Two new and two known species of the genus *Paraoxydirus* Jairajpuri and Ahmad, 1978 (Nematoda: Dorylaimida) from Western Ghats of India

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Article info

Received October 13, 2020

Accepted February 15, 2021

Summary

Two new and two known species of the genus *Paraoxydirus* Jairajpuri and Ahmad, 1978 are described and illustrated from Western Ghats of India. *P. vulvalpapillatus* n. sp. is characterized by having large sized body ($L = 4.6 - 4.8$ mm); lip region continuous with completely amalgamated lips; amphidial fovea cup-shaped; $5 - 6$ μ m long odontostyle; $11 - 13$ μ m long odontophore; pharyngeal expansion about $28 - 36$ % of neck length; transverse vulva; vulval papillae conspicuous; males with $46 - 54$ μ m long spicules; $11 - 14$ continuous ventromedian supplements and long filiform tail similar in both sexes. *P. indicus* n. sp. is characterized by having large sized body ($L = 4.0 - 4.8$ mm); lip region poorly offset with amalgamated lips; amphidial fovea cup-shaped; $7 - 8$ μ m long, robust odontostyle; $17 - 18$ μ m long odontophore; pharyngeal expansion about $32 - 40$ % of neck length; $21 - 26$ μ m long cardia; longitudinal vulva; $748 - 894$ μ m long filiform tail; males with $45 - 54$ μ m long spicules and $12 - 15$ continuous ventromedian supplements. *P. gigas* Jairajpuri, 1964 and *P. novus* Jairajpuri, 1965 are redescribed based on specimens collected from several localities. A diagnostic Key and compendium to the identification of its eight valid species is provided.

Keywords: Compendium; description; India; new species; *Paraoxydirus*; Western Ghats

Introduction

Jairajpuri and Ahmad (1978) proposed a new genus *Paraoxydirus* for *Oxydirus* species having asymmetrical lip region and odontostyle and short fusiform basal expanded part of the pharynx enclosed in a thick sheath of sinistrally spiral muscles, and designated *P. magnus* (= *Oxydirus magnus* Timm, 1964) as its type species and also transferred *P. gigas* (= *O. gigas* Jairajpuri, 1964), and *P. novus* (= *O. novus* Jairajpuri, 1965) from *Oxydirus* Thorne, 1939 to this genus. Ferris, Goseco and Ferris (1980) revised the genus *Oxydirus* and proposed a new genus *Tarjanius* with two new species *Tarjanius pelinus* Goseco, Ferris & Ferris, 1980 and *T. cavnessi* Goseco, Ferris and Ferris, 1980 and also transferred three

species, viz., *O. magnus*, *O. gigas* and *O. novus* from *Oxydirus* to this genus and provided a key for the identification of five valid species. Later, Ferris, Goseco and Ferris (1981) synonymised *Tarjanius* with *Paraoxydirus*. Dhanam and Jairajpuri (1998) added a new species *P. abnormus* from India. No further species has been added to this group since then. In recent years, we collected several populations of this rare genus from Western Ghats, a biodiversity hot spot in India. Some specimens were also collected from North-east India, another biodiversity hot spot in India. On detailed study these populations were found to represent four species, two of which are new to science. All the four species are described in the following. A diagnostic compendium as well as key to species of the genus is also provided.

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Fig. 1. *Paraoxydirus gigas* Jairajpuri, 1964. (A) Entire male; (B) entire female; (C) anterior region; (D) anterior end showing amphid; (E) expanded part of pharynx; (F) female genital system; (G) vulval region; (H) male posterior region; (I) spicule; (J) male posterior region; (K) female posterior region.

Fig. 2. *Paraoxydirus gigas* Jairajpuri, 1964. (A, B) Anterior region; (C) anterior region showing amphid; (D) expanded part of pharynx & DN; (E) cardia; (F) vulval region; (G,H) female genital branch; (I) rectum; (J) spicule; (K) ventromedian supplements; (L) female tail; (M) lateral guiding piece. (Scale bars: A – F, I, J, M = 10 μ m; G, H, K = 20 μ m; L = 100 μ m).

Materials and Methods

Soil samples were collected from around the roots of grasses, bushes, crop plants and forest trees in different localities of the Western Ghats (Indian states of Goa, Karnataka, Tamil Nadu and Kerala) as well as from Assam, India. Nematodes were extracted from the soil samples by Cobb's (1918) sieving and decantation and modified Baermann funnel technique. Nematode were killed and fixed in hot 4 % TAF (Courtney *et al.*, 1955) and dehydrated by slow evaporation in the desiccators containing desiccant and mounted in anhydrous glycerin on slides (Seinhorst, 1959). For scanning electron microscopy (SEM), dehydrated specimens were rehydrated then fixed in glutaraldehyde by using phosphate buffer, and dehydrated in ethanol series. Critical point dried specimens were coated with gold and observed in a JEOL JSM-65 10LV scanning electron microscope. Measurements were taken by using ocular micrometer and line illustrations were made using a drawing tube attached to OLYMPUS BX 51 Microscope. Photographs were taken with digital camera attached to "Nikon Eclipse 80i" Microscope. Photographs of the specimens were prepared by using Adobe Photoshop 7.0. Computer software. Spicule morphometrics were taken as per Peña-Santiago *et al.* (2014). Andrssy's (1998) as well as Loof and Coomans (1970) formula was followed for the measurements of the position of pharyngeal glands and their nuclei.

Results

Paraoxydirus gigas (Jairajpuri, 1964) Jairajpuri and Ahmad, 1978

= *Oxydirus gigas* Jairajpuri, 1964

= *Tarjanius gigas* (Jairajpuri, 1964) Ferris, Goseco and Ferris, 1980

(Figs. 1 & 2)

Measurements: See Table 1

Description: Adult: Large size nematodes, slightly curved ventrad, cylindroid, tapering towards both extremities but more so towards posterior end as tail is long filiform. Cuticle with fine transverse striations, about 1.0 μ m thick at anterior region, similar in both sexes, 1 – 3 μ m at mid-body, 3 – 6 μ m on tail in females, and about 2 μ m at mid body, 2 – 3 μ m on tail in males. Lateral chords with indistinct glandular bodies, 10 – 16 μ m wide, and occupying about one-fifth to one-fourth (19 – 25 %) of mid-body diameter. Body pores indistinct. Lip region continuous, gradually narrowing, about 2.0 – 2.7 times as wide as high or about one-fifth to one-fourth (20 – 25 %) of body diameter at neck base. Lips weakly angular, amalgamated, cephalic framework with poorly developed refractive elements; cephalic papillae distinct. Stoma wall poorly sclerotized. Amphidial fovea cup-shaped, their aperture occupying about 0.5 – 0.7 times the lip region diameter, fusus slightly posterior to odontophore base level. Guiding ring simple, poorly developed, at 0.4 – 0.6 times lip region diameter from anterior end.

Odontostyle slender, its ventral arm slightly bent at tip, 5 – 6 times as long as wide, about 0.4 – 0.6 times as long as lip region diameter, its aperture about one-third of its length. Odontophore simple, rod-like, weakly developed, 1.8 – 2.8 times the odontostyle length. Nerve ring encircling the anterior slender part of pharynx at about 41 – 49 % of neck length from anterior end. Anterior slender part of pharynx quite muscular, expanding gradually; expanded part 3.0 – 4.2 times as long as wide, 1.9 – 2.6 times as long as body diameter at neck base, occupying about 28 – 35 % of total neck length, enclosed in a thick sheath of sinistrally spiral muscles. Pharyngeal gland nuclei and their orifices are located as follows: DO = 73 – 75; DN = 74 – 76; DO-DN = 1.5-1.8; S1N1 = 82 – 83; S1N2 = 84; S2N = 94 as per Loof and Coomans (1970); D = 75 – 76; AS1 = 30 – 32; AS2 = 34; K = 88 – 92; PSN = 78 as per Andrssy (1998). Cardia oblong, 1.1 – 2.3 times as long as wide, occupying about one-fourth to less than one-half (26 – 45 %) of the corresponding body diameter.

Female: Genital system amphidelphic, both branches almost equally developed, anterior 6.7 – 9.3 % (n = 8) and posterior 7.4 – 9.6 % (n = 8) of total body length. Ovaries reflexed, not reaching oviduct-uterus junction, anterior 70 – 203 μ m, and posterior 69 – 250 μ m long, with squamous shaped oocytes arranged in single row except near tip. Oviducts joining ovary subterminally, anterior 133 – 240 μ m and posterior 147 – 240 μ m long, consisting of a long slender part with prismatic cells and a slightly wider *pars dilatata* with wide lumen. Sphincter present at oviduct-uterus junction. Uterus simple tube, but occasionally appearing bipartite (n=1), differentiated into a short proximal region with distinct lumen, and a large distal part with comparatively wide lumen; anterior branch 136 – 295 μ m or 2.5 – 4.8 times, and posterior 161 – 326 μ m or 3.0 – 5.3 times the corresponding body diameter long. Vagina extending inwards, about one-half to three-fifths (49 – 60 %) of corresponding body diameter; *pars proximalis vaginae* longer than wide, 18 – 22 $\times$ 6 – 8 μ m, with somewhat sigmoid walls, surrounded by circular muscles; *pars refringens vaginae* with two adjacent trapezoid-shaped pieces, 3 – 5 $\times$ 7 – 9 μ m, their combined width 15 – 24 μ m; *pars distalis vaginae* 4 – 6 μ m with rounded walls. Vulva transverse. Prerectum 7.4 – 10.3 and rectum 1.0 – 1.3 times anal body diameter long. Tail long filiform, 18 – 21 (n = 8) times anal body diameter long. Caudal pores two; sub-dorsal and sub-ventral in position.

