

A revision of the subfamily Ecphyadophorinae Skarbilovich, 1959 (Tylenchida : Nematoda) ⁽¹⁾

Dewey J. RASKI *, Puthenkandathil K. KOSHY ** and V. K. SOSAMMA **

* University of California, Davis, Ca 95616, U.S.A. and ** Nematology Laboratory,
CPCRI, P.O. Krishnapuram, Kayangulam, Kerala, India, 690 533

SUMMARY

Review of type specimens of some species of *Ecphyadophora* and *Ecphyadophoroides* plus new collections of others revealed one new species of *Ecphyadophora*, three new species of *Ecphyadophoroides* and reaffirmed the distinction of three separate genera : *Ecphyadophora*, *Ecphyadophoroides* and *Epicharinema*. Elongate amphidial slits or clefts on dorso-ventrally flattened cephalic regions characterize *Ecphyadophoroides*, whereas rounded heads with four symmetrical lobes annulate almost to the labial plate and bearing small pore-like amphids distinguish *Ecphyadophora*. *Tylenchus eurycephalus* De Man, 1921 is judged to be *Ecphyadophoroides eurycephalus* (De Man, 1921) n. comb. but assigned to *species inquirendae*. *Ecphyadophora tarjani* could not be confirmed as a separate species or a synonym of *Ecphyadophora quadralata* so is placed in *species inquirendae*. *Ecphyadophora acuta*, *E. basiri*, *E. goodeyi* and *E. tritici* are judged synonyms of *Ecphyadophora quadralata*. *Ecphyadophora teres* n. sp., *Ecphyadophoroides sheri* n. sp., *Ecphyadophoroides macrocephalus* n. sp. and *Ecphyadophoroides leptcephalus* n. sp. are described. Amended diagnoses are proposed for *Ecphyadophorinae* and its three genera. Keys to species of *Ecphyadophora* and *Ecphyadophoroides* are provided.

RÉSUMÉ

Révision de la sous-famille *Ecphyadophorinae* Skarbilovich, 1959 (Tylenchida : Nematoda)

L'examen des spécimens types de certaines espèces d'*Ecphyadophora* et *Ecphyadophoroides* ainsi que l'étude de nouvelles collections, ont conduit à la description de quatre nouvelles espèces (un *Ecphyadophora* et trois *Ecphyadophoroides*) ainsi qu'à confirmer la distinction des trois genres *Ecphyadophora*, *Ecphyadophoroides* et *Epicharinema*. Des fentes amphidiales allongées et une région céphalique aplatie dorso-ventralement caractérisent *Ecphyadophoroides*, tandis qu'une région labiale arrondie et tétralobée et des amphides en forme de pore distinguent *Ecphyadophora*. *Tylenchus eurycephalus* De Man, 1921 est transféré au genre *Ecphyadophoroides*, mais considéré comme *species inquirenda*. *Ecphyadophora tarjani*, à qui n'a pu être attribué le statut d'espèce distincte ou synonyme de *Ecphyadophora quadralata* Corbett, 1964, est également placé parmi les *species inquirendae*. *Ecphyadophora acuta*, *E. basiri*, *E. goodeyi* et *E. tritici* sont considérés comme synonymes mineurs de *E. quadralata*. *Ecphyadophora teres* n. sp., *Ecphyadophoroides sheri* n. sp., *Ecphyadophoroides macrocephalus* n. sp. et *Ecphyadophoroides leptcephalus* n. sp. sont décrits. Des diagnoses amendées sont proposées pour la sous-famille des *Ecphyadophorinae* et ses trois genres. Des clés concernant les espèces de *Ecphyadophora* et de *Ecphyadophoroides* sont établies.

Species belonging to the genus *Ecphyadophora* De Man, 1921 and to its two related genera are among the most remarkable of all nematodes. Their long and extremely slender forms with De Man's "a" coefficient values ranging up to

181 render their detection and handling specially difficult and are comparable to no other known species. Equally or more unusual is the dorso-ventrally flattened head region of some species which also bear elongated amphidial slits.

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Until relatively recent years very little was known about the ecphyadophorids. The first published record was De Man's (1921) description of a single male collected in The Netherlands. This he named *Ecphyadophora tenuissima* which he proposed as a new genus and species. In the same publication De Man described another new species it too based on a single male; this species he named *Tylenchus eurycephalus*. Evidence reported below suggests this is a species of *Ecphyadophoroides* but the description does not give enough detail to permit specific identification.

Thirty-six years elapsed before Tarjan (1957) redescribed *E. tenuissima* based on females and males from five locations in Florida and another location near Ruurlo, The Netherlands. He also designated one male from Ruurlo as neotype for *E. tenuissima*.

Corbett (1964) made the next discovery when he found a second species of *Ecphyadophora* which he named *quadralata* along with two other new species related to *E. quadralata* but different enough to warrant separate generic status for which he proposed the taxon *Ecphyadophoroides*. All three species surprisingly were found in the same locality in Nyasaland in soil about roots of the same plant type, *Fimbristylus* sp., growing in seasonally waterlogged grassland.

Corbett's (1964) report was followed by two publications of Husain and Khan (1965, 1968) and another by Verma (1972), in which a total of six new species of *Ecphyadophora* and two of *Ecphyadophoroides* were described.

In 1980 another dimension was added to the ecphyadophorids by the description of *Epicharinema keralense* by Raski *et al.* Especially important in that report was the discovery of large and sinuous, elongate amphidial canals in the cephalic region. In addition the esophagus of *E. keralense* was found to possess a well-defined, valvated metacarpus and esophageal glands that overlapped the intestine a short distance only. Since then new collections in Kerala, India and reexamination of other preserved specimens in the University of California Nematode Collections at Davis and Riverside indicate similar remarkable amphidial structures are present also in the genus *Ecphyadophoroides*.

This prompted a further study to review known species of *Ecphyadophora* and *Ecphyadophoroides* in light of the new information provided by *E. keralense*. Through the kind cooperation of several nematological laboratories (see Acknowledgments) type specimens of five species were obtained on loan. In addition, three collections were located in the University of California Nematode Collections of Davis and Riverside. One was a collection identified as *Tylenchus eurycephalus* made from soil about the roots of avocado in Riverside, California; another was from a cotton field near Madera, California; and a third from ornamental Neanthabella Palm plants which originated in a Texas nursery. New collections made about the roots of coconut palm in Kayangulam, Kerala, India held three new species. The total number of specimens assembled for this study included 246 females, 58 males and 69 larvae.

Materials and Methods

New collections of nematodes were separated from soil by washing through sieves and then killed by heating in water. Preservation in 2 or 2.5% formalin was followed by storage for varying periods from several weeks to years. The specimens then were fixed by transfer to FAA. Dehydration to glycerin followed Cobb's method of 2.5% glycerin in 30% alcohol then transfer to 5% glycerin in 30% alcohol. This was allowed to evaporate slowly to glycerin by storage in a Petri dish for several days. Ultimate dehydration was achieved over CaCl_2 crystals in a desiccation chamber. Mounting was made in dehydrated glycerin. *En face* and transverse sections in glycerin were cut by hand and mounted in glycerin-jelly.

Many specimens were furnished as permanent slide preparations in glycerin. Details of preservation are not known. In preparation for scanning electron microscopy the slides were opened and the specimens transferred to a mixture of glycerin-ethyl alcohol-water, 80 : 6 : 14. By gradual changes the glycerin was reduced until the specimens were held in 30% alcohol in water. The specimens were transferred to

FAA, to 2.5% formalin for at least one day each, then to ethyl alcohol by vapor exchange in 32° oven. This was followed by a graded series of amyl acetate in absolute alcohol from 30% finally to absolute amyl acetate. A 15 sec sonication was applied in absolute amyl acetate. After critical point drying with CO₂ the specimens were mounted on a stub and coated with 200 Å of gold sputtered on in several layers. Examination and photography was done on a Cambridge Mark II scanning electron microscope at 4,300-21,000 X and 10 KV.

Subfamily Ecphyadophorinae
Skarbilovich, 1959

DIAGNOSIS (emended)

Tylenchidae. Body very slender, cylindrical for most of its length but narrowing abruptly at cloaca in male. Body annules mostly fine to moderate; body appears smooth in some species but possess annules evident on scanning electron microscope. Lateral field four lines, a plain refractive band forming two lines, or not seen. Phasmids and deirids not seen. Anterior end rounded, with four symmetrical lobes, annulate almost to labial plate, amphids small, pore-like; or anterior end dorso-ventrally flattened, amphids with extended, longitudinal, straight or sinuous clefts. Stylet tylenchoid, mostly short, up to 13 µm; cone usually shorter than base (except *Epicharinema* with stylet 38-52 µm, cone length equal to base). Dorsal esophageal gland orifice obscure, close to base of stylet. Oesophagus a simple tube, junction with intestine obscure, glands form extensive overlap of intestine (except *Epicharinema* with prominent valvate metacarpus and short gland overlap of intestine). Vulva transverse, female gonad anteriorly directed, outstretched, with or without postuterine branch. Caudal alaeleptoderan, flap-like. Tylenchoid spicules, straight or curved, may or not be accompanied by a gubernaculum. Testis single, outstretched.

TYPE GENUS

Ecphyadophora De Man, 1921

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OTHER GENERA

Ecphyadophoroides Corbett, 1964
Epicharinema Raski, Maggenti, Koshy & Sosamma, 1980

Genus ***Ecphyadophora*** De Man, 1921

DIAGNOSIS (emended)

Ecphyadophorinae. Cuticle with fine transverse annules, appears smooth in some species but annules evident in scanning electron micrographs. Anterior end rounded, with four symmetrical lobes, annulate almost to labial plate. Amphids small, pore-like. Lateral field with four equidistant incisures or not observed. Stylet short, up to 12 µm, cone usually shorter than base. Oesophagus a simple tube, junction with intestine obscure, extensive gland overlap of intestine. Post-uterine branch short. Spicules straight, needle-like. Gubernaculum present or absent.

