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Review of Some Biological Aspects and Fisheries of Grey-Eel Catfish *Plotosus canius* (Hamilton, 1822)

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ABSTRACT

Plotosus canius, the grey-eel catfish belonging to the family Plotosidae is endemic to the south-east Asia and Australia. Primarily the fish is found in marine environment but at times may be found in brackish or fresh water environments. Despite the vast research that have been conducted on various catfish species, both marine and freshwater; little attention has been paid to *P. canius*. This study reviewed published information on the distribution, biology and fisheries of this economically important fish species.

Key words: Grey-eel catfish, *Plotosus canius*, fish biology, fisheries, marine environment

INTRODUCTION

The Grey-eel catfish, *Plotosus canius* (Hamilton, 1822) is a member of the family Plotosidae. Primarily it is found in marine habitat but sometimes can be caught in brackish or fresh water habitats (Riede, 2004). The fish according to Kottelat (2001), occur in coastal seas and fresh or brackish waters. Juveniles are mostly found to be densely aggregated and form very tight shoals with about 50 juvenile fish (Mohsin and Ambak, 1996). *P. canius* has been found to live on or near the bottom of the sea and migrate between sea and fresh water (Riede, 2004). The fish is important both commercially, being sold fresh in the market (Mohsin and Ambak, 1996; Gomon, 1983) and also as a source of food. Osman *et al.* (2001) reported it to be among the ten fish from marine waters that are preferred to be eaten daily by Malaysians and mentioned it among others as good source of marine Polyunsaturated Fatty Acid (PUFA), hence recommended that the fish when served 2-3 times per week is sufficient enough to supply the required level of PUFAs; with no need of any supplementation. Nurnadia *et al.* (2011) mentioned *P. canius* to be among the five fish that are commonly consumed from Malacca Straits of Malaysia. Though high content of fat was reported in the fish but the level of dioxins (PUFAs) and furans (PCDFs) was found to be safe for human consumption. The fish is highly priced and good for eating but avoided just because of its poisonous spines (Gupta and Gupta, 2006).

There is need of increasing concern on reproductive biology in marine fish, as this becomes very useful to get accurate estimate of the effect of fishing on the potential of reproduction of any fish (Mace, 1994; Murawski *et al.*, 2001). To manage any fish species knowledge of reproduction and feeding has become necessity (Rahman *et al.*, 2011; McAlhster *et al.*, 2000). There have been

several studies on reproductive biology (Khan *et al*., 1990; Dobriyal and Singh, 1993; Marriott *et al*., 1997; Solak *et al*., 2001a; Ahmed, 2004; Alp *et al*., 2004; Gomes and Araujo, 2004; Marcano *et al*., 2007; Offem *et al*., 2008; Muchlisin and Azizah, 2009; Gomes *et al*., 2011) and feeding ecology (Marriott *et al*., 1997; Solak *et al*., 2001b; Sreeraj *et al*., 2006; Offem *et al*., 2008; Prasad and Ali, 2008; Kadye and Booth, 2011; Alhassan and Ansu-Darko, 2011; Amin *et al*., 2009) of various marine and freshwater catfish species, however, far too little attention has been paid to the marine catfish, *P. canius*. Also, a few studies on *P. canius* on its reproductive biology and feeding habit have recently been carried out by few researchers (Ahmed and Haque, 2007; Khan *et al*., 2002; Sinha, 1981, 1986a). Though, the status of this fish has not been evaluated in the IUCN Red list (IUCN, 2011), Mijkherjee *et al*. (2002) reported it being among the thirty-nine fishes that are likely to become extinct in their native habitat in West Bengal, India. Also Mukhopadhyay (1994) listed it among other estuarine species of India that are vulnerable and facing extinction in the near future. Apart from the above mentioned studies, so far there have been no publications on the morphometric characteristics of this fish, in fact not any on its reproductive biology and feeding ecology from the waters of these countries where the fish is found. This review is therefore set out with the aim of reviewing literature on distribution, some aspects of biology and fisheries of *P. canius*.