Male: Similar to female in general morphology, except for posterior region of the body being more ventrally curved. Genital system diorchic, with oppositely outstretched testes. In addition to the adcloacal pair, located at 10 – 11 μ m from cloacal aperture, a series 11 – 14 irregularly spaced ventromedian supplements, 7 – 19 μ m apart, beginning at 94 – 103 μ m from the adcloacal pair. Copulatory muscles conspicuous, beginning from level of middle of spicule to beyond the range of supplements series. Spicules typically dorylaimoid, robust slightly curved ventrad, total length along the arc 1.0 – 1.1 times as long as chord, 4.3 – 5.2 times the maximum width and 1.5 – 1.8 times the body diameter at cloacal aperture.

Table 1. Measurements of *Paraoxydinus gigas* Jairajpuri, 1964 (All the measurements in μm except L in mm).

Locality	Goa population			Assam population			Nainital (type population)			Bijnore population (After Baqri & Jairajpuri, 1968)			others**	
Characters	Females	Males	Male	Females	Males	Male	Females	Males	Female	Males	Females	Males	Females	Males
n	8	5	1	4		1	2	2	1	2	25	10		
L	4.3 $\pm$ 0.2 (4.1 – 4.6)	4.2 $\pm$ 0.3 (3.8 – 4.5)	3.5	3.9 $\pm$ 0.4 (3.3 – 4.5)		3.5	3.8 – 4.5	3.7 – 4.3	3.89	3.6, 3.7	3.7 – 4.3	3.7 – 4.0		
Body width at neck base	44.2 $\pm$ 2.2 (42 – 49)	42.2 $\pm$ 1.0 (42 – 45)	40	46.2 $\pm$ 3.3 (42 – 51)		40	50*		-	-	50*	-		
Body width at mid body	54.4 $\pm$ 2.7 (50 – 59)	50.6 $\pm$ 2.3 (48 – 54)	49	57.2 $\pm$ 4.8 (52 – 62)		49			-	-	-	-		
Body width at anus/ cloaca	30 $\pm$ 1.1 (28 – 31)	34.7 $\pm$ 1.1 (33 – 36)	32	30.7 $\pm$ 1.6 (28 – 32)		32	30*	30*	-	-	-	-		
a	81.4 $\pm$ 3.2 (77 – 85.3)	83 $\pm$ 2.7 (80.5 – 87.7)	71.3	69.2 $\pm$ 3.4 (64.4 – 73)		71.3	65 – 66	61 – 86	70	84, 86	28 – 34	33 – 35		
b	14 $\pm$ 0.5 (13.5 – 14.7)	13.1 $\pm$ 1.0 (11.3 – 14.1)	10.7	12.3 $\pm$ 0.9 (11.1 – 13.7)		10.7	12 – 13	12 – 13	12.8	12, 12.2	72 – 83	66 – 79		
c	7.6 $\pm$ 0.3 (7.2 – 8.2)	9.2 $\pm$ 0.8 (8.2 – 10.3)	10.6	9.8 $\pm$ 0.8 (9.1 – 11.2)		10.6	10	11 – 12	9	10, 15	11 – 13	11.5 – 13		
c'	19.2 $\pm$ 0.8 (18.2 – 20.6)	13.2 $\pm$ 0.7 (12.2 – 13.9)	10.3	13.2 $\pm$ 1.7 (10.7 – 15.4)		10.3	13	12	-	-	14*	10 – 16		
V	38.7 $\pm$ 2.4 (34.8 – 42.1)	-	-	37.8 $\pm$ 1.5 (36.3 – 40.4)		-	40 – 42	-	39	-	42 – 45	13.5*		
G1	8.2 $\pm$ 1.0 (6.7 – 9.3)	-	-	11.3 $\pm$ 1.2 (9.8 – 13)		-	-	-	-	-	9 – 15	-		
G2	8.3 $\pm$ 0.8 (7.4 – 9.6)	-	-	12.5 $\pm$ 1.3 (10.6 – 14)		-	-	-	-	-	9 – 18	-		
Lip region width	10.2 $\pm$ 0.4 (10 – 11)	10.4 $\pm$ 0.5 (10 – 11)	10	10		10	-	11*	-	-	11*	-		
Lip region height	4.5 $\pm$ 0.5 (4 – 5)	4.2 $\pm$ 0.4 (4 – 5)	5	4		5	-	5*	-	-	4*	-		
Amphid aperture width	6.5 $\pm$ 0.5 (6 – 7)	6.5 $\pm$ 0.5 (6 – 7)	7	6.2 $\pm$ 0.4 (6 – 7)		7	-	6*	-	-	-	-		
Odontostyle length	5.1 $\pm$ 0.3 (5 – 6)	5	6	5.3 $\pm$ 0.5 (5 – 6)		6	-	5*	-	5, 7	6 – 7	6 – 7		
Odontophore length	12.2 $\pm$ 0.6 (11 – 13)	13	11	10.6 $\pm$ 0.9 (10 – 12)		11	-	10*	-	8, 10	10 – 12	12 – 13		
Guiding ring from ant. End	5	5	6	5.3 $\pm$ 0.5 (5 – 6)		6	-	-	-	-	6*	-		
Nerve ring from ant. End	145.5 $\pm$ 7.1 (137 – 157)	148.2 $\pm$ 5.3 (141 – 157)	140	144.2 $\pm$ 1.9 (142 – 147)		140	-	-	-	-	130*	-		
Neck length	314.7 $\pm$ 7.2 (304 – 326)	321.8 $\pm$ 11.2 (309 – 342)	325	321.2 $\pm$ 15.5 (302 – 341)		325	-	-	-	-	320 – 350	290 – 305		
Expanded part of pharynx	101 $\pm$ 4.2 (93 – 108)	94.4 $\pm$ 5.8 (88 – 104)	113	101.5 $\pm$ 13.5 (85 – 118)		113	-	-	-	-	130*	-		
Cardia length	14.3 $\pm$ 1.6 (12 – 17)	16.2 $\pm$ 0.8 (15 – 17)	17	17.2 $\pm$ 3.3 (13 – 21)		17	-	14*	-	-	20*	-		
Anterior genital branch	364.3 $\pm$ 38 (305 – 405)	-	-	447.2 $\pm$ 60.6 (398 – 547)		-	-	-	-	-	-	-		
Posterior genital branch	372.4 $\pm$ 31.6 (320 – 410)	-	-	495.2 $\pm$ 66 (405 – 590)		-	-	-	-	-	-	-		
Vaginal depth	29.4 $\pm$ 2.3 (27 – 34)	-	-	31, 32		-	-	-	-	-	38*	-		
Vulva from ant. end	1708 $\pm$ 94 (1519 – 1795)	-	-	1504.3 $\pm$ 199 (1242 – 1698)		-	-	-	-	-	-	-		
Prerectum length	277.1 $\pm$ 34.4 (260 – 303)	418 $\pm$ 29.3 (370 – 457)	280	271 $\pm$ 35.1 (220 – 319)		280	-	-	-	-	260 – 360	-		
Rectum length	34.5 $\pm$ 3.1 (30 – 39)	51.5 $\pm$ 2.7 (48 – 55)	50	37, 41		50	-	50*	-	-	29 – 36	-		
Tail length	577.5 $\pm$ 13.3 (565 – 604)	454.6 $\pm$ 14.6 (440 – 480)	330 broken	407.5 $\pm$ 65.9 (300 – 478) (broken)		330 broken	-	-	-	-	250 – 345	220 – 350		
Spicule length	-	52.7 $\pm$ 0.8 (52 – 54)	57	-		57	-	50	-	48, 51	-	50 – 55		
Lateral guiding pieces	-	11.2 $\pm$ 1.5 (9 – 13)	12	-		12	-	-	-	-	-	10 – 11		
Ventromedian supplements	-	10 – 14	11	-		11	-	15	-	13	-	11 – 13		

(*) = Calculated measurements from illustrations; (Broken) = broken tail length.

**Several-Indian populations; several district of Uttar Pradesh, Himachal Pradesh and Punjab states (Jairajpuri & Ahmad, 1978)

Fig. 3. *Paraoxydirus novus* Jairajpuri, 1965. (A) Entire female; (B) anterior region; (C) anterior region showing amphid; (D) expanded part of pharynx; (E) female genital system; (F) vulval region; (G) female posterior region.

Fig. 4. *Paraoxydirus novus* Jairajpuri, 1965 (A) Anterior region showing body pores; (B) anterior region; (C) anterior region showing amphid; (D) expanded part of pharynx; (E) spiral muscular sheath; (F) cardia; (G) vulval region; (H, I) female genital branch; (J) proximal part of ovary showing muscular sheath; (K) rectum; (L) tail. (Scale bars: A – G, K = 10 μ m; H – J = 20 μ m; L = 100 μ m).

Curvature about 133°. Dorsal contour regularly convex, ventral contour bearing prominent hump, located at 31–37 % of spicules total length from its anterior end; head 5–7 µm long, occupying about 9–13 % of total length; median piece 16–25 times as long as wide, occupying about 17–25 % of spicules maximum width. Posterior end 3–5 µm wide. Lateral guiding pieces simple, 6–7 times as long as wide or about one-sixth to one-fourth of spicules length. Prerectum 8.7–13.8 and rectum 1.4–1.6 times cloacal body diameter long. Tail long filiform, about 12.3–13.9 (n = 5) times cloacal body diameter long. Caudal pores three; a ventral, dorsal and sub-dorsal respectively.

