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An account of the wild collection of polychaete (Annelida) from the intertidal zones of Mumbai, Maharashtra, India

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Short Communication

Abstract

The study was planned to examine polychaete fishing activity along the coast of Mumbai city. Random sampling was performed for a period of six months and conducted interviews with bait diggers, traders and local fishers (n=30). Polychaete annelids were found to be the most extensively harvested taxa in the intertidal areas due to market demand from the aquaculture industry. The collected polychaetes were identified as *Marphysa* spp. During the survey, each pair (two partners) on a typical day is reported to collect around 1-2 kilogram of live worms, which earns them ₹1000 per kg. It is recorded that the average collection of worms from various locations in intertidal areas of Mumbai city is around 150-200 kg/day. Last decade, the annual consumption of polychaetes by shrimp hatcheries ranged from 16 to 20 tonnes. Shrimp farming in India is intensified and currently, there are 315 hatcheries registered with the Government of India for seed production of *Litopenaeus vannamei*. The demand for polychaete worms has therefore increased many folds and could be estimated in the range of 252 to 337 tonnes annually and nowadays, this demand is being met by an unreported wild-caught polychaete resource as well as import of Specific Pathogen Free (SPF) polychaete from overseas suppliers. There is scope for polychaete culture to satisfy the country's growing market demand. Moreover, polychaete fishing in coastal areas removes substantial biomass and hence can cause major impacts on coastal habitats. There is a need for regulation of its mass collection from the wild.

***Keywords**: Polychaete fishing, blood worms, sustainability issues, Mumbai city*

Introduction

Polychaetes constitute about 80% of the total macrobenthic community and inhabit muddy, sandy and rocky seashores. Some species live in brackishwater and some are found to colonize freshwater ecosystems. They play a vital role in the estuarine and marine food chain; perform a significant role in the mixing of sediment, mineralization, and cycling of organic matter. In addition, they are also considered an important biological indicator to assess or monitor the health of the ecosystem including pollution or environmental perturbations. The polychaete fishing for worms consists of an amalgam of species. There are 12,530 described species globally (WoRMS, 2020). However, as per the most recent update, only 1142 polychaete species (valid) have been reported from the Indian coastlines, which constitutes 9.11 per cent of the global diversity of polychaetes (http://www.biosearch.in as cited by Bhadury *et al.*, 2020). Out of the 1142 reported species in India, 180 (15.76%) species of polychaetes have been recorded along the Maharashtra coast (Pati *et al.*, 2015); while there are 84 polychaetes species known from the Mumbai waters (Sukumaran and Devi, 2009).

The polychaete annelids are one of the most widely harvested invertebrates community in coastal areas and estuaries worldwide due to their economic interest as live fishing bait or as broodstock maturation diet in aquaculture activities (Mosbahi *et al.,* 2016; Watson *et al.,* 2017a; Cole *et al.,* 2018; Pombo *et al.,* 2018; Sara Cabral *et al.,* 2019). A recent global review of polychaetes reported 60 species that are being used to cater for the needs of the recreational fishing and aquaculture industry (Cole *et al.*, 2018). Globally, the practice of collection of polychaete is known as 'bait harvesting' (Sara Cabral *et al.,* 2019) and the resources are threatened by local population loss due to over-harvesting, as well as by habitat degradation by bait digger activities (Watson *et al*., 2017b). Further, the extent of the wild harvest of polychaete worms is not well documented in many countries, including India, mainly because of its localised and artisanal nature. Hence no systematic capture production data is available. FAO (2020) database has a global mean of only 373.8 ± 73.4 tonnes per annum from 2008 to 2017. The production figures of FAO (2020) data sets seem to be underestimated mainly because of the non-inclusion of all countries in this database. These facts are widely reviewed by many fisheries researchers (Watson *et al*., 2017a; Pombo *et al*., 2018; Sara Cabral *et al*., 2019). According to Watson *et al.* (2017a), these underestimations are obvious, owing to limited resources and management frameworks available with global fisheries agencies. Thus, the global annual harvest of polychaetes was estimated at the tune of 121000 t/year valued at £ 5.9 billion (Watson *et al*., 2017a). In India, almost all shrimp hatcheries use polychaetes to promote the maturation and spawning of shrimp broodstock (Vijayan *et al*., 2005; Velvizhi *et al*., 2013; Kannan *et al*., 2015; Shalini *et al*., 2016) due to their high amount of omega-3 polyunsaturated fatty acids (PUFA), strong nutritional properties, and also as a good supply of reproductive hormones similar to those found in shrimp (Lytle *et al*., 1990; Bray and Lawrance, 1992; Wouters *et al*., 2001; Chimsung, 2014; Sahu *et al*., 2017). Further, polychaete worms in the diet of *P. vannamei* reported to promote maturation and yield better recovery of egg to nauplii *i.e.*, 60 to 65% compared to only 20 to 25% in shrimp fed on other live feeds (Velvizhi *et al*., 2013). In addition, including polychaetes in the diet of domesticated male shrimp broodstock has been found to improve growth, survival levels and boost reproductive maturation in terms of better sperm quality (Leelatanawit *et al*., 2014).

