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Chapter- 5

Let's cut the ribbon of ribbon worm conservation with special reference to India: A review

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Keywords: Nemertea, Conservation status, Proboscis, Bio-active compounds.

Abstract:

Rhynchocoela, Nemertini, or Ribbon worms are non-segmented bilaterally symmetrical with long, soft and contractile bodies. The Indian subcontinent has only 8 species of Nemertea out of 1275 species worldwide to date. Due to their lack of direct impact on human society, they have been neglected thus far. There is now a clear understanding of Nemertea's importance in many fields, such as top predators in soft bottom communities, maintaining community structure, and serving as indicators. Now they are vanishing at an alarming rate. There are two species of Nemertea that have become extinct. In IUCN Red Data Book, there is no information about this phylum other than terrestrial Nemertea. An in-depth survey is needed to explore them, identify new species, monitor existing species and save them from extinction.

Introduction:

Nemerteans are bilaterally symmetrical acoelomates whose non-segmented body is covered with a ciliated epidermis. (Turbeville, 2002; Thollesson and Norenburg, 2003). They are often called Nemertea, Rhynchocoela, Nemertini, or ribbon worms. The presence of a long, eversible, muscular retractile proboscis lying in a fluid-filled body cavity known as rhynchocoel represents synapomorphy supporting monophyly of this phylum.The rhynchoel extends above the gut and is considered a true coelom. In anoplan nemerteans, the proboscis is either unarmed or provided with rhabdites. In enoplan species, the proboscis is armed by one (Monostilifera) or several (Polystilifera) needle-like stylets. The proboscis, although structurally independent of

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the digestive system, is the key structure for capturing prey. Proboscis is also used against predators for defensive purposes.Marine nemerteans are distributed globally and settle in nearly each of marine ecosystems from shallow water to deep-sea bottom. Benthic species are slim and become flat dorsoventrally.They manifest the potential to stretch and contract their bodies considerably. They often are cryptic in habit and not frequently observed by non-specialists. Nevertheless, they have important effects as active predators, especially on molluscs, crustaceans and annelids (Roe, 1976; Thiel and Kruse, 2001; Caplins and Turbeville, 2012). The phylogenetic position of nemerteans among the metazoans is enigmatic and unsettled, although the evidence now points in the direction of attaching with protostome coelomates rather than having evolved from an acoelomate stock (Giribet et al., 2000). Recent studies support the hypothesis that phoronids (horseshoe worms) are their closest relatives within this group. Nemertean also seize the attention of different biological fields, such as regeneration (Coe, 1934; 1943), developmental biology (Martindale and Henry, 1995; Maslakova et al. 2004), genetics (Andrade et al. 2012; Chen et al. 2012), and pharmacology (Kem et al. 2006).

Distribution of Nemertea:

Nemertea is a worm with global distribution. They live in all marine ecosystem and Some Nemertea are found in fresh water ecosystem also.There are approximately 1275 species of Nemerteans distributed across 250 genera, most of which are found in marine environments (Kajihara et al. 2008). According to a recent study, Anopla accounts for approximately 38% of known genera and 44% of the named species, while Enopla accounts for approximately 62% and 56% respectively. The number of known freshwater nemerteans is very small; only 22 reported species represents less than 2% of the total number recorded. Only 13 terrestrial nemertea have been reported so far. In India, only 8 species of nemertea is found (Sreeraj, 2020). There are 2 species that bear stylets and others that do not have any (Paleonemertea-1, Heteronemertea-5, Hoplonemertea-2).

Order	Species	Distribution in India
Paleonemertea	*Balinonemertes australiensis* (Sundberg et al. 2003)	Tamil Nadu (Gulf of Mannar Biosphere Reserve).
Heteronemertea	*Gorgonorhynchus repens* (Dakin and Fordham, 1931)	Tamil Nadu (Gulf of Mannar Biosphere Reserve)
	Gorgonorhynchus sp. (Shrinivaasu, 2016.)	Tamil Nadu (Gulf of Mannar Biosphere Reserve).
	Cerebratulus gardineri (Punnett, 1903)	Lakshadweep (Minicoy Island)
	Evelineus mcintoshii (Langerhans, 1880)	Kerala (coast of Thiruvananthapuram)
	Baseodiscus hemprichii (Ehrenberg, 1831)	Lakshadweep (Minicoy Island), Tamil Nadu (Gulf of Mannar Biosphere Reserve), Gujarat (Gulf of Kachchh)
Hoplonemertea	*Prosadenoporus buergeri* (Punnett, 1903)	Lakshadweep (Minicoy Island)
	Dinonemertes investigatoris (Laidlaw, 1906)	Lakshadweep.

