

A new species of *Moniligaster* Perrier, 1872 (Annelida, Moniligastridae) from India, with status revision of *M. deshayesi minor* Michaelsen, 1913

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Abstract. The genus *Moniligaster* Perrier, 1872 is restricted to the Western Ghats mountain regions of the southern Peninsular India. A new species, *Moniligaster julkae* Narayanan & Paliwal, sp. nov., is described and illustrated using samples found in the Kerala districts of Kottayam and Pathanamthitta. Apart from that, the status of *Moniligaster deshayesi minor* Michaelsen, 1913 is critically reviewed, and it is upgraded to species rank as *Moniligaster minor* Michaelsen, 1913, based on a collection made near its type locality. Furthermore, new distributional records for other *Moniligaster* species are provided. With this discovery, the genus *Moniligaster* now has a total of 14 recognised species.

Keywords. Endemism, Kerala, Oligochaeta, rubber plantation, Western Ghats.

INTRODUCTION

Western Ghats is denoted as a world heritage site (UNESCO 2021) and more importantly one among the eight ‘hottest hotspots’ of global biodiversity (Mittermeier *et al.* 2011). In India, Western Ghats and the west coast plains are the areas with highest diversity of earthworm fauna, which is about 58.4% of all recorded earthworm species of the country (Narayanan *et al.* 2020). Taxonomic works on the earthworms of the Western Ghats mountain ranges started in the last quarter of the 19th century by the description of *Perichaeta* (now *Megascolex*) *lawsoni* from Nilgiris by Bourne (1886). Since then many species have been described from this unique land by eminent taxonomists (Michaelsen 1910, Cognetti 1911, Stephenson 1915, 1916, 1924, 1925, Aiyer 1929, etc.). With 264 recorded species, the

earthworm fauna of the Western Ghats Biodiversity Hotspot has been relatively well recognized (Narayanan *et al.* 2020, 2021a). About 70% of the currently known species were recorded in the early part of the last century. However, several new genera and species of earthworms have been described from this region in the last 25 years (Julka *et al.* 1997, 2004, Nair *et al.* 2010). Nevertheless, considerable areas of the Western Ghats are yet to be explored with respect to earthworm fauna, especially various kinds of forests, riparian habitats, mountain grasslands, scrublands etc.

In the recent past a number of new moniligastrid earthworm species have been described from Kerala part of the Western Ghats (Narayanan *et al.* 2017, 2021a). In this communication we report a new *Moniligaster* species

viz., *Moniligaster julkai* sp. nov., from the state. As a taxonomic side note, we discuss about the status of *Moniligaster deshayesi minor* Michaelsen, 1913, based on the details from the newly obtained specimens and it is raised to specific rank as *Moniligaster minor*. Furthermore, additional distributional records of several *Moniligaster* Perrier, 1872 species are provided.

MATERIAL AND METHODS

Collection and preservation. Earthworms were collected from several districts of southern Kerala by digging the soil with a spade, hand-sorting the soil for earthworms and also searching for organic microhabitats such as fallen tree trunks and leaf litter. Specimens collected were preserved in 5% formalin and later transferred to 95% ethanol. All relevant morphological and anatomical characterisation of the earthworms were carried out under a Nikon stereomicroscope (Model: SMZ 800N). Illustrations were made with the help of a camera lucida attached to the microscope. The type specimens of the new species are deposited in the national repository at the Zoological Survey of India - Western Ghats Regional Centre, Kozhikode, India. All the other specimens are housed in the Advanced Centre of Environmental Studies and Sustainable Development, Mahatma Gandhi University, Kottayam, Kerala, India.

General abbreviations of the terms used are as follows. Cl. – Clitellum; C.Atr.D. – Common atrial duct; L.L.G. – Leaflet-like glands; M.H.L. – Mass of hairpin loops; Pr.C. – Prostatic capsule; Pr. – Prostate; Pr.D. – Prostatic duct; Sp.A. – Spermathecal ampulla; Sp.Atr.G. – Spermathecal atrial gland; Sp.Atr.G.D. – Spermathecal atrial gland duct; Sp.D. – Spermathecal duct; S.M.A. – Secondary male aperture; Sp.P. – Spermathecal pore; T.S. – Testis sac; Vd. – Vas deferens.

Institutional abbreviations. ACCESSD: Advanced Centre of Environmental Studies and Sustainable Development, Mahatma Gandhi University, Kottayam, Kerala, India; ZMUH: Zoologisches Institut und Zoologisches Museum, Universität Hamburg, Hamburg (now CeNak – Centre of

Natural History), Germany; ZSIK: National Zoological Collections, Zoological Survey of India – Western Ghat Regional Centre, Kozhikode, India.

RESULTS

Family Moniligastridae Claus, 1880

Genus *Moniligaster* Perrier, 1872

Moniligaster julkai Narayanan & Paliwal, sp. nov.

(Figures 1A–D)

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Material examined. Holotype. Aclitellate (ZSIK Reg. No. ZSI/WGRC/IR.INV.19324), rubber plantation, Puthuvely (9°50'4.0"N 76°35'19.3"E) (4 km south of Koothattukulam town), Kottayam District, Kerala State, India, 2 September 2021, 41 m a.s.l., leg. R. Anuja, S.P. Narayanan, V.M. Kannan. *Paratypes.* 4 aclitellates (ZSIK Regd. No. ZSI/WGRC/IR.INV.19325), same data as for holotype; 1 clitellate (ZSIK Regd. No. ZSI/WGRC/IR.INV.19326), evergreen forest, between Chalakkayam and Plappally (09°22'51.4"N 77°03'00.5"E), Pathanamthitta District, Kerala State, India, 20 August 2013, 259 m a.s.l., leg. S.P. Narayanan, S. Sathrumithra, D. Kuriakose and S.A. Sasi.

Additional material examined. 1 aclitellate, 2 juveniles (Regd. No. ACCESSD/EW/1367), streamside within evergreen forest, Attathodu (09°24'09.5"N 77°01'30.5"E), Pathanamthitta District, Kerala State, India, 20 August 2013, 342 m a.s.l., leg. S.P. Narayanan, S. Sathrumithra, D. Kuriakose, S.A. Sasi. 3 aclitellates, 4 juveniles (Regd. No. ACCESSD/EW/1362), home garden, Puthuvely (9°50'4.0"N 6°35'19.3"E), Kottayam District, Kerala State, India, 9 September 2017, 41 m a.s.l., leg. R. Anuja, S. Sathrumithra, E. Thomas. 1 aclitellate (Regd. No. ACCESSD/EW/1363), home garden, Uzhavoor (9°47'12.3"N 76°36'59.3"E), Kottayam District, Kerala State, India, 9 September 2017, 73 m a.s.l., leg. R. Anuja, S.

Sathrumithra, E. Thomas. 2 a clitellates (Regd. No. ACCESSD/EW/1364), rubber plantation, Marangattupally (9°44'12.3"N, 76°36'38.5"E), Kottayam District, Kerala State, India, 9 September 2017, 24 m a.s.l., leg. R. Anuja, S. Sathrumithra, E. Thomas. 3 a clitellates, 1 juvenile (Regd. No. ACCESSD/EW/1365), home garden, Puthuvely (9°50'4.0"N 76°35'19.3"E), Kottayam District, Kerala State, India, 30 October 2018, 41 m a.s.l., leg. R. Anuja, P. Kumar, N.P. Sreekanth. 2 a clitellates, 7 juveniles (Regd. No. ACCESSD/EW/1366), rubber plantation, Puthuvely (9°50'5.2"N, 76°35'19.5"E), Kottayam District, Kerala State, India, 24 September 2020, 35 m a.s.l., leg. S.P. Narayanan, R. Anuja, N.G. Vishnu.

Diagnosis. Colour blue. Length 156–238 mm, diameter 6.5–8.5 mm, segments 237–342. Male pores paired, in transverse slits, lateral to *b* setal lines, at intersegmental furrow 10/11. Spermathecal pores paired, at *cd* setal lines, at intersegmental furrow 7/8. Genital markings absent. Gizzards, large, 2–3 in segments 12–16. Vas deferens a mass of hairpin loops, mass larger than testis sac, entering prostate directly, a little above the ectal end in the glandular portion. Prostates glandular, tubular, slender entally, bulbous at base, duct sinuous and bulged at base; prostatic capsule slender, tubular with smooth margins. Spermathecal atrial glands paired in segment 7, duct of each gland about five times the length of common atrial duct, which is hidden in the parietes in segment 7.

Description. External. Colour bluish, dorsum dark, ventrum pale; body circular in cross section. Dimensions: Holotype length 238 mm, width 8 mm at segment 9, segments 323; paratypes length 180–222 mm, width 6.5–8 mm at segment 9, segments 237–295; other materials: length 156–236 mm, width 6.5–8.5 mm at segment 9, segments 237–342. Setae lumbricine, small, closely paired, present from segment 2; setal formula $aa = 12.67$ $ab = 1.05$ $bc = 12.67$ $cd = 0.32$ dd at segment 8 and $aa = 17$ $ab = 0.89$ $bc = 17$ $cd = 0.33$ dd at segment 20 ($n=1$). Clitellum annular, on segments 10– $\frac{1}{2}$ 14 ($4 \frac{1}{2}$), colour reddish, setae visible, a pair of pale whitish patch present in

front of the secondary male apertures in segment 10. Spermathecal pores paired, small transverse slits at intersegmental furrow 7/8, aligned at *cd* setal lines. Secondary male apertures paired, male pores in transverse slits at intersegmental furrow 10/11, lateral to *b* setal lines (Fig. 1A); small, puckered epidermal thickenings present in front and back of secondary male apertures at segments 10 and 11 (in clitellate specimen, visible only in high magnification). Female pores paired, minute, at intersegmental furrow 11/12, at *b* setal lines? Nephridiopores present from segment 4 to posterior end, on *cd* setal lines; at *d* lines in Uzhavoor specimen. Genital markings absent.