TYPE SPECIES

Ecphyadophora tenuissima De Man, 1921

OTHER SPECIES

E. quadralata Corbett, 1964
syn. : *E. goodeyi* Husain & Khan, 1965
E. acuta Husain & Khan, 1968
E. basiri Verma, 1972
E. tritici Verma, 1972
E. teres n. sp.

SPECIES INQUIRENDA

E. tarjani Husain & Khan, 1965

Ecphyadophora tenuissima De Man, 1921

This species was described from a single male collected near Breda, The Netherlands and

which in so far as known is no longer extant. Tarjan (1957) redescribed *E. tenuissima* from specimens collected in marshy wasteland near Ruurlo, The Netherlands and from Florida, USA which fit very closely the original description by De Man. He also designated one male from Ruurlo as neotype. These may very well be conspecific with *E. tenuissima* and can serve as the basis for study and comparison. However, proper designation of a neotype specimen should be based only on specimens from the type locality itself or at least closer than the distance of Ruurlo to Breda. Resolution of this need can only be fulfilled by new collections from the vicinity of Breda.

The specimens from Ruurlo were examined with the following observations :

Three *females* (Ruurlo) : L = 0.85-0.93 mm ; a = 155-170 ; b' = 6.3 ; c = ? ; V = ¹⁹⁻²³ 74-76^{0.0.1} ; stylet = 8-9 μ m. No abrupt narrowing at vulva noted on females. A slight depression slightly posterior to vulva returns to same body diameter very shortly, body then shows gradual tapering to rounded terminus. Anterior lip of vulva clearly extends as a flap posteriad to opening. Spermatheca prominent, elongate oval, 22-35 \times 4.5 μ m, filled with sperm about 1 μ m in diameter.

Two *males* (Ruurlo) : L = 0.79-0.93 mm ; a = 132-169 ; b' = 5.1-5.7 ; c = 10-13 ; stylet = 8 μ m ; spicular tube = 3.5 μ m. Range of length extended by shorter male reported above, otherwise similar to descriptions by Tarjan.

The Florida collection reported by Tarjan (1957) included males, females and larvae from *Juniperus silicola* (Small) Bailey near Grant Haven Estate, Jacksonville, Florida. The adults were typical of *E. tenuissima* and the larvae held the following dimensions :

One juvenile, third-stage female ? (Florida) : L = 0.67 mm ; a = 166 ; b' = 4.8 ; c = 10 ; stylet = 8 μ m ; gonad = 43 μ m, 430 μ m from anterior end. Similar to adults. Anterior end rounded, body smooth. Developing rectum 15 μ m long, beginning 86 μ m from terminus.

One juvenile, fourth-stage female ? (Florida) : L = 0.71 mm ; a = 142 ; b' = 5.2 ; c = ? ; gonad = 32 μ m long, 533 μ m from anterior end. Similar to adult. Anterior end rounded, bearing four symmetrical lobes. Lateral lobes project prominently as inverted 'V' shape (dorsal and

ventral lobes may also but could not be verified by dorso-ventral orientation or by *en face* section).

One juvenile, fourth-stage male (Florida) : L = 0.91 mm ; a = 181 ; b' = 7.1 ; gonad = 38 μ m long, beginning 737 μ m from anterior end. Similar to adult. Anterior end with prominent lateral cephalic lobes as in above fourth-stage female. Body swells slightly at anus then narrows markedly posteriorly to terminus which is slightly conoid with rounded tip.

The three other collections as reported by Tarjan (1957) from Florida (Yeehaw Junction, Lake Alfred and Fort Pierce) held females only and from the published data are considered not to be specimens of *E. tenuissima*. These were not sent for study so specific identifications are not known.

***Ecphyadophora quadralata* Corbett, 1964**

syn. *Ecphyadophora goodeyi* Husain & Khan, 1965 n. syn.

Ecphyadophora acuta Husain & Khan, 1968 n. syn.

Ecphyadophora basiri Verma, 1972 n. syn.

Ecphyadophora tritici Verma, 1972 n. syn.

(Figs. 1 A, D ; 3 K-N)

Ecphyadophora quadralata is represented in more widely distributed collections than any other species of this subfamily. Five nominal species are on record in all of which males and females have been described. In addition five other collections, two from Kerala India and one each from Nigeria, Africa ; Texas, USA ; and Brazil, South America are similar to the above descriptions and specimens but females only were collected.

Several morphological characters were found to have considerable variability yet had overlapping ranges linking all of these species and collections. Total length is one example varying from 0.51-0.86 mm ; stylet length is another with 6.0-11.5 μ m representing the total range of all records. Vulva position also is very similar in *E. quadralata*, *E. acuta*, *E. basiri* and *E.*

trilici ($V = 67-73$) and overlaps the value, $V = 73-75$, reported for *E. goodeyi*. Furthermore the single female paratype of *E. goodeyi* which was available showed $V = 70$. The terminus is variously described as acute, subacute or finely rounded. Taking into account all the collections the tail tip is even more variable including finely digitate appearance in *E. quadralata* to more rounded in the Texas and Kerala specimens.

Consistent similarities are present in several characteristics : *i*) ovate spermatheca with relatively large sperms, about $1.0 \mu\text{m}$ in diameter, even in the populations in which males are not known ; *ii*) general body shape and tail tapering evenly to terminus ; open 'C' shape assumed by fixed specimens some with accentuated bending ventrad at vulva ; *iii*) vulva with anterior margin projecting posteriad covering the vulval opening with a short, thin, cuticular lip closely appressed to body ; and *iv*) body with small ventral indent in outline just back of vulva.

Four slides holding nine females, twelve males paratypes of *E. quadralata* were available for study. Unfortunately two of the slides were drying out and the specimens damaged. The others were well preserved and confirmed the description of *E. quadralata*. The single most striking difference found concerned the stylet of *E. quadralata* in which the knobs are fine but clearly visible and backwardly directed. In the other species and collections the knobs are somewhat smaller and apparently finely rounded swellings not so evidently backwardly directed in outline. The specimens measured fit the range of $6-8 \mu\text{m}$ reported by Corbett for *E. quadralata* ; the other described species range from $8-10 \mu\text{m}$ or $9-11.5 \mu\text{m}$; and the new collections reported below fall within the $6-8 \mu\text{m}$ range. It is concluded these stylet variations are intraspecific.

Three specimens labelled paratypes of *E. goodeyi* were available on loan : one female (slide T-337p) and one male (slide T-338p) from USDA Nematode Collection, Beltsville, Maryland ; and one male (slide WT-752) from Agricultural University, Wageningen. Dimensions obtained from these included :

Female (T-337p) : $L = 0.55 \text{ mm}$; $a = 82$; $b' = 5.4$; $c = ?$; $V = 1270^{0.7}$; stylet = $10 \mu\text{m}$; excretory pore = $76 \mu\text{m}$; hemizonid = $70 \mu\text{m}$.

Prominent spermatheca ovate, $14 \mu\text{m}$ long ; sperm round, about $1 \mu\text{m}$ in diameter. Vulva with slightly overlapping anterior lip, slight depression on ventral surface just posterior to vulva but contour in general does not show marked narrowing after vulva. (Illustration 2K of Husain and Khan (1968) does not show abrupt narrowing as described.) Body posterior to vulva narrows gradually with long taper to near terminus ; terminal $2-3 \mu\text{m}$ narrow more quickly to conoid terminus with finely rounded tip. Body widest near vulva, no discernible taper anterior until esophageal region then uniformly narrows to cephalic region which is not set off.

Male (T-337p) : $L = 0.53 \text{ mm}$; $a = 96$; $b' = 4.8$; $c = 7.4$; stylet = ? ; spicules = $14 \mu\text{m}$; gubernaculum = about $2.0 \mu\text{m}$; excretory pore = $77 \mu\text{m}$; hemizonid = $70 \mu\text{m}$.

Male (WT-752) : $L = 0.50 \text{ mm}$; $a = 97$; $b' = 5.3$; $c = 6.3$; stylet = ? ; spicules = $13 \mu\text{m}$; gubernaculum = about $2 \mu\text{m}$. Specimen badly damaged, almost useless except for general measurements above.

Both male specimens differ slightly from description ; both are shorter than $0.64-0.69 \text{ mm}$ range of length reported by Husain and Khan (1968). Spicules slightly longer (male on T-337p shows small protrusion of ventral surface at cloacal opening forming a short, rounded spicular tube). Terminus of both similar to above female.

In addition specimens identified as *E. quadralata* were found in five other collections from which the following dimensions were noted :

Females (10) (from soil about roots of coconut, Kayangulam, Kerala, India) : $L = 0.57 (0.54-0.62) \text{ mm}$; $a = 81 (69-99)$; $b' = 5.1 (4.9-5.3)$; $c = 10 (9-11)$; $V = 18(17-19) 71 (71-73)^{0.8}$; stylet = $7.0 (6.0-8.0) \mu\text{m}$; hemizonid = $79 (74-83) \mu\text{m}$; excretory pore = $84 (82-87) \mu\text{m}$; spermatheca = $9.0 (7.0-13.5) \mu\text{m}$ long, $5.0 \mu\text{m}$ wide.