Role of Nemertea:

Modern society pays more attention to organisms based on their contribution to ecosystems and their direct benefits to society. Until the importance of any organism is recognized, it is neglected. While organisms of many phyla are rich in important knowledge and resources, we are unable to uncover the importance of neglected organisms. Nemertea is such a phylum that has been overlooked till now as they have no direct impact on human society. But now, importance of Nemertea is well documented in many fields. Below is a discussion of their importance:

Maintain community structure as a top predator:

Predation impacts the structure of infaunal community in intertidal areas (Peterson, 1979; Reise, 1985). Decreasing the number of epibenthic predators leads to an increase of endobenthic species and individual numbers. As an predator nemertea plays an important role to maintain the structure of soft botto communities.Nemerteans act as common predators in a wide variety of marine habitats. Benthic nemerteans prey on different prey organisms, primarily polychaetes and crustaceans (McDermott and Roe, 1985), but some scavenges on recently dead organisms (Hines et al. 1990; Thiel, 1998). Among marine predators, nemerteans are unique in that they are very slow-moving in nature, primarily relying on their rapidly everted proboscis and presence of highly potent toxins. Furthermore, their chemosensory system is strongly developed, permitting them to remain on the trail of a prey item once 'smelled the rat' (Amerongen and Chia, 1982). For this reason, nemerteans may play a vital role in marine habitats in which they occur in high abundance. In order to capture their prey, Nemerteans sat and waited at a particular location. As a result of their body shape and feeding strategy, Nemertea can access habitats that are inaccessible to many other predators. They squeeze themselves through the smallest openings and crevices. Nemerteans preferentially prey on organisms that are well protected from other predators such as decapod crabs, fish and birds (e.g., polychaetes in deep burrows or solid tubes, amphipods between blue mussels, sea grass plants, or algal holdfasts.

As an Indicator Species:

Quantifying pollutants in aquatic habitats is challenging for researchers. Man's economic well-being depends heavily on the marine environment. Biological indicator species are now used to quantify aquatic pollution in order to better understand pollutant loading and its subsequent bioavailability in marine ecosystems. Biological availability of metal in the marine organism determines how much metal is uptaken through their body. However, one group of marine invertebrates with considerable potential for use in such monitoring has to date, received little attention. The organisms belong to the phylum Nemertea, a ubiquitous component of most shorelines' shallow-water fauna and intertidal zones. There are several species of Nemertea that secrete large quantities of mucus when irritated, such as Emplectonema gracile, Lineus longissimus, etc. Mucopolysaccharides can bind with ionic

elements in seawater, similar to ion exchange resin. Mucopolysaccharides can bind with ionic elements in seawater, similar to ion exchange resin. Considering the epidermis' ability to secrete significant amounts of mucus and its high metabolic activity, it could serve as an initial barrier to heavy metal absorption.Accumulation of metals in the mucus could afford protection against potentially toxic levels, whilst at lower ambient concentrations, nemertean could be used as indicator species for particular elements. Protection of this nature may confer a competitive advantage to these organisms in conditions of increasing pollution loading.

Source of Toxin :

In Nemertea, proboscis and epidermal mucus mediate toxicity to predators and prey. Certain nemertean species are known to contain remarkably potent toxins: pyridine alkaloids, tetrodotoxin (TTX), and cytolytic or neurotoxic peptides. The Concentration of toxins is high at the anterior proboscis. In Hoplonemertea, there is a stylet associated with a sac of toxin at the outermost tip of the proboscis. The papillary structure of epithelial cells of probosicis secrets toxin and glue-like substance. Some of these substances seem to be capable of dissolving tissue.Hoplonemertines possess a family of pyridine compounds that affects the nervous system (Kern, 1985). First isolated pyridine, anabaseine, stimulates nicotinic receptors.Two other substances, 2,3' -bipyridyl and nemertelline (a tetrapyridyl) were also isolated. TTX is relevant for the characterization of sodium channels and has promise as a drug candidate; it is expected that nemerteans will supply TTX on a large scale. DMXBA has been extensively investigated in pyridine alkaloids, and its medicinal potential is still under investigation. As for peptide toxins, the use of the α-nemertides in pesticide applications appear feasible. It is difficult to predict the outcome of nemertean toxins, but it is clear that they provide an intriguing addition to the field of toxin research.

