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paratus are very numerous. I have before me at this time more than five hundred substances, which I have analysed with a view to discover the chemical changes which occur during the preparation of the earth for the growth of vegetables, the germination of seeds, the vegetation of plants, the formation of vegetable products, the renovation of the atmosphere as regards both nitrogen and oxygen, and the various decompositions of vegetable matter; and many additional experiments will be required to complete the course of analysis which I find to be necessary to the purposes I have in view. The whole inquiry has reference more particularly to agriculture, to horticulture, and to some of those manufactures in which vegetable products are employed. ROBERT RIGG.

Walworth Road, Dec. 6, 1837.

X. On additional Fossil Species of the Order *Quadrumania* from the *Sewálík Hills*. By H. FALCONER, Esq., M.D., and Captain P. T. CAUTLEY.*

[With Figures : Plates I. and II.]

IN the November number of the Journal, (of the Asiat. Soc. of Bengal,) vol. v. p. 739, Messrs. Baker and Durand have announced, in the discovery of a quadrumanous animal, one of the most interesting results that has followed on the researches into the fossil remains of the *Sewálík Hills*. The specimen which they have figured and described comprises the right half of the upper jaw, with the series of molars complete; and they infer that it belonged to a very large species †. In the course of last rains we detected in our collection an *astragalus*, which we referred to a quadrumanous animal. The specimen is an entire bone, free from any matrix, and in a fine state of preservation from having been partly mineralized with hydrate of iron. It corresponds exactly in size with the *astragalus* of the *Semnopithecus Entellus* or *Langoor*, and the details of form are so much alike in both, that measurement by the callipers was required to ascertain the points of difference. We have forwarded the specimen with a notice to the Geological Society of London, after keeping it some months in reserve, having been diffident about resting the first announcement of fossil *Quadrumania* on any thing less decisive than the cranium or teeth ‡.

This *astragalus*, in conjunction with Messrs. Baker and Durand's specimen, satisfied us of the existence of at least two distinct fossil *Quadrumania* in the *Sewálík Hills*. We have lately become possessed of several fragments, more or

* From the Journal of the Asiatic Society of Bengal, vol. vi. p. 354.

† For Lieuts. Baker and Durand's paper, see *Phil. Mag.*, vol. xi. p. 33.

‡ See our report of the proceedings of the Geological Society, p. 393 of our last volume.—EDIT.

less perfect, belonging to the lower jaws of two species, both smaller than Messrs. Baker and Durand's fossil. These we shall now proceed to notice.

The principal specimen is represented in fig. 1. [Pl. I.] It consists of both sides of the lower jaw; a great portion of the right half is entire, with the whole series of molars; the left half is broken off to the rear of the antepenultimate molar. The two middle incisors are present, and also the left canine broken across at its upper third. The right canine and the lateral incisors had dropt out, leaving but the alveoli. The molars of the left side are destroyed down to the level of the jaw. The right ramus is wanting in more than half its width, together with the articulating and coronoid processes, and a portion of the margin at the angle of the jaw is gone. The specimen is a black fossil, and strongly ferruginous; the specific gravity about 2·70. It was incased in a matrix of hard sandstone, part of which is still left adhering to it.

The jaw had belonged to an extremely old animal. The last molar is worn down so as to have lost every trace of its points, and the three teeth in advance of it have been reduced to hollowed-out discs, encircled by the external plate of enamel. The muscular hollow on the ramus for the insertion of the temporal muscle is very marked, being ·35 inches deep upon a width of ·55.

The dimensions contrasted with those of the *Langoor* or *Semnopithecus Entellus* and the common Indian monkey, or *Pithecus Rhesus*, are as follow:—

Dimensions of the Lower Jaw.	Fossil Sewálík Monkey.	<i>Semnopithecus</i> <i>Entellus</i> .	<i>Pithecus Rhe-</i> <i>sus</i> .	Ratio of the Se- wálík fossil to the <i>Entellus</i> .	
	inches.	inches.	inches.		
1. Extreme length from the anterior margin of the ramus to the middle incisors	3·6	2·85	2·5	4	3·2
2. Extreme length of jaw (calculated in the fossil)	5·3	4·	3·6	4	3·02
3. Height of jaw, under the second molar measured to the margin of the alveoli	1·35	1·05	·85	4	3·1
4. Ditto at the rear molars	1·2	1·1	·95	4	3·6
5. Depth of symphysis	1·9	1·4	1·1	4	3·
6. Space occupied by the molars	2·3	1·9	1·5	4	3·3
7. Interval between the first molars	·9	·75	·65	4	3·2
8. Antero-posterior diameter of the canine	·5	·4	·3	4	3·2
9. Width of jaw behind the chin under the second molar	1·15	1·05	·95	4	3·7

Fig. 1.

