is a good ratooner. Varieties Co 91010 and Co 2002-22 will be micropropagated and released for general cultivation after big mill test.

4. AOAC. Official Methods of Analysis, Association of Official Analytical Chemists, Arlington, USA, Ch. 6, p. 16.

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Effects of 2004 tsunami on marine ecosystems – a perspective from the concept of disturbance

The word Japanese tsunami means ‘harbour waves’. They are triggered by largescale perturbations of the ocean floor. Earthquakes as perturbations account for most of the tsunamis recorded so far. Shetye1 has provided an excellent account on the generation and propagation of tsunamis in marine ecosystems. An earthquake of M 9.0 occurred offshore in northwestern Sumatra (epicentre: 3.32°N and 95.85°E) on 26 December 2004. It generated a huge tsunami, which devastated the Andaman and Nicobar Islands (AN), east coast of India and south Kerala. The objectives of this report are to provide a different look at the tsunami 26 December 2004 as a ‘disturbance’ to marine communities of the Indian Ocean and to present questions related to its most probable impacts that could be addressed by future researches. A few reports on the impact of the tsunami caused by the Sumatra earthquake were published recently2,4,5. But none of them focused on the tsunami as a disturbance to marine ecosystems.

Disturbance is a concept long recognized in ecology. Its prominence is witnessed by popular theories regarding its effects on organization and functions of ecological communities9. Excellent reviews are also available7–9. Disturbance is broadly defined as an uncommon, irregular event that causes abrupt structural changes in natural communities, thus moving them away from static or near-equilibrium conditions2. Pickett and White8 defined it as any relatively discrete event in time that disrupts ecosystem, community or population structure, and changes resources, availability of substratum, or the physical environment. Resh et al.4 included the criterion of intensity (physical force of the event), which is outside the predictable range in a typical disturbance. A tsunami fits well within all these definitions. Briefly, it is an infrequent, rare disturbance to marine communities, but with high intensity.

This tsunami devastated the AN, east coast of Andhra Pradesh and Tamil Nadu and south Kerala. The east coast of India from Srikakulam in Andhra Pradesh to Nagappattinam in Tamil Nadu was severely affected. Considering zonation of the ocean, littoral, neritic and benthic zones of AN as well as littoral and neritic zones of the Bay of Bengal (BB) are likely to have been disturbed intensively. More particularly, at the littoral and neritic zones of BB and AN, kinetic energy of the tsunami was converted to potential energy and resulted in severe devastation. The southern part of AN, located within 500 km from the epicentre of the earthquake was disturbed more severely. As one of largest tsunamis, triggered by the third largest earthquake on record12, it is expected that the disturbance must be also severe in intensity. This one occurred in a less open Indian Ocean, in low latitude. It may be unique for monitoring disturbance to the tropical marine ecosystems. Physical disturbance is considered to be an important factor structuring marine communities3,9,11–14. Thus biotic communities, physical habitats and their heterogeneity, nutrient distribution and exploitable resources of these zones could be disturbed significantly. Future studies should focus on tsunami-disturbed changes in:

- Distribution, habitat and yield of exploitable resources like fishes, crustaceans and molluscs.
- Species richness and rates and sequences of recovery, in cases of species loss; primary productivity by phytoplanktons.
- Species composition, distribution and abundance of the principle taxa of primary producers (dinoflagellates in BB).
- Trophic status of the regions in the ocean around AN.
- Species richness, community structure and standing crop of macro and meio fauna.
- Zooplankton biomass as estimate of secondary production in BB.
- Impact of sedimentation and mud shield on coral reef communities in AN.
• Changes in nutrients of BB due to massive influx of organic and inorganic matter from coastal mainland.
• Deviations, if any, in unique hydrographic and oceanographic features of the disturbed zones.
• Species loss, changes in habitat heterogeneity and biotic interactions at intertidal zones of BB and AN and species recovery rates and sequences of coral reef communities in AN.

Considerable pre-tsunami data are available for the above-mentioned aspects of BB and AN in Quasim and Kureishy (see also references therein)14. These are broad and prominent impacts. Subtle disturbances also need scientific attention; for instance, changes in food webs and biotic interactions like prey–predator relationships.

Tsunami-disturbed marine communities also offer good opportunities for experimentally testing available theories on disturbance. For instance, Connell2 hypothesized that in disturbanceless community, superior species will eliminate inferior species, thus reducing species richness; if disturbance is too large, the superior species will be eliminated and inferior species will colonize the system. Tsunami-disturbed coral reef and intertidal communities of AN are ideal systems for testing such hypotheses by long-term researches, which would yield valuable data on colonizing species that exploit the niches at disturbed habitats. Data on species diversity and community organization of coral reefs of AN are also available for comparative analysis.15

Post-disturbance recovery of species with long lifecycle in disturbed habitats is another area of long-term research. This is because according to Huston6, severe disturbance would eliminate such species from the community. Their recovery will also require relatively longer duration. Similarly, small-scale experiments may focus on single questions, while large-scale researches may test multiple hypotheses in an integrated fashion. Such researches are indispensable because both AN and BB constitute a significant part of the ‘exclusive economic zone’ of India. AN is one of the potential marine biosphere reserves in India. Moreover, the possibility of occurrence of such events in future in this region cannot be ruled out.10 Thus systematic researches may reveal many facts regarding the impact of a high intensity disturbance, tsunami on marine communities. In brief, tsunami-disturbed Indian Ocean needs systematic researches on structural and functional components of marine communities in the light of established concept of disturbance in marine ecology.


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Long-range monsoon rainfall prediction of 2005 for the districts and sub-division Kerala with artificial neural network

Weather forecasting (especially rainfall) is one of the most important and challenging operational tasks carried out by meteorological services all over the world. Weather prediction is a complicated procedure that includes multiple specialized fields of expertise. Lorenz3 separated weather forecasting methodologies into two main branches in terms of numerical modelling and scientific processing (AI) of meteorological data. The most widespread techniques used for rainfall forecasting are the numerical and statistical methods. Even though researches within these fields have been conducted for a long time, successes of these models are rarely visible.

The dynamical models are based on the system of nonlinear operator equations governing the atmospheric system. The physics and dynamics of the atmosphere can be better understood by none other than these set of governing equations. But in the absence of any analogue solution of this system of operator equations, numerical solutions based on approximations and assumptions are the only alternative. Furthermore, the chaotic behaviours of these nonlinear equations sensitive to initial conditions, make it more difficult to solve these equations. As a result, there is limited success in forecasting the weather parameters using the numerical model. The accuracy of the models is dependent upon the initial conditions that are inherently incomplete. These systems are not able to produce satisfactory results in local and short-term cases. The performances, however, are poorer for long-range predic-