agent as the bedded deposits is shown in a figure on the next plate of the same work, where a mass of Boulder-clay overlies such materials in the ice. The *moraine profonde* (including under this term all the drifts carried at and towards the base of the ice, whether derived from upland districts, or caught up from an ancient sea-floor over which the ice passed) coming from the flat tracts of the extreme East of England and the North Sea would be driven through the lateral valleys of the Sudbury area, and compressed laterally owing to the smaller space necessarily occupied by the lower parts of the ice under these circumstances. In this manner the contortion would be produced, accompanied by the small faults which are so common in these drifts, and so difficult to account for except upon the view that the drifts were solid at the time of faulting. Upon the melting of the ice, the drifts of this moraine,—Boulder-clays, gravel, and loam,—would be left standing upon the undisturbed beds of the irregular floor, once frozen, but resuming their incoherent condition upon the passing away of the cold.

In this way, and apparently in this way only, can we account for the phenomena of the Sudbury district, and the explanation has the advantage that it brings into play an agent which we know, from the researches of the Danish explorers upon the Greenland ice, does produce similar features at the present day, whereas all other explanations require the operation of agents, whose asserted mode of procedure is purely hypothetical.

V.—NOTES ON CHELONIA FROM THE PURBECK, WEALDEN AND LONDON-CLAY.

By R. LYDEKKER B.A., F.G.S., and G. A. BOULENGER, F.Z.S.

Introductory.—The writers having had occasion, in company with Mr. Davies, to examine the greater number of the remains of English fossil Emydine and Pleurodiran Chelonia in the collection of the British Museum, with a view both to their rearrangement in the cases and the determination of their affinities, and having in the course of such examination been enabled to add several genera to the British fauna, as well as to make certain emendations in regard to the age and affinity of some of the previously-described forms, have thought it advisable to put their observations on record. Several of these observations are, indeed, only supplemental to those already published by Prof. Rüttimeyer, of Basle, in the invaluable memoirs quoted below, but the writers have been able in some instances to add to his conclusions, owing to facts with which the learned Professor was necessarily unacquainted.

The reference by M. Dollo, of the Brussels Museum, of three of the Lower Eocene English species described by Sir R. Owen under the generic name of *Chelone* to a distinct genus *Pachyrhynchus*, has been already noticed by one of the present writers in last year's volume¹ of this MAGAZINE. The term *Pachyrhynchus* is, however,

¹ Page 521. I must apologize to M. Dollo for having in this notice misinterpreted him as retaining Prof. Cope's family *Propleuridae*. In the same notice I have quoted English forms under the generic names assigned to them by Owen, not having at that time entered on the question of the correctness of their determinations.—[R. L.]

preoccupied; and Prof. Cope had previously applied the generic term *Puppigerus* to several of Owen's species; some of which may, however, belong to other North American genera.¹ At least one of the carapaces of the Chelonians from the London Clay has nine costal bones, which is a character of Cope's *Propleuridæ*.² This group does not, however, form the proper subject of the present communication.³

Purbeck and Wealden.—The first genus for consideration is *Pleurosternum*, in which there appears a considerable amount of confusion. In their 'Monograph of the Chelonian Reptilia of the London Clay' (Pal. Soc. 1849) Owen and Bell figured in pl. xxi. a Chelonian plastron under the name of *Platemys Bullocki*, the specific name⁴ dating from 1842. This specimen, now in the British Museum, is characterized by the presence of a mesoplastral bone, and also by an intergular epidermal shield. Owing to the former feature Prof. Rüttimeyer⁵ pointed out that the specimen could not have belonged to *Platemys*, but must be referred to the genus *Pleurosternum* of the Purbeck; he was, however, necessarily unaware that the specimen is really from the Purbeck, and not from the London Clay as stated by Owen and Bell. A comparison of this plastron with other Purbeck examples of *Pleurosternum* shows that it cannot be distinguished from the form figured by Owen in his Purbeck and Wealden Reptilia (Mon. Pal. Soc. 1853) under the name of *Pleurosternum ovatum*, with which the specimen figured in pl. vii. under the name of *P. emarginatum* appears also specifically identical; under these circumstances the name *Pleurosternum Bullocki*, as being the earliest, must be adopted for the common Purbeck form.⁶ It should further be observed that it has been stated by Prof.

¹ See Amer. Nat. vol. xx. p. 968 (1886).

² Cope (*loc. cit.*) states that his *Propleuridæ* is identical with Dollo's *Pachyrhynchidæ*. The type species of the latter is, however, expressly stated to have only eight costals, which Cope makes a character of *Puppigerus*.