Food source:

The proximate analysis of Nemertean muscles represents 15.44% crude protein, 8.71% crude lipid, 69.74% moisture and 6.11% ash . The percentage of crude protein in Nemertean flesh is moderately elevated. Analysis of lipid contents of muscles and food sources of Nemerteans have revealed that the muscles of *Cerebratulus bengalensis* contain the highest amount (2.39%) of total lipids (TL) while detritus exhibited the lowest amount (0.18%). Fractional components of fatty acids of TL showed that food components of Nemerteans included an appreciable amount of α- linolenic acid (ALA). Muscles of Nemerteans have shown to contain 9 different types of MUFAs and 12 different types of PUFAs. Among PUFAs arachidonic acid (AA, 20: 4ω6) registered highest amount (5.00%) followed by eicosatrienoic acid (ETE, 20:3ω3) 4.48%, docosahexaenoic acid (DHA, 22:6ω3) 2.89% and so on. However, mangrove leaves did not reveal the occurrence of AA, ETE and DHA. The quantity of linoleic acid (LA, 18:2ω6) exhibited moderate to the high amount (1.84% - 49.50%) in different studied samples (Samanta et al. 2018). Some species can be used as fish bait, e.g.,*Cerebratulus lacteus*, *Malacobdella* sp., and *Ototyphlonemertes brevis*, as well as *Polybrachiyorhynchus dayi.*

Table 1: Percentage of Total Lipid (TL) obtained from various body parts of *Cerebratulus bengalensis* and its primary food sources (Samanta et al. 2018).

Sample	Amount taken	Total lipid obtained	Percentage of total lipid (w/w)
Nemertean muscles	5.23 gm.	125.34 mg.	2.39
Plankton	2.80 gm	23.6 mg.	0.84
Mangrove leaves	16.3 gm	28.1 mg	0.17
Detritus	9.63 gm	14.2 mg.	0.15

Conservation of Nemertea:

Despite knowing about the importance of biodiversity for a long time, human activity has been causing massive extinctions. Our planet is now in the midst of its sixth mass extinction of plants and animals. We're currently experiencing the most severe spate of species die-offs since the extinction of the dinosaurs 65 million years ago. Although extinction is a natural phenomenon, it occurs at a natural "background" rate of about one to five species per year. It is estimated that we are now losing species at a rate 1000 to 10000 times faster than the background rate.On a daily basis, dozens of species disappears. It could be a scary future indeed, with as many as 30 to 50 percent of all species possibly heading toward extinction by mid-century. 99 percent of currently threatened species are at risk from human activities, primarily those driving habitat loss, introduction of exotic species, and global warming. Because the rate of change in our biosphere is increasing, and because every species' extinction potentially leads to the extinction of others bound to that species in a complex ecological web,the numbers of extinctions are likely to snowball in the coming decades. The International Union for the Conservation of Nature (IUCN) maintains the Red List to assess the conservation status of species, subspecies, varieties, and even selected subpopulations on a global scale.Extinction risks outpace any conservation successes.

Table 2. Little information about the status of nemertea in Red Data Book. In Red Data Book only six species of terrestrial Nemertea are categorized in the following category.

Species Name	Status (According to IUCN Red Data Book)
Prosadenoporus Agricola	CR
Argonemertes stocki	DD
Geonemertes rodericana	EX
Antiponemertes allisonae	EN
Katechonemertes nightingaleensis	VU
Argonemertes hilli	LC
CR-Critically Endangered, **DD**-Data Deficient, **EX**-Extinct, **EN**-Endangered, **VU**- Vulnerable, **LC**-Least Concern * But there is no information on the status of aquatic Nemertea in Red Data Book.	

