

On the Age of the Deccan Trap as Evidenced by Fossil Fish-Remains.¹

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AT the discussion on the age of the Deccan Trap, held at the Hyderabad (Deccan) meeting of the Indian Science Congress, several speakers referred to the great stratigraphical value of the Inter-trappean fossils, and casual references were made by Crookshank, Sahni and the writer to the fossil fish-remains discovered from the inter-trappean beds. Since then the extensive

collected by Mr. F. Fedden have also been examined. The present investigation, when combined with that of A. S. Woodward's (1908) on the fossil fish-remains from the Lameta beds at Dongargaon, throws considerable light on the probable age of these beds.

From a stratigraphical point of view the results obtained so far may be tabulated as follows :—

Name of bed	Type of fish	Geological Horizon
Lameta, Dongargaon	<i>Lepidosteus indicus</i> A. S. Woodw.	Typically tertiary; Lower Eocene to present day in America.
" "	<i>Pycnodus lametæ</i> A. S. Woodw.	Not later than close of Eocene.
" "	<i>Eoserranus hislopi</i> A. S. Woodw.	Tertiary.
(?) Inter-trappean (possibly Lameta), Dongargaon.	<i>Clupea</i> sp. ; scale.	" Not known from below the Upper Eocene " (Zittel).
Infra-trappean, Dhamni.	<i>Clupea</i> sp. ; scales.	Do.
Inter-trappean, Paharsingha.	<i>Lepidosteus</i> spp. ; scales	Tertiary.
Inter-trappean, Takli.	<i>Nandid</i> scale.	Fossils of the family not known.
Inter-trappean, Deothan and Kheri.	<i>Clupea</i> spp. ; scales.	As known at present from Upper Eocene to recent.
Do.	<i>Musperia</i> sp. : scales.	Old Tertiary.
Do.	Cyprinid scale.	Lower Eocene to recent.
Do.	Polyacanthid scale.	Fossils of the family not known.
Do.	<i>Serranus</i> sp.	Tertiary to recent.
Do.	<i>Nandus</i> sp.	Fossils of the family not known.
Do.	<i>Pristolepis</i> sp.	Do.

material collected by Mr. H. Crookshank from the inter-trappeans of Deothan and Kheri has been worked out, though the results² have not yet been published. A few fossil scales from the inter-trappeans (Lameta?) at Dongargaon,³ Takli and Paharsingha, collected by Rev. Hislop and now preserved in the collection of the Geological Survey of India, have also been examined; these very fragmentary remains had not hitherto been studied by any specialist. Some fossil scales from the infra-trappean bed at Dhamni, east of Warora,

In all 10 principal types of fish have been discovered so far from the trappean beds. Of these, *Lepidosteus* and *Pycnodus* are Ganoid fishes which "exhibit their greatest development in Palæozoic, Triassic and Jurassic formations; and from the base of the Cretaceous system upwards they become more and more replaced by the bony fishes. The few still existing Ganoids live either exclusively, or at least partly, in fresh-water, while the large majority of the fossil forms occur in purely marine deposits. As a rule, only the Devonian and Tertiary Ganoids occur in fresh-water formations." From India, however, the remains of fresh-water Ganoids are known from the Kota Maleri beds of the Mesozoic period, from the Lameta beds at Dongargaon and from the Inter-trappeans⁴ at Paharsingha. About

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² The detailed results of these investigations will be published in the *Records of the Geological Survey of India*.

³ A scale of *Clupea* sp. in the collection of the Geological Survey of India is registered as having been obtained by Rev. Hislop from the inter-trappean bed at Dongargaon. Mr. H. Crookshank, however, informs me that, as far as is known, there are no inter-trappean beds at Dongargaon but only Lameta beds.

⁴ Since the above was written, Mr. S. R. Narayan Rao has discovered the remains of *Lepidosteus* scales in the inter-trappean bed at Kateru near Rajahmundry. Through the kindness of Prof. B. Sahni, I was given an opportunity to examine the Kateru specimen.