³ It is usual among English writers to term the bony parts of the Chelonian shell "plates," and the horny epidermal covering "scutes"; but Prof. Huxley, "Anatomy of Vertebrated Animals," 1st edition, pp. 197, 200 (1871), uses the former term for both. Since, however, the term "scute" is applied to the dermal bones of the Crocodilia and of the Armadillos (*vide* Huxley, *op. cit.* pp. 250, 338), which are homologous with some of the bony elements of the Chelonian shell, this use is certainly objectionable; and in previous works I have reversed the application of the two terms. This application is not, however, thought advisable by Mr. Boulenger, who usually employs the terms in their older sense; as a compromise, in the present paper the bony elements will therefore be alluded to as "bones," and the elements of the epidermal layer as "shields."—[R. L.]

⁴ Rep. Brit. Assoc. for 1841, p. 164 (1842).

⁵ Verh. Nat. Ges. Basel, vol. vi. p. 121 (1873).

⁶ Specimens of Purbeck Chelonia in the Cambridge Museum have been referred by Prof. Seeley (Index to Aves, Ornithosauria, etc., in the Cambridge Museum, pp. 86, 87 [1869]) to *Pleurosternum*, under the names of *P. Sedgwicki*, *P. Vansittarti*, *P. Oweni*, and *P. typocardium*. These specimens have, however, not been figured, and cannot therefore be compared with those in the British Museum; some of them may perhaps belong to *Plesiochelys*, while the distinction of others from *P. Bullocki* is not clear.

Cope¹ that the plastron of *Pleurosternum* has no intergular shield,² and the genus is accordingly referred by him to the Cryptodira; whereas its true position, as was pointed out by Prof. Rüttimeyer, is with the Pleurodira; and with that group—the *Pelomedusidæ* and *Peltocephalidæ* of Gray—characterized by the presence of eleven, instead of nine, plastral bones.

With regard to the carapace figured by Sir R. Owen in pl. iv. of his “Wealden and Purbeck Reptilia,” under the name of *Pleurosternum emarginatum* (of which it is the type), it appears from the emargination of the anterior border that the specimen does not belong to that genus at all; and it is highly probable that it should be referred to *Plesiochelys*, although, as only the ventral aspect of the carapace is visible, this cannot be definitely determined; the other specimen figured by Sir R. Owen under the same name cannot apparently be distinguished from *Pleurosternum Bullocki*. Another carapace from the Purbeck has been figured by Sir R. Owen in pl. i. of the above-mentioned work under the name of *Pleurosternum latiscutatum*, which differs from *P. Bullocki* by the notch in its anterior border, in the presence of a nuchal epidermal shield, and in the narrowness and length of the neural (vertebral) bones. A specimen of both carapace and plastron in the Museum (No. 23624) from the Wealden, which is evidently specifically identical, shows that there was no mesoplastron, and the species may apparently therefore be referred to the genus *Plesiochelys*.³ A second English species of that genus is indicated by an imperfect shell from the Wealden in the collection of the Museum (No. 28967) which evidently belongs to the group containing the Upper Jurassic *P. Soluthurnensis* and *P. Sanctæ-Verenæ* of Rüttimeyer,⁴ and agrees so closely with the latter that it may apparently be referred to the same species; a younger shell of the species (No. R. 583) from the Wealden near Hastings is also contained in the collection. Two plastra from the Purbeck (No. 45937) have a large central vacuity, and thereby agree with *P. Etalloni*, Rüttimeyer.⁵ Prof. Rüttimeyer⁶ has already observed that the fragmentary remains from the Wealden figured by Sir R. Owen⁷ under the name of *Platemys* and *Chelone costata* do not belong to those genera, and he has suggested that they may be Thallasemydians, but there seems no reason why they should not be referred to that group of *Plesiochelys* in which there is a large plastral vacuity. The occurrence in the English Wealden and Purbeck of several species of *Plesiochelys* apparently closely allied to those of the Upper Jurassic of the Continent is a matter of considerable interest.

¹ Proc. Amer. Phil. Soc. 1882, p. 143.

² The presence of an intergular shield is distinctly mentioned on page 5 of Owen’s “Wealden and Purbeck Reptilia,” although it is not shown in a complete state in any of the figured specimens.

³ Mr. Boulenger takes this view.—[R. L.]

⁴ Neue Denks. schweiz. Ges. Nat. vol. xxv. pls. xii. xiii.

⁵ *Ibid.* pl. xi.

⁶ Verh. Nat. Ges. Basel, *op. cit.* p. 166.

⁷ Wealden and Purbeck Reptilia, pls. viii. and ix.

