Quarterly Journal of the Geological Society

Note on some of the Generic Modifications of the Plesiosaurian Pectoral Arch

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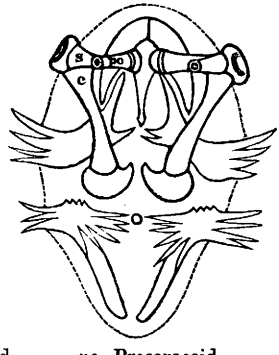
Quarterly Journal of the Geological Society 1874, v.30; p436-449.
doi: 10.1144/GSL.JGS.1874.030.01-04.48

Notes

34. Note *on some of the* Generic Modifications *of the* Plesiosaurian Pectoral Arch. By Harry G. Seeley, Esq., F.L.S., F.G.S. (Read May 13, 1874.)

In not having a sternum the Plesiosauria differ from the Crocodilia and from all the Lacertian orders of Reptiles. Serpents with limbs being as yet undiscovered, the only true Reptilia which admit of comparison with Plesiosaurs in the pectoral bones are the Chelonians. And even here, at first sight, the resemblance is not so evident as to command attention; for the shapes of the plastron-bones in embryonic Tortoises are more suggestive of the pectoral and pelvic girdles of Plesiosaurians than are the internal chelonian bones which support the limbs, since in Plesiosaurs these osteological elements are expanded shields which cover much of the abdominal surface. When, however, the embryonic pectoral arch of such a Chelonian as the *Chelone mydas** (fig. 1) is critically looked at, only

Fig. 1.—*Pectoral Arch and Bones of Plastron of* Chelone mydas. (After Parker.)



c. Coracoid. *pc*. Precoracoid. *s*. Scapula.

unimportant osteological modification is needed to change its characters to those of a Plesiosaur.

The chelonian coracoid bones (*c*) are rod-like; but their extension is entirely posterior to the articulation for the humerus: the bones approximate somewhat posteriorly, are somewhat concave on their outer margin, and terminate in cartilages of a shoe-shaped form, which are so extended inward that their toe-like terminations meet in the median line. Then, from the humeral articulation the two precoracoids (*pc*) extend inward towards the median line; they are inclined very slightly forward, and join either by their cartilages or intervening connective tissue.

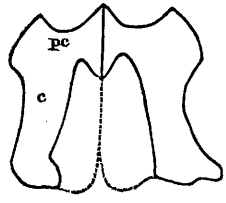
If, now, a line be drawn to join the median points of meeting of

* Mr. Parker, "Shoulder-girdle" (Ray Society), pl. xii. fig. 1.

the precoracoids and coracoids, and a thin film of ossified connective tissue extend over the interspace between them and unite these bones respectively on each side of the animal, a pair of coracoid bones will be constituted similar in form, position, and relation to those which characterize the Plesiosauria, the only difference being that in Plesiosaurs the precoracoid is connate with the coracoid, as in the Ostrich and many Lizards; while in Chelonians it is connate with the scapula (*s*): but much importance cannot be attached to the condition of the precoracoid, since no one will contend that Plesiosaurs are either Lizards or Tortoises; while among Amphibians the precoracoid is a distinct bone, so placed that it might combine indifferently with coracoid or scapula.

It is a noteworthy fact, familiar to all who collect Plesiosaurian coracoids from soft strata, that the whole of this triangular interspace between the precoracoid and coracoid parts, which I covered in the Turtle with an imaginary thin ossification, is liable to be broken away in extricating the fossil; and then there remains only a curious bone forked from the humeral articular surface, which closely resembles the precoraco-coracoid portion of the chelonian pectoral arch just described, and in which only the precoracoid parts similarly meet each other in the median line. A beautiful example of such a specimen from the Kimmeridge Clay, presented by J. C. Mansell-Pleydell, Esq., is exhibited in the British Museum (fig. 2)*.

Fig. 2.—*Coracoids of* Murænosaurus.



Showing connation of coracoid (*c*) and precoracoid (*pc*).

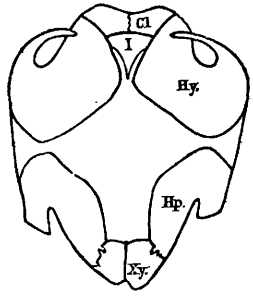
Such a specimen goes far to justify an interpretation of the Plesiosaurian coracoids as the combined coracoid and precoracoid bones.