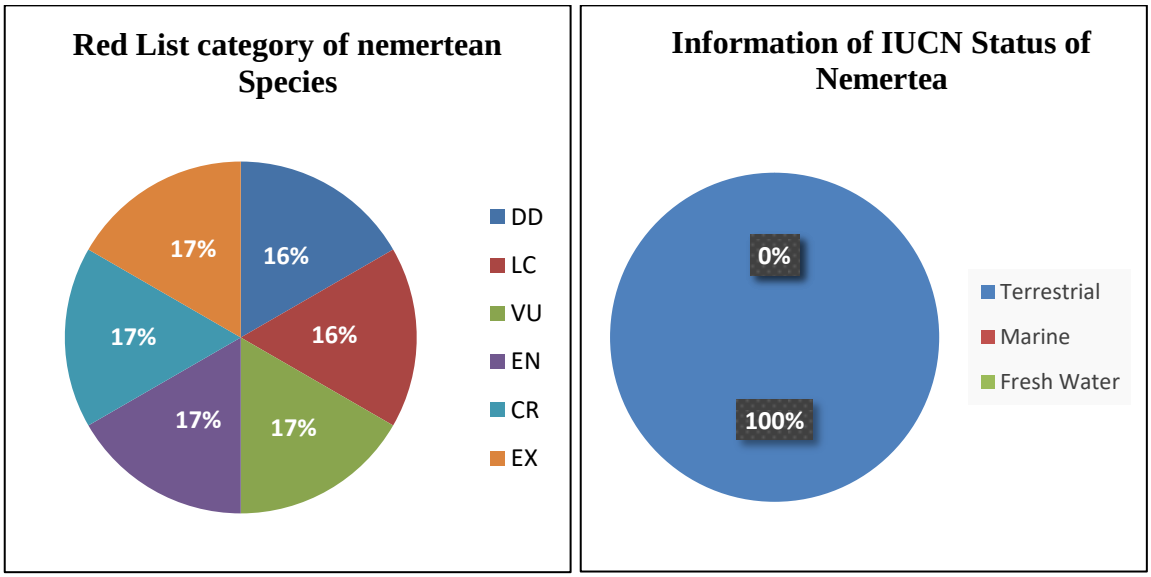


Figure 1. Red list category of Nemertean species and its ICUN status.

Interesting Features:

Nemertea is poorly known to the general public and research on nemertean biology and ecology is limited. However, the phylum includes some remarkable species, including *Parborlasia corrugatus* which is the major scavenger on the sea floor in Antarctica. Having reached 50 meter in length, *Lineus longissimus* is the longest animal on earth.They have a remarkable power for contraction and relaxation. They can extend upto 5-7 times than their original body length. In this case anoplan Nemertea is more suited than enoplan Nemerteas. Papillary epithelial cells of Nemertean proboscis secrets a glue-like substance that is effective even under water.

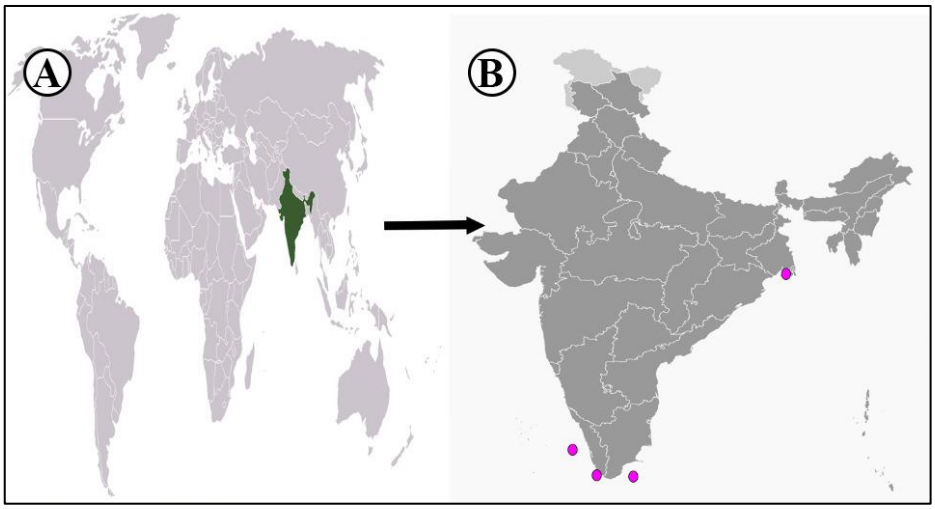


Figure 2. (A) Position of India on global map. (B) Violet spot shows the Nemertean distribution in India

