Forbidding invasive species – a way to attain sustainability of the coastal ecosystem

Coral reefs are the lifeline of islands and land masses, acting as a barrier against coastal erosion due to natural calamities and anthropogenic activities. We discuss here the pressure and impact of invasive marine algae *Kappaphycus alvarezii* on the coastal ecosystem. Using scientific results and environmental impact assessment (EIA) reports prepared by various research organizations, the harmful effects of introducing invasive algae in the coastal ecosystem are presented here. We intend to bring to the notice of policymakers in India, the urgency and importance of preserving corals not only through conservation efforts, but also by ensuring that the threats of invasive species are eliminated through appropriate legal mechanisms such as a ban – as it forms an important part of conservation and protection measures. We cannot afford to ignore the fact that corals are essential in maintaining healthy oceans and thus need to be protected from invasive species.

'If our grandchildren never have the opportunity to see living coral – it will be to the everlasting shame of our age… Let us not forget that we are responsible to posterity for the preservation of the beauties of the sea as well as for those on land… We have a moral obligation toward our descendants. We must not pass on to them a legacy of empty oceans and dead reefs' – Jacques-Yves Cousteau (excerpts from ref. 1). Corals are a core component of the marine ecosystem. They are marine polyps found in colonies in the shallow-water environment and are living organisms, breathing diffused gas through their exposed epidermal and gastro-dermal surfaces[2]. It would not be wrong to say that corals are the core of marine ecosystems. Coral reefs are communities of these living organisms forming some of the most diverse ecosystems in the world. However, they are also fragile ecosystems as they are sensitive to natural and anthropogenic disturbances. In India, coral reefs are facing threats mostly because of the lack of balance between the application of the principles of natural science and development science in coastal conservation and sustainable use of coastal resources for economic purposes.

The growth of algae has emerged as a serious challenge to the sustainability of coral reefs, and in turn, the ability of corals to protect and maintain environmental balance and counter the effects of climate change[3]. There is competition among a wide variety of organisms for the occupation of any unoccupied surface in the marine environment. Algae play an important role in colonizing most of the substrate[4]. The algal components are tertiary foulers which compete with the other marine organisms, particularly coral recruits on the dead coral surface, for perpetuation. Anthropogenic impact favours algal competition on the coral reef ecosystem and also induces major shift from coral to algae[5]. Eutrophication (excessive richness of nutrients that may be natural or caused by human activity) is also one of the factors which acts against coral recruitment processes.

K. alvarezii, a carrageenan producing red alga, was introduced at Palk Bay on the Tamil Nadu coast by Central Salt and Marine Chemicals Research Institute (CSMCRI), Bhavnagar, Gujarat for commercial cultivation in 2003 (ref. 6). These algae can grow over the coral colony, preventing access to sunlight. As a result, the corals suffocate because of inadequate availability of sunlight, restricting the photosynthesis of symbiotic algae associated with coral, and leading to their eventual death. Many peer-reviewed articles emerged both internationally[7–9] and nationally[10–12] pertaining to its impact on the survival rate of other marine organisms. Moreover, healthy discussions[10,13,14] on the protocol used for introduction and possible effects observed in the southeast coast of India were also reported by institutes under Council of Scientific and Industrial Research (CSIR), Government of India. In order to increase awareness against the cutivation of *K. alvarezii*, the Gulf of Mannar Marine Biosphere Reserve Trust (GoMBRT) published many photographs to demonstrate the ability of the invasive algae to penetrate as deep as 5–10 cm into the coral branches[15]. Even though the adverse effects of *K. alvarezii* have been reported[6], researchers laid emphasis on the benefit of *Kappaphycus* sp. for epifaunal diversity – which indicates that the conservation of pristine reef ecosystem was not a priority.

The need of the hour is to utilize the available funds for research which would ensure the health of our coastal and marine ecosystems in the face of rapid development and industrialization, instead of carrying out EIA on the same issue that has already been scientifically proved by peer-reviewed articles. Research and action must be directed towards searching for methods to bring about a resolution of the conflict that occurs between the objectives of environmental conservation and development. There is a need to ban the invasive species in order to prevent it from taking over the corals in their natural environment – in the same way as there is a need to check the type of development that does not ensure sustainability of coastal resources and marine ecosystems. The invasion on coral reef ecosystems by invasive species serves as a fitting metaphor for how sometimes, in the quest to develop the economy rapidly, we end up compromising on the quality of the environment. A symbiotic relationship between environment and development should be promoted by tapping the economic benefits of coral reefs through protection and conservation.

Corals are coastal resources that serve multiple purposes and if protected and utilized sustainably, they can contribute to development financially as well for sustained coastal protection. There is an urgent need for ecological management policy that recognizes their role in maintaining healthy oceans, and the importance of symbiotic relationship among the various marine organisms vis-à-vis coral reefs. The best environment conservation plans fail to materialize mainly because the principles of sustainable development are not applied. Extraction may be profitable for the short-term, but a long-term strategy is indespensible in order to help our oceans mitigate the harmful effects of industrial development and climate change.