One female (from soil about roots of banana, Trivandrum, Kerala, India) : $L = 0.46 \text{ mm}$; $a = 70$; $b' = ?$; $c = 9$; $V = 1571^{1.1}$; stylet = $8.0 \mu\text{m}$; hemizonid = $67 \mu\text{m}$; excretory pore = $74 \mu\text{m}$; spermatheca = $11 \mu\text{m}$ long.

One female (from soil about roots of Celosia trigyna collected by F. E. Caveness in Oyo

Province, Nigeria 16 Nov 60) : L = 0.51 mm ; a = 73 ; b' = 4.6 ; c = ? ; V = $2070^{1.0}$; stylet = 7.0 μm ; hemizonid = 72 μm ; excretory pore = 81 μm ; spermatheca = 11 μm long. Of special note on this female was vague evidence of a lateral field visible as two lines ; distance between was approximately 50% of body diameter, so widely spaced as to suggest more lines present but not discernible on light microscope.

One female (from soil about Abbalea near Belmonte, Brazil) : L = 0.57 mm ; a = 109 ; b' = 5.8 ; c = 10 ; V = $70?$; stylet = 8.0 μm ; excretory pore = 77 μm ; spermatheca not evident.

Females (14) (from soil about roots of *Neanthabella palm* intercepted in Sacramento, California originally shipped from Texas) : L = 0.52 (0.49-0.57) mm ; a = 76 (68-96) ; b' = 4.2 (3.7-4.7) ; c = 11 (10-12) ; stylet = 6-7 μm ; V = $15-1974 (72-76)^{0.8-1.0}$; excretory pore = 79 (73-85) μm . These fit the description and paratypes of *E. quadralata* closely except for terminus which tends to be more bluntly rounded. Photographs from SEM (Fig. 1A) show more detail as follows : cephalic region with rounded, equidistant lobes, fine annulations up to labial plate which bears six small, inner papillae surrounding oral aperture. Amphids small, pore-like, slightly posterior to margin of labial plate. *En face* section on light microscope shows few details ; only four equally spaced innervations to papillae not evident on SEM photographs and two finer innervations apparently to amphids (Fig. 3 K-N). Body annules fine but distinct, averaging about 0.3 μm wide. SEM photograph (Fig. 1 D) also shows lateral field with three bands forming four lines spaced about 0.3 μm apart.

A composite of dimensions reported for all the species as described is as follows :

Female : L = 0.49-0.81 mm ; a = 68-107 ; b' = 3.7-7.2 ; c = 5-13 ; V = 67-76 ; stylet = 6.0-11.5 μm ; excretory pore = 73-119 μm ; spermatheca = 7.0-21.0 μm long \times 5.0-6.7 μm wide.

Male : L = 0.50-0.86 mm ; a = 71-122 ; b' = 4.2-7.2 ; c = 6.3-13.0 ; spicules = 11-20 μm ; gubernaculum = 2.0-5.0 μm .

Ecphyadophora tarjani

Husain & Khan, 1965

One slide bearing a label indicating type specimens of *E. tarjani* was available for study on loan by P. A. A. Loof from the nematode collection at the Agricultural University, Wageningen, The Netherlands. The slide was labeled *E. tarjani*, two males, one female from *Cyperus rotundus* L. at Aligarh (U.P.), India and numbered WT 770.

The single male of *Ecphyadophora* which appeared best to fit the description of *E. tarjani* was very poorly fixed and damaged. The few characteristics which could be discerned were :

L = 0.66 mm ; a = 69 ; c = 8.8 ; spicules = 14 μm ; gubernaculum = 4 μm . Anterior end bluntly rounded, no details discernible. Body narrows abruptly posterior to cloacal opening, tapers gradually then narrows again abruptly about 4 μm from terminus giving a spicate outline. Body appears generally flattened, De Man's "a" coefficient figure of 69 reported above probably low due to flattening.

These data suggest *E. tarjani* falls within the definition of *E. quadralata*. Lack of specimens available on loan for comparison and study makes it impossible to judge the identity of *E. tarjani* based on present knowledge of the genus. Therefore it is recommended *E. tarjani* be placed in *species inquirendae*.

Two other specimens were on slide WT 770 : one male and one juvenile. These are obviously members of *Ecphyadophoroides* and probably conspecific with *Ecphyadophoroides graminis* Husain & Khan, 1968. Observations on these specimens are reported under that species.

Ecphyadophora vallipuriensis

Husain & Khan, 1968

No specimens, paratypes or others, available for study. In reported size *E. vallipuriensis* appears related to *E. quadralata* but differs in position of vulva (V = 56-58, most anteriorly located of all known *Ecphyadophora*). Four lines reported in lateral field is unusual because no

other nominal species of *Ecphyadophora* has definitely identifiable lateral field from light microscope observations. (Single female of *E. quadralata* from Nigeria an exception — even there only two very faint lines noted).

***Ecphyadophora teres* n. sp.**
(Figs 1 B-C, E ; 3 A-J)

DIMENSIONS

Females (16) : L = 0.91 (0.85-1.00) mm ; a = 153 (130-181) ; b' = 5.0 (4.0-6.3) ; c = 15.3 (13.9-16.7) ; stylet = 10.3 (10-12) μm ; cone = 3.7 (3.0-4.5) μm ; V = $^{22(20-24)}74$ (73-76)^{0.8-0.9} ; excretory pore = 122 (114-128) μm .

Males (10) : L = 0.86 (0.83-0.91) mm ; a = 157 (140-176) ; b' = 5.5 (4.7-6.2) ; c = 12.1 (11.6-12.6) ; stylet = 9.4 (9-10) μm ; cone = 3.4 (2.5-4.0) μm ; spicules = 18 (16-20) μm ; gubernaculum = 5 μm ; T = 26 (24-29) ; excretory pore = 119 (111-129) μm .

Juveniles

Third-stage ? (2) : L = 0.47-0.50 mm ; a = 111-114 ; stylet = 8-9 μm ; cone = 2-4 μm ; gonad = 351 μm from anterior end.

Fourth-stage ? (2) : L = 0.60-0.64 mm ; a = 109-127 ; b' = 4.8 ; stylet = 8-9 μm ; cone = 3 μm ; gonad = 47 μm long, 442 μm from anterior end.

Holotype (female) : L = 0.97 mm ; a = 130 ; b' = 6.1 ; c = 16.7 ; stylet = 11 μm ; cone = ? ; V = $^{22}75$ ^{0.8}.

Allotype (male) : L = 0.87 mm ; a = 152 ; b' = 6.2 ; c = 12.4 ; stylet = 9 μm ; spicules = 19 μm ; gubernaculum = ? T = 29.

DESCRIPTION

Female : Body almost straight, gently curved ventrally when killed by gentle heat ; extremely slender, body diameter about 7.5 μm at widest, similar over most of length, narrows gradually to about 5 μm near anterior region. Anterior end rounded ; en face section shows anterior end squarish, symmetrical, bearing four prominent

innervations of papillae on rounded sub-ventral and subdorsal lobes. Photomicrographs from SEM (Fig. 1 B, C) show oral aperture with squarish to rectangular labial plate. Amphids small, pore-like on slightly raised protuberances posterior to labial plate a distance about equal to one width of labial plate. Four prominent, equidistant, longitudinal lobes on head bear eleven fine annules averaging about 0.2 μm in width, beginning on posterior edge of amphids. Stylet short, about 12 μm long, with extremely fine cone, slightly shorter than base plus knobs. Knobs prominent with backwardly directed anterior margins. Dorsal gland orifice seems close to base of knobs but not clearly identifiable. Hemizonid not strongly defined, appears to be about 2 μm anterior to excretory pore which is very fine, 126 μm from anterior end. Nerve ring not discernible. Oesophagus irregularly tubular, no metacarpus or valve noted. Glands overlapping intestine as long slender lobe. Female gonad single, anteriorly directed, with long ovate spermatheca, 32 \times 4 μm , packed with rounded sperm about 1 μm in diameter. Vulva with narrow flap covering ventral surface which extends about 4 μm posterior to and covering vulvar opening. Post-uterine sac about 9 μm long. Body bends a few degrees ventrad at vulva then proceeds with almost straight line to terminus, curving gently dorsad only at very last 15-20 μm . Body diameter widens slightly at flap then narrows ventrally posterior to flap, widens again about one vulval body width posterior to vulva and gradually narrows to a finely rounded terminus bearing a slight swelling or protuberance.

On light microscope body appears smooth with no cross-striae or longitudinal lines even in transverse sections. Photomicrographs from SEM (Fig. 1 E) show annules at mid-body averaging 0.4 μm in width ; two anastomoses noted ; no evidence of lateral field.

Male : Similar to female. Stylet slightly shorter and less robust. Hemizonid not certainly seen appears to be about 2 μm wide, 93 μm from anterior end. Excretory pore not certainly seen, appears to be about 100 μm from anterior end. Testis single, outstretched, packed with sperm about 1 μm in diameter. Body forms a spicular tube about 5 μm long (up to 6-7 μm long in some paratypes) surrounding spicules.

Body about 5 μm wide at cloaca, narrows markedly at base of spicular tube to about 2 μm in diameter by depression of ventral surface. Spicules long, slender, gently curving ventrally then dorsally. Gubernaculum obscure, appears to be simple rod-shaped, about 5 μm long in one paratype only. Caudal alae narrow, projecting posteriorly off the spicular tube, about 4 μm long (up to 5 μm in some paratypes). Tail curves slightly ventrad at cloaca then widens to about 3 μm in diameter. Tail almost straight to terminus, tapering slightly, ends in rounded terminus with small digitate projection.

Juvenile : Similar to adults in general morphology. Stylet slightly shorter but robust with prominent knobs. Terminus bluntly rounded occasionally with slight digitate projection.