Habitats and localities: Soil samples collected from around the root of: i) unidentified grass from Canacona, South Goa, India; coordinates 14°59'35.21" N 74°2'51.5" E on April 18, 2016; ii) paddy from Tinsukia district, Assam, India; coordinates 27°30'0.0" N 95°22'1.2" E on November 26, 2005.

Diagnosis and Remarks: *P. gigas* is characterized by having 3.3–4.6 mm long body; lip region continuous, 10–11 µm wide; amphidial fovea cup-shape; guiding ring weak; odontostyle slender, 5–7 µm long; expanded part of pharynx about 28–35 % of total neck length; female genital system amphidelphic; vulva transverse, pre equatorial; *pars refringens vaginae* present; tail long filiform similar in sexes; males with 52–54 µm long spicules, 9–13 µm long lateral guiding pieces and 10–14 continuous ventromedian supplements. Jairajpuri (1964) described this species as *Oxydirus gigas* based on two females, two males and large number of juveniles from around roots of *Psidium guajava* L. from Nainital district of Uttarakhand, India. Siddiqi (1966) redescribed it based on a single male specimen from Madhya Pradesh and considered it a synonym of *O. magnus* Timm, 1964. Baqri and Jairajpuri (1968) reported this species from Bijnore, Uttar Pradesh and concluded that both these species are distinctly different. Jairajpuri and Ahmad (1978) recorded this species from several localities (Lakhimpur Kheri, Uttar Pradesh; Mandi, Kulu, Manali, Himachal Pradesh and Pathankot, Punjab) of India and transferred it to their newly proposed genus *Paraoxydirus*. Ferris, Goseco and Ferris (1980) in their revision of Belondiroidea provided description of this species based on the study of type material and placed it under their new genus *Tarjanus* as *T. gigas*. Ferris, Goseco and Ferris (1981) latter synonymized *Tarjanus* with *Paraoxydirus*. The present population of *P. gigas* from Goa and Assam India, conforms well with the original description except in having comparatively slender body (a = 77–85 vs 65–66); presence of vaginal sclerotization (vs vaginal sclerotization not mentioned); longer tail (c = 7.2–8.2 vs 10; c' = 18–20.6 vs 13); slightly longer spicules (52–57 vs 50 µm); it differs from the Madhya Pradesh male specimen in having longer tail (c = 8.2–10.3 vs 14); longer spicules (52–57 vs 49 µm) and slightly longer lateral guiding pieces (11–13 vs 10 µm); from Bijnore population it differs, in having slightly longer body (L = 4.0–4.36 vs 3.9 mm); shorter pharynx (b = 13.4–14.7 vs 12.8); longer tail (c = 7.2–8.2 vs 9); slightly longer spicules (52–57 vs 48–51 µm), and from Uttar Pradesh, Himachal Pradesh and

Punjab populations (Jairajpuri & Ahmad, 1978), in having longer tail (c = 7.2–8.2 vs 11–17 c' = 18.2–20.6 vs 14). It seems, the present populations consistently have longer tail than earlier described ones. It would not be out of place to mention that in such species with very long filiform tail, the tail is generally broken, however, for comparison we have taken the measurements of only those females which have intact tail.

***Paraoxydirus novus* (Jairajpuri, 1965) Jairajpuri and Ahmad, 1978**

=*Oxydirus novus* Jairajpuri, 1965

=*Tarjanus novus* (Jairajpuri, 1965) Ferris, Goseco and Ferris, 1980

(Figs. 3 & 4)

Measurements: See Table 2

Description: Female: Large sized nematodes, slightly curved ventrad, cylindroid, tapering towards both extremities but more so towards the posterior end as tail is long filiform. Cuticle with fine transverse striations, about 2–3 µm thick at anterior and mid-body, 4–5 µm on tail. Lateral chords with indistinct glandular bodies, 9–16 µm wide, and occupying about one-sixth to one-fourth (14.5–25.6 %) of mid body diameter. Ventral body pores poorly distinct, 11 in number; 6 in the pharyngeal region, 2 between pharyngeal base and vulva, and 3 from vulva to anus. Lip regions asymmetrical, slightly offset, about 2–3 times as wide as high or about one-fifth to one-fourth (20–25 %) of body diameter at neck base. Lips amalgamated, cephalic framework with poorly developed refractive elements; cephalic papillae distinct. Amphidial fovea stirrup-shaped, their aperture about half of lip region diameter, fusus at level of odontophore base. Guiding ring single, very conspicuous, at 0.5–0.9 times the lip region diameter from anterior end. Odontostyle robust, 3.2–4.0 times as long as wide, 0.5–0.7 times as long as lip region diameter, its aperture about one-half of its length. Odontophore simple, rod-like, 1.7–2.6 times the odontostyle length. Nerve ring encircling anterior slender part of pharynx at about 37–49 % of the neck length from anterior end. Anterior slender part of pharynx quite muscular, expanding gradually; expanded part 3.6–5.2 times as long as wide, 1.7–2.7 times as long as body diameter at neck base, occupying about 28–41 % of total neck length, enclosed in a thick sheath of sinistrally spiral muscles. Pharyngeal gland nuclei and their orifices are located as follows: DO = 67–71; DN = 67–72; DO-DN = 0.6–1.0; S1N1 = 75; S1N2 = 80; S2N = 93 as per Loof and Coomans (1970); D = 67–71; AS1 = 20; AS2 = 34; K = 58; PSN = 78 as per Andrssy (1998). Cardia oblong, 1.0–1.8 times as long as wide, occupying about one-third of the corresponding body diameter. Genital system didelphic–amphidelphic, both the sexual branches almost equally developed, anterior 8.8–11.5 % (n = 9) and posterior 9–12 % (n = 9) of body length. Ovaries reflexed, not reaching oviduct-uterus junction, anterior 78–135 µm, and posterior 88–145 µm long, with squamous shaped oocytes arranged in single row except near tip. Oviducts joining ovary subterminally, anterior

Table 2. Measurements of *Paraoxydrius novus* Jairajpuri, 1965 (All the measurements in μm except L in mm).

