OPEN ACCESS PEER REVIEW
DOI: https://doi.org/10.52756/boesd.2024.e03.010
Chapter- 10

Symbiotic Relationship of Nemertea: A Comprehensive Review

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Keywords: Community structure, Commensalism, Ecosystem, Nemertea, Symbiosis

Abstract:
Ribbon worms, or Nemertean's, are found in both freshwater and marine environments, where they display a wide variety of symbiotic connections. These relationships have a distinct impact on ecosystem dynamics and species interactions, including mutualistic, commensal, and parasitic relationships. The numerous symbiotic interactions involving Nemerteans are reviewed in this paper, with particular attention paid to their ecological functions, impacts on host animals and consequences for biodiversity and community structure. By scrutinizing contemporary literature and case studies, we underscore the intricacy and importance of Nemertean symbiosis and pinpoint domains that warrant further investigation.

Introduction:

Marine ecosystems are characterized by symbiosis, which includes parasitism, commensalism, and mutualism (Roughgarden, 1975; Margulis, 1991). Numerous animals have undergone morphological and ecological diversification due to these symbiotic connections, which alter the symbiont species' anatomy, physiology, and reproductive systems (Sotka, 2005; Joy, 2013). In commensal partnerships, in which symbionts inhabit the host's body, the hosts provide a home for the symbionts to dwell in for some or all of their lifetime.

Nemertea, or ribbon worms, is a phylum of Lophotrochozoa (Kocot et al., 2017; Laumer et al., 2019; Bleidorn, 2019). These soft-bodied, unsegmented worms are differentiated by an

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Nithar Ranjan Madhu, Tanmay Sanyal, Koushik Sen, Biswajit (Bob) Ganguly & Roger I.C. Hansell (eds.), A Basic Overview of Environment and Sustainable Development [Volume: 3]. ISBN: 978-81-969828-3-6, pp:165-174 ; Published online: 08th August, 2024

eversible proboscis located in a fluid-filled chamber known as the rhynchocoel (Gibson, 1982). There are currently roughly 1,350 species of Nemerteans (Hookabe et al., 2024), the majority of which live in maritime benthic settings. They usually live as free-living macrophagous carnivores, feeding on polychaetes, molluscs, and small crustaceans, or as scavengers (McDermott et al., 1985).

However, at least 50 Nemertean species have been shown to have symbiotic interactions with other creatures (Jensen and Sadeghian, 2005; Junoy et al., 2010; Sadeghian and Santos, 2010; Kajihara and Kuris, 2013; Simpson et al., 2017). Bivalves, crustaceans, and ascidians are the most diverse groups of invertebrates that host symbiotic Nemerteans. The majority of known symbiotic Nemertean species are found in the class Hoplonemertea, suborder Eumonostilifera, which includes 11 genera and two families (Malacobdellidae and Carcinonemertidae) that are entirely made up of symbiotic species.

Their associations with other organisms vary from mutualistic to parasitic, demonstrating their versatility and evolutionary success. Understanding these symbiotic connections is critical for understanding Nemertean ecology in general. This review summarizes current information about Nemertean symbiosis, focusing on mutualistic, commensal and parasitic connections and their impact on ecosystems.

Symbiotic Relationships:

Association with bivalve:

- *Malacobdella arrokeana* is found in *Panopea abbreviata* (Ivanov et al., 2002).
- *Malacobdella grossa* was discovered in the mantle cavity of the oval Piddock, *Zirfaea crispat*e (Gibson in 1967 and 1968).
- *Malacobdella siliquae* inhabits *Siliqua patula*, while *Malacobdella macomae* inhabits *Macoma secta* and *M. nasuta* (Kozloff 1991).
- *Tetrastemma fozensis*, a tiny hoplonemertine, lives in the mantle cavity of the bivalve *Scrobicularia plana* (Thiel et al., 1997).
- *Uchidana parasite* found in bivalve *Mactra chinensis* (Dieck, 1874).
- *Malacobdella japonica* is present in the mantle cavity of *Pseudocardium sachalinense* (Hookabe et al., 2024).

