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Morphological Analysis Of Four Pill-Millipedes Of The Genus Arthrosphaera In Kalakkad Mundanthurai Tiger Reserve Of Southern Western Ghats Of Tirunelveli District, Tamil Nadu, India.

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Abstract

In the phylum Arthropoda, millipedes are categorised as Diplopoda. The goal of the current study was to investigate the diversity and distribution of pill millipedes, which are abundant in the KMTR of Tamil Nadu's Southern Western Ghats. A total number of four pill millipede samples Arthrosphaera brandtii (Humbert, 1865), Arthrosphaera dalyi (Pocock, 1895), Arthrosphaera hendersoni (Pocock, 1895), Arthrosphaera magna (Attems, 1936) belonging to order Sphaerotheriida and family belongs to Arthrospharidae also of four genera were annotate from the forest and tropical of KMTR of Southern Western Ghats, Tamil Nadu. According to these findings, pill millipede conservation and the checklist would be greatly improved by additional research. For precise identification and keys, the current study defined the morphological characteristics of each millipede.

Keywords: KMTR, Southern Western Ghats, Morphology, Pill millipede, Arthrosphaera.

INTRODUCTION

The characteristic feature of a millipede is the exoskeleton, an almost rigid armored covering, which is impregnated largely with calcium salts, making the millipede incompressible. The animal is often round and cylindrical or hemispherical in cross-section (Lawrence, 1984). Millipedes consist of three main parts; head, body, and telson (Hopkin and Read, 1992). The short antennae are composed of eight segments. They carry the sense organs, which palpate the substrate immediately in front of the head (Blower, 1985). It can be noted that, when the millipede walks along, the tips of the antennae are constantly tapping against the ground (Lawrence, 1984). The mouth parts of millipedes consist of a pair of mandibles, of which, with a few exceptions (Hopkin & Read, 1992), the biting portion is armed with blunt and rather clumsy 'teeth'. Their task is, to some extent, to break up and grind the bigger parts into smaller particles for swallowing (Lawrence, 1984; Hopkin & Read, 1992). The gnathochilarium, which forms the floor of the buccal cavity, is hardly involved in chewing. Along the front edge of the gnathochilarium, the taste organs are found. As the food passes into the mouth, these organs come first into direct contact with the food. The detailed shape of the gnathochilarium varies from order to order, and so, it can be used for identification. It carries the taste organs on its margin (Lawrence, 1984; Blower, 1985). Several organs of millipedes could be judged for the difference in morphology based on light microscopic and ultrastructural studies. For instance, collum (C), thoracic shield (TS), second pair of the

leg (SPL) with gonopod (G) (male), ninth pair leg (NPL), anterior telopods (AT) and posterior telopods (PT) (males), second pair of the leg with the vulva (V) (female), washboard (WB) (female) and anal shield (AS) are important to differentiate between species. Few organs are of interest to association morphology with behaviour. For occasion: i) mandible (M) (with a row of teeth) for burrowing; ii) thoracic shield (TS) and anal shield (AS) with locking carinae for volvation; ii) telopods (T) (male), last pair of legs (LPL), anal shield (AS) with sclerotized spots and washboard (WB) (female) for stridulation. (Sirirut sukteeka, 2012).

Materials and methods

Study area

There are various types of forests like evergreen, dry evergreen, dry deciduous, scrub, deciduous, dry evergreen, teak plantation, moist deciduous, riparian, vegetation, woodland savanna, wet evergreen and grasslands located. Mainly Kalakkad Mundanthurai Tiger reserve is one of the huge diverse spots in the Tirunelveli District. KMTR is situated in the Ashambu Hills of the southern Western Ghats (southern India), with an area of 895 km2 (537 km² is the core zone) lying between 8º 25' and 8º 53' N and 77º 10' and 77º 35' E. The elevation ranges from 40 meters to 1867 meters above sea level. The hill slopes are steep with rugged and undulating terrain intercepted by deep gorges and ravines. The soil type in the upper reaches is clay loam to sandy loam; outer slopes have reddish-yellow or sandy loam. The climate is dry, humid and hot at the lower levels, but cooler at elevations of 500 m MSL and above. Temperature ranges between 24^0C and 44^0 C. It receives rainfall from both southwest (May-August) and northeast monsoons (October- December), but more from the northeast and the rainfall varies from 750 to 3000 mm.

