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TUNA FISHERY RESEARCH IN INDIA

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Tunas, belonging to the family Scombridae, are important worldwide for their economic and ecological value (Collette and Nauen, 1983). They are found in tropical and subtropical oceans around the world and account for the major proportion of the world fishery products. They are central components of the pelagic fisheries that operate in the exclusive economic zone.

Tunas are in great demand throughout the world market due to their excellent meat quality (FAO, 1997). The tuna industry has been a successful program in the past. However, problems on the fishing stock status have occurred due to the recently increased fishing intensity. Some tuna species and fisheries are at a risk of collapse and *Thunnus albacares* is now listed under the IUCN Red list of threatened species (Punt, 1996). Thus, there is an urgency to conserve the tuna resources.

To better conserve and maintain a sustainable yield of these species, there is a need to understand large-scale patterns of tuna stocks in space and time. The Indian Ocean Tuna commission (IOTC) was established in 1996, in order to strengthen the management role of the previous body, the Indo-Pacific Tuna Management and Development Programme (IPTP). One of the most essential tasks for the IOTC is therefore to elucidate the stock structure as the basic information needed for management.

India is fortunate to have rich tuna resources. Tuna fishing in Indian waters is carried out by small scale mechanized and traditional vessels operating in waters up to about 80 m deep all along the coastline of India and by oceanic exploratory survey and commercial longline vessels fishing in the Indian EEZ under joint-venture schemes (Somavanshi, et al., 2000). Several studies have been undertaken on population dynamics and over the years the Fishery survey of India and the Central Marine Fisheries Research Institute have given excellent details of the tuna fishery and their exploitation across the Indian waters (see Sudarsan and John, 1993; Pillai & Mallia, 2007). This clearly shows that tunas are important in the national context and are of important commerce commodity. There is however a general lack and concerted effort to understand the genetic structure of the stocks/populations across the Indian seas, which are critical parameters while deciding policies regarding exploitation and management of these resources. While there have

been several genetic studies on tunas in the Pacific and Atlantic Oceans, there has been no study on tuna stock structure specifically in the Indian region. The only preliminary molecular work done is on skipjack tuna using mitochondrial DNA (mtDNA) and microsatellite DNA techniques (Menezes et al., 2006; 2008).

mtDNA offers an alternative analysis for the role of migration on the genetic structure. As it evolves quickly without major rearrangements and its transmission is maternal, mtDNA polymorphism is a good historical marker for analysis of lineages. The presence of a typical mitochondrial clone in only one region or the presence of different predominant mitochondrial clones in each region would confirm the isolation among these regions. Quantification of intraspecific variation with mtDNA has been heralded as a powerful technique to examine questions of population structure and migratory movements in a variety of large aquatic vertebrates, including whales and tunas (Baker et al., 1990; Nakadate et al., 2005). Microsatellites are also very useful markers for population genetic studies, as well as for strain identification, paternity analysis, and mapping purposes because of their hypervariability, codominance and ubiquity in eukaryotic genomes (Broughton and Gold, 1997).

Tuna forms an important marine resource in India. There are a number of species on the west and east coasts of India including the Lakshadweep and Andaman Islands. They are highly migratory scombroid fish group and the development of tuna fishery in the inshore and oceanic waters of the EEZ of India need priority attention. We do not know whether the species occurring in the east coast, west coast, Lakshadweep and Andaman Islands belong to the same stock. Because we lack an understanding of the population genetic structure of the tuna species, there is much confusion in the views concerning the origin of recruits to the various tuna fisheries. Hence, genetic characterization and stock structure information is needed for making conservation strategy and enhancement program for sustainable use.

