ORDINARY MEETING.

FRIDAY, DECEMBER 3RD, 1886.

W. TOPLEY, Esq., F.G.S., Assoc.Inst.C.E., President, in the Chair.

The donations to the library since the previous meeting were announced, and the thanks of the Association accorded to the various donors.

The following were elected members of the Association :—F. B. Bather, B.A., F.G.S. ; A. Champernowne, M.A., F.G.S. ; J. Edmunds, M.D. ; R. M. Gordon ; Miss A. K. Harding ; F. Harrison ; C. Holme, F.L.S. ; Miss J. B. McLeod ; C. J. Mitchell, M.A. ; Commander C. E. Reade, R.N. ; J. P. Smart, junr. ; C. N. Peal ; T. Simpson ; Rev. H. H. Winwood, M.A., F.G.S. ; and R. B. Yardley.

The following papers were then read :—‘ On fossil leathery turtles and their occurrence in British Eocene deposits.’ By Mr. A. Smith Woodward, F.G.S.

‘ On some further researches in bone-caves in Wales.’ By Dr. H. Hicks, F.R.S.

Mr. S. J. Hawkins exhibited and remarked upon some specimens of polished Japanese marbles ; and Mr. Ogle exhibited specimens of Eocene vertebrate remains, including those of turtle.

ON “LEATHERY TURTLES,” RECENT AND FOSSIL, AND THEIR OCCURRENCE IN BRITISH EOCENE DEPOSITS.

By A. SMITH WOODWARD, F.G.S., of the British Museum
(Natural History).

As has often been remarked, there is no order of the Reptilian Class regarding the origin and development of which there is less information than that of the Chelonia. Throughout almost all the Tertiary and Secondary formations their fossil remains are scattered more or less abundantly, but there is very little approach to a generalized type as they are traced back in time, and even so low in the series as the Upper Trias there is undoubted evidence of completely differentiated members of the order. The most obvious character, of course, in which they differ from other reptiles, consists in their possession of a remarkably complete bony

armour, adapted—in the dorsal region—to the bones of the axial skeleton; and there is every reason to believe that in this peculiarity the *Chelytherium* of Von Meyer,* from the Upper Keuper Sandstone of Stuttgart, was as distinctively Chelonian as any genus of more modern times.

But it rarely happens that in a group of living organisms there are no surviving relics of an earlier stage of specialization; and, in accordance with the common rule, we find among existing Turtles and Tortoises at least one generic type, which appears to afford some slight glimpse into the condition of the remote ancestors of the group. The "Leathery Turtle" (*Sphargis coriacea*),† inhabiting the more tropical parts of the existing seas, is invested in an armoured covering much less removed from the similar shields of other reptiles than any of its congeners; and a consideration of the general anatomical features of this animal can leave no doubt that it is a direct and little-altered descendant of the most primitive members of the order. As such, it is of peculiar interest to the palæontologist, and the most fragmentary of its remains are worthy of careful study.

Hitherto, however, there is very little fossil evidence of the extinct allies of the genus under consideration; and with the exception of two comparatively perfect Cretaceous fossils, none but small fragments have yet been described. For this reason it may be of some interest to offer a few remarks upon our present knowledge of the important group to which it belongs—especially as so little prominence seems to be given to the type even in the ordinary modern text-books. I also venture to add a brief notice of one other fragmentary fossil, preserved in the British Museum, since its derivation from an English Eocene deposit that has been closely studied by so many members of the Association may not improbably result in the discovery of further remains.

* H. von Meyer, "Reptilien aus dem Stubensandstein des oberen Keupers," 'Palæontographica,' Vol. xiv (1865), pp. 120-124, pl. xxix, figs. 2-10. The type specimens are now in the British Museum.

