); $tail=17.6-19.2 \mu m$ (18.4 ± 0.80); $Tail/V-a=7.9-9.9\%$ (9.0 ± 0.94); $annule=1.4-1.7 \mu m$ (1.5 ; $n=3$).

Col. no. 10 ($n=9$): $L=490-639 \mu m$ (579 ± 48.5); $a=19.8-25.8$ (23.5 ± 1.86); $b=5.3-6.5$ (6.0 ± 0.41 ; $n=6$); $b'=4.0-4.8$ (4.5 ± 0.30 ; $n=6$); $c=33.9-46.4$ (38.7 ± 3.80); $c'=1.0-1.4$ (1.2 ± 0.14); $V=61.1-64.6\%$ (62.5 ± 1.16); $spear=20.4-22.8 \mu m$ (21.4 ± 0.85); $m=47.4-51.8\%$ (50.1 ± 1.63); $DGO=8.8-12.0 \mu m$ (10.4 ± 0.90); $O=42.3-57.7\%$ (49.0 ± 5.08); $EXPORE=90-103 \mu m$ (95 ± 3.7); $esophagus=89-102 \mu m$ (96 ± 5.2); $OVLBEG=24-36 \mu m$ (30 ± 4.3); $VL=317-390 \mu m$ (362 ± 24.5); $vulva-anus=160-232 \mu m$ (202 ± 23.2); $tail=12.8-18.4 \mu m$ (15.1 ± 1.67); $Tail/V-a=6.2-8.8\%$ (7.5 ± 0.86); $annule=1.1-1.4 \mu m$ (1.3 ± 0.09).

Morphology: Females: Body forming 1 to 1.25 spirals. Lip region truncate, continuous to body contour with 4-5 distinct annuli. Anterior margin of spear knobs flattened or sloping posteriorly, never concave. Hemizonid immediately anterior to excretory pore, 2 annuli long (1 female); hemizonion not seen. Spermatheca empty. Tail end truncate, curving dorsally, straight ventrally and bluntly rounded in tip (col. no. 10: Fig. 2N) or concave ventrally, convex dorsally and concave at middle resulting in short, broad ventral tip (col. no. 2: Fig. 2L, M); the latter state is also observed in col. no. 10 as a variation; fine striations in dorsal concave or straight section in all the specimens; 10-17 annuli (13-17 in col. no. 2; 10-15 in col. no. 10) on tail ventrally and mostly fully annulated to the tip. Inner incisures of lateral fields fuse closely before end of lateral