Internal. Bluish pigmentation in circular muscle layer. Septa 4/5 slightly muscular, 5/6–8/9 strongly muscular, septum 9/10 delicate. Gizzards, large, 2–3 in segments 12–16, septa pushed back to 16–20; intestinal origin in segment 27. Commissures for extra-oesophageal vessels present on posterior face of septum 8/9. Testis sacs paired, in segments 10–11, 12, sacs flat and oblong or pear-shaped; vas deferens long, large mass of hairpin loops in segments 9–13 (in holotype LHS in 12–13 and RHS 11–12), mass larger than testis sac, nearly hidden by hairpin loops, vas deferens zigzag-shaped before entering the prostate directly, at median side, a little above the ectal end in glandular portion, without penetrating musculature. Prostates paired, extending from segment 11 to segments 13–15, glandular, tubular, slender entally, bulbous at base (2.5 times thicker than the slender portion), ectal end sinuous and thick (Fig. 1B), glands reddish (holotype light yellowish) to bulbous portion, thin layer of chalk-white glands at slender portion, in a clitellate specimens whitish glands are weakly developed, in certain individuals prostate may be twisted upwards and confined to segment 11, or hook-shaped entally or U-shaped or bent on itself; prostatic capsule slender, smooth, tubular; prostatic duct with ‘n-shaped’ bent before the junction with prostate gland, blunt at junction with parietes (Fig. 1C), about one third of the combined length of gland and duct. Spermathecae paired in segment 8, ampulla ovoidal, each with a coiled duct penetrating septum 7/8 to discharge at junction of long, slightly sinuous ducts of spermathecal atrial

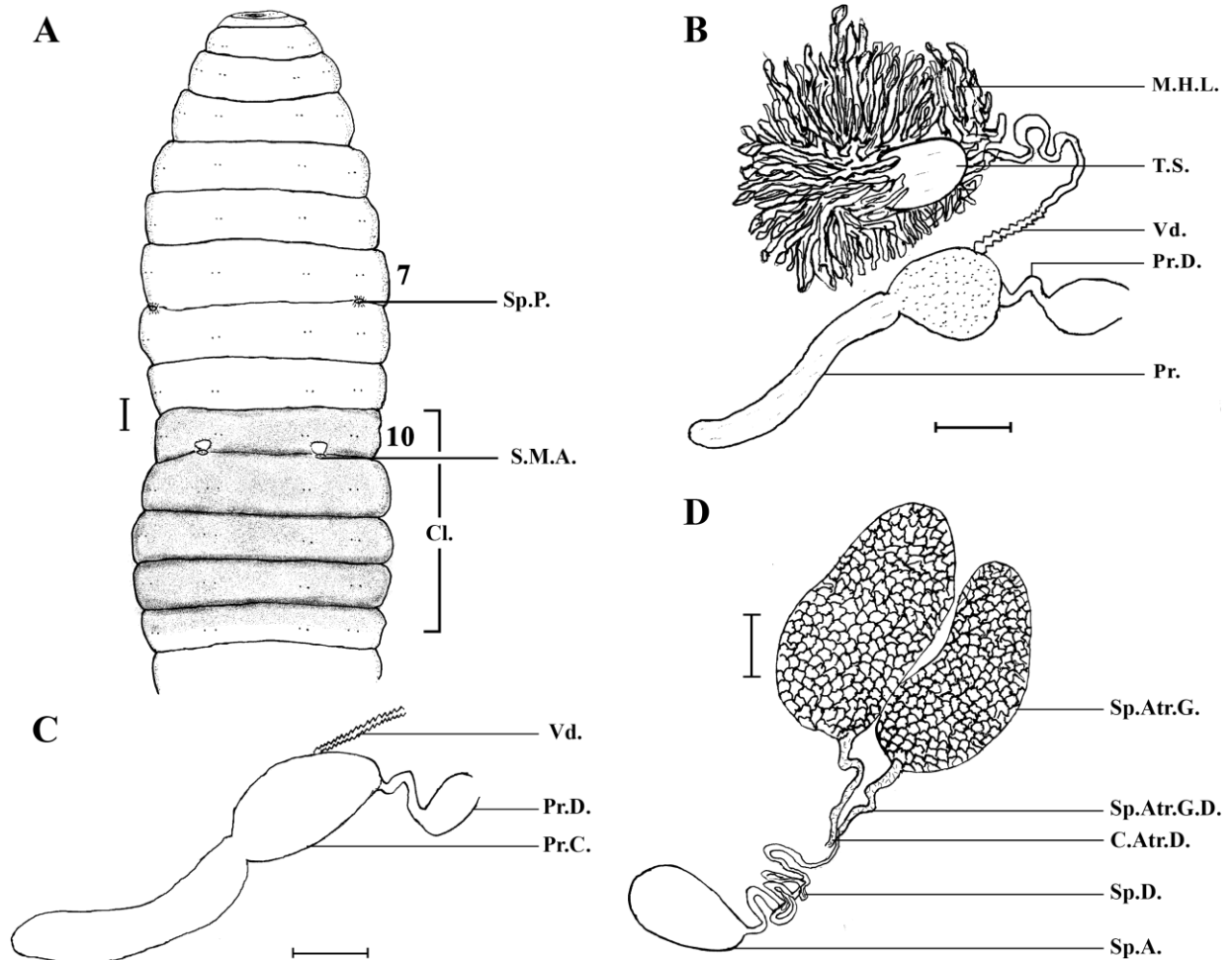


Figure 1. *Moniligaster julkai* Narayanan & Paliwal, sp. nov.: A = Ventral view; B = Prostate of right hand side, dorsal view; C = Prostatic capsule of right hand side, dorsal view; D = Spermatheca of the right hand side, dorsal view.

glands (Fig. 1D), atrial glands long and flat with slight bent, duct of each atrial gland about five times the length of common atrial duct, common atrial duct roughly concealed within parietes in segment 7. Ovarian chamber complete, ovisacs paired in segment 12, extending to segment 13–14, slightly bent or narrowed towards posterior side. Nephridia avesculate; functional at segment 10.

Ingesta. Fine reddish lateritic soil.

Habitat. Evergreen forest, home garden, rubber plantation, streamside with reeds in evergreen forest.

Biology. Endogeic species. Autotomy and regeneration of lost parts appear to be common. Cysts of parasitic protozoans were found in the gizzard region in one specimen each from the Marangattupally and Puthuvely (holotype).

Distribution. Endemic to India: Kerala State: Kottayam District: Marangattupally, Puthuvely, Uzhavoor; Pathanamthitta District: Attathodu, between Chalakkayam and Plapally.

Etymology. Specific epithet '*julkai*' is an eponym, named in honor of Dr. Jatinder Mohan Julka, eminent Indian earthworm taxonomist and academician, for his tremendous contributions to

Table 1. Comparison of *Moniligaster julkai*, sp. nov. with other closely related species

Character	<i>M. graveleyi</i> Stephenson, 1915 ^{1,2}	<i>M. trovi</i> Jamieson, 1977 ³	<i>M. bahi</i> Narayanan & Julka, 2021 ⁴	<i>M. blakemorei</i> Narayanan & Julka, 2021 ^{4,5}	<i>M. keralensis</i> Narayanan & Julka, 2021 ^{4,5}	<i>M. julkai</i> Narayanan & Palwal, sp. nov.
Length	118–130 mm	60–63 mm	75–134 mm	81–136 mm	58–155 mm	156–238 mm
Diameter	5–6 mm	3.5–3.7 mm	4.5–7 mm	3.5–7 mm	3–6 mm	6.5–8.5 mm
Segments	139 (1 ex.)	123–153	135–200	183–278	109–201	237–342
Spermatheca	atrial gland single (?); ampulla ovoid	atrial glands paired; duct of each gland c. 1/4 the length of common atrial duct; ampulla elongate- ovoid	atrial glands paired; duct of each gland c. 1/5 the length of common atrial duct; ampulla ovoid	atrial glands paired; duct of each gland c. four times the length of common atrial duct; ampulla ovoid	atrial glands paired; duct of each gland about as long as common atrial duct; ampulla elongate- ovoid	atrial glands paired; duct of each gland c. five times the length of common atrial duct; ampulla ovoidal
Prostates	strap-shaped	club-shaped	strap-shaped	bluntly club-shaped	tubular	tubular
Prostatic capsule	tubular with deeply incised margins and nodulated surface	(?)	Tubular with smooth margins and a few nodulations at ental end	club-shaped with smooth margins	tubular with smooth margins	tubular with smooth margins
Length of prostatic duct	c. 1/7 the length of gland plus duct	c. 1/3 the length of gland plus duct	c. 1/7 the length of gland plus duct	c. 1/3 the length of gland plus duct	c. 1/9 the length of gland plus duct	c. 1/3 the length of gland plus duct
Vas deferens	segments 9–10, enters prostate entally	segment 9, enters prostate sub-ectally	segments 9–12 (–16), enters prostate sub-entally	segments 9–11 (–12), enters prostate near entally	segments 9–10, enters prostate sub-ectally	segments 9–12 (–13), enters prostate sub-ectally
Gizzards	4–5 (in segments 13–18)	3 (in segments 13–15)	3–4 (in segments 13–18)	2 (in segments 12–16)	3–6 (in segments 14–20)	2–3 (in segments 12–16)
Intestinal origin	in segment 25	in segment 27	in segments 24–26	in segments 26–28	in segments 27–29	in segments 27

Data from: ¹Stephenson (1915); ²Gates (1940); ³Jamieson (1977); ⁴Narayanan *et al.* (2021); ⁵Present study.

the taxonomic and ecological studies on the earthworms of India and neighboring countries.