† Duméril and Bibron, 'Erpétologie générale,' Vol. ii, 1835, p. 560, pl. xxiv, fig. 2.—C. J. Temminck and H. Schlegel, 'Siebold's Fauna Japonica—Reptiles,' 1838, pp. 6-12, pls. i-iii.—J. E. Gray, 'Catalogue of the Shield Reptiles in the British Museum,' pt. i, 1855, p. 71.—J. H. Sears, "*Dermatochelys coriacea*, Trunk Back or Leathery Turtle," 'Bull. Essex Institute,' Vol. xviii (1886), pp. 87-94. Mr. Garman admits a second species in his "N. American Reptiles and Batrachians," 'Bull. Essex Institute,' Vol. xvi (1884), p. 6; he also employs the generic name of *Dermatochelys*, which was proposed nine years later than that of *Sphargis* (Agassiz).

As already suggested, it is the relation of the dermal armour to the underlying skeleton that invests the Leathery Turtle with such extreme interest. The dorsal shield (or representative of the "carapace") consists of a large number of irregular, polygonal bony plates, firmly united by jagged sutures, and covered externally by a tough, wrinkled skin; * and the ossifications do not extend to the deepest portion of the integument, so that there is no evidence of them on the under side of the detached shield. A median longitudinal row of these plates, and three pairs of lateral rows, are somewhat larger in size than those adjoining, and are slightly raised, so as to form seven long ridges; while the remaining plates are almost smooth and flat, exhibiting only a small pit in the middle of each, with faint radial grooves.†

There is no connection whatever between this bony dermal armour and the underlying ribs and vertebral spines, such as is the case with the true carapace of more specialized Chelonia, and the only shield bearing any relation to the underlying skeleton is a remarkable squamous plate ‡ attached to the top of the last neck-vertebra, which is evidently represented by the "nuchal" plate in the ordinary turtles and mud-tortoises (*Trionyx*).

The skin of the ventral surface is also studded with numerous small polygonal ossifications, but these are scarcely so compacted together as on the back; § and it is interesting to observe that there are present, in addition, no less than eight of the nine bones which ordinarily form the inferior shield (or "plastron") in Chelonia. These bones, however, are merely represented by overlapping slender splints, and the curious anterior median element, or "entoplastron" (= "interclavicle," Parker), is the portion of which no ossified evidence is observed.||

* In young individuals, scattered horny scutes are also said to be present. Duméril and Bibron, 'Erpétologie générale,' Vol. ii, 1835, p. 559.

† P. Gervais, "Ostéologie du Sphargis Luth (*Sphargis coriacea*)," *Nouv. Archiv. Mus.*, Vol. viii (1872), pp. 221, 222, pl. ix, figs. 1, 3.—H. G. Seeley, "Note on *Psephophorus polygonus*," *Quart. Journ. Geol. Soc.*, Vol. xxxvi (1880), p. 409.—St. G. Mivart, Art. "Reptiles," *Encycl. Brit.*, 9th ed., Vol. xx (1886), p. 447.

‡ P. Gervais, *loc. cit.*, pp. 223, 224, pl. vii, fig. 12.

§ P. Gervais, *loc. cit.*, p. 223, pl. ix, fig. 2.

|| H. Rathke, 'Ueber die Entwicklung der Schildkröten,' 1843, p. 122; translated in W. K. Parker's 'Monograph on the Shoulder Girdle,' Ray Society, 1868, p. 134.—P. Gervais, *loc. cit.*, pp. 215, 216, pl. vii, fig. 3; pl. viii, fig. 5. The entoplastron is also absent both in the fine skeleton of an adult *Sphargis* and that of a young individual (only four inches long) in the British Museum; and I have failed to discover on what authority this

The skull,* at first sight, bears considerable resemblance to that of the common turtles (*Chelone*), having the same curious roof to the hollow for the biting muscles. But there are several well-marked differences, and one, to be noted in the palate, is especially conspicuous. In front, the vomerine bone is connected merely with the premaxillæ, and there are no palatal outgrowths of the maxillæ, throwing the aperture of the posterior nares slightly backwards, as is the case in the living turtle; and there is no very prominent process from the back of the head, like that of the supra-occipital bone in the more familiar marine type. The frontal bones also differ somewhat, extending forwards almost to the external nostrils, and all the bones are considerably more delicate and scale-like than those of any other existing members of the order.