Fossil

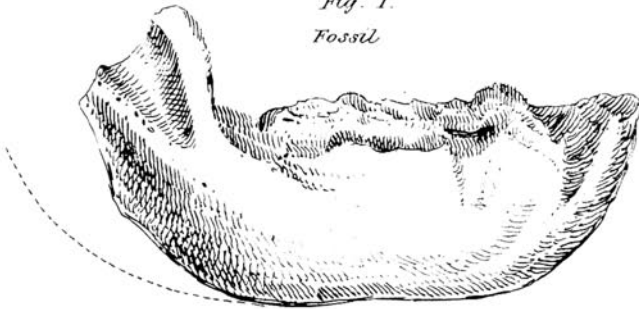
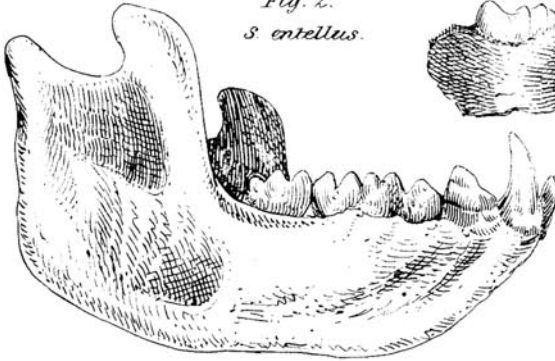


Fig. 2.
S. entellus.



Fossil. Fig. 4.

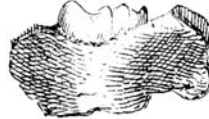
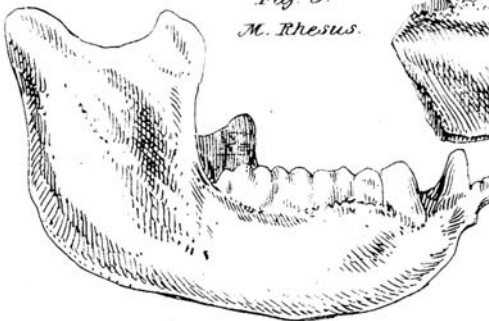
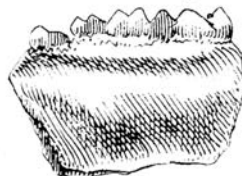


Fig. 3.
M. Rhesus.



Fossil. Fig. 5.



Scale $\frac{1}{2}$ of Nat. size.

As in all other tribes of animals in which the species are very numerous, and closely allied in organization, it is next to impossible to distinguish an individual species in the *Quadrumana* from a solitary bone. In the fossil, too, the effects of age have worn off those marks in the teeth by which an approximation to the subgenus might be made. It very closely resembles the *Semnopithecus Entellus* in form, and comparative dimensions generally. The differences observable are slight. The symphysis is proportionally a little deeper than in *Entellus*, and the height of the body of the jaw somewhat greater. The chin, however, is considerably more compressed laterally under the second molar than in the *Entellus*, and the first molar more elongated and salient. So much of the canine as remains has exactly the same form as in the *Entellus*, and its proportional size is fully as great. As shown by the dimensions, the jaw is much larger than in the full-grown *Entellus*: in the former the length would have been about 5·3 inches, while in the latter it is exactly 4 inches. The fossil was a species of smaller size than the animal to which the specimen described by Messrs. Baker and Durand belonged, but less so than it exceeds the *Entellus*.

Our limited means for comparison, restricted to two living species, besides the imperfection of the fossil, and the few characters which it supplies, do not admit of affirming whether it belongs to an existing or extinct species; but the analogy of the ascertained number of extinct species among the Sewálik fossil mammalia, makes it more probable that this monkey is an extinct one than otherwise. There is no doubt about its differing specifically from the two Indian species with which we have compared it.