The demand for broodstock diets by hatchery operators from the late eighties has drawn considerable attention to harvests of polychaete worms, primarily from natural sources in India. During the early 1990s, when the shrimp culture sector in India was witnessing substantial growth, the polychaete fishery was at its peak; however, the outbreak of white spot viral disease in 1995-96 paralysed the shrimp farming industry and as a consequence polychaete collection activity was halted in late 1990s. Further, because of the possibility of WSSV transfer from live feed (as a passive vector) to *Penaeus monodon* broodstock (Vijayan *et al*., 2005; Shalini *et al*., 2016), the polychaete collection activity was discontinued. However, from 2009 to 2010, the polychaete worms were back in demand due to the establishment of seed production units of *P. vannamei* in the country. It is a fact that polychaete collection in India has emerged as an artisanal fishery in many coastal states to meet the increased demands of shrimp hatcheries and some extent ornamental fish industry (Velvizhi *et al*., 2013; Asha and Diwakar, 2018). Very few records document the worm collection/polychaete fishing operation in the country and are mainly from the Tamil Nadu and Puducherry coastal belts (Tampi, 1959; Velvizhi *et al*., 2013; Asha and Diwakar, 2018). To date, there are no reports of this form of operations from the State of Maharashtra. Tampi (1959) documented the harvesting of polychaete worms intended for use as bait in hook and line fishing along the coast of Madras (presently Chennai). In Tamil Nadu and Puducherry, about 200 families of Irular communities are involved in the collection along various locations (Velvizhi *et al*., 2013). A group of fishers in Tuticorin Bay, Tamil Nadu, was reported to engage in regular harvesting of polychaete worms from Thoothukudi, Puducherry and Chidambaram areas (Asha and Diwakar, 2018). The harvested polychaetes in the latter two reports were destined for shrimp hatcheries in India.

Material and methods

Two main intertidal areas regularly harvested for different organisms as a means of sustenance, or simply for leisure in Mumbai city *viz*., Worli and Haji Ali were selected for the study. Haji Ali and Worli shores are located in the southern part of the Mumbai metropolis region (Fig. 1). The upper part of the