Millipedes were collected from various locations from KMTR of Southern Western Ghats forests, foothills, and planting sites of Tirunelveli district, Tamil Nadu. This survey was carried out from January 2024 to December 2024 periods. These are collected from various forests and altitudes. Samples were kept in a plastic container with native soil then samples were preserved with 70% ethanol after cleaning the soils from the millipede surface. After that these millipedes were evaluated based on the exaggeration under a low- high-power microscope (Nikon smz1500, Japan). Each morphological feature of individuals has been documented. Millipedes were analyzed the body structures specifically antennae, mandibles, gnathochilarium, endotergam, 2nd leg pair in females and males, 9th pair of legs in females and males, sub-anal plates with washboard in females, anterior and posterior pairs of telopods for morphological identifications. The dimension of the individuals (length, width, segments, and gender) reporting was using measuring scales. Individual millipede (Morphological features) was identified based on various keys and literature.

Results

Four pill millipede samples were identified from KMTR of Southern Western Ghats of Tamil Nadu. The colour of the body and various parts, specifically the head, antennae, mandibles, gnathochilarium, collum, thoracic shield, tergites, anal shield, first and 9^{th} pair of legs, female sexual characters and male sexual characters given for individual morphotype.

Each dimension such as body length, width, segments, and sample gender also provided. Morphotypes have been listed based on the available keys and literature.

Table. 1 Identified pill millipedes' colour, length, Width and Segments

S. No	Species	Coloration	Length (mm)	Width (mm)	Segments (Adult)
1.	*Arthrosphaera magna*	Yellowish brown	48.9	19.9	12
2.	*Arthrosphaera brandtii*	Pale brown with the black line between segments	32.47	18.3	12
3.	*Arthrosphaera dalyi*	Deep olive - brown with a reddish posterior margin	44.43	19.8	13
4.	*Arthrosphaera hendersoni*	Shiny Dark brown	39.61	18.6	12

TAXONOMICAL STUDY

Order Sphaerotheriida (Brandt, 1833)
Family Arthrosphaeridae (Jeekel, 1974)
Genus *Arthrosphaera (*Pocock, 1895)
1. *Arthrosphaera brandtii (*humbert, 1865)
2. *Arthrosphaera dalyi (*Pocock, 1895)
3. *Arthrosphaera hendersoni (*Pocock, 1895)
4. *Arthrosphaera magna (*Attems, 1936)

1936. Attems, *Mem. Ind. Mus.* 11 (4): 160. 1936.

Key to the Order
Body of adult with 13 rings, counted on the back of the animal, collum small and oval, 2nd tergite very broad; 13th ring the broadest; noozopores**…..…….Sphaerotheriida**

Key to the Genus
Coxae of 2nd legs of the female separated. Basal part of the vulva bipartite. Tibia of the posterior telopods with 2 white lappets. Tarsal part of the tibiotarsus of the anterior telopods with a broadly rounded lobe, the margin of the lobe beset with knobs. **…… …….....*Arthrosphaera*** .

