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The Late Quaternary sediments from Tripura, North-east India: perspective on the constraints of their radiocarbon dating

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ABSTRACT

The Quaternary sediment deposits in Tripura, North-east India are very limited and are restricted to the Holocene aged sub-surface sediment deposits. There is a dearth of Early Quaternary sediments explored from the region. Four sub-surface sediment profiles were collected from northern, western and southern parts of Tripura. The ^{14}C radiocarbon dates of the profile sediments collected were mostly Holocene aged. There was also noted reversal of dates that indicated overturning of sediments due to natural or anthropogenic factors in the region. Few other studies from the region also recorded Holocene ages of sub-surface sediment deposits. Natural phenomenon and anthropogenic activities may have caused the paucity of well-preserved Early Quaternary sediments.

Key-words: ^{14}C dates, Quaternary, sub-surface sediments, Tripura.

INTRODUCTION

Tripura is the southernmost state of Northeastern India, which has the Ganga-Brahmaputra deltas in its west and the Bay of Bengal confining towards the southern margins. The southwest Monsoon winds from the Bay of Bengal, cause heavy rainfall sometimes leading to catastrophic floods in Tripura. Tripura has widespread practices of agriculture and plantation in modern times. The impact of human activity is extensive and is causing a major shift in the land and forest cover of the state. Studies based on the Quaternary sediments from Tripura are extremely limited. Here we present records of Late Quaternary sub-surface sediment profiles from Tripura. We attempt to compare the chronology of all these profiles (Text Figure 1) whose radiocarbon dating was carried out at the Radiocarbon dating laboratory of Birbal Sahni Institute of Palaeosciences. The other previously studied Quaternary sedimentary records from the region were also dated in the same laboratory and yielded comparable chronologies. So, we try to understand the chronological sequences of all these records from Tripura and reason why most ^{14}C dates are confined to the Holocene ages. Although this region has a high sedimentation regime, wide spread recent deposits, favorable depositional environments and extensive underlying deposits of older Tertiary formations. We also try and identify the possible causes for this lack of the Early and middle Quaternary deposits in Tripura.

ENVIRONMENTAL SETTING

The Tropic of Cancer passes right across the Tripura state subjecting it to tropical climatic conditions. The nearest meteorological station is in Agartala which records annual minimum and maximum temperature between 8°C and 36°C respectively. The average annual rainfall varies between 2,250 mm and 2,500 mm. The Pliocene aged Tipam group of rocks which mainly comprise of sandstone, siltstone, sandy mudstones are overlain by the Quaternary sediments (Kesari et al.

Table 1. ^{14}C Dates of sediment samples at different depths within the sediment profiles from Tripura.

SN	LOC (SC)	LAT	LONG	SAM-No	DR (cm)	LN	UCA[a]	CA	MD	References
1	West Tripura (††)	23.86†	91.57†	Teliamura- Unit T1	††	††	34680±2960	40303	P	Ramesh 1983, 1986
				Champaknagar-Unit T3	††	††	1190±90	1115	P	
				Champaknagar-Unit T3	††	BS-322	3450±110	3724	P	
				Kalyanpur Unit T3	††	BS-313	1430±80	1352	SCW	
				Unit T4	††	††	160±80	167	SCW	
2	Sekarkot (††)	23.71	91.27	††	90	BS-174	1930±115	1881	P	Sarkar 1999
				††	115	BS-156	3340±140	3599	P	Prasad 1986
3	Kalapanya II (††)	23.49	91.37	††	15	BS-189	Recent	Recent	P	Sarkar 1999
				††	80	BS-153	Recent	Recent	P	
				††	190	BS-152	2940±200	3116	P	
4	Kanchanpura (††)	24.03†	92.20†	††	~40-50	††	900±110	831	S	Bera et al. 2011
				††	~100-110	††	1400±110	1317	S	
				††	~160-170	††	3600±170	3936	S	
				††	~240-250	††	6020±190	6888	S	
5	Charilam (CL)	23.63	91.30	CL-12	65	BS-2475	5220±240	5996	S	Present study
				CL-5	135	BS-2474	6920 ± 270	7795	S	
6	South Srinagar (SS)	23.09	91.64	SS-14	37.5	BS-2479	3730±110	4100	S	Bhattacharyya et al. 2011 / Present study
				SS-10	57.5	BS-2478	3930±100	4371	S	
				SS-1	115	BS-2477	6890±420	7784	S	
7	Rudrasagar (RJ)	23.50	91.32	RJ-4	17.5	BS-3708	1060±110	988	S	Present study
				RJ-7	32.5	BS-3707	Recent	Recent	S	
8	Sonai Muri (SM)	24.20	92.03	SM-3	8	BS-3710	100±120	170	S	Present study
				SM-29	95.5	BS-3709	Recent	Recent	S	
				SM-46	166.5	BS-37011	Recent	Recent	S	