TYPE HOST

Unknown.

TYPE LOCALITY

Sandy loam soil about roots of coconut, *Cocos nucifera* L., from a depth of 10-75 cm. Palm No. 65, Block No. 1 of Central Plantation Crops Research Institute, Regional Station, Kayangulam, P. O. Krishnapuram, Kerala, India-690 533; located at a latitude of 9° 8' N and longitude of 76° 31' E, height of 3.05 m above mean sea level; a hot, humid, tropical climate, annual rainfall 2 415 mm in 120 days mostly between June and November, mean temperature ranges from 30-34°.

TYPE MATERIAL

Holotype : Female, collected 26 August 1980, by V. K. Sosamma, slide number 1600, University of California Nematode Collection (UCD NC) Davis, California.

Allotype : Male, same data and slide number as holotype, UCNC Davis, California.

Paratypes : 24 females, 9 males, 3 juveniles same data as holotype deposited as follows : 18 females, 3 males, 3 juveniles, UCNC, Davis; one female, one male each to the fol-

lowing : National Nematode Collection, Indian Agricultural Research Institute, New Delhi, India; Nematology Laboratory, CPCRI Regional Station, Kayangulam, Kerala State, India; USDA Nematode Collection, Beltsville, Maryland; Nematology Department, Rothamsted Experimental Station, Harpenden, England; Agricultural University, Wageningen, The Netherlands; Commonwealth Institute of Helminthology, St. Albans, Herts., England.

DIAGNOSIS

E. teres n. sp. is closely related to *E. tenuissima* from which it differs by its more prominent stylet bearing large basal knobs, longer spicules (16-20 μm vs 13-15.6 μm for *E. tenuissima* as reported by Tarjan (1957) and longer more prominent spicular tube in *E. teres* n. sp.

Genus *Ecphyadophoroides* Corbett, 1964

DIAGNOSIS (emended)

Ecphyadophorinae. Cuticle with fine to moderate transverse annules. Cephalic region dorso-ventrally flattened, smooth, amphids with deep, extended, longitudinal straight clefts. Lateral field with four incisures; a plain refractive band forming two lines; or lacking. Stylet short, up to 13 μm , cone usually shorter than base. Post-uterine branch present, short. Spicules curved, tylenchoid.

TYPE SPECIES

Ecphyadophoroides annulatus Corbett, 1964

OTHER SPECIES

E. graminis Husain & Khan, 1968
E. indicus Verma, 1972
E. leptcephalus n. sp.
E. macrocephalus n. sp.
E. sheri n. sp.
E. tenuis Corbett, 1964

SPECIES INQUIRENDAE

E. eurycephalus (De Man, 1921) n. comb.
syn. *Tylenchus eurycephalus* De Man, 1921

***Ecphyadophoroides annulatus* Corbett, 1964**

This species was designated type species of *Ecphyadophoroides* and is the most distinctive of all the ecphyadophorids by its longitudinal striae marking off small rectangular areas of cuticle. Three slides holding ten female and ten male paratypes were available for study. Unfortunately two of the slides holding most of the specimens (nine females and nine males respectively) both were drying out and many specimens badly flattened. Only a few were relatively unaffected.

From the better specimens it was noted cephalic capsule is strongly set-off, smooth, prominently flattened dorso-ventrally. Transverse body annules strong, distinctly visible. Lateral field a plain refractive band marking two lines about 1 μm apart. Other longitudinal incisures seemed closer than reported and may be more numerous than twelve. Exact count will be verifiable only by transverse sections. Body annules extend from posterior margin of smooth head almost to terminus. In some specimens body narrows more abruptly about 5-6 μm from terminus forming set-off, conical outline; in others outline evenly conoid to terminus.

Male 10 μm in diameter over most of body, narrows to 7 μm near cloaca, slight depression to diameter of 4.5 μm immediately posterior to cloacal opening, again widens to 6 μm , then tapers gradually to terminus.

***Ecphyadophoroides tenuis* Corbett, 1964**

Paratype specimens were available for study which enabled confirmation of several characteristics. Without doubt the annules of this species are fine but distinctly visible. However,

the lateral field described as a plain refractive band (forming two longitudinal lines) is difficult to distinguish with certainty. Spermatheca not distinctly set-off or identifiable in most specimens. Where it appears to be present it is a small oval, length about 1.25 \times width.

Corbett reported a single female from soil about roots of grapefruit, *Citrus paradisi* Macf. from Venezuela. Dimensions of this specimen fit fairly closely those of *E. tenuis* except for $c = 3.5$ (vs 4.9-5.7 for *E. tenuis*) and excretory pore 131 μm (vs 72-92 μm for *E. tenuis*). That specimen was loaned for study but unfortunately is damaged beyond useful condition. Another female from the same collection also was available. Although broken and mounted in two pieces it is in better condition to observe. Body annules if any too fine for positive resolution and body judged smooth. More important y tail is very fine, narrowing in posterior region to effilate, whip-like outline unlike *E. tenuis*. Possibly fixation may render annulations difficult to resolve and such slender forms pose special problems in describing subtle differences in shape. Nevertheless the drawn out fine tail of the Venezuela specimen cannot be conspecific with *E. tenuis*. This collection might even represent a new species but insufficient material is available for proper description. In any event it should be removed from consideration as another record of host and locality for *E. tenuis*.

Ecphyadophoroides eurycephalus

(De Man, 1921) n. comb.

syn. *Tylenchus eurycephalus* De Man, 1921

The description and illustration of the single male on which this species is based give strong evidence that the nominal species *Tylenchus eurycephalus* belongs to the genus *Ecphyadophoroides*. Several characteristics fit the generic definition of *Ecphyadophoroides*, namely: length = 0.72 mm; absence of median bulb; excretory pore 96 μm from anterior end; bursa relatively small, only 19 μm long; spicules 9.6 μm long, of simple form, a little arcuated; no cuticular annulations observed; tail narrows slowly but does not terminate in a very slender point.

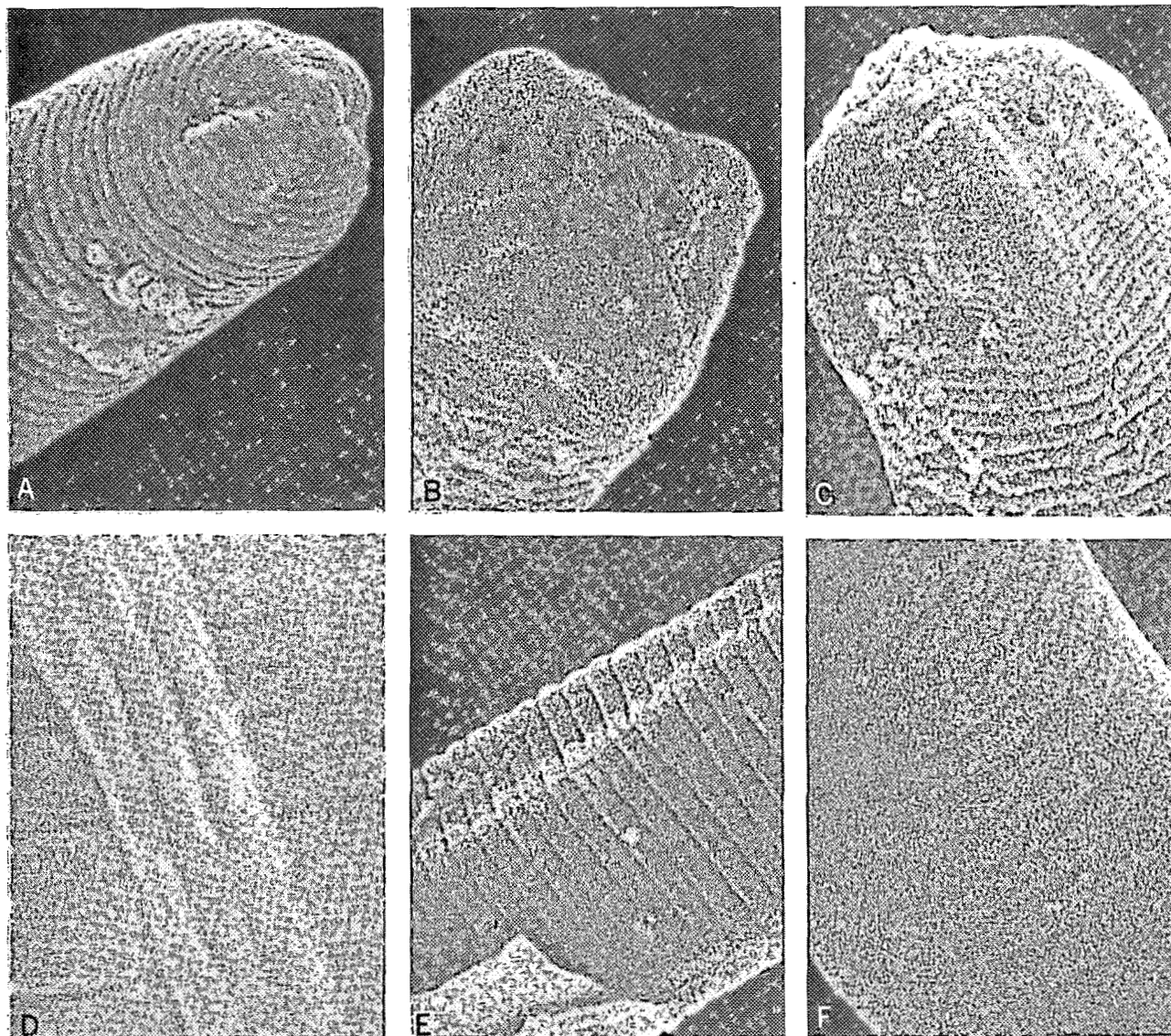


Fig. 1. *Ecphyadophora quadralata*. Female, A : Cephalic region, 9 000 \times ; D : Lateral field, 21 000 \times . *Ecphyadophora teres* n. sp. : Female, B, C : Cephalic region, 10 000 \times ; E : Annulation at about mid-body, 10 000 \times . *Ecphyadophoroides sheri* n. sp. : Female, F : Annulation at about mid-body, 10 500 \times .