Key to the Species
Pygidium. without inner crest; 2nd tergite and posterior border of rest smooth. **…… ……..……*Arthrosphaera brandtii.***

Anterior half of the terga densely pubescent in the adult (terga entirely pubescent in young**…… ……..……..*Arthrosphaera dalyi.***

Posterior inferior angles of terga 8-10 thickened and turned outwards. Tergadensely oorrugated, mottled **…….…….....……...…*Arthrosphaera hendersoni.***

No sulcus behind the marginal groove. Pygidium with 2 ridges on the underside, posterior border not marginated. The marginal thickening of the second segment is equally thick. The anterior border of the 2nd segment is hairless. Collum without edge**. …….....*Arthrosphaera magna.***

1. Arthrosphaera brandtii (Humbert, 1865)
Classification

Kingdom	**:**	Animalia
Phylum	**:**	Arthropoda
Subphylum	**:**	Myriapoda
Class	**:**	Diplopoda
Order	**:**	Sphaerotheriida
Family	**:**	Arthrospharidae
Genus	**:**	Arthrosphaera
Species	**:**	*Arthrosphaera brandtii*

Sergei I. Golovatch & Thomas Wesener. 2016. A species checklist of the millipedes (Myriapoda, Diplopoda) of India (Zootaxa 4129). 2016. http://doi.org/10.11646/zootaxa.4129.1.1. P. 13.

Sphaeropoeus brandtii (sic) Humbert, 1865: 38 (D). Sri Lanka and Tanzania. Also, India, Madras, Tamil Nadu.
Zephronia brandtii-Butler, 1872: 355 (M); Preudhomme de Borre, 1884a: 23 (M);
Zephronia brandtii-Butler, 1873: 178 (D).
Sphaeropoeus brandti (sic)Karsch, 1881b: 29 (D); Pocock, 1899a: 272 (R); de Saussure & Zehntner, 1902: 14 (M); Attems, 1914: 147 (M).

Arthrosphaera brandti (sic)-Pocock, 1892: 143 (D, R); Attems, 1936: 164 (D); Rajulu, 1970b: 125 (M); Jeekel, 2001a: 8 (M); Wesener & VandenSpiegel, 2009: 548 (D); Wesener *et al.,* 2010: 1185 (D); Sridhar & Ashwini, 2013: 18 (R); Sridhar, 2015: 3 (M).
Zephronia chitinoides Butler, 1872: 354 (D), synonymized under *A. brandtii* by Pocock (1892: 143).
Zephronia chitonoides (sic)-Butler, 1873: 178 (D); Preudhomme de Borre, 1884a: 24 (M).
Arthrosphaera brandtii-Minelli, 2015: 130, 149, 376 (M, D); Chezhian & Prabakaran, 2016: 91, 92 (R, D).

1936. *Arthrosphaera brandtii* Attems, *Mem. Ind. Mus.* 11 (4): 164. 1936.
Description: 6th joint of the antenna strongly expanded laterally. Collum not punctate, with a fine anterior edge. The marginal groove of the second segment continued over the dorsum, very shallow and not hairy in the middle, the surface of the second segment was not punctate. Anterior edge of tergites with irregularly arranged pearls. The anterior part of tergites is coarsely punctate, punctures united to form common grooves, posterior part is smooth, not punctate. Pygidium regularly, finely punctate, border marginated by a fine furrow in both males and females. Coxae of legs with 21ateral teeth beset with small acute cones. Coxae of 2nd legs of the female with one tooth of similar shape. The median piece of the vulva is larger than the operculum, all 3 pieces of the vulva are perforated by apertures, in which bristles are inserted. Prefemur of anterior telopods *with* a sharp edge; femoral process situated beside the tibiotarsus, small and slender, at the top of the surface opposite tibiotarsus some minute acute cones, at the lateral side a triangular tooth, a rounded lamella beset at the border with small knobs; tarsus a small cone with 2 bristles and inserted before the top of the tibia. Coxal horns of posterior telopods strongly curved backward, terminal lobe broad. The femoral process is shorter than the tibiotarsus; tibia and tarsus coalesced, or tarsus not visible. A row of tibial rasp buttons nearly reaching the top but interrupted in the middle, 3 or 4 and 7 buttons: hairs of tibia short and fine. (Figure. 1).

