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REVIEW ARTICLE

A Brief Overview of Population Biology of Mangrove Fisheries in Malaysia

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Abstract

One of important habitat for estuarine fish and their juvenile are mangrove areas, as hundreds of studies had been conducted since 1950s until now to assess and understand the distribution and diversity of them over there. The study of population biology in tropical and sub-tropical mangrove estuaries nowadays have reached new level of achievement where they contribute significantly in the socio-economic field. So, the main objective of this paper are briefly described and reviewed some aspects of population biology (such as distribution and diversity) of mangrove fisheries in Malaysia. In the making of this paper, literature materials from the past such as scientific journals, reference books and online statistics related to mangrove fisheries were collected and referred. Species diversity and distribution of fish is one of the most important aspects in stock assessment of mangrove fishes as it provides a brief information on the composition of fish species and their populations. Overall, the information from this paper can be shared with the concerned authorities and researchers for management purposes and population studies to a greater extent.

Keywords: Population, biology, mangrove, fish, Malaysia

Introduction

Apart from being useful to human for aquaculture, forestry and agriculture, mangrove areas are proved by many environmentalist and researchers as suitable home to numerous branches of fauna communities either aquatic or terrestrial (Nagelkerken et al., 2008). The example of fauna organisms is as follow; birds, amphibians, reptiles, elasmobranchs, insects, crustaceans, macrofauna, meiofauna and sponges (Lugendo et al., 2007). Those organisms had been extensively studied by many mangrove scholars in order to better understand their role and value in mangrove ecosystem, but none of them have elaborately conducted detail and comprehensive study on fish fauna, especially bony fishes (Dorenbosch et al., 2007). Basically, the bony fishes that live in the mangrove estuary are hardy and can highly adapt to various environmental factors (Hogarth, 1999) with the majority of the species can be found in Indo-West Pacific region.

As one of the countries that strategically reside in the equatorial and tropical region, Malaysia is indeed blessed with all sorts of flora and fauna in terms of numerous types of forests together with the high diversity of animals that thrive there. Mangrove forests, which can be found predominantly alongside coastal line of Malaysia, is one good example of important ecosystem, with an estimated total area of estimation of about 577,500 ha comprising of Peninsular Malaysia 104,200 ha (18%), Sarawak 132,000 ha (23%) and the highest coverage of this forest goes to Sabah with a roughly estimation of total area is about 341,000 ha (59%) (Faridah-Hanum & Ibrahim, 2015). Compared to the other forests which are generally utilized as timber or logging sites, the mangrove forests in Malaysia are fairly known for fisheries production, with the total annual production derive mainly from Peninsular Malaysia (about 70%), which has developed and sometimes over-developed mangrove fisheries rather than East Malaysia (Sabah and Sarawak), constituting 30% of total fisheries catch (Chong, 2005).

Based on the importance of mangrove fisheries toward human and environment in many aspects, the main objective of this paper are specifically described and reviewed some aspects of population biology (distribution, diversity, population parameters and feeding habit) of mangrove fisheries in Malaysia and other countries. In the making of this paper, literature materials from the past 20 years such as scientific journals, reference books and online statistics related to mangrove fisheries in Malaysia and other countries were carefully collected and referred. Thus, the information from this paper can be shared with the concerned authorities and researchers for management purposes and population studies to a greater extent.

Results and Discussion

Fish Classification

There are numerous types of classification of the fishes in the mangrove estuary. One of them is the classification of where they come from or originate. The bony fishes in the mangrove estuary can be divided into four main categories, namely, estuarine species (sub-tropics and tropics), marine migrants from the sea, anadromous species and freshwater migrants (Glaser, 2003). Among them, the estuarine species that come from the tropical mangrove estuary are believed to have the highest number with the estimation of 600 species that had been identified so far by mangrove ichthyologists (Baker and Sheaves, 2005). As for now, the tropical mangrove estuaries in the Indo-West Pacific region have the highest diversity of estuarine species as these places are very good in terms of ecological and geological characterizations (Vance et al., 1996).

For the fishes that are originated from the sub-tropical mangrove estuary, the occurrences and diversity of the species are generally less than their tropical counterparts due to the low variety of interactions between abiotic and biotic elements over there (Fry & Ewel, 2003). Engraulids, gobies, atherinids, ambassids, syngnathids and clupeids are some fishes that are significantly important and major in this area (Nagelkerken et al., 2008). One of special features of species that live in there is that they can be more clearly classified in term of adaptation towards salinity (euryhaline or stenohaline), as in sub-tropic region. This water parameter is recognized by many researchers to be principal factors in regulating the composition of fishes (Blaber, 2000).