Notwithstanding the total disconnection of all but one from any superjacent bones, the neural spines of the vertebræ have flattened summits; † and each arch conforms to the ordinary Chelonian plan in being placed, not directly upon the middle of a centrum, but upon the hinder half of one and the anterior half of the next. ‡ The ribs are likewise quite normal—articulating directly (not by transverse processes) with facettes at the junction of each pair of vertebræ—but these bones are remarkable for their very slight expansion.

The limbs and their supporting "arches" are very similar to those of the turtles in general plan, being adapted for analogous conditions of existence; and, though several features are characteristic, detached bones require comparative study for definite recognition.§

The possession of the more striking of these anatomical characters has caused the remarkable genus in question to assume a con-

bone is said to be largely developed in the Leathery Turtles, in the new edition of the 'Encyclopædia Britannica' (Art. 'Reptiles'), Vol. xx, p. 447.

* P. Gervais, *loc. cit.*, pp. 200-208, pl. v, pl. viii, fig. 1. J. E. Gray, "Notes on the Families and Genera of Tortoises (Testudinata), and on the characters afforded by the study of their Skulls," 'Proc. Zool. Soc.', 1869 p. 224.

† The summits of the neural arches are also flattened to some extent in certain Crocodilia—especially in the heavily-armoured Mesozoic types.

‡ See excellent figure in Art. "Reptiles," 'Encycl. Brit.', 9th edit., Vol. xx, 1886, p. 449.

§ See figures and descriptions in Gervais' elaborate Memoir already quoted.

tinually more prominent place in the various classificatory schemes of the Chelonia that have successively been proposed. Originally made the type of a family or sub-family by Fitzinger,* Gray,† Strauch,‡ and others, it was first raised to the rank of a sub-order, in 1870, by Professor Cope,§ who proposed the name of ATHECÆ in allusion to the imperfection of the external armour, and considered it equivalent to each of two other divisions into which the remaining Chelonia were distributed, according as the hip-bones were united or unconnected with the plastron; the entire order being thus classified as follows:—

- I. ATHECÆ. Dorsal exoskeleton not merged with vertebræ and ribs; plastron very slightly developed. Ex. *Sphargis*.
- II. CRYPTODIRA. Carapace and plastron more or less developed: the former always intimately connected with vertebræ and ribs: pelvis disconnected from plastron. Ex. *Chelone*, *Trionyx*, *Emys*.
- III. PLEURODIRA. Carapace and plastron well developed: the former always intimately connected with vertebræ and ribs: pelvis connected with plastron. Ex. *Chelys*, *Chelodina*.

Ten years later, Prof. Seeley|| again proposed a threefold arrangement, regarding the Leathery Turtle as the surviving representative of one section, and dividing the other types into two, according to the absence or presence of horny scutes; and he further suggested that the granulations upon the dorsal armour of the mud-tortoises (*Trionyx*) might possibly be regarded as definite relics of a dermal shield resembling the tessellated pavement of *Sphargis*, which had become degenerated in these more specialized forms by the progress of evolutionary development.¶ The scheme may be briefly stated thus:—

* L. Fitzinger, 'Systema Reptilium,' 1843, p. 30.

† J. E. Gray, 'Catalogue of Shield Reptiles in the British Museum,' pt. 1, 1855, p. 71.

‡ A. Strauch, "Chelonologische Studien," 'Mém. Acad. Sci. St. Pétersbourg' [7], Vol. v, No. 7, 1862, p. 58.

