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THE PRESENCE OF TUBULIDENTATES IN THE MIDDLE SIWALIK BEDS OF NORTHERN INDIA

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Among the fossils collected by Mr. Barnum Brown in the Siwalik series of northern India, during the season of 1922, are two specimens representing the order Tubulidentata. This discovery is of considerable importance, not only as an additional record of a rare fossil form, but also in that it establishes the Tubulidentates far to the east of their hitherto known range—a fact the significance of which will be brought out in the following paragraphs.

The material is fragmentary, as might be expected of a mammal so infrequently found in the fossiliferous state as are the aardvarks. Both specimens are referable to the genus *Orycteropus*, and they seem to represent two species of almost contemporaneous geologic age. The one, a fragmentary maxilla with the last two molars, is a small species, retaining certain primitive characters; the other, a single molar tooth, represents a large form comparable to the Pliocene aardvarks of Greece and the Island of Samos.

The drawings in this paper are by Margaret Matthew. The four photomicrographs were taken by Dr. Philip Krieger of Columbia University.

Order Tubulidentata

Family Orycteropodidae

Orycteropus browni, new species[1]

TYPE.—Amer. Mus. No. 29840, fragment of a maxilla, with LM^{2-3}.

HORIZON AND LOCALITY.—Middle Siwaliks, near base. One half mile south of Nathot, northern Punjab, India.

DIAGNOSIS.—*Orycteropus browni* is a small member of the genus, the teeth indicating it to be about three-fifths the size of *Orycteropus gaudryi*. The same approximate ratio holds between the Siwalik form and the modern *Orycteropus erikssoni* of Africa. The teeth are worn flat across the occlusal surface, as in the modern *Orycteropus*. The second molar is bilobed, and the vertical indentation between the columns is considerably greater on the buccal than on the lingual side of the tooth. The third molar is characterized by the extreme reduction of its posterior column, so that the tooth is little more than half the length of the molar preceding it. The teeth terminate below in open pulp cavities, as is characteristic of the genus.

[1]Named in honor of Mr. Barnum Brown of the American Museum.

The reduction of the posterior column in M^3 would apparently indicate an advance towards the modern type of *Orycteropus*. *O. gaudryi* from the Pontian (lower Pliocene) of Greece and Samos Island is typified by its strongly bicolumnar third molars. Consequently the Indian form, though fully as old geologically as *O. gaudryi*, would seem to show a modern specialization in the shape of its last molar. On the other hand, the microscopic structure of the tooth in *O. browni* shows some primitive traits. Evidently this species enjoyed a precocious development as to the form of the third molar, a development of degree rather than of kind, which did not extend to the fundamental micro-structure of the tooth.

Concerning the size of *O. browni*, I feel convinced that this animal was a small species (again an indication of its primitive nature) rather than a young individual or a local variant of a large species. The bone of the maxilla is that of an adult animal. Moreover, the discrepancy in size between this specimen and the large tooth, mentioned above, is much greater than that between young and adult, or between races of the modern African species.

TABLE OF MEASUREMENTS

	A.M. 29840 *O. browni*	A.M. 22978 *O. gaudryi*
M^2		
Length	7.7 mm.	10.2 mm.
Width	5.3	7.5
Height	10.0	....
M^3		
Length	4.7	9.8
Width	4.7	6.7
Height	8.0	....
Ratio, length of M^3 to M^2 M^3/M^2 x/100	61	95

MICROSCOPIC STRUCTURE OF M^2

Longitudinal and cross sections were prepared from the second molar of *Orycteropus browni*, and similar sections from the homologous tooth in *Orycteropus gaudryi* were made, in an effort to determine, if possible, any structural peculiarities in the tooth of the new Siwalik species.

CROSS SECTION.—The tubules are closely appressed, which has caused them to lose the original (hypothetical) circular section, thereby becoming irregularly poly-

gonal. Their shapes may be contrasted with tubules in the *O. gaudryi* molar, in which species these structures are more regularly hexagonal in cross section. In *O. browni* the tubules vary greatly in size throughout the diameter of the tooth, a condition similar to that found by Lönnberg[1] in a "supernumerary" tooth of *Orycteropus erikssoni*. On the other hand, the tubules in the molar of *O. gaudryi* show much less variation in size. Moreover, in this latter species, there is a regular gradation from large tubules around the periphery of the molar, to smaller tubules at the center of the tooth. In addition, the tubules in *O. gaudryi* are definitely elongated along their radial axes.