Locality	Tamil Nadu population	Karnataka population	Goa population	Assam population
Characters	Females	Females	Females	Females
n	6	4	5	5
L	3.9 $\pm$ 0.1 (3.7 – 4.0) (n=3)	3.4 $\pm$ 0.1 (3.3 – 3.5)	3.3 $\pm$ 0.1 (3.2 – 3.5) (n=3)	3.2 $\pm$ 0.1 (3.1 – 3.4) (n=3)
Body width at neck base	52.6 $\pm$ 3.8 (50 – 61)	46.5 $\pm$ 1.7 (44 – 48)	49.4 $\pm$ 3.8 (43 – 54)	49.4 $\pm$ 4.3 (42 – 55)
Body width at mid body	61.1 $\pm$ 3.8 (57 – 69)	57.7 $\pm$ 3.4 (52 – 61)	59.8 $\pm$ 5.9 (49 – 67)	55.4 $\pm$ 4.4 (50 – 62)
Body width at anus/ cloaca	32.5 $\pm$ 1.6 (31 – 36)	31.7 $\pm$ 1.1 (30 – 33)	31.2 $\pm$ 1.5 (30 – 33)	29 $\pm$ 1.4 (27 – 31)
a	61.7 $\pm$ 3.9 (56.7 – 66.2) (n=3)	59 $\pm$ 4.0 (55.6 – 65.8)	55.3 $\pm$ 2.3 (52.4 – 58) (n=3)	58.7 $\pm$ 5.3 (53 – 68.2) (n=3)
b	11.7 $\pm$ 0.4 (11 – 12.2) (n=3)	10.6 $\pm$ 0.2 (10.2 – 10.8)	10 $\pm$ 0.4 (9.7 – 10.6) (n=3)	10.6 $\pm$ 0.5 (9.9 – 11.2) (n=3)
c	5.3 $\pm$ 0.2 (5.1 – 5.4) (n=3)	7.3 $\pm$ 1.1 (6.3 – 9.1)	4.8 $\pm$ 0.3 (4.5 – 5.2) (n=3)	4.6 $\pm$ 0.5 (4.0 – 5.4) (n=3)
c'	22.1 $\pm$ 1.9 (20 – 24.7) (n=3)	14.8 $\pm$ 2.4 (11.2 – 17.1)	22.3 $\pm$ 1.5 (20.3 – 23.7) (n=3)	24.3 $\pm$ 3.2 (20.5 – 28.7) (n=3)
V	34.6 $\pm$ 1.1 (33.4 – 36.1) (n=3)	33.7 $\pm$ 2.3 (29.7 – 35.3)	34.9 $\pm$ 0.8 (33.8 – 35.8) (n=3)	33.8 $\pm$ 0.3 (33.4 – 34.2) (n=3)
G1	10.3, 9.7	10.4 $\pm$ 0.6 (9.6 – 11.2)	11.2 $\pm$ 0.2 (11 – 11.4) (n=3)	9.1 $\pm$ 0.3 (8.9 – 9.5) (n=3)
G2	10.2 $\pm$ 0.4 (9.8 – 10.7)	11.1 $\pm$ 1.2 (9.8 – 13.0)	11.4 $\pm$ 0.6 (10.5 – 12) (n=3)	9.3 $\pm$ 0.1 (9.2 – 9.5) (n=3)
Lip region width	12.3 $\pm$ 0.5 (12 – 13)	11.2 $\pm$ 0.4 (11 – 12)	11	10.4 $\pm$ 0.5 (10 – 11)
Lip region height	5	4.5 $\pm$ 0.5 (4 – 5)	4.6 $\pm$ 0.5 (4 – 5)	4.7 $\pm$ 0.4 (4 – 5)
Amphid aperture width	6.6 $\pm$ 0.4 (6 – 7)	5	5.2 $\pm$ 0.4 (5 – 6)	6
Odontostyle length	7	7.3 $\pm$ 0.4 (7 – 8)	7	6.8 $\pm$ 0.2 (6 – 7)
Odontophore length	17 $\pm$ 0.5 (16 – 18)	17.5 $\pm$ 0.5 (17 – 18)	16.5 $\pm$ 1.1 (15 – 18)	15 $\pm$ 1.9 (12 – 17)
Guiding ring from ant. End	8.5 $\pm$ 0.8 (8 – 10)	8	8 $\pm$ 0.9 (7 – 9)	7.2 $\pm$ 1.0 (6 – 9)
Nerve ring from ant. End	146.1 $\pm$ 3.3 (142 – 151)	137.7 $\pm$ 2.3 (135 – 140)	141 $\pm$ 1.4 (140 – 144)	126 $\pm$ 5.7 (115 – 130)
Neck length	328 $\pm$ 16.6 (303 – 348)	318.5 $\pm$ 2.9 (314 – 321)	331.6 $\pm$ 14.1 (319 – 358)	304.8 $\pm$ 6.2 (294 – 311)
Expanded part of pharynx	104.3 $\pm$ 9.1 (86 – 114)	110 $\pm$ 6.1 (105 – 120)	113 $\pm$ 12.1 (101 – 135)	114.8 $\pm$ 8.8 (105 – 130)
Cardia length	15.3 $\pm$ 1.5 (14 – 18)	16.7 $\pm$ 0.8 (16 – 18)	13.6 $\pm$ 1.9 (11 – 16)	15.8 $\pm$ 1.0 (15 – 17)
Anterior genital branch	367.2 $\pm$ 27.2 (341 – 418)	354.2 $\pm$ 24.3 (330 – 381)	375 $\pm$ 21.4 (341 – 396)	298 $\pm$ 12.1 (274 – 306)
Posterior genital branch	374.8 $\pm$ 37.6 (314 – 434)	378.2 $\pm$ 42.7 (336 – 442)	375 $\pm$ 20.4 (345 – 406)	308.4 $\pm$ 13 (284 – 318)
Vaginal depth	36.3 $\pm$ 1.5 (34 – 38)	34.5 $\pm$ 0.5 (34 – 35)	34.4 $\pm$ 0.5 (34 – 35)	31.7 $\pm$ 1.3 (30 – 33)
Vulva from ant. end	1296.8 $\pm$ 84 (1161 – 1413)	1144.4 $\pm$ 76 (1019 – 1226)	1197.4 $\pm$ 115.6 (1063 – 1382)	1095 $\pm$ 62.9 (1024 – 1167)
Prerectum length	442.6 $\pm$ 24.1 (408 – 475)	420.7 $\pm$ 34.4 (396 – 480)	385.6 $\pm$ 61.4 (283 – 448)	384 $\pm$ 56.1 (298 – 435)
Rectum length	40.6 $\pm$ 1.6 (38 – 43)	43.2 $\pm$ 1.9 (41 – 46)	43 $\pm$ 2.4 (40 – 45)	40.2 $\pm$ 3.2 (35 – 45)
Tail length	736 $\pm$ 40.9 (695 – 792) (n=3) broken L = (230 – 623)	469.7 $\pm$ 66.2 (370 – 550) (broken L)	694 $\pm$ 62.5 (610 – 760) (n=3) broken L = (495, 560)	750.6 $\pm$ 44.1 (697 – 805) (n=3) broken L = 620, 635

Broken L = broken tail length

125 – 197 μm and posterior 130 – 205 μm long, consisting of a long slender part with prismatic cells and a slightly wider *pars dilatata* with wide lumen. Sphincter present at oviduct-uterus junction. Uterus simple tube, anterior 131 – 226 μm or 2.6 – 3.6 times and posterior 142 – 231 μm or 2.7 – 3.9 times the corresponding body diameter long. Spermatozoa not observed in genital tract. Vagina extending inwards about one-half to two-thirds (51 – 69 %) of the corresponding body diameter; *pars proximalis vaginae* longer than wide, 17 – 25 $\times$ 5 – 9 μm , with somewhat sigmoid walls, surrounded by circular muscles; *pars refringens vaginae* with two adjacent trapezoid-shaped pieces, 5 – 9 $\times$ 5 – 10 μm , their combined width 14 – 22 μm ; *pars distalis vaginae* 4 – 7 μm with rounded walls. Vulva transverse. Prerectum 9.5 – 16 and rectum 1.2 – 1.5 times anal body diameter long. Tail long filiform, 20 – 28.7 ($n = 9$) times anal body diameter long. Caudal pores two; dorsal and lateral in position.

Male: Not found.

Habitats and localities: Soil samples collected from around the roots of: i) unidentified grasses from Mudumalai National Park, Nilgiri Hills, Nilgiri district, Tamil Nadu, India; coordinates 11°29'52.4940" N 76°37'47.0028" E on November 20, 2016; ii) unidentified grasses in paddy field from Canacona, South Goa, India; coordinates 14°59'35.21" N 74°2'51.5" E on April 18, 2016; iii) unidentified plant roots from village Verna, South Goa, India; coordinates 15°21'52.01" N 73°56'21.51" E on April 22, 2016; iv) unidentified shrub's from village Gajanur, Shimoga district, Karnataka, India; coordinates 13°50'20.4" N 75°31'7.2" E on October 25, 2018; v) paddy field from district Tinsukia, Assam, India; coordinates 27°30'0.0" N 95°22'1.2" E.

Remarks: *P. novus* is characterized by having 3.1 – 4.0 mm long body; lip region continuous, 10 – 13 μm wide; amphidial fovea stirrup-shaped; guiding ring very conspicuous; odontostyle robust, 7 – 8 μm long, its aperture about one-half of its length; expanded part of pharynx about 28 – 41 % of total neck length; female genital system amphidelphic; vulva transverse, pre equatorial; *pars refringens vaginae* present; tail long filiform and males absent. Jairajpuri (1965) described this species as *Oxydirus novus* from the Andaman Island of India. Jairajpuri and Ahmad (1978) transferred it to their newly proposed genus *Paraoxydirus* as *P. novus*. Ferris, Goseco and Ferris (1980) in their revision of Belondiroidea transferred it to *Tarjanius* which was later returned back to *Paraoxydirus* by Ferris, Goseco and Ferris (1981). The present populations from various localities of India conforms well with the original description of Jairajpuri (1965) but differs in having slightly larger odontostyle aperture (about one-half vs one-third of odontostyle length); shorter cardia (one-third vs one-half) of corresponding body diameter long; longer vagina (one-half to two-thirds vs one-third) of body diameter; comparatively shorter prerectum (9.4 – 16 vs 17 times of anal body diameter long); slightly longer tail ($c' = 20.3$ – 28.7 vs 20). This is the first report of the species from main land India as well as first ever report after the original description.

***Paraoxydirus indicus* n. sp.**

(Figs. 5 & 6)

Measurements: See Table 3

Description: Adult: Large sized nematodes, slightly curved ventrad. Body cylindroid, tapering towards both extremities but more so towards the posterior end as tail is long filiform. Body cuticle with fine transverse striations, about 2 μm thick along the body length, similar in both sexes except tail, 4 – 5 μm and 3.0 μm on tail in female and male respectively. Lateral chords with indistinct glandular bodies, 13 – 14 μm wide, occupying about one-fourth (23 – 24 %) of mid-body diameter. Lip region low, slightly offset, gradually narrowing, 2.3 – 3.2 times as wide as high and about one-fifth to one-third (20 – 30 %) of body diameter at neck base. Lips amalgamated, cephalic framework with poorly developed refractive elements; under SEM lip region continuous with the body contour, lips amalgamated; oral aperture triradiate, located in a ring-like elevation, surrounded by inner labial papillae that form parts of six small lobes distinctly protruding. Amphidial fovea cup-shaped, their aperture occupying about 0.6 – 0.7 times the lip region diameter, fovea slightly posterior to odontophore base level. Guiding ring single, very conspicuous, at 0.6 – 0.7 times lip region diameter from anterior end. Odontostyle robust with wide lumen, 3.5 – 4.0 times as long as wide, or about 0.5 – 0.6 times the lip region diameter long, their aperture about one-half of its length. Odontophore simple, rod-like, 2.1 – 2.6 times the odontostyle length. Nerve ring encircling the anterior slender part of pharynx at about 41 – 46 % of neck length from anterior end. Anterior slender part of pharynx quite muscular, enlarging gradually; expanded part 3.9 – 5.4 times as long as wide, 2.2 – 2.6 times as long as body diameter at pharynx base, occupying about 32 – 40 % of total neck length, enclosed in a thick sheath of sinistrally spiral muscles. Pharyngeal gland nuclei and their orifices are located as follows: DO = 67; DN = 68; DO-DN = 0.3; S1N1 = 76; S1N2 = 77; S2N = 91 ($n = 1$) as per Loof and Coomans (1970); D = 67; AS1 = 28; AS2 = 29; K = 97; PSN = 70 as Andrssy (1998). First pair of subventral gland nuclei almost at the same level. Cardia oblong, 1.6 – 2.3 times as long as wide, occupying about two-fifths to one-half (42 – 53 %) of the corresponding body diameter. Well developed coelomocytes present, 32 – 110 μm behind pharyngeal base, ovoid, measuring 20 $\times$ 13 – 73 $\times$ 20 μm ; in addition, 5 – 18 smaller ones behind pharynx base to vulva and 5 – 8 in post-vulval region. Body pores indistinct. Female: Genital system didelphic-amphidelphic, posterior branch slightly longer than anterior genital branch, anterior 10.5, 9.3 % ($n = 2$) and posterior 12.7, 11.3 % ($n = 2$) of total body length. Ovaries reflexed, not reaching oviduct-uterus junction, anterior 104 – 115 μm , and posterior 108 – 128 μm long, with squamous shaped oocytes arranged in a single row except near tip. Oviduct joining ovary subterminally, anterior 158 – 212 μm and posterior 185 – 260 μm long, consisting of a long slender part with prismatic cells and a slightly wider *pars dilatata* with distinct lumen. Sphincter present at oviduct-uterus junction. Uterus a simple tube filled with spermatozoa, anterior 214 – 260 μm or 3.7 – 4.0 times and posterior

Fig. 5. *Paraoxydirus indicus* n. sp. (A) Entire female; (B) entire male; (C) anterior region; (D) anterior end showing amphid; (E) expanded part of pharynx; (F) female genital system; (G) vulval region; (H) male posterior region; (I) spicule; (J) male posterior region; (K) female posterior region.