§ E. D. Cope, "Catalogue of the Families of the Reptilia," 'Proc. Amer. Assoc. Adv. Sci.' Vol. xix, 1870, p. 235; "The Reptiles of the American Eocene," 'Amer. Nat.', 1882, p. 987.

|| H. G. Seeley, "On *Psephophorus polygonus*," 'Quart. Journ. Geol. Soc.', Vol. xxxvi (1880), p. 412.

¶ This idea had previously been alluded to by Gervais (*loc. cit.*, p. 224), who considered it disproved by a study of the microscopical structure of the plates.

- I. *DERMATOCHELYDÆ*.* Carapace but slightly developed, and not anchylosed with the vertebræ and ribs in the adult. Ex. *Sphargidæ*.
- II. *PELTOCHELYDÆ*. Symmetrical bony carapace, more or less firmly united with the vertebræ and ribs in the adult: external surface with granular ornament: no epidermic scutes. Ex. *Trionychidæ*.
- III. *ASPIDOCHELYDÆ*. Symmetrical bony carapace, firmly united with the vertebræ and ribs in the adult, and covered with symmetrical horny scutes. Ex. Turtles, Emydians, and Tortoises.

Quite recently,† M. Dollo, of Brussels, has advanced a step further, and made the *ATHECÆ* of equivalent value to all other Chelonia grouped together under the denomination of *THECOPHORA*; ‡ and there can be little doubt that this arrangement will become universally adopted, as our knowledge in regard to the extinct forms, of which there are already some glimpses, is increased by future discoveries. We agree, however, with a recent reviewer in the 'Geological Magazine,'§ that there is no evidence to suggest that the Chelonian Reptiles had all become toothless by the time that they arrived at this stage of differentiation; and modern researches upon birds || and monotremes afford a strong argument for the non-acceptance of any classification by which the mere presence of teeth in a fossil turtle or tortoise is made to prevent its reference to one or other of the great divisions just mentioned.

Turning to the evidence of fossils, with which we are here more particularly concerned, it is unfortunate that hitherto there have

* Prof. Seeley's original definition of this group will not strictly include *Sphargis* itself (the "nuchal plate" being doubtless part of the true carapace), much less Prof. Cope's *Protostega*, which was described before 1880, and Prof. Capellini's *Protosphargis*. We have therefore ventured to make a slight modification above.

† L. Dollo, "Première Note sur les Chéloniens du Bruxellien (Éocène moyen) de la Belgique," 'Bull. Mus. Roy. d'Hist. Nat. Belg.,' Vol. iv, 1886, p. 79.

‡ M. Dollo makes no reference to Prof. Seeley's previous remarks upon the classification of the Chelonia; in this connection, however, it is right to quote the following paragraph from the Professor's earlier paper, *loc. cit.*, p. 412:—" *Sphargis* is the only member known of a great division of the Chelonia which must have included many types of organization, and is probably as important morphologically as all the other Chelonia put together."

§ 'Geol. Mag.' [3], Vol. iii, p. 522 (Nov., 1886).

|| See H. Woodward, Appendix to paper on "Flightless Birds," 'Proc. Geol. Assoc.,' Vol. ix (1886), p. 371.

been no undoubted discoveries of primitive Leathery Turtles in rocks below the Cretaceous. It is true that certain fragments of peculiar dermal shields, more or less suggestive of *Sphargis*, have been described by Von Meyer * both from British and from foreign Rhætic beds ; but there is no very good reason for placing these with any type of Chelonian, and Prof. Seeley's more recent researches have led him particularly to express such an opinion † in regard to the most perfect fossil—the *Psephoderma alpina*. The latter, however, is quoted by Prof. Cope‡ as truly belonging to the Chelonian order.

It is also uncertain whether the remarkable tribe of "Macelognatha," discovered by Professor O. C. Marsh§ in the Jurassic of Wyoming, U.S.A., is to be regarded as allied to the Athecæ, or even to be associated with them ; no remains beyond the dentary bones of the mandible having hitherto been described. But the distinguished Professor of Yale College considers the specimens as very suggestive of a race of toothed Chelonia,|| and biologists are eagerly looking forward to the discovery of further materials in support of this interesting possibility.