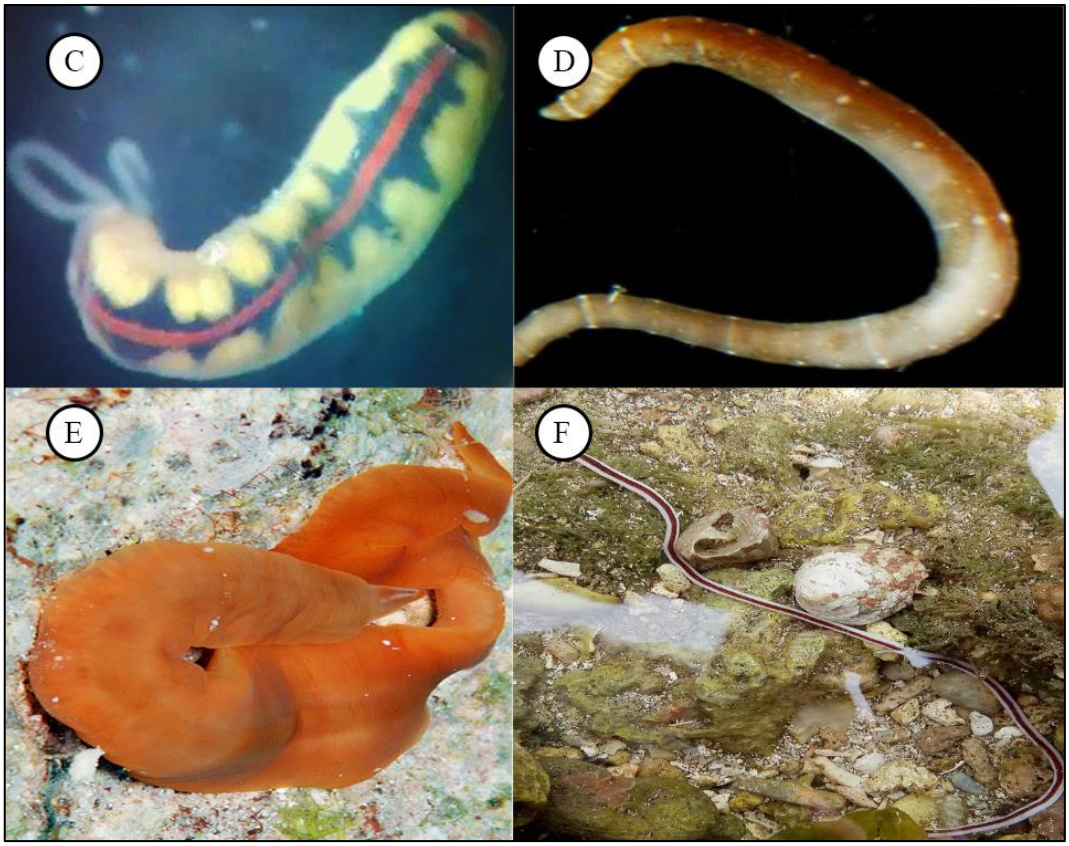


Figure 3. (C-F) Four nemertean species found in India, Evelineus mcintoshii Balionemertes australiensis, Gorgonorhynchus repens, Baseodiscus hemprichii respectively.

