Biological Forum – An International Journal **11(1): 194-198(2019)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Enhancement of Reef Diversity using Plastic Waste: A Novel way to Reduce Plastic Pollution

CH. Ramesh*, S. Koushik, T. Shunmugaraj and M.V. Ramana Murthy
National Center for Coastal Research (NCCR)
NCCR Field Office, Ministry of Earth Sciences (MoES) Mandapam-623519, Tamil Nadu, India.

(Corresponding author: CH. Ramesh)
(Received 17 January 2019, Accepted 25 March, 2019)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: An increasing plastic debris accumulation around the globe and across the coastline has become a life threatening concern to humans and considerably to marine life. Several studies have reported the pervasive occurrence and distribution of plastic waste in several marine animals. Therefore, mitigation and reduction of plastic waste originated from land and marine sources have become challenging issues in the current research. In this study, we propose an innovative way to mitigate plastic by using plastic debris as an enhancer of the marine life. Underwater investigations revealed that various plastic forms supported the development of diverse marine algae, particularly the reef building crustose coralline algae and other invertebrates. This proposed method can be implemented for reducing the plastic debris rapidly from different environments.

Keywords: Plastic debris, plastic modules, crustose coralline algae, invertebrates, waste management.

How to cite this article: Ramesh, CH., Koushik, S., Shunmugaraj, T. and Ramana Murthy, M.V. (2019). Enhancement of Reef Diversity using Plastic Waste: A Novel way to Reduce Plastic Pollution. *Biological Forum – An International Journal*, **11**(1): 194-198.

INTRODUCTION

Since the discovery of plastics, they have become an essential part of the growing world population. However, an increasing accumulation of plastic debris in different environments, particularly in the marine environment has become a great concern to protect marine life as well as life on terrestrial environment. It was estimated that about 4.8 to 12.7 million metric tonnes of plastic debris discharge from terrestrial sources was found in the world's oceans in 2010 merely, and these statistical data may likely to increase near future (Jambeck *et al.*, 2015). Among several marine life forms, more often, the endangered sea turtles have been facing life threatening incidents in the ocean due to ingestion and entanglement by several types of plastics (Caron *et al.*, 2018). Occurrence of various forms of micro and macro plastics were reported from marine environment, causing potential threats to marine mammals, turtles, and birds (Pawar *et al.*, 2015). Disposed plastic in the marine environment can cause smothering to marine animals, reduces sunlight penetration, habitat degradation, and also decline of species (Pawar *et al.*, 2015). Considerably, corals that have contact with plastic were highly susceptible to microbial diseases (Lamb *et al.*, 2018). It takes several years for degradation of plastics. Therefore, management of plastic waste in the ocean as well as terrestrial environment is very crucial currently.

Along the shorelines of the world oceans, all types of plastics originated mostly from land based sources are encountered due to careless disposal and dumping of plastic waste, causing several threats to marine life. In order to mitigate different plastic polymers, several methods such as landfill, incineration, down gauging, re-use of plastics, plastics recycling, gasification, chemical recycling, mechanical recycling, thermolysis, hydrocracking and biodegradable plastics are being practiced in different places (Hopewell *et al.*, 2009; Al-Salem *et al.*, 2009). Utilization of this plastic except recycling has become a question mark now a days. Therefore, alternative and innovative methods are required to completely diminish plastics. In this study, we propose evidence based novel theoretical method in which various plastics are used to enhance the reef diversity in the marine environment.

MATERIALS AND METHODS

A. Field investigations

Several underwater surveys were carried out in coral reefs present in the different islands of Gulf of Mannar region, southeast coast of Tamil Nadu, India.

Various types of plastic forms found in the reef areas were meticulously investigated for their positive impact on development of marine diversity. Marine life forms growing on various plastic materials found in underwater and on shoreline were photographed using Nikon Cool pix.

B. Theoretical methodology on plastic management

Based on field observations, a novel theoretical methodology is developed in this study (Fig. 1). Initially, plastic waste from land based sources and marine environment are collected, dumped and sorted at respective local plastic recycling centers (Hopewell *et al.*, 2009). The segregated plastic types are further melted and overlaid as a thick external layer on natural hard substrates such as rocks, bricks, iron metal armour modules of different shape (Cube, grooved cube, Haro, Shed, Cob, Diahitis, Dolos, Seabee, Accropode, Tetrapode, paralleileped block) etc. or manufactured artificial substrates can be deployed. A complete coating and drying steps are needs to be performed before deploying them into sea. The thickness and quality of dried plastic coated substrates has to be checked by the expertise. Also, during melting of plastic waste, emission of harmful gasses needs to be captured using available gas filters. Experts on plastic chemistry are very much important in this process to study the chemical gasses released during melting of various plastic types and also to study the chemical constituents leaching in the ocean. After taking all the safety measurements, the dried plastic substrates are deployed in coastal waters or in dead reef areas or in barren land waters. The shape of artificial substrates may be designed according to the environment flexibility and suitability.

