Lanternfishes (Myctophids): by-catch of deepsea shrimp trawlers operated off Kollam, south-west coast of India

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Introduction

By-catch and discards have received a great deal of scientific attention, their minimisation being a goal of marine fisheries management (Powers, 2006). The Nordic workshop (Nordic Council of Ministers, 2003) defined by-catch as "the proportion of the catch which is taken on the board, or brought to the surface by the vessel and which is subsequently thrown back to sea, dead or dying or likely to die". Most of the earlier studies deal with optimisation of fishing efficiency and minimisation of fishing impact, but by-catch and discards data have rarely been used to learn about the distribution, abundance and biology of the incidental species being caught, although several recent studies have indicated the informative value of by-catch concerning food habits (Koen Alonso *et al.,* 2001), feeding ecology (Rheeder and Sauer, 1998) and recruitment indices (Payne *et al.,* 2005).

According to FAO discard database, during 1992 - 2001, yearly average discards were estimated as 7.3 million t of which Indian Ocean accounted for about 9%. Mesopelagic fishes are common by-catch in many of the world's fisheries targeting deepsea shrimp species. Shrimp trawl fisheries generate a higher proportion of discards than any other fishery type (Alverson *et al.,* 1994) and account for more than one third of the estimated total global discards from fisheries (Pascoe, 1997). In most cases, the weight of the by-catch exceeds that of the shrimp catch and is comprised of tens or hundreds of species of fish and invertebrates (Stobutzki *et al.,* 2001; Steele *et al.,* 2002). In the past, most of the mesopelagic fish catches were discarded without being properly recorded.

The mesopelagic zone has been defined in different ways based on depth, temperature and light regimes. Depth seems to be the best criterion and mesopelagic fish can be defined as fishes that live in the mesopelagic zone *i.e.*, between 200 and 1000 m depth. Beebe (1935) was the first fishery biologist to observe myctophid fishes in the mesopelagic zone of the ocean. Many fish families fall within this definition, but generally the Myctophidae, Neoscopilidae and Gonostomatidae are dominant. Sternoptychidae, Bathylagidae, Chiasmodontidae, Trichiuridae, Nomeidae and others seem to be fairly important in some areas. In the present paper, the main emphasis has been given to the family Myctophidae.

Myctophids are the most species-rich family of mesopelagic communities in the world's oceans (Gjøsaeter and Kawaguchi, 1980), with an estimated biomass of about 70–200 million t (Lubimova *et al.,* 1987). Family Myctophidae comprises 32 genera with at least 240 species (Nelson, 2006), found in all oceans from near surface to deep waters. They are thought to migrate to the productive epipelagic zone, which contributes to their abundance in the open sea (Watanabe *et al*., 2002). About 55 species of myctophids are known from the Arabian Sea including its southern part of the Indian Ocean (Kornilova and Tsarin, 1993; Tsarin, 1993), with an estimated biomass of 100 million t of *Benthosema pterotum* (US GLOBEC, 1993). Karuppasamy *et al.* (2006) reported 27 species of myctophids from Indian EEZ. Somvanshi *et al.* (2009) reported five species of myctophids from south-west coast of India. Gopakumar *et al*. (1983) studied the fatty acid composition of *B. pterotum* and Lekshmi Nair *et al.* (1983) carried out nutritional evaluation of the fish meal and fish hydrolysates of *B. pterotum* from Gulf of Oman and found them to be of good quality, which could be used as a protein supplement in animal feeds.

The present report describes the myctophid by-catch along with other mesopelagic fish catch by deepsea shrimp trawlers operating in the

Quilon bank (8^0 N -11^0 N and 74^0 E -76^0 E), Kerala coast. Regular observations were made in the two major fish landing centres, Sakthikulangara, Kollam and Cochin Fisheries Harbour from December, 2008 to May, 2009 and subsamples of by-catch were collected to identify the myctophid species in the deepsea trawl fisheries. The trawlers operating from Neendakara and Cochin Fisheries Harbours have an OAL of 13-16 m with an engine power of 100 to 120 HP and fitted with echosounders, GPS *etc.* (Fig. 1). The shrimp trawls have mesh sizes ranging from 40 mm (in the front part) to 28 mm (in the codend). Based on the usual catches of bottom trawl operation, it was found that shrimps mostly inhabited the uneven bottom surface. The trawlers specifically targeted *Aristeus alcockii, Heterocarpus woodmasoni, Heterocarpus gibbosus, Plesionika spinipes* and *Metapenaeopsis andamanensis*. These trawlers stay back at sea for 9 to 15 days and operate at a depth range of 350 to 450 m. Trawling operations are mainly carried out during early morning as well as late evening and the catches were dominated by deepsea shrimps. The trawling operations extend from 4 to 6 h at a towing speed of 2 knots. Normally in each operation, by-catch contributes about 20 to 40% along with targeted species. Sometimes the by-catch exceeded more than 80% and was discarded without being taken onboard the vessel. So far there is no mechanism to make a reasonable estimate of these discards. Identification of fish species was carried out following Smith and Heemstra (1986) and Fischer and Bianchi (1984).

