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Cymothoa exigua (Tongue-Eating Louse): Biology, Geographic Distribution, Life Cycle, and Host–Parasite Interactions

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ABSTRACT

Background: *Cymothoa exigua (tongue-eating louse) is one of the most marine parasites within the family Cymothoidae because of its unique ability to replace the tongue of fish host. This topic also has scientific significance due to its environmental and health impacts.*
Objectives*: This review summarizes the biology, taxonomy, geographic distribution, life cycle, environmental specialization, host–parasite interactions of Cymothoa exigua, research gaps and future perspectives.*
Methods*: A narrative literature review conducted using published articles from scientific databases among them PubMed, Web of Science, Google Scholar, and World Register of Marine Species (WoRMS). Peer-reviewed studies related to Cymothoa exigua were selected, reviewed and synthesized according to the objectives of this review.*
Results*: The literature indicates that Cymothoa exigua is distributed in the eastern Pacific Ocean, ther are also a few reports confirming its presence in other regions around the world. This parasite has a complex life cycle includes (protandrous hermaphroditism) and establishes itself within the oral cavity of fish. Tongue-replacement strategy of this parasite effects on host feeding, respiration, and reproductive performance. Significant gaps were also revealed concerning molecular taxonomy, host immune responses, and the effects of environmental changes on parasite distribution.*
Conclusion: *Cymothoa exigua is considered unique model for understanding coevolution between host and parasite and the mechanism of parasitism in the marine environment particularly in fish. Research that integrates ecological and microbiological aspects is important for understanding the biology of this parasite and for support fisheries management and conservation of marine biodiversity.*

KEYWORDS: Cymothoa exigua, tongue-eating louse, marine fish.

1. Introduction

Crustaceans is one of the major subphylum within the phylum Arthropoda, many of which have parasitic lives and infect fish species. With over 10,000 species that majorly, yet not entirely, inhabit aquatic environments, the order Isopoda is remarkably speciose group within phylum [1]. Brackish, freshwater, and marine fish are parasitized by isopods belonging to the family Cymothoidae Leach, 1818 [2]. Members of Cymothoidae family, such as *Cymothoa Fabricius* (1793), typically infest wild marine fish species in variety of environments worldwide. There are 46 recognized species in the genus [3]. Because of poor species descriptions, intraspecific variability, species lacking type material, and variations in how its species adhere to the host fish, *Cymothoa* is considered to be the most difficult genus in family Cymothoidae in terms of morphology [4]. The shape and size regarding amphicephalic processes of pereonite 1 could be used for classifying *Cymothoa* species into two categories. The processes are either undeveloped or badly developed in certain species, while they are moderately or substantially developed in others [5].

Among many marvels regarding the world beneath waters is unusual parasitic isopod (*Cymothoa exigua*), which is well-known for its unusual as well as sometimes unsettling way of living. Because of its peculiar way of operation—replacing its fish host's tongue—this small crustacean has gained notice. A fascinating insight at the intricate interactions occurring in the marine ecosystems is provided by examining the behavior, life cycle, also impacts regarding *Cymothoa exigua* [6]. The tongue louse, or *Cymothoa exigua*, can be defined

as one of the parasitic isopods belonging to Cymothoidae family. It enters through a fish's gills. In addition, the female attaches to tongue, whereas the male is attached to the gill arches that are beneath as well as behind female. The length of females is between 8 and 29 mm (0.3–1.1 in), while their width is between 4 and 14 mm (0.16–0.55 in). The length of males is between 7.5 and 15 mm (0.3–0.6 in) and their width is between 3 and 7 mm (0.12–0.28 in)[7]. As show in figure(1). The genus *Cymothoa* belongs to the family Cymothoidae [8], the taxonomic classification of Cymothoa exigua is summarized in Table [1].

Table 1: The Scientific classification for tongue-eating louse (*Cymothoa exigua*).