The oceans of the world are already under pressure from various human activities. An example of this is the creation of dead zones in the Baltic sea (in this case, due to excessive use of fertilizers), which

serve as a warning against the inducement of any such activity that may create an environment in the sea which poses as a potential site for becoming a dead zone[16]. Addressing the issue of invasive species will be a step forward in the direction of eliminating one of the serious threats faced by oceans. Thus, a ban on introducing invasive species that eat into the natural ecosystem, through promulgation of a proper law for the same, will go a long way in upholding sustainable development along the coasts of India.

1. Hatziolos, M. E., Hooten, A. J. and Fodor, M., *Coral Reefs; Challenges and Opportunities for Sustainable Management*, The World Bank, Washington, DC, USA, 1998, p. iii.
2. Pechenik, J. A., In *Biology of the Invertebrates*, McGraw-Hill Co, USA, 2000, 4th edn.
3. Crabbe, M. J. C., *Comput. Biol. Chem.*, 2008, **32**(5), 311–314.
4. Nylund, G. M. and Pavia, H., *Mar. Biol.*, 2003, **143**, 875–882.
5. Barott, K. L., Williams, G. J., Vermeij, M. J. A., Harris, J., Smith, J. E., Rohwer, F. L. and Sandin, S. A., *Mar. Ecol. Prog. Series*, 2012, **460**, 1–12.
6. Satheesh, S. and Kitto, M. R., *Curr. Sci.*, 2012, **103**(8), 875–876.
7. Conklin, E. J. and Smith, J. E., *Biol. Invas.*, 2005, **7**, 1029–1032.
8. Kamalakannan, B., Jeevamani, J. J. J., Nagendran, N. A., Pandiaraja, D. and Kutty, N. K., *Coral Reefs*, 2010, **29**, 1077.
9. Edward, J. K. P. and Bhatt, J. R., In *Invasive Alien Plants: An Ecological Appraisal for the Indian Subcontinent* (ed. Bhatt, J. R.), CABI, UK, 2012.
10. Pereira, N. and Verlecar, X. N., *Curr. Sci.*, 2005, **89**(8), 1309–1310.
11. Chandrasekaran, S., Nagendran, N. A., Pandiaraja, D., Krishnankutty, N. and Kamalakannan, B., *Curr. Sci.*, 2008, **94**, 1167–1172.
12. Kamalakannan, B., Jeevamani, J. J. J., Nagendran, N. A., Pandiaraja, D. and Chandrasekaran, S., *Curr. Sci.*, 2014, **106**(10), 1401–1408.
13. Tewari, A., Eswaran, K., Rao, P. V. S. and Jha, B., *Curr. Sci.*, 2006, **90**(5), 619–620.
14. Verlecar, X. N. and Pereira, N., *Curr. Sci.*, 2006, **90**(5), 620.
15. SDMRI, Report submitted to GoMBRT, Ramnathapuram, Tamil Nadu, 2010, pp. 1–12; http://www.sdmri.in/admin/pdf/1306920757sdmri2.pdf (accessed on 28 February 2014).
16. Tirado, R., In *Dead Zones: How Agricultural Fertilizers Kill our Rivers, Lakes and Oceans*, Greanpeace, Toronto, Canada, 2008, p. 8; http://www.greenpeace.org/canada/Global/canada/report/2008/7/dead-zones.pdf (accessed on 28 February 2014).

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Dual burden of malnutrition and hidden hunger among tribal children of North East India

The new edition of the *American Journal of Clinical Nutrition* includes a supplementary volume on the double burden of undernutrition and obesity in Latin America. It could gather nine articles from different countries signifying the major health implication of the same. The implication of double burden is found to be major in some countries like Uruguay[1], but in others like Brazil, its impact is trivial due to the inclusive social policies[2]. But the condition is

Table 1. Dual burden of stunting and stunted overweight cases among the Mising tribal children of North East India (according to WHO 2007 criteria)

	Boys					Girls				
		Total stunt (WHO, 2007)		Stunted overweight (WHO, 2007)			Total stunt (WHO, 2007)		Stunted overweight (WHO, 2007)	
Age (years)	Total	Number	%	Number	%	Total	Number	%	Number	%
6	96	41	42.7	0	0.0	105	48	45.7	3	2.9
7	93	34	36.6	3	3.2	102	38	37.3	5	4.9
8	100	24	24.0	4	4.0	101	34	33.7	3	3.0
9	96	41	42.7	4	4.2	100	26	26.0	7	7.0
10	107	12	11.2	3	2.8	105	53	50.5	7	6.7
11	98	16	16.3	5	5.1	105	29	27.6	5	4.8
12	101	23	22.8	5	5.0	107	28	26.2	3	2.8
13	103	26	25.2	8	7.8	92	27	29.4	8	8.7
14	90	18	20.0	5	5.6	91	36	39.6	5	5.5
15	90	19	21.1	3	3.3	97	36	37.1	5	5.2
16	91	32	35.2	8	8.8	100	33	33.0	7	7.0
17	93	25	26.9	6	6.5	104	32	30.8	8	7.7
18	99	41	41.4	5	5.1	100	30	30.0	11	11.0
19	96	33	34.4	9	9.4	90	23	25.6	7	7.8
Total	1353	385	28.5	68	5.0	1399	473	33.8	84	6.0