Remarks. *Moniligaster julkai* sp. nov. belongs to the 'gravelyi' group of *Moniligaster* species characterized by (i) vas deferens opening directly into the prostate, *i.e.*, without penetrating the longitudinal muscle layer, (ii) spermathecal atria confined to segment 7, and (iii) leaflet like glands absent on the vas deferens. The group consists of six species, apart from the new species described in this paper: *M. gravelyi* Stephenson, 1915, *M. troyi* Jamieson, 1977, *Moniligaster bahli* Narayanan & Julka, 2021, *M. blakemorei* Narayanan & Julka, 2021 and *M. keralensis* Narayanan & Julka, 2021.

M. julkai sp. nov. is distinguished from *M. gravelyi* and *M. bahli* by the shape of the prostate (tubular *vs* strap-like). It can also be differentiated from *M. troyi* by the large size of the atrial gland duct, and from *M. blakemorei* by the tubular shape of the prostatic capsule. However, it differs from *M. keralensis* by larger size (length 156–238 *vs* 58–155 mm; diameter 6.5–8.5 mm *vs* 3–6 mm; segments 237–342 mm *vs* 109–201), the length of the prostatic duct, and intestinal origin (in segments 27 *vs* segments 27–29). Detailed comparison of these species is provided in Table 1.

Status revision of *Moniligaster deshayesi minor* Michaelsen, 1913

Michaelsen (1913) described a subspecies of *M. deshayesi*, namely, *Moniligaster deshayesi* var. *minor* Michaelsen, 1913, based on a single clitellate specimen collected by Shunkara Nayama Pilley (misnomer of Shankara Narayana Pillai) on 26 December 1911 from Chimungi (now Chemmunji: Narayanan *et al.* 2016). Later, Gates (1940) in his revision of the genus synonymised it with *M. deshayesi*. Since then it was considered as a junior synonym of *M. deshayesi*. However, Blakemore (2007) treated it as a subspecies without furnishing any details. Concurrently, certain web based databases treated it as a variety or subspecies (e.g. <https://earthwormsofindia.com>, <http://earthworm.uw.hu> etc.). Though following

Gates (1940), Narayanan *et al.* (2016) treated it as a synonym of *Moniligaster deshayesi* in the checklist of Kerala earthworms. During a recent survey of the earthworms near the type locality of *M. d. minor* we have obtained many specimens of a *Moniligaster* species. Careful studies of the key taxonomic features of these freshly collected specimens revealed that they are *M. d. minor* which is unmistakably distinct from *M. deshayesi*. Therefore, being distinct taxa, it is resurrected from the synonymy of *Moniligaster deshayesi* Perrier, 1872 and raised to species rank as *Moniligaster minor* Michaelsen, 1913. Here we discuss the details of the newly obtained *M. minor* along with figures.

Moniligaster minor Michaelsen, 1913

(Figures 2A–D, 3)

Moniligaster deshayesi var. *minor* Michaelsen, 1913: 78.
Moniligaster deshayesi var. *minor*: Stephenson 1923: 122.
Moniligaster deshayesi (part): Gates 1940: 499.
Moniligaster deshayesi minor: Blakemore 2007: 9.

Type material. *Holotype.* Clitellate, (ZMUH 8096) (Michaelsen 1913, Gates 1940, Reynolds & Wetzel 2020), Chimungi, Thiruvananthapuram District, Kerala State, India, 26 December 1911, leg. Shunkara Nayama Pilley.

Material examined. 1 clitellate, 13 acitellates (Reg. No. ACESSD/EW/1126), from thick root mat of grasses growing on rocky hilltop near shola forest, Agasthyarkoodam peak (8°36'58.1" N, 77°14'45.1"E) in Neyyar Wildlife Sanctuary (21 km from Bonacaud), Thiruvananthapuram District, Kerala State, India, 1865 m a.s.l., 4 October 2014, leg. D. Kuriakose, S.P. Narayanan, T. Augustine, S.A. Sasi, S. Sathrumithra. 13 clitellates (Reg. No. ACESSD/EW/1127), shola forest, same collection data as for preceding. 3 acitellates (Reg. No. ACESSD/EW/1128), higher altitude evergreen forest, Athirumala (8°37'4.4"N, 77°13'47.2"E) (16 km from Bonacaud) in Neyyar Wildlife Sanctuary, Thiruvananthapuram District, Kerala State, India, 1011 m a.s.l., 27 April 2016, leg. S.P. Narayanan, Al Badush, S. Sathrumithra.

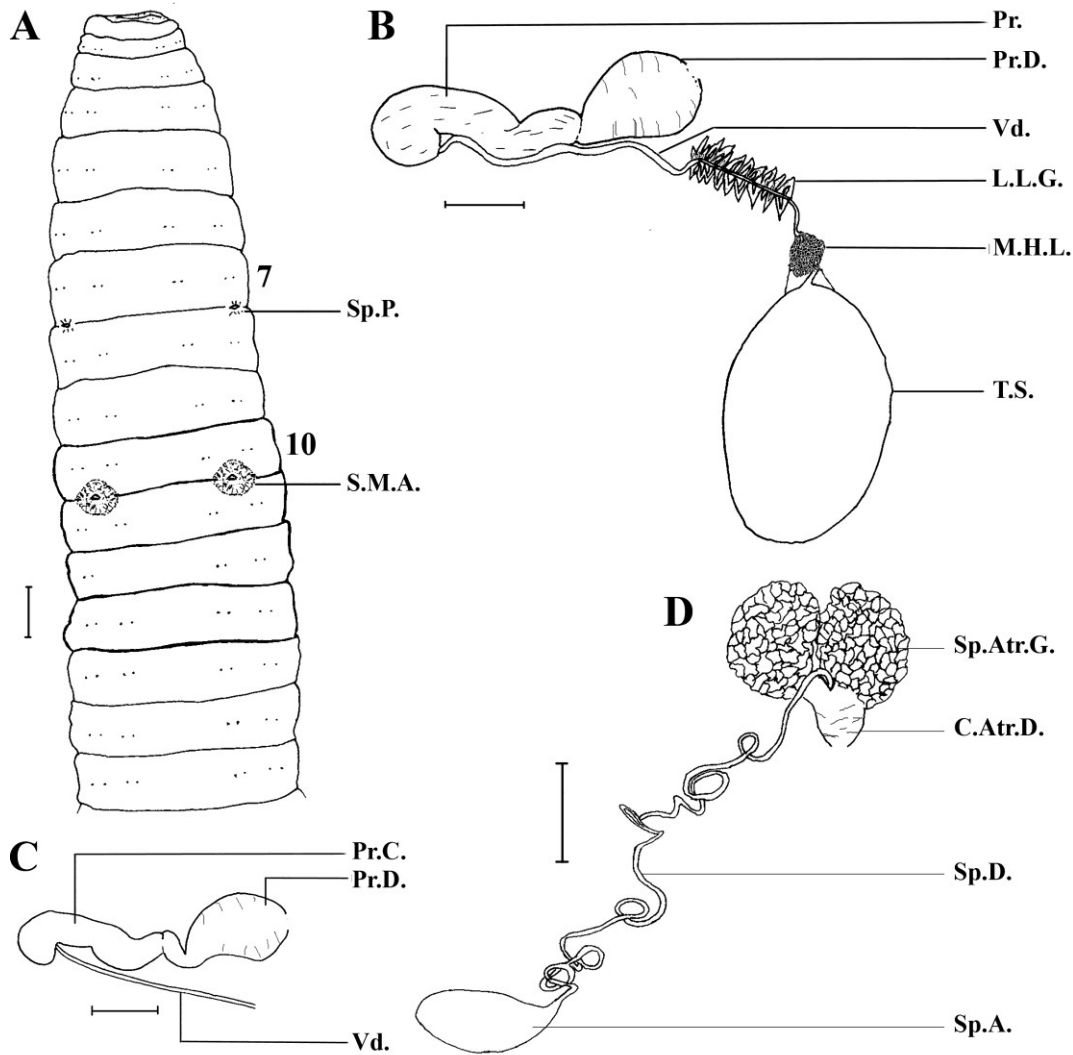


Figure 2. *Moniligaster minor* Michaelsen, 1913: A = Ventral view; B = Prostate of left hand side, dorsal view; C = Prostatic capsule of left hand side, dorsal view; D = Spermatheca of the left hand side, dorsal view.

Diagnosis. Colour brownish to bluish. Length 69–122 mm, diameter 3–6 mm, segments 112–200. Secondary male apertures paired, minute, transverse invagination, in centre of a shallow transversely oval depression, between *b-c* setal lines, median to *c* setae, at intersegmental furrow 10/11. Spermathecal pores paired, at *cd* setal lines, at intersegmental furrow 7/8. Genital markings absent. Gizzards 4–5 in segments 14–19. Vas deferens, coiled into mass, mass smaller than testis sac, passing through light mass of leaflet-like glands, small size and less in number, ental portion slender, entering prostate directly, at

the ental end. Prostates short, glandular, tubular-shaped, prostatic duct bulged at ectal end; prostatic capsule tubular with smooth margins. Spermathecal atrial gland paired in segment 7, duct of each gland about one third the length of common atrial duct.

Description. External features. Colour brownish to bluish; body circular in cross section. Dimensions: length 69–122 mm, width 3–6 mm at segment 9, segments 112–164. Setae lumbricine, present on segment 2, closely paired; setal formula $aa = 5.71-7.5$ $ab = 0.65-1.33$ $bc = 7.5-8$

$cd = 0.25-0.27$ at segment 9 and $aa = 8-10$ $ab = 0.97-1.09$ $bc = 10-13.33$ $cd = 0.2-0.29$ dd at segment 20 ($n=3$). Clitellum annular, distinct, brown to reddish colour at segments 10–13 (4). Spermathecal pores paired, large transverse slits at intersegmental furrow 7/8, aligned at cd setal lines (Fig. 2A). Secondary male apertures paired, minute, transverse invagination, in centre of distinct pale coloured, shallow transversely oval depression at intersegmental furrow 10/11, between $b-c$ setal lines, median to c setae. Female pores, paired, conspicuous, at intersegmental furrow 11/12, at b setal lines. Nephridiopores minute, almost in one rank at or close to d setal lines, recognizable from segment 3, functional at segment 10. Genital markings absent.