Toxonomic Rank	Scientific Name
Kingdom	Animalia
Phylum	Arthropoda
Subphylum	Crustacea
Class	Malacostraca
Order	Isopoda
Family	Cymothoidae
Genus	Cymothoa
Species	*Cymothoa exigua*
Binomial name	*Cymothoa exigua*

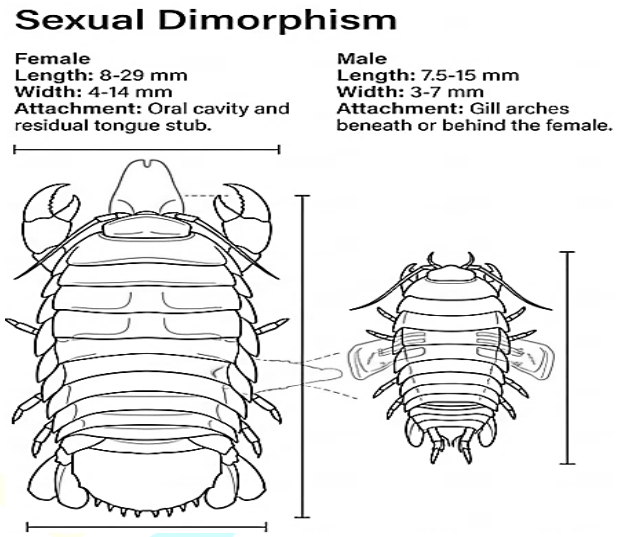
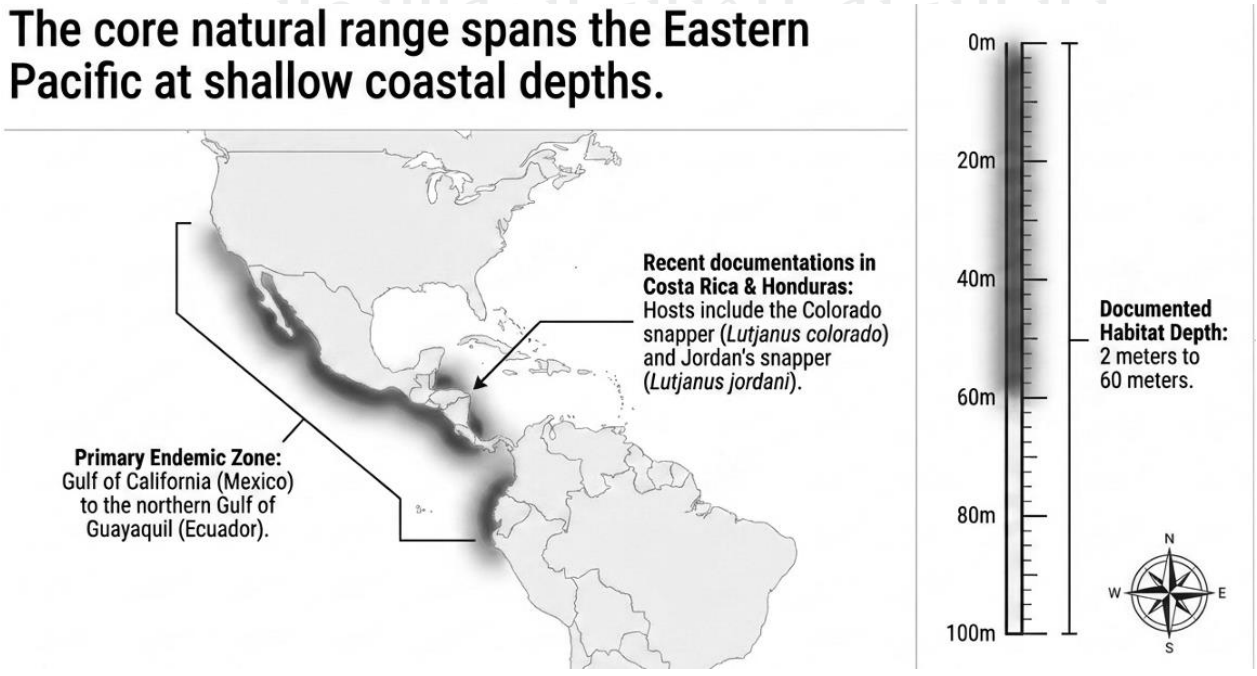