Association with crustacean:

- *Nemertopsis quadripunctata* and *Nemertopsis mitellicola* are found in the goose-neck barnacle *Capitulum mitella* (Kajihara, 2007).
- *Carcinonemertes kurisi* is found in *Randallia ornate* crabs, while *Carcinonemertes tasmanica* lives in *Dittosa laevis* crabs (Sadeghian and Santos, 2010).
- *Ovicides paralithodis* is a symbiotic egg predator for the red king crab, *Paralithodes camtschaticus* (Kajihara and Kuris, 2013).

- *Carcinonemertes conanobrieni* feeds on the eggs of the Caribbean spiny lobster, *Panulirus argus* (Simpson et al., 2017).
- *Pesudocarcinonemertes homari* are ectoinhabitants of the lobster *Homarus americanus* (Fleming and Gibson, 1981).

Figure 1. *Malacobdella japonica* is found in the mantle cavity of *Pseudocardium sachalinense* (Hookabe et al., 2024).

- *Ovicides jasoni* juveniles or regressed adults were detected in the mucous sheaths of *Austinograea alayseae* crabs.*Ovicides davidi* derives its name from the bythograeid crab *Cyanagraea praedator*. *Ovicides jonesi* are found in *Bythograea vrijenhoeki*, while *Ovicides julieae* suppress *Chlorodiella* spp. (Xanthid crab) (Shields and Segonzac, 2007).
- *Carcinonemertes pinnotheridophila* discovered in the branchial chambers of *Pinnixa chaetopterana*, Decapoda (McDermott and Gibson, 1993).
- *Carcinonemertes divae*, *C. caissarum*, and *C. sebastianensis* are associated with the crabs *Libinia spinosa*, *Hepatus pudibundus*, and *Menippe nodifrons* (Santos et al., 2006).
- *Carcinonemertes regicides* from red king crabs *Paralithodes camtschatica* and *C. errans* affect the Dungeness crab *Cancer magister* (Kuris, 1993).
- *Cephalothrix galatheae is found in the anomuran crab Galathea strigose* (Dieck, 1874).
- *Carcinonemertes camanchaco lives in the Host crab species Romaleon setosum and Cancer porteri* (Leiva, 2021).

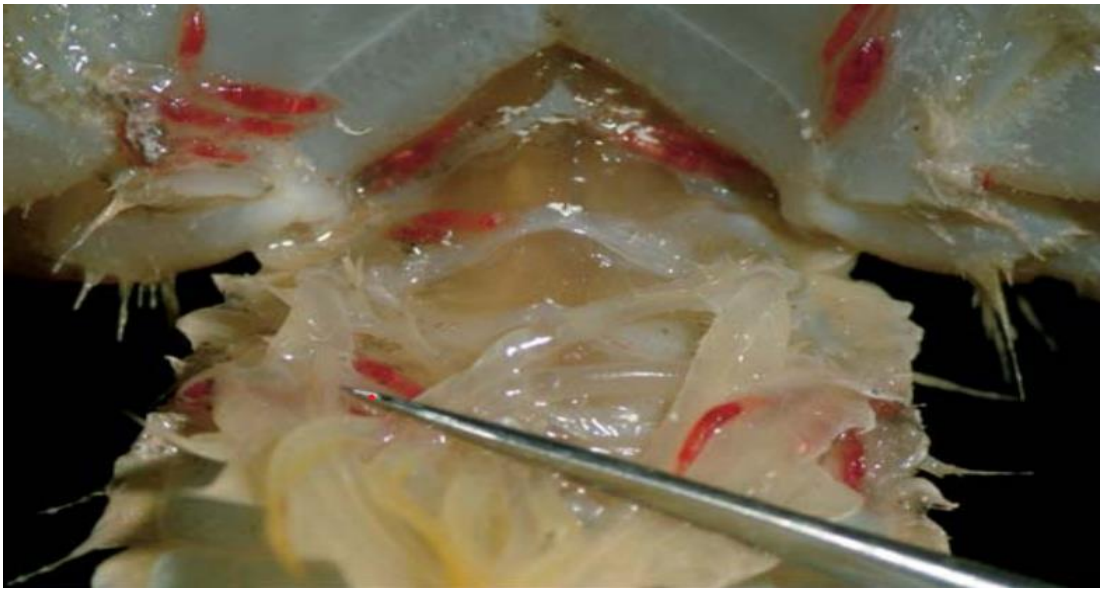

Figure 2. Juvenile worms of *Ovicides jasoni* present on the sternum, pleon, and pleopods of *Austinograea alayseae* (Shields and Segonzac, 2007).