Material examined: Location- 1(Courtallam): Site- 1 (Five falls- Eco park-12), Site- 2 (Tiger falls-26), Site-3 (Senbagadevi falls-9), Site- 4 (Kundaru dam-11), Site- 5 (Kambili hill- 5). Location. 2 (Papanasam): site- 1 (Papanasam river- 5), Site- 2 (Agasthiyar falls-8), Site-3 (Electric production station-10), Site- 4 (Kayal Aquarium & Nursery-19), Site- 5 (Papanasam check post-6). Location- 3 (Mundanthurai): Site- 1 (Servalaru-3), Site- 2 (Kulamadi-5), Site- 3 (Valayaru-2), Site- 4 (Chinna pul-6), Site- 5 (Kovil theertham-2). (Figure. 1)
Distribution: India: Tamil Nadu: Tirunelveli: Southern Western Ghats: Courtallam, Papanasam, Mundanthurai,

2. Arthrosphaera dalyi Pocock, 1895

Classification

Kingdom	**:**	Animalia
Phylum	**:**	Arthropoda
Subphylum	**:**	Myriapoda
Class	**:**	Diplopoda
Order	**:**	Sphaerotheriida
Family	**:**	Arthrospharidae
Genus	**:**	Arthrosphaera
Species	**:**	*Arthrosphaera dalyi*

Sergei I. Golovatch & Thomas Wesener. 2016. A species checklist of the millipedes (Myriapoda, Diplopoda) of India (Zootaxa 4129). 2016. http://doi.org/10.11646/zootaxa.4129.1.1. P. 13.

Arthrosphaera dalyi Pocock, 1895: 412 (D). India, the Western Ghats, Palani Hills (Palani Hills, Palani Hills), Lone Cottage and Kodaikanal; Algarkovil Hills; Kerala; Cannanore District, Wynad (Wayanad); Ninthikkalu; Lonavla between Bombay and Poona.
Arthrosphaera dalyi-Pocock, 1899a: 280 (R, D); Attems, 1914: 147 (M); 1936: 165 (M); Rajulu, 1970b: 125 (M); Chowdaiah & Kanaka, 1974: 55 (M); 1979: 18 (M); Rangaswamy *et al.,* 1978c: 98 (R); 1983: 7 (M, R); Bano, 1983: 168 (M); Janardanan & Ramachandran, 1983a: 93 (M); 1983b: 405 (M); Achar, 1986: 90 (M); Jeekel, 2001a: 8 (M); Kadamannaya & Sridhar, 2009a: 761 (R); 2009b: 505 (R); Sridhar & Kadamannaya, 2009: 66 (M); Kadamannaya et al., 2009: 64 (M); 2010a: 467 (M) 2010b: 245 (M); Sridhar et al., 2013: 539 (M); Sridhar & Ambarish, 2013: 1544 (M); Sridhar & Ashwini, 2013: 18 (R); Ambarish & Sridhar, 2013b: 63, 64 (R); 2014a: 49 (M); 2014c: 12, 14 (M, R); 2016a: 105 (R); 2016b: 1, 4, 5 (R, D); Sridhar, 2015: 3 (M).
Arthrosphaera dalyi (sic)-Demange, 1977a: 231 (R).
Arthrosphaera dalyii (sic)-Nattutharai & Subbiah, 1983: 112 (R).

Arthrosphaera dalvi (sic)-Achar, 1987: 149 (M).
Arthosphaera (sic) dalyi-Nandre & Joshi, 1993: 40, 41 (R).

1895. *Arthrosphaera dalyi* Pocock, *Ann. Mag. Nat. Hist*., 6: 412.