Figure (1): Morphological differences between male and female *Cymothoa exigua.*

2. Geographical Distribution and Host Range

Cymothoa exigua is widely distributed. It could be identified in portions of Atlantic and from Gulf of California south to north of Gulf of Guayaquil, Ecuador. In addition, it was identified in waters that range in depth from 2 meters (6 feet 7 inches) to about 60 meters (200 feet). It is indicated that this isopod parasitizes eight fish species from four families and two orders, including seven species regarding the order Perciformes: one grunt species, three snappers, three drums, and one silverside—one grunion—are all members of the Perciformes. Jordan's snapper as well as Colorado snapper are two new [clarification needed] Costa Rican hosts [9].



Figure(2): Global geographic distribution and depth range of *Cymothoa exigua*.

2.1 Current Global Geographic Distribution of *Cymothoa exigua*

The distribution of *Cymothoa exigua* begins in **Gulf of California** (eastern Pacific Ocean) and extends southward to **northern Gulf of Guayaquil** in **Ecuador**. Additionally, it was **reported in limited areas of the Atlantic Ocean**, though these reports are typically **isolated cases** (e.g., a specimen found in the UK was likely introduced via imported fish rather than representing a natural range) [10].

1. Eastern Pacific

Location: From Gulf of California (Mexico) southward to northern Gulf of Guayaquil, Ecuador. This is considered the core natural range of the species, occurring in waters from about 2 m to nearly 60 m deep [10].

2. Central America

Location: Mexico, Costa Rica, Honduras (eastern Pacific coast). New host species reported: Lutjanus Colorado and Lutjanus jordani have been recorded as hosts in Costa Rica and Honduras [10].

3. Africa & West Asia

Location: Egypt, Nigeria, Sudan, Yemen (Red Sea / Western Indian Ocean).

the presence regarding six species of *Cymothoa* in fish in the southwestern Indian Ocean [11]. A total of nine species of *Cymothoa* were identified by [12] among fish species found along the Brazilian coast. Fish in Americas have been found to be infested with *C. excisa* [13] as well as *C. exigua* [14] fish in Cuba were found to be infected with *C. exigua*, *C. excisa*, and *C. oestrum* [15]. According to [16] sixteen fish species in Caribbean Sea were infested with C. excisa. Furthermore, we discovered that whereas *C. exigua* was present in 18 fish species, *C. excisa* affected an additional 12 host fish species. Thus, the host specificity regarding the two of such parasite species is minimal.

The distribution of this parasite is influenced by several environmental factors, not just geographical location. Environmental conditions such as temperature, seawater temperature, salinity and the types of fish that serve as hosts for this parasite play a key role in determining its spread. This parasite is associated with tropical and subtropical marine environments due to the abundance of host species. Conversely, its absence in other countries is attributed to several reasons, including unsuitable environmental conditions, the absence or scarcity of host fish, or misdiagnosis resulting from confusion with other species of the genus *Cymothoa*. Furthermore, more studies combining morphological and molecular diagnosis are needed to clarify its global distribution more accurately.

3. Reproductive Behavior and Life Cycle

Cymothoa exigua begins its life cycle as free-swimming as well as small larva. With regard to this stage, it searches for suitable fish hosts to attach to. As soon as it finds host, generally snapper, isopod transforms. It attaches to host's gills with its front claws as well as begins to consume blood from gill arches. With maturing of isopod, it undergoes amazing transformation. It is migrating from fish's gills to its mouth prior to landing on its tongue [17]. *Cymothoa exigua* employs significant approach: it cuts fish's tongue's blood vessels, which causes the organ to atrophy and fall off. Furthermore, the isopod after that attaches itself to residual stub, and substituting its own body for fish's tongue [6].

