# A note on Onychophora

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**Introduction:**

Onychophorans are presently an established taxonomic categories in kingdom Animalia. It has long been regarded as connecting link between arthropoda and annelida but recent study established that Onichophorans are separate group of animals coevolved with annilida and arthropoda from an unknown ancestor. A cladistic analysis which places the Onychophora in an intermediate position between the Polychaeta and the Tardigra-Arthropoda clade. The current view is that the Onychophora represent a sister group to the Arthropods on the basis of morphological, paleontological and molecular data. According to Marshall and Williams (1972)- Onychophora can be rightly described as aberrant arthropods or highly modified annelids and can be placed all the species under twelve genera of Onychophora in a separate subphylum "Onychophora" under the phylum Arthropoda. But absence of jointed chitinons exoskeleton and jointed segmental appendages do not support the inclusion of Onychophora within Arthropoda. Some peculiar features of Onychophores which support neither annelids nor arthropods, and demand a separate phylum status. Ruppert, Fox and Barnes (2004) pass the remark that Onychophorans are not usually considered arthropods rather a phylum animals closely related to arthropods.

**Anatomical Peculiarities of Onychophora:**

**A. Primitive features:**

1. Onychophora are worm-like body covered with thin, flexible, chitinous cuticle.
2. Onychophora are sluggish in nature.
3. Head segments are comparatively small (3 head segments in onychophores but in true arthropods head segments are 5 or 6).
4. Presence of segmentally arranged nephridia.
5. Presence of cilia in the reproductive tracts.

**B. Sole peculiarities:**

1. Segmentation indistinct on external surface.
2. Head appendages include a pair of antennae, a pair of jaws and a pair of oral papillae.
3. Texture of the skin is present.
4. Numerous, un-jointed, stumpy walking legs, terminated into a pair of claws, quite unlike the parapodia of polychaeta.
5. Tracheae and disposition of the tracheal apertures are not arthropod-like.
6. Presence of a pair of slime glands opening at the ends of the oral papillae that secrete proteinaceous adhesive substance and helps to capture the prey.

7. Lacking of blood pigments.
8. Subcutaneous haemal channels.

**C. Salient features:**

1. Caterpillar-like body, ranging from 5 mm to 15 cm in length.
2. Body soft and covered by a thin, flexible, chitinous cuticle which is moulted periodically.
3. Indistinct segmentation externally and marked only by the presence of paired, un-jointed, hollow stumpy appendages (13 to 43 pairs according to species). These un-jointed walking legs are called lobopods.
4. Each walking leg terminates in a pair of curved claws.
5. Integument with fine transverse wrinkles and with numerous conical large and small tubercles.
6. Simple eyes, similar with that of an-nelidan polychaetes.
7. Head with 3 pairs of appendages including a pair of annulated antennae, a pair of claw-like mandibles (jaws) which are the modified 2nd pair of appendages and a pair of oral papillae (3rd pair of appendage).
8. A pair of slime glands are present inside the body which open to the tip of the oral papillae that discharge the adhesive material, used for to capture prey and defence.
9. Body wall dermomuscular. Muscles are un-striated.
10. Reduced coelom.
11. Haemocoelomic body cavity.
12. Open circulatory system with lateral valvular ostia on the heart.
13. Elongated tubular heart which is surrounded by pericardial sinus occurring the entire length of the body.
14. Delicate un-branched, rarely branched tracheal tubes open by means of small spiracles, scattered irregularly. Spiracles are without any closing device.
15. A single pair of nephridia in each segment except the genital opening bearing segment.
16. Ladder-like nervous system. Brain is large, bilobed and situated dorsal to the pharynx.
17. Reproductive and excretory ducts are ciliated.
18. Dorsal coelomic gonads.
19. Sexes separate (gonochoristic).
20. Fertilization internal.
21. Oviparous or ovoviviparous with yolky or non-yolky eggs.
22. Viviparous with placenta.
23. Cleavage holoblastic in the eggs of viviparous species and superficial in the oviparous forms which lay their eggs in moist condition.
24. Development direct.
25. Nocturnal and carnivorous in habit.