Nor must many other fragmentary fossils of Mesozoic age be referred to the interesting group under consideration without some definite confirmatory evidence ; for it is necessary to remember that in very young Chelonia of the normal type the outer skeleton is much less complete than in the adult condition, and may often lead to the wrong identification of scarcely-hatched individuals when found in a fossil state. Thus we may conclude that the little *Aplax* of Von Meyer,¶ for example, really owes its imperfect carapace to

* H. von Meyer, "*Psephoderma alpina*, aus dem Dachsteinkalke der Alpen," 'Palæontographica,' Vol. vi. (1858), pp. 246-252, pl. xxix ; and "*Psephoderma anglica*, aus dem Bone-bed in England," *ibid.*, Vol. xv, pp. 261-263, pl. xl, figs. 1-6. See also G. Curioni, 'Mem. R. Instituto Lombardo di Scienze,' Vol. ix, p. 268, pl. vii, fig. 3.

† H. G. Seeley, *loc. cit.*, p. 413.

‡ E. D. Cope, "On the Systematic Arrangement of the Reptilia," 'Proc. Amer. Assoc. Adv. Sci.,' vol. xix (1870), p. 244.

§ O. C. Marsh, "A New Order of Extinct Jurassic Reptiles (Macelognatha)," 'Amer. Journ. Sci.,' Vol. xxvii (1884), p. 341.

|| It is worthy of note that in the embryos of certain existing Chelonia there are distinct indications of a toothed ancestry. In *Trionyx*, for example, "the development of the continuous horny maxillary sheath commences from a series of distinct papillæ, which sink into alveolar cavities, regularly arranged along the margins of the upper and lower jaw-bones" (R. Owen, 'Anatomy of Vertebrates,' Vol. i, 1866, p. 385).

¶ H. von Meyer, 'Reptilien des Lithographischen Schiefers,' p. 129, pl. xviii, fig. 2.

the accident of immaturity, and not to its appertaining to the Athecan group. Moreover, portions of unornamented, tessellated, dermal armour are not always to be regarded as belonging to animals allied to the living *Sphargis*; for in the British Museum there is the plaster cast of a fossil of this nature, from the Wealden of Sussex, preserved in Mr. Beckles' collection, and there is no doubt whatever that this formed part of a Dinosaurian skin.

Professor Cope was the first to make known a true fossil Leathery Turtle almost in its entirety, by his discovery of the *Protostega* in the Cretaceous Beds of Western Kansas.* Of this interesting genus he was able to study portions of the cranium, five vertebræ, ten ribs, the pectoral arch, and both humeri, nine phalanges, and a number of dermal bones, all belonging to one and the same individual: and a reference to his beautifully-illustrated monograph will afford a tolerably complete idea of the skeleton of the animal. The bones of the head are even more fragile and scale-like than those of the living *Sphargis*, but they are disposed in an essentially similar manner, and there are no traces of teeth in the jaw. The vertebræ, even in the dorsal region, seem to have been procœlian (concavo-convex), and there are obscure indications of another peculiarity that is equally unknown in the surviving type, namely, the articulation of the ribs with transverse processes at the middle of each vertebra, and not directly with the central at their points of contact one with another. But the ribs are evidently slightly more expanded than those of *Sphargis*, and sometimes exhibit ragged margins, with radiating grooves and ridges upon the upper surface. Of the dermal bones, several are regarded as undoubtedly "marginal" (i.e., as having been arranged round the edge of the back), and a small pit on the under surface of each seems to have lodged the tip of the corresponding rib. Another squamous plate, of symmetrical form, is, perhaps, the representative of the nuchal plate in the existing type; and other larger bony laminae are considered by Professor Cope as not improbably pertaining to the lateral regions of the upper shield. The entire carapace is estimated to have been about seven feet in length, and seems to have presented

* E. D. Cope, "Letter," 'Proc. Amer. Phil. Soc.,' Vol. xii, 1872, p. 175; "A Description of the Genus *Protostega*, a Form of Extinct Testudinata," *ibid.*, pp. 422-423. Also, E. D. Cope, "The Vertebrata of the Cretaceous Formations of the West" ('Rep. U.S. Geol. Surv. Territ.,' 1875), pp. 99-113, pls. ix-xiii.

a more elongated shape than that of any existing member of the order.