Internal anatomy. Septa 6/7/8/9 slightly muscular, septum 9/10 delicate. Gizzards 4–5 in segments 14–19; intestinal origin in segments 26–28; commissures of extra-oesophageal vessels present on the posterior face of septum 8/9 and 9/10. Testis sacs paired, asymmetrical, in segments 9–12 on one side and dislocated to segments 13–16 on the other side but retaining connection with septum 9/10 through a narrow tube like membranous structure; vas deferens in segments 9–15, coiled, mass smaller than testis sac, passing through light mass of small leaflet-like glands, less in number, ental portion slender, entering prostate directly without entering musculature, at the ental end of the prostate gland. Prostates paired, glandular, tubular, extending from segment 11 to segments 12–15 (3.8–5 mm long), slightly bent entally with a notch mesially (Fig. 2B), in some specimens prostate bent on itself or twisted and projecting to anterior side; prostatic capsule tubular (Fig. 2C), margins smooth, slightly narrowed towards ectal side, ectal portion of prostatic duct bulged (conspicuous in clitellate specimens, less distinct in acitellates), bound down to the parietes by several diagonal muscles, greater than one third of the combined length of gland and duct. Spermathecae paired in segment 8, ampulla elongate-ovoidal, with lightly coiled duct penetrating septum 7/8 to emerge in segment 7 to discharge at the junction of spermathecal atrial glands duct (Fig. 2D); duct of each atrial gland about one third the length of common atrial

duct. Ovarian chamber complete, horseshoe shaped; ovisacs paired in segment 12, extending to segments 16–19. Nephridia avesculate; functional at segment 10.

Ingesta. Mostly fine soil with bits of delicate rootlets, tiny pieces of bark and quartz.

Habitat. Higher altitude evergreen forest (above 1000 m) and shola forest–grassland complex.

Distribution. Endemic to India, it is restricted to the higher altitudes of Agasthyamalai Biosphere Reserve (Kerala State: Thiruvananthapuram District: Agasthyarkoodam peak, Athirumala, both in Neyyar Wildlife Sanctuary and Chimungi (= Chemmunji) in Peppara Wildlife Sanctuary) (Fig. 3).

Remarks. *M. minor* belongs to a group of *Moniligaster* species, characterized by (1) vas deferens opening directly into prostate, i.e., without penetrating the longitudinal muscle layer, (2), spermathecal atria confined to segment 7, and (3) leaflet-like glands present on the vas deferens. The only other member of the group is *Moniligaster deshayesi* Perrier, 1872. *M. minor* can be differentiated from *M. deshayesi* by the shape of the prostatic capsule, which is smooth and tubular against ‘rod like’ with ridges in *M. deshayesi*. The length of the prostate gland is shorter (3.85–5 mm) as compared to longer prostates (12–15 mm) in *M. deshayesi*. Vas deferens long, coiled, passing through light mass of smaller sized leaflet-like glands, entering at ental end of prostate vs. long, with a number of loops, passing through heavy mass of larger leaflet-like glands, entering slightly below the ental end of prostate in *M. deshayesi*. Nephridiopores are in almost one rank at or close to d setal lines as compared to irregular dislocation ventrally to ab setal lines in segments behind clitellum in *M. deshayesi*. Based on the above mentioned key characters we herein elevate *M. minor* to the species rank as *Moniligaster minor* Michaelsen, 1913. Further, *M. minor* is easi-

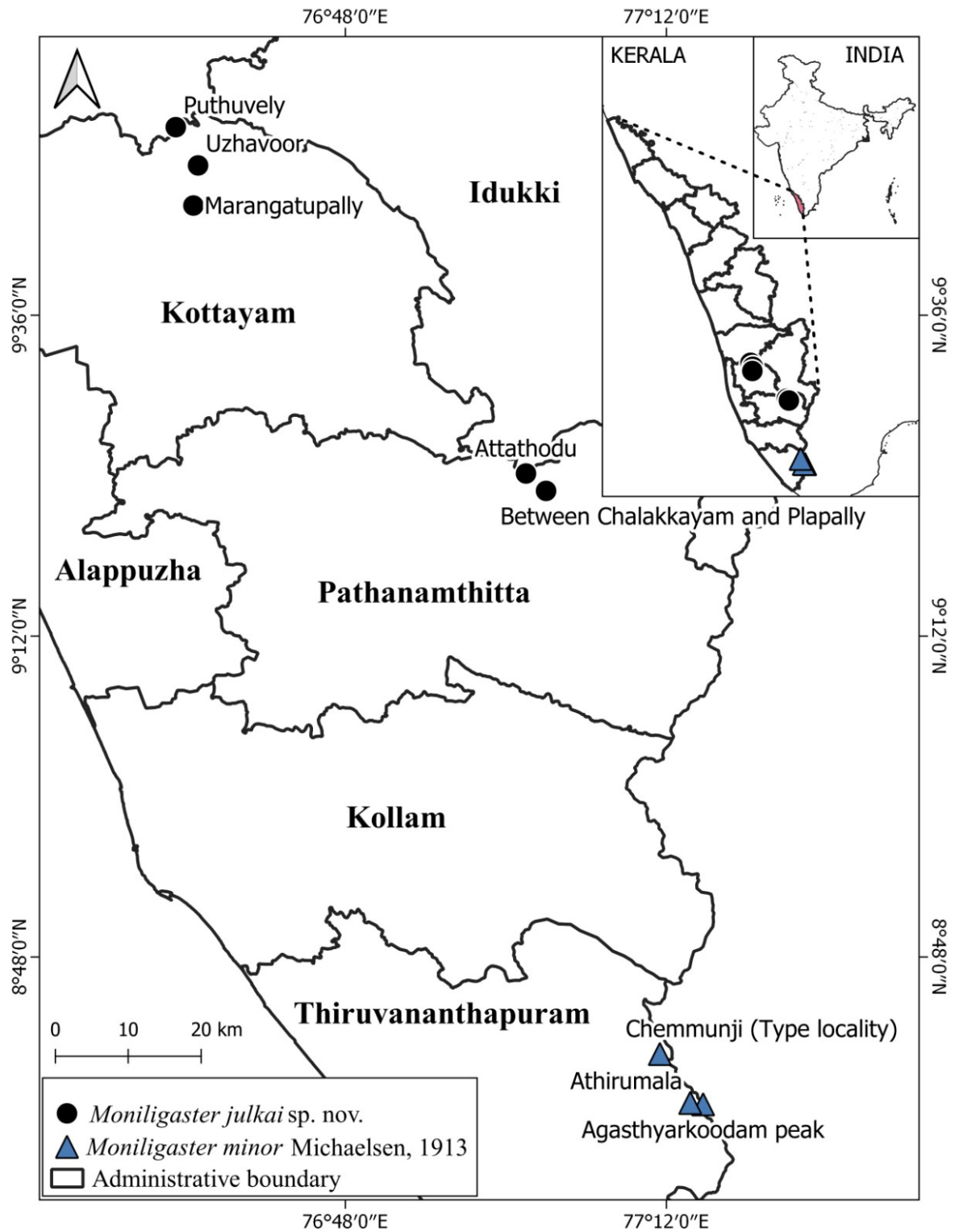


Figure 3. Current known distribution of *Moniligaster julkai* sp. nov. and *Moniligaster minor* Michaelsen, 1913

Table 2. Comparison of the characters of *Moniligaster deshayesi* Perrier, 1872 and *M. minor* Michaelsen, 1913

Character	<i>Moniligaster deshayesi</i> Perrier, 1872 ^{1,2,3,4}	<i>Moniligaster minor</i> Michaelsen, 1913 ^{4,5}
Length	114–163 mm	69–122 mm
Diameter	4–8 mm	3–6 mm
Segments	136–195	112–200
Nephridiopores	irregular dislocation ventrally to <i>ab</i> setal lines in segments behind clitellum	almost in one rank at or close to <i>d</i> setal lines
Female pores	minute, on or close to setae <i>b</i>	conspicuous, at <i>b</i> setal lines
Spermatheca	atrial glands paired; duct of each gland <i>c.</i> 1/2 to 1/3 the length of common atrial duct; ampulla ovoid	atrial glands paired; duct of each gland <i>c.</i> 1/3 the length of common atrial duct; ampulla elongate-ovoidal
Prostates	dark red, long (12–15 mm), rod-like, narrowed ectally	chalk white to yellowish white, short (3.8–5 mm), tubular, slightly bent entally with a notch mesially
Prostatic capsule	raised into crisscrossed ridges, prostatic duct slender	smooth, ectal portion of prostatic duct bulged
Length of prostatic duct	<i>c.</i> 1/4 th the length of gland plus duct	greater than 1/3 rd the length of gland plus duct
Vas deferens	passing through heavy mass of larger leaflet-like glands, entering slightly below the ental end of prostate	passing through light mass of smaller leaflet-like glands, entering at ental end of prostate
Gizzards	4–5 (in segments 13–20)	4–5 (in segments 14–19)

Data from: ¹Gates (1940), ²Aiyer (1929), ³Stephenson (1923), ⁴present study, ⁵Michaelsen (1913).