**Affinities of Onychophora:**

The features of Onychophora have made it difficult to place it within any one of the ten major phyla. The detailed studies of Onychophores have now confirmed that in addition to its own peculiar features it has characters common with three other large groups, Annelida, Arthropoda and Mollusca.

**An account of such relationship is given below:**

**A. Relationship with Annelida:**

**Similar features (Structural):**

1. Segmentation in both is homonymous.
2. Presence of paired nephridia in almost every segment of the body.
3. Reproductive tracts are lined by cilia.
4. Skin is thin and flexible.
5. Dermomuscular body wall like Hirudinea. Body wall musculature smooth and composed of circular, diagonal and longitudinal muscle fibres.
6. True head is absent.
7. Structure of the eye is same as in polychaetes. Simple eyes (Ocelli) rather than compound eyes.
8. Hollow and non-jointed appendages like those of parapodia.
9. Slime glands and coxal glands correspond with the similar glands of polychaetes and oligochaetes.
10. Straight gut with an anus.
11. Vermiform boy.

**Embryological similarities:**

1. Spermatozoan morphology resembles that of oligochaetes and leeches.
2. Meroblastic cleavage.
3. Gastrula by epiboly.
4. Elongated blastopore.

**Dissimilar features:**

1. Ventrally placed mouth in Onychophores.
2. Heart and ostia present in Onychophores.
3. Clawed appendages in Onychophores.
4. Presence of antennae in Onychophores.
5. Ladder-like nervous system.
6. Tracheal tube for respiration in Onychophora.
7. Absence of true metamerism in Onychophora.
8. Texture on the skin.
9. Disposition of the gonads and
10. Haemocoelomic body cavity.

**Remarks:**

In view of the anatomical peculiarities Grube (1874) placed the group under Annelida and it appears that Onychophora have evolved from the annelids, if not directly from them, from the ancestral stock from which the annelids have evolved.

**B. Affinities with Arthropoda:**

Moseley (1874) demonstrated its relation with arthropods by showing the presence of tracheae.

**Structural similarities:**

**Following features show that Onychophora is more related to Arthropoda:**

1. The appendages are provided with claws.
2. Locomotion is not annelid-like but takes place with the help of legs having definite musculature.
3. Jaws are modified appendages.
4. Heart dorsal and tubular, perforated by lateral ostia.
5. Body cavity is a haemocoel, not a true coelom.
6. Absence of perivisceral part of coelom.
7. Body is covered with chitinous cuticle and is moulted.
8. Jaws are provided with striated muscles.
9. Presence of antennae.
10. Brain is large and resembles the brain of typical arthropods.
11. Presence of tracheae as respiratory organs.
12. Excretory organs closely resemble the green glands of Crustacea.
13. Salivary glands formed by the modification of nephridia.
14. Pattern of development is same as in other arthropods.

**Dissimilarities:**

In spite of these similarities, Onychophores differ in many respect from the Arthropods.

1. Arrangement of tracheae is not arthropod-like. Here in each segment there are numerous permanently opened spiracles (no closing mechanism).
2. Jaw is the modification of second appendages and the movements of jaws operate from anterior end and proceed towards posterior end.
3. Formation of skin is not like that of arthropods.
4. Segments behind head are simple and identical.
5. Segmentation not distinct in Onychophora.
6. Absence of malpighian tubules in Onychophores.
7. Simply, un-jointed, numerous stumpy legs in Onychophores.
8. Structure of eye is less complicated.

9. Two ventral nerve cords are widely separated and without true ganglia.
10. Body regions or tagmata are not well developed in Onychophores, which are well developed in Arthropoda, e.g., in most cases the body is divided into head, thorax and abdomen.

**Remarks:**

According to Sedgwick (1908) there is no doubt that the Peripatus belongs to the Arthropoda in all the above mentioned characters which are all of morphological importance. Developmental features of Peripatus confirmed the view.

**C. Similarities with Mollusca:**

1. Slug-like appearance.
2. Ladder-like nervous system resembling that of chiton and lower prosobranchia.
3. Antennae tentacle-like.

**Remarks:**

Guilding (1826) first discovered a peripatus and considered to be an aberrant mollusc. But according to many scientists the resemblances with molluscs are only superficial.

**Time of origin:**

Onychophora evolved from the marine fossil onychophoran-like organism Aysheaia pedunculata from the Mid-Cambrian period about 520 million years ago.