Fig. 6. *Paraoxydirus indicus* n. sp. (A, B) Anterior region; (C) anterior region showing amphid; (D) lip region in frontal view (female, SEM); (E) lateral view showing amphid (SEM); (F) pharyngeal expansion and spiral muscle sheath; (G) cardia; (H) vulval region; (I, J) female genital branch; (K) coelomocyte cells; (L) ventromedian supplements series; (M) spicule; (N) lateral guiding piece; (O) female tail. (Scale bars: A - C, G - H, M, N = 10 μ m; D, E (SEM) = 2 μ m; F, I-L = 20 μ m; O = 100 μ m).

Table 3. Measurements of *Paraoxydirus indicus* n. sp. (All the measurements in μm except L in mm).

Locality		Type population		Kerala population
Characters	Holotype female	Paratype females	Paratype males	Female
n		3	9	1
L	4.0	4.0 ± 0.4 (3.6 – 4.6)	3.8 ± 0.1 (3.7 – 4.0) (n = 4)	4.8
Body width at neck base	48	50 ± 2.2 (48 – 53)	47 ± 2.4 (44 – 51)	60
Body width at mid body	56	58 ± 2.4 (55 – 61)	49.1 ± 3.7 (44 – 55)	67
Body width at anus/ cloaca	30	31 ± 1.4 (30 – 33)	33.8 ± 1.8 (31 – 36)	32
a	72.8	70.4 ± 4.5 (66.1 – 76.6)	78.7 ± 4.2 (72.8 – 82.2) (n = 4)	71.5
b	12.2	11.2 ± 0.7 (10.4 – 12.2)	11.5 ± 0.6 (11 – 12.5) (n = 4)	13.2
c	5.4	6.3 ± 0.4 (5.85 – 6.6)	5.4 ± 0.2 (5.2 – 5.7) (n = 4)	5.4
c'	24.9	20.7 ± 0.5 (20 – 21.3)	21.2 ± 1.5 (19.4 – 23.3) (n = 4)	27.9
V	32.1	32.8 ± 1.1 (31.2 – 33.6)	-	30.6
G1	10.5	10.1 ± 0.4 (9.7 – 10.7)	-	9.3
G2	12.7	12.1 ± 1.4 (11 – 14)	-	11.3
Lip region width	13	13.6 ± 0.5 (13 – 14)	12.8 ± 0.6 (12 – 14)	12
Lip region height	5	5 ± 0.8 (4 – 6)	5.4 ± 0.5 (5 – 6)	5
Amphid aperture	8	8.3 ± 0.5 (8 – 9)	7.6 ± 0.8 (7 – 9)	
Odontostyle length	7	7.5 ± 0.4 (7 – 8)	7.4 ± 0.4 (7 – 8)	7
Odontophore length	17	17.6 ± 0.5 (17 – 18)	17.3 ± 1.0 (16 – 19)	17
Guiding ring from ant. End	9	9.3 ± 0.5 (9 – 10)	8.3 ± 0.5 (8 – 9)	8
Nerve ring from ant. End	153	149.3 ± 6.0 (141 – 155)	146.5 ± 2.1 (142 – 149)	153
Neck length	334	361.6 ± 14.3 (347 – 381)	344.7 ± 15.4 (314 – 366)	362
Expanded part of pharynx	107	122.6 ± 6.6 (114 – 130)	114.3 ± 10.3 (102 – 129)	146
Cardia length	25	24 ± 2.2 (21 – 26)	22 ± 2.4 (17 – 25)	25
Anterior genital branch	429	415 ± 27.7 (388 – 453)	-	445
Posterior genital branch	519	503 ± 114.2 (404 – 663)	-	542
Vaginal depth	34	31.6 ± 1.2 (30 – 33)	-	35
Vulva from ant. End	1310	1339 ± 100 (1217 – 1463)	-	1464
Prerectum length	519	545.3 ± 41.9 (500 – 601)	532.5 ± 79.8 (412 – 660)	597
Rectum length	41	41.6 ± 0.5 (41 – 42)	46.7 ± 2.8 (44 – 52)	41
Tail length	748	642 ± 44.3 (602 – 704) (broken L)	704 ± 26.9 (671 – 746) (n = 4) broken L (565 – 680)	894
Spicule length	-	-	49.5 ± 2.2 (45 – 53)	-
Lateral guiding pieces	-	-	13.7 ± 1.5 (12 – 16)	-
Ventromedian supplements	-	-	12 – 15	-

Broken L = (broken tail length)

225 – 314 μm or 4.1 – 5.4 times the corresponding body diameter long. Vagina extending inwards, about one-half to three-fifths (52 – 60 %) of the corresponding body diameter; *pars proximalis vaginae* longer than wide, 21 – 25 $\times$ 7 – 8 μm , with somewhat sigmoid walls and surrounded by circular musculature; *pars refringens vaginae* with two triangular pieces separated by an intermediate space, measuring 5 – 8 $\times$ 4 – 8 μm , their combined width 14 – 18 μm ; *pars distalis vaginae* 5 – 6 μm long with rounded walls. Vulva longitudinal. Prerectum 16.7 – 19.7 and rectum 1.3 – 1.4 times anal body diameter long. Tail long filiform, 27.9, 24.9 ($n = 2$) times anal body diameter long (tail terminus fragile, mostly broken off). Two pair of caudal pores present; subventral and subdorsal in position.

Male: Similar to female in general morphology, except for posterior region of the body being more ventrally curved. Genital system diorchic, with opposed outstretched testes. In addition to the adcloacal pair, located at 10 – 12 μm from cloacal aperture, a series of 12 – 15 irregularly spaced ventromedian supplements, 6 – 7 μm apart, beginning at 84 – 101 μm from the adcloacal pair; nine pairs of subventral precloacal papillae present. Copulatory muscles conspicuous, beginning from the level of middle of spicule to beyond the range of supplements series. Spicules typically dorylaimoid, robust, ventrally curved, total length along the arc, 1.0 – 1.3 times as long as chord, 3 – 5 times the maximum width and 1.3 – 1.7 times the body diameter at cloacal aperture. Curvature about 125°. Dorsal contour regularly convex, ventral contour bearing prominent hump, located at 33 – 43 % of spicules total length from its anterior end; head 2 – 5 μm long, occupying about 4.0 – 9.4 % of spicules length; median piece 16 – 24 times as long as wide, occupying about 12 – 27 % of spicules maximum width; posterior end 3 – 5 μm wide. Lateral guiding pieces simple, 4 – 6 times as long as wide or about one-fourth to one-third of spicules length. Prerectum 11.7 – 20.6 and rectum about 1.2 – 1.7 times cloacal body diameter long. Tail long filiform, about 19.4 – 23.3 ($n = 4$) times cloacal body diameter long. Caudal pores four; two lateral, one dorsal and one ventral.

Type habitat and locality: From soil around the roots of unidentified grass from Mudumalai National Park, Nilgiri Hills, Tamil Nadu, India; coordinates 11°29'52.4940" N 76°37'47.0028" E; collected on November 20, 2016.

Other habitat and locality: From around roots of unidentified grasses from the Chungathara, Malapuram, Kerala, India; coordinates 11°20'1.1" N 76°16'32.44" E; collected on November 16, 2016.

Type specimens: Holotype female on slide *Paraoxydirus indicus* sp. n. / 1; paratype females and males on slides *Paraoxydirus indicus* sp. n. / 2 – 14; deposited with the nematode collection of the Department of Zoology, Aligarh Muslim University, India.