Description: Olive brown with reddish posterior margin on each tergite. Head and collum with dark brown, antennae and legs are green. Polished and smooth with numerous hairs and setiferous pits around the central part and lateral sides of the eyes.Few hairs on the posterior margin of the head possess very. Antennae have long, thin, long and cylindrical joints. The relative length of the antennomere, the 6th antennomere is the longest and oval tip bearing 35-40 sensorial cones. Numerous hairs are present allover the surface of each antennomere. Molar plates are present mouthparts with the process of the mandible with a small furrow near the apical end with 5 pectinatelamellae with long and thin teeth and the number of teeth declining proximally. The posterior surface of Gnathochilarium with many hairs, hairs on the lingual lamella are less and few sensorial cones are seen on the lateral palpi. The collum is polished, smooth with few isolated long hairs and a posterior margin with a tuft of hairs at the center. Thoracic shield of few hairs is present in concave lateral extension of thoracic shield and marginal brim little broaden anteriorly. Tergites are pubescent and punctured in front,perfectly smooth, polished in their hinder half. Anterior paratergite depression of the anterior tergites has several ridges and ridges are not seen posteriorly. Tips of the paratergite project posteriorly. The single endotergum row presents marginal bristles. The inner area is covered with few depressions. The anal shield is rounded, punctured and pubescent throughout. The ventral surface carries two black locking carinae on each side. A small invagination exists in the middle of the carinae. Leg's tarsi of the first 3 legs pair with a few ventral spines, claws only weakly curved and without an apical spine. Tarsi of the remaining pairs of legs have 6-8 ventral spines with an apical spine and curved claw. Absent of coxal lobe in the ninth leg pair. All the podomeres possess long hair. Female sexual characters second pair of legs without a coxal lobe. The operculum of vulvae is long and slender, anterior margin without indentation and a lower margin with indentation at the center. The inner plate of vulvae is long and broad and its anterior margin reaches over the operculum. Exterior plates are not as long as an innerplate. The anterior margin of the exterior plate extends below the base of the operculum. Subanal plate semicircular, hairs are present at the periphery and a dense area of hair mesially. The washboard possesses four symmetrical stridulation ribs. Male sexual characters with anterior telopods: First joint (perfumer) with a harp-like structure with two stridulating ridges (one displaced to the lateral side). The femoral process situated behind the tibiotarsus is blunt. Tibia and tarsus are distinctly separated, and the tibia possesses a lobe above. The tarsal process has three lateral blunt cones. Posterior telopods: Syncoxite with a few hairs. Coxal horns (inner horns) are dark brown and have a pointed tip. The movable finger possesses two white lobes with a row of crenulated teeth. The opposite finger has crenulations juxtaposed with the crenulated teeth of the movable finger. (Figure. 2)

Material examined: Location. 1 (Papanasam): site- 1 (Papanasam river- 21), Site- 2 (Agasthiyar falls-20), Site-3 (Electric production station-17), Site- 4 (Kayal Aquarium & Nursery-15), Site- 5 (Papanasam check post-6). Location- 2 (Karayar): Site- 1 (Sorimuthu ayyanar temple-4), Site-2 (Agasthiyar kaani kudiyiruppu-19), Site-3 (Panangattu eri-1), Site- 4 (Maan clot-7), Site- 5 (Watch tower-4). (Figure. 2)
Distribution: India: Tamil Nadu: Tirunelveli: Southern Western Ghats: Papanasam, Karayar.

***3. Arthrosphaera hendersoni* Pocock, 1895**

Classification

Kingdom	**:**	Animalia
Phylum	**:**	Arthropoda
Subphylum	**:**	Myriapoda
Class	**:**	Diplopoda
Order	**:**	Sphaerotheriida
Family	**:**	Arthrospharidae
Genus	**:**	Arthrosphaera
Species	**:**	*Arthrosphaera hendersoni*

Sergei I. Golovatch & Thomas Wesener. 2016. A species checklist of the millipedes (Myriapoda, Diplopoda) of India (Zootaxa 4129). 2016. http://doi.org/10.11646/zootaxa.4129.1.1. P. 13.

