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**Reproduction in Aquatic Animals:  
From Basic Biology to Aquaculture  
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Reproductive biology is one of the most important research areas in studies of aquatic organisms; it is of considerable importance in aquaculture, rehabilitation and conservation programs (RADKHAH & EAGDERI 2020a). The book *Reproduction in Aquatic Animals: From Basic Biology to Aquaculture Technology* is one of the references that have been published by Springer International Publishing in this field. Given the remarkable approach of this book, which studies the reproduction of aquatic organisms from basic biology to aquaculture technology, we present a review of this publication. It consists

of 17 chapters grouped in 5 parts.

**Part I. Overview.** This section has only one chapter, which briefly examines the reproductive systems in aquatic organisms. It discusses reproductive systems in freshwater and marine environments and refers to the asexual reproductive systems, parthenogenesis, internal or external fertilization, viviparity or oviparity as well as hermaphrodite or dioecious organisms. In addition, this chapter examines reproductive behaviours.

**Part II. Basic knowledge of male gametes in aquatic animals.** Chapter 2 examines the movement of sperm in aquatic organisms. Chapter 3 refers to sperm activation and chemotaxis in invertebrates. Chemotaxis is the movement of a single-celled organism or a cell under the influence of chemical stimuli in the environment. Chapter 4 deals specifically with the maturity, potential and motility of fish sperm. It examines the role of factors affecting sperm motility and activation, especially ionic fractions. In Chapter 5, the authors provide a guide to the characteristics of sperm in teleost fish. They focus on important commercial species and examine the sperm characteristics of various representatives.

**Part III. Basic knowledge of female gametes and sperm-egg interaction in aquatic animals.** This part consists of 6 chapters. Chapter 6 studies the structure of mature oocytes. Egg development is described from the beginning of its development, including oogenesis, primary oocyte, cortical alveolus stage, vitellogenesis, oocyte maturation and ovulation. The authors focus on the structure of mature oocytes, which include egg envelope, yolk mass components and cortical alveoli. In another part of this chapter, the hormonal control of the maturation is studied, which can be very useful from aquaculture perspectives. In the final part of this chapter, the role of environmental factors in the maturation process is discussed but it seems that this issue has not been sufficiently addressed. Given the effects of environmental factors on fish reproduction, it is necessary to explain this section in detail. Fortunately, various studies have been carried out in this field, which the respected authors can refer to complete this section. Chapter 7 introduces important concepts such as gametogenesis, spawning and fertilization in bivalves and other protostomes. The mechanism and processes of fertilization in protostomes (mollusks, annelids and arthropods) are studied. On the other hand, the endocrine system in relation to reproduction in bivalves has been briefly reviewed, with main subheadings reflecting the multiplication of gonial cells, oocyte growth and spawning. Chapter 8 examines reproduction in coral *Acropora*; the characteristics of *Acropora* gametes are mentioned and the stages of egg and sperm development as well as spawning to fertilization are discussed. Chapter 9 examines the self/non-self recognition of gametes in ascidians; although this chapter is short compared to other chapters in the book, it provides specialised and accurate information. In Chapter 10, the authors focus on the reproduction

of chondrichthyans (sharks, rays and chimaeras); in view of the importance of protecting cartilaginous species, information on their reproductive biology can help many conservation and management programs. Fortunately, this issue has been endorsed by the authors and has actually been their main concern. Chapter 11 focuses on the fertilization of amphibians. The authors believe that amphibians do not produce amniotic eggs, so they have to must reproduce in aquatic environment only. The information presented in this chapter is important from biological and ecological perspectives.

**Part IV. Behavior, ecology and reproductive strategies.** Chapter 12 deals with sperm motility and conduction in sea urchins. Chapter 13 examines reproductive behaviour of squids, sperm allocation, sperm dimorphism, sperm behaviour and chemotaxis as well as sperm longevity and metabolism. The question that comes to mind about this section is why the editors did not address reproductive strategies, ecology and behaviour of fish? Given the widespread importance of fish among aquatic animals and their ecological role, it would be very useful to focus on this issue. We suggest including such chapter in future editions.

**Part V. Biotechnology in aquatic species.** The fifth part is a very important section because it studies the role of biotechnology in the reproduction of aquatic organisms. Chapter 14 specifically refers to the improvement and control of reproduction in European eels. The authors state that the stock of European snakefish has declined sharply to the point where it may be identified as endangered. Many experts believe that the reproduction of this species in captivity is the best approach to protect it. The authors review recent research on European eel reproduction, examining factors affecting the sexual maturity of this species. In addition to the effect of environmental variables such as temperature and salinity, they also study the role of nutrition on the maturation. Chapter 15 refers to cryopreservation technology, reviewing the importance of the technology in storing the sperm of aquatic species. We recommend the study of this chapter to aquaculture activists; the authors first state the principles of cryopreservation and then, in a section entitled “cryopreservation of fish sperm”, discuss collecting, storing and determining the quality of sperm, sperm freezing and sperm efficiency. It should be noted that there are two different techniques for cryopreservation of fish sperm, which include conventional sperm and sperm vitrification. The latter approach, which is used as an alternative method for conventional freezing, has been applied in some fish species and has been associated with limited success (XIN et al. 2017). Chapter 16 is one of the most interesting and useful chapters in this book because it examines the germ cell technologies in sturgeon. As sturgeon stocks are particularly endangered in the Caspian Sea, the study of reproductive technologies in these fish can be very useful in order to restore their stocks (RADKHAH et al. 2019; RADKHAH & EAGDERI 2020b). Chapter 17 examines the intraperitoneal germ cell transplantation technique in marine teleost fish – male and female gametes are transferred from one species to another, resulting in the production of both male and female gametes in the gonads of the recipient species. It should be noted that this method has been considered in many countries and has been performed for several endangered species (FARLORA et al. 2014).

The present book, although remarkable in some respects, also has its drawbacks. Unfortunately, this book does not specifically mention the species that are widely cultivated in aquaculture. E.g., the authors specifically examine the reproductive aspects of freshwater fish such as Chinese carps (common carp, silver carp, bighead carp, grass carp), tilapia, salmon (rainbow trout, brown trout) as well as marine fish such as Atlantic cod (*Gadus morhua*) and flatfish (such as flounder, turbot, and halibut). These species are an important part of aquaculture in the world (CAI et al. 2017). Therefore, it is necessary to provide comprehensive information on their reproductive characteristics.

Despite these shortcomings, the book has many strong features. Dedicating a special chapter to sturgeon is commendable, showing the accurate and up-to-date awareness of the editors of the problems and difficulties facing the aquaculture industry. The attention to the conservation aspects of aquatic species is another outstanding feature, with an excellent example being the chapter on reproduction in European eel.

This book can be useful as an effective reference for researchers and students working in the fields of aquatic biology, fisheries and aquaculture. It is hoped that this book will have new editions in the coming years in order to comprehensively address aquatic reproduction issues. It should be noted that the scope is very wide and requires international cooperation between editors and experienced researchers from various countries.

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