Table 3. Records of *Moniligaster minor* and *M. deshayesi* along with altitudinal and habitat details

Sl No.	Location	District	State	Reference	Altitude	Habitat
<i>Moniligaster minor</i>						
1	Chimungi (= Chemmunji)	Thiruvananthapuram	Kerala	Michaelsen (1913)	1200 m	?
2	Agasthyarkoodam peak	Thiruvananthapuram	Kerala	Present study	1865 m	Shola forest and from thick root mat of grasses growing on rocky hilltop near shola forest
3	Athirumala	Thiruvananthapuram	Kerala	Present study	1011 m	Higher altitude evergreen forest
<i>Moniligaster deshayesi</i>						
1	Neduvangand (= Nedumangad)	Thiruvananthapuram	Kerala	Michaelsen (1910)	68 m	?
2	Courtallam	Tenkasi	Tamil Nadu	Stephenson (1926)	160 m	?
3	Tenmalai (= Thenmala)	Kollam	Kerala	Aiyer (1929)	500 m	?
4	Anachardie	Thiruvananthapuram	Kerala	Gates (1940)	?	?
5	Charupara	Kollam	Kerala	Sathrumithra et al. (2018)	266 m	Semi evergreen forest
6	Njandukombu	Kollam	Kerala	Sathrumithra et al. (2018)	146 m	Semi evergreen forest
7	Kurichi	Pathanamthitta	Kerala	Sathrumithra et al. (2018)	534 m	Evergreen forest
8	Kallipara in Kottavasal (Reg. no. ACESSD/EW/162)	Kollam	Kerala	Present study	474 m	Evergreen forest

9	Near to Ambanad estate (Reg. no. ACESSD/EW/186)	Kollam	Kerala	Present study	795 m	Evergreen forest
10	Between Kumbavuruttu and Kottavasal (Reg. no. ACESSD/EW/619)	Kollam	Kerala	Present study	241 m	Disturbed evergreen forest
11	Pulachippara in Achankovil Forest (Reg. no. ACESSD/EW/620)	Kollam	Kerala	Present study	288 m	Deciduous like forest near teak plantation
12	Priya estate (Reg. no. ACESSD/EW/621)	Kollam	Kerala	Present study	486 m	Disturbed evergreen forest
13	Aluvamkudy (Reg. no. ACESSD/EW/605)	Pathanamthitta	Kerala	Present study	513 m	Evergreen forest
14	Pandimotta in Shendurney Wildlife Sanctuary (Reg. no. ACESSD/EW/1294)	Kollam	Kerala	Present study	174 m	Evergreen forest
15	below Ponmudi (Reg. no. ACESSD/EW/1318)	Thiruvananthapuram	Kerala	Present study	800 m	Evergreen forest

ly distinguished from *M. deshayesi* by the characteristics as given in table 2.

Type locality of *M. minor*, Chimungi (= Chemmunji) is close to the present collection sites, Agasthyarkoodam peak and Athirumala and are practically at the same altitudinal range. *M. deshayesi* is known to inhabit mainly evergreen, semi-evergreen and disturbed evergreen forests, below 800 m altitude, whereas *M. minor* is confined to the higher altitude evergreen forest and shola-grassland complex above 1000 m (Table 3).

Additional distributional records of *Moniligaster* species from Kerala

Moniligaster aiyeri Gates, 1940

Moniligaster aiyeri Gates, 1940: 493.

Material examined. 1 a clitellate (Reg. No. ACESSD/EW/1047), shola forest, Agasthyarkoodam (8°36'56.1"N, 77°14'45.1"E) in Neyyar Wildlife Sanctuary, Thiruvananthapuram District, Kerala State, India, 1865 m a.s.l., 4 October 2014, leg. D. Kuriakose, S.P. Narayanan, T. Augustine, A. Sasi, S. Sathrumithra.

Brief description. Colour bluish. Length 118–456 mm, diameter 12–13 mm, segments 189–310. Spermathecal pores transverse slits, in *cd* setal lines, at intersegmental furrow 7/8. Male pores

paired, transverse elliptical apertures, nearer to *b* setal lines. Gizzards 4–6, in segments 16–23. One or both testis sacs dislocated posteriorly under ovarian chamber. Vas deferens long, slender, thickened portion into cluster of loops which is larger than testis sac; vas passes under longitudinal musculature before entering anterior ental end of prostate; prostates mushroom-shaped, prostatic capsule spheroidal. Spermathecal atrial glands in segments 7 and 8, duct of each atrial gland about one fourth the length of common atrial duct, atrial gland duct only recognizable after removal of basal portions of the glands.

Habitat. Shola forest.

Distribution. Endemic to India, restricted to the higher altitudes of Agasthyamalai Biosphere Reserve. Kerala State: Thiruvananthapuram District: Agasthyarkoodam – Neyyar Wildlife Sanctuary* (*present record) (Fig. 4); Tamil Nadu State: Muthukkuzhi (Gates 1940).

Remarks. Dimensions of the present specimen - length 303 mm, width 12 mm, segments 285. It has five gizzards in segments 16–20. Hence the diagnosis of the species has been updated based on the present specimen from the Agasthyarkoodam. Recently, Narayanan *et al.* (2016) mistakenly included it in Kerala checklist. Recent record of *M. aiyeri* from Kerala state by Thakur *et al.* (2021) is clearly a misidentification. The key

diagnostic features of *M. aiyeri*, is its characters of prostate, which is erect and mushroom-like and vas deferens joins the prostate at its ental end, but in the figure provided, it is shown that the prostate as long, tubular with wider base, directed anteriorly, vas deferens join the prostate at its middle. Other key features such as penetration of vas deferens through the longitudinal musculature of the body wall prior to junction with the prostate, segmental location of spermathecal atrial glands are not mentioned. Hence the present record of *M. aiyeri* becomes the first positive report of this species from the political boundary of the Kerala state.

***Moniligaster blakemorei* Narayanan & Julka, 2021**

Moniligaster blakemorei Narayanan et al., 2021a: 385.

Material examined. 1 clitellate, 6 a clitellates (Reg. No. ACESSD/EW/1296), roadside in evergreen forest, above Moozhiyar KSEB office (9°19'7.2"N 77°4'49.7"E), Pathanamthitta District, Kerala State, India, 689 m a.s.l., 27 September 2011 leg. T. Augustine, S.P. Narayanan. 1 a clitellate (Reg. No. ACESSD/EW/1297), road side in evergreen forest, near Moozhiyar dam (9°18'18.1"N, 77°3'15.7"E), Pathanamthitta District, Kerala State, India, 27 September 2011, leg. T. Augustine, S.P. Narayanan. 1 clitellate, 4 a clitellates (Reg. No. ACESSD/EW/1298), *Ochlandra* reed break in evergreen forest, Gavi in Periyar Tiger Reserve, Pathanamthitta District, Kerala State, India, 28 September 2011, leg. S.P. Narayanan, T.K. Subash. 5 clitellates, 4 a clitellates (Reg. No. ACESSD/EW/1299), disturbed evergreen forest, Pampa in Periyar Tiger Reserve (9°24'7.79"N, 77°4'1.3"E), Pathanamthitta District, Kerala State, India, 266 m a.s.l. 28 August 2013, leg. A. Sasi, S. Sathrumithra, S.P. Narayanan, D. Kuriakose. 4 clitellates (Reg. No. ACESSD/EW/1300), stream side with reeds in evergreen forest, Attathodu (9°24'9.6"N, 77°1'30.5"E), Pathanamthitta District, Kerala State, India, 342 m a.s.l. 20 August 2013, leg. S.P. Narayanan, S. Sathrumithra, D. Kuriakose and

A. Sasi. 1 a clitellate (Reg. No. ACESSD/EW/1301), evergreen forest, near to Ambanad estate (9°2'26.4"N, 77°7'6.3"E), Kollam District, Kerala State, India, 795 m a.s.l., 24 August 2013, leg. S.P. Narayanan, D. Kuriakose, S. Sathrumithra, A. Sasi. 11 a clitellates (Reg. No. ACESSD/EW/1302), evergreen forest, Aluvamkudi (9°16'7.8"N, 77°00'6.8"E), Kollam District, Kerala State, India, 513 m a.s.l., 21 August 2013, leg. S.P. Narayanan, S. Sathrumithra, D. Kuriakose, A. Sasi. 4 clitellates, 5 a clitellates, 2 juveniles (Reg. No. ACESSD/EW/1309), home garden, Poonjar (9°34'46.03"N, 076°42'43.1"E), Kottayam District, Kerala State, India, 54 m a.s.l., 11 May 2017, leg. R. Anuja, S. Sathrumithra, E. Thomas, V.T. Kurien. 2 clitellates, 2 a clitellates, 2 juveniles (Reg. No. ACESSD/EW/1310), rubber plantation, Poonjar (9°39'42.0"N, 76°48'48.2"E), Kottayam District, Kerala State, India, 54 m a.s.l., 11 May 2017, leg. R. Anuja, S. Sathrumithra, E. Thomas, V.T. Kurien. 5 a clitellates, 3 juveniles (Reg. No. ACESSD/EW/1311), rubber plantation, Munnilavu (9°41'24.7"N, 76°46'58.6"E), Kottayam District, Kerala State, India, 59 m a.s.l., 18 December 2018, leg. R. Anuja, P. Kumar, N.G. Vishnu (Fig. 4).

Brief description. Colour bluish. Length 81–136 mm, diameter 3.5–7 mm, segments 183–278. Secondary male apertures paired, large transverse slits, slightly lateral to *b* setal lines at intersegmental furrow 10/11. Spermathecal pores, paired, small transverse slits, close to *cd* setal lines at intersegmental furrow 7/8. Genital markings absent. Gizzards 2 in segments 12–16. Testis sacs asymmetrical. Vas deferens a mass of hairpin loops, mass about as large as testis sac, entering prostate directly, near to ental end. Prostates glandular, bluntly club-shaped, prostatic capsule shiny, smooth, club-shaped. Spermathecal atrial glands paired in segment 7, duct of each gland about four times the length of common atrial duct.

Habitat. Forest (disturbed evergreen*, evergreen, *Ochlandra* reed breaks* and semi evergreen*), home garden and rubber plantation (*present record).

