

In the case of a freezing mixture I suppose it does so, but such a case would not occur among minerals. Some geologists think that dynamo-metamorphism takes place *viâ* heat; but I am inclined to think that the energy developed by the work upon the rocks takes at once the form of chemical energy, without passing through the intermediate stage of heat. I should like to hear what is thought on this question by those who know.

In the case of the Bude rocks, and of the similar series at Tenby, I suppose that the movement took place at the same time as that of the disturbance of the Carboniferous rocks of the West of England. The Poikilitic series, which is the next in sequence, has not partaken of this disturbance. Hence, it is possible that the "cover" at the time of the disturbance was not great, and this will go some way to account for the small amount of metamorphism observed by General McMahon. Perhaps, also, the argillaceous beds may have acted as lubricants, and diminished the friction, thus reducing the magnitude of the force $P - W$, and the corresponding work expended on the rocks.

HARLTON, CAMBRIDGE.

VI.—NOTE ON A PLIOCENE MAMMALIAN FAUNA AT OLIVOLA IN THE UPPER VAL DI MAGRA (PROV. MASSA-CARRARA), ITALY.

By C. J. FORSYTH MAJOR, M.D.

FOSSIL Mammalian remains from Olivola were already known in the last century. Giovanni Targioni Tozzetti describes and figures several bones from that locality, which he refers to some species of *Trichechus* or *Phoca*, but which, as far as the figures permit of a judgment, belonged to Ruminants.¹ In this century, the deposit was mentioned by Pareto,² and by Cocchi,³ who from stratigraphical considerations ascribe it to the Pleistocene.

A few remains from this locality, collected by Prof. Cocchi and Prof. Capellini, are preserved in the museums of Pisa and Florence, and in that of Bologna. Rüttimeyer has made known an imperfect skull of an Antelope (*Palæoryx Meneghinii*, Rütim.) from Olivola, preserved in the Pisa Museum.⁴ He, too, divides the opinion of the before-mentioned Italian geologists as to the geological age of the deposit, which he calls an Ossiferous Breccia. As, however, the skull of Antelope in which he recognizes a type from Pikermi, points to an older horizon, he supposes it to have been floated into this "Breccia" from an older deposit.

¹ Giovanni Targioni Tozzetti, Relazione d'alcuni Viaggi fatti in diverse parti della Toscana, ed. seconda, t. x. 1777, pp. 386-395, tav. i.

² L. Pareto, Note sur les subdivisions que l'on pourrait établir dans les terrains tertiaires de l'Apennin septentrional (Bull. Soc. Géol. de France, 2^e série, t. 22. (Séance du 20 févr. 1865).

³ I. Cocchi, L'Uomo fossile nell'Italia Centrale, Studi Palæontologici (Mem. Soc. Ital. Scienze Natur. vol. iii.), Milano, 1867, pp. 34-36.

⁴ L. Rüttimeyer, Die Rinder der Tertiär-Epoche, nebst Vorstudien zu einer natürl. Geschichte der Antilopen (Abhh. Schweiz. Palæont. Gesellsch.), vol. iv. Zurich, 1877, 1878, fasc. vii. figs. 13, 14, pp. 86, 87.

An upper jaw of *Equus* from this same deposit, preserved in the Museum of Pisa, has been described by me as *Equus Stenonis*, Cocchi. On that occasion I gave my reasons for retaining it as of Pliocene age, relying on the few mammalian remains known at that time.¹

During the autumn and beginning of winter of 1889, I had an opportunity of undertaking some excavations at Olivola, which brought to light a rich Mammalian fauna of undoubtedly Pliocene age, that is, contemporaneous with the Val d'Arno fauna. I was prevented through illness from terminating the work; but the results already obtained are deserving of mention, as besides some quite new forms of Antelope, up to this day fifteen species have been discovered, most of which are components of the Val d'Arno fauna, and are represented partly by much more complete remains than even the rich Florentine Museum can boast of.

Carnivora.—The genera *Felis*, *Machairodus*, *Hyæna*, *Canis*, *Ursus* are represented. The remains of *Felis* (two crania, two lower jaws and several leg bones) belong to a large form which may be provisionally referred to the *Felis arvernensis*, Cr. et Job.

