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Coastal Eutrophication as a Cause of Elimination of Lugworms: First Record of *Arenicola marina* (Linnaeus, 1758) from Coastal Areas of Bay of Bengal at Chandipur, Odisha, India

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ABSTRACT

Arenicola marina (Linnaeus, 1758), a marine polychaete worm of the phylum Annelida is rarely seen but its coiled castings are a familiar sight on a beach at low tide of both northern and southern hemisphere. The genus *Arenicola* enjoys a wide distribution and in the tropical and sub-tropical regions *A. cristata* is the dominant species. Apart from a few records on the beaches of Indian Ocean and Arabian Sea the genus has not been known so far from any other part of India. In a study on the sandy as well as mudflats of Bay of Bengal at Chandipur in Odisha, India, we observed quite a big numbers of castings of *Arenicola* during the end of December, 2015 and accidentally found a full grown individual at the sandy beach. From that point of view it is the first report of its kind from this part of the globe, especially from Bay of Bengal, India.

***Keywords*:** Lugworm, *Arenicola*, *Arenicola marina*, Bay of Bengal, Chandipur, India, Indian Ocean, Arabian Sea

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1. INTRODUCTION

Lugworms, *Arenicola marina* (Linnaeus, 1758) is a large marine polychaete worm of the phylum Annelida. The animal itself is rarely seen without dig the worm out of the sand but its coiled castings are a familiar sight on a beach at low tide. Lugworms are burrow-dwelling annelid worms and can reach densities as high as 100-150 per square meter in certain areas (Fish, 1996). The lifespan of lugworms is estimated to be 5-6 years (Howie, 1984), and they can make up to 30% of the biomass of an average sandy beach, making them a very important part of the food web in their habitat. They bioturbate (re-oxygenate) the sand and serve as a food source for a wide variety of other animals such as flatfish and birds.

The genus *Arenicola* enjoys a wide distribution and is generally divided into cold water and warm water species. *Arenicola marina* and *A. clapqredii* dominate the cold waters of the northern hemisphere and *A. assimilis* is more common in the southern hemisphere. In the tropical and sub-tropical regions *A. cristata* is the dominant species while *A. caroledna, A. glasselli, A. loveni and A. bombayensis* have also been reported. Bhatti and Soofi (1949) have recorded *A. cristata* from Karachi and Ranade (1952) reported the occurrence of *Arenicola* from Bombay (later described as a new species *A. bombayensis* by Kewalramani *et al*. 1959). During a collection tour to the Andaman and Nicobar Islands in February-March 1960, Tampi and Rangarajan (1963) observed a few *Arenicola spp.* Fauvel (1953) did not mention these in his compilation of the Polychaete Fauna of India and apart from these scanty records the genus has not been known so far from any other part of India.

In a study on the sandy as well as mudflats of Bay of Bengal at Chandipur in Odisha, India, we observed quite a big numbers of castings of *Arenicola cristata* during end of December, 2015 and accidentally found a full grown individual at the sandy beach. From that point of view it is the first report of its kind from this part of the globe and especially from Bay of Bengal.

2. MATERIALS AND METHODS

2. 1. Physiography and climate of Chandipur

The area under study is Bay of Bengal at Chandipur in Odisha, India. Chandipur is situated between 860 .20’ to 870 .29’ East (Longitude) and 210 .3’ to 210 .59’ North (Latitude). The uniqueness of the beach lies in the fact that during a low tide the water recedes up to 5 km. into the sea exposing the golden sands.

The sea is very shallow and long distances in the sea bed from the coast become exposed (dissipative) during low tide. The beach becomes harder after the exposure due to the muddy soil mixed with sand. Annual rainfall ranges from 800 to 5500 millimetres which commences in April and lasts up to November. December rainfalls are rare. Though the average temperature at Chandipur is 35 °C during December it ranges from 12-22 °C. Ocean currents originating from the Indian Ocean flow along this coastline in two directions - from North to South during December to May and from South to North from June to November. During December-January there is a shift in current direction along the coast of the Bay when there is a northerly flow of warm water originating from Indian Ocean. Once again during the end December, when the study was conducted, there is a northerly flow reversal of the current, the direction shifting southwards. So, there is a gradual overlap of cold current from the north with the strong warm

current from the south. For this reason, the upper strata of water remains cold and the lower one is warm during the end of the year.

2. 2. Rivers in the Coastal plains near Chandipur

The Odisha Coastal Plains are the depositional landforms of recent origin and geologically belong to the Post-Tertiary Period. This region is the combination of several deltas of varied sizes and shapes formed by the major rivers of Odisha, such as the Subarnarekha, the Budhabalanga, the Baitarani, the Brahmani, the Mahanadi, and the Rushikulya. Therefore, the coastal plain of Odisha is called the "Hexadeltaic region". It stretches along the coast of the Bay of Bengal having the maximum width in the Middle Coastal Plain (the Mahanadi Delta), narrow in the Northern Coastal Plain (Balasore Plain) and narrowest in the Southern Coastal Plain (Ganjam Plain). Chandipur is in the North Coastal Plain comprises the deltas of the Subarnarekha and the Budhabalanga rivers and bears evidences of marine transgressions.

2. 3. A unique phenomenon at Chandipur beach

A unique phenomenon rarely seen anywhere else, the sea recedes by as much as five kilometres every day on the Chandipur beach, not just enthralling the onlooker but also offering an opportunity to literally walk into the sea. The sea recedes massively from the beach during ebb and returns to fill the emptiness during high tide. This hide-and-seek of the sea comes to play twice a day have significant bearing on the benthic lives on the beach. The study was conducted twice a day on the long stretch of the beach, covered by a mudflat followed by sandy beach towards the sea during low tide. This mudflat region is due to the presence of the deltas of the Subarnarekha and the Budhabalanga rivers. As this place is quite thickly populated, human interferences enrich the riverine discharges in this coastal delta region.

