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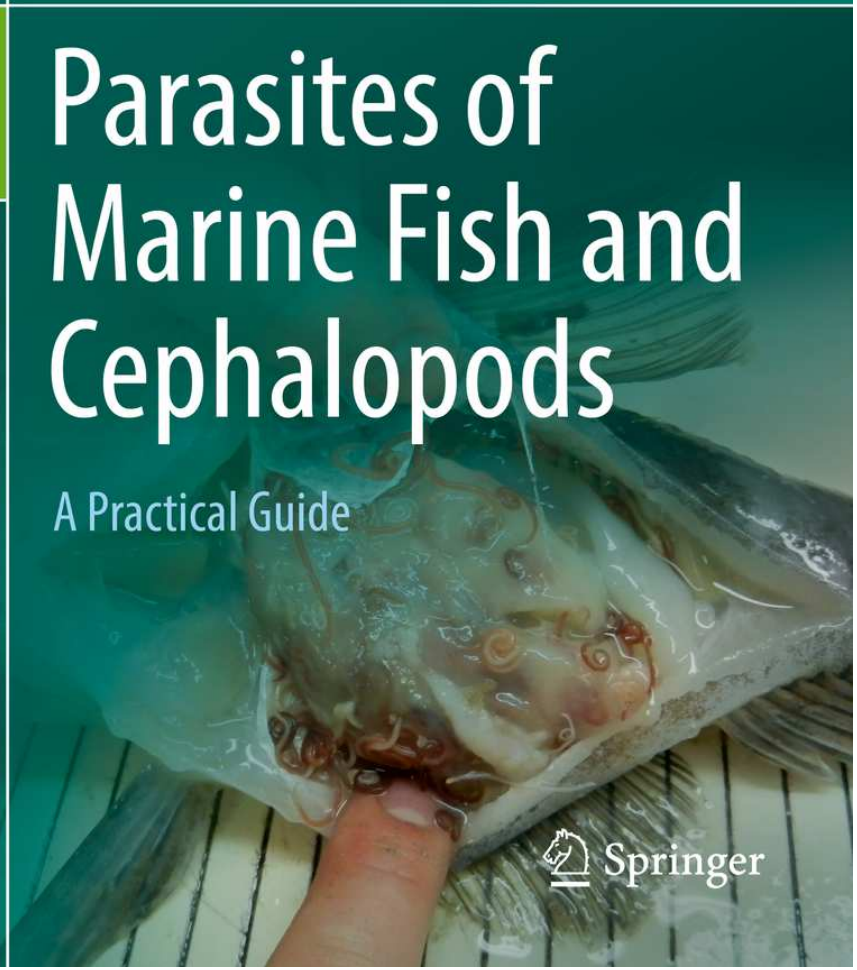
Parasites of Marine Fish and Cephalopods

A Practical Guide



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Preface and Acknowledgements

Parasites are an integral but often neglected part of any ecosystem. It is very likely that nearly every organism gets parasitised, at least temporarily, during its lifespan. According to today's knowledge, it is assumed that more parasitic than non-parasitic organisms exist on earth. The number of marine fish parasites alone is estimated at 20,000–100,000 species. Parasites live inside (endoparasites) or on (ectoparasites) host organisms, using them as a source of nourishment. The damage parasites can cause to the host can be either direct (e.g. mechanical destruction of cells, tissues and organs) or indirect (e.g. withdrawal of nutrients and intoxication). Parasites are also often the cause of secondary bacterial infections. In the field of marine fish parasitology, so-called host–parasite and parasite–host lists exist for certain geographical regions, which provide evidence of the regional differences in parasite diversity in fish and are related to abiotic and biotic factors, e.g. water temperature, salinity, water depth, food and the availability of intermediate and final hosts. Numerous studies have shown that these factors have direct and indirect effects on the marine food web. However, abiotic and biotic factors also affect the parasites as well as their developmental stages directly. This applies to parasites with a direct life cycle, but also to those with an indirect life cycle. The latter require one or more intermediate hosts (e.g. Cephalopoda, Crustacea, Elasmobranchii and Teleostei) for their development to reach sexual maturity in the final hosts. Knowledge of the life cycles of marine parasite species is important to understand and interpret the parasite load of fish. At the same time, parasites can be used as bioindicators, i.e. they can provide detailed information about their hosts and their habitats. Several studies from various areas and regions exist in which the benefits of parasites have been investigated or in which parasites have been successfully used as bioindicators. In fisheries biology, parasites are used to e.g. separate fish stocks or even subspecies of fish species, show migration habits of fish or solve questions concerning the diet of individual fish species and their position in the food web. Parasites are also used to monitor the pollution and eutrophication of water bodies.