Machairodus.—Several upper canine teeth of *M. cultridens*, Cuv., and a nearly complete hinder leg.

The remains of *Hyæna* belong to the larger Val d'Arno form, named by Weithofer *H. robusta*; right and left maxilla of a young individual, with the milk dentition still in situ; several lower jaws, and various bones.

The remains of *Canis* are very numerous, and partly in a fine state of preservation. Several skulls and nearly all the parts of the skeleton have been secured. The majority of these remains belong to the species described by the present writer under the name of *Canis etruscus*; but there is a larger form too, which may prove to belong to *Canis Falconeri*, Major, incompletely known at present.

The *Ursus etruscus*, Cuv., which, as well as all the other forenamed *Carnivora*, has not hitherto occurred frequently in the Val d'Arno, is well represented at Olivola by an incomplete skull, various upper and numerous lower jaws, besides bones of the skeleton.

Rhinoceros etruscus, Falc.—A complete cranium, with adhering mandibula, several other crania, less complete, several mandibulæ, and numerous other remains.

Equus Stenonis, Cocchi.—Two crania; mandibulæ; numerous bones.

Mastodon arvernensis, Cr. et Job., is for the present represented only by the proximal parts of a cubitus and radius.

Sus Strozzi, Menegh.—A skull and various mandibulæ. A lower canine tooth of *Sus* from Olivola, deposited many years ago in the Museum of Pisa by Prof. Cocchi, was declared by Rüttimeyer² to be indistinguishable from the corresponding canines of the living *Sus scrofa*. A comparison, however, with the lower canines of living

¹ Forsyth Major, Beitræge zur Geschichte der fossilen Pferde insbesondere Italiens, IIter Theil. (Abhh. Schweiz. palæontol. Gesellsch. vol. vii. 1880, pp. 124, 125, Taf. iv.).

² *loc. cit.* p. 86.

and Pliocene species shows it to agree exactly with the latter, the outer plate of enamel being as large from behind forwards as the inner, as is the case also in the Siwalik species, and in the living *Sus celebensis*, Müll. & Schleg., and *Sus verrucosus*, Müll. & Schleg., from Java, whilst in *Sus scrofa* the outer side is very narrow from behind forwards. The more complete remains of *Sus* found last year at Olivola have placed beyond doubt their identification with *Sus Strozzii* from the Val d'Arno.

Ruminantia.—Numerous pieces: skulls, jaws and other parts of the skeleton of at least three forms of *Cervus*, the largest of which, in the form of the antlers, comes very near to *Cervus dicranius*, Nesti. The other cervine remains have not yet been satisfactorily identified with known Pliocene species, their preparation not being as yet advanced enough.

Of *Bovine* animals the deposit has yielded several crania of a hornless form; one incomplete cranium provided with horns; besides numerous other parts of the skeleton.

Since Prof. Rüttimeyer examined the remains of bovine Ruminants from the Val d'Arno deposited in the Florentine Museum, several valuable pieces have been added to that collection. These, together with the skulls discovered at Olivola, have been lately re-examined by me, and the result is that I in some respects disagree with Rüttimeyer's views on the subject. It will be remembered that Rüttimeyer placed the hornless crania of the Val d'Arno in the genus *Leptobos* (*Leptob. Strozzii*, Rütim.), represented in the Siwaliks by horned and hornless (female?) crania of the *Leptobos Falconeri*, Rütim., and in the Pleistocene of the Narbada Valley by a hornless cranium, named *Leptobos Fraseri*, Rütim.¹ For my part, I cannot discover any differences between the crania of "*Leptobos Strozzii*" and "*Bos etruscus*," besides those which are the consequences of the presence or absence of horn-cores. The same opinion was expressed by me many years ago, when I declared the hornless skull in the Florentine Museum a mere variety of "*Bos etruscus*," suggesting that it was probably the female form.²

As, moreover, the differences between the horned crania of *Leptobos Falconeri*, Rütim., on the one hand, and of *Bos etruscus*, Falc., on the other, which have induced Rüttimeyer to place the first in his group of the *Portacina*, the second in the *Bibovina*, are not marked enough in my opinion, there being several transitional forms in the various known crania of *Leptobos Falconeri*, as well as in those of "*Bos etruscus*," the only way of resolving the question seems to me to include all the known remains of bovine animals of the Italian and French Pliocene in the genus *Leptobos*. The synonymy of the only species therefore runs as follows:—

LEPTOBOS ELATUS (Croizet sp.).