The Chelonian, however, has the form of its pectoral and pelvic arches modified by the enormous amount of potential epiphysial ossification which characterizes the subclass. The epipleural cartilages of the Crocodile and the small epipleural bones of *Hatteria* and of Birds are, among Chelonians, changed by potential growth into ossifications, in comparison with which the original pleural elements are small; while they so grow and unite that an epipleural skeleton is formed, encased not in muscles as in most other animals, but in representatives of muscles, now converted, in most Chelonians, into horny scutes corresponding with muscles in their extension.

* It is at present standing over the remains of *Megalosaurus*, without osteological determination, and is placed upside down.

On the chelonian ventral surface (fig. 3) potential growth has in the same way repeated, in the connective tissue, the girdle-ossifications, which were subjected most energetically to the intermittent pressure of movement, by which all ossifications are originated, extended, and

Fig. 3.—*Plastron of Embryonic* Testudo. (After Owen.)



Cl. Clavicle of authors (potential precoracoid). *I.* Interclavicle. *Hy.* Hyosternal. *Hp.* Hyposternal. *Xy.* Xyphisternal.

moulded. Thus the hyposternal and xyphisternal bones (*Hp*, *Xy*) reproduce the pubes and ischia in the region of the posterior abdominal ribs; and in certain Chelonians those pelvic bones become as firmly united to the elements of the plastron beneath them as the epiphyses of a mammalian limb-bone to the shaft in old age. In the same way the coracoids are potentially represented by the hyosternal bones on which they rest (*Hy.*). The precoracoids are potentially represented by the pair of bones which have been variously named the clavicles or episternal bones (*Cl*). The chelonian interclavicle or entosternal bone (*I*) has no prototype in the chelonian pectoral girdle, and is probably the interclavicular element pressed into the external skeleton by the precoracoids, though it might even have been generated kinetically as a consequence of the alternate pressure and tension of those ossifications against each other consequent on locomotion, if there were any reason for supposing the interclavicle absent.

These remarks upon the chelonian plastron and appendicular girdles seem the more necessary, because the Plesiosauria show no sign whatever of an accumulation of organic energy in their organization which could not be manifested in extension of the vertebral column; and we look in those animals for no such elements as characterize the chelonian plastron, precisely because we find empirically that the energy of organization, due to movement of the vertebral column, expended itself in adding new segments to the body; while the development of the chelonian plastron is equally in harmony with the specialization of locomotive energy in the limbs: but since the girdle-bones of Plesiosaurs occupy similar positions to the pieces of the chelonian plastron, and the similarity of the limbs implies not dissimilar functions for the abdominal region in the marine groups of both types, I attri-

bute the better ossification of the pectoral girdle in Plesiosaurs, as contrasted with Chelonians, to the larger amount of organic energy brought to bear upon the bones in consequence of their external position, and the absence of an epipleural skeleton. The structural differences of the limbs from those of Chelonians, in view of their capacity for work, are only a matter of detail.

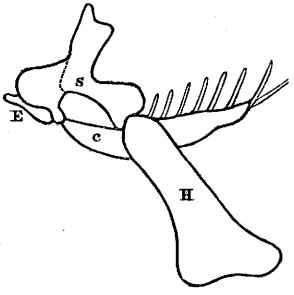
The other important constituent element of the articular surface for the humerus is the scapula. In Chelonians this bone is a slender rod directed upward to the side of the vertebral column, being thus unlike that of a Plesiosaur in disposition even more than in form—since in Plesiosaurs the bones are invariably directed forward in approximately the same plane with the coracoids, converging anteriorly. This consideration led Cuvier to doubt the determination which named them scapulæ. But considering the enormous number of vertebræ in the cervical region of Plesiosaurs, as compared with Chelonians, I would suggest that potential growth, carrying the vertebræ further and further forward, would probably take the free ends of the scapulæ onward too, till those bones came to occupy their singular position anterior to the coracoids. This supposition perhaps receives some support from scapula and coracoid being approximately in the same plane (though a different one) in Lizards, and by the slightly anterior direction that the scapula occasionally takes.

These two bones are the essential parts of the Plesiosaurian pectoral arch; and if clavicles or interclavicle exist, their presence is exceptional, and only a generic difference.