The major components in the by-catch belonged to the families Rhinochimaeridae, Echinorhinidae, Centrophoridae, Squalidae, Stomiidae, Sternoptychidae, Gonostomatidae, Ateleopodidae, Chlorophthalmidae, Ipnopidae, Evermannellidae, Neoscopelidae and Myctophidae. The identified species are listed in the Table 1.

By-catch comprised considerable quantity of small shrimps and non-conventional deepsea fishes of marketable size (Fig. 2). After onboard sorting, they were brought to the landing centres and sold for nominal price, to be mainly used in fishmeal production (Fig. 3). Of late, due to heavy demand for fish and high cost, some of the species are being used for human consumption, fetching about Rs. 30-45/- per kg. All large sized chondrichthyans belonging to families like Rhinochimaeridae, Echinorhinidae, Centrophoridae and Squalidae are getting high values in the landing centres.

Fig. 1. Deepsea shrimp trawler at Kollam

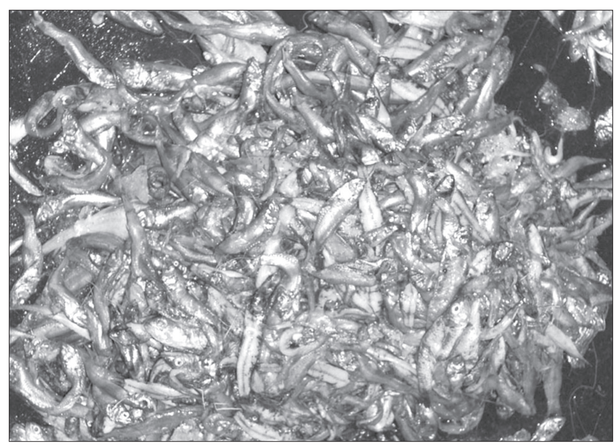

Fig. 2. By-catch and discards

Fig. 3. Low value by-catch landed at Cochin

Among the lanternfishes, benthopelagic myctophids dominated followed by Neoscopilids. *Diaphus* was the most abundant genus followed by