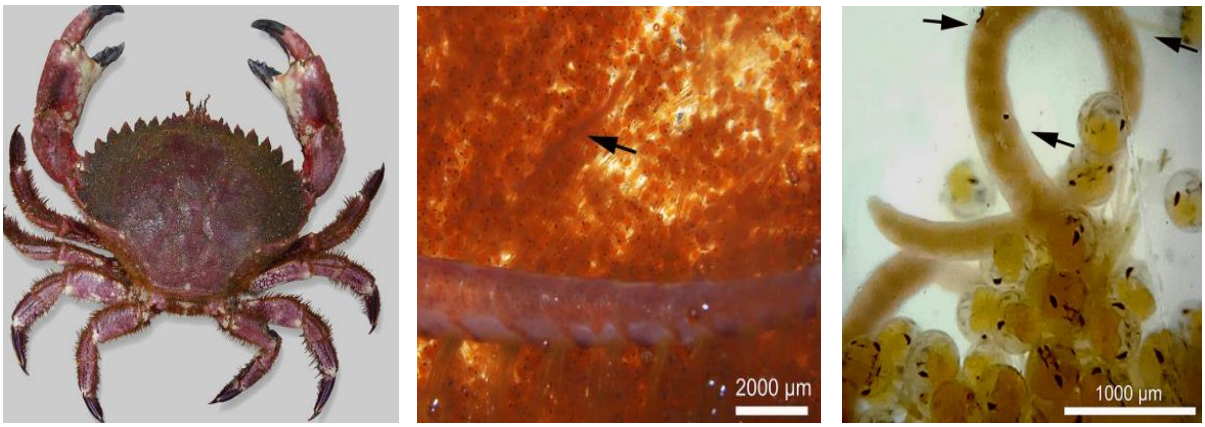

Figure 3. Host crab species *Romaleon setosum* infected by *Carcinonemertes camanchaco* and also present in their egg masses (Leiva, 2021).

Association with Ascidian

- *Gononemertes australiensis* was found in *Pyura pachydermatina*, an ascidian host (Egan, 1984).
- *Vieitezia luzmurubeae* is linked to *Phallusia mamillata* (Junoy et al., 2010).

Association with Echiuran

- *Nemertoscolex parasiticus* is an endoparasitic heteronemertean found in the coelomic fluid of *Echiurus echiurus* (Berg and Gibson, 1996).

Association with Actiniarians

- *Nemertopsis actinophi* is associated with two species of swimming actiniarians: *Stomphia coccinea* and *Stomphia didemon* (Gibson, 1986).

Association with echinoderms

- Eumonostilifera is associated with echinoderms, such as *Asteronemertes commensalis* and *Asteronemertes gibsoni*, which live in the ambulacral grooves of starfish from the Solasteridae and Pterasteridae families (Chernyshev, 1991; Kyao, 1954).
- *Cephalotrichella echinicola* is linked to heart urchins *Metallia spatagus* and *M. sternalis* (Britayev et al., 2018).

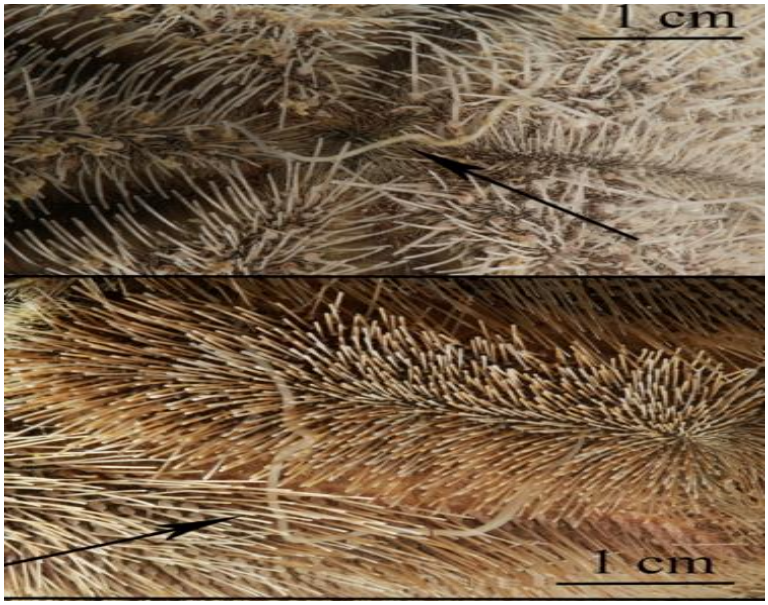

Figure 4. *Cephalotrichella echinicola* is associated with heart urchins (Britayev et al., 2019).

