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Notes on Natural History

Visual Impact of Tectonic Movements on the Caves in Andaman Islands

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Study Area: Andaman & Nicobar islands, India

Coordinates: 6°45' & 13°41'N latitudes and 92°12' & 93°57'E longitudes

Key words: Submerged Caves, Land upliftment, Cave swiftlet, Tsunami

Introduction:

Caves are considered as unique natural laboratories for studying biological and geological processes. Constant geophysical characteristics, perpetual darkness, low energy input with all such unique characteristics caves harbour a typical set of fauna especially adapted for the subterranean environments (Biswas, 2010; Biswas & Harries, 2011). The region of the Burmese arc including the Andaman and Nicobar Islands is characterized by highly seismic, seismic and aseismic zones, with earthquake segments of shallow to intermediate centre in the earth crust (Kumar, 1990). The tectonic activity of the Andaman area is intense along two broad belts: the western non-volcanic arc comprising the Andaman Nicobar Islands, and the eastern volcanic arc. The eastern island arc is the most active belt along which a lithospheric convergence has taken place (Jafri *et al.*, 1993).

A subduction of the Indo-Burma plate occurred due to the M 9.15 earthquake in 26 December 2004, the epicentre of which was located 150 km off the west coast of northern Sumatra Island in Indonesia (Sankaran *et al.*, 2005). It led to significant ground deformation in the Andaman and Nicobar region. As the Andaman and Nicobar Islands lie within the subduction zone of the Burma plate, north of the epicentre of mega tsunami, it was the most affected region in India (Rao & Chary, 2005; Jain *et al.*, 2005; Sankaran *et al.*, 2005; Rajendran *et al.*, 2007). In the subsequent months, series of aftershocks were also realized. The Mega-disaster not only affected people but also the ecosystems and wildlife (Sankaran *et al.*, 2005) in these islands. As per Manchi & Sankaran (2009) cave habitats of these islands were also affected severely due to this geological disaster.

Though, the earlier report of Manchi & Sankaran (2009) was restricted to the inland caves at Chalis-ek on North Andaman and caves on interview Islands, further more of a special survey was done where all types of caves were considered on the basis of visual qualitative impacts rather than quantifying it. In the present survey, our major focus was to know the effect of the tectonic activity on different types of caves.

Area Surveyed:

Sankaran (1998) located and mapped 384 caves in Andaman and Nicobar islands, of which 236 (61.5%) were inland caves (located in forests) and the rest were coastal caves (located on the shore). Among the 236 inland caves, 86% were underground out of which 1% was located at the origin of a stream. Fourteen percent of the caves apparent above the ground were sub-divided as located above ground on

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inland cliffs (3%) and 97% on inland hills (Sankaran, 1998; 2001).

In the present survey total 314 caves in North plus Middle Andaman and Ritchi's Archipelago were visited. The survey was done during February and March months of 2012 & 13. All the explored caves were observed minutely and the post-tsunami changes like rock fall inside the cave and/or opening/closing of the cave entrances etc. were documented minutely. For understanding the changes in the type of caves we followed the standards described by Sankaran (1998) and all the 384 limestone caves known from the Andaman & Nicobar islands were categorized as per Sankaran (1998) into eight particular types (Table 1).

Observations and Discussion :

Out of 384 limestone caves, 325 caves in Andaman islands were of five types. The number of Post tsunami type of caves in Andaman islands did not change but Kruskal-Wallis H test showed the types did differ considerably ($\chi^2 = 16.040$, $p = 0.042$; Table 1). The coastal caves seem to be affected significantly, showing major alterations in the types of caves pre and post tsunami.

Map 1. Location and number of surveyed caves and unsurveyed caves

Table 1. Cave types in the Andaman Islands pre (Sankaran, 1998) and post (Manchi, 2014) tsunami disaster

Cave Type*	A	AB	B	BD	Ci	Cii	Ciii	D	Total
Pre-tsunami (Sankaran, 1998)	0	1	92	3	0	199	0	30	325
Post-tsunami (Present Report)	2	14	72	3	0	199	0	30	320
Difference in number of caves	+2	+13	-20	0	0	0	0	0	15
Caves closed			5						5
New caves found (Present Report)	1		2			7			10

*Table Legends: A = On, coast approachable on foot; B = On, coast, entrance partially submerged and access by swimming into cave; AB = On coast, Approachable on foot after swimming ashore; BD = Cave above sea level on cliff face ending in the sea; Ci = In the forest, at the origin of stream; Cii = In the forest, cavern bellow the ground; Ciii = In the forest; D = Midway on inland cliff; E = Japanese bunker (manmade tunnel). (+) indicates addition and (-) indicates decline in cave number.

Of the four types of coastal caves (Table 1), type B were found to be the most affected (Manchi & Sankaran, 2009). In the present survey, other than the caves reported earlier few other caves were also found to be affected by the dislocation of huge rocks inside. Entrances of Five caves (2 caves on Henry Lawrence and 3 caves on South Button Islands) are permanently closed because of the heavy rock fall at cave opening. Dislocated rock blocked the cave entrances leaving small spaces which may allow aeration and insect trafficking from the cave.

Since caves are the biosphere having a complete isolated ecosystem, it becomes very important to understand each biotic and abiotic systems of it in detail. The caves once collapsed perhaps get buried with itself all such precious species which were either unknown to the world or endemic to that particular cave (Biswas, 2009). Nevertheless, the rack fall rising of land out of the sea by almost 1.32 M (Sankaran *et al.*, 2005) converted 15 submerged coastal caves (B type) into dry caves i.e. A (2 caves) and AB (13 caves). It is quite obvious that changing of wet caves into dry must have led to microclimate changes inside caves. This has already been observed by Manchi & Sankaran (2009) and Manchi (unpublished) that sudden changes in microclimatic conditions inside the caves of Andaman islands

might have resulted to mortality/shifting of the several sensitive fauna from the effected caves.

As per Manchi & Sankaran (2009) the rock fall inside the caves at Chalis-ek led to extinct the Edible-nest swiftlet (*Aerodramus fuciphagus*) populations from the same venue either because of disturbance in microhabitat or closure of caves entry due to blockage by rock fall. The effects on such a troglone species like swiftlet directly indicate that the rock falls in such tsunami affected caves must have affected/abolished various sensitive cave fauna (troglonites and stygonites) too. As baseline information regarding cave fauna in the region is lacking, in the present state it's difficult to estimate the level of damage in this regard. Closure of five earlier known caves and *vis a vis* discovery of 10 new caves (Table 1) makes total number of caves in the Andaman islands from 325 to 330 and in total Andaman and Nicobar islands from 384 to 389 caves.

As the caves are most fragile structure in the world, a little disturbance in its ambient environment may harm several times more to it. As the island arc is, one of the most active parts of the earth, undergoing lot of geological changes it's important to understand composition of flora and fauna available there. Further, presence of good number of limestone caves depicts requirement of bio-speleological studies in the region.

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