SN = Serial number (same as in Fig. 1); **LOC (SC)** = Location (Sample Code); **LAT** = Latitude in degree N; **LONG** = Longitude in degree E; **SAM-No** = Sample number; **DR (cm)** = Depth ranges in centimeter; **LN** = Laboratory number; **UCA** = Uncalibrated age (^{14}C dates) in years BP; **CA** = Calibrated dates in years BP for present study; **MD** = Material dated

P = Peat; SCW = Semi-carbonized wood; S = Soil sediments

[a] Sample dated in Radiocarbon Dating Laboratory, Birbal Sahni Institute of Palaeosciences (previously Birbal Sahni Institute of Palaeobotany), Lucknow, India.

† Latitude and Longitude not provided in original research publication, estimated for present study with nearest known location

†† Information not available in original publication

Present sub-surface sediment studies

Other records studied previously were considered for the present study to provide additional overview of ^{14}C dates recorded of these sub surface sediment profiles. Additionally, we carried out sample collection. These samples were from Northern, western and southern parts of Tripura. Sediment profiles were collected from Sonaimuri (SM) in Kumarghat District (North Tripura), Charilam (CL) in Bishalgarh District (West Tripura), Rudrasagar (RJ) in Sepahijala District (southwestern Tripura) and Srinagar (SS) in South Tripura (Table 1). Sediment samples were selected from all these profiles, which were dated at the Radiocarbon dating laboratory at Birbal Sahni Institute of Palaeosciences Lucknow, India. The details of sample collection along with their lithology are described in following section.

The 1.70 m sediment profile CL was collected near Charilam, near Bishalgarh, West Tripura, situated south of Agartala town (Text Figure 1). The lithology of the sediment profile ranges from silty brown clay, black clay, to dark black clay. The sampling site and the comparative lithology is illustrated in Text-Figure 2a and Text-Figure 2b.

Samples were collected from south of Srinagar town in south Tripura (Text Figure 1), after digging a trench to a depth of 1.20 m and designated as SS profile (Text Figure 2c). It comprised of (Text Figure 2d) layers of grey sticky clay (100–120 cm), sticky dark black clay (50–100 cm), and clay with rootlets (5–50 cm) and clay rich in organic matter (0–5 cm). A few cm of surface sample with excessive rootlets was not analyzed due to sampling discrepancies. This profile has been studied for pollen analysis for past vegetation vis-à-vis climate reconstruction (Bhattacharyya et al. 2011).

The sediment profile (RJ) was collected from a trench that was dug upto a depth of 0.90m at a site Rudijala in the basin/catchment area of Rudra Sagar Lake, located in the Melaghar Block of Sonamura Sub–Division of Sipahijala district (Text Figure 1). In the basin area which had dried up in the summer season, we selected a site which was behind the royal palace named Nir Mahal at Rudijala. The profile (Text Figure 2e and Text Figure 2f) samples were mostly composed of grey sticky clay up to the entire depth.

The 170 cm profile (SM) was collected from near a re–excavated fishery pond in Sonaimuri in Kumarghat, Unokoti District of Tripura (Text-Figure 1). This site was said to be lying in the course of river Manu until it changed its course. The river was flowing nearer to the site 40 years ago, when it shifted it course, now flowing 200–300 m approximately away from this site. Earlier there was a pond for fishery and it had dried up too. So, the authorities were re-excavating / re-digging it into a very large pond. The profile SM collected (Text Figure 2g and Text Figure 2h) was having a varying lithology throughout its length. The top 0–115 cm was clay sediment, which had slight specks of reddish orange soil. Then from 115–119 cm it was composed of sandy deposit layer up to 143 cm. From 143 cm–163 cm the sediments were again clay deposits. The last speck from 163 to 170 cm had laminated layers showing micro flow current structures and made up of clay–sand cross beds. Samples were collected from different intervals depending upon the lithology. The lithology depicted of the profile is probable flood events or flow structures of Manu River before it shifted its course