Lepidosteus Woodward (1908) observed that it is "typically Tertiary, differing essentially from the numerous secondary Ganoids to which it is related, by its highly specialised vertebræ. It ranges from the Lower Eocene to the Lower Miocene in Europe, and from Eocene to the present day in North America." With regard to *Pycnodus*, he stated that "according to European standard, cannot be later than the close of the Eocene." *Eoserranus* is a Percoid fish of a very primitive type, as its scales have not assumed the typical features of the modern Acanthopterygian fishes. Woodward says that "No true Percoid has hitherto been recognised in a typically Cretaceous formation in any part of the world." Accordingly, he fixed the age of the Lameta fish-fauna of Dongargaon to be between the Danian Cretaceous and the Upper Eocene.

From the inter-trappean (Lameta?) bed at Dongargaon, Hislop collected a nicely preserved scale of *Clupea* Linn. in which the transverse radii are complete and well marked. According to Zittel, *Clupea* is "not certainly known below the Upper Eocene of Monte Bolca, near Verona." This record would seem to fix the age of the Dongargaon beds as Upper Eocene, but it may be that the remains of *Clupea* have not yet been recognised from the older formations, for the family Clupeidae dates from the Cretaceous period.

The scales from the infra-trappean bed at Dhamni also belong to the genus *Clupea* and are very similar to the scale found at Dongargaon.

The inter-trappeans at Paharsingha contain small *Lepidosteus* scales, while those at Takli contain a very primitive type of *Nandid* scale. The Nandidæ belong to the Percoid group and presumably are not older than the Tertiary period. Though no fossil remains of the Nandidæ are known, these fishes must have been in existence at a time when there was still a land connection between India, Africa and South America, for their close allies of the family Polycentridæ are found at the present day in West Africa and South America.

The inter-trappean beds at Deothan and Kheri yielded the remains of Teleostean fishes only. Scales of *Clupea* of two types—some with the transverse radii complete and others with the transverse radii widely interrupted—are very abundant; those with complete transverse radii are similar to the one found in the inter-trappean (Lameta?)

at Dongargaon and the infra-trappean at Dhamni.

The most remarkable discovery is, however, the occurrence of the Osteoglossidæ in the Deothan beds. There are 3 fragments of the characteristic scales of this family which I have referred to the fossil genus *Musperia* Sanders (1934) recently described from the old Tertiary formations of Middle Sumatra. Of all the living Teleostean fishes, Osteoglossidæ have a remarkable distribution; they are found in Australia, Indo-Australian Archipelago, Siam, Africa and South America. It has now been recorded, though in a fossil state, for the first time from India. The Osteoglossidæ grow to a large size; *Arapaima* of South America attains a size of 15 feet and is the largest fresh-water fish known. The fossils of the Osteoglossidæ are found in Tertiary formations only.

There is one fragment of a primitive Cyprinid scale of the sub-family Abramadinae. The Cyprinoids form the most dominant group among the present-day fresh-water fishes, but they do not extend to below the Lower Eocene.

The rest are all Acanthopterygian fishes which are found in great abundance in seas, estuaries and fresh waters not very far from the coasts. Of these, there is one Labyrinthid scale, probably of the family Polyacanthidæ. The Labyrinthid fishes are found in South-eastern Asia and Africa. There are also numerous scales of *Serranus*, *Nandus* and *Pristolepis*, all Percoid fishes of a highly specialised type. The Serranidæ are mostly marine, but a few occur in fresh waters. The Nandidæ, to which the Pristolepidæ are closely allied, are strictly fresh-water forms; they are represented in Africa and South America by allied forms of the family Polycentridæ. Neither of these families is hitherto represented by any fossil form.