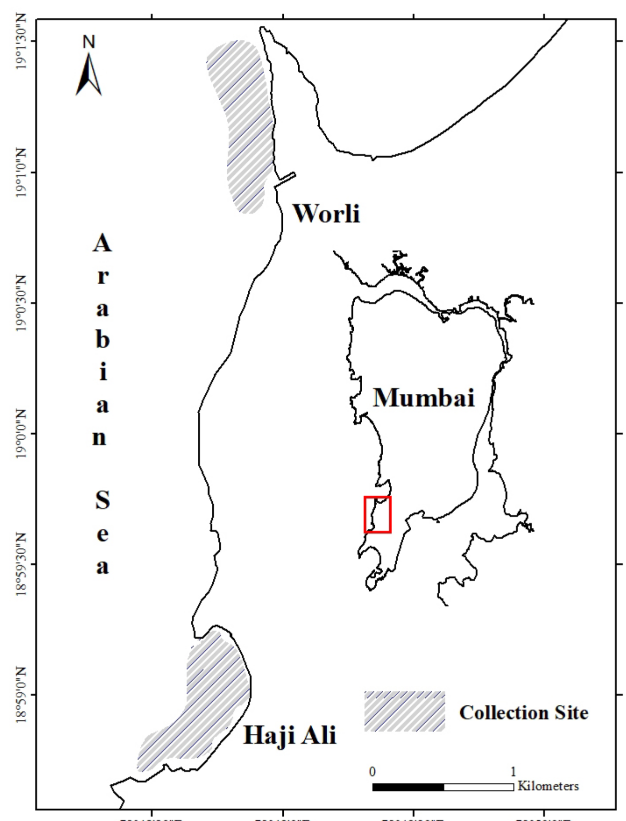

Fig. 1. Map showing study locations

intertidal area mainly consists of basalt rocks with sporadic patches of sand; further in some places upper and partly the middle zone consist of mud, coarse sand and big pebbles. Twelve random surveys were performed for a period of six months from September 2019 to February 2020. This timeframe was chosen because it is the peak time for the operation. The observations were performed during the diurnal lowest spring tide (<1.0 height) in both locations. Throughout the survey interview with 30 numbers of stakeholders, including bait diggers, traders, and local fishermen, were conducted to obtain a general understanding of polychaete fishing in the study area. The potential exploitable intertidal area for polychaete fishing is marked in shaded lines on the ArcGIS platform (Fig. 1). Collected polychaetes were identified up to the generic level as per the key provided by Fauvel (1953). Water samples during the study period were collected from the study area and analysed for selected hydrobiological parameters following standard procedures (APHA, 2005) and using standard multi-parameter probes.

Results and discussion

The polychaete worms are locally known as '*Chara*' in Marathi. The worms collected from these areas were identified as *Marphysa* spp. (Fig. 2). The genus *Marphsya* was identified by the presence of five antennae. Cirri is absent from apodous segment, thread-like gills. Blades of compound chaetae hooked and (or) tapering.

Systematics

Kingdom : Animalia
Phylum : Annelida
Class : Polychaeta
Order : Eunicida
Superfamily : Eunicoidea
Family : Eunicidae
Genus : *Marphysa*

Marphsya Quatrefages, 1866 is an important genus in the family Eucinidae comprising 114 numbers of recognized species (Read and Fauchald, 2020, WoRMS online database). They are free-living burrowing polychaetes that occupy a broad range of environments, from soft sediments to rocky grounds, usually in warm and temperate waters (Martin *et al.,* 2020). The distribution and heterogeneity of polychaetes rely on environmental factors such as characteristics of sediment, organic load, salinity, water depth and also latitudinal scales (Etter and Grassle, 1992; Ysebaert and Herman, 2002; Carr, 2012). The salient

Fig. 2. (A) Polychaete worms collected by bait diggers identified as *Marphysa* spp. (B) Microscopic image of *Marphysa* spp., showing pygidium, ventral view (C) Microscopic image of *Marphysa* spp. showing anterior end, dorsal view with three central antennae, two lateral palps

Table 1. Site-wise salient findings during the study period.

Particulars	Haji Ali	Worli
Nature of bottom	Mud, coarse sand and big pebbles	Sporadic patches of mud, coarse sand and big pebbles
Species collected	*Marphysa*	*Marphysa*
Nature of activity	Part-time	Part-time
Number of persons in the group	3-4	2-3
Tools used for digging	Iron rod	Iron rod
The daily quantity collected by a group based on tides (in Kgs)	1-3	1-2
Monthly active fishing days	15	15
The peak period for collection	September to December	September to December
Rate per kg (Rs)	1000	1000
Single selling point	Worli lotus jetty	Worli lotus jetty