Two characters strongly point to *Ecphyadophoroides*. First is the slender form, $a = 110$, of uniform diameter over most of body. Body diameter is widest, 6.6 μm , at mid-body, 5 μm at level of anal opening and 4.2 μm at posterior extremity of stylet. The second and more important is the "lamellate arched dilation" of the cephalic region. De Man was uncertain whether the dilation existed laterally only or

surrounded the anterior end. He did report the dilation extended to posterior end of retracted stylet, and was as long as its breadth at mid-level. He further reported the cephalic region was bare, without lips, papillae or setae. Based on present knowledge the "dilation" probably was lateral only resulting in a dorso-ventral flattening of the cephalic region. Furthermore the stylet was weak, but distinctly swollen at

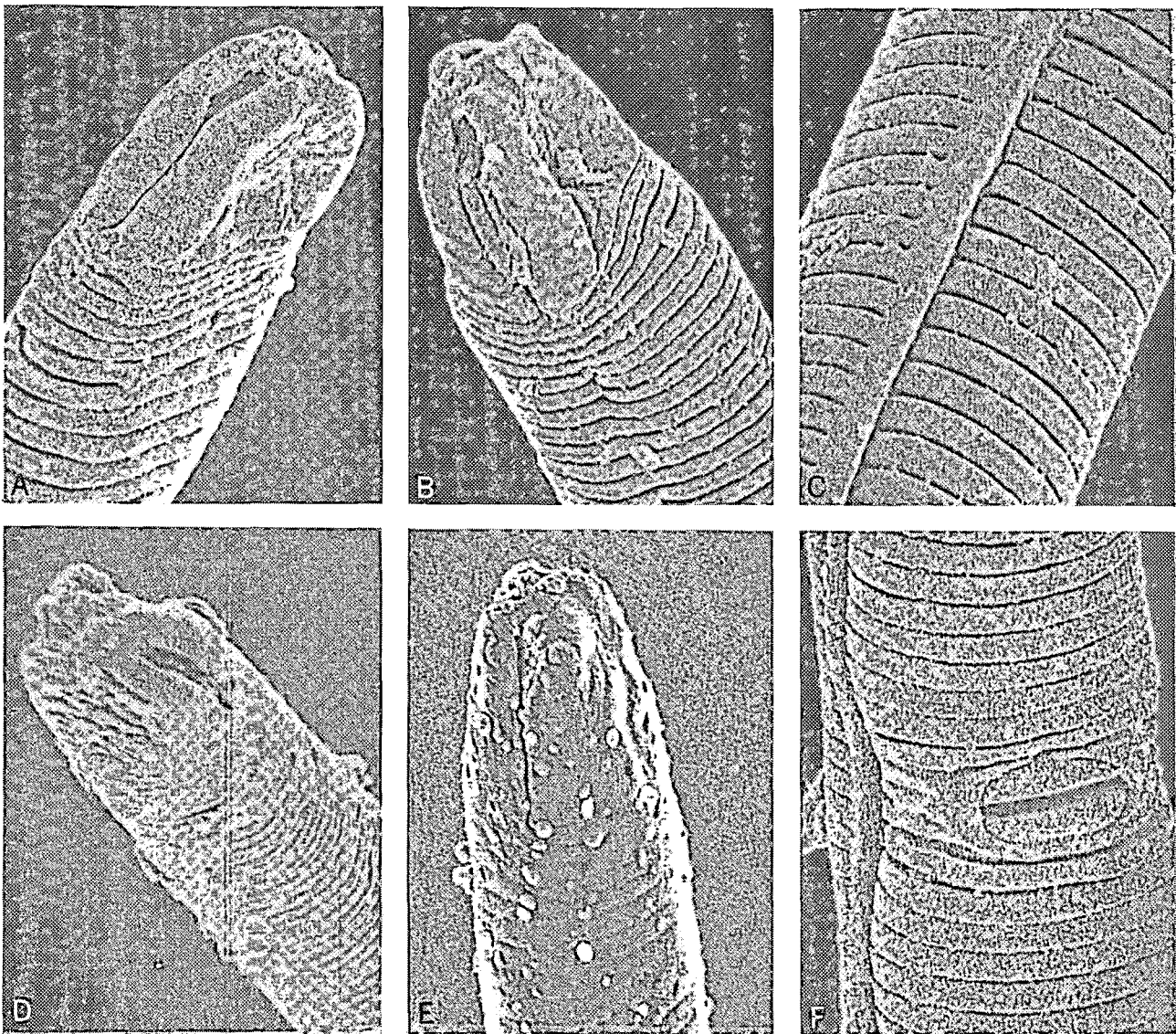


Fig. 2. *Ecphyadophoroides leptcephalus* n. sp. Female, A,B : Cephalic region, A = 5 500 \times , B = 4 500 \times ; C : Lateral field about mid-body, 5 100 \times ; F : Vulva, ventral view, 4 300 \times . *Ecphyadophoroides sheri* n. sp. Female, D,E : Cephalic region, 5 500 \times .

the posterior extremity (small knobs) and probably was 8-9 μm long. De Man reported the distance from anterior extremity of body to posterior extremity of stylet to be 10 μm . In the ecphyadophorids the stylet tip usually is about 1 μm posterior to oral aperture when retracted.

Unfortunately the observations of De Man are inadequate for specific placement of *T.*

euryccephalus among known species. Specimens collected in California and described below as a new species were initially identified as *Tylenchus euryccephalus*. There is a resemblance; however, the population consists of females only, males unknown. Until specimens including females can be recollected from the type locality in The Netherlands there will remain doubt as to the exact nature of *T. euryccephalus*. It is

proposed therefore to designate *Tylenchus eurycephalus* De Man, 1921 as *Ecphyadophoroides eurycephalus* (De Man, 1921) n. comb., but assigned the status of *species inquirenda*.

***Ecphyadophoroides sheri* n. sp.**
(Figs 1 F ; 2 D-E ; 3 O-V)

DIMENSIONS

Females (11) : L = 0.85 (0.82-0.89) mm ; a = 109 (103-119) ; b' = 6.7 (6.0-7.4) ; c = 4.2 (3.8-4.8) ; stylet = 8.7 (8.0-9.0) μm ; V = $18.8^{(16-22)}$ 59 (56-62) $^{1.04(0.8-1.0)}$; excretory pore = 91 (89-93) μm .

Holotype (female) : L = 0.89 mm ; a = 107 ; b' = 7.2 ; c = ? stylet = 8 μm ; V = $18.57^{0.9}$; excretory pore = ?.

Juveniles

Third-stage ? (1) : L = 0.49 mm ; a = 122 ; stylet = 8.0 μm ; gonad = 28 μm long, 271 μm from anterior end.

Fourth-stage ? (14) : L = 0.64 (0.58-0.72) mm ; a = 114 (94-131) ; b' = 5.7 (4.9-6.7) ; stylet = 8-9 μm ; cephalic region = 4-5 μm wide, 4-5 μm long ; excretory pore = 86 μm ; gonad = 67 (52-71) μm long, 332 (288-356) μm from anterior end.

DESCRIPTION

Female : Body almost cylindrical in shape from vulva anteriorad, tapering only slightly but uniformly, regularly from widest diameter of 7-8 μm near vulva to 4-5 μm near knobs of stylet. Cephalic region about 4 μm long, bluntly rounded, dorso-ventrally flattened, distinctly set off, appears slightly dilated or swollen when seen dorso-ventrad ; narrowing bottle-shaped in ventral view. *En face* sections on light microscope show dorso-ventral flattened anterior region with four rounded lobes each bearing a small refractive innervation (Fig. 3 Q-S). SEM photomicrographs (Fig. 2 D-E) do not reveal surface evidence of these papillae ; oral aperture

surrounded by small circular elevation ; amphids with large longitudinal clefts, fine annules of body extend up to base of clefts leaving cephalic region smooth. Stylet delicate, cone not clearly set off ; knobs very small, rounded. Dorsal gland orifice not certainly seen, appears to be near base of stylet. Oesophagus long, tubular, difficult to follow exactly, no metacarpus or valve identifiable ; nerve ring not detected ; glands overlap intestine but esophageal-intestinal junction not seen. Excretory pore 89-93 μm from anterior end. Female gonad single, anteriorly directed, outstretched ; spermatheca lacking ; post-uterine branch short, about one ABD in length. Vulva bears small cuticular flaps on each lateral margin of opening otherwise no marked change in body shape or diameter in vulvar region. Posterior to vulva body begins very slight, gradually narrowing to long, extremely slender, almost whip-like tail especially in posterior half ; terminus acute.

Body appears smooth when studied under light microscope but SEM photograph (Fig. 1 F) shows distinct transverse annulations about 0.4 μm wide at mid-body ; no lateral field noted.

Male : Unknown.

Juvenile : Similar to adult female.

TYPE HOST

Unknown.

TYPE LOCALITY

Soil about roots of avocado, *Persea* sp., Riverside, California.

TYPE MATERIAL

Holotype : Female, collected 4 February 1957, by S. A. Sher, slide number 1601, UCDNC, Davis, Calif.