Species Distribution and Diversity

Throughout the studies, many policies about the conservation of mangrove estuaries can be implemented as the status of fish assemblages over there will be revealed (Sheaves, 2005). Overall, there are five geographic zones worldwide where the study area of fish population had been and are commenced; the Americas (south, north and central), West Africa, East Africa, Australasia (Australia, New Zealand and islands countries of Pacific Ocean), and last but not least, South and Southeast Asia (Blaber, 2000).

In Americas region, the mangrove areas are divided into two main zones; one zone is facing Atlantic Ocean (Tropical West Atlantic) and another one is adjacent to Pacific Ocean (Tropical East Pacific) (Nagelkerken et al., 2000). The mangrove areas of Tropical West Atlantic commonly extend from northern South America to the Gulf of Mexico, with several areas such as Mississipi delta region (USA), Tortuguero estuary (Costa Rica), Guaratuba Bay (Brazil), Sinnamary estuary (French Guiana), Orinoco system (Venezuela), Laguna Madre (Texas, USA), and Terminós Lagoon and Campeche Sound (Gulf of Mexico), are among the main study sites for fish distribution and diversity (Faunce & Serafy, 2006). Meanwhile, Rio Claro (Costa Rica), the coastal lakes of Guerrero State (Mexico) and Jiquilisco Bay (El Salvador) are the main study sites in Tropical East Pacific (Sedberry & Carter, 1993).

The mangrove estuaries in the West Africa (Tropical East Atlantic) remain to be under presented in terms of study about fish assemblages due to the remoteness and lack of logistic facilities (Kimani et al., 1996). However, numerous efforts had been done to solve this matter and as for now, researchers already came for stock assessment of fish at several mangrove estuaries of West Africa, such as Elichi Creek (Nigeria), Niger Delta (Niger), Nigerian Coast (Nigeria), Dubreka and Tabunsu Estuary (Guinea), and Lagos Lagoon (Nigeria), Ebrié Lagoon (Ivory Coast), Fatala Estuary (Guinea) (Dankwa & Gordon, 2002).

The mangrove areas of East Africa cover South Africa eastwards, including islands in Indian Ocean (Lugendo et al., 2005). Gazi estuary and bay (Kenya), Morrumbene estuary (Mozambique), Kosi estuary (South Africa and Mozambique), the St Lucia estuary and Mhlanga estuary in KwaZulu-Natal (South Africa), and Taitinga River estuary (Comoro Islands) (Faunce & Serafy, 2006), are some of the examples of mangrove estuaries over there that had been studied by mangrove scholars.

For mangrove researchers, the Australasia region, especially in Australia itself, is known to be popular for high impact mangrove fisheries study (Blaber, 2000). Over there, there are several reputable establishments or institution that are dedicated toward this topic. The example of study areas of mangrove fisheries in Australia are as follows; Trinity Inlet System, Moreton Bay, Serpentine Creek, Botany Bay, Alligator Creek, Leanyer Swamp, Embley River and Estuary, Gulf of Carpentaria, Raby Bay and Tin Can Bay (Sheaves, 1998). Apart from Australia, other countries from Australasia region also have their own share of research sites such as; Wairiki Creek (Fiji), Saint-Vincent Bay (New Caledonia) and Solomon Islands (Blaber & Milton, 1990). Overall, when comparing to other regions, the fishes and their juveniles in the mangrove waters of Australian region are mainly composed of marine and estuarine (brackich) species, with little contribution from freshwater species (Laedsgard & Johnson, 1995).

The South and Southeast Asian region of mangrove estuaries can be assumed as highly diversified mangrove ecosystems on earth as they contain hundreds of fish species, apart from countless number of other terrestrial and aquatic organisms (Nagelkerken et al., 2008). This region covers Japan and China to the northeast, Pakistan to the west and including Indonesian and Malaysian Archipelago Islands (Sasekumar et al., 1992).

