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Review

Molecular studies, disease status and prophylactic measures in grouper aquaculture: Economic importance, diseases and immunology

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ABSTRACT

Groupers are potentially important and economically valuable aquaculture species in Southeast Asian countries. Among sport and artisanal fishers is a prized catch demanding lucrative price. Groupers belong to the subfamily Epinephelinae, which include 159 species under 15 genera; they are widely distributed in the tropical and sub-tropical waters of Atlantic Ocean and Mediterranean Sea. Grouper culture was first introduced in the early 1970s in Singapore, Malaysia, Hong Kong, Thailand, and Taiwan, and is now widely practiced throughout Southeast Asia. At present, its production is essentially in the hands of small-scale farmers; however the interest in its larger scale production in offshore systems is gaining momentum. In recent years the global production of groupers has increased tremendously due to its escalated demand with 60,774, 99,378, 163,093, and 198,690 mt in 1990, 2000, 2005, and 2007 respectively. Despite the wholesale premium price of up to US$100/kg groupers fetch in the Chinese live-fish markets in Hong Kong and South China its culture is ravaged by various diseases; for instance the large-scale seed production of groupers continues to encounter increasing difficulties, especially with a host of infectious diseases including various viral, bacterial, and parasitic pathogens and non-infectious (environment, management, and nutritional) disease agents and a number of undiagnosed diseases of unknown origin. Apart from some documented viral problems in Southeast Asia in groupers, little is known about the impact of major diseases that may go beyond direct mortalities and production losses. Immunization with formalin-killed viral and parasitic vaccines increased survival rates and dietary administration of DHA/EPA, L-ascorbic acid, vitamin C and E, sodium alginate, κ-carrageenan yeast, probiotics, and herbals significantly increased the specific and non-specific immune response and protect from diseases. In this review will discuss the available information on infectious diseases and its immune status in grouper culture.

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1. Introduction

Groupers are popular carnivorous fish with a high market demand in many parts of the world, such as in Kuwait, Indonesia, Singapore, Malaysia, Thailand, Philippines, Hong Kong, Taiwan, China, Mexico, Japan, and the USA (INFOFISH, 1989; Brais, 1987). Groupers are ideal candidate species for intensive aquaculture particularly in the Asia–Pacific region because of high consumer demand, desirable taste, hardiness in a crowded environment, fast growth, efficient feed conversion, and rapid growth (Sim et al., 2005; Chen and Tsai, 1994; Millamena, 2002; Boonyaratpalin, 1997; Fukuhara, 1989; Chen, 1990; Kuo, 1995; Kohno et al., 1993). Besides due to overexploitation of wild stock grouper culture is emerging as a viable venture in many countries. However despite its advantages as an ideal candidate species culture is still in infancy with problems like disease management, feed, and seed production; as a new species preferred for intensive culture there is a paucity of molecular studies for many grouper species. Taxonomy, economic importance, culture, production, infectious diseases and its immune status in groupers belonging to the genera *Epinephelus, Cromileptes*, and *Plectropomus* will be summarized in this review.

1.1. Taxonomy and geographical distribution

The family Serranidae and subfamily Epinephelinae, commonly known as groupers, includes 159 species that come under 15 genera, which are distributed world-wide in the tropical and sub-tropical waters; species of the genus Epinephelus, Cephalopholis, Mycteroperca, and Paranthias are present in the Atlantic Ocean and in the Mediterranean sea (Maggio et al., 2005; Heemstra and Randall, 1993; Zhu and Yue, 2008; Boglione et al., 2009). Smith (1971) has given the detailed account of the groupers whereas Heemstra (1991) has completed a taxonomic revision of fourteen species of groupers that occur in the eastern Atlantic Ocean and Mediterranean Sea. Randall and Heemstra (1991) have revised the Indo-Pacific groupers consisting of 110 species. Johnson (1983, 1988), Kendall (1984) and Leis (1986) have been reported the composition and phylogenetic relationships of the family Serranidae. The FAO catalogue is most comprehensive guide to the worldwide distribution of groupers (Heemstra and Randall, 1993).