A crushed and broken shell with several of the bones of the pectoral and pelvic girdles, obtained by the late Mr. Fox from the Wealden of Brook, in the Isle of Wight, and now preserved in the Museum (No. R. 171), together with another crushed specimen (No. 48349) from the Wealden, and the anterior portion of a plastron (No. 46325) from the Purbeck, belong to the genus *Tretosternum*, and enable us to arrive at a conclusion as to the affinities of that genus. These specimens show, moreover, that the Chelonian remains from the Wealden of Bernissart in Belgium, described by M. Dollo,¹ under the name of *Peltochelys Duchastelii*, are not separable from the English *Tretosternum Bakewelli* (Mantell² sp.). M. Dollo was led to separate the Belgian form because Sir R. Owen³ has suggested that *Tretosternum* may have had incomplete marginals; which the present specimens show is not the case. The suggestion of Sir R. Owen⁴ that *Tretosternum* had a permanent plastral vacuity is shown by these specimens to be incorrect, although a small one exists in the young. M. Dollo places the genus in the Pleurodira, a view which is not supported by the examination of the remains in the Museum.

As may be seen from M. Dollo's figure, and still better from the Museum specimens, the anterior border of the nuchal bone is broadly emarginate, a character which occurs in none of the *Pleurodira*, for the reason that the head takes shelter on the side; but is found in all *Cryptodira* in which the head is particularly large and non-retractile, with the temporal fossæ roofed over by bone, as in *Chelydra*, *Platysternum*, *Chelone*, etc. Another peculiarity shown by the nuchal before us lies in the presence of a costiform process on each side, as in *Chelydra*; a process which, judging from Dollo's figures, is also shown in the young specimens from Bernissart. Important again is the fact, shown by our specimens, that the plastron articulates with the carapace by gomphosis, exactly as in *Chelydra*, and does not send off any axillary and inguinal peduncles like those so highly developed in all known *Pleurodira*. The plastron is essentially of the *Dactylosternine*-type of Cope. M. Dollo has, it is true, recognized the presence of an intergular shield, a character which has hitherto been regarded as infallibly diagnostic of the *Pleurodiran* group; this shield is also well shown in the type-specimen of *Tretosternum*. A careful examination shows, however, that this intergular is, in addition to only five pairs of plastral shields, exactly as in

¹ Bull. Mus. R. Hist. Nat. Belg. vol. iii. p. 78 (1884). The name itself is not very happily selected, since Prof. Seeley (Quart. Journ. Geol. Soc. vol. xxxvi. p. 412, 1880), has proposed the name *Peltochelyda* for an entirely different group of Chelonians.

² Geology of S.E. of England, p. 255 (1833)—*Trionyx*. *Tretosternum punctatum*, Owen, dates from 1842.

³ Rep. Brit. Assoc. for 1841, pp. 165-7 (1842). Sir R. Owen's words are, "The entire and rounded margins of the truncated and expanded extremities of the ribs, beyond which there is not the slightest trace of projecting tooth-like processes, strongly indicates that the marginal plates [bones] were either wanting or rudimental, as in the genus *Cryptopus* [*Trionyx*]."

⁴ *Op. cit.* p. 167. The generic name was given upon the assumed existence of this feature; since, however, the vacuity occurs in the young, no reasons can be adduced for changing the name.

certain specimens of *Dermatemys*, instead of the six pairs of all recent Pleurodira; and we think too great importance has hitherto been attached to the disposition of the epidermic plastral shields, as is shown by a specimen of *Macrolemmys Temminckii* in the Museum, which exhibits an intergular shield situated within the margin of the plastron, exactly as in the Australian *Chelodina*. Again, the number of plastral shields of *Tretosternum*, viz. 11, is that of a Cryptodiran, and not of a Pleurodiran. In addition to the above arguments, the remains before us give elucidation on a point which is in itself decisive; viz. the attachment of the pelvis. Two bones only are preserved, but they will suffice for our purpose; these are a sacral vertebra and a pubis. The former bone shows a large articular surface for a sacral rib, which was therefore present, and gave attachment to the ilium. In the Pleurodira, in which the ilium anchyloses with the carapace, sacral ribs are either atrophied or disappear altogether in the adult. The pubis, of a rather peculiar shape, owing to the great elongation and distal expansion of the inner or symphyseal branch, is intact and shows that the extremity of the outer process was thin and compressed, and did not anchylose with the plastron.¹

In the absence of any remains of the caudal vertebral column, it is impossible to say for certain that *Tretosternum* belongs to the family *Chelydridæ*, but we may surmise that such was probably the case. As far as can be judged from a comparison with Leidy's figure of *Anostira*, the two genera were very closely allied.