**Probable views regarding the Origin of Onychophores:**

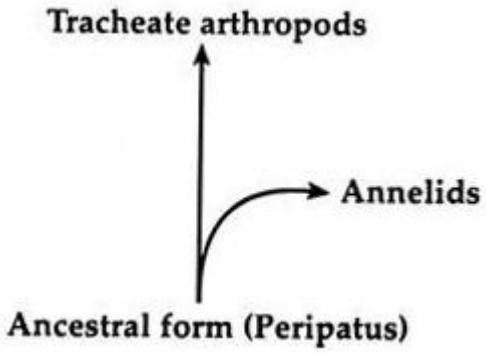
Different zoologists have put forward different views regarding the origin of Onychophores.

**1. Hills (1930):**

Only known fossil resembling Peripatus was found in the Mid-Cambrian period. In the Pre-Cambrian era only fossils of soft- bodied, segmented worms, annelids were found. Then according to Hills, in early Pre- Cambrian some tracheate arthropods underwent specialization while others were less specialized to give rise to the Peripatus in Mid-Cambrian.

**2. Thomson and Ritche (1944):**

Thomson and Ritche (1944) Opined that the Peripatus is a survivor of forms that were ancestral to the tracheate arthropods and closely related to the annelids.




**3. Snodgrass and Stromer (1944):**

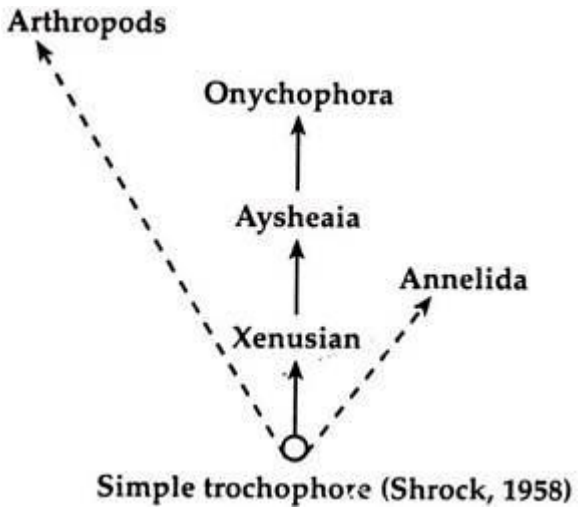
Snodgrass and Stromer (1944)—said that the Onychophora originated from the ancestral form of both annelids and arthropods.

**4. Tiegs and Manton (1958):**

According to them, Onychophora evolved from generalised lobo-pod ancestor, such as, this line of evolution is not followed by any other arthropod. They have again stated that the Mid-Cambrian Aysheaia pedunculata has generally been accepted more or less as a marine ancestor of modern terrestrial onychophorans.

**5. Shrock (1958):**

Shrock (1958)—remarked that peripatus is not the ancestral form of annelids nor gives rise to modern arthropods but is a separate autonomous isolated group evolving from the ancestral trochophore.




**Zoological Importance of Onychophora:**

**Onychophora show a great zoological importance because:**

1. They furnish an example of discontinuous distribution and
2. They represent an example of living connecting link between the two phyla—Annelida and Arthropoda.

**Systematic Position of Onychophora:**

The characters of Onychophora have made it most interesting from the point of view of evolution. It is an oldest terrestrial group which probably originated from some marine ancestors.

It has attained a number of features for terrestrial life, i.e., internal fertilization, viviparity, semi-solid excretory product, less permeable skin, etc. But at the same time the structure of spiracles speaks about its limitation on land life and thus shows its primitiveness.

The resemblances with annelids are probably the examples of convergence. Onychophorans have a mixture of morphological characteristic features which make them effectively cross between the Annelid worms and the Arthropods. But our modern understandings suggest they do not represent a missing link between the annelids and the arthropods.

Presence of variously developed specialized characters in Onychophora, such as trachaea with open spiracles and the origin of jaws do not support the above view that Onychophores represent a missing link. Instead, like the Tardigrades they are considered as a separate line of evolution and arose independently from some forgotten ancestor.

Again the common characteristic features of Onychophora regard a common relative to annelids and arthropods. Hence, it is regarded as a living connecting link between two phyla and it is undoubtedly an ancient form but not an ancestor of arthropods.