Etymology: The new species is named after its type locality, India. Diagnosis and relationships: *Paraoxydirus indicus* n. sp. is characterized by having 4.0 – 4.8 mm long body; poorly offset lip region with amalgamated lips, 12–14 μm wide; amphidial fovea cup-shaped; guiding ring conspicuous; odontostyle 7 – 8 μm long,

robust; expanded part of pharynx about 32 – 40 % of total neck length; female genital system amphidelphic; vulva longitudinal, pre-equatorial; tail long filiform, 27.9, 24.9 times anal body diameter in females and 19.4 – 23.3 times cloacal body diameter in males; spicules 45 – 53 μm long, robust and 12 – 14 irregularly spaced ventromedian supplements. In the presence of a poorly offset lip region, robust odontostyle, distinct guiding ring and fusiform expanded part of pharynx, the new species come close to *P. novus* Jairajuri, 1965; *P. magnus* Timm, 1964 and *P. pelinus* Goseco, Ferris and Ferris, 1980 but differs from the former mainly in having slightly angular lip region (vs rounded); longitudinal vulva (vs transverse); in shape of *pars refringens vaginae* (two triangular pieces separated by an intermediate space vs two trapezoid pieces without intermediate space); in the presence of coelomocytes (vs not reported) and males present (vs male absent). From *P. magnus* Timm, 1964, it differs, in having relatively shorter (4.0 – 4.8 vs 4.9 – 5.7 mm) and robust body ($a = 71 - 82$ vs $85 - 117$); cephalic and labial papillae not interfering the labial contour (vs distinctly protruding); amphids cup-shaped (vs stirrup-shaped); differently shaped odontostyle (vs. odontostyle almost beak-shaped with anterior half of ventral arm distinctly bent dorsally); larger cardia (21 – 26 vs 8 μm); longitudinal vulva (vs transverse); longer prerectum (16 – 20 vs 7 times anal body diameter long); longer tail ($c = 5.4$ vs $12.1 - 14.7$ $c' = 25 - 28$ vs 8); relatively shorter spicule (45 – 53 vs 54 – 57 μm); ventral arm of spicules bearing distinct hump (vs smoothly arcuate) and coelomocytes present (vs not reported). From *P. pelinus* Ferris, Goseco and Ferris, 1980, it differs, in having smaller (4.0 – 4.8 vs 5.2 – 5.4 mm) and robust body ($a = 71.4 - 73$ vs $102 - 140$); wider lip region (13 – 14 vs 9 μm); distinct guiding ring (vs guiding ring obscure); longer odontophore (17 – 18 vs 10 μm); longer pharynx ($b = 12.2 - 13.2$ vs $16.7 - 20.2$); expanded part of pharynx slightly longer (32 – 40 vs 30 %); longitudinal vulva (vs transverse); longer prerectum (500 – 601 vs 112 – 256 μm); longer tail ($c = 5.4$ vs $9 - 11$; $c' = 25 - 28$ vs 20); proximal part of spicule simple (vs proximal end appearing notched) and coelomocytes present (vs not reported).

***Paraoxydirus vulvalpapillatus* n. sp.**

(Figs. 7, 8 & 9)

Measurements: See Table 4

Description: Adult: Large sized nematodes, slightly curved ventrad, cylindroid, tapering towards both extremities but more so towards the posterior end as tail is long filiform. Cuticle with fine transverse striations, about 1 – 2 μm thick at anterior region, 2 – 4 μm at mid-body and 3 – 5 μm on tail, similar in both sexes. Lateral chords with indistinct glandular bodies, 12 – 19 μm wide, occupying about one-fourth to one-third (23 – 30 %) of mid-body diameter. Body pores indistinct. Lip regions almost continuous, gradually narrowing, 2.0 – 3.3 times as wide as high and about one-fifth to two-seventh (21 – 27 %) of body diameter at neck base. Lips poorly angular, amalgamated; cephalic framework with poorly developed refractive elements; under SEM, lip region continuous

Fig. 7. *Paraoxydirus vulvalpapillatus* n. sp. (A) Entire female; (B) entire male; (C) anterior region; (D) anterior end showing amphid; (E) expanded part of pharynx; (F) female genital system; (G) vulval region; (H) male posterior region; (I) female posterior region; (J) male posterior region; (K) spicule.

Fig. 8. *Paroxydirus vulvalpapillatus* n. sp. (A, B) Anterior region; (C) anterior end showing amphid; (D) expanded part of pharynx, DN; (E) S1N1, S1N2; (F) spiral muscular sheath; (G) cardia; (H) vulval region, vulval papillae and *pars refringens*; (I) vulval papillae; (J, K) female genital branch; (L) ventromedian supplements series; (M) spicule; (N) lateral guiding piece; (O) rectum; (P) female tail. (Scale bars: A - I, M - O = 10 μ m; J - L = 20 μ m; P = 100 μ m).

Fig. 9. *Paraoxydirus vulvalpapillatus* n. sp. (SEM). (A) Lip region in face view; (B) lip region in ventral view; (C) vulva in ventral view; (D) vulval papillae in ventral view; (E) male posterior ventral view, showing adcloacal pair, caudal pores and cloacal opening; (F) female anal opening in ventral view. (Scale bars: A, C = 5 μ m; B = 1 μ m; D – F = 10 μ m).

Table 4. Measurements of *Paraoxydirus vulvalpapillatus* n. sp. (All the measurements in μm except L in mm).

Locality	Type population			Karnataka population
Characters	Holotype female	Paratype females	Paratype males	Female
n	1	5	8	1
L	4.8	4.6 $\pm$ 0.3 (4.3 – 4.9)	4.4 $\pm$ 0.5 (3.8 – 5.0) (n=3)	4.6
Body width at neck base	40	42 $\pm$ 1.3 (41 – 44)	42.1 $\pm$ 2.4 (38 – 45)	47
Body width at mid body	53	51.6 $\pm$ 2.6 (47 – 55)	48.6 $\pm$ 4.7 (41 – 56)	65
Body width at anus/ cloaca	31	28.6 $\pm$ 2.4 (25 – 32)	36 $\pm$ 2.2 (32 – 39)	32
a	92	88.9 $\pm$ 4.9 (83.2 – 95.2)	84.4 $\pm$ 10.7 (69.3 – 92.7) (n=3)	71.6
b	14.3	14.1 $\pm$ 0.6 (13 – 15)	14.1 $\pm$ 0.8 (13 – 15) (n=3)	13.2
c	15	13.9 $\pm$ 0.3 (13.5 – 14.3)	14.2 $\pm$ 5.0 (8.1 – 20.3) (n=3)	14.9
c'	10.5	11.2 $\pm$ 1.2 (9.7 – 12.6)	9.8 $\pm$ 3.6 (6.8 – 14.8) (n=3)	9.8
V	36.3	37.8 $\pm$ 1.6 (35.6 – 39.5)	-	41.6
G1	10.2	9.2 $\pm$ 1.9 (6.6 – 13.3)	-	6.9
G2	10.5	11.2 $\pm$ 0.7 (10.2 – 11.7)	-	7.6
Lip region width	10	10.6 $\pm$ 0.5 (10 – 11)	10.3 $\pm$ 0.5 (10 – 11)	10
Lip region height	4	4.2 $\pm$ 0.7 (3 – 5)	4.5 $\pm$ 0.5 (4 – 5)	3
Amphid aperture width	5	5.0 $\pm$ 0.6 (4 – 6)	6.3 $\pm$ 0.7 (5 – 7)	5
Odontostyle length	5	5.2 $\pm$ 0.4 (5 – 6)	4.8 $\pm$ 0.3 (4 – 5)	5
Odontophore length	11	11.5 $\pm$ 0.7 (11 – 13)	12 $\pm$ 0.7 (11 – 13)	11
Guiding ring from ant. End	5	5.2 $\pm$ 0.4 (5 – 6)	5.3 $\pm$ 0.5 (5 – 6)	4
Nerve ring from ant. End	143	149.4 $\pm$ 2.9 (145 – 153)	145.1 $\pm$ 6.1 (135 – 155)	142
Neck length	340	331.8 $\pm$ 11.6 (317 – 352)	322.8 $\pm$ 14.9 (297 – 339)	352
Expanded part of pharynx	90	93 $\pm$ 10.4 (82 – 107)	86.3 $\pm$ 10.6 (76 – 107)	138
Cardia length	13	15.6 $\pm$ 2.2 (12 – 19)	13.1 $\pm$ 2.5 (11 – 19)	15
Anterior genital branch	499	469.2 $\pm$ 102.6 (288 – 575)	-	320
Posterior genital branch	512	514 $\pm$ 33.2 (492 – 580)	-	356
Vaginal depth	30	30.2 $\pm$ 0.7 (29 – 31)	-	34
Vulva from ant. end	1770	1703 $\pm$ 115.8 (1550 – 1896)	-	1934
Prerectum length	455	373.7 $\pm$ 42.5 (315 – 435)	486.7 $\pm$ 61 (432 – 602)	290
Rectum length	37	36.6 $\pm$ 2.7 (32 – 40)	46.7 $\pm$ 2.6 (42 – 50)	43
Tail length	325	broken L = 310 – 365	341 $\pm$ 97(247 – 475) (n=3) (broken L= 185 – 279)	312
Spicule length	-	-	51 $\pm$ 2.5 (46 – 54)	-
Lateral guiding pieces	-	-	12.5 $\pm$ 1.6 (11 – 16)	-
Ventromedian supplements	-	-	11 – 14	-

Broken L = (Broken tail length)

Table 5. Compendium of morphometrics of species belonging to the genus *Paraoxydirus* Jairajpuri & Ahmad, 1978 (Measurements in μm except L in mm)