As for Malaysia itself, notable examples of mangrove areas in Peninsular Malaysia that are renowned for fisheries activities are Matang Mangrove Forest Reserve in Perak with a handful numbers of artisanal and commercial fishermen that live over there (Affendy & Chong, 2006). To this date, there were numerous studies pertaining toward Mangrove fisheries in Matang, mainly revolved around fish composition and distribution. The estuarine fish composition in the Matang mangrove estuaries was first explained by Khoo (1990) when a total of 44 fish species were observed during a one-year study. Then, the study by Sasekumar et al. (1994) managed to identify 117 fish species in a extensive three and half year of study by recording the fish composition in mangrove channels and adjacent mudflat areas with nearshore waters. The mangrove channels of Matang were predominated by seven fish families, namely Ambassidae, Sciaenidae, Clupeidae, Engraulidae, Scatophagidae, Ariidae and Leiognathidae. Hayase and Muhammad Fadzil (1999) observed a total of 142 fish species in a two-year study of Matang mangrove estuaries. Later,

Chong (2005) reported a total of 138 fish species from Matang mangrove channels after taking into consideration the synonyms of taxa used. Apparently, the fish in Matang area utilize the mangrove channels and adjacent mudflats as breeding and / or nursery grounds, (Sasekumar et al., 1994). Apart from Matang, notable location of fish composition and distribution study in mangrove fisheries of Malaysia can be found at Sungai Pulai Estuary, Johor (Chong & Sasekumar, 2012), Sungai Merbok Mangrove Forest Reserve, Kedah (Zainal Abidin et al., 2021), and Klang Islands Mangrove Forest Reserve, Selangor (Rozainah et al., 2018). From this, it can be said that many studies have been carried out to elucidate mangrove and adjacent mudflats in various field of fisheries, yet it is still not enough in covering the whole area of mangrove in Malaysia. The lack of fisheries studies in mangrove areas are mainly due to the demands of sufficient sampling (to counter the problem of patchiness), the time-consuming examination of fish samples, and a very long time is required to analyze the data.

Production and Productivity

Commonly, the yield of fish catches from the mangrove waters worldwide are counted as tonnes landed per km^2 per year (Blaber, 2000). Majority of the reports about the catch production show that there is distinguished variability of the results due to several factors such as different methods of estimating catches and numerous ways of preparing fisheries statistics among researchers (Nagelkerken et al., 2007). Furthermore, the data of the reports usually come from big mangrove waters because they contribute a lot in supplying yield data of mangrove fisheries compared to the small ones (Meynecke et al., 2008).

The reported values of mangrove fish catch from tropical and sub-tropical countries show some differences especially in term of yield patterns. Apart from the total catch, the biomass (also in tonnes per km2) of the fish from the mangrove waters worldwide are also greatly differs in range (Meynecke et al., 2008). Overall, majority of previous studies from various mangrove estuaries obviously showed that the tropical mangrove areas had higher fish productivity than their sub-tropical counterpart due to several factors such as low depth, high exchanges of nutrients from the upstream and large concentration of vegetation's which are located in and adjacent areas of mangrove estuaries (Faunce & Serafy, 2006). As for Malaysia, the landings of mangrove fisheries for the recent years (2008 – 2017) constitute less than 1% of total fish of the whole country. It is imperative that more studies about the production and yield of the mangrove fishes can be done in the future to understand the linkages between tidal mangroves and fish distribution (Alongi, 2002).

There are several important factors in influencing the catch rate of the fishes in the mangrove areas. One of them is the geographical features, wherein the catch quantity in the tropical mangroves is is usually far higher than their sub-tropical counterparts due to the high distribution and diversity over there (Cappo, 1998). Human factors such as fishing efforts and types of fishing gears also determine the fish production (Blaber, 2000). For example, the fish yield from mangrove waters that have numerous commercial fishing activities seem to show highly positive trend compared to the ones that only enjoy little intensive fishing with subsistence and artisanal fisheries as the main principal of catch efforts (Alongi, 2002). The use of active fishing gears such as trawl net in commercial fishing activities yield both adult and juvenile fish indiscriminately. Thus, the catch rate will be much higher than using passive fishing gears such as gill net and trap that yield only specific size of fish based on the mesh size. Hence, the government policies (such as fishing rules and procedures in the conservation of mangrove forests) are the other miscellaneous element that can influence the fish production in the mangrove estuaries (Spalding et al., 1997).