Ecological Implications

Effects on Host Behaviour and Fitness

The effect of Nemertean symbiosis on host behavior and fitness varies with the nature of the interaction. Hosts who have commensal Nemerteans may demonstrate behavioral modifications to accommodate their symbionts. For example, bivalves that host Nemerteans may change their eating patterns to accommodate their presence. Fitness effects are particularly noticeable in parasitic partnerships when Nemerteans can lower the host's growth rates, reproductive success, and overall health. Commensal and mutualistic partnerships have less severe consequences, and hosts frequently profit from the encounter.

Impact on the Community Structure

Nemertean symbiotic partnerships can have an impact on overall community dynamics by changing species interactions and composition.

The presence of parasitic Nemerteans can decrease the host population, which impacts predator-prey dynamics and resource availability for other species. Commensal Nemerteans may also impact host species' competitive interactions.

Symbiotic partnerships help increase ecosystem resilience and stability by providing complexity to species interactions. The presence of Nemerteans can improve the diversity and function of marine communities, promoting overall ecosystem health.

Contributions to biodiversity

Nemerteans contribute to the complexity of marine environments through their various interactions with other creatures. Their existence produces new niches and microhabitats, allowing for a broader range of species and ecological processes. Nemerteans are important in nutrient cycling, habitat structure, and food web dynamics. Their interactions with other species assist in keeping the environment balanced and contribute to total biodiversity.

Future Research Directions

To further understand Nemerteans' ecological roles in symbiotic partnerships, future studies should focus on many crucial areas:

Detailed ecological studies

Long-term investigations are required to assess the impact of Nemertean symbiosis on host populations and community dynamics. These investigations should focus on seasonal and regional differences in symbiotic interactions.

Molecular approaches

Advances in genetic and molecular techniques, like DNA barcoding and metagenomics, are crucial for finding and classifying Nemertean species and comprehending their evolutionary links.

Behavioural research

Both observational and experimental investigations are needed to study Nemertean behavior and interactions with hosts. This study will help understand host recognition, attachment, and exploitation mechanisms.

Environmental Impact Assessment

Assessing the effects of environmental changes on Nemertean symbiosis is essential for forecasting future ecosystem dynamics. This includes assessing the impact of pollution, climate change, and habitat loss on symbiotic relationships.

Integrative Approaches

Integrating ecological, molecular, and behavioral studies leads to a complete understanding of Nemertean symbiosis. Collaboration across disciplines will improve our ability to address the problems and possibilities presented by these interconnections.

Conclusion

Nemertean symbiosis is a broad and diverse topic of study that covers relationships ranging from mutualism to parasitism. These connections substantially impact marine ecosystems and provide important insights into evolutionary and ecological processes. Continued research is required to understand the full extent of Nemertean symbiosis and its implications for ecosystem health and management.

Acknowledgments

We want to express our deep and sincere gratitude to Santosh Kr. Bera, Sujit Das, and Sourav Bar for their support. We are thankful to Coastal Ecology Research Laboratory for allowing us to do this work smoothly. We are also grateful to UGC and CSIR-HRDG, India for their financial support.

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HOW TO CITE

Jhumpa Majhi, Soumik Dhara, Nithar Ranjan Madhu, Roger I.C. Hansell and Sudipta Kumar Ghorai (2024). Symbiotic Relationship of Nemertea: A Comprehensive Review © International Academic Publishing House (IAPH), Dr. Nithar Ranjan Madhu, Dr. Tanmay Sanyal, Dr. Koushik Sen, Professor Biswajit (Bob) Ganguly and Professor Roger I.C. Hansell (eds.), *A Basic Overview of Environment and Sustainable Development [Volume: 3]*, pp. 165-174. ISBN: 978-81-969828-3-6. DOI: https://doi.org/10.52756/boesd.2024.e03.010