Table 1. Major species observed in the by-catch

Family	Species
Rhinochimaeridae	*Neoharriotta pinnata* (Schnakenbeck, 1931)
Echinorhinidae	*Echinorhinus brucus* (Bonnaterre, 1788)
Centrophoridae	*Centrophorus* sp.
Squalidae	*Squalus* spp.
Rajidae	*Dipturus* sp.
Notacanthidae	*Notacanthus* sp.
Congridae	*Bathyuroconger vicinus* (Vaillant, 1888)
Nemichthyidae	*Nemichthys scolopaceus* Richardson, 1848
Alepocephalidae	*Alepocephalus* spp.
Stomiidae	*Astronesthes indicus* Brauer, 1902
	Chauliodus sloani Bloch & Schneider, 1801
Sternoptychidae	*Polyipnus indicus* Schultz, 1961
	Polyipnus sp.
Phosichthyidae	*Vinciguerria* sp.
Ateleopodidae	*Ateleopus indicus* Alcock, 1891
	Ijimaia loppei Roule, 1922
Chlorophthalmidae	*Chlorophthalmus bicornis* Norman, 1939
	Chlorophthalmus agassizi Bonaparte, 1840
Ipnopidae	*Bathypterois atricolor* Alcock, 1896
Evermannellidae	*Evermannella indica* Brauer, 1906
Neoscopelidae	*Neoscopelus microchir* (Matsubara, 1943)
Myctophidae	*Myctophum obtusirostre* Tåning, 1928
	Diaphus thiollierei Fowler, 1934
	Diaphus watasei Jordan & Starks, 1904
	Myctophum fissunovi Becker & Borodulina, 1971
	Diaphus garmani Gilbert, 1906
Macrouridae	*Malacocephalus laevis* (Lowe, 1843)
	Nezumia propinqua (Gilbert & Cramer, 1897)
	Gadomus spp.
Moridae	*Physiculus roseus* Alcock, 1891
Ophidiidae	*Dicrolene multifilis* (Alcock, 1889)
	Glyptophidium argenteum Alcock, 1889
	Glyptophidium sp.
Acropomatidae	*Synagrops* spp.
Lophiidae	*Lophiomus setigerus* (Vahl, 1797)
Trachichthyidae	*Gephyroberyx darwinii* (Johnson, 1866)
Berycidae	*Beryx splendens* Lowe, 1834
	Beryx sp.
Zeidae	*Zenopsis conchifer* (Lowe, 1852)
Setarchidae	*Setarches guentheri* Johnson, 1862
Scorpaenidae	*Pontinus nigerimum* Eschmeyer, 1983
Triglidae	*Pterygotrigla hemisticta* (Temminck & Schlegel, 1843)
Priacanthidae	*Priacanthus hamrur* (Forsskål, 1775)
	Heteropriacanthus sp.
Centrolophidae	*Psenopsis cyanea* (Alcock, 1890)
Trichiuridae	*Trichiurus auriga* Klunzinger, 1884
Bathyclupeidae	*Bathyclupea* sp.
Gempylidae	*Neoepinnula orientalis* (Gilchrist & von Bonde, 1924)
Polymixiidae	*Polymixia japonica* Günther, 1877
Ariommatidae	*Ariomma indica* (Day, 1871)
Nomeidae	*Cubiceps whiteleggii* (Waite, 1894)
	Cubiceps sp.
Percophidae	*Bembrops caudimacula* Steindachner, 1876
Peristediidae	*Peristedion miniatum* Goode, 1880
Bothidae	*Chascanopsetta lugubris* Alcock, 1894
Samaridae	*Samaris cristatus* Gray, 1831
Cynoglossidae	*Cynoglossus arel* (Bloch & Schneider, 1801)

Myctophum in the family Myctophidae. Among the myctophids, *Diaphus watasei* was the most dominant species. *Diaphus garmani* was recorded for the first time from the Indian waters (Fig. 4). The identified species of the family Myctophidae includes *D. watasei, D. thiollierei, D. garmani, Myctophum obtusirostre* and *M. fissunovi.* Length frequency studies of *D. watasei* was carried out. A total of 90 samples of *D. watasei* were examined and the S_L ranged from 7 to 13 cm with a prominent mode at 10 cm. Gut content analysis of *D. watasei* (n = 86) revealed that stomach of most of the fishes were empty.

Fig. 4. *Diaphus garmani*, 54 mm LS

In the present study, information on landings of myctophids as a major component in the by-catch of deepsea shrimp trawlers was confirmed. Most of the species obtained were benthopelagic and are available significantly during early morning and late evening which provide information on biology and species compositions. *D. watasei* was the most dominant species observed during the study. Based on the observations of the present study, it is suggested that bottom trawling survey along with midwater trawling should be carried out in order to estimate the actual biomass of myctophids in the Arabian Sea.

Preliminary studies on the growth in captivity of *Spirastrella inconstans* (Dendy) collected from the intertidal region of Palk Bay, south-east coast of India

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Marine sponges are rich sources of bioactive metabolites that can be used as lead compounds to treat various diseases. Although concerted efforts resulted in the development of many new bioactive compounds from marine sponges, only very few compounds have reached the clinical trial stage. One of the reasons for this, as cited by many workers is that many of the sponge bioactive metabolites are highly toxic, thus leading to a low therapeutic index. However, the second major reason is the ‘supply problem’. Collection of large quantities of sponge biomass from the wild becomes a pre-requisite for obtaining sufficient amounts of metabolites from natural populations. Consequently, the natural populations may not be able to sustain such heavy exploitation.

Although chemical synthesis of the target compounds is a more direct method to overcome the issue of over-exploitation of wild population, many natural products are not amenable to chemical synthesis due to the complexity of their chemical structure. Therefore, the second option is to produce large quantities of the target species through suitable aquaculture techniques which would ensure a steady supply of material. This would also ensure the protection of depleting natural stocks.

In India, studies on sponge aquaculture is still at infancy. Preliminary studies on the growth of selected species would provide baseline information for future strategic research planning to develop innovative culture techniques for potential marine sponges.

In this backdrop, an attempt was made to understand the growth behaviour of one of the potential sponge species, *Spirastrella inconstans* which is found distributed in the Gulf of Mannar and Palk Bay,