Issues of Mangrove Fisheries

Shrimps, mainly from penaeid family, are the prized catches for local communities as they constitute higher marketing prices and demands, although there are numerous species of valuable

fish and crab that are also available abundantly in the mangrove waters (Kiso & Mahyam, 2003). Meanwhile, aquaculture activities, especially the culture of oyster by attaching the spat at submersible poles, and the culture of finfish (grouper and catfish) in the cage are becoming trendy and popular day by day for nearby residents of mangrove areas as they realized that they cannot sustain their living by only continuously and solely relied on fishing activities (Alongi, 2002).

Therefore, one of issues that usually arise pertaining to hamper and disturb the management of mangrove fisheries in Malaysia is the constant declination of commercially fish stocks due to various reasons as followed; Mangrove clearance for aquaculture purpose, particularly the opening of shrimp farms, can be hazardous toward mangrove ecosystem for long term of time as those farms are generally built in large scale and often involved with massive mangrove deforestation (Faridah-Hanum & Ibrahim, 2015). Additionally, the use of chemical materials in the shrimp ponds to enhance production can also be a major cause in badly changing the quality of mangrove soils, as happened in many parts of mangrove areas in Malaysia (EIA, 1997). Apart from that, other common reason for lower yield of catch is the occurrence of over-fishing that come mainly from commercial fishing, which use destructive gears such as trawl net and push net to get large hauls in shorter time (Ahmad Adnan et al., 2002). The Department of Fisheries (DOF), on behalf of the federal government, had taken several necessary actions in combating this situation in Malaysia by restricting the fishing areas for using boats and limiting the issuance of fishing licenses for commercial operators (Shaharuddin et al., 2004).

The mangrove fishes are considered important and popular in contributing highly diversify species of flora and fauna, apart from maintaining food chain and energy flow of them (FAO, 2007). Evidently, numerous studies from different kinds of related topics such as mangrove vegetation, marine and terrestrial fauna, water quality and characteristic, macro and micro-organism, and, socio-economy of people that are resided in or nearby mangrove estuarine areas, had been done in the past (Alongi, 2002). Those studies suggested or concluded that the mangrove fishes are among the most productive in the world in term of catch production.

It is also well known to most aquarist that mangrove area plays important part as major breeding area for numerous marine and freshwater fish species. Unfortunately, many mangrove researchers agree that overfishing (catching the fish beyond the maximum sustainable yield) is the main culprit of severing the production of fish in the mangrove areas (Verweij et al., 2006). Commonly, this kind of problem is more affecting the developing countries than developed nations as their governments (including policymaker and enforcement authority) are not sufficient enough in terms of knowledge and financial to manage this issue (Laedsgard & Johnson, 1995). Overfishing in the mangrove waters can disturb the life cycle of the fish by three ways, either by ecosystem or growth or recruitment (Dorenbosch et al., 2007).

In order to solve these problems, care of managing mangrove fishes must be taken. Managing fisheries stocks, especially in the habitat that are richly abundance with all kinds of aquatic organisms such as estuarine areas, could be complex with the need of many efficient strategies and policies to sustain ideally socio-political objectives (properties and job opportunities), economic features (investment maximization), and, ecological approach (stock conservation) (Blaber, 2000). Hence, the comprehensive and sustainable management of mangrove estuaries, either in the developing or developed countries, has evolved continuously and systematically according to yield production and socio-economic status of respected countries (Mumby, 2006). Coincidently, the information about the implementation of fisheries management for both types of nations is generally obtained from the study.

Conclusion

Nowadays, the exact status of estuarine fish stocks in Malaysian waters and are still in a doubtful state (either under-exploited or over-exploited). The lack of research on the estuarine ecosystem

seems to be the major cause for this problem. Thus, the implementation of population biology study (the identification, species diversity, population dynamics and trophic level) of fishes in the estuarine area can contribute significantly towards the improvement of the fisheries management in mangrove areas. By having extensive information, only better management procedures can be applied to the exploitation of this resource.

The information from this paper will not only be useful for the improvement of the present fisheries but also for unexploited stocks. Furthermore, from the output from this paper, numerous further details of study on estuarine fishes are needed for better fisheries management in the estuarine waters. There is a possibility of managing an enormous stock of fishes in estuarine waters through detailed studies on population dynamics, stock assessment as well as trophic links. Other field of study toward estuarine fishes such as genetic, aquaculture and biotechnology can also suitable in developing the sustainable stock of fish in mangrove areas, thus, ensuring high availability of fish as main source of nutrient and income to local community.

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