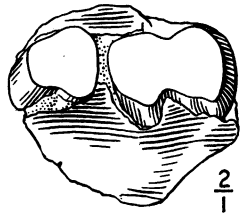

Fig. 1

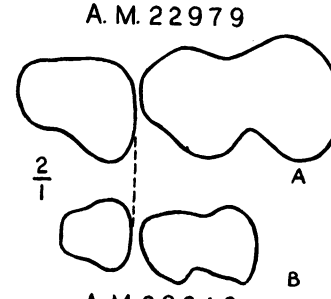

Fig. 2

Fig. 1. *Orycteropus browni*, new species. Type, Amer. Mus. No. 29840. Crown view of right M^{2-3} in maxillary fragment. Twice natural size.

Fig. 2. Outlines of crowns of the right upper second and third molars in (A) *Orycteropus gaudryi* Forsyth Major, and in (B) *Orycteropus browni*, new species. Twice natural size.

Thus it is seen that, in several characters, the molar of *Orycteropus browni* is structurally closer to a primitive tooth in the modern *Orycteropus* than it is to the molar of a Pliocene species. The described teeth of *O. browni* and *O. erikssoni* (the presumably primitive supernumerary tooth) are defined by:

1. Great irregularity in the shape of the tubules.
2. Considerable variation in the size of the tubules.
3. A size variation that ranges throughout the diameter of the tooth.

Orycteropus gaudryi must be considered as an advanced form, in that it demonstrates in the molar structure;

1. Regular hexagonal columns.
2. A definite gradation in the size of the tubules, from large ones around the outside of the tooth, to smaller ones in the center.

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[1]Lönnberg, Einar. 1905. Arkiv für Zool., Bd. 3, N. 3, pp. 24–25. The supernumerary teeth described by Lönnberg may represent either milk molars or teratological developments. If they are milk molars, which seems probable, they would show a type of structure somewhat more primitive than that of the permanent dentition.

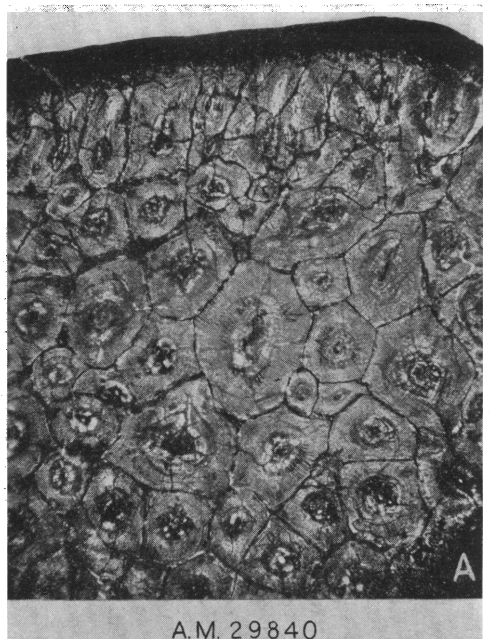

Fig. 3A

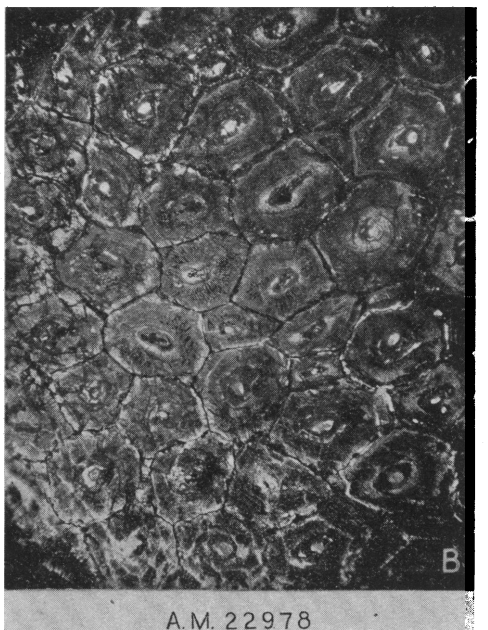

Fig. 3B

Fig. 3. Photomicrographs of cross sections of the right upper second molar in (A) *Orycteropus browni*, new species, and in (B) *Orycteropus gaudryi* Forsyth Major. In A, a section of the thin band of cementum, which surrounds the tooth, is shown at the top, and below are the irregular tubules characteristic of *O. browni*. Section B shows the regular tubules characteristic of *O. gaudryi*. Both sections about forty times natural size.

