News

Marine debris in little and Great Nicobar Islands

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News

The pristine Andaman and Nicobar Islands consists of a group of 572 Islands and located at an approximate distance of 1200 Km from Indian continent, off the East Coast of India in the Bay of Bengal (Lat. 6°45'-13°45' N and Long 92°15'-94°00'E) forming India's southeast border. The group of Islands are surrounded by the Andaman Sea which is considered to be in the cradle of Bay of Bengal. These Islands have proximity to some South East Asian countries like Malaysia, Myanmar, Thailand, Singapore and Indonesia. Average area of Andaman sea is about 6,00,000 Km2 with a coastal stretch of 1912 Km.

During the Marine Fisheries Census programme conducted by Fishery Survey of India (FSI), Port Blair, a sub-ordinate office under the administrative control of Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, New Delhi during February to March 2016 at Andaman and Nicobar Islands, an attempt was initiated to survey the debris littered at the pristine beaches of Little and Great Nicobar, which can be further termed as Marine Debris (MD).

The United Nations Environment Programme (UNEP) and the European Commission have adopted the most accepted definition of marine debris as "any persistent, manufactured or processed solid material discarded, disposed or abandoned in the marine and coastal environment, is an escalating environmental problem". During this survey, the most alarming environmental hazard i.e. plastic debris were found in all along the shore regions of Little and Great Nicobar (Figure 1) which were recorded promptly and these areas are under the strict surveillance of the Andaman and Nicobar administration for the welfare and protection of Particularly Vulnerable Tribal Groups and permission is strictly required to enter these areas. The population (about 10,000; according to our survey) in Great Nicobar is mixed i.e. occupied by the tribes (Shompen), Nicobaries and others, whereas the population in Little Nicobar (about 3,000; according to our survey) is only occupied by the Nicobari tribes. Majority of these areas are protected by law [Shompen Policy (2015)] in order to ensure the safety of the aboriginal tribes dwelling in these Islands. The recorded debris is not of the Indian origin; majorly originated from adjacent countries like China, Cuba, Indonesia, Malaysia, Myanmar and Thailand. Of all the debris, plastics occupy the major proportion which are highly non-degradable and cannot be degraded naturally. Moreover, the process of photo-degradation takes longer time in the ocean rather than on land because of the cooling capacity of the ocean.

Rubbish aggregation in the beaches poses a grave threat worldwide, starting from poles to equator. MD is the human introduced solid stuffs that are discarded at the sea or reach the sea through waterways or domestic or industrial effluents. Many recreational activities such as picnicking, boating, swimming and fishing in the sea can generate MD like plastics, food wrappers, fishing nets, containers, and paper cups etc. and most of MD are buoyant in nature and subsequently reach the beaches via the action of tides and currents. Unwanted quantities of plastic debris in these regions are strictly due to intentionally dumping of wastes violating the law of MARPOL 73/78 (the International Convention for the Prevention of Pollution from Ships) by the above said adjacent countries. The evidence to this statement points out to the illegal fishing and garbage generated in the coastal areas of China, Indonesia, Malaysia, Myanmar and Thailand and by International shipping services who dispose off their wastes in Indian waters. The role of foreign passenger ships in this regard is also notable. The dumped off wastes in Indian waters are carried to the shore by prevailing currents, circulated along the coastal waters and in the open sea and subsequently washed ashore.

Figure 1 Plastic pollution at Gandhi Nagar Jetty, Great Nicobar.

There are many instances of ingestion of plastic debris (PD) starting from marine invertebrates to large pelagic. Most of the plastic floating in the surface is being mistakenly ingested by marine birds, turtles and fishes. The author had also recorded significant ingestion of foreign plastic debris by pelagic thresher sharks (*Alopias pelagicus* & *Alopias superciliosus* unpublished data). Further, this may be a potential hazard to various turtles species, as their breeding and hatchlings