Judging from the present-day geographical distribution of the Pristolepidæ and the Polyacanthidæ and from the present-day migratory habits of certain large species of *Clupea*, the Trappean fish-beds were probably laid down after the supposed severance of the land connection between India and Africa in the early tertiaries. The ecological associations of the Lameta and the inter-trappean fish-faunas also point to the same conclusion. When large fishes of the type of *Eoserranus*, *Lepidosteus* and *Pycnodus* flourished in the Peninsula (the age of the infra-trappean bed at Dongargaon) the main river of the area

was probably very large, placid and deep, and its mouth was not very far from Dongargaon. But by the time the inter-trappeans of Deothan and Kheri were laid down, marshy conditions, with lakes and marshes of varying sizes in the neighbourhood of the mouth of a large river, had been established. The conditions then were probably similar to those now prevailing in the lower reaches of the Ganges. The presence of a considerable number of Clupeoid scales of fairly large size clearly indicates the deltaic nature of such a river not very far from the beds mentioned above. Clupeoids are marine fishes but some, like the Shad of America and the Hilsa of India, ascend into large rivers for long distances and give rise to immense, seasonal fisheries. The occurrence of the Nandidæ, the Pristolepidæ, the Polyacanthidæ and the Serranidæ also indicates the maritime nature of the area, for fishes of these families, even at the present day, are commonly met with in fresh waters usually not very far removed from the sea.

Considerable support is lent to the estuarine nature of the fish-fauna of the inter-trappean beds from the discovery of the remains of a genus of palms, *Nepadites* or *Nipa*, in the inter-trappean beds at Chhindwara, a place not very far away from Deothan and Kheri. As is well known, these palms still survive in the Sundarbans and other tropical estuaries. On this point Sahni (1934) observed that:

"*Nepadites* is not only a genus very characteristic of the Eocene period but, unless these palms have changed their mode of life since then, its occurrence in the northern part of the Deccan indicates the existence of an estuary, during the early part of the inter-trappean period in the proximity of Chhindwara."

Though the geological data about the drainage of the area are obliterated by the overlying traps, still from the very meagre evidence available Mr. H. Crookshank has been able to support my conclusions concerning the habitat of the Deothan fossil fishes. It also appears probable that all inter-trappean beds are probably not of the same age. Judging from the meagre evidence provided by the fish scales, the inter-trappeans of Paharsingha and Takli would seem to be older than those of Deothan and Kheri. Of course, the Lameta beds at Dongargaon are the oldest of all trappean

beds from which fish-remains have been studied so far.

From the above it may be concluded that the infra-trappean beds at Dongargaon and the inter-trappean beds at Paharsingha, Takli, Deothan and Kheri were laid down in the early tertiaries, and that there was probably some interval between the deposition of the infra- and the inter-trappean beds during which the change from a predominantly Ganoid to an almost exclusively Teleostean fauna took place. One thing seems to be fairly certain that ecological conditions usually associated with a large and deep river characterised the infra-trappean period, and that by the advent of the inter-trappean period marshy conditions, usually associated with the mouths of large rivers, had set in.

SUMMARY.

The systematic position of the fossil fish-remains from the infra-trappean beds at Dongargaon and from the inter-trappean beds at Takli, Paharsingha, Deothan and Kheri along with their known geological ages are tabulated. The distribution in space and time of the 10 principal types of trappean fishes is discussed, and it is concluded that these beds were probably laid down in the early tertiaries when the lower part of the supposed land connection between India and Africa had already disappeared and when the area occupied by the beds was not very far from the sea coast. It is further pointed out that there was probably sufficient interval between the formation of the infra- and the inter-trappean beds to permit the change from a predominantly Ganoid fauna, comprising *Lepidosteus* and *Pycnodus* of the Lameta beds at Dongargaon, to a fauna of almost exclusively Teleostean fishes, such as the Clupeidæ, the Osteoglossidæ, the Cyprinidæ and a great variety of Acanthopterygians, in the inter-trappeans at Deothan and Kheri.

From an ecological point of view, one thing seems fairly certain that the conditions usually associated with a large and deep river characterised the infra-trappean period, and that by the advent of the inter-trappean period marshy conditions, usually associated with the mouths of large rivers, had set in.

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