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Epinephelus fuscoguttatus mariculture in Indonesia: Implications from fish parasite infections

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HIGHLIGHTS

- Natural fish feed provides route of parasite dispersal.
- Different management practices result in different parasite infection patterns.
- Treatments need improvement to prevent parasite spread and disease outbreaks.

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ABSTRACT

Indonesia plays a major role in grouper supply for the Hong Kong based Live Reef Food Fish Trade. Hong Kong is the biggest consumer of Live Reef Food Fish in the world and around 50% of the grouper originate from Indonesia. In order to match Hong Kong market demands, the Indonesian Ministry of Marine Affairs and Fisheries started to implement plans to intensify mariculture farming, to boost grouper production. One inevitable consequence of this intensification is the increase of fish diseases and parasite infections. Samples of *Epinephelus fuscoguttatus* were obtained from four mariculture facilities in Lampung Bay (South Sumatra) and one in Pulau Seribu (North off western Java), Indonesia, to investigate and compare the parasite composition. In total 35 parasite species were detected. Different ecological parameters e.g. ecto/endoparasite ratio and Shannon–Wiener diversity Index were utilized to analyze the parasite composition at the different mariculture sites. We also recorded the cultivation methods for each facility including e.g. density of fish in the cages and other cultivation strategies. Our results demonstrate that the feeding strategy and e.g. the stocking density of fish in the cages significantly affect the composition of the grouper's parasite fauna. As trash fish, which enables parasite transmission, is still one of the main feed sources, one of the major future tasks is the search for alternative feed sources and feeding strategies to prevent parasite spread and pathogenic outbreaks. Education of the farm management and unified standards for the often small-size producers are required in order to safeguard grouper mariculture development in the future.

1. Introduction

Increasing fish demand, as a result of a growing human population, challenges fish producing countries, companies, and fishermen to enhance fish production worldwide. According to Dey et al. (2008), Asia supplied 60% of the world fish production. Around 13% of their food expenditure is spent to buy fish. With still exponential population growth, capture fisheries and aquaculture production is and will be of increasing importance in the future.

Groupers belong to the most important fish species in Asia (Sadovy et al., 2012). They form the base of the Live Reef Food Fish (LRFF) trade with its major market being Hong Kong, followed by Singapore and China. Indonesia plays a major role in the supply of grouper for the LRFF (Lau and Parry-Jones, 2000; Pet-Soede et al., 2004; Johnston and Yeeting, 2006). In 2012, 87% originated

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from capture fisheries and only 13% from mariculture facilities (Ministry of Marine Affairs and Fisheries, 2013). In 2009, the Indonesian government declared the ambitious vision to become the main producer of aquaculture-raised fishes until 2015 under a new fisheries policy (Ministry of Marine Affairs and Fisheries, 2010). The Indonesian Ministry of Marine Affairs and Fisheries (MMAF) is implementing a variety of activities to support the country wide grouper production, involving fisheries, mariculture and stock enhancement (Yulianto et al. 2015).

The grouper production increased significantly since 2001, when MMAF and private hatcheries started providing fingerlings for mariculture (Sugama et al., 2013). Moreover, the harvest doubled from 2009 to 2010 based on the new fisheries policy (Ministry of Marine Affairs and Fisheries, 2013). However, the intensification of mariculture has several constraints. From a fish health point of view these are viruses, bacteria, fungi, and parasites (Zafran et al., 1998; Koesharyani et al., 2001; Bondad-Reantaso et al., 2005). The latter group has been the focus of several studies due to their implications for fish disease outbreaks, food safety and functions as biological indicators for e.g. environmental change and fish health (Leong, 1997; Jakob and Palm, 2006; Palm, 2011; Palm et al., 2011; Kleinertz and Palm, 2015; Kleinertz et al., 2014). Fish parasites of the most popular grouper species (e.g. *Cromileptes altivelis*, *Epinephelus areolatus, E. fuscoguttatus*) from tropical marine waters have been of special interest in recent years (Kleinertz and Palm, 2015; Rückert et al., 2009a,b, 2010).

Indonesia's coastal region comprises one of the highest levels of aquatic biodiversity on earth (Veron et al., 2009; Palm, 2004). This includes, beside many other organisms, fish species as well as their parasite fauna, but only about 4% of the estimated fish parasite fauna in Indonesia has been explored (Jakob and Palm, 2006; Kleinertz and Palm, 2015). Since the 1980's several authors have worked on parasites (mainly ectoparasites) and diseases of groupers from mariculture facilities in Indonesia (e.g. Diani, 1989, 1992, 1995, Diani and Rukyani, 1990, Diani et al., 1993, 1996, 1999, Asmanelli and Partasasmita, 1992, Asmanelli et al., 1993, 1994, Koesharyani et al., 2001, 1998, 1999a,b, Kurniastuty and Hermawan, 1998, Bu et al., 1999, Kurniastuty et al., 1999, 2000, Wijayati and Djunaidah, 2001, Zafran et al., 1998, 1997, 2000, Akbar and Sudaryanto, 2001). More recent studies on parasites from cultured groupers focused on protists (e.g. trichodinids) and metazoans (ecto and endoparasites) (Palm et al., 2011; Rückert et al., 2009a; Rückert, 2006; Kleinertz, 2010). So far, nine different epinephelid species belonging to three different genera (*Epinephelus*, *Cromileptes*, *Plectropomus*) were studied from Indonesian mariculture facilities.