grounds are located in the Little and Great Nicobar area. After the Tsunami (26th December 2004), these islands notices the growth of beautiful coral reefs and it is assumed that these debris may also impose threat to these reefs. Further, plastic pieces can attract and hold hydrophobic compounds like PCB and DDT up to one million times background levels, which are considered as potential endocrine disrupter. PD can affect large marine animals on a broad scale and are responsible for deterioration of water quality, as the plastics are susceptible to contamination by waterborne organic pollutants and can leach potential toxic plasticizers due to percolation in the water medium. Ubiquitous and long lasting effects of PD are also observed when it gets accumulated resulting in fragmentation of macroplastics into small pieces in the marine environment and thereby increasing the potentiality of ingestion by marine organisms. Another major ecological problem contributed by the marine debris is the movement of invading or alien species which may carry many organisms such as small crustaceans, plankton, algae, bacteria and fungi. When organisms from one environment are carried to another part of the world, significant problems can arise. Recently PD recognised as a major threat to marine life due to polymers like Polyethylene (PE), which shares 64% production among synthetic plastic wastes produced. PE is most commonly found as a non-degradable solid waste and causes blockages in the intestine of fish, birds and marine mammals. Studies related to ubiquitous presence of debris; comforting them in the marine food web via ingestion by zooplanktons to apex predators is also evident. Thus, marine debris including PD can affect marine wildlife via entanglement and ingestion.

The tribal people of Little Nicobar collect the foreign plastic bottles and use it for their domestic use (Figure 2). Another major reason for getting abundant foreign material is the intrusion of fishermen of adjacent countries to these islands for salt water crocodile hunting. As shown in Figure 3, sea-surface current prevailing in that region might have resulted in debris being circulated continuously in the open sea and coastal areas, and subsequently washed ashore in the coastal areas. From the above study, it may be inferred that the garbage generated in the coastal areas of adjacent countries and by International shipping services are not disposing wastes properly and directly dump into the sea and this is taken by the currents and washed ashore on our pristine beaches of the little and Great Nicobar group of islands. Apart from this foreign plastic invasion through oceanic circulation, plastic and glass find several ways, like our domestic materials, to enter into our pristine islands and subsequently into the coastal ecosystem, since there is no proper solid-waste disposal practice.

Figure 2 Foreign plastic bottles used by Nicobari tribes in Little Nicobar

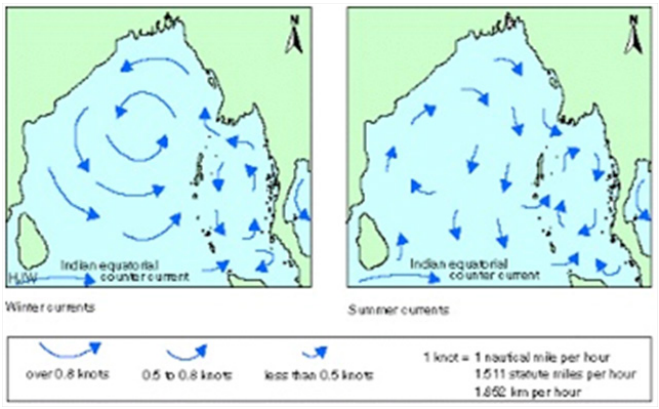

Figure 3 Surface current profile in the Andaman Sea.

Since the matter relates to international crisis, controlling the marine debris problem in our coast is not easy. However, an assessment and periodically monitoring of the floatable debris in the coastal waters, beach and underwater clean-up campaign can be taken up periodically to check the MD in our coastal water and beaches. Above all, quick setting up a pilot-scale plastic recycling plant near to these affected beaches will be advantageous in curbing this problem effectively. This will also generate revenue and improve the socio-economic status of the coastal community.

Introduction

Aquarium fish keeping has evolved as an indispensible part of interior decoration in the 21st century.[1] Colour is one of the major factors which determine the price of the ornamental fish in the world market.[2,3] The color of fish skin is primarily dependent on chromatophores (melanophores, xanthophores, erythrophores, iridophores, leucophores, and cyanophores) that contain pigments such as melanins, carotenoids (e.g. astaxanthin, canthaxanthin, lutein, zeaxanthin), pteridines, and purines Goodwin[4,5] established that fish do not possess the ability to synthesize carotenoids. The carotenoid pigmentation of fish results from the pigment present in the diet.[6] Many reports have demonstrated that skin color change over time depended on the level of carotenoid in the diet and differed among species.[7-11] Therefore, to increase the skin and flesh colour in captivity, fish must obtain an optimum level of carotenoids in their diet.[12]