Biology. Specimens from Attathodu and Gavi had protozoan cysts in the region of gizzards and ovisacs.

Distribution. India: Kerala State: Kollam District: near to Ambanad estate*; Kottayam District: Melukavu, Munnilavu* and Poonjar*; Pathanamthitta District: above Moozhiyar KSEB office*, Aluvamkudi*, Attathodu*, Gavi in Periyar Tiger Reserve*, near Moozhiyar dam*, Pampa in Periyar Tiger Reserve*, between Aranamoozhi and Ilampampa (*present records; Narayanan *et al.* 2021a).

Remarks. Diagnosis of the species is updated based on the present materials from Kollam, Kottayam and Pathanamthitta districts of Kerala state. Segmental location of gizzard varied in specimens from Moozhiyar (Reg. no. ACESSD/EW/1296–1297) area, where it is in segments 12–13 or 13–14. Whereas, a specimen from Pampa it is in segments 15–16. First gizzard in the segment 13 is weak compared to the one in 14, in specimen from near Moozhiyar Dam (Reg. no. ACESSD/EW/1297). Gizzard being large, septa are pushed back to posterior, even up to segment 18. Specimen from the Ambanad estate (Reg. no. ACESSD/EW/1301) of Kollam district, prostate on the right hand side is twisted and directed anteriorly. Specimens from the Kottayam district showed a slight difference in the shape of prostate and joining of vas deferens to prostate. Pathanamthitta and Kollam districts specimens have bluntly club-shaped prostate and vas joins the prostate sub-entally, whereas Kottayam specimens have narrowly club-like prostate and vas joins prostate at its middle.

***Moniligaster deshayesi* Perrier, 1872**

Moniligaster deshayesi Perrier, 1872: 130.

Material examined. 2 clitellates, 12 aclitellates, 3 juveniles (Reg. No. ACESSD/EW/162), evergreen forest, Kallipara in Kottavasal (9°4'17.4"N, 77°12'24.5"E), Kollam District, Kerala State, India, 474 m a.s.l., 22 August 2013, leg. S.P. Narayanan, T. Augustine, S.A. Sasi, S. Sathru-

mithra, D. Kuriakose. 1 clitellate, 4 aclitellates (Reg. No. ACESSD/EW/186), evergreen forest, near to Ambanad estate (09°02'26.4"N, 77°07'06.3"E), Kollam District, Kerala State, India, 795 m a.s.l., 23 August 2013, leg. D. Kuriakose, S. Sathrumithra, S.P. Narayanan, T. Augustine, A. Sasi. 1 aclitellate (Reg. No. ACESSD/EW/605), evergreen forest, Aluvamkudy (9°16'07.8"N, 77°00'16.8"E), Pathanamthitta District, Kerala State, India, 513 m a.s.l., 21 August 2013, leg. S.P. Narayanan, D. Kuriakose, S. Sathrumithra, A. Sasi. 1 clitellate, 2 aclitellates (Reg. No. ACESSD/EW/619), disturbed evergreen forest, between Kumbavurutty and Kottavasal (9°04'26.2"N, 77°11'26.8"E), Kollam District, Kerala State, India, 241 m a.s.l., 23 August 2013, leg. D. Kuriakose, S. Sathrumithra, S.P. Narayanan, T. Augustine, A. Sasi. 1 aclitellate, 3 juveniles (Reg. No. ACESSD/EW/620), deciduous like forest near teak plantation, Pulachippara (9°5'58.9"N, 77°8'46.7"E), Kollam District, Kerala State, India, 288 m a.s.l., 23 August 2013, leg. D. Kuriakose, S. Sathrumithra, S.P. Narayanan. 2 aclitellates (Reg. No. ACESSD/EW/621), disturbed evergreen forest, Priya estate (9°2'45"N, 77°7'39.1"E), Kollam District, Kerala State, India, 486 m a.s.l., 24 August 2013, leg. S.P. Narayanan, D. Kuriakose, S. Sathrumithra, T. Augustine, A. Sasi. 2 clitellates (Reg. No. ACESSD/EW/1294), evergreen forest, Pandimotta (9°14'23.9"N, 76°55'24.2"E) in Shendurney Wildlife Sanctuary, Kollam District, Kerala State, India, 174 m a.s.l., 19 June 2015, leg. S. Sathrumithra, P. Manoj, D. Raju. 1 aclitellate (Reg. No. ACESSD/EW/1318), evergreen forest, below Ponmudi, Thiruvananthapuram District, Kerala State, India, 800 m a.s.l., 2 October 2014, leg. S.P. Narayanan, D. Kuriakose, S. Sathrumithra, S.A. Sasi (Fig. 4).

Brief description. Colour bluish. Length 114–163 mm, diameter 4–8 mm, segments 136–195. Clitellum red, in segments 10–13, intersegmental furrows distinct. Secondary male apertures paired, between *b* and *c* setal lines at intersegmental furrow 10/11. Spermathecal pores paired, in *cd* setal lines at intersegmental furrow 7/8. Nephridiopores minute, recognizable from segment 3, from segment 13 to posterior end dislocated dor-

sally or ventrally to *ab* setal lines but quite irregularly. Genital markings absent. Four to five gizzards in segments 13–20. Testis sacs confined to segments 9 and 10 or dislocated posteriorly. Vas deferens a mass of hairpin loops passing through heavy mass of large leaflet-like glands, entering prostate directly, slightly below the ental end. Prostate glandular, long, prostatic capsule rod like, with crisscrossed ridges, prostatic duct slender. Spermathecal atrial glands paired in segment 7, duct of each gland smaller than common atrial duct.

Habitat. Forest (deciduous like*, disturbed evergreen*, evergreen and semi evergreen) (*present study; Sathrumithra *et al.* 2018).

Distribution. India: Kerala State: Kollam District: between Kumbavurutti and Kottavasal*, Charupara, near to Ambanad estate*, Njandukombu, Pandimotta in Shendurney Wildlife Sanctuary*, Pittny, Priya estate*, Pulachippara in Achankovil Forest*, Tenmalai (= Thenmala); Pathanamthitta District: Aluvamkudy*, Kurichi; Thiruvananthapuram District: Anachardie, below Ponmudi, Neduvangand (= Nedumangad) (*present record; Michaelsen 1910; Aiyer 1929; Gates 1940; Sathrumithra *et al.* 2018). *Elsewhere.* Tamil Nadu State, India: Courtallam (Stephenson 1926).

Remarks. Type specimen of the species is perhaps from the Southern Western Ghats portion of the Kerala State, India. Stephenson (1915) has recorded *M. deshayesi* from the Parambikulam. Later, during the revision of the genus Gates (1940) stated that Stephenson's specimens do not belong to *M. deshayesi* due to the lack of leaflet-like glands on the vas deferens. Recently, Thakur *et al.* (2021) reported *M. deshayesi* from the Parambikulam Tiger Reserve, but the figures depicted by them lack the diagnostic features (*e.g.* shape of the prostate, absence of leaflet-like glands on the vas deferens, etc.) implying it to be a different species.

***Moniligaster horsti* Gates, 1940**

Moniligaster horsti Gates, 1940: 506.

Material examined. 1 aclitellate (Reg. No. AC ESSD/EW/1295), higher altitude evergreen forest, between Pettymudi and Parappayarkudi (10° 11.250'N, 77°1.519'E), Idukki District, Kerala State, India, 1627 m a.s.l., 22 February 2019, leg. S.P. Narayanan, A. Mohan, R. Nair (Fig. 4).

Brief description. Colour bluish to brownish. Length 118–206 mm, diameter 8 mm, segments 189–191. Spermathecal pores large transverse slits, slightly median to *c*, at intersegmental furrow 7/8. Male pores paired, transverse slits, at about mid *bc*. Gizzards 4–5, in segments 14–20. Testis sacs in segment 10. Vas deferens coiled into a mass of hairpin loops, mass twice the size of testis sac; vas deferens passes under longitudinal musculature before entering ental end of prostate; prostates ovoid, capsule ovoidal to anvil-shaped. Spermathecal atrial glands in segments 7 and 8, duct of each atrial gland about one fourth the length of common atrial duct, which is longitudinally placed and partially buried in parietes.

Habitat. Forest (disturbed evergreen, evergreen, higher altitude evergreen* and shola forests) (*present record; Narayanan *et al.* 2021a).

Distribution. India: Kerala State: Palakkad District: Karimalagapuram in Parambikulam Tiger Reserve; Idukki District: between Pettymudi and Parappayarkudi*, Moothassery, Ozhuvathadam, Pampadam Shola National Park (*present record; Narayanan *et al.* 2021a). *Elsewhere.* Tamil Nadu State: Bungitappal (Gates 1940).

Remarks. Present specimen had five gizzards in segments 16–20. Hence the diagnosis of the species has been updated based on the present specimen from the Idukki district.

***Moniligaster keralensis* Narayanan & Julka, 2021**

Moniligaster keralensis Narayanan *et al.*, 2021a: 386.