Kaestner (1967) has stated that the Onychophora probably represents an early lateral branch of the evolutionary line terminating in the arthropods. Peripatus are also called living fossils because they truly represent archaic animals and have changed little in their body shape for about 500 million of years.

A cladistic analysis which places the Onychophora in an intermediate position between the Polychaeta and the Tardigra-Arthropoda clade. The current view is that the Onychophora represent a sister group to the Arthropods on the basis of morphological, paleontological and molecular data.

According to Marshall and Williams (1972)-Onychophora can be rightly described as aberrant arthropods or highly modified annelids and can be placed all the species under twelve genera of Onychophora in a separate subphylum “Onychophora” under the phylum Arthropoda. But absence of jointed chitinons exoskeleton and jointed segmental appendages do not support the inclusion of Onychophora within Arthropoda.

Some peculiar features of Onychophores which support neither annelids nor arthropods, and demand a separate phylum status. Ruppert and Barnes (1994) pass the remark that

Onychophorans are not usually considered arthropods rather a phylum animals closely related to arthropods.

**Classification of Onychophora:**

Phylum Onychophora [Gk. onyx or onychos = claws, phoros = bearer], Approx. less than 200 species.

**Origin:**

Early Cambrian period.

**Characters:**

1. Commonly known as velvet worms or walking worms. [Peripatus. (Gk. Peripatos = walking about; Gk. Peripatein = to walk about, stroller).
2. Bilaterally symmetrical, metamerically segmented and protostomous coelomates.
3. Body soft and Caterpillar-like.
4. Head is not clearly differentiated. Tagmatization is not well pronounced.
5. Body may grow from 5 mm to 15 cm in length (e.g., Peripatopsis torquatus).
6. Externally the segmentation is denoted only by the presence of short paired (14-13 pairs) un-jointed stumpy walking legs (lobopods). The legs are terminated into curved claws.
7. **The head bears 3 paired appendages:**

(i) One pair fleshy annulated antennae

(ii) A single pair of jaws (2nd pair of appendages) and

(iii) a pair of short oral papillae (3rd pair of appendages), situated adjacent to the jaws.

8. Eyes are represented by ocelli rather than compound eyes.
9. Integument is thin and the chitinous cuticle contains varied ring-like striations.
10. Body colouration is blue, green, orange or black with papillae and scales.
11. Muscles are un-striated.
12. A straight gut with an anus.
13. Haemocoelomic body cavity.
14. Respiration is carried by tracheal tubes, open through the small spiracles.
15. Spiracles without any closing devise.
16. Slime glands discharge adhesive material through the openings of the oral papillae used for prey capture or defence.
17. Malpighian tubules are absent.
18. Excretory organs are paired segmental coelomoducts.
19. Sexes separate (gonochoristic).
20. Fertilization internal.
21. Usually viviparous but may be oviparous or ovoviviparous.
22. Reproductive and excretory ducts are ciliated.

23. All are terrestrial and are found in moist habitats.

**Classification of the Phylum:**

**The phylum includes approximately about 200 species which are distributed among 49 genera and 2 families:**

(i) Peripatopsidae and (ii) Peripatidae.

The defined categories above the family level are absent due to conservative body features of the Peripatus.

**Fossil History of Onychophora:**

The most primitive fossil of Onychophora is marine, such as the genus Aysheaia (Fig. 1) of Mid-Cambrian period, whose fossils are found in rocks which are probably 520 million years old.

Other fossils have been recorded from the Baltic and Myanmer Ambers. Onychophorans became adapted to land before the Late Ordovician period and the two living families became distinct by the Late Triassic. Other genera are Hallucigena, Tertiapatus, etc.

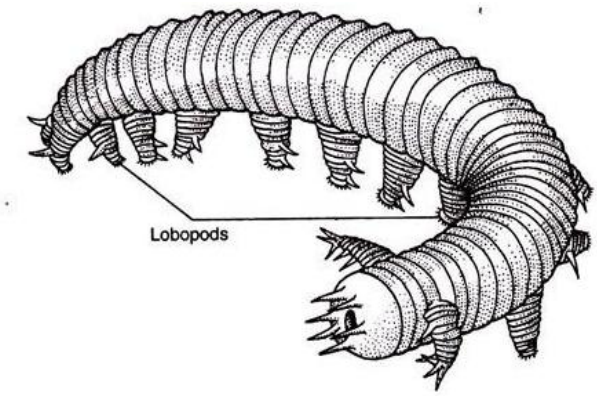



Fig. 1 : External features of a primitive, fossil peripatus, *Aysheaia pedunculata*.