Family plotosidae: These are referred to as "Catfish eels". Members are characterised by elongated body that is compressed and tapers towards the tail end. Two dorsal fins present; the first bearing strong serrated spines, while the second is long and confluent with the caudal fin. The anal fin is also confluent with the caudal fin while the pectoral fin also possesses strong and serrated spine. The first dorsal and pectoral fin is associated with production of poisonous substances (venom). A complete lateral line is present (Gupta and Gupta, 2006; Mohsin and Ambak, 1996).

This family is generally known to be represented by two species *P. canius* and *P. lineatus* but in recent years, nine species were described. These include: *P. canius* (Hamilton, 1822), *P. abbreviates* (Shinkafi and Daneji, 2011), *P. fisadoha* (Ng and Sparks, 2002), *P. japonicas* (Yoshino and Kishimoto, 2008), *P. limbatus* (Valenciennes, 1840), *P. lineatus*, Stripped eel-catfish (Thurnberg, 1787), *P. nhatrangensis* (Prokofiev, 2008), *P. nkunga* (Gomon and Taylor, 1982) and *P. papuensis* (Weber, 1910). But this review mainly focuses on *P. canius* (Hamilton, 1822), as focusing on other species is beyond the scope of this review.

Distribution of *P. canius*: The distribution of *P. canius* shows that the fish is native to South-east Asia and Australia. According to Mohsin and Ambak (1996), it is found in India, Sri Lanka, Bangladesh and extending eastwards to Malaysia, Thailand, the Philippines and Papua New Guinea. While, Ferraris (2007) stated that *P. canius* originates from coastal regions of Thailand, Sulawesi, Moluccas and India and into the lower Mekong River. The fish is found in the Indo-West Pacific, West and South coasts of India and off Sri Lanka eastward along the coast of Bangladesh and Myanmar, through the Indo-Australian Archipelago and the Philippines as far as Papua New Guinea (Table 1, Fig. 1).

Taxonomy and identification key: *Plotosus canius* belongs to the phylum: Chordata, sub-phylum: Vertebrata, class: Actinopterygii; sub-class: Neopterygii, super order: Scopelomorpha, order: Siluriformes, family: Plotosidae, genus: *Plotosus* and species: *canius*. It can be distinguished from other species of Plotosidae by possessing a long nasal barbel which extends well behind the eye and almost reaching nape. Also stripes are absent on the body (Mohsin and Ambak, 1996).

Table 1: Distribution and occurrence of *P. canius* in different countries

Country	Occurrence	References
Andaman Island	Native	Rajan *et al.* (2011)
Australia	Native	Hoese *et al.* (2006)
Bangladesh	Native	Rahman (1989)
Brunei	Native	Gomon (1983)
Cambodia	Native	Gomon (1983)
Fiji	Native	Seeto and Baldwin (2010)
India	Native	Talwar and Jhingran (1991)
Indonesia	Native	Gomon (1983)
Laos	Questionable	Kottelat (2001)
Malaysia	Native	Mohsin *et al.* (1993)
Myanmar	Native	Gomon (1983)
Papua New Guinea	Native	Kailola and Hoese (1991)
Philippines	Native	Gomon (1983)
Singapore	Native	Gomon (1983)
Sri Lanka	Native	Gomon (1983)
Thailand	Native	Suvatti (1981)
Vietnam	Native	Nguyen and Nguyen (1994)