In 1865 I figured and described, under the name of *Plesiosaurus cliduchus*, an animal in which the scapula appeared to carry, on its outer and anterior margin, a bone holding the same position as the clavicle in *Ichthyosaurus*. A clavicle being needed to complete the resemblance between the two types, I at the time identified the process as the clavicular bone. Owing to conditions of fossilization, I believe the Woodwardian specimen was delusive, and that what appeared to be a separate clavicle was only a thin process of the scapula, broken and partly displaced so as to show a sharp line of division from the thicker part of the scapula, against which it abuts nearly at right angles. Prof. Owen in 1839 (Brit. Assoc. Report, 1840, p. 56), and later, in the 'Anatomy of the Vertebrates' (1866, vol. i. p. 171), stated that the Plesiosaurian "scapula develops an acromial process representing the clavicle;" but I do not think Prof. Owen and I intended the same interpretation; for in the same author's 'Palæontology' (1861, 2nd edit., p. 247) a figure is given of the scapula, which does not seem to be in accord with any figure or published description of the genus. This figure is reproduced in the 'Anatomy of the Vertebrates' (vol. ii. p. 52). I have seen no skeleton of *Plesiosaurus* which will justify such a scapula as Prof. Owen figures (fig. 4, p. 440); and probably the broad portion of the bone, which is represented as extending dorsally and backward over the ribs, bearing upon it the number 51, should have been directed anteriorly along the interclavicle; so that

the bone might be more intelligible were it revolved through half a circle.

Fig. 4.—*Pectoral Arch and Humerus of* Plesiosaurus, *as restored by Prof. Owen.*

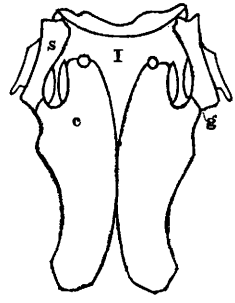


E. Episternum. S. Scapula. *c.* Coracoid. H. Humerus.

Prof. Huxley ('Anatomy of Vertebrated Animals') apparently regards the Plesiosaurian pectoral arch as a constant quantity, since the species are said to differ in little more than the proportions of the head to the trunk, and the relative length and degree of excavation of the centra of the vertebræ. The scapula finds its affinities in the Lacertilia, the ventral part of the bone in *Plesiosaurus* being supposed to correspond to the glenoid part of the scapula of *Iguana*, while the mass of the Lizard-scapula is supposed to be represented by the lateral portion of the scapula of *Plesiosaurus*. I should not attach more than epiphysial importance to the glenoid ossifications in Lizards, seeing how largely epiphyses are developed in the order, and therefore believe that no part of the Plesiosaurian scapula corresponds to the glenoid ossification adjoining the scapula and coracoid bones in some Lizards. The two chief objections to Prof. Huxley's view are, that in Plesiosaurs there is no evidence of more than one ossification in the scapula; while the preglenoid part of the bone in Lizards is commonly in intimate relation with the clavicle, which on the hypothesis would not be the case in Plesiosaurs. The lateral part of the scapula is of such varying size, that I prefer to suppose it moulded from the scapula in the several species by muscular developmont.

At page 210 of the same work Prof. Huxley gives a diagram of the Plesiosaurian pectoral girdle (see fig. 5), based, as I learn by letter, on "what he imagines to be sufficient evidence." The chief point in which I dissent from that figure is the treatment of the interclavicle; but granting that, as Prof. Huxley remarks, the bone is not always perfectly ossified, no specimen hitherto described, or, as far as I know, exhibited in any Museum, shows the characters of the five-rayed mass named by Prof. Huxley "*a*, clavicles and interclavicle?" (fig. 5, *I*).

Fig. 5.—*Pectoral Arch of* Plesiosaurus, *as restored by Prof. Huxley.*



s. Scapula. *I.* Interclavicle and clavicles. *g.* Glenoid cavity. *c.* Coracoid.