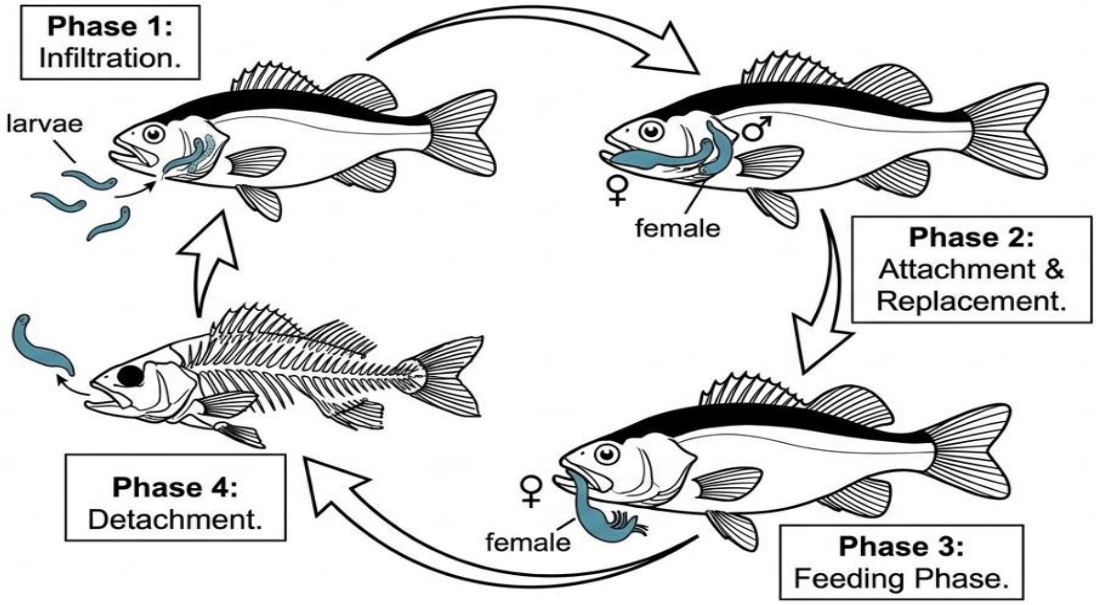


Figure (3): Diagram of Life cycle of a Lithognathus Mormyrus with *Cymothoa Exigua*

Survival strategies: The tongue-replacement behavior of *Cymothoa exigua* is a two-fold solution: Sustenance and protection. The isopod has access to ready source regarding blood by replacing the tongue of the fish which keeps it nourished. The isopod also benefits of host fish protection. It is well-guarded as well as hidden resident of the fish in its mouth, where it is not noticed by predators, and where it thrives in a comparatively safe environment. [6].

4. Host–Parasite Interactions and Effects

The interaction of *Cymothoa exigua* and its fish host can be considered one of the most peculiar instances of the marine crustacean parasitism; [18]. *C. exigua* is an ectoparasitic isopod which is a member of Cymothoidae family. It infects the host mostly via the gill chamber and then becomes attached to the tongue [19]. The parasite feeds on the tongue's blood supply; this results in degeneration of the tissue causing its ultimate atrophy and thus rendering the organ nonfunctional. Then it also attaches to the remaining muscles and is essentially a sort of a prosthetic tongue ([20]. Such parasitic relationship possesses considerable physiological and ecological consequences on the host as shown in figure (4).

It is claimed that cymothoid isopods cause decreased fish growth, feeding efficiency, reproductive performance, and general survival [21,22] Poor body conditions in infected fish are a result of loss of blood, nutritional stress, and loss of energy. Also, young stages that attach on the gills can hinder respiration prior to them moving to the oral cavity [23]. Changes in behavior have also been reported, such as less feeding activity, a change in swimming behavior, and a decrease in predator avoidance [22]. Such alterations can have an effect on the dynamics of population and ecosystems within the marine environment [18].