The next specimen is shown in fig. 5. [Pl. I.] It is a fragment of the body of the right side of the lower jaw, containing the four rear molars. The teeth are beautifully perfect. It had belonged to an adult, although not an aged animal, the last molar having the points a little worn, while the anterior teeth are considerably so. The dimensions, taken along with age, at once prove that it belonged to a different and smaller species than the fossil first noticed.

The dimensions are as follow:—

Dimensions of the Lower Jaw.	Smaller fossil Sewálik species.	Larger fossil Sewálik species.	Semnopithecus Entellus.	Pithecus Rhesus.
1. Length of space occupied by the four rear molars	inches. 1·48	inches. 1·7	inches. 1·48	1·25
2. Height of jaw at the third molar	·95	...	1·1	·9

The length of jaw, therefore, estimated from the space occupied by the teeth, would be 4 inches, while in the larger fossil it is 5·3 inches, a difference much too great to be dependent merely on varieties of one species. Besides, we have another fragment, also belonging to the right side of the lower jaw, and containing the last molar, which agrees exactly in size with the corresponding tooth in the figured specimen*. This goes to prove the size to have been constant. The fossil, although corresponding precisely in the space occupied by the four rear molars with the *Entellus*, has less height of jaw. There is further a difference in the teeth. In the *Entellus* the heel of the rear molar is a simple flattened oblique-surfaced tubercle, rather sharp at the inside. In the fossil, the heel in both fragments is bifid at the inside. The same structure is observable in the heel of the rear molar of the common Indian monkey *P. rhesus*. It is therefore probable that the fossil was a *Pithecus* also. It was considerably larger, however, than the common monkey, and the jaw is more flattened, deeper, and its lower edge much sharper than in the latter. This difference in size and form indicates the species to have been different.

It would appear, therefore, that there are three known species of fossil *Quadrumana* from the Sewálík Hills: the first a very large species, discovered by Messrs. Baker and Durand; the second, a large species also, but smaller than the first, and considerably larger than the *Entellus*; the third, of the size of the *Entellus*, and probably a *Pithecus*; and further, that two of the three at least, and most probably the third also, belonged to the types of the existing monkeys of the old Continent, in having but five molars, and not to the *Sapajous* of America.

There are at present upwards of 150 described species of existing *Quadrumana*, and as the three fossil ones all belonged to the larger-sized monkeys, it is probable that there are several more Sewálík species to be discovered. We have some specimens of detached teeth, of large size, which we conjecture to be quadrumanous; but their detached state makes this conjecture extremely doubtful.

Besides the interest attaching to the first discovery in the fossil state of animals so nearly approaching man in their organization, as the *Quadrumana*, the fact is more especially interesting in the Sewálík species, from the fossils with which they are associated. The same beds, or different beds of the same formation, from which the *Quadrumana* came, have yielded species of the camel and antelope, and the *Anoplo-*

[* We presume that fig. 4. of Pl. I. represents this third fragment.—
EDIT.]

therium posterogenium, (nob.): the first two belonging to genera which are now coexistent with man, and the last to a genus characteristic of the oldest tertiary beds in Europe. The facts yielded by the reptilian orders are still more interesting. Two of the fossil crocodiles of the Sewálíks are identical, without even ranging into varieties, with the *Crocodylus biporcatus* and *Leptorynchus Gangeticus*, which now inhabit in countless numbers the rivers of India; while the *Testudinata* are represented by the *Megalocheilus Sivalensis* (nob.), a tortoise of enormous dimensions, which holds in its order the same rank that the *Iguanodon* and *Megalosaurus* do among the *Saurians*. This huge reptile (the *Megalocheilus*)—certainly the most remarkable of all the animals which the Sewálíks have yielded—from its size carries the imagination back to the æra of gigantic Saurians. We have leg bones derived from it, with corresponding fragments of the shell, larger than the bones in the Indian unicorned rhinoceros!

There is, therefore, in the Sewálík fossils a mixture in the same formation of the types of all ages, from the existing up to that of the chalk; and all coexistent with *Quadrumana*.