findings of the survey in the study sites are given in Table 1. It was observed that untreated or partially treated domestic sewage containing significant quantities of particulate matter is released from nearby households. Such particulate matter settles down between pebbles and coarse sand, thus forming a muddy substratum. The process of muddy base creation is fuelled by the consistent discharge of domestic sewage from the densely populated human settlement in these areas, together with organic loadings. The sedimentation process creates a conducive environment for the growth of polychaetes. The range of the selected hydrobiological parameters that supports the characteristics of the study area is given in Table 2. The regularly harvested organisms include oysters, clams, crabs, and polychaete annelids. During the study period, polychaete annelids were found to be the most heavily harvested taxa in these areas due to market demand from the aquaculture industry.

Table 2. Water quality characteristics in the study area

Parameters	Range and mean	
	Haji Ali	Worli
Air Temperature (°C)	29.0-30.50 (29.50)	29.0-30.0 (29.67)
SST (°C)	25.0-29.0 (27.33)	27.0-28.0 (27.67)
Salinity (PPT)	35.0-35.71 (35.28)	34.15-36.54 (34.95)
Dissolved Oxygen(mg/l)	1.15-2.39 (1.89)	1.95-2.55 (2.32)
pH	8.08-8.28	7.95-8.21
Phosphate (mg/l)	0.09-0.32 (0.22)	0.08-0.40 (0.27)
Nitrate (mg/l)	0.20-0.30 (0.27)	0.30-0.40 (0.37)
Nitrite (mg/l)	0.03-0.07 (0.04)	0.03-0.11 (0.08)
Silicate (mg/l)	0.85-2.62 (1.69)	1.42-2.19 (1.78)
Ammonia (mg/l)	0.48-0.51 (0.49)	0.27-0.48 (0.41)
Turbidity (NTU)	6.63-15.70 (12.02)	15.59-18.28 (16.96)
TSS (mg/l)	0.52-0.63 (0.57)	0.52-0.63 (0.56)
TDS (ppt)	48.77-13.80 (29.56)	11.58-49.69 (29.82)

The groups of non-fishing community and fisher groups were noticed to harvest the worms during the ebb tide period from the inshore areas. During the survey, it is revealed that the worms are harvested primarily for shrimp breeding units to be used as a live feed for shrimp maturation in south India. Such harvests were also noted for the same intent by Velvizhi *et al.* (2013) and Asha and Diwakar (2018). The present study and past report (Tampi, 1959) additionally observed the use of polychaete as bait for hook and line fishing in India. The process of worm collection includes removing the stone with a digging bar followed by excavating the sand or gravel by hand (Fig. 3). When one person unearths the bottom, other searches for the polychaete worms by breaking the lump. The earth digging is done up to 2-3 feet and digging hours vary from 2-3 hours per tide. In three hours, a group of four gather about 2-3 kg of worms. Collected worms are then kept in live condition in a bucket with salt water before they are handed over to dealers at the Worli lotus collection centre. The 10-12 kg shipment of polychaete worms is packed in thermocol containers and transported by rail to Chennai, Tamil Nadu, where it is worth around Rs. 2000 per kg. During the survey, it is found that polychaete fishing has been in operation for the past six years. It is carried out for eight months in a year, starting in September until April. The peak operation season is September to December. Velvizhi *et al.* (2013) mentioned that the average collection of polychaetes on a typical day ranges from 20 to 25 kg with the involvement of 15-20 families and the value of 1.0 kg of worms was around 500 rupees. While Asha and Diwakar (2018) reported that paired young couples can collect 2-3 kg of worms per day; one kilogram of live worms earns them Rs 300 per kg. In the present survey, each pair is typically reported to collect about 1-2 kg of live worms per day which earns them 1000 rupees per kg on the spot itself. Per kg price reported in the present observation is quite lucrative compared with the price mentioned by Velvizhi *et al.* (2013) and Asha and Diwakar (2018). A group of 10-20 people were reported to collect around 5-8 kg of polychaetes per day. The average gamut of worms in Mumbai city from various locations in the intertidal area was in the range of 150-200 kg/day. In addition to Worli and Haji Ali intertidal areas, polychaetes collection was also reported from Khardanda, Bandra Chimabai, Cuffe parade and Walkeshwar seashore area in Mumbai city. In the entire district, about 300 to 500 individuals

Fig. 3. (A) A group of non-fishing community harvesting polychaete worms near Haji Ali (B) A pair collecting polychaete worms near Worli intertidal area. (C) Collected worms by a pair at Worli intertidal location

are engaged in this activity on a regular or part-time basis and this gives them an alternate source of income generation.