Fig. 1: Distribution of *P. canius* in the world

External morphology: Externally, body is long, sub-cylindrical and eel- like which tapers and flattens near the tail region (Gupta and Gupta, 2006). The fish measures between 50-80 cm total length and maximum size can reach up to 150 cm (Gomon, 1983; Mohsin and Ambak, 1996). It appears plain dusky-brown in colour with darker fins (Kuiter and Tonozuka, 2004). Upper region of the body and head is dark olive green, while pale at its ventral region. Barbels and fins are grey, while the first dorsal and pectoral fin appear darker and are associated with serrated spines that are found to be poisonous (Gupta and Gupta, 2006; Mohsin and Ambak, 1996). Second dorsal fin is very long and confluent with the caudal fin; anal fin also merged with the caudal fin. A complete lateral line present and a dendritic organ, posterior to the ventral fin and near the genital pore is present (Fig. 2), the function of which is still not revealed. Head is large, broad, depressed and covered with a thick skin. It bears small eyes and four pairs of long barbels (nasal, maxillary and a pair of mandibular barbels). Skin does not bear scales (Mohsin and Ambak, 1996). The mouth which is comparatively small with a transverse gape is inferior, fleshy and papillated (Fig. 3). Upper

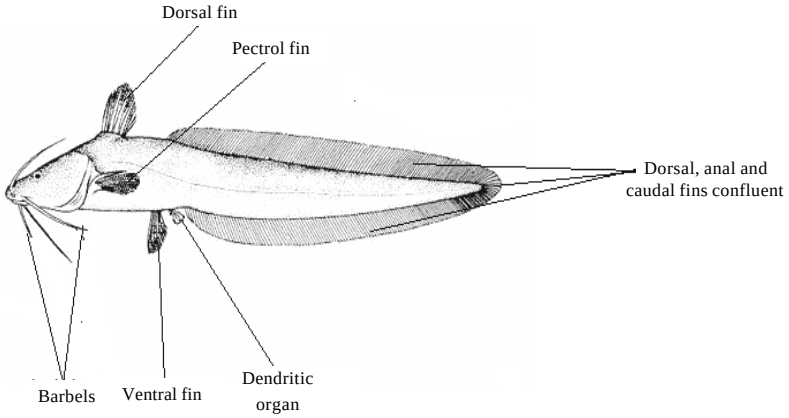

Fig. 2: External features of *P. canius* (De Bruin *et al*., 1995)

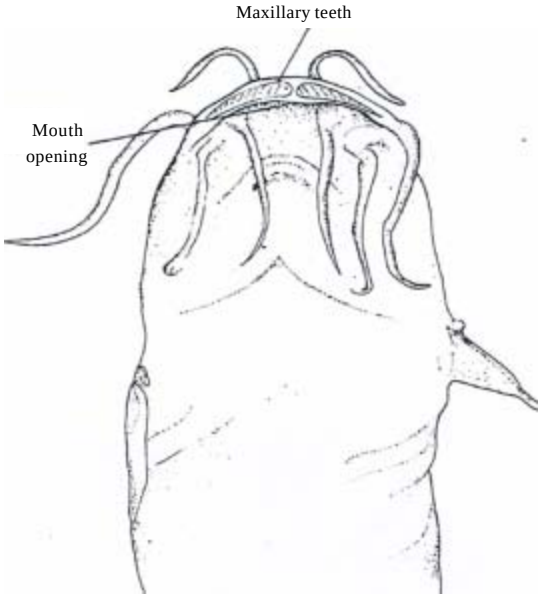

Fig. 3: Ventral view of anterior portion of *P. canius* (Sinha, 1986b)

jaw is cartilaginous, slightly longer and thicker than the lower jaw. Teeth are both present on jaws and palate (prevomer). Dentition is heterodont, with conical teeth located in the upper jaw and in the lower jaw. The teeth are a combination of molar and conical teeth, while on vomer, the kind of teeth found are molar. Also in the pharynx situated the pharyngeal teeth, which are small and conical in shape (Sinha, 1986a; Mohsin and Ambak, 1996; Gupta and Gupta, 2006).