Paratypes : 40 females, 48 juveniles, same data as holotype deposited as follows : 27 females, 31 juveniles, UCDNC ; 2 females, 4 juveniles, National Nematode Collection, Indian Agricultural Research Institute, New Delhi, India ; 3 females, 3 juveniles, USDA Nema-

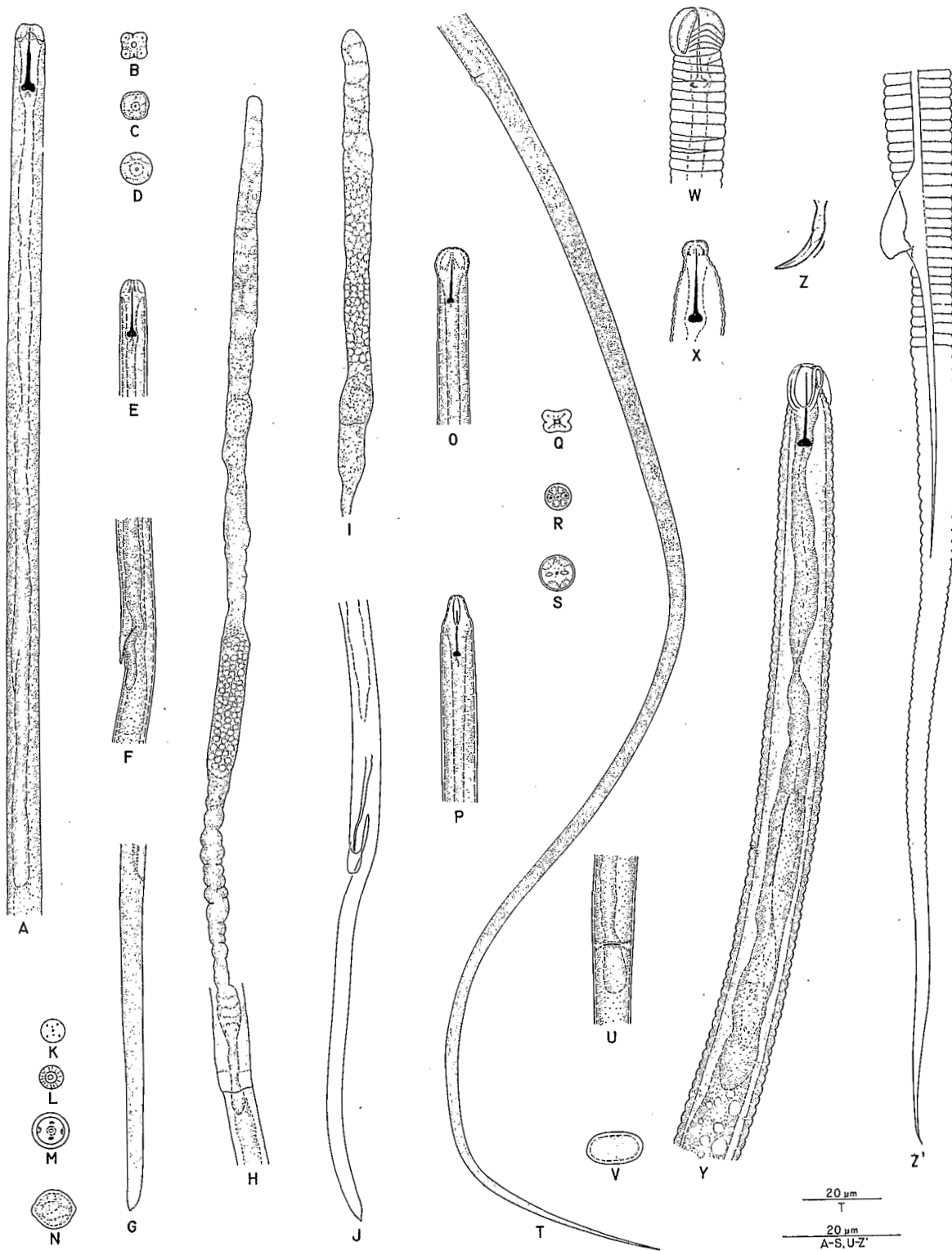


Fig. 3. *Ecphyadophora teres* n. sp. Female, A-D, F-H. A : Oesophageal region ; B-D : Transverse sections from anterior surface (B) each one successively posterior up to (D) ; F : Vulvar region, Lateral view ; G : Tail ; H : Gonad with vulva, ventral view. Male, E, I-J. E : Cephalic region ; I : Gonad ; J : Tail. *Ecphyadophora quadralata* (Texas, USA). Female, K-N : Transverse sections from anterior surface (K) each one successively posterior up to (N). *Ecphyadophoroides sheri* n. sp. Female, O-V. O : Cephalic region, dorso-ventral view ; P : Cephalic region, lateral view ; Q-S : Transverse sections from anterior surface (Q) each one successively posterior up to (S) ; T : Tail region ; U : Vulvar region, ventral view ; V : Transverse section, mid-body. *Ecphyadophoroides macrocephalus* n. sp. Male, W-Z'. W : Cephalic region, dorso-ventral view ; X : Cephalic region, lateral view ; Y : Oesophageal region ; Z : Spicule and gubernaculum ; Z' : Tail.

tode Collection, Beltsville, Maryland; 2 females, 3 juveniles, Nematology Department, Rothamsted Experimental Station, Harpenden, England; 2 females, 3 juveniles, Agricultural University, Wageningen, The Netherlands; 4 females, 4 juveniles, Commonwealth Institute of Helminthology, St. Albans, Herts., England.

DIAGNOSIS

Ecphyadophoroides sheri n. sp. is most closely related to *E. indicus* from which it differs in stylet length (8-9 μm vs. 11-12 μm for *E. indicus*); small rounded cuticular flaps on margins of vulva (apparently lacking in *E. indicus*); fine annulation detectable only on SEM (more strongly developed on *E. indicus*). Unfortunately type specimens of *E. indicus* were not available for more critical comparisons. *E. sheri* n. sp. also bears resemblance to *E. eurycephalus* which was described from a single male only (see above).

ADDITIONAL COLLECTION

Dimensions

Females (7) : L = 0.69 (0.68-0.72) mm; a = 98 (89-108); b' = 5.6 (5.3-6.1); c = ?; stylet = 8-9 μm ; V = $^{17(16-18)}60$ (59-61)^{1.5} (1.3-1.6); excretory pore = 84 (82-86) μm .

Juveniles (3) : L = 0.51 (0.49-0.54) mm; a = 82 (72-93); c = 5.2; stylet = 8 μm ; hemizonid = 67 μm ; excretory pore = 68 μm ; gonad = 33-46 μm long, 275-289 μm from anterior end.

The above specimens were collected by S. A. Sher from soil in a cotton field near Madera, California. The specimens were poorly preserved but definitely resemble *E. sheri* n. sp. The cotton specimens have a smaller size with a range that does not overlap the range of *E. sheri* n. sp. Also the cephalic region does not exhibit as much dilation as seen in *E. sheri* n. sp. This may be due to fixation. In almost all other characteristics these closely resemble *E. sheri* n. sp. and the difference in length is not considered sufficient distinction to represent a separate species.

Ecphyadophoroides graminis

Husain & Khan, 1968

On slide WT 770 labelled *Ecphyadophora tarjani*, two males and one female, Paratypes, from *Cyperus rotundus* L., Aligarh, India were found two males and one juvenile. One male appeared to be *E. tarjani* (see above). The other two, a male and juvenile, are judged conspecific with *Ecphyadophoroides graminis*. Unfortunately the state of preservation was poor and few details discernible. Dimensions taken were as follows :

Male : L = 0.55 mm; a = 128; c = 4.4; stylet = 9.0 μm ; spicules = 11.0 μm . Anterior end rounded, apparently dorso-ventrally flattened, slightly swollen laterad. Stylet very faint, knobs small, apparently asymmetrical. Spicules curved, tylenchoid; gubernaculum not discernible; caudal alae obliquely directed posteriad, about 6 μm long, squared off posteriorly. Body narrows markedly posterior to cloacal opening then narrows gradually giving narrow, fine outline; terminus acute. Cuticle with distinct, fine annulations observable only on oil immersion. Lateral field described as four distinct lines by Husain and Khan not seen.

Juvenile : L = 0.51 mm; a = 93; stylet = 8 μm ; gonad = 54 μm long, located 254 μm from anterior end. Cephalic region similar to male. Stylet very faint, knobs small, symmetrical. Position of gonad suggests fourth-stage female. Tail long, slender, almost whip-like; terminus acute as in male.

Another single male and female identified as *E. graminis* were found in a collection from soil about roots of coconut at Kayangulam, Kerala. They bear the following dimensions :

Female : L = 0.62 mm; V = 61.