The tuna resources presently exploited in India are the small tunas, such as *Euthynnus affinis* (Little tuna), *Auxis thazard* (Frigate tuna), and *Thunnus tonggol* (longtail tuna) in the coastal sector, and *Katsuwonus pelamis* (skipjack tuna) and *Thunnus albacares* (yellowfin tuna) in the oceanic waters. The stock structure in each of these tuna species is now being studied at the National Institute of Oceanography (NIO), Goa, under the project entitled "Genetic characterization of tunas using DNA markers". The Project aims to assess and quantify genetic variation, differentiation and relationships of the tuna species from different

localities of the west and east coasts of India including Lakshadweep and Andaman islands which will provide insights into the pattern of colonization of each species in the Indian waters. The genetic composition, species specific diagnostic markers and levels of genetic variation within each species will also be obtained which will facilitate the design of effective conservation and management strategies.

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SOME FINDINGS OF AN EXPEDITION TO UNRAVEL THE DETAILS OF TSUNAMI

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The SEATOS (Sumatra Earthquake and Tsunami Offshore Survey) was a scientific expedition going up to the epicentre of the tsunami that devastated large parts of Asia on December 26, 2004. The work allowed our team to plumb the depths of the ocean in quest of the mysteries that lie embedded there. The expedition was funded by the Discovery Channel, and was well worth going up to the point of origin of tsunami. The data and photographs collected during the expedition were one-of-its-kind and these yielded groundbreaking information because they revealed the cause and nature of the disaster.

For 17 eventful days in May 2005, an international, interdisciplinary, 27-member team of seismologists, geophysicists, oceanographers, biologists and computer modellers, including the present writer as India's sole representative on the expedition, was on board the vessel *MV Performer*, a purpose-built deep-water research ship. The team included marine scientists from the US, the UK, France and Australia, among other countries. Their mission was to conduct a detailed survey of the seafloor in the vicinity of the epicentre of the Great Sumatra Earthquake. Measuring 9.3 on the Richter Scale, it had set off a chain of events that the world was ill-prepared to face.

But not anymore, the results of the expedition team's efforts, backed by the state-of-the-art geophysical survey tools and a remotely-operated vehicle (ROV), were truly astounding. These unravelled the phenomenon behind the Asian tsunami: the forces

that interacted with each other following the initial undersea tremor, and unleashed a series of landslides which, in turn, triggered the killer waves.

It took the SEATOS team months to sift through and analyse the ROV photographs and data and draw clear conclusions from them to enable the world to understand the tsunamis better.

The December 26 tsunami killed nearly 300,000 people in ten Asian countries. The absence of a tsunami warning system and the lack of awareness among the people about the oncoming disaster contributed to the high fatality rate. The SEATOS expedition was designed specifically to shape scientific understanding of tsunamis with a view to minimising loss of human lives in the future.

The tsunami affected India, Sri Lanka, Thailand, Indonesia and other countries around the Indian Ocean. It was the worst natural disaster in recorded history. Yet, barring the ghastly footage of the aftermath of the disaster, and a few stray home video images captured by fleeing tourists, very little was known about the actual nature of the calamity. That knowledge gap is precisely what the SEATOS scientific expedition set out to address.

What was it that triggered the deadly tsunami? Ruptures of about 30 km. below the ocean surface gave thrust to a side of an underwater mountain range up by as much as 12-13 metres. As the plates came apart and moved over a distance of more than 1200 km, it lifted the seabed and the entire ocean above it. The dislodged water sparked a series of giant ripples, causing a tsunami.

According to the fresh estimates done by the SEATOS team, only 3 metre high but more than hundred kilometres in length, the tsunami, with 200 trillion tonnes of water, travelled at a speed of over 800 kmph. As it neared the coast, it slowed down, but the end of the wave, more than hundred km behind, was still in a relentless rush. When the rear end caught up, it compressed the wave into a 40 m high wall of water. It pounded the Banda Aceh with a force of 60 hurricanes. Twenty-five minutes later, a 20 m wave hit Phuket. Forty-five minutes after that, it engulfed the island of Phi Phi. At the same time, on the other side of the Ocean, the wave travelling west battered Sri Lanka and India.

The first task before the SEATOS team was to create a detailed and accurate map of the ocean floor terrain around the area of the faultline. This was done using specially developed compressed seismic