Material examined. 1 juvenile (Reg. No. ACESSD/EW/1269), grassland, Kurisumala in Wagamon, Kottayam District, Kerala State, India, 17 August 2018, leg. R. Anuja, V. Balan, T. Subash. 2 clitellates (Reg. No. ACESSD/EW/1272), road side in evergreen forest, Chelikuzhi (9°23'17.4"N, 76°56'00.8"E), Pathanamthitta District, Kerala State, India, 514 m a.s.l., 26 September 2011, leg. S.P. Narayanan, T. Augustine, T.K. Subash. 1 clitellate, 4 a clitellates, 3 juveniles (Reg. No. ACESSD/EW/1273), Vallikettu (9°22'00.0"N, 76°58'43.8"E), evergreen forest, Pathanamthitta District, Kerala State, India, 139 m a.s.l., 26 September 2011, leg. T. Augustine, S.P. Narayanan, T.K. Subash. 4 a clitellates, 1 juvenile (Reg. No. ACESSD/EW/1274), disturbed forest with reeds and canes, Chenthamarakokka near Gavi (9°25'1.00"N, 76°58'43.8"E) in Periyar Tiger Reserve, Pathanamthitta District, Kerala State, India, 947 m a.s.l., 28 September 2011, leg. T.K. Subash, T. Augustine. 1 clitellate, 5 a clitellates (Reg. No. ACESSD/EW/1275), evergreen forest, between Aranamoozhi and Ilampampa (9°18'51.6"N, 77°7'24.1"E) in Periyar Tiger Reserve, Pathanamthitta District, Kerala State, India, 1056 m a.s.l., 27 September 2011, leg. S.P. Narayanan, T. Augustine. 1 a clitellate (Reg. No. ACESSD/EW/1276), road side in evergreen forest, above Moozhioyar KSEB office I (9°19'7.2"N, 77°4'49.7"E), Pathanamthitta District, Kerala State, India, 689 m a.s.l., 27 September 2011, T. Augustine, leg. S.P. Narayanan. 8 a clitellates, 3 juveniles (Reg. No. ACESSD/EW/1277), shola-like forest, Varayadumkokka in Periyar Tiger Reserve (9°22'41.5"N, 77°8'58.3"E), Pathanamthitta District, Kerala State, India, 1055 m a.s.l., 28 September 2011, leg. T. Augustine, S.P. Narayanan, T.K. Subash. 4 a clitellates (Reg. No. ACESSD/EW/1278), evergreen forest, Attathodu (9°24'9.6"N, 77°1'30.5"E), Pathanamthitta District, Kerala State, India, 342 m a.s.l., 20 August 2013; leg. S.P. Narayanan, S. Sathrumithra, D. Kuriakose, A. Sasi. 2 clitellates, 10 a clitellates, 1 juvenile (Reg. No. ACESSD/EW/1279), disturbed evergreen forest edge, Pampa in Periyar Tiger Reserve (9°24'7.79"N, 77°4'1.3"E), Pathanamthitta District, Kerala State, India, 266 m a.s.l., 20 August 2013, leg. A. Sasi, S. Sathrumithra, S.P.

Narayanan, D. Kuriakose. 4 a clitellates (Reg. No. ACESSD/EW/1280), evergreen forest, between Chalakkayam and Plappally (9°22'51.4"N, 76°56'00.8"E), Pathanamthitta District, Kerala State, India, 259 m a.s.l., 20 August 2013, leg. S.P. Narayanan, S. Sathrumithra, D. Kuriakose, A.S. Sasi. 9 clitellates, 1 a clitellate (Reg. No. ACESSD/EW/1281), semi evergreen forest, Thalamanam Reserve Forest (9°13'23.4"N, 76°56'17.3"E), Pathanamthitta District, Kerala State, India, 350 m a.s.l., 11 June 2016, leg. S. Sathrumithra. 7 clitellates, 2 a clitellates, 1 juvenile (Reg. No. ACESSD/EW/1282), rubber plantation, Thalamanam settlement area (9°13'31.6"N, 76°56'9.6"E), Pathanamthitta District, Kerala State, India, 329 m a.s.l., 11 June 2016, leg. S. Sathrumithra. 5 a clitellates, 2 juveniles (Reg. No. ACESSD/EW/1283), teak plantation, Kakara temple (9°14'21.5"N, 76°54'4.3"E), Pathanamthitta District, Kerala State, India, 385 m a.s.l., 28 October 2016, leg. S. Sathrumithra. 2 a clitellates, 1 juvenile (Reg. No. ACESSD/EW/1284), teak plantation, Avolikuzhi (9°14'31.5"N, 76°54'4.3"E), Pathanamthitta District, Kerala State, India, 385 m a.s.l., 27 October 2016, leg. S. Sathrumithra. 12 a clitellates, 11 juveniles (Reg. No. ACESSD/EW/1285), streamside in evergreen forest, Njaloor (9°15'2.7"N, 76°52'17.6"E), Pathanamthitta District, Kerala State, India, 339 m a.s.l., 27 October 2016, leg. S. Sathrumithra. 25 a clitellates, 2 juveniles (Reg. No. ACESSD/EW/1286), semi evergreen forest, Chempanaruvu (9°7'51.8"N, 77°1'2.6"E) in Mannarapara Forest Range, Pathanamthitta District, Kerala State, India, 57 m a.s.l. 28 October 2016, leg. S. Sathrumithra. 4 a clitellates, 2 juveniles (Reg. No. ACESSD/EW/1287), Aruvapulam, Pathanamthitta District, Kerala State, India, 28 October 2016, leg. S. Sathrumithra, mixed crop area. 4 a clitellates, 2 juveniles (Reg. No. ACESSD/EW/1288), mixed vegetation area, Athumukalam Range (9°14'41.8"N, 76°53'44.7"E), Pathanamthitta District, Kerala State, India, 378 m a.s.l., 27 October 2016, leg. S. Sathrumithra. 1 a clitellate, 1 juvenile (Reg. No. ACESSD/EW/1289), shola-grassland ecotone, Eanipara shola (10°10'37.8"N, 77°2'59.8"E) in Eravikulam National Park, Idukki District, Kerala State, India, 2140 m a.s.l., 22 November

2016, leg. S.P. Narayanan, S. Sathrumithra, G. Christopher. 1 clitellate (Reg. No. ACESSD/EW/1290), shola-grassland ecosystem, Pettymudi forest camp shed area (10°10'26.87 N, 77°1'25.6"E) in Eravikulam National Park, Idukki District, Kerala State, India, 1966 m a.s.l., 21 November 2016, leg. S.P. Narayanan, S. Sathrumithra, G. Christopher. 7 clitellates, 1 a clitellate (Reg. No. ACESSD/EW/1291), shola forest, Meenthottychola (10°10'21.4 N, 77°0'2.3" E) in Eravikulam National Park, Idukki District, Kerala State, India, 2010 m a.s.l. 22 November 2016, leg. S.P. Narayanan, S. Sathrumithra, G. Christopher. 2 a clitellates (Reg. No. ACESSD/EW/1292), beneath decaying wood in evergreen forest, Inchiparathodu (9°25'16 N, 77°17'14"E) in Periyar Tiger Reserve, Idukki District, Kerala State, India, 1050 m a.s.l., 22 January 2019, leg. S.P. Narayanan, Sreehari K. Mohan. 1 a clitellate (Reg. No. ACESSD/EW/1293), *Ochlandra* reed break, Gavi in Periyar Tiger Reserve, Pathanamthitta District, Kerala State, India, 28 September 2011, leg. S.P. Narayanan, T.K. Subash. 1 a clitellate (Reg. No. ACESSD/EW/1374), grassland, near Thangalpara (9°39'59.3"N, 76°54'1.4"E) in Wagamon, Kottayam District, Kerala State, India, 1010 m a.s.l., 17 October 2018, leg. R. Anuja, V. Balan, T. Subash (Fig. 4).

Brief description. Colour bluish. Length 58–155 mm, diameter 3–6 mm, segments 109–201. Secondary male apertures paired, large transverse slits, slightly lateral to *b* setal lines, at intersegmental furrow 10/11. Spermathecal pores paired, small transverse slits, close to *cd* lines, at intersegmental furrow 7/8. Genital markings absent. Gizzards 3–6 in segments 14–20. Vas deferens a mass of hairpin loops, mass as large as testis sac, entering prostate directly, near the ectal end. Prostates glandular, tubular with irregular margins, slightly flattened, prostatic capsule tubular, smooth, prostatic duct bent downwards and narrowed. Spermathecal atrial glands bilobed in segment 7, glands bound together, duct of each gland about as long as the common atrial duct.

Habitat. Forest (disturbed*, evergreen, mixed vegetation*, *Ochlandra* reed breaks*, semi evergreen, shola* and shola-like forests*), higher altitude grassland*, mixed crop area*, plantations (cardamom, black pepper, rubber, teak) (*present record).

Biology. Autotomy and regeneration is very common. A specimen from the Meenthottychola (Reg. no. ACESSD/EW/1291), Idukki district had parasitic protozoan cysts on the ovisacs.

Distribution. Most widespread species within the genus. India: Kerala State: Idukki District: Chathurangappara, Eanipara shola in Eravikulam National Park*, Inchiparathodu in Periyar Tiger Reserve*, Meenthottychola in Eravikulam National Park*, Peruvanthanam, Pettymudi forest camp shed area in Eravikulam National Park*; Kottayam District: Kurisumala in Wagamon*, near Thangalpara in Wagamon*; Pathanamthitta District: above Moozhioyar KSEB office*, Aluvamkudy, Aruvapulam*, Athumukalam*, Attathodu*, Avolikuzhi*, between Aranamoozhi and Ilampampa in Periyar Tiger Reserve*, between Chalakkayam and Plappally*, Chelikuzhi*, Chempanaruvi in Mannarapara Range*, Chengara, Chenthamarakokka near Gavi in Periyar Tiger Reserve*, Gavi in Periyar Tiger Reserve*, Kakara*, Kurichikanam, Mundomoozhy, Njaloor*, Pampa in Periyar Tiger Reserve*, Pananthodu, Thalamanam*, Thannithodumoozhy, Vallikettu*, Varayadumkokka in Periyar Tiger Reserve*; and Kollam District: Kottavasal, near to Ambanad estate (*present records; Narayanan *et al.* 2021a).

Remarks. As reported by Narayanan *et al.* (2021a) majority of the specimens possess four gizzards in segments 14–19 but in certain specimens it ranged from 3–6 (in segments 17–20). Body dimensions and number of gizzards in selected specimens are given in table 2. Narayanan *et al.* (2021a) stated that the prostates extending from segment 11 to segments 13–14.