Facing a world population of more than 7.5 billion people and an annual increase of about 40 million, the world's adequate food supply presents a major challenge for

the future. In 2005, approximately 80% of the world's population lived in so-called developing countries, mainly concentrated in coastal areas. Fishing has served as a food source for these people for centuries and led, among others, to the current settlement structure. Still today, there are nomadic peoples who build their livelihoods exclusively on fishing. In industrialised countries, the demand for fish and fishery products is also steadily increasing. As the population continues to grow, the pressure on natural food resources such as the sea also increases. Despite highly modern and technologically advanced fishing fleets and fishing gear, it is no longer possible to guarantee an increase in yield which at the same time accounts for a sustainable use of natural resources. The need to develop alternative methods for fish production is therefore becoming more and more apparent. In this context, aquaculture as a growing global industry plays a crucial role.

Due to their central position in aquatic ecosystems and their economic importance, fish are crucial research objects for parasitological studies. Fish is considered of high quality for human nutrition, and the question about the risk potential of fish parasites as pathogens for the fish host as well as for humans is of high scientific relevance. Parasitological work on fish has been intensified worldwide in recent decades, and various research vessels and fishing gear are used for diverse scientific research. Although all host organs can be infected by parasites, the infection of the fish muscles is of particular interest for the fish industry and human consumption. Muscle infection can lead to loss of muscle, which reduces the swimming speed of free-living fish (Richards and Arme 1981; Sprengel and Lüchtenberg 1991; Rohlwing et al. 1998). The consequence is a greater selectivity, for example in trawl fishing, and leads to greater landings of infected fish, which is then offered for consumption on the markets. Furthermore, parasitic diseases have a negative impact on fish farming, resulting in loss of production and a negative impact on the sustainable development of (marine) fish farming.

The consumption of parasitised fish can lead to serious diseases in humans. Diphyllobothriasis and anisakidosis are particularly common diseases in regions where traditionally raw or semi-cooked fishery products are consumed. They are caused by the ingestion of living larval stages of cestode or nematode parasites, which leads to the infection of the human gastrointestinal tract. One of the fastest developing disciplines in this field of research is studying the cause and spread of anisakidosis caused by species of the genera *Anisakis, Contracaecum* and *Pseudoterranova,* which use whales and seals as their final hosts. This disease can occur after the consumption of raw or insufficiently cooked fish (sushi, sashimi). Anisakidosis is currently a serious problem with more than 20,000–25,000 disease cases in humans per year; however, the true infection rate could be much higher due to symptoms that are similar to those of other gastrointestinal diseases. A continuous increase of this zoonotic disease is to be expected worldwide.

The idea for this book emerged from teaching regular courses in parasitology and infection biology at different institutions and universities (especially at the Helmholtz Centre for Ocean Research Kiel, Heinrich-Heine-University Düsseldorf and Goethe University Frankfurt/Main). The need of undergraduate and postgraduate students for a comprehensive presentation of practices and methods in aquatic parasitology was

equally a crucial factor. The content of this book therefore differs from but does not replace textbooks on parasitology or specific literature for the identification of protozoan and metazoan parasites. It is primarily intended for students, doctoral students, applied parasitologists and fish ecologists, employees of the fishing industry with a basic biological understanding, anglers and 'interested laymen'.

The structure of the book is very concise. In the introduction, more general information is given. This includes the presentation of fish and cephalopod morphology and anatomy as well as the most important taxonomic groups of parasites. The main part contains the techniques of dissections and analyses, both accompanied by graphic representations and photographs. At the end of each chapter, the most important information is summarised in boxes and a list of important original papers, review articles and monographs is given as well. Textbooks are only mentioned if they are particularly useful for the respective chapter.

I am grateful to a number of colleagues who have provided information, assistance and other material for this edition. Among them is Dr. Ken MacKenzie (University of Aberdeen, School of Biological Sciences), who has edited this text with a lot of patience, time and expertise. I had invaluable support from creative staff and colleagues during the organisation and textual implementation of the book, and they deserve my sincere appreciation: Birgit Nagel, Gabriele Elter, Dr. Sarah Cunze, Katharina Alt, Sina Zotzmann, Fanny Eberhard (all from Goethe University Frankfurt/Main, employed at the Department of Integrative Parasitology and Zoophysiology), Prof. Dr. Jörg Oehlmann (Goethe University Frankfurt/Main, Department of Aquatic Ecotoxicology), Dr. Horst Karl (Max Rubner-Institut—Federal Research Institute of Nutrition and Food, Department of Safety and Quality of Milk and Fish Products, Hamburg), Dr. Heino Fock (Johann Heinrich von Thünen Institute—Federal Research Institute for Rural Areas, Forestry and Fisheries, Institute of Sea Fisheries, Bremerhaven), Dr. Uwe Piatkowski (GEOMAR—Helmholtz Centre for Ocean Research Kiel) and Dr. Arne Levsen (University of Bergen, National Institute of Nutrition and Seafood Research).

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Frankfurt/Main, Germany Sven Klimpel

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