

REMARKS ON THE EVOLUTION OF THE RECENT MARINE MOLLUSCAN FAUNA IN THE NEWER TERTIARY ROCKS OF INDIA.

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PLATE XIII.

THE diagram on Plate XIII illustrates the evolution of the modern marine molluscan fauna in the Oligocene and Miocene of India. The materials for the construction of the diagram were obtained from the researches upon which the author has latterly been engaged in connexion with his surveys in the Tertiary regions of North-Western India, which have yielded a series of marine fossils representing several successive stages of the post-Eocene. The formations represented are locally known under the names of Nari, Gáj, and Hingláj. Amongst the fossils which they contain there are a certain number of Foraminifera and Mollusca identical with well-known European forms, from which it has been ascertained that the age of the Nari fauna corresponds with that of the Stampian (Upper Oligocene) of Europe, that the Gáj corresponds essentially with the Aquitanian, being the Indian counterpart of the European Schio Beds, while the Hingláj is approximately astride of the boundary between Burdigalian and Vindobonian.

The proportions of Recent species occurring in the successive stages are as follows :—

	Gastropoda.			Lamellibranchiata.			Total Mollusca.		
	Number of species.	Number of Recent forms.	Percentage of Recent forms.	Number of species.	Number of Recent forms.	Percentage of Recent forms.	Number of species.	Number of Recent forms.	Percentage of Recent forms.
Nari	82	3	3·7	35	4	11·4	117	7	6·0
Upper and Lower Gáj	84	11	13·0	53	13	24·5	137	24	17·5
Lower Hingláj	44	12	27·2	28	7	25·0	72	19	26·3
Upper Hingláj	16	7	43·0	30	12	40·0	46	19	41·3

For the two older stages the proportion of recent Gastropoda is lower than that of Recent Lamellibranchiata. This difference is in harmony with the more rapid evolution of the Gastropoda as compared with the Lamellibranchiata. The proportion is reversed in the case of the Hingláj Beds, but the number of available forms is too small to expect closely accurate statistics.

Compared with the Tertiary faunas of European, both foraminiferal and molluscan, the correspondence is close enough to allow of no hesitation regarding the age of these beds, at least with regard to the

two lowest stages, the Nari and Gáj, which respectively correspond with the Stampian and Aquitanian, and this correlation is also supported by the stratigraphical data. For stratigraphical reasons the newest age that can be assigned to the Hingláj is Vindobonian. It is evident, therefore, that the proportion of Recent species is much greater than in European strata of the same age. The Gáj, which is essentially Aquitanian, contains a proportion of living forms which is as great or greater than that met with in the uppermost Miocene of Italy, while the Hingláj, if judged by the European standard, would have to be regarded as Pliocene. Yet the Hingláj Beds are unconformably overlaid by the Siwalik formation, whose lower strata contain mammalian remains of Miocene age.

A similar divergence from the European standard had already been noticed in 1879 by Professor Karl Martin in his study of the fossil Miocene fauna of Java (*Tertiärschichten auf Java*, general part, p. 24). The figures arrived at by Martin are as follows (loc. cit., p. 28):—

	Number of species.	Number of Recent forms.	Percentage of Recent forms.
Gastropoda . . .	160	47	29·0
Lamellibranchiata . .	74	28	38·0
Total Mollusca . . .	235	75	31·9

Martin was under the impression that the Miocene fauna of Java corresponds essentially with the Gáj. Little is known of the stratigraphy of the deposits that have yielded the Javanese fauna, but from a comparison with the fauna of North-Western India, which contains a very large number of species identical with fossil Javanese forms, it is evident that the Java fossils were not derived all from one zone, but from several successive horizons. The greater number evidently were derived from strata situated on the same geological horizon as the Lower Hingláj, but there is a considerable admixture of typical Gáj and Upper Hingláj species, showing that both these horizons are also represented, though to a minor extent.

The explanation of this difference is to be sought in the chequered career of the European seas, both geographical and climatic, during later Tertiary times, as compared with the uneventful history of the Indian Ocean during the same period, which must have allowed therefore a much more gradual evolution of the marine fauna.

When we compare the Indian fossil faunas with European fossil faunas of the same zones, we observe a rapid decrease of the proportion of identical species in the stages following the Nari. The proportions are as follows:—

	European species.	Percentage of European species.
Nari . . .	48	41·0
Lower and Upper Gáj . .	17	12·4
Lower Hingláj . . .	4	5·4
Upper Hingláj . . .	3	6·5

The fossil fauna of the Nari resembles the Oligocene fauna of Europe so closely as to constitute an eastern extension of the same zoological province, indicating great freedom of oceanic communication.

The connexion between the two regions was already much less direct in Aquitanian times, as indicated by the much smaller proportion of European species in the Gáj fauna, while in the successive faunas the contrast between the eastern and western faunas approximates the conditions observed at the present day. Several geologists, amongst whom I may mention Oppenheim and Rovereto, have already commented upon the similarity between the Indian Eocene and Oligocene faunas and those of Europe, as contrasted with the divergence between the Miocene faunas. It is satisfactory to find these conclusions confirmed by a closer study of the fossils than had been practicable hitherto. It is worth mentioning that the Egyptian Miocene marine fauna, so far as is known, contains a large admixture of Eastern forms, indicating that the land barrier between the two marine provinces must have extended across the Eastern Mediterranean further north than the present isthmus of Suez. I should also mention that the similarity between the Tertiary faunas is restricted to those of the Lutetian and Oligocene. The Lower Eocene molluscan fauna of India differs vastly from that of Europe, quite as much as the faunas from the Middle Miocene.

An attempt has been made at showing the above data in the form of a diagram upon which have also been inserted the relative position of the principal post-Eocene mammalian faunas of India, and also some of the main geological events such as the earth-movements of the Himalaya and of the Indian Peninsula, and the corresponding oscillations of the sea-level, so far as can be gathered from the information at present available.

In addition to the molluscan faunas from North-Western India, I have inserted the proportion of living forms in the Gastropod fauna of Karikal, another Upper Tertiary Indian fauna latterly monographed by Cossmann, and which, from the identity of several characteristic fossils, appears to be on a level with the Hingláj Beds, more especially the Upper Hingláj. I have thought it interesting, for the sake of comparison, also to illustrate diagrammatically the much more rapid evolution of the Echinoidea, and especially of the terrestrial mammalia.



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