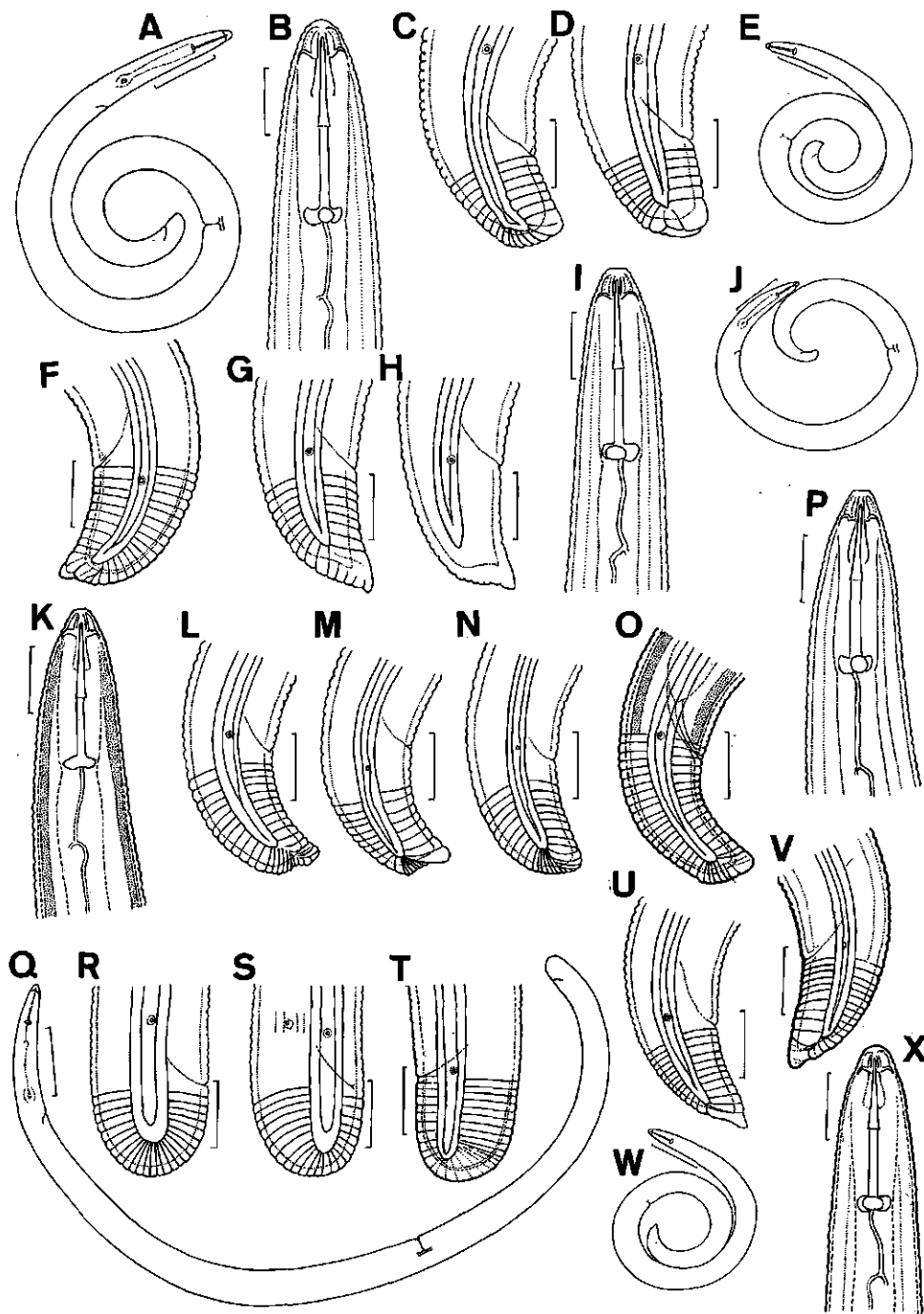


Fig. 2. A-D: *Helicotylenchus dihystra* (COBB), females, col. no. 9. E-I: *H. egyptiensis* TARJAN, females, col. no. 29. J-O: *H. indicus* IDDIQI, females; J-N: col. no. 2; O: col. no. 10. P-T: *Helicotylenchus* sp. 1, col. no. 5; P-SIDDIQI: females; T: juvenile. U-X: *Helicotylenchus* sp. 2, female, col. no. 22. Scale bars: general views: 50 μ m; parts: 10 μ m.

fields or at the middle of tail. Caudalid not seen. Phasmids between 4 annuli anterior and 4 annuli posterior to anus in both populations.

Male: Not found.

Host plants and localities: Cytronella grass (*Cymbopogon nardus* RENDLE), Bangkok (col. no. 2); Betel nut (*Areca catechu* L.), Bangkok (col. no. 10).

Remarks: These populations differ from *H. indicus* in the original description¹⁹⁾ in the tail morphology having dorsal fine annuli and full striations to the tip, although the latter is shallow and often indistinct. These are considered intra-specific variation in *H. indicus*.

Helicotylenchus sp. 1

(Fig. 2 P-T)

Measurements (females): Col. no. 5 ($n=3$): L=710-788 μm (756); a=28.1-31.0 (29.9); b=7.1-7.5 (7.3); b'=4.7-5.6 (5.2); c=49.3-60.2 (53.9); c'=0.8-1.0 (0.8); V=60.6-63.0% (61.7); spear=24.4-25.2 μm (24.9); m=45.9-47.6% (46.8); DGO=12.0-13.6 μm (12.7); O=49.2-54.0% (50.8); EXPORE=93-107 μm (99); esophagus=96-111 μm (103); OVLBEG=30-56 μm (43); VL=430-485 μm (467); vulva-anus=266-288 μm (276); tail=12.8-16.0 μm (14.1); Tail/V-a=4.7-5.6% (5.1); annule=1.2-1.4 μm (1.3).

Morphology: Females (n=3): Body forming open-C when killed by gentle heating. Lip region truncate, slightly offset from body contour with 4-5 indistinct annuli. Anterior margin of spear knobs concave. Hemizonid 2-3 annuli long, level with or immediately posterior to excretory pore; hemizonion 14-15 annuli posterior to excretory pore. Lateral vulval membrane absent. Spermatheca empty. Tail cylindrical with entirely annulated hemispherical terminus, with 8-9 annuli on ventral surface, annuli indistinct at the tail tip. Inner incisures of lateral fields fuse at posterior edges of lateral fields. Caudalid not seen. Phasmids 8-2 annuli anterior to anus in female.

Males: Not found.