Another interpretation lately given is that of Prof. E. D. Cope, who, in his splendid memoir "On the Extinct Reptilia &c. of North America" (Trans. Am. Phil. Soc., vol. xiv. pt. 1. p. 51, pl. 2), conjectures that the bones which I have here named scapulæ should be called "clavicles or procoracoids;" and consequently, in restoring the skeleton, an imaginary scapula is introduced, which he supposes should extend dorsally over the ribs after the pattern of Prof. Owen's diagram. Prof. Cope's genus *Elasmosaurus*, in which this structure is represented in a restoration (pl. 1), is formed so entirely on the Plesiosaurian type, that I think the laws of osteological correlation warrant us in affirming that, since no trace of such structure exists in any European Plesiosaur, no such bone will ever be found in *Elasmosaurus*. The above hypothesis alone could have induced that distinguished naturalist to name the scapulæ clavicles; it may also have induced him to draw the limits of the glenoid cavities for the humeri entirely in the coracoid bones, excluding therefrom these elements of the scapular arch, because it would be contrary to analogy for them to enter into the glenoid cavity if the scapulæ are supposed to be clavicles. I am convinced that clavicles form no part of the ossified mass figured by Prof. Cope. If it were asked what becomes of the clavicles? the same question might be repeated with regard to those bones in Crocodiles; and if the so-called clavicles of Chelonians are, as I believe, only potential representatives of the precoracoids, there would be no need to account for clavicular bones, even to complete the osteological analogy with the chelonian pectoral arch. If Mr. Parker's nomenclature were accepted, we should be led, starting with a chelonian comparison, to look for the clavicles rather in relation with the interclavicle than with the scapulæ.

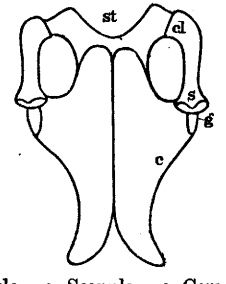
Professor Phillips, whose loss we have lately had to deplore, appears, in his 'Geology of Oxford,' to have mistaken the bones of the pectoral arch in *Plesiosaurus* for those of the pelvic arch: bones which have all the characters of coracoids are named pubic bones, while the scapula is identified with the ischium. These determinations seem to me attributable to the occurrence in the Oxford Clay of unsuspected generic modifications, and to a Teleosaurian theory of

the affinities of *Plesiosaurus*, by which alone it became possible to regard the pectoral as the pelvic girdle. I allude especially to the fig. 116, p. 310 (Geology of Oxford), which represents, I think, the pectoral arch of a new genus with the posterior end turned forwards. The forms of these bones are exactly paralleled by pectoral bones of undescribed genera of Plesiosauria from the great Pelolithic Period of Oxford to Kimmeridge Clay. The fact that no ilium was found by Professor Phillips is similarly explained. Diagram 180, p. 379, marked "ischium," appears to me to be a left scapula; diagram 179, p. 378, named "coracoid of *Plesiosaurus*," is the right ischium; diagram 177, called "ischial bones of *Plesiosaurus*," appears to me to represent the scapulæ of a new genus.

The English Plesiosauria hitherto indicated have been arranged in the genera *Plesiosaurus*, *Pliosaurus*, *Polyptychodon*, *Stereosaurus* (which is a genus instituted for the stiff-backed Plesiosaurs of the Cambridge Greensand), *Placodus*, and *Tanystrophœus**. Very little is known as yet of most of these, especially of the pectoral arch; so that I prefer to limit this note to the genus *Plesiosaurus* as it is usually understood.

Plesiosaurs may be divided into those which are furnished with a separate interclavicle and those in which that bone has no separate existence. Of the first family, the Plesiosauridæ, the type should be *Plesiosaurus dolichodeirus* of Conybeare; but none of the specimens so named in the British Museum gives certain evidence about its pectoral bones. Of the pectoral bones of other Plesiosaurs, Conybeare gave, in 1824, a restoration which has not since been materially improved upon (fig. 6), chiefly made from specimens said to be

Fig. 6.—*Pectoral Arch of* Plesiosaurus, *restored by Conybeare.*



st. Sternum. *cl.* Clavicle. *s.* Scapula. *c.* Coracoid. *g.* Glenoid cavity.

in the Oxford Museum, but which seem to have long been mislaid. Conybeare correctly identified the coracoids, and accurately placed the interclavicle (sternum) anterior to them, so that its hinder part is overlapped and hidden by the coracoids. The scapula correctly formed part of the humeral articular surface behind; and in front it overlapped a lateral wing of the interclavicle. The scapula in this spe-

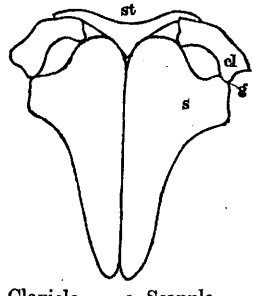
* The last two genera are from the Rhætic beds,—*Placodus* in the collection of Mr. C. Moore, of Bath, *Tanystrophœus* in that of Mr. James Plant, of Leicester.

cimen appears to be transversely divided; and Conybeare lettered the anterior piece (the piece which meets the interclavicle) as the lateral clavicular bone. Conybeare's figure and interpretation were both adopted by Cuvier, except that the bone named clavicle and scapula is regarded by Cuvier as so singularly placed that its homology needed investigation.