Morphometric characteristics: For proper identification of fish, certain morphometric characters are taken into account. These various measurements provide terminological data that are often useful in fishery research and documentation. This data can also give an indication of the fish welfare in their environment (Haruna, 2003). Also morphometric characteristics can shed more

light on the taxonomic variation among populations of fish to ascertain the possibility of genetic variation among them and to evaluate nutritional status of fish (Lawson *et al*., 2011; Lawson, 2010).

Morphology of the digestive tract: Digestive tract is the dietary stand point. Little knowledge on the digestive system and digestive tract of *P. canius* exists presently. At the time of this review only one published article by Sinha (1986a) was found. From his findings, the digestive tract of the fish is of primitive form and it is not uniform throughout but made up of turns at several points. Only the mouth and the bucco-pharynx (Fig. 4) were found to be clearly demarcated morphologically but other parts were partially demarcated. The mouth lacks salivary glands and leads into the bucco-pharynx, which is short and readily expanded possess teeth that help in compressing food slightly further. As in catfishes, stomach is present but in the case of this fish (*P. canius*), stomach is poorly differentiated from the intestine. The stomach is sac-like and can only be differentiated from the intestine by being a little wider than the intestine. Pyloric region has small external constriction at the junction with cardiac stomach. Intestine is long, highly folded and consists of three regions (anterior, mid and hind intestine) with varying width at different points (Fig. 5). No clear defined rectum, the rectum terminates at the anus which leads to the outside (Sinha, 1986b).

Information on morphometric characteristics of *P. canius* is very scarce, in addition no research has been found elsewhere that surveyed the populations of this fish within a particular country. It is evident from the local fishermen of Malaysia around different areas of the country that *P. canius* (locally called Sembilang) occur in the coastal waters, also as reported by Mohsin and Ambak (1996). A better study would examine these fish populations and compared the different areas, so that any variations among these populations can be explained.

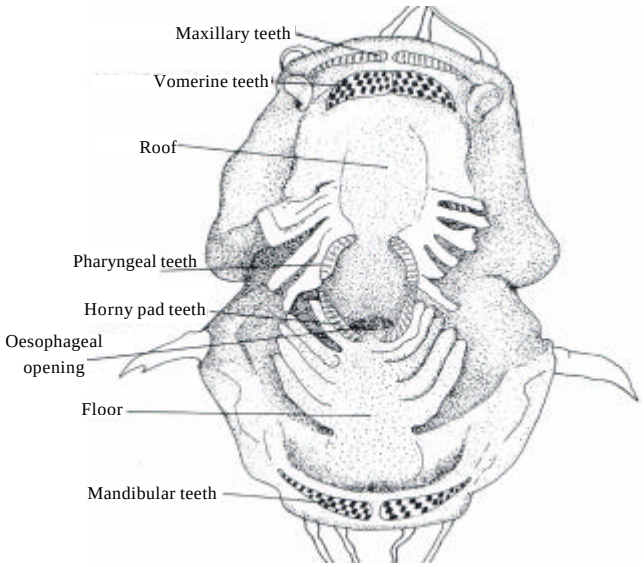

Fig. 4: Bucco-pharyngeal region of *P. canius* (Sinha, 1986b)

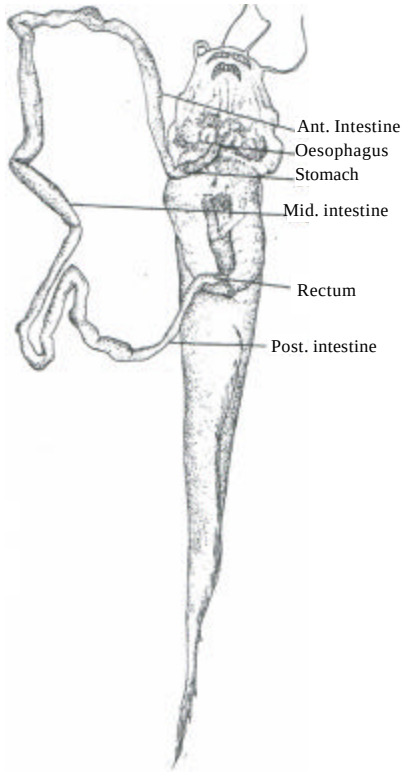

Fig. 5: Nature and disposition of alimentary tract of *P. canius* (Sinha, 1986b)