1828. *Bos elatus*, Croizet, Coll. Mus. Paris

1854. *Bos elatus* and *Bos elaphus*, Pomel, Catalogue Méthodique.

¹ L. Rüttimeyer, Die Rinder der Tertiär-Epoche, etc., p. 157, seqq.

² Forsyth Major, Nagerüberreste aus Bohnerzen Süddeutschlands und der Schweiz. Paläontographica, ii. 2 (xxii.), 1874, p. 123.

1859. *Bos etruscus*? Falconer MS., cf. Palæontological Memoirs and Notes, ii. p. 481.
 1866. *Bos (Bibos) etruscus*, Rüttimeyer, Versuch einer natürl. Geschichte des Rindes, etc. ii. p. 71, seqq.
 1874. *Bos etruscus*, Forsyth Major, Nagerüberreste aus Bohnerzen Süddeutschlands und der Schweiz, Palæontographica, ii. 2 (xxii.), p. 123.
 1877–8. *Bos (Bibos) etruscus*, Rüttimeyer, Die Rinder der Tertiaer-Epoche, Abhh. Schweiz, Palæont. Ges. p. 154.
 1877–8. *Leptobos Strozzi*, Rüttimeyer, *ib.*, pp. 167, 168, 173, 175.
 1884. *Bos elatus*, Depéret, Nouvelles études sur les Ruminants pliocènes et quaternaires d'Auvergne (Bull. Soc. Géol. de France 3^e série, t. xii. p. 247).
 1885. *Bos elatus*, Lydekker, Catalogue of the Fossil Mammalia in the British Museum (Nat. Hist.), part ii. p. 19.

The *Rodentia* are for the present represented only by a large incisor, referable to the genus *Castor*.

VII.—ON THE BASE OF THE SEDIMENTARY SERIES IN ENGLAND AND WALES.

By the Rev. Prof. J. F. BLAKE, M.A., F.G.S.

AS Dr. Callaway has asked in a recent Number of the GEOLOGICAL MAGAZINE¹ for the grounds on which I suggest that some of the volcanic rocks of Shropshire may perhaps be classed as Cambrian, I take this opportunity for bringing before your readers the present state of the inquiry into the nature and classification of the earliest sedimentary rocks in this country. This inquiry has been spoken of by Dr. Callaway as the “Archæan controversy”; but we must not necessarily call everything that is earlier than the Cambrian “Archæan,” any more than in old days it was right to call everything Precarboniferous “unfossiliferous greywacké”; nor should the inquiry be considered a controversy in its present stage, but rather a search for more accurate knowledge.

Omitting the Charnwood Forest rocks, and the Caldecott ashes, about which there is little definite to say, the areas in which Precambrian rocks have been described are—1. St. Davids; 2. Anglesey; 3. North-west Carnarvonshire; 4. Malvern; 5. Shropshire; 6. Devonshire and Cornwall. I propose to point out, according to my view, our present state of knowledge, and the history of its growth, in each of these localities.

1. *St. Davids District*.—It appears that when this was mapped by Prof. Ramsay, before 1857, he recognized below the basal Cambrian conglomerates, besides a mass of crystalline rock, a series of more or less volcanic detritus and lavas, but that this recognition was never published. In its place was the indication that the latter were “altered Cambrian.” In 1877, however, Dr. Hicks, considering that the Cambrian conglomerates, from the nature of their contents, and their apparent unconformity, indicated a greater break than had been recognized by Prof. Ramsay, set to work to describe the underlying rocks as distinct formations. He was also under the influence of theories of metamorphism; but whereas, in Prof. Ramsay’s hands, these theories had led him to consider lavas and ashes as the

¹ GEOL. MAG. Decade III. Vol. VII. p. 143, 1890.