The author of the article "Plesiosaurus," in the 'Penny Cyclopædia,' in reproducing Conybeare's figure, named the whole bone clavicle, and supposes that the upward and backward process of the bone (not seen in the figure) is alone to be named scapula.

In 1834 Mr. Hawkins printed his memoirs of Ichthyosauri and Plesiosauri, and gave therein a restoration or diagram of the pectoral bones, professing to be chiefly drawn from the specimen which he named *Plesiosaurus triatarsostinus* (a species with three conspicuously large bones in the tarsus), which Prof. Owen, for the inadequate reason that there may be one or two more small bones in the tarsus, proposed to change to *Pl. Hawkinsii*. Mr. Hawkins's name has fair claim to retain its place; for to Mr. Hawkins belonged the merit of recognizing the species, which Dr. Buckland, who was likely to have been well advised, in 1836 confounded with *Pl. dolichodeirus* in his 'Bridgwater Treatise,' a name which it still retains in the last edition of that work. But in the pectoral restoration (fig. 7) Mr. Haw-

Fig. 7.—*Pectoral Arch of* Plesiosaurus, *as restored by Hawkins.*

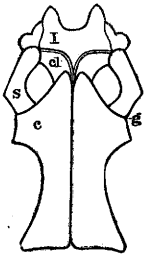


st. Sternum. *cl.* Clavicle. *s.* Scapula. *g.* Glenoid cavity.

kins was less happy; for, naming the interclavicle sternum as others had done (and as it theoretically might be), he regarded the scapulæ as clavicles, as Prof. Owen subsequently did, while the coracoids are named scapulæ. I am not sure whether Prof. Owen's description of the scapula in this species is supported by evidence; for the second specimen in the British Museum, named *Pl. Hawkinsii*, in which an approximation to such a structure is seen, certainly might be separated as another species. These species being regarded as the types of the genus *Plesiosaurus*, the definition of the genus depends upon the accuracy of these osseous determinations, if generic characters are to be drawn from the pectoral arch; but the girdle-bones are obscure in *Pl. dolichodeirus*, and the scapulæ are not sufficiently excavated to determine the forms of the bones in *Pl. triatar-*

sostinus, Hawkins, though analogy would make it not improbable that they have the form ascribed to them by Prof. Owen. This doubt existing, the type of the pectoral bones of the genus *Plesiosaurus* may be taken from the fine specimen contained in Case 6 of Room III., North Gallery, British Museum, at present named *Pl. Hawkinsii*, and which may appropriately be left so named. The entire animal is about 6 feet 6 inches long, and has the arrangement of pectoral bones which I here figure reduced (fig. 8).

Fig. 8.—*Pectoral Arch of* Plesiosaurus, *restored from Specimen in the British Museum.*



I. Interclavicle. *cl.* Clavicle. *s.* Scapula. *c.* Coracoid. *g.* Glenoid cavity.

The interclavicle, which is very small in *Pl. triatarsostinus*, only just emerging in front of the coracoids, in this species is seen to be of large size and unusual antero-posterior extent (I). This large bone extends behind the coracoids, much as the interclavicle extends behind the hyosternal bones of Chelonians, and posteriorly shows indications of a median cleft. A groove, or perhaps a suture, diverging, extends therefrom forward and outward, most clearly seen on the left side of the animal. If this mark indicates separate ossifications, which were distinct in early life and have become anchylosed with the interclavicle in mature growth, those ossifications would probably represent the hitherto missing clavicular bones. Similar elements, not well defined, appear to occupy corresponding positions in the large pectoral arch of the animal in the British Museum, named by Prof. Owen *Pl. laticeps*, MS. If these marks do not indicate the union of clavicle and interclavicle, then, in *Plesiosaurus*, clavicles have no existence.

I proceed now to describe and define the pectoral characteristics of the genus *Plesiosaurus*.

Plesiosaurus. (Fig. 8.)

The coracoid bones are longer than broad, chiefly placed behind the articulations for the humeri, but also extending anterior to them, contracting in breadth. Part of the curved anterior margin contributes, with the interclavicle and a scapula, to form on each side a moderately large foramen. The coracoid unites with the scapula, by suture, to form the articulation for the humerus.