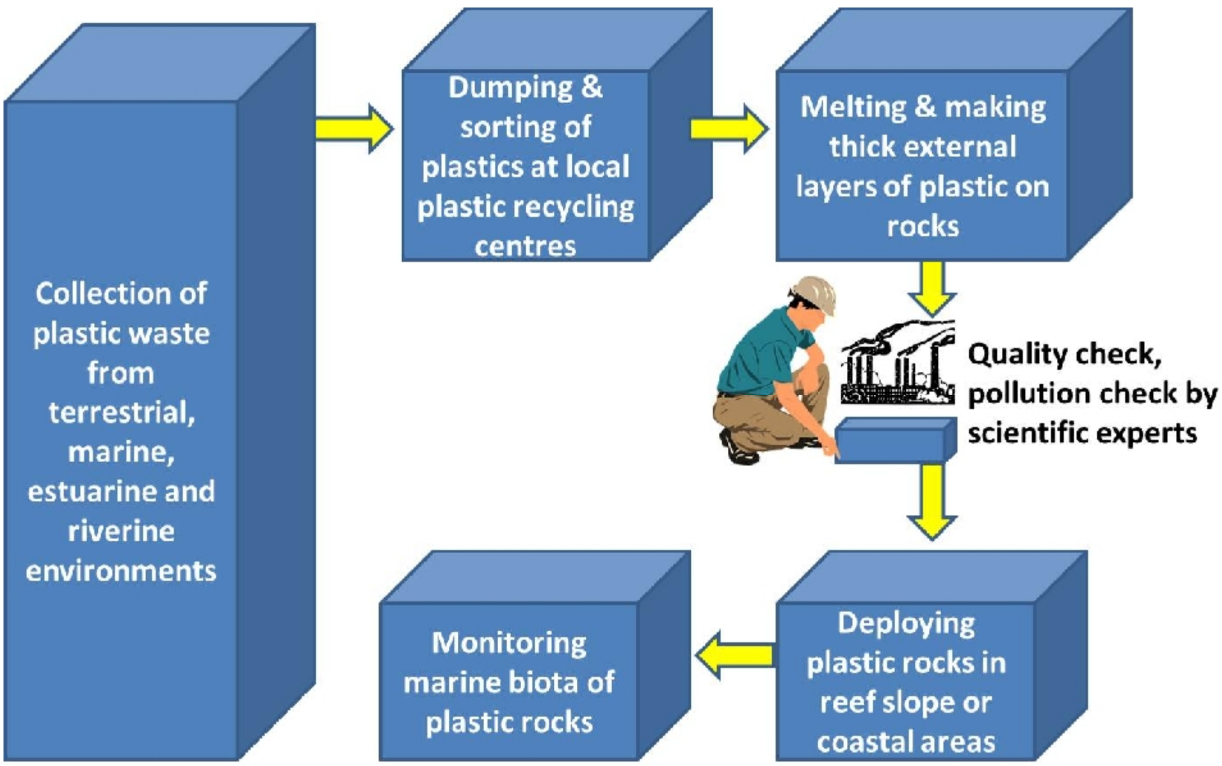

Fig. 1. Illustration depicting the various steps involved in developing plastic rocks using plastic waste.

The second method is to tie the compressed plastic waste with polypropylene and nylon nets and ropes. These plastic substances have supported the growth of crustose coralline algae greatly. Therefore, compressed plastic waste can be fully packed over hard substrates and tied with polypropylene and nylon substances.

RESULTS

Underwater investigations revealed that various forms of plastics were prevalent in coral reef areas. More frequently, entanglement of fish nets to corals was observed. Entanglement of fish nets have caused growth inhibition and disease propagation in entangled areas of coral polyps. Also, a dead olive ridely turtle *Lepidochelys olivaceea* found in the southern Hare Island was died due to entanglement of net as its neck was wounded deeply. During our field observations, these two incidents have influenced us to think about positive impacts of plastic to manage plastic pollution.

Therefore, careful observations were made in underwater and found the positive way to use various plastics for marine biodiversity development. Fish nets (nylon), plastic buoys (polyethylene), rubber tires, polycarbonate materials, and ropes (high-modulus polyethylene) that were settled down in the reef area have supported the development of reef building crustose coralline algae. Polystyrene buoys were also significantly found to support the development of hydroid and barnacles (Fig. 2). Along the shoreline and in reef area several other macro plastic wastes were observed, whereas micro plastics were highly prevalent on all the beaches.