Reproductive biology: After attaining a definite age and size through a period of sustained growth, a time comes in the life cycle of an individual when it arrives the adult stage. It is during this period that it is able to reproduce itself and also exhibit some secondary sexual characteristics. Catfishes are no exception to it and this stage of life cycle plays a very important role in the aquaculture practices (Gupta and Gupta, 2006). Changes occur in the gonads of both males and female before reaching full maturity and becoming ripe.

Catfishes generally exhibit sexual dimorphism, whereby there are sexual differences among them. In most cases the sex may not be determinable by merely the external characters and in such cases it is necessary to examine the gonads. In few cases, differences exist in the shape of the anal fin of males and females, while in others like *Clarias* sp. males possess anal papilla (Haruna, 2003). In other cases males may be substantially bigger than the females, because males need to be active to prepare the brooding nest. In this case females are found to be smaller so that they can easily be accommodated into the nest. Also because of territoriality by some catfishes, males need to be larger so that the territory can be defended (Ota *et al*., 2010). In other cases females are typically bigger than males to ensure the largest fecundity of the stock (Gupta and Gupta, 2006), while others exhibit different colouration among males and females example in Eel-tail Banjo (*Platystacus cotylephorus*).The knowledge of sexual dimorphism in *P. canius,* which will give picture of basic information concerning the sex of the fish has not been reported in the literature.

Understanding the reproductive biology of any fish species is very important for its successful culture (Lawson, 2011). It also plays a very important role in the aquacultural practice in raising economically important fishes in aquaculture system as well as to evaluate the level of exploitation,

seasonal variation and conservation of fish stock (Islam and Kurokura, 2012; Adebiyi *et al*., 2011; Gupta and Gupta, 2006; Khan *et al*., 2002). Studies on reproductive biology of fish require knowledge of sex ratio, stage of gonad development, fecundity, size at maturity and spawning period.

For a successful fishery operation, the ratio of male to female is very essential to ensure full viability of the offspring. A shortage of either male or female in the breeding ground can result to the decreased number of eggs being fertilized, which may result in apparent changes in the sex- ratio of the offspring. Differences in size exist among various fish species; such displacement in the average size of the fish in commercial catches can also alter the sex composition of the stock. Sex ratio varies considerably among species. But, it is close to 1 in majority of fishes. It also differs from one population to another of the same species and may vary from year to year in the same population. Sex ratio and size at maturity are very important in fish stock assessment (Gupta and Gupta, 2006; Wang *et al*., 2003).

Gonads are the reproductive organs of a fish which play a very important role during reproduction as such needed to be well developed and matured. Condition of the gonad is an indicator of the breeding season of a fish (Adebiyi *et al*., 2011; Gupta and Gupta, 2006). Fish gonads consist of testis in the males and ovaries in the females and lie in the body cavity (Haruna, 2003). Before a fish matures, its ovary undergoes marked changes, both morphologically and histologically until it ripe and these changes depend on some factors both internal (pituitary and hormone) as well as several other external factors such as food and environmental conditions (Gupta and Gupta, 2006). Several stages of ovarian development were described by various researchers using different criteria for classification. Some classified ovary development into eight stages (Solomon and Ramnarine, 2007; Gupta and Gupta, 2006; Van der Molen and Matallanas; 2004; Utoh *et al*., 2003), seven stages (Adebiyi *et al*., 2011; Cek *et al*., 2001; De Martini *et al*., 2000), six stages (Shinkafi and Daneji, 2011; Chelemal *et al*., 2009; Murua *et al*., 2003), five stages (Morris *et al*., 2011; Abascal and Medina, 2005) and four stages (Koc *et al*., 2008; Nejedli *et al*., 2004; De Lestang *et al*., 2003; Ravaglia and Maggese, 2002; Kumar *et al*., 2003).