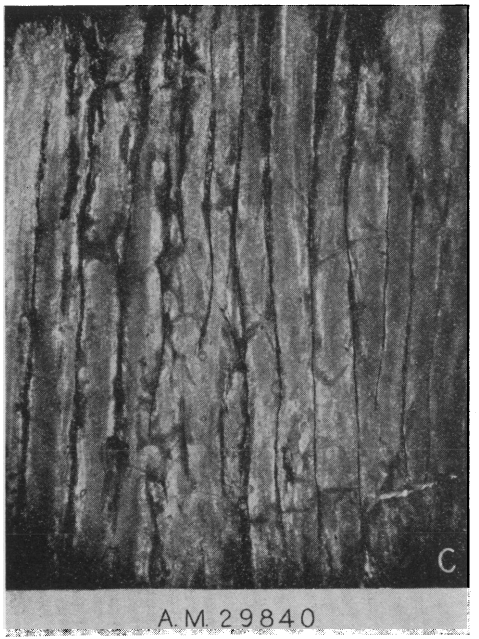

Fig. 4C

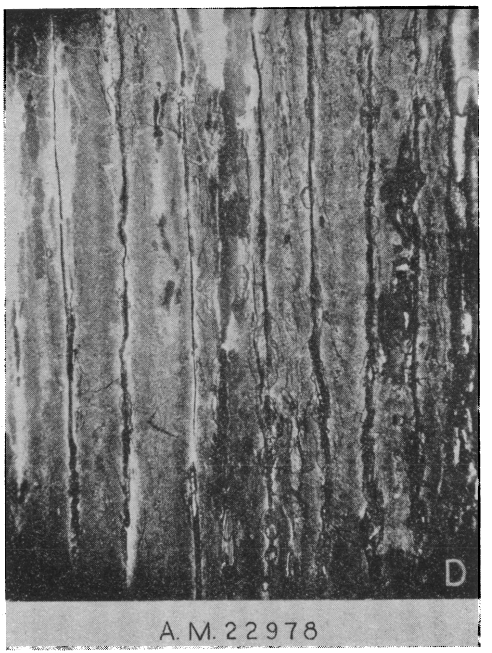

Fig. 4D

Fig. 4. Photomicrographs of longitudinal section of the right upper second molar in (C) *Orycteropus browni*, new species, and in (D) *Orycteropus gaudryi* Forsyth Major. Section C shows the branching and irregular tubules characteristic of *O. browni;* section D shows the parallel tubules of *O. gaudryi*. Both sections about forty times natural size.

As seen under a high magnification, the individual tubule in the *Orycteropus browni* molar consists of a hollow center, surrounded by a dentine column, in which the dentinal canals are radially arranged.

It should be added that there is an external band of cement shown in the cross section of the *Orycteropus browni* molar. A thin outer cement covering is a typical character of the *Orycteropus* tooth.

LONGITUDINAL SECTION.—In the molar of *Orycteropus browni*, the tubules are essentially parallel one to another, but a certain amount of branching is to be seen. This branching of the dentine tubules is a primitive feature, as proved by the structure of the supernumerary tooth described by Lönnberg,[1] and, more recently, by the molar of a Wind River (Eocene) tubulidentate described by Jepsen.[2]

In the molar of *Orycteropus gaudryi*, the tubules are strictly parallel, again an advanced character.

TABLE OF MEASUREMENTS

	A.M. 29840, *O. browni*	A.M. 22978, *O. gaudryi*
Radial diameter of tubules (average)	2/20–10/20 mm.	7/20 mm.
Tangential diameter of tubules (average)	2/20–5/20	5/20
Width of external cement band	2/20	

Orycteropus pilgrimi, new species[3]

TYPE.—Amer. Mus. 29997, a single tooth, identified as RM_2.

HORIZON AND LOCALITY.—Lower part of the Middle Siwaliks. Four and one half miles west of Hasnot, northern Punjab, India.

DIAGNOSIS.—A tubulidentate comparable in size to *Orycteropus gaudryi*. In the form of the occlusal surface, the tooth differs from *O. gaudryi* by having straighter (that is, less rounded) anterior and posterior edges, and a slightly shallower groove on the lingual side between the anterior and posterior columns.