The last of the Chelonians from the Wealden and Purbeck that we have to notice is a small cordiform carapace from the latter formation (B. M. No. 40676), which may confidently be referred to the Thallasemydes of Prof. Rüttimeyer (*Eurysternidæ* of Dollo), and may probably be referred to the genus *Eurysternum*.²

London Clay.—The first specimen from this formation that calls for notice is the hinder portion of a carapace in the Museum (No. 40099), which evidently belongs to the genus *Pseudotrionyx*, Dollo,³ from the Middle Eocene (Bruxellian) of Belgium, and is apparently specifically identical with the typical *P. Delheidi*, Dollo. This genus is included by its founder in the *Chelydridæ*, but from the absence of epidermal shields may probably be regarded as belonging to a distinct family.⁴

The next species for notice is founded on the shell figured by Owen and Bell⁵ under the name of *Platemys Bowerbanki*; ⁶ in regard

¹ On this occasion it may be well to observe that Rüttimeyer's statement, made with due reserve, but since repeated by others as an admitted fact, that, in some recent *Pleurodira*, the ischium anchyloses with the plastron before the pubis, was derived from the examination of figures accompanying one of Gray's memoirs; and that an investigation of the actual specimens which gave rise to this statement has proved it to be erroneous.—[G. A. B.]

² = *Acichelys* = *Aplax* = *Palæomedusa* = *Achelonia* = *Euryaspis* = *Parachelys*.

³ Bull. Mus. R. Hist. Nat. Belg. vol. iv. p. 96 (1886).

⁴ The suggestion made in the above-quoted notice in the GEOLOGICAL MAGAZINE that the genus might perhaps be referred to the *Trionychidæ* will not hold.—[R. L.]

⁵ Reptilia of the London Clay, pt. i. pl. xxiii.

⁶ Rep. Brit. Assoc. for 1841, pp. 163 (1842).

to which Prof. Rüttimeyer¹ has already pointed out that the specimen figured by the same writers² under the name of *Emys levis* is merely the young of the former, and that owing to the presence of a small mesoplastral bone the reference to *Platemys* is incorrect, and it is suggested that the species may probably belong either to *Podocnemis* or *Peltocephalus*. The type is unfortunately not in the collection of the Museum, but the figure shows that the length of the bony union between the carapace and plastron is comparatively long, from which its affinity appears to be rather with the former than the latter, and it may accordingly be provisionally referred to that genus.

With regard to the large Chelonian figured by Owen³ under the name of *Emys Conybeari*, which appears specifically identical with the younger specimen figured as *Emys Delabechi*, Bell,⁴ Professor Rüttimeyer⁵ has observed that it is difficult to say whether these forms belong to the *Emydidæ* or the *Chelydidæ*, but this difficulty has now been decisively solved. The best preserved and larger of the two specimens, or that figured under the name of *E. Conybeari*, shows both carapace and plastron, and exhibits in the latter distinct mesoplastral bones like those of *Podocnemis*. The matrix between the carapace and plastron has recently been chiselled away, and the characteristic Pleurodiran ankylosis of the ischium and pubis to the plastron is thus exhibited. In the number of the neural (vertebral) bones, in the flatness and general contour of the carapace, in the shape of the plastron and the relative length of the bridge uniting the latter with the carapace, and in the absence of a nuchal epidermal shield, the specimen accords so well with *Podocnemis*, that it may be pretty safely referred to that genus, under the name of *P. Delabechi*. The presence of two epidermal pygal shields differentiates it from the allied genus *Peltocephalus*; the vertebral shields agree in form very closely with those of *Podocnemis Dumeriliana*, although the contour of the carapace accords more closely with that of *P. expansa*. With regard to the so-called *Emys bicarinata*⁶ from the same formation, a cutting-away of the matrix shows no trace of the pelvis, which was probably, therefore, of the Cryptodiran type, and the species may accordingly, in the absence of any evidence to the contrary, be included in the genus *Clemmys*. The occurrence of *Podocnemis* in the London Clay indicates that the *Pleurodira*, which are now almost entirely relegated to the Southern Hemisphere, were dominant forms at that period in the European area, as they also were in the corresponding epoch in India, where there were representatives of both *Podocnemis* and *Platemys* in the Lower Eocene.⁷

¹ Verh. Nat. Ges. Basel, p. 121.

² *Op. cit.* pl. xxii.

³ Reptilia of London Clay, Supplement, pls. xxviii. A, B.

⁴ *Ibid.* pl. xxviii.

⁵ Verh. Nat. Ges. Basle, *op. cit.* p. 121.

⁶ Owen and Bell, Reptilia of the London Clay, pt. i. pls. xxv. xxvi.

⁷ These species will be described in a forthcoming memoir in the "Palæontologia Indica," ser. 10, vol. iv. pt. 3.—[R. L.]