Gonadosomatic Index (GSI) is an index used to estimate the development of gonads in fish. In most fishes, GSI increases with the maturation of fish and become highest during the period of peak maturity and declining abruptly thereafter, when the fish is spent. Breeding or spawning period can be confirmed easily after determining the stage of maturity of the gonads (Gupta and Gupta, 2006). GSI is calculated as weight of ovary in grams by weight of fish in grams multiplied by 100 (Adebiyi *et al*., 2011).

Fecundity is the capability of fish in terms of egg production or the number of ripening eggs in the ovaries of the female before spawning; or the number of eggs per unit length of weight of fish per year. Knowledge of fecundity in is very important to assess spawn production from the available stock of breeders and also to explain variation in population and increase fish harvest (Mekkawy and Hassan, 2011). Information on fecundity is very important in assessing the commercial potentialities of fish stock (Khan *et al*., 2002).

Significant numbers of researches have been conducted on reproductive biology of many catfish species for both marine and freshwater (Gomes *et al*., 2011; Rondineli *et al*., 2011; Offem *et al*., 2008; Ahmed, 2004; Gomes and Araujo, 2004; Rahman *et al*., 2004; Solak *et al*., 2001a; Marriott *et al*., 1997; Dobriyal and Singh, 1993; Khan *et al*., 1990). In contrast, at the time of this review, few reports were found on the reproductive biology of *P. canius* (Ahmed and Haque, 2007; Khan *et al*., 2002; Sinha, 1981). Summary of their findings are presented in Table 2. Changes in

Table 2: Spawning season, fecundity and size of maturity of *P. canius* in different geographical region

Country of original research	Sex ratio	Spawning period	Fecundity (eggs/female)	Size at maturity (cm)	References
Bangladesh	Not given	April-August	1180-2250	36.5	Khan *et al.* (2002)
Bangladesh	Not given	April-July	2122	Not given	Ahmed and Haque (2007)
India	Not given	Feb-August	Not given	Not given	Sinha (1981)

gonad condition indicated that there are four periods in the annual cycle of this fish (Sinha, 1981). From their reports, the spawning period of this species is rather controversial as no general agreement is established about the period it spawns. However, the report by Ahmed and Haque (2007) and Sinha (1981) failed to show the size at maturity of the fish. Also, the three reports failed to examine sex ratio in the stock, as these are very important in reproductive studies. More data need to be collected on this fish for a better understanding of its reproductive biology.

Food and feeding habits: The food and feeding habit of fish can be done by examining the stomach content. Various methods were reviewed by Lima-Junior and Goitein (2001), Mohan and Sankaran (1988), Hyslop (1980) and Hynes (1950). For a successful management of any aquaculture candidate, knowledge of food and feeding habit is very essential and such information helps in placing a fish in its ecological niche into appropriate trophic level of a food web (Alhassan and Ansu-Darko, 2011; Amani *et al.*, 2011). A considerable amount of literature has been published on food and feeding habits of other catfish species from various countries (Alhassan and Ansu-Darko, 2011; Kadye and Booth, 2011; Prasad and Ali, 2008; Offem *et al.*, 2008; Sreeraj *et al.*, 2006; Solak *et al.*, 2001b; Marriott *et al.*, 1997). It is somewhat surprising that only the works of Sinha (1984) and that of Ahmed and Haque (2007) have reported the kind of feed items in the diet of *P. canius*. The diet of the adult consisting mainly of crabs, prawns, fish, molluscs and aquatic insects, plant matter, amphipods. Some debris were also found in small quantities and were described as accidental inclusions (Sinha, 1984). While the main diet of the fingerlings was reported to be comprised of prawns, planktons and insects only. In their report, Ahmed and Haque (2007) showed that the food of *P. canius* from coastal waters of Bangladesh consisted mainly of crabs, shrimp and molluscs, while other food items include: fish, insects, algae and miscellaneous. In other countries of its occurrence, no single work was found on food and feeding habit of this fish. There is a dearth need for further data collection on this fish from various countries so that the food of *P. canius* can exactly be identified.

