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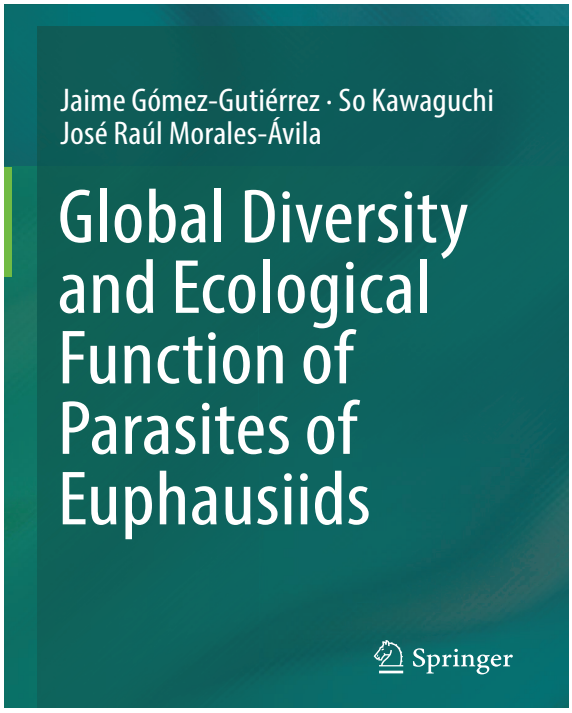
BOOK REVIEW
GLOBAL DIVERSITY AND ECOLOGICAL FUNCTIONS OF PARASITES OF EUPHAUSIIDS Gómez-Gutiérrez, J., Kawaguchi, S., Morales-Ávila, J.R. SPRINGER (2017)

Gómez-Gutiérrez, J.



Diversidad global y funciones ecológicas de los los parásitos de eufásidos

Parasitism is the most common trophic strategy in the planet. About 40% of all organisms on earth (estimated as 8.5 million species) are parasites. Each species interacts with a diverse community of symbionts forming a holobiont. Symbionts range from almost innocuous epibionts to parasitoids that must kill the host to complete their life cycle. Historically the study of parasitism in zooplankton has been conceptualized as incredible rare (quite low prevalence) or even insignificant in the tropho-dynamic function of the marine ecosystem. They may be small but they are considerable more prevalent than previously thought. The function of parasites in the complex food web of marine ecosystems is still being little investigated and therefore little understood.

This book is a comprehensive worldwide review meta-analysis that synthesizes about 130 years (162 publications published between 1885-2017) of Euphausids research on all parasites known of a taxonomically well-known crustacean group called euphausiids (Order Euphausiacea), also known as krill. This group of crustaceans is convenient to study from a parasitological perspective because it only includes 86 extant species, their biogeographic distributions are very well known worldwide, and several species attain huge population biomasses that tend to swarm, attracting a diverse number of predators and also epibionts, pathogens and parasites. The book includes 12 chapters, 42 illustrations (19 in color), and 9 tables. About 26 figures are originals and the rest of the 16 species were taken from previously published articles.

This book provides a fresh perspective on parasites from a historic point of view since 1885, written under an ecological and evolutionary frame of work. This book critically reviews all previously published work of parasites that interact with krill (Order Euphausiacea) updating misconceptions and summarizing the diversity of epibionts, ectoparasites, mesoparasites and endoparasites. As far as I know, there is a scarcity of books about parasites of marine crustaceans that are not targeted on fisheries and aquaculture. Thus, this would be the most complete and integrative monograph of parasites of marine zooplankton and micronektonic organisms worldwide. Krill form immense aggregations and serve as food for multiple planktonic and nektonic predators, playing a crucial role in pelagic food web. Besides, several krill species are also used for human consumption. For these reasons, there is a growing concern about the health issues that krill parasites may impose on other species, including us. This book provides a comprehensive review of publications of parasites of a crustacean order that can extrapolate to potential parasites in other crustacean taxa worldwide.

Parasites employ one of the most ubiquitous and specifically diverse trophic strategies on the planet. Marine pelagic organisms provide numerous ecological microhabitats and thus hold many interspecific, parasitic associations. Considering that each host species interacts with multiple parasite species, and also that several parasites can be parasitized themselves (hyperparasitism), the diversity of parasites that infect planktonic and nektonic organisms likely exceeds the diversity of their hosts. This high parasite diversity challenges us to develop a synthesis, partly to understand the density-dependent control they exert on marine populations. The authors review the current, worldwide knowledge of parasites interacting with crustaceans of the Order Euphausiacea, showing the complex diversity and life cycles of the parasitic species known so far. They usually have broad distributional ranges, and several species form considerably dense social aggregations making large stocks of biomass available for predatory and parasitic interactions.