The scapulæ are very narrow, concave on the inner border, and

straight on the outer border, which makes a sharp angle with the lateral vertical part of the bone, which, arising in front, widens from before backward, in a long narrow ◁-shape, to the articulation, where it is often prolonged as a spur over and above the proximal end of the humerus. The scapulæ converge anteriorly, but are divided from each other by nearly the whole width of the interclavicle, on the extreme lateral wings of which they rest.

The interclavicle is large, often as long as broad, and apparently may include in its posterior part a pair of subordinate ossifications. It is of modified V-shape, being concave in front, with concave sides, which, converging posteriorly, are prolonged behind the coracoids in a sharp point; the lateral wings are much expanded.

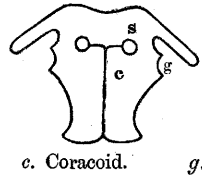
The other British animals usually referred to the genus *Plesiosaurus*, which do not conform to this type, are shown, by their pectoral girdles, to belong to the Elasmosauridæ, typified by Prof. Cope's genus *Elasmosaurus*, in which the interclavicular bone is entirely wanting. At present I am able to define three new English genera which seem to agree in this negative character of wanting an interclavicle; they are:—*Eretmosaurus*, founded on the *Plesiosaurus rugosus*, of Owen, from the Lias, in the British Museum; *Colymbosaurus*, to be indicated by *Plesiosaurus megadeirus*, of the Kimmeridge Clay, in the Woodwardian Museum and in that belonging to Marshall Fisher, Esq., of Ely; and *Muræenosaurus*, from the Oxford Clay, indicated by a new species in the collection of C. E. Leeds, Esq.

I have seen indications of several other genera, which may hereafter be defined; and probably, when other parts of the skeleton are critically examined, the number will be increased.

Eretmosaurus, g. n. (Fig. 9.)

Prof. Owen has had drawn, with more than usual clearness, in the 'Monograph of Lias Plesiosaurs,' the chief characters of *Pl. ru-*

Fig. 9.—*Pectoral Arch of* Eretmosaurus, *restored from Specimen in the British Museum.*

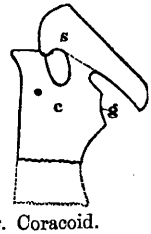


s. Scapula. *c.* Coracoid. *g.* Glenoid cavity.

gosus; but as the pectoral bones are badly preserved in that specimen from the Lias of Leicestershire, it is only after some study that I venture to express ideas of their forms and relations. There may be a little doubt as to whether a distinct interclavicular ossification ever existed; but if such a bone were present, which another specimen disinclines me to believe, then the bone has entirely lost its individuality in the mature animal, and is blended with the scapulæ, just as the scapular bones in the region between the small precora-

coid foramen and the glenoid cavity become united with the coracoids into one bone. Important light is thrown on this pectoral arch by an isolated anchylosed scapula and distally imperfect precoracocoracoid bone, also from the Lias, clearly belonging to the same genus, though probably referable to another species (fig. 10). The

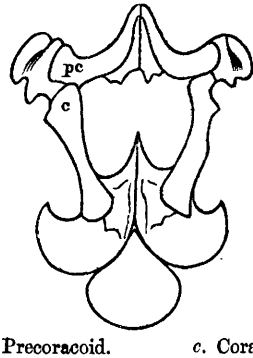
Fig. 10.—*Left Side of Pectoral Arch of* Eretmosaurus.



s. Scapula. *c*. Coracoid. *g*. Glenoid cavity.

coracoid portion of this mass is extremely thin, but thickens at the median line of the body of the animal, as is usual. The articular surface for the humerus shows no indication of being formed by more than one bone, so perfectly are the scapula and coracoid blended. On a line with the anterior margin of the articular surface, and nearer the median line than the precoracoid foramen, is a small vertical perforation, which I suppose to be homologous with the foramen similarly placed in the coracoid of Lizards, Crocodiles, and many Dinosaurs, and to be similarly definitive of the limits of the precoracoid and coracoid elements of the bones, and to indicate that in some amphibian ancestral race the precoracoids were as distinct from the coracoids as they are in the Cape frog (*Dactylethra*), which has a pectoral region not altogether incomparable with that of some members of the Plesiosaurian order (see fig. 11). The ante-

Fig. 11.—*Pectoral Arch of* Dactylethra. (After W. K. Parker.)



pc. Precoracoid. *c*. Coracoid.

rior margin of the precoracoid portion of the bone is truncated in the median line, though a suture there extends between it and the

scapula. The anterior and inner margin of the scapula similarly terminates in an edge which gave attachment to cartilage, showing, I think, that the anterior median portion of the pectoral arch was occupied not by an interclavicle, but by a common cartilage, at the expense of which the scapular ossifications extended till they met in the median line.