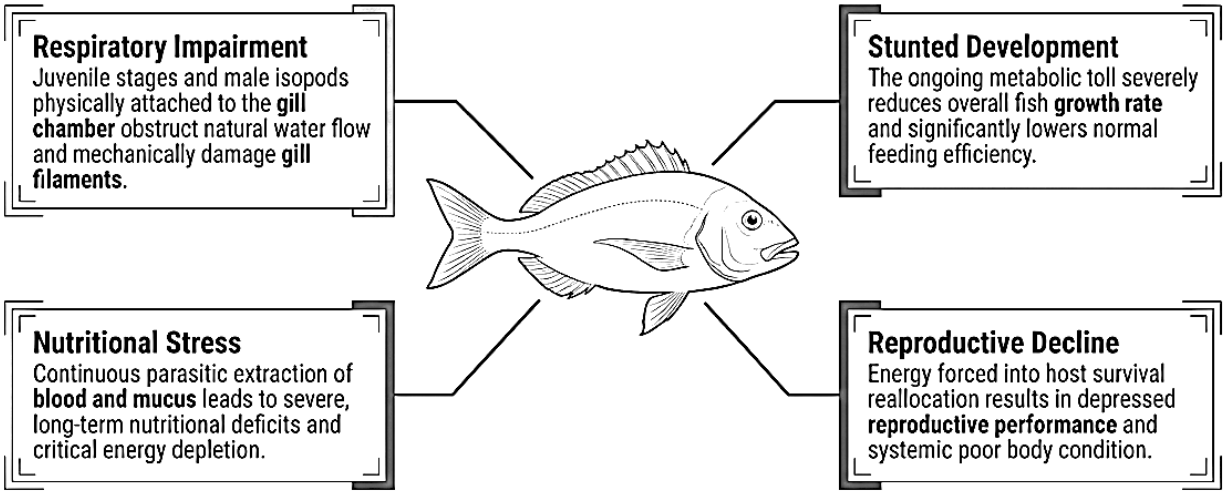


Figure (4): pathological effects of *Cymothoa exigua* infestation on fish hosts.

The intensity of infection is different depending on parasite load, host species and environmental factors [21]. In spite of these effects, it is possible that some hosts can persist with the parasite following tongue replacement. The organ lost might be partially recovered by offering mechanical assistance in feeding performed by the isopod [7]. This characteristic of not causing instant death in the host, but rather long-term survival, is the difference in this interaction with a lot of other parasitic interactions [19]. Altogether, cymothoid parasites are significant in ecology as they can impact on the trophic relations and fish community structure. Weakening hosts, they make them more susceptible to predation and disease, causing a shift in the energy flow in marine food webs [18,22].

The *Cymothoa exigua* parasite causes pathological effects only in its fish hosts and does not cause foodborne illnesses from consuming infected fish. This parasite is highly specific to its host, affecting fish and not humans. Live individuals may cause minor mechanical injuries such as bites, but they are not toxic to humans [24].

5. Research Gaps and Future Perspectives

Although there was a growing scientific interest in the *Cymothoa exigua*, a number of aspects of its biology, ecology and host-parasite interactions are incompletely understood. The majority of studies provided are devoted to taxonomy, morphology, and distribution records, but little has been done on the molecular, physiological, and immunological studies [19]. Specifically, the processes of host immune responses, parasite adaptation to environmental stress, and ecological consequences of these processes on the marine fish populations need to be studied further [18]. Also, the possible impact of climate change, ocean warming, and habitat change on occurrence and geographical spread of cymothoid parasites has not been well studied. The existing information about the genetic diversity and evolutionary connections of *C. exigua* remains incomplete, although recent developments in molecular phylogenetic analyses have taken place [1]. To comprehend the evolutionary success and ecological importance of this parasite, future studies need to combine molecular methods, histopathological studies, and ecological modeling. Further research on host specificity, population processes, and fishery-associated effects will also help to enhance the strategies of conserving marine biodiversity and managing fish health.

6. Conclusions: A good example of the extraordinary adaptations of parasitic crustaceans is *cymothoa exigua*. It is unique in its tongue-replacement strategy, geographical distribution, and relatively low host specificity, compared with other marine parasites. Although its immediate effect on the health of its host may not be as harmful as that of other ectoparasites, its presence has ecological and economic consequences, especially in commercial fisheries. Further studies on its distribution, interactions with hosts and environmental change will enhance our knowledge of marine parasitism and its overall ecological implications.

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