3. RESULTS

In Chandipur, when we observed quite a good numbers of castings of *Arenicola* during end of December, 2015 on the sandy beaches just following the mudflats during low tide we had undertaken this study to find out the species near the castings and holes beside. However, it was not possible to dig them out of the holes because of the presence of shallow sea water in the evening. At night the high tide swept the entire sand and the mudflat of the beach. We started our search in the same site in the following morning, once again when the sea receded due to low tide and found a few full grown individual at the sandy beach. All of the lug worms however were dead and only one complete organism could be observed. We were interested because this is the first report of *Arenicola* from this part of the globe and especially from any beaches of Bay of Bengal.

3. 1. Biology of lugworm

3. 1. 1. Morphology (Fig. 1)

When fully grown, the lung worm of the coasts of Europe measures up to 23 cm long and 1.0 cm in diameter. Other species of North American coasts range from 7.6 to 30.5 cm. The specimen recorded by us from the coast of Bay of Bengal, Chandipur, Odisha measures 26 cm in length and 1.5 cm in diameter. The body is like that of an earthworm, metamerically

segmented. The head end is blackish- red in colour and without any tentacles or bristles. The middle part is greenish-black, broader which terminates into a thinner yellowish red tail end. The middle part possesses bristles along the sides and also pairs of feathery gills. The anterior end also has a muscular eversible pharynx. There is a well developed system of blood vessels with red oxygenated blood.

Fig. 1. *Arenicola marina* (Linnaeus, 1758), on the sandy beach of Chandipur, India

3. 1. 2. Feeding behaviour

Lugworms are found on middle to lower shores in sand and muddy- sand and in sheltered, estuarine sediments. They live in J-shaped burrows, about 20 cm below the surface and can tolerate salinities down to 12 ppt (Fish, 1996).

These worms feed on organic material such as micro-organisms and detritus present in the sediment. They ingest the sediment while in the burrow, leaving a depression on the surface sand. Once the sediment is stripped of its useful organic content it is expelled, producing the characteristic worm cast. The animal lives in the burrow head down and correctly orient themselves for feeding. It has been shown that if an aquarium is tilted they will compensate for the difference and change position (Ruppert & Barnes, 1991).

Arenicola is a burrower. They dig tunnel in the ground which may reach 50cm and are lined by brown mucus. The depth of the burrow depends on body size; the smaller live in the surface whereas the larger worms penetrate deeper. In the head down posture they continuously swallow the ground containing food particles such as detritus, small animals, diatoms and green algae with their eversible pharynx.

The posterior part of the body is stuffed with ground food particles. Lugworms in the tide pool feed all day long but those living in the drying burrows feed only when the burrows are under water.

3. 1. 3. Life History

Lugworms have separate sexes with external fertilization and are known as 'broadcast' spawners, breeding several times in their life. In the wild they are sexually mature at 2-3 years. These worms live in separate burrows, and entirely separated populations will release their eggs and sperm at low tide just before the winter. Spawning in males is accompanied by intermittent muscular contractions of the body wall, causing ejaculation which continues for more than an hour until the worm is exhausted.

Females take much longer to spawn (up to 19 hours) and the process is less active, which reflects the fact that females keep eggs in their burrows whilst males must eject sperm onto the sand surface outside their burrows. Spawning occurs at low tide and as the tide comes in, the viscous sperm puddles are washed, diluted and enter the burrows of the females. The sperm puddles contain inactive sperm, the addition of seawater triggers them to become active and begin swimming.

Fertilization occurs in the female burrow and the larvae undergo early development here, later moving to the surface to be transported by the tide to settle on firmer areas. They then develop in mucous tubes attached to the substratum. Once developed, the worms are carried by the tide to more sandy/mud sediments where they can burrow (Fish, 1996).

4. DISCUSSION AND CONCLUSIONS

Although Fauvel (1953) did not mention *Arenicola* in his compilation of the Polychaete Fauna of India later it was found that in the tropical and sub-tropical regions *A. cristata* is the dominant species while *A. caroledna, A. glasselli, A. loveni and A. bombayensis* have also been reported. Bhatti and Soofi (1949) have recorded *A. cristata* from Karachi and Ranade (1952) reported the occurrence of *Arenicola* in Bombay (later described as a new species *A. bombayensis* by Kewalramani *et al*. 1959). Apart from these records the genus has not been known so far from any other part of India especially from the beaches of Bay of Bengal.

Several reports are there on total or partial local extinction of many littoral forms like *Solen, Gastrana, Donax, Donacilla* among molluscs and *Arenicola* and *Ophelia* among worms, *Eriphia* and *Chtamalus* among crustaceans due to eutrophication in coastal areas. We observed the same is true for these lug worms of Chandipur beach as during this time, which is in the day time a high degree of eutrophication in the sea water. The water turned dark green and the effect of such bloom could be observed even on the shore as the receding sea left a dark green patch all along the beach.

We could easily correlate the reason of such bloom as nutrient discharge in the coastal areas also favours exceptional algal blooms. The delta region receives huge amount of riverine discharge which might triggered such eutrophication. Though, in the littoral zones lug worms are generally adapted to be exposed at low tide for different periods of time, from a few minutes to more than five hours but the extent of eutrophication and the anoxic condition created due to that might have been the reason for their elimination.

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