The discovery of another Athecan genus of *Chelonia* in the Upper Cretaceous formations of Italy is of great interest on account of the excellent state of preservation of the dorsal vertebræ and ribs, and the bones forming the plastron, or ventral armour, in the single example already described. This fossil, however, exhibits no portions of the skull, and scarcely any traces of the fore-limbs; and the remains of the hinder extremities are likewise not so complete as might be desired. Two years ago, the specimen formed the subject of an elaborate memoir by Professor Capellini,* who proposed the name of *Protosphargis*, in reference to its connection with the progenitors of the existing Leathery Turtle, and added to his description seven beautifully-executed plates. The vertebræ and ribs show none of the aberrant characters supposed to be indicated by the corresponding bones of *Protostega*, and appear to be very similar to those of the living *Sphargis*. There is no evidence of any dorsal dermal plates—though their complete absence in the living animal is, perhaps, not absolutely demonstrated—and the ribs have no ragged, scaly expansions like those of the American genus.† The plastron agrees with that of *Sphargis* in being destitute of an anterior unpaired element (the "interclavicle"), but the two middle pairs of bones ("hyoplastra" and "hypoplastra") are considerably broader than in the existing form, and make a definite approach to the corresponding parts of the ordinary turtles (*Chelone*). It is interesting to observe, also, as Prof. Capellini has pointed out, how closely these plates agree in shape with those of *Protostega*, provisionally referred by Prof. Cope to the lateral regions of the back. It is very probable, indeed, that these "lateral dermal bones" are really hyoplastra and hypoplastra, and that the American form agreed with the Italian in the considerable development of the ventral shield, just alluded to.

According to Professor Cope,‡ there is still other evidence of

* G. Capellini, "Il Chelonio Veronese (*Protosphargis veronensis*, Cap.) scoperto nel 1852, nel Cretaceo superiore presso Sant' Anna di Alfaedo in Valpolicella," 'Atti R. Accad. Lincei.' [3], Vol. xviii (1884), pp. 291-320, pls. i-vii.

† It is interesting to note that in the embryos of existing *Chelonia* the plastron is said to appear before the carapace.

‡ E. D. Cope, 'Proc. Amer. Phil. Soc.,' Vol. xii, 1872, p. 433.

Cretaceous Leathery Turtles in America, though this is certainly very imperfect and fragmentary. Two humeri—or rather one, and half of a second—originally described by Professor Leidy as Mosasaurian, are considered as truly referable to *Protostega*, or some closely-allied form; and one of these, from Columbus, Mississippi, bears the name of *P. tuberosa*,* while the other, from the Greensand of New Jersey, is known as *P. neptunia*.†

Hitherto, no remains of the sub-order appear to have been recognized among British Cretaceous fossils; and I have failed to discover any fragments among the large series of undetermined bones from the Chalk and Greensand in the collection of the British Museum.

Of the Leathery Turtles flourishing in the Eocene Period, no relics have yet been recorded, beyond fragments of the tessellated bony armour. These have been found in the Upper Eocene Limestone of Alabama, U.S.A., associated in such a manner with the bones of the huge primitive whale, *Zeuglodon*, as to lead at first to the idea that they really formed part of the integument of this creature. Carus,‡ indeed, originally figured a specimen showing sixteen tesserae, as part of the dermal covering of the jaw of *Zeuglodon*; and Müller, again, referred to similar fossils in his work on the last-named genus,§ though here he succeeded in detecting their resemblance to the carapace of *Sphargis* (*Dermatochelys*), and suggested that they were truly Chelonian.