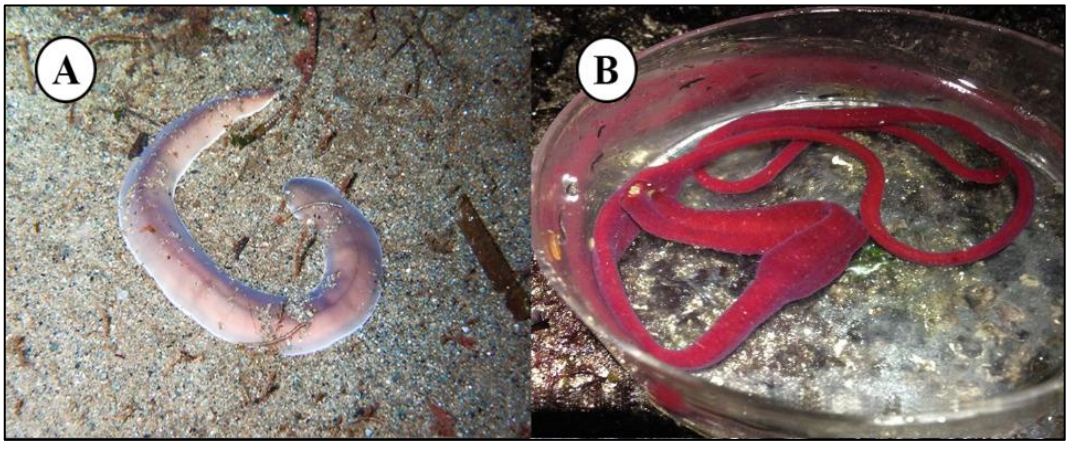


Figure 4. (A) *Cerebratulus marginatus* (B) *Kulikovia montgomeryi*

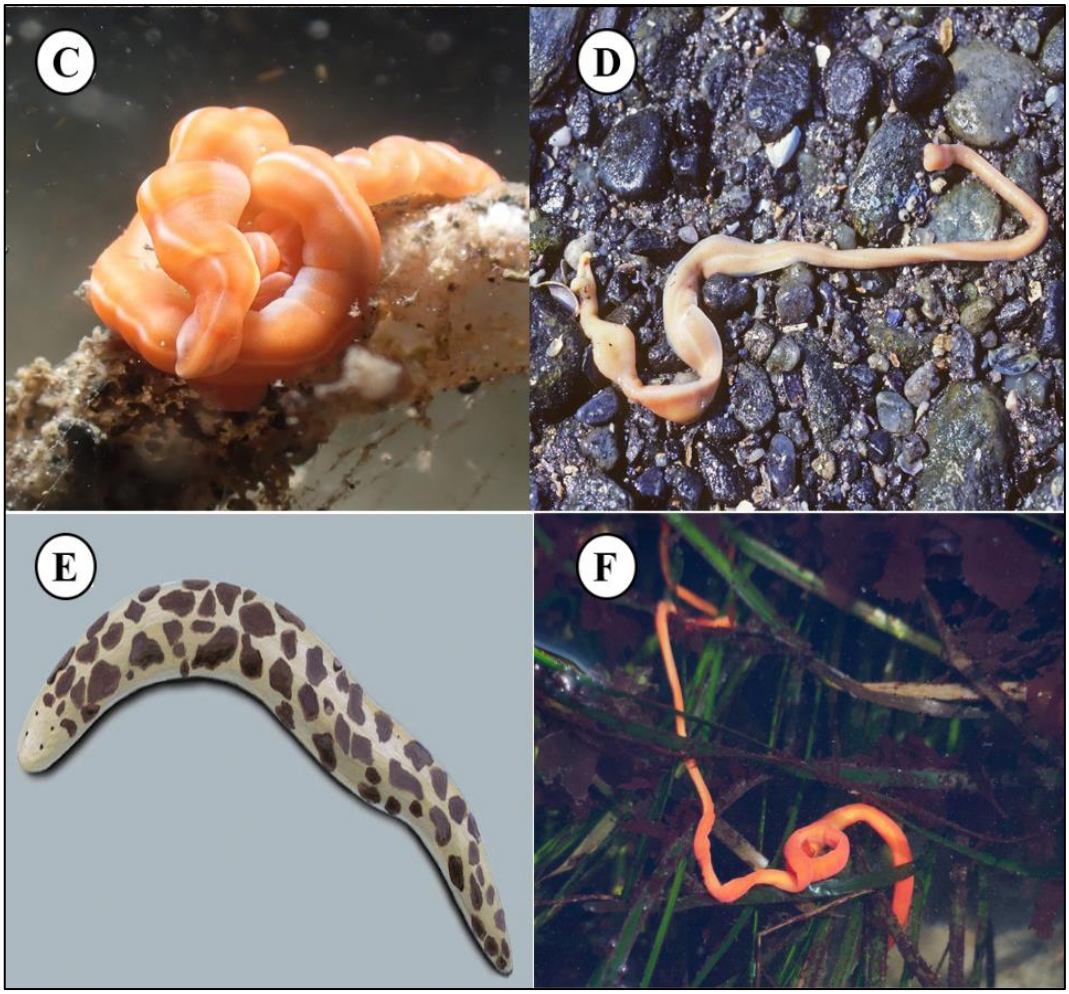
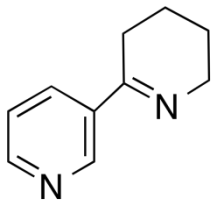
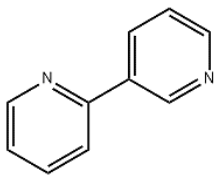
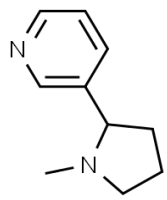