**Characters of the living families:**

**I. Peripatopsidae:**

Number of legs varies from 14-19 pairs; legs with complete spinous pads are 3; the absence of a diastema on the inner side of the jaws; primary dermal papillae without a constriction nephridial opening on 4th and 5th pairs of legs in between third spinous pads; genital opening between or behind last pair of legs, oviparous or ovoviviparous.

**Distribution:**

They are found in the chilie, South Africa, Australasia, New Britain and New Guinea.

The family includes 39 genera and the revision of the family is being done by C. Brockmon, A Reid, R. Gleeson and H. Ruhberg.

**Table 19.2: A list of some Onychophoran genera (Fam. Peripatopsidae) and species with their distribution is given in the list :**

| | | |
|---|---|---|
| 1. Genus *Aethrikos Reid*<br>e.g., *Aethrikos setosa* | 1 species | Australia |
| 2. Genus *Austroperipatus Baehr*<br>e.g., *Austroperipatus superbus*<br>*Austroperipatus aequabilis*, etc. | 4 species | Australia |
| 3. Genus *Euperipatoides* Ruhberg<br>e.g., *Euperipatoides kanangrensis*<br>*Euperipatoides rowelli*, etc. | 3 species | Australia and Tasmania |
| 4. Genus *Metaperipatus Clark*<br>e.g., *Metaperipatus blainvillei*<br>*Metaperipatus inae* | 2 species | Chilie |
| 5. Genus *Ooperipatellus* Ruhberg<br>e.g., *Ooperipatellus insignis*<br>*Ooperipatellus nanus*, etc. | 4 species | New Zealand |
| 6. Genus *Ooperipatus* Dendy<br>e.g., *Ooperipatus birgus*<br>*Ooperipatus oviparus*<br>*Ooperipatus porcatus*<br>*Ooperipatus purcellus* etc. | 13 species | Australia, Tasmania and New Zealand |
| 7. Genus *Opisthopatus* purcell<br>e.g., *Opisthopatus centipes*<br>*Opisthopatus herbertorum*<br>*Opisthopatus pulchellus*<br>*Opisthopatus centipesnatalensis*, etc.<br>*Opisthopatus costesi* | 7 species | South Africa and Chilie<br><br><br>South Africa<br><br>Chilie |
| 8. Genus *Paraperipatus* Willey<br>e.g., *Paraperipatus papuensis*<br>*Paraperipatus amboinensis*<br>*Paraperipatus lorentzi*, etc. | 5 species | New Britain, New Guinea, Singapore |
| * *Parapetipus papuensis* were found in Singapore, probably carried by the fern fibre imported from New Guinea. | | |
| 9. Genus *Peripatoides* Pocock<br>e.g., *Peripatoides indigo*<br>*Peripatoides novaezealandie*<br>*Peripatoides orientalis*, etc. | 4 species | Australasia |

| | | |
|---|---|---|
| 10. Genus *Peripatopsis* Pocock<br>e.g., *Peripatopsis capensis*<br>*Peripatopsis moseleyi*<br>*Peripatopsis alba*, etc. | 6 species | South Africa |
| 11. Genus *Phallocephale* Reid<br>e.g., *Phallocephale tallagandensis* | 1 species | Australia |
| 12. Genus *Planipalllipus* Reid<br>e.g., *Planipallipus bulgensis*<br>*Planipallipus tectus*<br>*Planipallipus mundus*, etc. | 12 species | Australia |
| 13. Genus *Tasmanipatus* Ruhberg, Mesibove, Briscoe and Tait<br>e.g. *Tasmanipatus baretti* etc. | 2 species | Tasmania |

* Some other genera are *Cephalofovea, Florelliceps, Lathropatus, Mantonipatus, Nodocapitus, Tasmania*, etc.