P.S. Since the above remarks were put together, we have been led to analyse the character presented by a specimen in our collection, which we had conjectured to be quadrumanous. The examination proves it to be so incontestably. The specimen is represented in figs. A, B, and C [of Pl. II.] It is the extra-alveolar portion of the left canine of the upper jaw of a very large species. The identification rests upon two vertical facets of wear, one on the anterior surface, the other on the inner and posterior side, and the proof is this. The anterior facet *b* has been caused by the habitual abrasion of the upper canine against the rear surface of the lower one, which overlaps it, when the jaws are closed or in action. This facet would prove nothing by itself, as it is common to all aged animals in the carnivora and other tribes in which the upper and lower canines have their surfaces in contact. The second facet *c* must have been caused by the wear of the inner and rear surface of the canine against the outer surface of the first molar of the lower jaw. But to admit of such contact, this molar must have been contiguous with the lower canine, without any blank space intervening; for if there was not this contiguity, the upper canine could not touch the lower first molar, and consequently not wear against it. Now this continuity of the series of molars and canines without a diasteme or blank interval, is only found, throughout the whole animal kingdom*, in man, the *Quadrumana*, and the

* Cuvier, *Ossements Fossiles*, tome iii. p. 15.

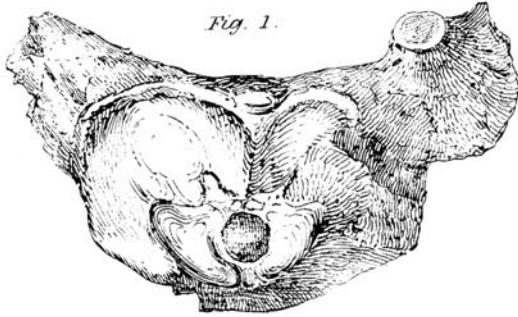


Fig. 1.

Scale of Natural size.

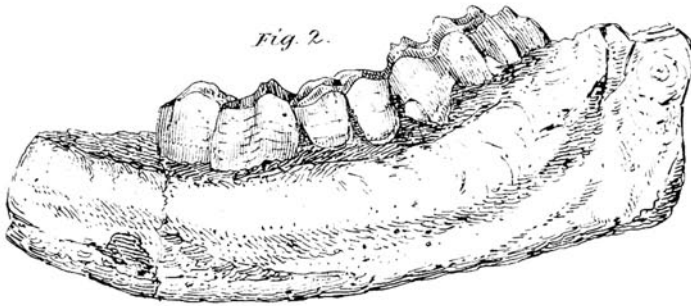


Fig. 2.

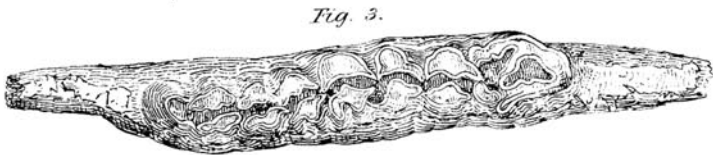


Fig. 3.

$\frac{1}{3}$ of Natural Size.

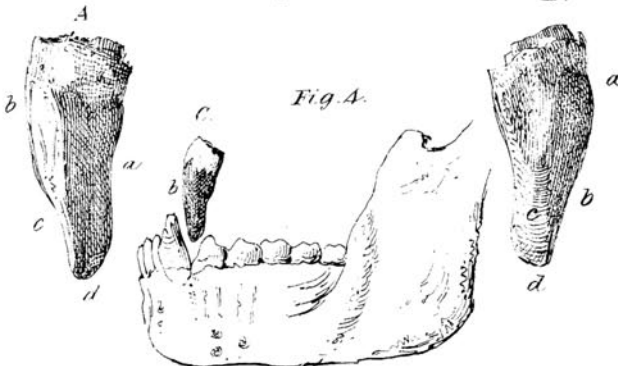


Fig. 4.

$\frac{1}{2}$ of Natural Size.