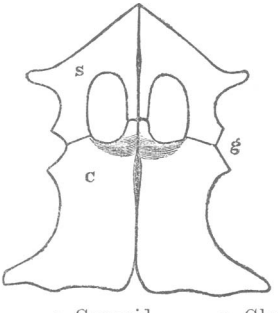
The scapula is remarkable chiefly for the length of the acromial process (which is directed outward), for the straight antero-lateral margin which the bone thus obtains, for the expansion of its anterior end, and for the small foramen which it combines with the coracoid to enclose.

These characters are supported by others in all parts of the skeleton: thus the pubic bones have a prepubic process directed anteriorly, like that seen in Chelonians; and Prof. Owen describes and figures distinct olecranon and patella bones. The caudal vertebræ give no indication of chevron bones.

Colymbosaurus, g. n. (Fig. 12.)

The coracoid bones are oblong, widening at the posterior angles, and not extending anterior to the humeral articulation, except

Fig. 12.—*Pectoral Arch of* Colymbosaurus, *from a Specimen in the Museum at Ely.*



s. Scapula. *c.* Coracoid. *g.* Glenoid cavity.

slightly in the median line of the body, and not cupped deeply to form the foramen between the scapula and coracoid.

The scapula is of extraordinary form; the two bones meet in the median line of the body, meet the coracoids behind by a narrow union, and enclose the greater part of a large foramen; the anterior margins of the bones are straight, converge at about an angle of 90°; the posterior end of the straight side is prolonged into a blunt process, between which and the humeral articulation the side of the bone is concave.

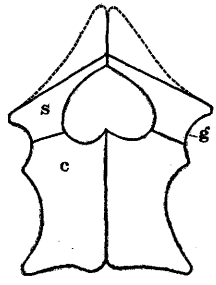
These Plesiosaurians all have very long slender necks, and closely approximate to the *Elasmosaurus* of Cope, with which I hesitate to identify it till we know more details of the structure of the Ame-

rican animal. The species are found in the Oxford Clay, Ampthill Clay, and Kimmeridge Clay.

Murænosaurus. (Fig. 13.)

Both pelvic and pectoral arches are characterized by the bones having no median antero-posterior osseous union. Thus, instead of

Fig. 13.—*Pectoral Arch of* Murænosaurus.



s. Scapula. *c.* Coracoid. *g.* Glenoid cavity.

two obturator foramina, this genus has but one. In the same way there is but one foramen enclosed between the scapulæ and coracoids. The scapulæ converge in front with straight anterior margins, which make a right angle with enormous lateral processes, which differ from those of all other Plesiosaurians in being prolonged forward.

With these characters are associated a union of the neural arches of vertebræ, only comparable to that seen in Serpents and Iguanoid Lizards, but with semicylindrical zygapophysial facets; while the chevron bones join tubercles at the base of the centrum instead of articulating between two centrums; and the ulna and radius, and tibia and fibula, are distinct in form from those of other genera. The type of the genus is *Murænosaurus Leedsii*, Seeley, Q. J. G. S. vol. xxx. p. 197. I should place the *Plesiosaurus Oxoniensis* and *Pl. Manselli* in a subgenus of *Murænosaurus*. The species are found in the Oxford Clay, Ampthill Clay, and Kimmeridge Clay.

Rhomaleosaurus, g. n.

One genus, found in the Alum shale of the Upper Lias at Whitby, is represented by the fine species in the Museum of the Royal Dublin Society, which has been named, by Mr. Baily and Dr. Carte, *Plesiosaurus Cramptoni*. This type has given no evidence of its sternal bones; but its other characters differ so far from those usual in *Plesiosaurus*, that it may be placed in a genus by itself, to be named *Rhomaleosaurus*.

