

## APPENDIX.

### NOTE ON THE GEOLOGICAL HISTORY OF *TURBINELLA* IN INDIA.

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of the Director, *Geological Survey of India*).

The genus *Turbinella* first appears in India in oligocene times, when it is represented by a handsome somewhat nodose species with a tall stepped spire, *Turbinella episoma* Michelotti, which was first described from the same geological horizon in northern Italy. As we trace the successors of this fossil into formations of later age, they do not show the slightest indication of any approach towards the "sankh" of India. The oligocene shell is at first succeeded, in miocene times, by *Turbinella affinis*, J de C. Sowerby, whose main distinction from *Turbinella episoma* consists in the slightly more effaced ornamentation, principally on the body-whorl. The difference in outward appearance is so slight that it would often be difficult to distinguish specimens relatively of both species but for the fact that the miocene form bears five columellar folds instead of three as in the oligocene fossil. During the miocene, *Turbinella affinis* was succeeded by two more forms, first, a hitherto undescribed species which may be named *T. præovoidea*, very closely related to *T. affinis*, but in which the distinction from *T. episoma* becomes much more clearly accentuated owing to a greater portion of the spire becoming nearly smooth, and lastly, in middle or upper-middle miocene times by a smooth form which corresponds so closely with *T. ovoidea* Kiener, of the coasts of Brazil, that it cannot be separated from it otherwise than as a variety. In *T. præovoidea*, the columella bears only four spiral folds, of which the most anterior one is apt, in certain specimens, to become indistinct. In the fossil variety of *T. ovoidea*, three folds are especially well developed, a fourth anterior fold being always present, but often feeble. This is the only distinction from the living Brazilian shell in which, judging from the single specimen available in Calcutta, there is no indication of this fourth anterior fold. In their shape and ornamentation, the four Indian fossil forms constitute a connected series the evolution of which consists principally in the gradual obliteration of the sculpture, but the spire always retains its elongate outline which is much steeper even than in the most elongate varieties of the living Indian species.

The age of the Indian fossil specimens of *Turbinella ovoidea* is probably not older than "tortonian," that is middle miocene. The modern "sankh" appears in a fossil condition in beds whose age must be at the limit of pliocene and uppermost miocene, along the Coromandel coast, at Karikal. The only specimen so far available from that formation is in a fragmentary condition and has not been figured, but is sufficiently preserved to have enabled Mr. Cossmann to refer it to one of the particular

varieties recognized by Mr. Hornell, the one corresponding with Gmelin's *Turbinella rapa*. According to Mr. Cossmann, "la spire un peu élevée, avec des nodosités transverses, très obsolètes, ressemble plutôt à celle de *T rapa*, qu'à la spire tout à fait déprimée de *T pirum*." (Faune pliocénique de Karikal, *Journ. Conch.*, Vol. L, 1902, p. 130). Mr. Hornell has observed specimens of the modern Indian species in pleistocene or sub-recent formations near Rameswaram and Tuticoriñ.

It has been above noticed that the oligocene species of India, *Turbinella episoma*, corresponds with a European fossil. The similarity between the oligocene faunas of India and of Europe is most remarkable, the percentage of European species in the case of the oligocene mollusca of north-western India, amounting to as much as 40 per cent, indicating that the seas of India and Europe constituted, at that time, portions of one zoological province. In the case of the lower miocene beds of India with *Turbinella affinis*, and in those with *T præovoidea*, the faunistic correspondence with Europe is very feeble, and the points of resemblance between the faunas of both regions finally disappear completely when we reach the horizon of the beds with *Turbinella ovoidea*. The Indian Ocean and Mediterranean regions seem to have been as thoroughly disconnected in middle miocene times as they are at the present day. The presence of the Brazilian species becomes therefore all the more remarkable, and seems to indicate that, while direct communication was closed with the Mediterranean and eastern Atlantic, an easy interchange of species could nevertheless take place between the Indian Ocean and the regions now constituting the western Atlantic, or at least with the Caribbean Sea. It is worth noticing that *Turbinella ovoidea* occurs in a fossil condition in the Miocene of San Domingo, and it is highly interesting to recall, in this same connection, the observation made years ago by Duncan as to the extraordinary similarity between the lower miocene coral fauna of India and that of the West Indies. Naturally enough, Duncan was under the impression that the connection between India and the West Indies took place, in lower miocene times, across the Mediterranean and Atlantic. We find now, however, from a study of the mollusca, that the directness of the marine connection between India and Europe had been much impaired in lower miocene times, while in middle miocene times, when the communication was certainly completely cut off, we find a remarkable instance of specific identity with Brazil and the West Indies in the case of one of the commonest and most conspicuous mollusca. It should also be kept in mind that, in miocene times, the climatic conditions, throughout the Mediterranean region, had already become unfavourable to the growth of reef-building corals, and therefore, even had a free communication subsisted, the spread of these organisms through that region would no longer have been possible.

It may very well be therefore that, already in lower miocene times, we should look to the east of India for the free communication that allowed the intermingling of the coral faunas of India and of the West Indies.

In conclusion, the oligocene *Turbinella episoma* of India and Europe is not the ancestor of the Indian "sankh," or, if at all connected genealogically, the line of

descendance did not take place through its Indian miocene mutations. The genus did not survive into the miocene of Europe.<sup>1</sup> In the miocene of India, *Turbinella episoma* was succeeded by three related "mutations," *Turbinella affinis*, *Turbinella praovoidea*, and finally *Turbinella ovoidea*, which latter spread eastwards as far as the West Indies. The latter species has survived to the present day along the coasts of Brazil, while, in India, at the end of the Miocene or beginning of the Pliocene, it was superseded by the totally different *Turbinella pirum*.

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<sup>1</sup> As noticed by Bellardi (*Moll. terr. terz. Piem. e Lig.*, IV, p. 53) the attribution of a fragment of *Turbinella* to the Pliocene of Asti is probably due to an error of labelling.