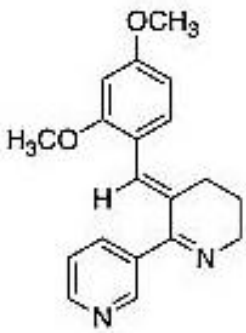
Figure 5. (C) Quasitetrastemma nigrifrons (D) Cerebratulus lacteus (E) Oerstedia dorsalis (F) Tubulanus polymorphus

Some bioactive compounds found in Nemertea

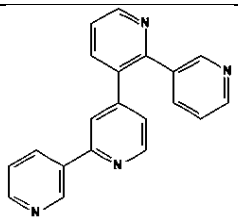

Anabaseine

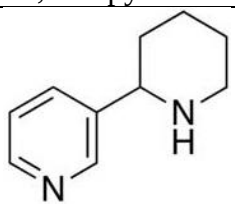

2,3'-Bipyridine


(-)-nicotine

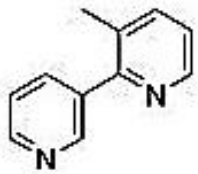


DMXBA (GTS-21)


Nemertelline



Anabasine



3-methyl-2,3'-bipyridine

Conclusion:

The contribution of Nemertea to human society is very limited. Therefore, they caught little attention. Although they are rich in resource, we are unable to extract them. Nemertean represents the source of bioactive compounds, given that only less than 5% of the world's ribbon worm species have been analysed for toxin content to any extent. There is also a geographical limitation to these efforts. Sampling has been carried out at a limited number of sites globally. They are currently facing a huge threat of extinction. *Prostoma jenningsi* has been listed in the Red Data Book as a taxon under threat from habitat usage.It is crucial to determine whether nemertea numbers decreases rapidly in the background due to anthropogenic forces and other unknown factors.So, we should monitor the existing species and find a new ones and protect them from the threat of extinction.

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References:

Amerongen HM, Chia FS (1982) Behavioural evidence for a chemoreceptive function of the cerebral organs in Paranemertes peregrina Coe (Hoplonemertea: Monostilifera). *J. Exp. Mar. Biol. Ecol.*, 64: 11–16

Andrade SCS, Strand M, Schwartz M, Chen H, Kajihara H, von Döhren J, Sun S, Junoy J, Thiel M, Norenburg JL, Turbeville JM, Giribet G, Sundberg P (2012) Disentangling ribbon worm relationships: multi-locus analysis supports traditional classification of the phylum Nemertea. *Cladistics*, 28: 141–159. doi: 10.1111/j.1096-0031.2011.00376.x

Caplins, S. Penna-Diaz, MA. Godoy, E. Valdivia, N. Turbeville, JM. & Thiel, M, (2012) Activity patterns and predatory behaviour of an intertidal nemertean from rocky shores: *Prosorhochmus nelsoni* (Hoplonemertea) from the southeast pacific. *Mar Biol*, 159:1363-1374

Chen HX, Sun SC, Sundberg P, Ren WC, Norenburg JL (2012) A comparative study of nemertean complete mitochondrial genomes, including two new ones for Nectonemertes cf. mirabilis and Zygeupolia rubens, may elucidate the fundamental pattern for the phylum Nemertea. *BMC Genomics*, 13: 139. doi: 10.1186/1471-2164-13-139

Coe WR (1934) Analysis of the regenerative processes in Nemerteans. *Biological Bulletin*, 66(3): 304–315.

Coe WR (1943) Biology of the nemerteans of the Atlantic coast of North America. *Transactions of the Connecticut Academy of Arts and Sciences*, 35: 129–328.