Such remains, of course, are of little or no value from an anatomical point of view, and are merely sufficient to indicate the presence of Leathery Turtles in the Eocene seas. In one respect, however, these fragments are far from destitute of interest, namely, as showing that the single existing type is but the degenerate representative of forms which once attained to comparatively huge dimensions.

It is also well worth while to note the occurrence of these isolated fossils in any particular deposit, because they will occasionally afford a clue to the identification of some of the nondescript bones that may be found upon the same horizon. And on this

* *Mosasaurus*, J. Leidy, "Cretaceous Reptiles of the United States" (Smithson. Contrib., 1864), p. 42, pl. viii, figs. 1-2.

† *Mosasaurus*? J. Leidy, *op. cit.*, p. 42, pl. viii, figs. 3-5.

‡ C. G. Carus, "Das Kopfskelet des *Zeuglodon hydrarchos*," *Nova Acta Acad. Cæs. Leop. Carol. Nat. Cur.*, Vol. xxii, 1848, p. 382, pl. xxxixa, fig. 5.

§ J. Müller, 'Ueber die fossilen Reste der Zeuglodonten von Nordamerika,' Berlin, 1849, p. 34, pl. xxvii, fig. 7.

account I propose to call attention to the small fragment in the British Museum, which appears to be the first definite trace of Athecan Chelonia recorded from English Eocene formations.

The precise locality of the fossil in question is unfortunately uncertain, but Mr. Etheridge is of opinion, from the nature of the matrix, that there can be little doubt of its derivation from the well-known Middle Eocene strata of Bracklesham, in Sussex. It must originally have belonged to an animal quite as large as the Alabama specimens already mentioned. The thickness of the fragment varies from seven to eleven millimetres, and it exhibits six tesserae of unequal size and irregular shape. The largest of these divisions is at the thickest end, oblong, and measuring approximately six-and-a-half centimetres by three-and-a-half; while the smallest is of a nearly quadrate form, and is scarcely more than two centimetres across. All the sutures are distinctly visible on the inferior surface of the shield, as well as on the upper; and there are some indications of these having been jagged, as in the existing *Sphargis*, though it would require a section to show the character satisfactorily. The bone is very dense, the superficial layer being especially so, and the deeper parts exhibiting a more cancellous structure; and the external surface is almost smooth, showing only one or two small indented pits towards the centre of each tessera.

Fossils very similar to that just described, and of equally large size, have been made known by Gervais,* from the Miocene beds of Vendargues, Hérault, France, under the name of *Sphargis pseudostracion*. There is, however, no proof of their appertaining to the existing genus, nor do such specimens admit of any specific diagnosis; so that it seems advisable to await the discovery of further materials before definitely naming the British form. The first of Gervais' figured specimens was originally described as part of the dermal skeleton of a "Coffer-fish" allied to *Ostracion*, and the second shows a trace of one of the carinate ridges so characteristic of the *Sphargidæ*.

The most complete remains, however, of an early Tertiary Leathery Turtle hitherto recorded were unfortunately fossilized by iron pyrites; and nearly the whole skeleton was dispatched to

* P. Gervais, 'Zoologie et Paléontologie françaises,' 2nd. Edit., 1859, p. 438, pl. ix, fig. 1; and "Ostéologie du *Sphargis*," 'Nouv. Archiv. Mus.,' Vol. viii, 1872, p. 222, pl. ix, fig. 4.

a chemical works, where the precious relics were rapidly utilized in the manufacture of sulphuric acid. This interesting discovery was made in the Oligocene (Rupelian) strata of Waas, in Belgium, and only eight fragments were preserved for the study of the biologist. Prof. Van Beneden has published an interesting notice* of the relics, which comprise three dermal plates, three vertebræ, a coracoid, and an ilium; and he has shown that they closely correspond with the homologous bones of the living *Sphargis*. They are too imperfect, however, for precise specific determination, though the author ventures to give them the provisional name of *S. rupeliensis*. The dermal plates are described as possessing a well-marked superficial ornament; and it is interesting to note that this animal agreed with all its known congeners of early Tertiary date in its comparatively large dimensions.