Arthrosphaera hendersoni Pocock, 1895: 411 (D). India, Palnai Hills (Palani Hills, Palani Hills), Kodaikanal.
Arthrosphaera hendersoni-Pocock, 1899a: 277 (D); Attems, 1914: 148 (M);
Arthrosphaera hendersoni-Attems, 1936: 162 (D, R); Rajulu, 1970b: 124 (M); Chowdaiah & Kanaka, 1974: 55 (M); 1979: 18 (M); Bano, 1983: 168 (M); Rangaswamy *et al.,* 1983: 7 (M, R); Achar, 1987: 149 (M); Jeekel, 2001a: 9 (M); Sridhar & Kadamannaya, 2009: 66 (M); Kadamannaya *et al.,* 2010a: 469 (M); Sridhar & Ashwini, 2013: 18 (R); Ambarish & Sridhar, 2013b: 63 (M); 2016b: 1, 4, 5 (R, D); Sridhar, 2015: 3 (M).
Arthrosphaera handersoni -Rangaswamy *et al.,* 1978c: 99 (R).

1936. *Arthrosphaera hendersoni*: Attems, *Mem. Ind. Mus.* **11** (4): 162.
Description: Head very smooth, sparsely punctate. 6th joint of the antenna is not expanded laterally. Collum is densely and very finely punctuated, near the anterior border is a fine edge. The margin of the second segment is incrassating opposite the knob on the underside and projects into the marginal groove; the latter in the middle is very narrow andshallow, not hairy and has no radial folds. Tergites from the second segment densely and coarsely punctate in the anterior two-thirds puncture more or less united to form depressions, the surface between these wrinkled. The posterior third is sparsely punctate, not wrinkled. Towards the caudal and the unwrinkled zone become gradually narrower and the last segments are wrinkled almost to the posterior boarded. A marginal bristleis not extending over the border. The pygidium is very densely punctate, nearly to the posterior border; punctures are not united to form grooves. On the underside, one ridge corresponds to the anterior ridge of the species with 2 ridges and one apical spine in the tarsus. Coxa with a large lateral tooth beset with several cones. Valva consisted with basal part is bipartite, the median piece is very long and surpassing the small operculum. Coxa of female 2nd legs had lateral tooth as per other legs. Prefemur of anterior telopods with a sharp edge behind over femoral process situated behind the tibia-tarsus and not visible from the front, short, blunt, curved; tibia and tarsus distinctly separated; tibia with a rounded lobe above; tarsus above and behind with rounded lobe, blunt cone near theapex. Coxal horns of the syncoxite of the posterior telopods with a dark-colored lateral claw at the apex. The femoral process is thick, pointed and longer than the tibia. No tarsus. Tibia with two separated white lobes, edge covered with well develop knobs. (Figure. 3)

Material examined: location. 1 (Courtallam): Site- 1 (Five falls- Eco park-1), Site- 2 (Kundaru dam-1). Location. 2 (Papanasam): Site- 1 (Agasthiyar falls-1). Location- 3 (Kalakkad): Site- 1 (Nambikovil-1), Location- 4 (Ambasamudram): Site- 1 (Kottrangar-1). Location- 5 (Karayar): Site- 1 (Sorimuthu ayyanar temple-1). (Figure. 3)

Distribution: India: Tamil Nadu: Tirunelveli: Southern Western Ghats: Courtallam, Papanasam, Kalakkad, Ambasamudram, Karayar.

4. Arthrosphaera magna Attems, 1936

Classification

Kingdom	**:**	Animalia
Phylum	**:**	Arthropoda
Subphylum	**:**	Myriapoda
Class	**:**	Diplopoda
Order	**:**	Sphaerotheriida
Family	**:**	Arthrospharidae
Genus	**:**	Arthrosphaera
Species	**:**	*Arthrosphaera magna*

Sergei I. Golovatch & Thomas Wesener. 2016. A species checklist of the millipedes (Myriapoda, Diplopoda) of India (Zootaxa 4129). 2016. http://doi.org/10.11646/zootaxa.4129.1.1. P. 13