Ehrenberg, C.G., 1831. Nemertes hemprichii, Ehrenberg. Berolina: *Officina Academica*, 12

Giribet, G., D. L. Distel, M. Polz, W. Sterrer, and W. C. Wheeler (2000) Triploblastic relationships with emphasis on the acoelomates and the position of the Gnathostomulida,

Cycliophora, Plathelminthes and Chaetognatha: A combined approach of 18S rDNA sequences and morphology. *Syst. Biol*., 49:539–562.

Hines, A. H., A. M. Haddon, and L. A. Wiechert (1990) Guild structure and foraging impact of blue crabs and epibenthic fish in a subestuary of Ches- apeake Bay. *Mar. Ecol. Pro.*

Kajihara, H., Chernyshev A.V., Sichun S., Sundberg P. and Crandall F.B (2008) Checklist of nemertean genera and species (Nemertea) published between 1995 and 2007. *Species Diversity*, 13: 245-274

Kem W, Soti F, Wildeboer K, LeFrancois S, MacDougall K, Wei DQ, Chou KC, Arias HR (2006) The Nemertine Toxin Anabaseine and Its Derivative DMXBA (GTS-21): Chemical and Pharmacological Properties. *Marine Drugs,* 4(3): 255-273. doi: 10.3390/md403255

Laidlaw, F.F (1906) On two new genera of deep-sea nemertines, *Annals and Magazine of Natural History,* 7(17): 185-188.

Langerhans, P (1880) *Die Wurmfauna von madeira. III. Zeitschrift fur Wissenschaftliche Zoologie,* 34, 87-146.

Martindale MQ, Henry JQ (1995) Modifications of cell fate specification in equal-cleaving nemertean embryos: Alternate patterns of spiralian development. *Development*, 121(10): 3175

Maslakova SA, Martindale MQ, Norenburg JL (2004) Fundamental properties of the spiralian developmental program are displayed by the basal nemertean *Carinoma tremaphoros* (Palaeonemertea, Nemertea). *Developmental Biology,* 267(2): 342–360. doi: 10.1016/j. ydbio.2003.10.022

McDermott JJ, Roe P (1985) Food, feeding behavior and feeding ecology of nemerteans. *Am Zool.*, 25:113–125

Peterson, C. H., 1979. Predation, competitive exclusion, and diversity in the soft sediment benthic communities of estuaries and lagoons. In: R. C. Livingstone (ed.), *Ecological Process in Coastal and Marine Systems*. Plenum Press, New York, pp. 233 -264.

Punnett, R.C (1903) Nemerteans. In: Gardiner J.S. (Ed.),The fauna and geography of the Maldive and Laccadive Archipelagos. Vol. 1 (part 11). Cambridge, UK: *Cambridge University Press*, pp. 101-188.

Reise, K., 1985. Tidal ecology. *Ecological studies*, Vol. 54. Springer, Berlin, 191 pp

Roe, P., 1976. Life history and predator-prey interactions of the nemertean Paranemertes peregrina *Coe. Biol. Bull*. 150: 80–106.

Samanta S, Das T, Ghorai S & Chakraborty SK (2018) Biocycling of Fractional fatty acid components of lipids in mangrove-benthic systems, in Midnapore(East) coast,India. *Examines in Marine Biology and Oceanography*, 1(2). EIMBO.000510.

Shrinivaasu, S., 2016. Studies on the coelobites of Gulf of Mannar and Palk Bay. PhD. Thesis submitted to the University of Madras.

Thiel M (1998) Nemertines as predators on tidal flats—high noon at low tide. *Hydrobiologia* 365:241–250

Thiel, M. & Kruse, I (2001) Status of the Nemertea as predators in marine ecosystems. *Hydrobiologia*, 456:21-32

Thollesson, M. & Norenberg , JL (2003) Ribbon worm relationships: a phylogeny of phylum Nemertea. *Proc. R.Soc. Lond*. B.270, 407-415

Turbeville JM (2002) Progress in Nemertean Biology: Development and Phylogeny. *Integ. and Comp. Biol.*, 42: 692-703

Sreeraj, C.R (2020) Nemertea. In: Faunal Diversity of Biogeographic Zones : Coasts of India, pp. 603-606 (Published by the Director, Zool. Surv. India, Kolkata).

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