Parasites have co-evolved in multi-specific associations with euphausiid species, affecting eggs and

almost all euphausiid life stages (so far, no parasites are known to occur in nauplius, pseudometanauplius or metanauplius larval stages). Thus, parasites tend to be more diverse and prevalent in adult euphausiids than in the larval and juvenile phases. Symbiotic interactions with euphausiid hosts range from apparently innocuous epibionts, through ectoparasites, micropredators, internal parasites and castrators to obligatory histophagous killers (parasitoids). Euphausiids interact with 18 types of symbionts: (1) pathogenic chitinoclastic bacteria (on the exoskeleton); (2) gut bacteria; (3) fungi, several protists; (4) epibiont diatoms (Bacillariophyta); endoparasitic dinoflagellates, which infect and kill euphausiid eggs, of the Orders (5) Blastodiniales (particularly of the family Chytriodiniaceae) and (6) Syndiniales; (7) Alveolate mesoparasites of the family Ellobiopsidae (like *Thalassomyces fagei*); (8) epibiont ciliates of the Subclass Suctoria (sessile planktophagous predators); Apostomatida ciliates of the families (9) Foettingeriidae (that feed on the hosts' moults as exuviotrophic ecto-commensals), (10) Opalinopsidae (attached to the euphausiids mouth appendages); and (11) Pseudocollinidae (histophagous ciliates); (12) Apicomplexa of the family Gregarinidae (living in gut and hepatopancreas); metazoan endoparasites (13) Trematoda, (14) Cestoda, (15) Nemathelminta and (16) Acanthocephala; and crustaceans (17) isopods of the family Dajidae, and (18) a Rhizocephalan (a single record, likely an accidental infection). Although microsporidians have been reported as endoparasites of krill, it is now clear they were misidentified, confused with apostome ciliates of the genus *Pseudocollinia*. Thus, microsporidian parasitism has not been confirmed in euphausiids. The discovery of unicellular parasitoids infecting euphausiid eggs (dinoflagellates) and adults (ciliates, *Pseudocollinia*) challenges the paradigm that predation and starvation are the major sources of euphausiid mortality. The very small size, short life span, high reproductive rates and the currently known to be widespread distribution patterns of these parasitoids make them particularly dangerous to euphausiid populations. Exuviotrophic ciliates feed on fluids in euphausiid moults, but their roles in setting sinking rates of moults and carbon remineralisation in the pelagic ecosystem are unexplored. They are potentially significant enough to be included in carbon flux numerical models.

Pathogenic viral infection has never been studied in euphausiids, but it deserves investigation, because viruses cause lethal infections in decapods and other crustaceans. Also, it is necessary to investigate bacterial diversity and pathogenicity to understand their roles in euphausiid health and population dynamics. Parasitic castrators (Ellobiopsidae, helminth worms, and Dajidae) have been recorded from most of the euphausiid species. They typically infect with low prevalence, but current research demonstrates they could be more prevalent than previously thought. Although complete castration does not always occur, the infection can decrease host's fecundity and fitness. Parasitism is favoured by the dynamic social behaviour and wide trophic spectra of euphausiids. A general perspective is emerging that several parasitic species can influence the dynamics of euphausiid populations, as they do in better-studied top predators. Krill are key intermediate hosts for trophically transmitted helminth parasites, which infect cephalopods, teleost and elasmobranch fish, sea birds and marine mammals. The roles of pathogens and parasites in carbon flux through the marine ecosystem deserve considerably more investigation.

Currently, there are records of parasites infecting 49 of the 86 euphausiid species. Euphausiids typically interact with one or maximum two types of epibionts and/or parasites simultaneously in the same individual host. Parasites of the mesopelagic and bathypelagic genera *Bentheuphausia*, *Nematobrachion*, *Tessarabrachion* and *Thysanopoda* are unknown. The most likely near-future advance in studies of euphausiid's parasites will be application of molecular methods (particularly multigenomic or metagenomic) to identify and understand the taxonomy, diversity and phylogenetic associations of euphausiid and their parasites. One major concern focuses on several parasites that infect euphausiids as intermediate (nematodes) or final hosts (bacteria), because they may be potential threats to human health. The authors summarize the potential impacts of these interspecific, symbiotic interactions on the krill life cycle, on their secondary productivity and on the biogeochemical cycles of pelagic ecosystems.

The book includes unpublished information-from research on krill parasites carried out by Jaime Gómez-Gutiérrez after years of research at Oregon, northeast of Mexico, Chile, and Australia. However, the book lacks a chapter on the fate of trophically transmitted parasites that infect euphausiids. In other words, parasitized host must be consumed by predators to infect animals of higher trophic levels. Although the authors discuss aspects of numerically modelling of euphausiid swarming and parasites, as well of novel techniques of molecular technology to detect preys and parasites, the book may deserve an additional chapter discussing in detail these two relevant aspects of investigation of the parasite-krill interactions. This book is directed to graduate students and scientists interested in parasites of marine organisms. The book is currently available at Springer as 1) a book with hardcover, 2) a less expensive printed eBook or 3) sold per chapter electronically requested at Springer webpage: springer.com.shop.

REFERENCE

Gómez-Gutiérrez, J., Kawaguchi, S. & Morales-Ávila, J.R. 2017. *Global diversity and ecological functions of parasites of Euphausiids*. 214 pp. Springer Nature, Switzerland, ISBN https://doi.org/10.1007/978-3-319-41055-5