Male : L = 0.69 mm; a = 126; b' = 4.5; c = 5.1; stylet = 10 μm ; cone = 4.0 μm ; spicules = 10 μm ; gubernaculum = 3.0 μm ; T = 28; caudal alae = 7 μm . Anterior end rounded, about 5 μm wide, 5 μm long; dorso-ventrally flattened with lateral dilations. Female stylet indistinguishable. Male stylet fine, knobs small but distinct, asymmetrical, dorsal knob slightly anterior to subventrals. Spicules, caudal

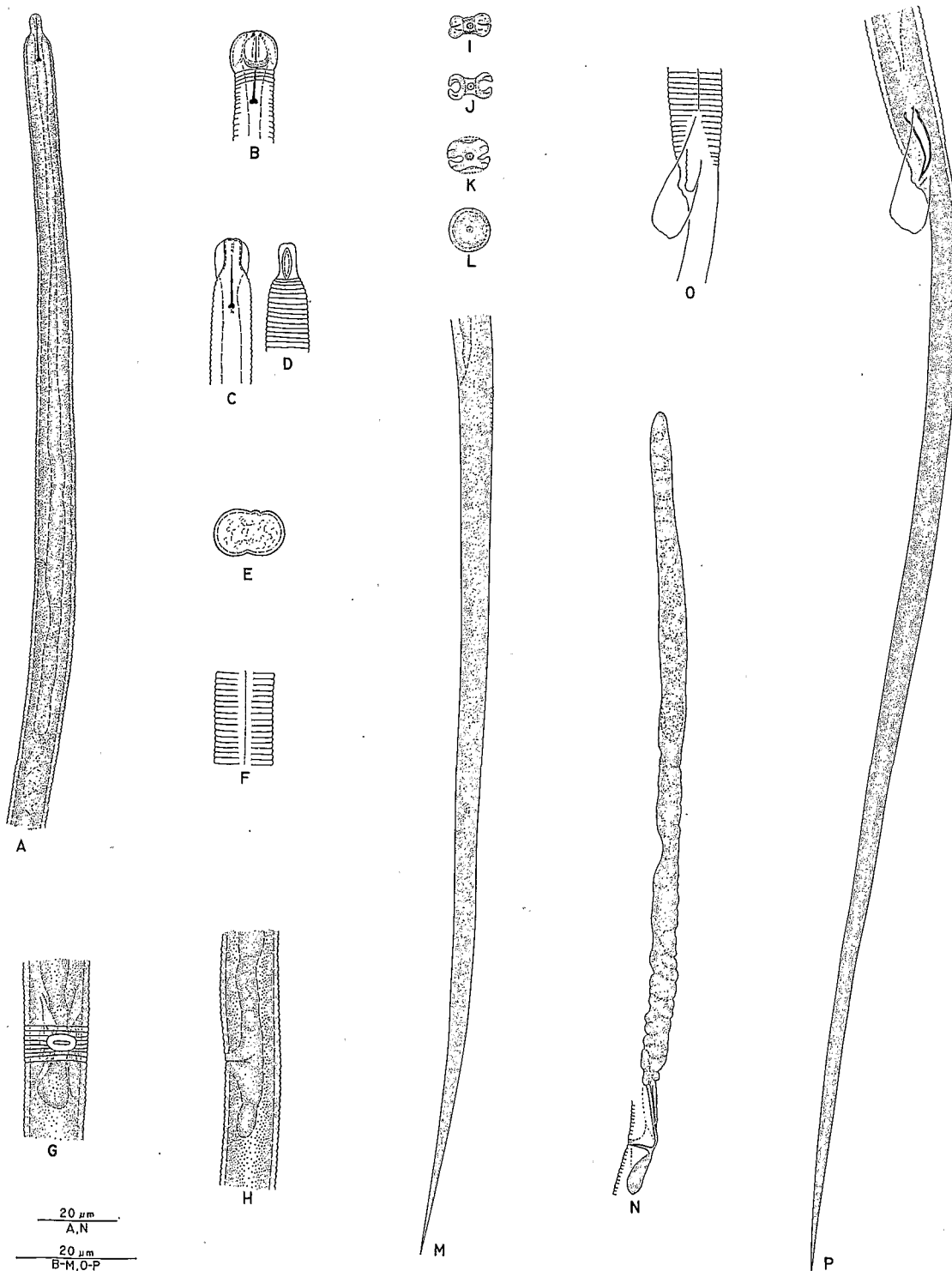


Fig. 4. *Ecpyadophoroides leptocephalus* n. sp. Female, A-N. A : Oesophageal region ; B : Cephalic region, dorso-ventral view ; C : Cephalic region, median level, dorso-ventral view ; D : Cephalic region, surface level, lateral view ; E : Transverse section about mid-body ; F : Lateral field about mid-body ; G : Vulva, ventral view ; H : Vulvar region, lateral view ; I-L : Transverse sections of cephalic region from anterior surface (I) each one successively posterior up to (L) ; M : Tail ; N : Gonad. Male, O-P. O : Caudal alae and cloacal opening, surface view ; P : Tail, spicules and gubernaculum.

alae, tail shape, distinct fine annules as in above male specimen from Aligarh.

Ecphyadophoroides macrocephalus n. sp.
(Fig. 3 W-Z')

DIMENSIONS

Males (3) : L = 0.66 (0.64-0.69) mm ; a = 57 (55-61) ; b' = 5.1 (4.9-5.4) ; c = 4.2-4.3 ; stylet = 13 μ m ; cone = 5-6 μ m ; spicules = 15-17 μ m ; gubernaculum = 4.0-5.0 μ m ; T = 23 (20-29).

Female : Unknown.

Juvenile : Unknown.

Holotype (male) † L = 0.64 mm ; a = 61 ; b' = 5.1 ; c = 4.2 ; stylet = 13 μ m ; cone = 5.5 μ m ; spicules = 16 μ m ; gubernaculum = 5 μ m ; T = 29.

DESCRIPTION

Male : Body curved slightly ventrad when killed by gentle heat ; slender, tapering slightly and gradually to bluntly rounded, dorso-ventrally flattened anterior end ; cephalic capsule about 8-9 μ m long from anterior end to base ; annules narrow and extend anteriorly on capsule on dorsal and ventral sides to within 2-3 μ m from anterior tip. Capsule about 9 μ m wide in dorso-ventral view, laterally bears large oval structures 7-8 μ m long, 4-5 μ m wide at greatest development, probably amphidial in nature but will require SEM photographs to determine more exactly their nature ; stylet prominent, knobs rounded, not definitely sloping backward or projecting forward ; dorsal gland orifice not clearly seen, seems to be close to base of stylet. Excretory pore 82 μ m from anterior end (85-92 μ m in paratypes). Nerve ring not definitely identified. Oesophagus tubular, no metacarpus or valve ; glands extend over intestine, oesophageal-intestinal junction not clearly located, possibly 5 μ m posterior to level of excretory pore ; body begins to narrow markedly at beginning of caudal alae then tapers evenly

through long, slender tail to acute terminus ; spicules tylenchoid, short, curved ; gubernaculum simple, rod-shaped ; caudal alae short, leptoderan, projecting ventrad, beginning about 11-12 μ m anterior to cloacal opening ; ventral edges coincide with ventral margin of lateral field. Caudal alae fin-like, slightly posteriad to cloacal opening outline of alae forms almost a right-angle to body ; then gradually alae continue posteriad and again meet ventral edge of lateral field ; about 17-20 μ m long, 5-6 μ m wide. Testis single, prodelphic, packed with sperm nearly 2 μ m in diameter.

Body has coarse annules up to 2.0 μ m wide ; annules extend laterally to lateral field margins forming one clear band 1.0-1.5 μ m wide, without areolations ; lateral fields extend posteriad to cloacal opening, narrowing gradually, meet and end about 56 μ m from cloacal opening ; body annules become narrower on tail but can be traced to acute terminus.

TYPE HOST

Unknown.

TYPE LOCALITY

Sandy loam soil about roots of coconut, *Cocos nucifera* L., from a depth of 10-75 cm. Palm No. 65, Block No. 1 of Central Plantation Crops Research Institute, Regional Station, Kayangulam, P. O. Krishnapuram, Kerala, India-690 533 ; located at a latitude of 9° 8' N and longitude of 76° 31' E, height of 3.05 m above mean sea level ; a hot, humid, tropical climate, annual rainfall 2 415 mm in 120 days mostly between June and November, mean temperature ranges from 30-34°.

Holotype : Male, collected 26 August 1980, by P. K. Koshy, slide number 1602, UCNC.

Paratypes : Two males, same data as holotype, deposited one each in National Nematode Collection, IARI, India ; Nematology Department, Rothamsted Experimental Station, Harpenden, Herts., England.

DIAGNOSIS

E. macrocephalus n. sp. is distinctive from all other *Ecphyadophoroides* by its well-developed stylet, gross amphidial structures and wide body annules (up to 2.0 μm wide).

It is notable in the original collection two males only of this species were found. An intensive search for more specimens in the type locality yielded over 350 specimens of other ecphyadophorid species but only one additional male of *E. macrocephalus*.

***Ecphyadophoroides leptcephalus* n. sp.**
(Figs 2 A-C, F; 4 A-P)

DIMENSIONS

Females (13) : L = 0.88 (0.71-1.04) mm; a = 78 (66-91); b' = 4.6 (3.7-5.4); c = 5.5 (5.2-6.3); stylet = 10.8 (9.5-12.0) μm ; cone = 5.3-6.3 μm ; V = $^{20(16-25)}62$ (60-68) $^{1.4(1.1-1.8)}$; excretory pore = 138 (114-154) μm .

Holotype (female) : L = 0.90 mm; a = 79; b' = 5.1; c = 5.3; stylet = 11 μm ; cone = 6.3 μm ; V = $^{25}61^{1.2}$; excretory pore = 142 μm .

Allotype (male) : L = 1.01 mm; a = 101; b' = 4.0; c = 5.0; stylet = 11 μm ; cone = 5.0 μm ; spicules = 13 μm ; gubernaculum = 2.0 μm ; T = 25.

Juveniles - 3rd and/or 4th stages (8) : L = 0.60 (0.50-0.75) mm; a = 83 (76-92); b' = 4.9-5.1; c = ?; stylet = 8-11 μm ; hemizonid = 78 μm ; excretory pore = 101 μm ; gonad = 37 μm long, 348 μm from anterior end; annules = average about 0.8 μm wide.