Character	species	n	L	a	b	c	c'	v	Lrd	Odont.	Neck	Ph.exp.	Abd	Prerect.	Tail length	Vms	Spicule length	Geo. Dist.	References
<i>abnormus</i>		4♀	5.0-6.0	102-124	13-18	8-11	18-20	35-39	12	8	342-416	118-146	31-34	279-331	596-668	-	-	Karnataka- India	Dhanam & Jairajpuri, 1998
		3♂♂	5.0-6.0	111-130	14-16	12-16	10-13	-	-	8	350-365	113-129	36-37	566-681	354-465	12-15	48-53		
<i>cavernessi</i>		5♀	1.9-4.0	59-78	6.5-11.7	5-10	13-21	35-44	10	5-7	252-350	95-140	19.4-28	175-311	252-588	-	-	Nigeria	Ferris <i>et al.</i> , 1980
		3♂♂	2.0-2.5	63-66	6.4-9.0	5-8	-	-	-	-	280-315	100-144	-	-	336-448	7-8	36-37		
<i>gigas</i>		2♀	3.8-4.5	65-66	12-13	10	-	40-42	11*	5*	-	-	-	-	-	-	-	Naintal- India	Jairajpuri, 1964
		2♂♂	3.7-4.3	61-86	12-13	11-12	13	-	11*	5*	-	-	30*	300*	390*	15	50		
		1♂	3.7	88	13	14	-	-	-	6	-	-	-	-	-	15	49	M.P.- India	Siddiqi, 1966
		1♀	3.9	70	13	9	-	39	-	5-7	-	-	-	-	-	-	-	UP-India	Baqri & Jairajpuri, 1968
		2♂♂	3.6-3.7	84-86	12.0-12.2	10-15	-	-	-	-	-	-	-	-	-	13	48-51		
		25♀♀	3.7-4.3	72-83	11.2-12.9	11-17	14*	42-45	12*	6-7	320-350	140*	28-34	260-360	250-345	-	-	Several localities-India	Jairajpuri & Ahmad, 1978
		10♂♂	3.7-4.0	66-79	11.5-12.9	10-16	13*	-	-	6-7	290-305	-	33-35	-	220-350	11-13	50-55		
		8♀♀	4.1-4.6	77-85	13-15	7-8	18-21	35-42	10-11	5-6	304-326	93-108	28-31	260-303	425-604	-	-	Goa- India	Present paper
		5♂♂	3.8-4.5	80-88	11-14	8-10	12-14	-	10-11	5	309-342	88-104	33-36	370-457	440-480	10-14	52-54		
		4♀♀	3.3-4.5	64.4-73	11-13.7	9-11	10.7-15.4	36.3-40.4	10	5-6	302-341	85-118	28-32	220-319	300-478+	-	-	Assam-India	Present paper
		1♂	3.5	71.3	10.7	10.6	10.3	-	10	6	325	113	32	280	330+	12	57		

Character species	n	L	a	b	c	c'	v	Lrd	Odont.	Neck	Ph.exp.	Abd	Prerect.	Tail length	Vms	Spicule length	Geo. Dist.	References
<i>magnus</i>	6♀	4.8-5.7	85-117	13-17	12-15	12.5	33-40	10	8	334-367	84-118	32.8	230	389-400	-	-	Bangladesh	Timm, 1964
	6♂	4.4-4.9	87-103	14-15.4	17-20	-	-	-	-	-	-	-	-	-	12-16	54-57	-	-
<i>novus</i>	2♀	3.9-4.0	65-68	11-12	4-6	20	34-35	10*	7	-	-	33*	17abd	615*	-	-	Andaman-India	Jairajpuri, 1965
	5♀	3.1-3.4	53-68	10-11	4.0-5.4	21-29	33-34	10-11	6-7	294-311	105-130	27-31	298-435	697-805	-	-	Assam-India	Present paper
<i>pelinus</i>	5♀	3.2-3.5	52-58	10-11	4.5-5.0	20-24	34-36	11	7	319-358	101-135	30-33	283-448	610-760	-	-	Goa-India	Present paper
	6♀	3.7-4.0	57-66	11-12	5.1-5.4	20-25	33-36	12-13	7	303-348	86-114	31-36	408-475	695-792	-	-	Tamil Nadu	Present paper
<i>pelinus</i>	4♀	3.3-3.5	55-66	10-11	6.3-9.0	11-17	30-35	11-12	7-8	314-321	105-120	30-33	396-480	370-550+	-	-	Karnataka-India	Present paper
	3♀	5.2-5.4	102-140	17-20	9-11	20	29-34	9	7	266-311	90-96	26	112-256	496-592	-	-	Philippines	Ferris et al., 1980
<i>indicus</i> sp.n.	2♂	4.8-4.85	89-127	15.0-15.4	12-17	-	-	-	-	311	96	-	-	281-383	11-13	50-55	-	-
	4♀	3.6-4.6	66-76	10.5-12.3	5.4-6.6	21-25	31-33	13-14	7-8	334-381	107-130	30-33	500-601	748 (602-704+)	-	-	Tamil Nadu-India	Present paper
<i>vulva papillatus</i> sp.n.	9♂	3.7-4.0	73-82	11.0-12.5	5.2-5.7	19-23	-	12-14	7-8	314-366	102-129	31-36	412-600	671-746	12-15	45-53	-	-
	1♀	4.8	71.5	13.2	5.4	28	30.6	12	7	362	146	32	597	894	-	-	Karnataka-India	Present paper
<i>vulva papillatus</i> sp.n.	6♀	4.3-4.8	83-95	13-15	13-14	10-13	36-39	10-11	5-6	317-352	82-107	25-32	315-435	325 (310-365+)	-	-	Goa-India	Present paper
	8♂	3.8-5.0	69-93	13.0-15.2	8-20	7-15	-	10-11	4-5	297-339	76-107	32-39	432-602	247-475	11-14	46-54	-	-
	1♀	4.65	72	13	15	9.8	42	10	5	352	138	31	290	312	-	-	Karnataka-India	Present paper

Lrd = Lip region diameter; Odont = Odontostyle length; Ph. exp = Pharyngeal bulb; Prerect. = Prerectum length; Vms = Ventromedian supplements; Abd = Anal body diameter; (+) = Tail broken length; Geo. distr = Geographical distribution; (*) = Calculated measurements from illustrations

with amalgamated lips; cephalic papillae distinctly protruding, labial papillae low, weakly protruding; inner labial papillae button-like, and surrounded by an annulus. Amphidial fovea cup-shaped, their aperture occupying about 0.4 – 0.5 times the lip region diameter, fusus slightly posterior to the odontophore base level. Guiding ring single, at 0.4 – 0.5 times lip region diameter from the anterior end. Odontostyle slender, irregular in shape, its ventral arm bent toward dorsal arm, 5 – 6 times as long as wide, about 0.4 – 0.6 times the lip region diameter long, its aperture about one-fourth to one-third of its length. Odontophore simple, rod-like, 2.0 – 2.4 times the odontostyle length. Nerve ring encircling the anterior slender part of the pharynx at 40 – 47 % of neck length from anterior end. Anterior slender part of pharynx quite muscular, expanding gradually; expanded part 3.0 – 4.6 times as long as wide, 2.1 – 2.7 times as long as body diameter at neck base, occupying about 28 – 36 % of total neck length, enclosed in a thick sheath of sinistrally spiral muscles. Pharyngeal gland nuclei and their orifices are located as follows: DO = 69 – 77; DN = 70 – 77; DO-DN = 0.3-0.6; S1N1 = 81 – 84; S1N2 = 82 – 86 (n = 3); S2N = 92 (n = 1); as per Loof and Coomans (1970); D = 73 – 77; AS1 = 29 – 30; AS2 = 31 – 32; K = 92 – 96; PSN = 65, 67 as per Andrssy (1998). Cardia oblong, 1.1 – 1.6 times as long as wide, occupying about two-seventh to two-fifths (28 – 43 %) of corresponding body diameter. Female: Genital system didelphic-amphidelphic, both branches al-

most equally developed, anterior 6.8 – 10.2 % (n = 2) and posterior 7.6 – 10.5 % (n = 2) of body length. Ovaries reflexed, not reaching oviduct-uterus junction, anterior 94 – 156 μ m, and posterior 94 – 160 μ m long, with squamous-shaped oocytes arranged in a single rows except near tip. Oviduct joining ovary subterminally, anterior 125 – 314 μ m and posterior 136 – 300 μ m long, consisting of long slender part with prismatic cells and a slightly wider *pars dilatata* with wide lumen. Sphincter present at oviduct-uterus junction. Uterus a simple tube filled with sperms, anterior 190 – 260 μ m or 3 – 5 times and posterior 187 – 277 μ m or 2.9 – 5.3 times the corresponding body diameter long. Vagina extending inwards, about one-half to three-fifths (52 – 62 %) of the corresponding body diameter; *pars proximalis vaginae* longer than wide, 16 – 21 $\times$ 6 – 9 μ m, with somewhat sigmoid walls and surrounded by circular musculature; *pars refringens vaginae* with two asymmetrical triangular pieces, separated by a narrow intermediate space, 8 – 10 $\times$ 6 – 7 μ m, their combined width 12 – 19 μ m; *pars distalis vaginae* 4 – 7 μ m with rounded walls. Vulva transverse slit, about 4 μ m wide with prominent lips. Vulval papillae conspicuous, 1 – 13 in numbers. Prerectum 9 – 15 and rectum 1.0 – 1.6 times anal body diameter long. Tail long, filiform, 9.8, 10.5 (n = 2 not broken) times anal body diameter long (tail terminus fragile, mostly broken off). Caudal pores three on each side; one dorsal, sub-ventral and lateral respectively.