Arthrosphaera magna Attems, 1936: 160 (D). India. Khandala, Lonavla, Bombay Presidency; Shevaroy Hills, S. India; Rajamandri, Madras Presidency; Phonda ghat, Kolhapur State, Bombay Presidency; Karnataka, Tamil Nadu, Maharashtra and Andhra Pradesh states; Adyanadka.
Arthrosphaera magna-Rajulu, 1970b: 124 (M); Bano, 1983: 168 (M); Achar, 1986: 90 (M); 1987: 149 (M); Bai, 1997b: 461 (D); Jeekel, 2001a: 10 (M); Ashwini & Sridhar, 2002: 20 (M); 2005: 307 (M); 2006a: 954 (M); 2006b: 27 (M); 2006c: 1323 (M); 2006d: 58 (R); 27 (M); 2008: 749 (R); Sridhar & Kadamannaya, 2009: 66 (M); Kadamannaya et al., 2010a: 469 (M); 2010b: 245 (M); Kämpfer et al., 2010: 1765 (M); 2011: 1334 (M); Ramanathan & Alagesan, 2011: 365 (R); 2012a: 55, 56 (R); 2012b: 141 (R); Sridhar et al., 2006: 104 (M);

2013: 539 (M); Alagesan & Ramanathan, 2013: 1, 2 (R); Sridhar & Ashwini, 2013: 19 (R); Sridhar & Ambarish, 2013: 1544 (M); Ambarish & Sridhar, 2013a: 1 (M); 2013b: 63, 64 (R); 2014a: 49, 50 (R); 2014c: 12, 14 (M, R); 2015a: 638 (M); 2015b: 117, 118 (R); 2016a: 105 (M); 2016b: 1, 4, 5 (R, D); Sridhar, 2015: 1 (M); Chezhian & Prabakaran, 2016: 91, 92 (R, D).
1936. *Arthrosphaera magna* Attems, *Mem. Ind. Mus.* 11 (4): 160. 1936.

Description: Head collum and second segment bright chestnut, yellowish-brown, olive-brown, olive-green, other tergits dark brown, posterior border of tergites yellowish, forming a narrow stripe. Length is 65 mm; width 16 mm and head sparsely punctate, clypeus also not densely punctate. 6th joint of the antenna of male strongly expanded laterally, terminal disc narrow, oval and oblique. In female's 6th joint only weakly expanded. Collum without anterior edge or sulcus, with an anterior row of setiferous punctures and a similar row near the posterior border; the surface is not punctate. The second segment is polished like a mirror, not punctate, marginal groove vanishing near eyes, anterior zone in the middle of dorsum not punctate or with few scattered punctures, each puncture with or without a hair, lateral part of groove with scattered fine yellow hairs. Marginal thickening is equally thick. Anterior edge of tergite with small granules, behind the furrow no zone of bristles, anterior half of tergite densely punctate and hairy, posterior half smooth and shining, with only a few punctures near the posterior margin, especially visible on the 12th segment. Amarginal bristle is not extending over the border. Entire pygidium densely punctate punctures fine or coarse, sometimes several punctures united to form common shallow depressions: hair visible only in the anterior zone, this zone more densely punctate. Pygidium of the male lightly expanded like a bell, not marginated. Lateral notch distinct and Coxae of legs with a small or strong tooth; claw sigmoid, curved. Femoral process of anterior telopods short and blunted; situated behind tibiotarsus, not forming pincers with the lateral, tibia and tarsus distinctly separated, tibia with a superior rounded lobe, tarsus with a similar lobe, then narrowed, cylindrical, with long bristles at the apex. On the posterior side are a small knob and a small spine. Posteriors telopods like those of related species; coxal horns large, thick at the base, densely and shortly hairy on the medial side, apex with a rounded, dark-coloredclaw, femoral process longer than tibia, with numerous rounded tubercles, situated beside the tibia; tibia with 2 short broadly rounded lappets, posterior edge withnumerous rounded tubercles. Valva resembled that. of *Arthrosphaera hendersoni*,but the operculum is large and broader. Coxae of 2nd legs of a female with small lateral cone. (Figure. 4).