DESCRIPTION

Female : Body assumes an open "C" position when killed by gentle heat in water; body shape slender, cylindrical from vulva anteriorly but narrows slightly and gradually to bluntly rounded anterior end; posteriorly body narrows gradually resulting in long conical outline. Cephalic capsule distinctly set off, about 6-8 μm

long, dorso-ventrally flattened; bearing single innervations on each sublateral pair of lobes (no papillae distinguishable on surface of lobes by SEM photographs). Amphidial opening a slender-ovate cleft about 5-6 μm long; *en face* section shows oral aperture surrounded by small circular elevation bearing six inner papillae; amphidial clefts prominent at various levels in transverse sections. Photographs on SEM (Fig. 2 A, B) confirm dorso-ventral flattening of cephalic capsule, large elongate amphidial clefts bordered with large, smooth, longitudinal, lip-like swellings. Annulations of body strongly developed, extending up to base of amphidial clefts; cephalic capsule smooth. Stylet very slender, knobs only minute dark swellings; dorsal gland aperture obscure, appears to be close to base of stylet; oesophagus long, tubular, glands extending over intestine, oesophageal-intestinal junction obscure, excretory canal prominently sclerotized near pore; vulva without flaps, position not marked by change in body diameter. Ventrally vulva appears as transverse narrow ovate slit surrounded by smooth cuticular band; vagina perpendicular to longitudinal axis, female gonad single, anteriorly directed, outstretched; no evidence of spermatheca; post-uterine branch short, about one vulva body width in length; anus obscure but discernible, about half way from vulva to tail terminus; tail tapers uniformly to acute terminus, annulation continues as minute evidences of striae almost to very tip.

Body annules average about 1.3 μm wide, narrowing slightly near cephalic capsule; lateral field marked by single striation; transverse striae end slightly short of midline giving a narrow band appearance with a mid-line. SEM photographs (Fig. 2 C, F) clearly show strong transverse annulations, about 1 μm wide, forming lateral field as one band, two longitudinal lines about 1 μm apart; vulva with two equal cuticular lips set within oval cuticular formation from 3-4 transverse annules which are slightly narrower in body diameter than adjacent annules. Phasmids not seen.

Male : Only one male collected; similar to female. Body narrows markedly in cloacal region then continues posteriorly almost cylindrical in outline for approximately one-half its length then begins narrowing slightly and uniformly

to acute terminus; spicules tylenchoid, well-developed with set-off capitulum, curved ventrad in distal third, tip acute; caudal alae begin at level of retracted spicule head flap-like in outline, projecting obliquely posteriad with squared off distal edge, about 12 μm long; gubernaculum simple rod-shaped. Two, blunt, cuticular protuberances between caudal alae and cloacal opening on each side of body lateral to cloacal opening.

Body annules similar to female; transverse striae stop slightly short of midline leaving narrow clear band for lateral field; caudal alae originate in lateral field, end merging on dorsal margin of cuticular protrusions beside cloacal opening; lateral field band merges into single line slightly posterior to cloacal opening then imperceptibly disappears at about distance 25% of tail length posterior to cloacal opening.

Juvenile: Similar to adults in general morphology; fixation and preservation poor, too few details discernible to judge differences in stages. Cephalic capsule rounded, about 5 μm at widest, 4-6 μm long. Stylet slender, distinct, knobs finely rounded, symmetrical.

TYPE HOST

Unknown.

TYPE LOCALITY

Sandy loam soil about roots of coconut, *Cocos nucifera* L., from a depth of 10-75 cm. Palm No. 65, Block No. 1 of Central Plantation Crops Research Institute, Regional Station, Kayangulam, P. O. Krishnapuram, Kerala, India-690 533; located at a latitude of 9° 8' N and longitude of 76° 31' E, height of 3.05 m above mean sea level; a hot, humid, tropical climate, annual rainfall 2 415 mm in 120 days mostly between June and November, mean temperature ranges from 30-34°.

TYPE MATERIAL

Holotype: Female, collected 26 August 1980, by P. K. Koshy, slide number 1563, UCNC, Davis.

Allotype: Male, same data as holotype, slide number 1564, UCNC, Davis.

Paratypes 1 55 females, two juveniles, same data as holotype deposited as follows: 25 females, two juveniles, UCDNC; 5 females each to the following: National Nematode Collection, Indian Agricultural Research Institute, New Delhi, India; Nematology Laboratory, CPCRI Regional Station, Kayangulam, Kerala State, India; USDA Nematode Collection, Beltsville, Maryland; Nematology Department, Rothamsted Experimental Station, Harpenden, Herts., England; Agricultural University, Wageningen, The Netherlands; Commonwealth Institute of Helminthology, St. Albans, Herts., England.

DIAGNOSIS

Ecphyadophoroides leptcephalus n. sp. is most closely related to *E. indicus* from which it can be distinguished by the coarser annules (averaging 1.0 μm wide vs 0.4-0.5 μm for *E. indicus*); excretory pore strongly sclerotized and more posteriorly located (138 (114-154) μm vs faintly sclerotized and 96-105 μm from anterior end in *E. indicus*); spermatheca lacking (*E. indicus* described with distinct oval spermatheca); acute terminus vs finely rounded in *E. indicus*. Unfortunately type specimens of *E. indicus* were not available for study and comparison of all the characteristics of both species. There is critical need to do so because no mention is made of dorso-ventral flattening of anterior end in *E. indicus* and this cannot be determined from illustration given. The cephalic capsule is shown with an oblique longitudinal line suggesting an amphidial cleft and the narrowing, cleared cephalic capsule further suggests similarity to dorso-ventral flattening. This needs confirmation.

Ecphyadophoroides indicus Verma, 1972

No specimens, paratypes or others, available for study. This species was described from females only. Study of type material would be most valuable to confirm the characters as described. Meantime, the differences reported above distinguishing *E. indicus* from *E. lept-*

cephalus n. sp. are judged sufficient to justify separate specific status for the two.

Genus **Epicharinema** Raski, Maggenti,
Koshy & Sosamma, 1980

DIAGNOSIS (emended)

Ecphyadophorinae. Body longest (L = 1.11-1.53 mm) of this subfamily, smooth over most of body, several faint annules seen on scanning electron microscope immediately posterior to cephalic region. Cephalic capsule smooth, flattened dorso-ventrally, amphids with long, sinuous clefts. Stylet 38-52 μm ; cone very slender, longer than base. Metacarpus distinctly rounded and set off, with well-developed valve. Oesophageal glands slightly overlapping intestine. Postuterine branch lacking. Spicules long (39-43 μm), slightly curved ventrally. Caudal alae prominent, leptoderan, with two sclerotized ribs supporting each ala. Gubernaculum 8-14 μm , thin but clearly evident.

TYPE AND ONLY SPECIES

Epicharinema keralense Raski, Maggenti, Koshy & Sosamma, 1980.

Key to species of *Ecphyadophora*

- 1 — V = 56-58 *vallipuriensis*
- V > 69 2
- 2 — Exceptionally thin, a > 133 3
- a < 122 *quadralata*
- 3 — Stylet prominent, knobs well-developed; long spicular tube (5-7 μm) *teres*
- Stylet fine, knobs moderately developed; spicular tube short *tenuissima*

Key to species of *Ecphyadophoroides*

- 1 — Body with 12 longitudinal striations dividing annules into rectangular blocks *annulatus*
- Body annules without such striations 2
- 2 — Body annules coarse (up to 2.0 μm wide)
... *macrocephalus*
- Body annules fine or moderate (\leq 1.3 μm wide) 3

- 3 — Lateral field with 4 lines *graminis*
- Lateral field with 2 lines or not observed 4
- 4 — Body annules averaging 1.3 μm wide
..... *leptocephalus*
- Body annules finer, averaging 0.5 μm wide .. 5
- 5 — V \geq 65 *tenuis*
- V \leq 62 6
- 6 — L \leq 0.89 mm *sheri*
- L \geq 0.91 mm *indicus*

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REFERENCES

- CORBETT, D. C. M. (1964). Central African nematodes. I. *Ecphyadophora quadralata* n. sp. and two species of *Ecphyadophoroides* n. gen. (Nematoda: Neotylenchidae). *Nematologica*, 10: 121-130.
- DE MAN, J. G. (1921). Nouvelles recherches sur les nematodes libres terricoles de la Hollande. *Capita zool.*, 1: 1-62.
- HUSAIN, S. I. & KHAN, A. M. (1965). A new genus and six new species of nematodes from India belonging in the family Neotylenchidae with an amendment of the subfamily Ecphyadophorinae. *Proc. helminth. Soc. Wash.*, 32: 7-15.
- HUSAIN, S. I. & KHAN, A. M. (1968). *Ecphyadophoroides graminis* n. sp. and two new species of *Ecphyadophora* (Nematoda: Ecphyadophorinae) from North India. *Nematologica*, 14: 377-384.
- RASKI, D. J., MAGGENTI, A. R., KOSHY, P. K. & SOSAMMA, V. K. (1980). *Epicharinema keralense*

- n. gen., n. sp., and comments on Atylenchinae and Ecphyadophorinae (Nemata : Tylenchidae). *Revue Nématol.*, 3 : 297-304.
- SURYAWANSHI, M. V. (1971). Studies on Tylenchida (Nematoda) from Marathwada, India, with descriptions of four new species. *Nematologica*, 17 : 393-406.
- TARJAN, A. C. (1957). Observations on *Ecphyadophora tenuissima* de Man, 1921. *Nematologica*, 2 : 152-158.
- VERMA, R. S. (1972). Three new species of nematodes in the subfamily Ecphyadophorinae associated with cereal crops in Uttar Pradesh (India). *Zool. Anz.*, 189 : 89-94.

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