Table 4. Length, width, number of segments and number of gizzards in selected specimens of *Moniligaster keralensis* Narayanan & Julka, 2021 from various localities

Locality name (Reg. no.)	Length	Width	Segments	Gizzards (in segments)
Vallikettu (ACESSD/EW/1273)	N	N	N	4 (16–19)
Chenthamarakokka (ACESSD/EW/1274)	N	N	N	5 (14–18)
Between Aranamoozhi and Ilampampa (ACESSD/EW/1275)	N	N	N	6 (13–18), 5 (16–20), 5 (15–19)
Above Moozhiyar KSEB office I (ACESSD/EW/1276)	141 mm	6 mm	201	N
Varayadumkokka (ACESSD/EW/1277)	N	N	N	3 (17–19)
Pampa (ACESSD/EW/1279)	N	N	N	5 (12–16)
Between Chalakkayam and Plappally (ACESSD/EW/1280)	N	N	N	5 (14–18)
Thalamanam reserve forest (ACESSD/EW/1281)	136 mm	5 mm	201	3 (16–18)
Kakara temple (ACESSD/EW/1283)	80 mm	4 mm	140	6 (13–18)
Njaloor (ACESSD/EW/1285)	155 mm	5.5 mm	193	N
Aruvapulam (ACESSD/EW/1287)	N	N	N	3 (18–20)
Eanipara Shola in Eravikulam National Park (ACESSD/EW/1289)	N	N	N	3 (14–16)
Inchiparathodu in Periyar Tiger Reserve (ACESSD/EW/1292)	68 mm, 58 mm	3.5 mm, 3 mm	156 133	5 (14–18), N

N – Not counted/measured

But certain specimens exceeds this limit, Aruvapulam (ACESSD/EW/1287) specimen it is in segments 11–15, specimen collected between Aranamoozhi and Ilampampa (ACESSD/EW/1275) it is in 11–16, and Varayadumkokka (ACESSD/EW/1277) in 11–17. Apart from this certain individuals prostate is not directed posteriorly, instead either single or both prostates may be erect, twisted and confined to segment 11, or directed anteriorly or bent like a hook. Based on the present materials from Idukki and Pathanamthitta districts of Kerala state, the species diagnosis is updated.

DISCUSSION

The genus *Moniligaster*, has a complex taxonomic history beginning with the description of *Moniligaster deshayesi* by Perrier (1872) with type locality as Sri Lanka. However, later Michaelsen (1910) doubted its Sri Lankan origin and it has not been included in the recent updated checklist of the Sri Lankan earthworms (Narayanan *et al.* 2021b). There is a strong distributional pattern

within various earthworm groups along the Western Ghats. The southern Western Ghats is dominated by the megascolecid and moniligastrid species (Narayanan *et al.* 2020). Present findings from the southern Western Ghats portion are also agreeing the same. *Moniligaster* species are primarily associated with forest habitats especially shola forest (Narayanan *et al.* 2021a). Discovery of a new *Moniligaster* earthworm mainly from human habitation is of significance and several new species are anticipated to be described from outside the protected areas within the Western Ghats. Previously Narayanan *et al.* (2021a) has recorded *M. blakemorei* and *M. keralensis* from the human modified habitats such as home garden, mixed crop field and plantations (*Elettaria cardamomum*, *Hevea brasiliensis*, *Tectona grandis* etc.). It corroborates that they can withstand the anthropogenic activities. With the addition of *M. julkai* sp. nov. and resurrection of *M. minor*, total valid species known in the genus has been raised to 14, among these 12 are recorded in Kerala state.

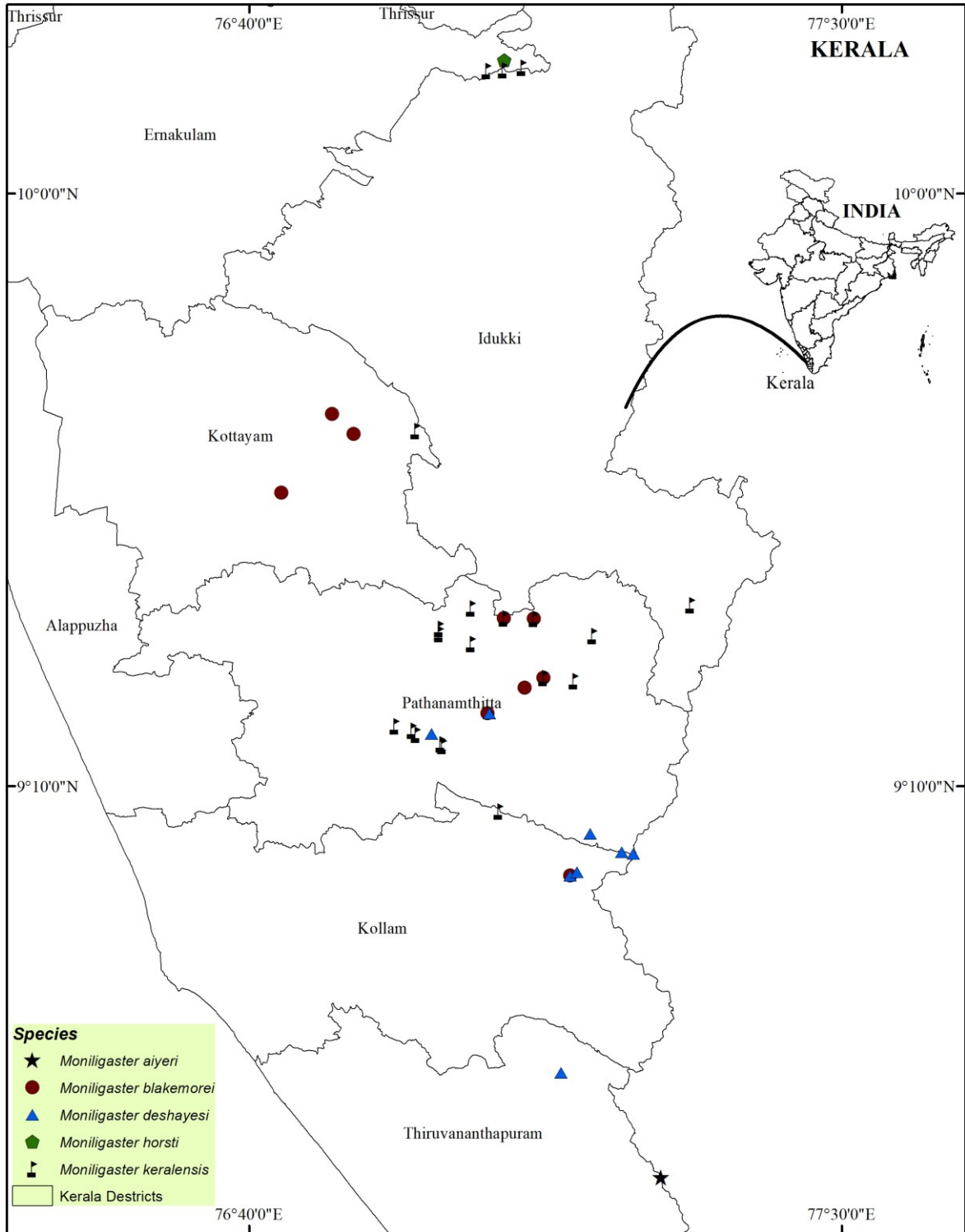


Figure 4. Map of sampling localities of various *Moniligaster* species recorded in this study.

Key to the species of the genus *Moniligaster* Perrier, 1872 (modified from Gates 1940; Narayanan et al. 2021a)

1. Vas deferens penetrates longitudinal muscle layer prior to junction with prostate 2
– Vas deferens enters prostate directly, without penetrating longitudinal muscle layer 4
2. Prostatic capsule anvil-like *Moniligaster horsti* Gates, 1940
– Prostatic capsule different 3
3. Body length > 400 mm; prostatic capsule spheroidal
..... *Moniligaster aiyeri* Gates, 1940
– Body length < 200 mm; prostatic capsule disc-like and latero-mesially flattened
..... *Moniligaster stephensoni* Gates, 1940
4. Spermathecal atrial glands confined to segment 7 5
– Spermathecal atrial glands in segments 7 and 8 12
5. Leaflet-like glands present on vas deferens 6
– Leaflet-like glands absent on vas deferens 7
6. Prostate long, capsule with criss-crossed ridges, prostatic duct slender *Moniligaster deshayesi* Perrier, 1872
– Prostate short, capsule smooth, prostatic duct bulged
..... *Moniligaster minor* Michaelsen, 1913
7. Vas deferens joins prostate at or close to ental end 8
– Vas deferens joins prostate at or close to ectal end 10
8. Prostatic capsule with deep incisions on margins
..... *Moniligaster graveyi* Stephenson, 1915
– Prostatic capsule without marginal incisions 9
9. Prostatic capsule tubular, ental end slightly sinuous and nodulated *Moniligaster bahli* Narayanan & Julka, 2021
– Prostatic capsule club-shaped, ental end without nodulations *Moniligaster blakemorei* Narayanan & Julka, 2021
10. Prostates clavate, duct of each atrial gland short, about ¼ the length of common atrial duct
..... *Moniligaster troyi* Jamieson, 1977
– Prostates tubular 11
11. Duct of each atrial gland about as long as common atrial duct *Moniligaster keralensis* Narayanan & Julka, 2021
– Duct of each atrial gland about five times the length of common atrial duct
..... *Moniligaster julkai* Narayanan & Paliwal sp. nov.
12. Prostate and duct bound to parietes in a C-shaped figure, capsule ovoidal *Moniligaster michaelseni* Gates, 1940
– Prostate and duct not bound to parietes, capsule shape otherwise 13
13. Prostatic capsule reniform, without nodulations
..... *Moniligaster perrieri* Michaelsen, 1907
– Prostatic capsule short, tubular and U-shaped, with irregularly placed nodulations
..... *Moniligaster cernovitovi* Gates, 1962

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