Fig. 2. Various plastics found in the reef area and along the shoreline. Hydroids growing on thermoplastic or polystyrene (a); development of seaweed and shells on synthetic rubber tires (b); brown alga *Turbinaria* on polyethylene (c); coral Acropora growing on high-modulus polyethylene (HMPE) rope (d); *Sargassum* growth on polyamide –nylon (e); CCA overgrowing polyethylene (f); CCA overgrowing HMPE (g) and polypropylene (h); green alga *Halimeda* on HMPE(i); gooseneck barnacle *Lepas* on polypropylene tub (j); *Balanus reticulatus* on polyethylene terephthalate (k) and polystyrene (l); cyanobacterial mat (m) and CCA (n) on nylon fishing net; sedimented HMPE with newly growing algal cover (o); free floating low density polyethylene in reef area (p), high density polyethylene bag (q); HMPE washed on to dead coral rubbles (r); fishing ropes (s) and mixed types of plastics and cotton washed ashore (t).

DISCUSSION

Significantly our observations highlights that stable plastic forms in the reef area have supported the marine life forms, particularly, the reef building crustose coralline algae growth was more prevalent on plastics. Whereas, free floating or moving plastic waste were found to pose danger to marine animals such as the endangered sea turtles.

The plastic waste discarded in the open ocean by various sources ultimately reaches to the shoreline via coral reefs –the important ecosystems of sea. Also, land based plastic debris entered in the coastal waters has contact with various marine animals including corals. Irrespective of the origin of plastics found in the sea, more often, free floating micro and macro plastic debris was reported to ingested by marine mammals, turtles, birds and even corals and also entanglement by nets (Vegter *et al.,* 2014; Wilcox *et al.,* 2016). Therefore, plastic waste from different sources may be collected and subjected to this proposed method for reducing plastic pollution.

It is a well-known fact that use of plastic can cause worse health issues such as cancer to human, and lethal and subleathal effects to turtles (Clukey *et al.,* 2017). Therefore, the overwhelming plastic waste from marine and terrestrial environments may be collected and used to make plastic rocks as marine life enhancers. Melted plastic is overlaid as a thick external layer on heavy rocks and rubbles and deployed in the ocean. The deployed plastic coated rocks will initially occupied by the crustose coralline algae –the primary vital plant component in the reef area that supports the development of corals by secreting calcium carbonate as a hard substrate for coral polyps settlement. After CCA overgrowing plastic coated substrates, inhabitation and draping of marine life forms such algae, sponges, corals, molluscans, annelids and echinoderms begins on these substrates (Fig. 3). Since CCA is known to support the development of algal assemblage and corals, these rocks may be employed in bare reef areas to culture economically important *Sargassum* and *Turbinaria* as well as to restore corals in the dead reef area. These plastic rocks can be of great use in new 'habitat creation'. Therefore, we propose this method to be implemented to reduce the plastic waste.

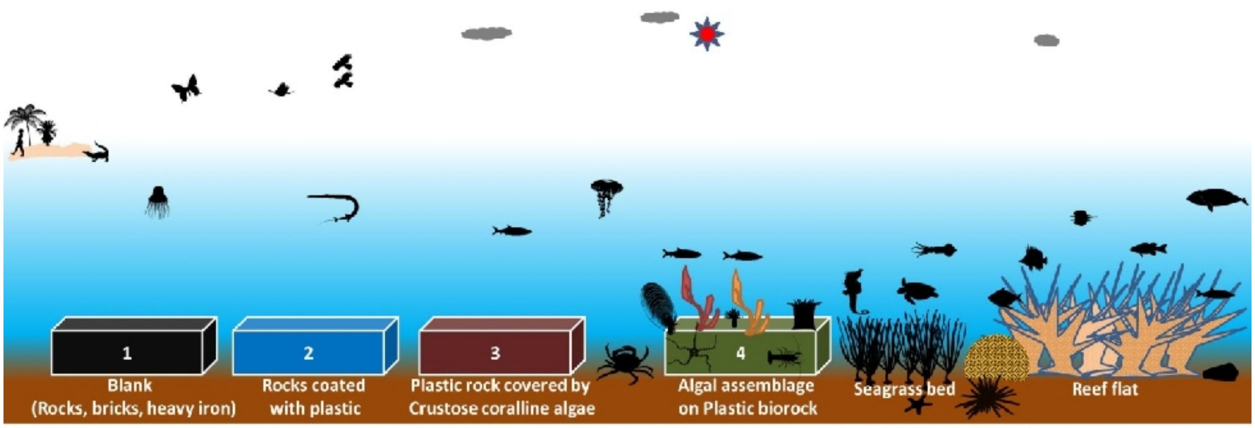

Fig. 3. Theoretical illustration showing pre-deployment and post-deployment changes in the plastic rocks placed in the reef area.