Of course it is questionable whether the slight differences outlined above are of sufficient value to establish this Siwalik tooth as a separate species. However, an examination of a number of specimens of *O. gaudryi*, shows that the occlusal shape of M_2 is constant, and that differences from the Siwalik tooth are readily recognizable. Moreover, it is quite likely that two terrestrial forms geographically separated by a distance as great as that between India and Greece, would belong to different species, even though they were contemporaneous in their geologic age.

[1]Lönnberg, E. op. cit., p. 29, fig. 10.
[2]Jepsen, Glen. 1932. *Tubulodon taylori*, a Wind River Eocene Tubulidentate from Wyoming. Proc. Am. Phil. Soc., Vol. 71, No. 5, pp. 255–274.
[3]Named in honor of Dr. Guy E. Pilgrim, for many years associated with the Geological Survey of India.

MICROSCOPIC STRUCTURE.—The tubules show quite plainly on the occlusal surface of the *O. pilgrimi* tooth, and on one side of the specimen a fracture reveals an excellent view of the tubules as seen longitudinally.

As to the microscopic structure, this species is very similar to *O. gaudryi*. The tubules are closely appressed, and rather regularly hexagonal, as in the Samos species. There is no great variation in size, the tubules averaging about 5/20 mm. in diameter. Near the periphery of the tooth, the tubules are slightly elongated radially, and the diameters may reach 7/20 mm. or 8/20 mm. along the long axes. The hollow centers of the tubules seem to be slightly smaller than in *O. gaudryi*. The columns are strictly parallel.

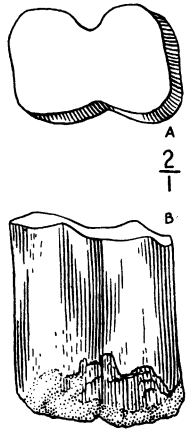

Fig. 5

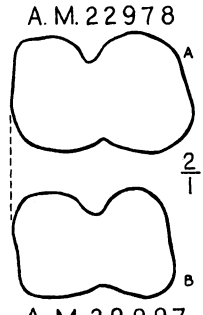

Fig. 6

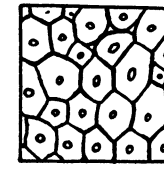

Fig. 7

Fig. 5. *Orycteropus pilgrimi*, new species. Type, Amer. Mus. No. 29997. A, crown view of right M_2, anterior edge of tooth facing the left. B, side view of lingual surface of the same, showing on the broken basal portion the parallel tubules. Twice natural size.

Fig. 6. Outlines of crowns of the right second lower molar in (A) *Orycteropus gaudryi* Forsyth Major, and in (B) *Orycteropus pilgrimi*, new species. Twice natural size.

Fig. 7. Section of the occlusal surface of the right second lower molar of *Orycteropus pilgrimi*, new species, showing the rather regular, hexagonal tubules. Twenty times natural size.

DISTRIBUTION OF THE TUBULIDENTATES

The Siwalik species of *Orycteropus* establish the Tubulidentates far to the east of their previously known range of distribution in the Old World. According to our present knowledge, the occurrences of Tubulidentata are as follows.

Orycteropus afer (Pallas) and its several varieties	Recent	Africa
Orycteropus capensis, etc.		
Plesiorycteropus madagascariensis Filhol	Pleistocene	Madagascar
Orycteropus gaudryi Forsyth Major	Pliocene (Pontian)	Pikermi Samos
Orycteropus pilgrimi, new species	Pliocene or upper Miocene (Base of Middle Siwaliks)	Punjab, India
Orycteropus browni, new species	Pliocene or upper Miocene (Base of Middle Siwaliks)	Punjab, India
Palaeorycteropus quercyi Filhol (Based on an humerus; very doubtful)	Oligocene Quercy	France
Tubulodon taylori Jepsen	Eocene Wind River	Wyoming

If Jepsen's newly described form is really a tubulidentate, and I should think that his conclusions are correct on this point, it would seem that this peculiar order of mammals had its origin in North America, during the late Mesozoic or the Eocene. Consequently it migrated from thence, westward through Asia to Africa. *Tubulodon* appeared in the Eocene of Wyoming. Next, *Orycteropus* occurred in the upper Miocene or lower Pliocene of India, and almost simultaneously the order reached the Mediterranean region. Then in the Pleistocene, the order arrived in Madagascar, and finally, in recent times, it became distributed through south Africa. This is an example of a westward migration of an order, somewhat the opposite of the commonly postulated radial migration from central Asia, applied to so many groups of mammals.