Anoplotherium. The fossil canine must therefore have belonged to one of these. It were needless to point out its difference from the human canine, which does not rise above the level of the molars. In all the species of *Anoplotherium* described by Cuvier, the canines, while in a contiguous series with the molars, do not project higher than these, being rudimentary, as in man. Of the Sewálík species, *Anoplotherium posterogenium* (nob.), we have not yet seen the canines; but it is very improbable, and perhaps impossible, that the fossil could belong to it. For if this species had a salient canine, it must have been separated from the molars by an interval, as in the other *Pachydermata*; otherwise the jaws would get locked by the canines and molars, and the lateral motion required by the structure of the teeth, and its herbivorous habit, would be impracticable; and if there was this interval, the upper canine could not have the posterior facet of wear. The fossil canine must therefore have belonged to a quadrumanous animal. This inference is further borne out by the detrition of the fossil exactly corresponding with that of the canines of old monkeys.

The dimensions are:—

Length of the fragment of canine . . .	1·75 inches.
Antero-posterior diameter at the base . . .	·8
Transverse ditto	·7
Width of the anterior facet of wear . . .	·6

The two diameters are greater than those of the canine of the Sumatra Orang-otang described by Dr. Clarke Abel* as having been $7\frac{1}{2}$ feet high. The *Cynocephali* have large and stout canines, more so comparatively than the other *Quadrumanus*. But to what section of the tribe our fossil belonged, we have not a conjecture to offer. We may remark, however, that the tooth is not channeled on three sides at the base, as in the *Entellus*. Does the fossil belong to the same species as the jaw discovered by Messrs. Baker and Durand, or to a larger one?

Note by the Editor of the Journal of the Asiatic Society.—We have sketched Dr. Falconer's highly curious fossil tooth in position with the lower jaw of the Sumatran Orang-otang from the Society's Museum, in fig. C [of Pl. II.] There is a third facet of wear at the lower extremity *d*, which on reference we find Dr. Falconer attributes, like *c*, to attrition against the first molar, being observable, he says, in many aged animals. The worn surfaces *c* and *d* are uniformly polished, and have evidently originated from attrition against a tooth; but with regard to the principal facet *b*, we

* Asiatic Researches, vol. xv. p. 498; [or Phil. Mag. and Annals, N. S. vol. i. p. 219.]

confess we have a degree of scepticism, which can only be removed by a certainty, that the fossil had been seen extracted from the matrix. In the first place, the great extent of the worn surface and its perfect flatness could hardly be caused by attrition against the lower canine, which should produce a curvature measured by the length of the jaw as radius. In the next place, the enamel of the tooth is less worn than the interior and softer part of the fossil; and, thirdly, on examination with a magnifier, numerous scratches are visible in divers directions: all these indicating that the facet may have been produced *on the fossil*, by grinding it on a file, or some hard flat surface. On showing the fossil to Madhusudana, the medical pandit of the Hindu College, he at once pronounced that the tooth had been ground down to be used in medicine, being a sovereign specific in the native pharmacopœia. This circumstance need not necessarily affect the question, for it is probable that the native druggist would commence his rubbing on the natural plane, if any presented itself to his choice; but Dr. Falconer and Captain Cautley, to whom we have returned the fossil with a communication of our doubts, assure us in reply that the fossil tooth was brought in along with a large collection, so that there is every improbability of its having been in possession of a native druggist. At any rate, it is not on the front wear that they so much rest their argument of its origin, as on the posterior abrasion, which could only happen in the jaw of a quadrumanous animal. In fact, they have recent quadrumana showing precisely similar wear on a small scale, and no other head will do so. We find only one exception in the Society's Museum, viz., the tapir, whose right upper incisor (or non-salient canine) falling between the two lower ones, is worn nearly in the fashion of the fossil; but it is less elongated.

XI. *Notice of additional Fragments of the Sivatherium.**

[With Figures : Plate II.]

BEFORE Colonel Colvin's departure for Europe, we requested permission to take a cast of the beautifully preserved lower jaw of the *Sivatherium* which he exhibited at the Government House scientific party in January last [1837]. In further token of his zeal for science, and of his ever-readiness to oblige, he has, even in the hurry of embarkation, favoured us with the accompanying lithographic drawings of the same jaw, and of the larger fragment of the occiput, also on its way to adorn some cabinet of fossil osteology in his native

* From the Journal of the Asiatic Society of Bengal, vol. vi. p. 152; being a communication by the Secretary, James Prinsep, Esq., F.R.S.