Factors that can influence the occurrence of parasites inside mariculture facilities are: fish density, environmental conditions and water quality (e.g. temperature, salinity, pH), fish handling, nutrition, feed source, feeding pattern, and also parasite-/host-species relationships (South East Asian Fisheries Development Centre, 2001; Rohde, 2002). High stocking densities provide excellent conditions for the spread of monoxenous ectoparasites that are transferred directly from fish to fish (Balasuriya and Leong, 1994). Farmers using locally caught trash fish as feed for valuable fish species can promote transmission of parasites from surrounding areas into the mariculture facilities (Rückert et al., 2009a). In general, managers of mariculture facilities and fish farmers have a big influence on possible parasite infections through their choice of holding conditions, feed source and treatments, which is mainly based on their experience, but also on economic efficiency and profitability. There is the need for rapid diagnostics and information transfer to allow quick and correct treatment after the infection of cultured fishes with parasites has been detected.

The aim of this study was to examine possible impacts of different management methods and feeding strategies commonly used in Indonesia on the parasite compositions of cultured groupers from several mariculture facilities in Lampung Bay and Seribu Islands (Pulau Seribu), Indonesia, and to identify possible threats for grouper mariculture. In addition, we summarize all available information on fish parasites from Indonesian grouper mariculture, including parasite species, site of infection, locality, and when possible prevalence of infection. This has direct implications for the available grouper quality on international markets that originate from Indonesian mariculture facilities.

2. Materials and methods

2.1. Fish samples and parasitological examination

Samples were taken at different mariculture facilities in Indonesia (Fig. 1): in Lampung Bay (South Sumatra) during dry season in 2003 and rainy season 2003/04 and at Pulau Seribu (North off western Java) during rainy seasons 2003/04, 2010/11 and 2011/12. A total of 175 specimens of *Epinephelus fuscoguttatus* were studied from Lampung Bay and 105 specimens from Pulau Seribu (Fig. 1, Table 1). According to total length of fish and the growth parameters of wild *Epinephelus fuscoguttatus*, all fish samples were between 4 and 6 months (less than 1 year) of age, and all individuals within a sample were transferred to the facilities as small fingerlings of the same age/size.

The fish were examined directly after collection from the net cages, timed to not collide with any recent freshwater treatment, to avoid an underestimation of ectoparasites such as Monogenea. Total fish length (TL) and weight (TW), were measured to the nearest 0.1 cm and 0.1 g (Table 1) prior to the parasitological examination (see Rückert et al., 2009a). The skin, fins, eyes, gills, mouth and gill cavity were studied for ectoparasites. The inner organs (digestive tract, liver, gall bladder, spleen, kidneys, gonads, heart and swim bladder) were separated and transferred into saline solution for examination under a dissecting scope. Isolated parasites were fixed in 4% borax-buffered formalin and preserved in 70% ethanol. Finally, the musculature was sliced into 0.5–1 cm thick filets, pressed between two petridishes and examined on a candling table to identify and isolate parasites from the musculature. For identification purposes, Nematoda were dehydrated in a gradated ethanol series and transferred into 100% glycerine through the evaporation techniques described by Riemann (1998). Digenea, Monogenea and Cestoda were stained with acetic carmine, dehydrated, cleared with eugenol and mounted in Canada balsam. Crustacea were dehydrated and transferred into Canada balsam. Parasite identification literature included original descriptions (details see Palm et al., 2011). Trichodinid ciliates were not identified to the species level.

2.2. Parasitological parameters

Different ecological parameters were evaluated to indicate regional differences, such as the diversity indices Shannon–Wiener and Evenness, fish ecological indices like Hepatosomatic Index (HSI), and parasitological parameters like ecto–endoparasite ratio (Ec/En ratio) and prevalence of infection of different parasite taxa (Palm et al., 2011; Kleinertz and Palm, 2015; Kleinertz et al., 2014; Palm and Rückert, 2009).

The parasitological terms follow Bush et al. (1997): prevalence (P) is the number of infected fish with one or more individuals of a particular parasite species (or taxonomic group) divided by the number of hosts examined (expressed as a percentage); intensity (of infection, I) is the number of individuals of a particular parasite species in a single infected host (expressed as a numerical range); mean intensity (of infection, mI) is the average intensity, in other