Material examined: location. 1 (Courtallam): Site- 1 (Five falls- Eco park-16), Site- 2 (Tiger falls-12), Site- 3 (Senbagadevi falls-8), Site- 4 (Kundaru dam-3), Site- 5 (Kambili hill-9). Location- 2 (Ambasamudram): Site- 1 (Aladiyur-6), Site- 2 (Keela eravampuram-3), site- 3 (Mela eravampuram-5), Site- 4 (Annanagar-7), Site- 5 (Kottrangar-1). Location- 3 (Mundanthurai): Site- 1 (Servalaru-2), Site- 2 (Kulamadi-3), Site- 3 (Valayaru-4), Site- 4 (Chinna pul-1), Site- 5 (Kovil theertham-2). Location- 4 (Karayar): Site- 1 (Sorimuthu ayyanar temple-7), Site-2 (Agasthiyar kaani kudiyiruppu-9), Site-3 (Panangattu eri-3), Site- 4 (Maan clot-20), Site- 5 (Watch tower-13). (Figure. 4)

Distribution: India: Tamil Nadu: Tirunelveli: Southern Western Ghats: Courtallam, Ambasamudram, Mundanthurai, Karayar.

Figure.1
Arthrosphaera brandtii
(humbert, 1865)

Figure.2
Arthrosphaera dalyi
(Pocock, 1895)

Figure.3
Arthrosphaera hendersoni
(Pocock, 1895)

Figure.4
Arthrosphaera magna
(Attems, 1936)

Conclusion

Millipede species was micro endemic and its plays a vital role in biodiversity. The millipede diversity denotes the environmental conditions on that particular scape. These were found from wet scape and healthy moisture environments particularly. Mainly the pill millipedes are the best decomposers of other genera. This investigation should improve the millipede populations. Millipedes should maintain the forest's healthy and moist ecosystem with the cyclic system. Most of the pill millipedes are found in deep organic matters. The present result also creates the checklist of the checklist.

Discussion

Ashwini & Sridhar, 2008 briefly classified that Seven sampling sites in each of three biomes (the Western Ghats, foothills of the Western Ghats and west coast) of South western India were investigated to study the distribution, abundance and ecology of pill millipedes (*Arthrosphaera*) and associated fauna in relation to edaphic features. The abundance and biomass of *Arthrosphaera* and other millipedes were the highest in the Western Ghats, while earthworms were in the foothills. *Arthrosphaera magna* and *Arthrosphaera* spp. were common in the Western Ghats and foothills respectively, while no *Arthrosphaera* were found on the west coast. None of the sampling sites consisted of more than one species of *Arthrosphaera*. Attems, 1936 he briefly listed the millipedes in India. The Indian fauna contains 290 species and subspecies of Diplopoda. Only very few millipede species demonstrate vast natural distributions. The majority have restricted ranges, with many local endemics in a single cave, mountain, valley or island. This contrasts with the remarkable overall diversity of the Diplopoda (currently estimated as exceeding 80,000 species, mostly confined to tropical countries), as there are few places on the globe where a local diplopod fauna, or faunal, exceeds two dozen species. The world record is apparently a patch of rainforest in central Amazonia where as many as 33 millipede species have been revealed (Adis *et al.*, 2002). Enghoff, 1990 defined Millipedes as never having a thousand legs as the name suggests, many have less than 50 pairs and a maximum of 375 pairs. The Presence of two pairs of legs per body segment differentiates the class Diplopoda from the other three classes (Chilopoda, Symphyla and Pauropoda) of super class Myriapoda. Diplopoda is one of the largest classes of animal kingdoms belonging to the ancient group of Devonian periods constituting the third - largest group in terrestrial arthropods following Insecta and Arachnida (Golovatch *et al.,* 1995).

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