Because of the reticence of traders to disclose the details, it would be virtually impossible to provide an exact estimation of the biomass harvested in Mumbai city. However, based on the approximate daily harvested information of polychaete worms (150 to 200 kg) and considering monthly active fishing days (15) and annually active months (8); the annual polychaete landings in the Mumbai district could be estimated roughly in the range of 18 to 20 tonnes. During the past decade, the yearly devouring of polychaetes by shrimp hatcheries in India especially *P.monodon* was estimated to be between 16 to 20 tonnes (Vijayan *et al.,* 2005). However, with the advent of SPF *L.vannamei's* commercial-scale farming, the demand for polychaetes in India has increased since 2009 (Velvizhi *et al.* 2013). As a result of the intensification of shrimp farming in India, the total shrimp production (*L. vannamei* and *P. monodon*) increased phenomenology from 75996.54 t in 2008-09 to 6,80,018 t during 2017-2018 (MPEDA, 2020). Currently, there are 315 hatcheries registered with Govt. of India, the Ministry of Agriculture and Farmer's Welfare for the import of 790200 numbers of *L.vannamei* broodstock for seed production (CAA, 2020). Therefore, the present demand for polychaete worms has increased many folds than reported by Vijayan *et al.* (2005). Besides, in 2018, India imported 1, 68,620 brood-stocks (DAHDA &F, 2020); if we assume the daily requirement of polychaete worms @ 10 kg/day as stated by Velvizhi *et al.* (2013) to sustain about 600-800 shrimps, the approximate daily consumption of polychaete worms by 1,68,620 numbers of brood-stock could be estimated at 2.1 -2.8 t/day. Likewise, considering the minimal feeding regime for repetitive spawning (5 to 6 spawns) over a period of 120 days; the annual polychaete requirement for 2018 can be estimated at 252 to 337 tonnes. In addition to import of SPF polychaete from the overseas suppliers, the increased demand is mainly met by unreported wild-caught resources resulting in a gradual decline in natural stocks and thus could no further yield sustained delivery for shrimp hatcheries in India. Additionally, the commercial interest in this activity is also degrading the fragile habitats by bait diggers.

In India, polychaete fishing activities are small-scale in terms of production and trade and are mostly carried out using small hand digging tools. Although such activities are concentrated in a few areas in the country, they remove considerable biomass and have significant impacts on the coastal ecosystem. In the coming days, it is predicted that the polychaete populace may face growing thrust either by overfishing or other anthropogenic activities like pollution, habitat degradation and developmental projects. Bait harvesting activities in India are currently unregulated, owing to a lack of proper reporting mechanisms and short market links. Therefore, the governance of this operation has become imperative. For the sustainable management of such activities, region-wise comprehensive studies are necessary to know the current exploitation pattern and to identify different potentially usable locations for polychaete fishing. This will help in regulation and monitoring of the activity in future based on the potential exploitable locations, management measures like closed areas or rotation of harvesting grounds can be suggested for sustainable harvesting and sustained supply to the aqua industry. Further, there is a scope for the culture of polychaete worms to meet the growing market demand and thus avoid over-exploitation in wild populations. Moreover, the bio-security issue in wild polychaetes can be addressed by developing sustainable culture practices. Globally over half a dozen species of polychaete annelids have been farmed and nearly a dozen of species have potential candidature for culture activities. Rearing techniques for the production of polychaetes like *Marphysa* spp have also been attempted. Therefore, the development of polychaete farming and management of polychaete fishing should be given priority by fisheries agencies in India.

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