Of course, the gap between *Tubulodon taylori* of the North American Eocene, and *Orycteropus browni* of the Siwalik lower Pliocene, is very great. If intermediate forms are to be found, they should be expected in eastern Asia. An Oligocene tubulidentate from Mongolia would complete the sequence, showing the migration of this order from the New to the Old World.

NOTE.—Jepsen's paper should be consulted for the latest views as to the ancestry of the tubulidentates. He would derive the order from some group of Mesozoic mammals, a view advocated by Broom, rather than linking it with the proto-ungulates, as was done by Sonntag and other authors.

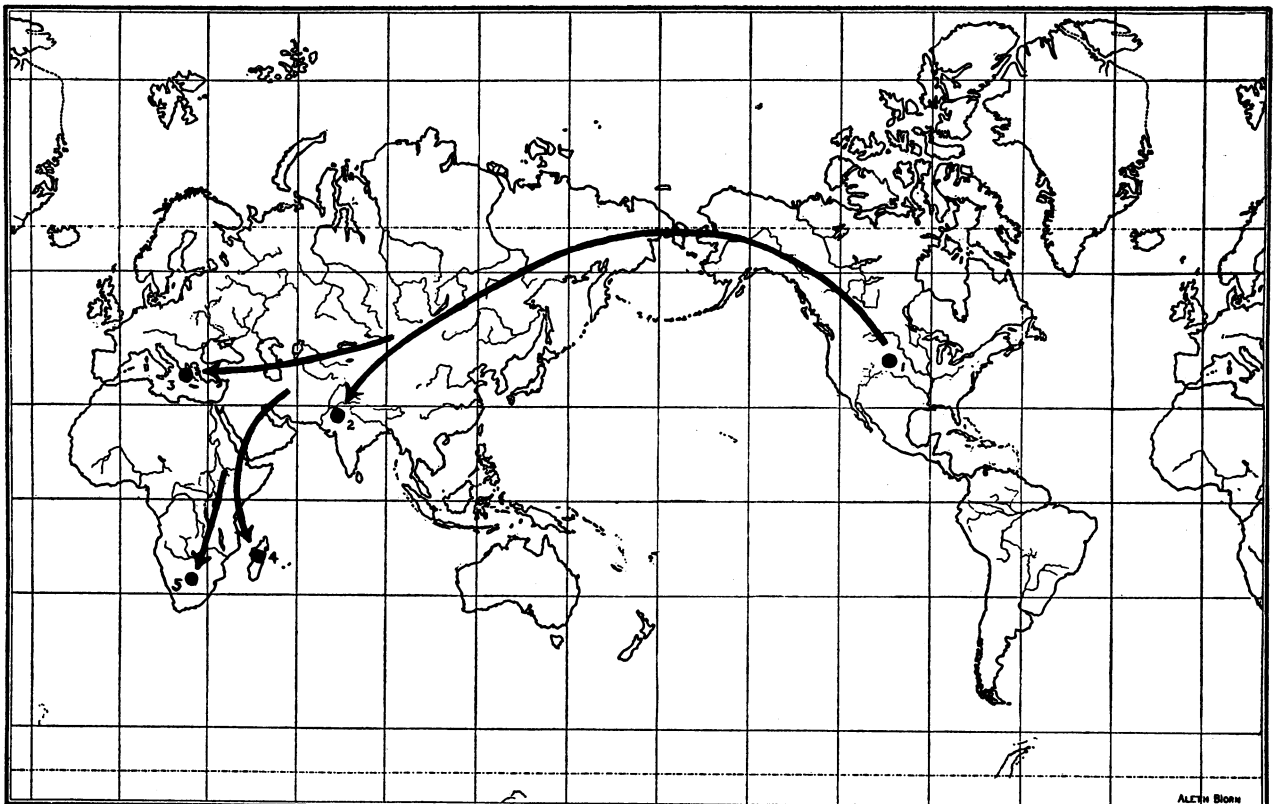

Fig. 8. The probable migration routes of the Tubulidentata during Tertiary times. Key to figures on map.

1. *Tubulodon taylori.* Wind River, Eocene. Wyoming.
2. *Orycteropus browni, Orycteropus pilgrimi.* Lower portion of Middle Siwaliks, Miocene-Pliocene. India.
3. *Orycteropus gaudryi.* Pontian, Miocene-Pliocene. Samos Island.
4. *Plesiorycteropus madagascariensis.* Pleistocene. Madagascar.
5. *Orycteropus afer*, etc. Recent. South Africa.

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