The RAPD, Polymerase Chain Reaction-Restriction Fragment Length Polymorphism (PCR-RFLP), and Polymerase Chain Reaction-Single Strand Conformation Polymorphism (PCR-SSCP) assays have been used for identification of grouper species and taxonomy (Parenrengi et al., 2001; Govindaraju and Jayasankar, 2004; Asensio et al., 2001). Richardson and Gold (1997) have been developed Mitochondrial DNA variations assay for grouper species identification. Further microsatellite studies also carried out for identification of grouper populations (Stevenson et al., 1998; Nugroho et al., 1998; Sola et al., 1999; De-Innocentiis et al., 2001).

Five species of *Epinephelus* endemic to Eastern Atlantic are present in the Mediterranean Sea; they are *Epinephelus aeneus, E. caninus, E. costae, E. haifensis*, and *E. marginatus*. Besides two species of *E. tauvina* and *E. coioides* are also present in the Mediterranean sea of Indo-Pacific. Another grouper, *Lessepsian migrants* entered the Mediterranean via the Suez Canal from the Red Sea (Ben-Tuvia and Lourie, 1969; Heemstra and Golani, 1993; Parenti and Bressi, 2000; Golani et al., 2002). The genus Mycteroperca (Gill, 1962), is represented by 15 species which usually live on coral reefs and rocky bottoms. In the eastern Atlantic, the genus is represented by two species: *Mycteroperca rubra*, ranging from the Mediterranean Sea to the Bay of Biscay and along the west coast of South Africa to Angola, and *M. fusca* found in Madeira, the Azores and the Canary and Cape Verde islands (Baldwin and Johnson, 1993). *M. rubra* was originally described as *E. ruber* (Bloch, 1973). Jordan and Eigenmann (1988) synonimized *E. ruber* with *M. rubra* based on the number of fin rays, projecting lower jaw, pointed snout and the general features regarding the shape of the body, fins, head, and teeth.

1.2. Economic importance of the groupers

Groupers are economically valuable, making up an important part of the catch of sport and artisanal fishers throughout their distribution (Seng, 1998). About 40 species of groupers occur in the Philippines, where they are caught by small-scale fishermen with hook and line, bamboo traps, or dip net from estuaries and coral reefs (Kohno et al., 1988). Global grouper production increased dramatically in recent years, with 60,774, 99,378, 163,093, and 198,690 mt in 1990, 2000, 2005, and 2007, respectively (FAO, 2005a,b, 2009). Historically the red grouper, *E. morio* constituted the most important finfish fishery in the Mexican territorial waters within the Gulf of Mexico (Albanez-Lucero and Arreguín-Sánchez, 2009). Growth of the fishery has been observed from 1947 to 1972, with the highest yield of about 21,000 mt in the year 2000s (Burgos-Rosas and Pérez-Pérez, 2006). Since then, the wild stock appears to have been depleted; by 2004, the yields were less than 6000 mt. Present stocks are about a third of those estimated in the early 70 s (Doi et al., 1981). In 1995, feral production of groupers reached 27,359 mt from the Philippines, Malaysia, Taiwan, and Thailand; while the total grouper production from the entire South China Sea area yielded 1348 mt from brackish water aquaculture and 771 mt from mariculture (SEAFDEC, 1997). However there is an insatiable demand for groupers as luxury protein. For instance in Spain, dusky grouper is highly appreciated by consumers owing to the excellent properties of the meat. This species is frequently sold around 30–40 €/kg in the market place (Asensio et al., 2009).

1.3. Grouper culture

Grouper culture was first introduced in the early 1970s in Singapore, Malaysia, Hong Kong, Thailand, and Taiwan, and now occurs throughout Southeast Asia (Seng, 1998). In Thailand, grouper farming appears to have begun in the 1980s in Southern Thailand, although a small number of producers have been raising grouper for