The cervical vertebræ are nearly as short, from back to front, as in *Pliosaurus*; and the cervical rib is articulated with the centrum by two facets, as is the case with the early cervical vertebræ of *Pliosaurus*. The ulna and fibula have not the usual reniform shape, but are short and broad, and resemble the radius and tibia in being

slightly constricted. No mention is made of chevron bones in the caudal vertebræ. There are only six bones, in two rows, in the carpus and in the tarsus, and only four digits in each limb. The premaxillary bones appear to extend backward so as to divide the nasal bones; and the lower jaw is unusually deep at the coronoid bone. The double articulation for the cervical rib probably indicated relationship to the Pliosauridæ rather than to either of the families that I have discussed; but it is seen in isolated vertebræ from the Lias, contained in the British Museum.

I cannot but consider it a matter for regret that, although so large a number of species have been found in the Cambridge Upper Greensand and other Cretaceous strata, we are still ignorant of all those parts of the body which would warrant us in placing them in genera. One is thus unable to pronounce any opinion on the evolution of modifications of the Plesiosaurian girdle in relation to time. And the only general conclusion at which I have arrived is that Plesiosauria, in common with all similar groups, show, in the newer rocks as compared with the older ones, a greater amount of ossific energy, probably coincident with higher organization, which manifests itself in more perfect ossification of the bones, elongation of processes, and blending of subordinate with the principal ossific centres.

[*To face* p. 35.

CORRIGENDA *to the* ABSTRACT *of* Capt. GODWIN-AUSTEN'S Paper—"GEOLOGICAL NOTES *on* PART *of the* NORTH-WESTERN HIMALAYAS," published in Quart. Journ. Geol. Soc. vol. xx. p. 383–387.

Page 385, line 29, *erase the paragraph commencing* As these limestones, *and ending* Ladak and Little Thibet.

The Nummulitic series occurs, as has been stated at the commencement of § 3, p. 385, line 27, on the southern face of the Pir-Pinjal range and close to the older Siwalik rocks, but I have nowhere seen it in the Kashmir valley, and I think it very probable that in ancient days the Nummulitic sea conformed to the base of the present line of Himalayahs, more or less, and did not extend to the north at all. The limestone near the Wuller Lake, and at the base of the hills on the northern side of the Kashmir valley is undoubtedly Carboniferous.

Page 385, line 12 from bottom, *the paragraph commencing* On the southern slopes *up to* showing the palates very well, p. 386, line 2, should have come into § 2. *The Siwalik Series*; it not being Nummulitic, but the next formation in the series above.

5. *The Carboniferous Series*, p. 386, line 14.—It is a little ambiguous, and might lead the reader to suppose that the genera mentioned occurred indiscriminately through the whole mass of the beds up to that and together with the bed containing Goniatites. These, I may mention, contained no other shells that I could find.

I see it also stated—"*These also occur in superposition.*" Now I should say hardly ever, and never in the Kashmir valley itself. Further east, in Zauskar, Spiti, &c., the Palæozoic and Mesozoic may do, but not in the mountains to the south, south-east, and east of the valley.

In Mr. Davidson's note on the fossils, p. 387, line 20, it is stated:—"*From this rock, at Shigar, near Skardo, Capt. Godwin-Austen obtained six or seven*, &c." Now the fossils mentioned were all found in the Carboniferous limestones of the Kashmere valley and have no connexion with the very imperfect specimens, said to be Palæozoic, obtained near Skardo. I am afraid the labels on the fossils must have come off, or that by some means they got mixed together. The same must have occurred to the land and freshwater shells sent home; for *Helix hispida* was obtained in the lacustrine clay of the Kashmere valley, and not from Kuardo near Skardo. Some of the other shells are from other localities, but as I have no duplicates I cannot remember whence they came.

H. GODWIN-AUSTEN.

Deyrah Dhoon,
7th December, 1865.

ERRATA.

Vol. LXXXII, p. 538, line 1, for '*gleanensis*,' read '*pleanensis*.'

p. 538, line 20, *for* 'Glean', read 'Plean.'

In table facing p. 552, for '*Cerithioides (?) gleanensis*,' read '*Cerithioides (?) pleanensis*.'

p. 554, line 3, for '*gleanensis*', read '*pleanensis*.'

Vol. LXXXIII, p. 161, line 2, for 'dolomitic', read 'doleritic.'

The title and explanation of fig. 2, in pl. vi apply to fig. 1 of pl. viii, and *vice versa*. In the explanation of the view of the Head of the Nordenskjöld Glacier, read: *a*=Mount Terrier nunatak: Upper Carboniferous on Hecla Hook rocks (*not* 'or' Hecla Hook rocks).