As an important fossil Leathery Turtle of still more recent times, the *Psephophorus polygonus* of Von Meyer remains to be mentioned. This form is known from an interesting slab from the Pliocene of Neudörf, on the borders of Austria and Hungary, preserved in the Geological Museum of Vienna; and it was first exhaustively studied by Professor Seeley, who published an elaborate description of its characters in 1880.† The fossil in question comprises part of a tessellated shield, which shows a short length of one of the longitudinal, keel-like ridges so characteristic of *Sphargis*; and there are also preserved some more or less fragmentary remains of five vertebræ. The dermal plates—except those of the ridge—are slightly ornamented on the external surface with radial markings; and, except in size, it is difficult to distinguish the shield from that of the surviving type. Professor Seeley suspects, however, that the number of longitudinal keels may have been less than seven. It is interesting to note, further, that there is some evidence of a less complete inferior armour, quite similar to that of the surviving type.‡ The complete distinctness of the Pliocene

* P. J. van Beneden. "Note sur les ossements de *Sphargis* trouvés dans la terre à brique du pays de Waas," 'Bull. Acad. Belg.' [3], Vol. vi, 1883, p. 665, plate.

† H. G. Seeley, "Note on *Psephophorus polygonus*, v. Meyer, a new Type of Chelonian Reptile allied to the Leathery Turtle," 'Quart. Journ. Geol. Soc.', Vol. xxxvi (1880), pp. 406-413, pl. xv. References to previous notices of the fossil are here given.

‡ Prof. Seeley was evidently unacquainted with Gervais' memoir on *Sphargis* already quoted. He remarks that tessellated bony plates are absent upon the ventral aspect in the existing genus.

fossil is demonstrated, however, by the few remaining vertebræ, which seem to belong to the posterior cervical or dorsal region. There are well-marked transverse processes, anchylosed to the centrum, such as have already been mentioned in connection with the Cretaceous *Protostega*; and "the great development and height of the neural arch" are, likewise, quite extraordinary.

With the Austrian Pliocene fossil, the palæontological history of the Leathery Turtles, for the present, ends. It is obviously a most imperfect and fragmentary record, and such as it is frequently the lot of the student of past life to be compelled to accept with contentment. It may even be suggested that the various scattered allusions to the subject have proved scarcely worthy of collation. But the task has not been altogether in vain, if the foregoing array of facts tends in any measure to emphasize the morphological importance of the group of Leathery Turtles, which have rarely been given sufficient prominence in any but technical memoirs; and the series of bibliographical references may possibly be of some slight service to the next fortunate discoverer of fossils of this character, in the all-important preliminary search through the writings of his predecessors.

ON SOME FURTHER RESEARCHES IN BONE-CAVES IN NORTH WALES.

BY HENRY HICKS, M.D., F.R.S., F.G.S.

Since I read my paper 'On some Recent Researches in Bone-Caves in Wales,' before the Association, on Nov. 7th, 1884, I have, in conjunction with others, carried on some further explorations in the Ffynnon Beuno and Cae Gwyn Caverns, which were described for the first time in that paper. The results obtained have been given in papers to the Geological Society* and to the British Association for the Advancement of Science.† The caverns have been worked by the aid of grants from the Royal Society and from the British Association.

They are situated in a Carboniferous Limestone escarpment, forming the north side of a ravine near Tremeirchion, on the east side of the Vale of Clwyd, and are about two miles from the

* 'Quart. Journ. Geol. Soc.,' Feb., 1886.

† 'Brit. Assoc. Reports,' 1885 and 1886.