Diversity of carotenoids in fish

Species specific carotenoids are known to occur in fishes.[13,4] The diverse carotenoids commonly occurring in fishes with their colours are tunaxanthein (yellow), lutein (greenish yellow), beta carotene (orange), doradexanthins (yellow), zeaxanthin (yellow orange), canthaxanthin (orange red), astaxanthin (red), eichinenone (red) and taraxanthin (yellow).[4,13,14] Accumulation of carotenoids in fishes mostly occurs in their integuments and gonads.[4,5] With few exceptions of Salmonidae fish where astaxanthin accumulates[8] in muscle.[5,9,15] Moreover in catfish, an esterified form of carotenoids exists in the integuments.[5]

Carotenoids absorption and transport

There is profound influence of age and physiological state of fish, type of feed and the dwelling environment and not merely species on the absorption and distribution of carotenoids in fishes.[15-19] Being hydrophobic in nature carotenoids are not easily solubilized in the

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aqueous environment of the gastrointestinal tract. So carotenoids are associated with the lipids to carry out transportation.[2,11,20] Several steps are involved in the intestinal absorption of carotenoids with inclusion of disruption of matrix, followed by dispersion in lipid emulsions and subsequent solubilization into mixed bile salt micelles, before being absorbed in enterocyte brush border.[2,21,22] Moreover the absorption of carotenoids is a much slower process in comparison to other fish nutrients.[2] For example approximately 18 to 30 hours are required for absorption of approximately 35% astaxanthin in Salmonids through the proximal intestine.[2,24-30] In addition the process of passive diffusion is involved in the intestinal absorption from micelles.[30,31]

Carotenoids metabolism and deposition

In fishes there does not exist any universal pathways for metabolism of carotenoids in tissues and its subsequent transformations.[9] It is suggested that organs such as liver or intestine where metabolites of carotenoids exist the metabolism of carotenoids take place.[2,32,27,33,34] Studies indicate fish classification based on capacity of metabolism of carotenoids.[10,23] One type of fish requires inclusion of specific oxygenated derivatives in diet as it is unable to perform the oxidation of ionone and the another type of fish such as gold fish or the fancy red carp are capable of oxidation of 4 and 4′ positions of ionone ring and hence have the potentiality of conversion of zeaxanthin and lutein to astaxanthin.[10,35]

Enhancement of fish pigmentation

Significant work has been done on pigmentation of many commercial fish species using carotenoids. In this respect, Mircoalgae such as *Chlorella vulgaris* is as effective as its synthetic counterpart in pigmentation of two most important ornamental fish species, Cyprinus carpio & Carassius auratus.[36] Enhancement of pigmentation was observed in *Xiphophorus helleri* when fed with formulated feed containing *Calendula officinalis* concluding that this lutein can be used as pigmenting source are some examples.[37]

Natural sources of carotenoids

Animals are incapable of biosynthesizing carotenoids, so diet is their sole source as only plants, bacteria, fungi and algae have the capacity for its synthesis.[38] However certain synthetic carotenoids are being developed for commercial utilization. However synthetic carotenoids have several limitations, firstly, synthetic processes have only specific carotenoids such as beta carotene; moreover they involve petrochemical solvents as well as complex organic solvents causing residual problems. Additionally synthetic carotenoids are costly to be used in many aqua feeds. Contrary to it natural sources contain varieties of carotenoids such as astaxanthin, alpha carotene, beta carotene, zeaxanthin etc. Specific plants such as paprika (*Capsicum* annuum) only contain Red xanthophylls (*capsanthin, capsorubin*) possessing pigmentation efficiency of canthaxanthin nearly half to a third.[39-41] Phaffia rhodozyma a microorganism contain around 85% astaxanthin have much significance as pigmenting source in commercial aquariculture.[2,42] Diet comprising of 1.5-2% carotenoids enriched strain of *Spirulina platensis* with *Haematococcus pluvialis* for a duration of three weeks significantly improves colour intensity in swordtail (Xiphorus helleri), topaz cichlids (Cichlasoma myrnae) and rainbow fish (Pseudomugil furcatus).[43]

Conclusion and recommendations

Detailed study on ornamental fish nutrition and colour enrichment is lacking. The above study depicts that carotenoids are indispensible part of commercial ornamental fish industry. Owing to the adverse effects of synthetic carotenoids on aquatic environment, natural plant sources can be harnessed and incorporated in formulated feeds for colour retention or enhancement in captive environment. It will create avenues for promotion of the ornamental fish industry as well as colour enhancer feed industry and employment generation.

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Conflicts of interest

None.

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