**II. Family Peripatidae:**

Number of legs varies from 19-43 pairs; legs with complete spinous pads 4-6; the presence of a diastema on the inner blade of the jaws; primary dermal papillae with a constriction; nephridial openings on 4th and 5th pairs of legs in between third spinous pad; genital opening in between the legs of the penultimate pair. Skin pigment brownish, extracted by alcohol; ovoviviparous or viviparous.

**Distribution:**

Mexico, Central America, Northern South America, Galapagos Islands, West Indies, West equatorial Africa and South East Asia.

**The family includes 10 genera and these are:**

(i) Eoperipatus,
(ii) Epiperipatus,
(iii) Heteroperipatus,
(iv) Macroperipatus,
(v) Mesoperipatus,
(vi) Oroperipatus,
(vii) Peripatus,
(viii) Plicatoperipatus,
(ix) Speleoperipatus and
(x) Typhloperipatus.

**Clark (1913) divided the genus Peripatus into 4 sections:**

(i) Plicatoperipatus,
(ii) Macroperipatus,
(iii) Peripatus and

(iv) Epiperipatus.

**Table 19.3: A list of some Onychophoran genera (Fam. Peripatidae) and species with their distribution is given in the list :**

| | | |
|---|---|---|
| 1. Genus *Eoperipatus Evans* | 3 species | Malaya and Sumatra |
| e.g., *Eoperipatus horsti* | | |
| *Eoperipatus sumatranus* (Sedgwick, 1888) = *Peripatus sumatranus* Sedgwick, 1888 | | |
| *Eoperipatus weldoni* Evans, 1901 = *Eoperipatus butleri* Evans, 1901 | | |
| 2. Genus *Epiperipatus* Clark | 6 species | Brazil, Costa Rica, Surinam, Guyana, French Guyana, Trinidad and Tobago, Grenada |
| e.g., *Epiperipatus simoni* | | |
| *Epiperipatus tucupi* | | |
| *Epiperipatus brasiliensis* | | |
| *Epiperipatus cratensis* | | |
| *Epiperipatus eduwardsii* | | |
| *Epiperipatus trinidadensis* | | |
| 3. Genus *Heteroperipatus* Zilch | 2 species | Central America |
| e.g., *Heteroperipatus clarki* | | |
| *Heteroperipatus engelhardi* | | |
| 4. Genus *Macroperipatus* Clark | 8 species | Brazil, Costa Rica, Jamaica |
| e.g., *Macroperipatus insularis* | | |
| *Macroperipatus torquatatus*, etc. | | |
| 5. Genus *Mesoperipatus* Evans | 1 species | Republic of Congo |
| e.g., *Mesoperipatus tholloni* | | |
| 6. Genus *Oroperipatus* Cockerell | 14 species | Mexico, South America |
| e.g., *Oroperipatus balzoni* | | |
| *Oroperipatus bimbergi* | | |
| *Oroperipatus kockei*, etc. | | |
| 7. Genus *Peripatus* guilding | 24 species | South America, Mexico, Galapagos Islands, West Indies |
| e.g., *Peripatus equadorensis* | | |
| *Peripatus manni* | | |
| *Peripatus evelinae* | | |
| *Peripatus capensis* etc. | | |
| 8. Genus *Plicatoperipatus* Clarck | 1 species | West Indies |
| e.g., *Plicatoperipatus jamaicensis* | | |
| 9. Genus *Speleoperipatus* Peck | 1 species | West Indies |
| e.g., *Speleoperipatus spelaeus* | | |
| 10. Genus *Typhloperipatus* Kemp | | |
| e.g., *Typhloperipatus williamsoni* | 1 species | N.E. India |

**Acknowledgements:**

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**Referance:**

Ruppert, Fox and Barnes (2004). Invertebrate Zoology: A Functional Evolutionary Approach (7th ed.). Belmont: Thomson-Brooks/ Cole.P.505. ISBN: 978-0-03-025982-1.

Marshall and Williams (1972)

Grube (1874)

Sedgwick (1908)

Guilding (1826)

Hills (1930)

Thomson and Ritche (1944)

Snodgrass and Stromer (1944)

Tiegs and Manton (1958)

Shrock (1958)

Kaestner (1967)

Clark (1913)