Length-weight relationship (LWR): According to Gupta and Gupta (2006), the study of LWR in fishery is undertaken to accomplish two main objectives; first to provide mathematical relationship between length and weight as a means of conversion, second to calculate the condition factor or coefficient of condition. The relationship between length and weight is very important in fishery resource management (Arshad *et al.*, 2012; Kalayci *et al.*, 2007; Rahman *et al.*, 2008). LWR can be used to compare the life history and various external features of fish from same or different locations (Amani *et al.*, 2011; Goncalves *et al.*, 1997). The mathematical correlation between length and weight is very important because in such cases where only length of a fish is known, the weight can be estimated (Froese, 1998; Harrison, 2001). Despite the usefulness of assessing the LWR of fish, at the time of the present review, only Sinha (1981, 1986b) studied the length-weight relationship of *P. canius* from Hooghly-Matlah, West Bengal; India. His results showed no significant difference between males and females but fluctuations in monthly condition factor were observed. The length of *P. canius* at different ages using Petersen's length

frequency method, probability plot method and study of rings on vertebrae showed an annual nature of vertebral rings and isometric growth between vertebral centrum radius and total length of the fish, which established that a valid study of age in *P. canius* can be done by the vertebral method of age determination.

However, these results were based upon data from almost 30 years ago by a single researcher from a small area which is unclear if this still persists. So, there is a serious need of similar investigation so that more and recent information from wide range of locations can be generated on the LWR of the grey-eel catfish.

The fisheries of *P. canius*: In general, a catfish fishery is fast growing in the Asian region with Malaysia, China, Indonesia, India and Thailand being the top producers (Lungren *et al*., 2006). Mohsin and Ambak (1996) reported from Malaysian coastal waters that total landings of fishes belonging to this family (Plotosidae) were 986 t in 1988. The catch for the west coast of Peninsular Malaysia was 582 t (59%), while it was 403 t (41%) for East Malaysia. The catch for the east coast of Peninsular Malaysia was less than 1 t. Peak season is in May for the west coast and in October for East Malaysia. Currently, lack of information on this fish is a great obstacle towards reviewing its fisheries status. Information from the local fishermen in Malaysia indicated that the catch from coastal waters is always dechining and its seasonal availability uncertain. In India, it has been listed among the 39 fish species facing extinction (Mijkherjee *et al*., 2002). Also Mukhopadhyay (1994) listed it among other estuarine species of India that are vulnerable and facing extinction in the near future. In Bangladesh, *P. canius* has been reported by Khan *et al*. (2002) as a considerable part of catfish catch from brackish waters but the report failed to show the amount of catch from these waters. Although the IUCN Red list (IUCN, 2011) has not reported its status but it seemed (especially from Malaysian perspective) that *P. canius* is in serious need of attention to ensure aquaculture and conservation of the species.

CONCLUSIONS AND RECOMMENDATIONS

Knowledge of distribution, taxonomy, biology and fisheries of any fish species is of paramount importance for its proper management, conservation, boosting of food security programme of any government as well as lifting the aquaculture industry of any country. Adequate and proper knowledge of fish biology ensures its availability for culture purposes. *P. canius* is an economically important marine catfish in Malaysia and in South East Asia as a whole. This review has identified the fact that despite the distribution of *P. canius* in the region, the fish has been seriously disadvantaged in comparison to other catfishes. Literature on important aspects of its life history such as distribution, biology and fisheries among others is scarce; this is clear indication for more research on this fish, so that its status could be assessed in order to properly manage and conserve the species.

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