Key to species of the genus *Paraoxydirus*

1. Odontostyle robust, with comparatively wide aperture.....2
Odontostyle slender, with comparatively narrow aperture.....5
2. Vulva longitudinal.....*P. indicus* n. sp.
Vulva transverse.....3
3. Body length 3.1 – 4.0 mm; guiding ring very conspicuous, irregular in shape; c = 4.0 – 6.0 in females.....*P. novus* Jairajpuri, 1965
Body length 4.8 – 5.7 mm; guiding ring simple, less conspicuous; c = 9 – 15 in females.....4
4. Odontostyle 9 μ m long, irregular in shape; amphids stirrup-shaped; expanded part of the pharynx 32 – 35% of total neck length; c' = 12.5; spicules slightly arcuate, anterior part not notched.....*P. magnus* Timm, 1964
Odontostyle 7 μ m, regular in shape; amphids cup-shaped; expanded part of the pharynx 30% of total neck length; c' = 20; spicules strongly arcuate, its proximal part appearing notched.....*P. pelinus* Ferris, Goseco & Ferris, 1980
5. Body 5.0 – 6.0 mm long, slender (a = 102 – 124); amphids stirrup-shaped; vulva pore-like;.....*P. abnormus* Dhanam & Jairajpuri, 1998
Body 1.9 – 4.8 mm long, comparatively robust (a = 59 – 95); amphids cup-shaped; vulva transverse.....6
6. Vulval papillae present.....*P. vulvalpapillatus* n. sp.
Vulval papillae absent.....7
7. Expanded part of pharynx about 28 – 35% of total neck length; spicules robust, 48 – 57 μ m long; ventromedian supplements 11 – 15.....*P. gigas* Jairajpuri, 1964
Expanded part of pharynx 36 – 42% of total neck length; spicules comparatively slender 36 – 37 μ m long; ventromedian supplements 7 – 8.....*P. cavenessi* Ferris, Goseco & Ferris, 1980

Male: Similar to female in general morphology, except for posterior region of the body being more ventrally curved. Genital system diorchic, with opposed outstretched testes. In addition to the adcloacal pair, located at 7 – 9 μm from cloacal aperture, a series 11 – 14 irregularly spaced ventromedian supplements, 7 – 10 μm apart, beginning at 62 – 101 μm from the adcloacal pair. Copulatory muscles conspicuous, beginning from posterior end of spicule to beyond the range of supplements series. Spicule dorylaimoid, robust, slightly curved ventrad, total length along the arc 1.0 – 1.1 times as long as chord, 4.6 – 6.0 times the maximum width and 1.2 – 1.5 times body diameter at cloacal aperture. Curvature about 130°. Dorsal contour regularly convex, ventral contour bearing prominent hump, located at 35 – 41 % of spicules total length from its anterior end; head 5 – 7 μm long, occupying 9 – 13 % of total length; median piece 22 – 49 times as long as wide, and occupying 9 – 11 % of spicules maximum width. Posterior end 3 – 5 μm wide. Lateral guiding pieces simple, 5 – 8 times as long as wide or about one-fourth to one-third of spicules length. Prerectum 11.8 – 15.3 and rectum 1.1 – 1.6 times cloacal body diameter long. Tail long filiform, about 6.9 – 14.8 ($n = 3$) times cloacal body diameter long. Caudal pores four; one ventral, one dorsal and two lateral in position.

Type habitat and locality: From soil around roots of unidentified plant near the Cuncolim, South Goa, India; coordinates 15°10'38.28" N 73°59'38.11" E; collected on April 20, 2016.

Other locality: From soil around roots of unidentified plant near Thirthahalli, Shimoga, Karnataka; India; coordinates 13°41'22.19" N 75°14'41.96" E; collected on October 25, 2018.

Type specimens: Holotype female on the slide *Paraoxydirus vulvalpapillatus* n. sp. /1; paratype females and males on slides *Paraoxydirus vulvalpapillatus* n. sp. /2 – 14; deposited with the nematode collection of the Department of Zoology, Aligarh Muslim University, India.

Etymology: The new species is named *vulvalpapillatus* because of the presence of vulval papillae.

Diagnosis and relationships: *Paraoxydirus vulvalpapillatus* n. sp. is characterized by having 4.6 – 4.8 mm long body; lip region almost continuous with body with amalgamated lips, 10 – 11 μm wide; amphidial fovea cup-shaped, guiding ring single; odontostyle slender, 5 – 6 μm long, asymmetrical; expanded part of pharynx about 28 – 36 % of total neck length; female genital system amphidelphic; transverse vulva, pre-equatorial; vulval papillae conspicuous; tail long filiform similar in sexes; male with 46 – 54 μm long dorylaimoid spicules and 11 – 14 continuous ventromedian supplements. In the presence of slender odontostyle, transverse vulva, robust dorylaimoid spicules, and number of ventromedian supplements, the new species come close to *P. gigas* Jairajpuri, 1964, and *P. cavenessi* Ferris, Goseco and Ferris, 1980 but differs from the former in having ventral arm of odontostyle strongly bent toward dorsal arm (vs ventral arm slightly bent at tip); prominent vulval papillae (vs absent); shape of *pars referinges vaginae* (triangular vs trapezoid). From *P. cavenessi* Ferris, Goseco and Ferris, 1980, it differs, in having irregular shaped odontostyle (vs regular

in shape); longer cardia (12 – 19 vs 10 μm); vulval papillae present (vs absent); longer prerectum (10 – 15 vs 7 – 9 times anal body diameter long); higher number of ventromedian supplements (11 – 14 vs 7 – 8); longer spicules (46 – 54 vs 36 – 37 μm). It also comes close to *P. magnus* Timm, 1964, but differs, in having relatively slender and shorter odontostyle (5 – 6 vs 9 μm with wide lumen); amphidial fovea (cup-shaped vs stirrup-shaped); longer prerectum (9 – 15 vs 7 times anal body diameter long); prominent vulval papillae (vs absent); slightly shorter spicules (46 – 54 vs 54 – 57 μm or 1.2 – 1.5 vs 2 times anal body diameter long); ventral arm of spicules bearing a distinct hump (vs without distinct hump or smoothly arcuate).

Acknowledgments

The authors are thankful to the Chairman, Department of Zoology for providing necessary laboratory facilities. The first author also thanks the University Grants Commission, Govt. of India for providing financial assistance under UGC-RGNF Fellowship.

References

- ANDRÁSSY, I. (1998): Once more the oesophageal gland nuclei in the dorylaimid nematodes. *Opusc Zool*, 31: 165 – 170
- BAQRI, Q.H., JAIRAJPURI, M.S. (1968): Studies on Belondiroidea (Nematoda) from India. *Nematologica*, 14: 300 – 310. DOI: 10.1163/187529268X00516
- COBB, N.A. (1918): Estimating the nema population of the soil. *United States Department of Agriculture, Bureau of plant Industry, Agriculture Technical Circular*, 1: 1 – 48
- COURTNEY, W.D., POLLEY, D., MILLER, V.L. (1955): TAF, an improved fixative in nematode technique. *Plant Dis*, 39: 570 – 571
- DHANAM, M. & JAIRAJPURI, M.S. (1998): New belondirid nematodes: Two new genera, two new subgenera and seven new species from the Malnad Tracts of Karnataka, India. *Int J Nematol*, 8 (2): 193 – 213
- FERRIS, V.R., GOSECO, C.G., FERRIS, J.M. (1980): Revision of *Oxydirus* and *Tarjanus* n. gen. in Oxydiridae, Belondiroidea (Nematoda: Dorylaimida); and *Oxydiroides* in Prodorylaiminae, Dorylaimidae. *Research Bulletin Purdue University, Agricultural Experiment Station, West Lafayette, Indiana*, No. 956: 29 pp.
- FERRIS, V.R., GOSECO, C.G., FERRIS, J.M. (1981): *Tarjanus* a junior synonym of *Paraoxydirus* and emended description of *Paraoxydirus* (Nematoda: Dorylaimida). *Nematologica*, 27: 350 – 351. DOI: 10.1163/187529281X00593
- JAIRAJPURI, M.S., AHMAD, M. (1978): Some remarks on the genus *Oxydirus* Thorne, 1939 with proposal of *Paraoxydirus* n. gen. *Indian J Nematol*, 8: 146 – 148
- JAIRAJPURI, M.S. (1964): Studies on Nygellidae n. fam. and Belondiroidea Thorne, 1939 (Nematoda: Dorylaimoidea) with description of ten new species from India. *Proc Helminthol Soc Wash*, 31: 173 – 187

- JAIRAJPURI, M.S. (1965): Three new species of Dorylaimoidea (Nematoda) from India. *Proc Helminthol Soc Wash*, 32: 78 – 81
- LOOF, P.A.A., COOMANS, A. (1970): On the development and location of the oesophageal gland nuclei in the Dorylaimina. *Proc. IX Int. Nem. Symp.* (Warsaw, 1967), 79 – 161. DOI: 10.1163/187529268X00345
- PEÑA-SANTIAGO, R., ABOLAFIA, J. & ALVAREZ-ORTEGA, S. (2014): New proposal for a detailed description of the dorylaim spicule (Nematoda: Dorylaimida). *Nematology*, 16: 1091 – 1095. DOI: 10.1163/15685411-00002834
- SEINHORST, J.W. (1959): A rapid method for the transfer of nematodes from fixative to anhydrous glycerin. *Nematologica*, 4: 67 – 69. DOI: 10.1163/187529259X00381
- SIDDIQI, M.R. (1966): Studies on species of Belondiroidea (Nematoda: Dorylaimida) from India. *Proc Helminthol Soc Wash*, 22: 139 – 149
- THORNE, G. (1939): A monograph of the nematodes of the superfamily Dorylaimoidea. *Capita Zool*, 8: 1 – 261
- TIMM, R.W. (1964): Nematode of the superfamily Dorylaimoidea from East Pakistan. *Proc Helminthol Soc Wash*, 31: 144 – 153