If the deployed plastics have found to support the growth of invasive species, those may be harvested for industrial applications. According to our present observations in this study, we have not found any invasive species growth on plastics. Mostly, crustose coralline algae which are the essential components of coral reef were found to grow on various plastics except polystyrene. A recent survey from Indonesia has also observed the similar finding that synthetic fiber fishing nets settled in the reef area have supported the growth of corals and fouling organisms (Hoeksema and Hermanto, 2018). Therefore, we propose this theoretical method for reducing plastic waste. Our observations also infer that plastic specific animals may be cultured in the coastal waters for biotechnological applications. Also, we recommend that heavy rocks that are used for jetty construction are may be plastic coated. Further, we invite scientists and researchers from different countries to test this proposed method for comparing the results with our field observations as well as with our theoretical method.

CONCLUSIONS

Indeed many educators and also the increasing population are not aware about the actual impact of plastics on marine environment. The use and disposal of plastics has increased enormously in different countries. Therefore, awareness via media (movies), legislations (such as ocean dumping act 1972) and ban on plastics are needs to be implemented strictly to completely stop the plastic pollution in land and water. Also, combing shorelines and coastal waters with plastic size specific grabbing combs or with various cleaning activities are recommended for plastic free Blue Ocean.

ACKNOWLEDGEMENTS

We are grateful to the Ministry of Earth Sciences, New Delhi for the financial support.

REFERENCES

Al-Salem, S.M., Lettieri, P. & Baeyens, J. (2009). Recycling and recovery routes of plastic solid waste (PSW): A review. *Waste Management,* **29**: 2625-2643.

Caron, A.G.M., Thomas, C.R., Berry, K.L.E., Motti, C.A., Ariel, E. & Brodie, J.E. (2018). Ingestion of microplastic debris by green sea turtles (*Cheloniamydas*) in the Great Barrier Reef: Validation of a sequential extraction protocol. *Marine Pollution Bulletin,* **127**: 743-751.

Clukey, K.E., Lepczyk, C.A., Balazs, G.H., Work, T.M. & Lynch, J.M. (2017). Investigation of plastic debris ingestion by four species of sea turtles collected as by catch in pelagic Pacific longline fisheries. *Marine Pollution Bulletin,* **120**(1-2): 117-125.

Hoeksema, B.W. & Hermanto, B. (2018). Plastic nets as substrate for reef corals in Lembeh Strait, Indonesia. *Coral Reefs,* **37**: 631.

Hopewell, J., Dvorak, R. & Kosior, E. (2009). Plastics recycling: challenges and opportunities. *Philosophical Transactions of the Royal Society B.* **364**: 2115-2126.

Jambeck, J.R., Geyer, R., Wilcox, C., Siegler, T.R., Perryman, M., Andrady, A., Narayan, R. & Law, K.L. (2015). Plastic waste inputs from land into the ocean. *Science,* **347**: 768-771.

Lamb, J.B., Willis, B.L., Fiorenza, E.A., Couch, C.S., Howard, R., Rader, D.N., True, J.D., Kelly, L.A., Ahmad, A., Jompa, J. & Harvell, CD. (2018). Plastic waste associated with disease on coral reefs. *Science,* **359**: 460-462.

Pawar, P.R., Shirgaonkar, S.S. & Patil, R.B. (2015). Plastic marine debris: Sources, distribution and impacts on coastal and ocean biodiversity. *PENCIL Pub. Biol. Sci.,* **3**(1): 40-54.

Vegter, A.C., Barletta, M., Beck, C., Borrero, J., Burton, H., Campbell, M.L., Costa, M.F., Eriksen, M., Eriksson, C., Estrades, A., Gilardi, K.V.K., Hardesty, B.D., Ivar do Sul, J.A., Lavers, J.L., Lazar, B., Lebreton, L., Nichols, W.J., Ribic, C.A., Ryan, P.G., Schuyler, Q.A., Smith, S.D.A., Takada, H., Townsend, K.A., Wabnitz, C.C.C., Wilcox, C., Young, L.C. & Hamann, M. (2014). Global research priorities to mitigate plastic pollution impacts on marine wildlife. *Endangered Species Research,* **25**: 225-247.

Wilcox, C., Mallos, N., Leonard, G.H., Rodriguez, A. & Hardesty, B.D. (2016). Using expert elicitation to estimate the consequences of marine litter on seabirds, turtles and marine mammals. *Marine Policy,* **65**: 107-114.