Host plant and locality: Clove tree (*Eugenia caryophyllus* BULLOEK et HARRISON), Bangkok.

Remarks: By having hemispherical tails and body form in open-C to closed circle, never in spiral, this species comes close to *H. retusus* SIDDIQI & BROWN, 1964¹⁸⁾, *H. tumidicaudatus* PHILLIPS, 1971⁹⁾, *H. girus* SAHA et al., 1973¹⁴⁾, *H. paragirus* SAHA et al., 1973¹⁴⁾, *H. obtusicaudatus* DAREKAR & KHAN, 1979³⁾, *H. incisus* DAREKAR & KHAN, 1979³⁾ and *H. gratus* PATIL & KHAN, 1983⁸⁾. Differences from those species are as follows: *H. retusus*¹⁸⁾ has longer spear (26-27 μm), body forming closed circle, lateral membranes at vulva, phasmids at 9-15 annuli anterior to anus; *H. tumidicaudatus*⁹⁾ has hemispherical lip region, longer spear (25-28 μm), spermatheca filled with spermatozoa (males present) and phasmids at 5-12 annuli anterior to anus; *H. girus*¹⁴⁾ has smooth and rounded lip region and phasmids at 0-4 annuli anterior to anus; *H. paragirus*¹⁴⁾ has longer body (800-1000 μm) and phasmids at 11-17 annuli anterior to anus; *H. obtusicaudatus*³⁾ has smooth lip region, clavate tail with indistinct terminal annuli and phasmids at 10-15 annuli anterior to anus; *H. incisus*³⁾ has smooth lip region, larger c-value (58-68 μm) and phasmids 15-19 annuli anterior to anus; *H. gratus*⁸⁾ has longer body (750-900 μm), longer spear (25-27 μm), numerous tail annuli (14-18) and smooth lip region. Of them, *H. gratus* is closest to our specimens, since states of reliable characters such as position of phasmids (3-12 annuli anterior to anus) and lip morphology (truncate at the tip and continuous with body contour) agree with our specimens.

Helicotylenchus sp. 2

(Fig. 2 U-X)

Measurements (females): Col. no. 22 ($n=2$): L=562-577 μm ; a=24.0-27.0; b=5.9-6.2; b'=4.2-4.7; c=32.8-35.1; c'=1.3-1.4; V=61.7-62.7%; spear=23.2-24.0 μm ; m=41.4%; DGO=9.2-11.2 μm ; O=39.7-46.7%; EXPORE=96.8-98.4 μm ; esophagus=93.6-94.4 μm ; OVLBEG=24-43 μm ;

VL=352-356 μ m; vulva-anus=194-203 μ m; tail=16.0-17.6 μ m; Tail/V-a=8.3-8.7%; annule=1.1-1.3 μ m.

Morphology: Females (n=2): Body forming 1.5 to 2 spirals when killed by gentle heating. Lip region hemispherical, continuous to body contour with 4 distinct annuli. Spear knobs thick, anterior margin flattened. Hemizonid 2 annuli long, level with or immediately anterior to excretory pore. Vulva with lateral membrane. Spermatheca empty, rounded and offset from ovary. Tail slightly convex dorsally, ventrally with lobed terminal projection (less than 2 annuli long), with 13-14 annuli on ventral surface. Inner incisures of lateral fields fuse at the very end of lateral fields. Caudalid not seen. Phasmids 1-3 annuli anterior to anus.

Males: Not found.

Host plant and locality: Papaya, *Carica papaya* L., Nakhon Ratchasima.

Remarks: Morphometrics and lip morphology led the specimens close to *H. abunaamai* SIDDIQI, 1972¹⁷⁾. Differences are observed in smaller c-value (33-35 vs. 33-44 (39)) and numerous tail annuli (13-14 vs. 7-11 (9)). Present specimens are excluded from those identified herein as *H. abunaamai* in the body habitus (1.5-2 spirals vs. 1-1.5 spirals).

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和文摘要

タイ国における作物加害線虫の調査

I. ヘリコティレンクス属

水久保隆之・樋田 幸夫・KELEEWAN, S.

タイ国の作物圃場から検出されたヘリコティレンクス属 (*Helicotylenchus*) の8種: *H. abunaamai*, *H. certus*, *H. crenacauda*, *H. dihystra*, *H. egyptiensis*, *H. indicus* 及び未同定の2種の計測値を示し、形態の記載と図示を行った。これらの線虫と既知種との形質状態の異同、個体群内における形質変異について言及し、未同定種とそれらの近似種との相違点も示した。*H. certus* はタイ国における新記録種であった。