RESULTS

All the profile sediments that were collected yielded Holocene to recent radiocarbon dates. The details of which are given in Table 1. The profiles SS and CL had ^{14}C dates, which were in chronological order with the depth sequence. Yet they only cover ages up to the Middle Holocene and not the major segment of the Quaternary deposits. But the other two profiles RJ and SM ironically recorded younger or recent ^{14}C dates at lower depth, which indicated probable mixing or overturning of sediments. The short profile RJ although collected from a lake site had overturned sediments indicated the extent of anthropogenic impact on a closed environment like that of Rudra Sagar Lake. The periphery of this lake has large farming lands around it and possibly fishing and other human activities are persistently disturbing the environmental condition of this lake (Barman et al. 2013). This might have caused the disturbance of sediments collected from close to the periphery of the lake. The profile SM clearly indicated a rapid mixing of sediments probably caused by natural causes such as flooding of the nearby Manu River and an overload of sediments being dumped. The other possible cause of the occurrence of recent deposit at lower depths could be mixing due to anthropogenic activities such as construction of man-made fish tank. Near this site similar activity was going on but overturning at such depths could not be expected during sample collection. Other previous records from similar sampling sites in dug fish tanks (Prasad 1986) had yielded Holocene radiocarbon ages and Late Quaternary palynomorphs. Thus, it was expected that other such sites from Tripura would yield reasonable dates. Although these sediments collected by Prasad (1986) were from peat sections and SM comprised mostly of fluvial clay and sandy clay. Thus, it might be the differences in the deposition and preservation of these sedimentary sequences that the radiocarbon ages recorded are recent to Holocene ages.

The sediment profile from the northeastern site at Dhananjoypara area of Kanchanpur District reserve forest northeastern Tripura (Bera et al. 2011) had recorded a number of radiocarbon dates. This is the only record from the eastern sector of the state but again is dating back to the Holocene ages even at 2.5 m depths. Thus, sampling depth also does not clearly depict the concurrency of the Quaternary deposits in Tripura. Nevertheless, the northeast Tripura region is still less explored than in comparison to other parts. Hence there could be a possibility for longer records available in the region.

DISCUSSION AND CONCLUSIONS

All the profiles that were dated had either date reversal or short time span at longer sampling depths.

The profiles from South and West Tripura however gave few but specific ^{14}C dates ranging between 3000–7000 years BP and 5000–7000 years BP. But the problematic yield of dates came from the dated sediment profiles from North and southwest Tripura. The profile RJ had very poor and recent dates which are close to being modern samples although the sampling was done up to sufficient depths. The profile SM that was collected for a long length of about 170 cm had a reversal of dates. The top part of this profile had 100±120 BP and the bottom samples were given to be modern samples. It can therefore be said that Tripura has generally disturbed Late Quaternary sections. These discrepancies in ^{14}C dating are because of the influence of human induced disturbances due to anthropogenic activities such as farming, fishing and tilling of soils. The extensive cultivation activities and fishery related practices even happening today have caused the preservation of Late Quaternary sections to be unimaginably impossible. The most common agricultural practice happening till recent times i.e. *Jhum* cultivation and/or thrash and burning of forest areas for cultivable land has also disturbed the Quaternary sediments of the region. Also, the region especially in its southern parts may have been affected by transgression events followed by regression movements of the Bay of Bengal waters. Such events have also probably not let the proper depositional history be preserved during the Quaternary period.

The variation of climate vis–à–vis vegetation based on the Quaternary sediments from this region has very little documentation. Other regions in northeastern India have Late Quaternary palaeoclimate records based on proxy data such as fossil pollens (Mehrotra et al. 2014). Another study from Ziro valley, Arunachal Pradesh, Eastern Himalaya have sediment records dated back to 40000±1 years BP (Bhattacharyya et al. 2014) indicating the presence of the Late Quaternary deposits in northeastern India. But only one record from western Tripura dates back to 34680±2960 years BP giving the Upper Pleistocene or the Late Quaternary age to sediment unit (Ramesh 1986). The stone tools recorded from this sedimentary unit in west Tripura indicated the inhabitance of humans since Pre-neolithic times around 35000 years BP, having close linkages to SE Asian stone tool records (Ramesh 1986). Hence humans could have possibly migrated extensively from SE Asia and influenced the land cover and the Quaternary sedimentary deposits in Tripura since the prehistoric times. The human impact could have also reduced the well-preserved Quaternary sedimentary sequences.

The Tripura state being inhabited by many tribes and sub-tribes has witnessed deforestation, *Jhum* cultivation or thrash and burn farming, and modern day commercial plantation crops such as rubber, timber, fruits and vegetables etc. Nevertheless, progressive civilizations, farming and pastoral activities along with natural causes such as floods and surface pedogenic processes have disrupted and in some parts destroyed the Quaternary deposits in Tripura. But further investigations and more sampling from remote and undisturbed locations of Tripura could provide further sediment records essential for palaeoclimate and other related studies in Tripura.

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