27. Some early Fossil Cirripedes of the Genus *Scalpellum*.

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(Text-figs. 64 & 65.)

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Among the Cirripede remains from the Albian (Gault) of Folkestone in the collection of the British Museum (Natural History), three detached valves were noticed, which, for certain reasons to be explained later (see p. 532), appear to be the original valves upon which Darwin founded the species *Scalpellum arcuatum* †. A portion of one of the valves, a carina ‡, happened to be broken away from its matrix, showing that the intraparietes, said by Darwin to be absent in this species, were really present. These parts, however, are developed in such a way that they can be seen only by cleaning the valve free from matrix. The finding of the intraparietes in Darwin's type of *S. arcuatum* led to the examination of further examples of the carina, and the fact was established that intraparietes are developed in all carinae of this species.

*S. trilineatum* Darwin (1851, p. 38, pl. i. fig. 5), from the Cenomanian (Grey Chalk) of Dover, was said by Darwin to come nearest to *S. arcuatum*, owing to the absence of intraparietes. The carina, which is the holotype of *S. trilineatum*, is in the British Museum (Natural History), registered 38461. On freeing this specimen from the gum and matrix which obscured the inner portion of the valve, it was at once apparent that not only were the intraparietes present, but that they were developed almost exactly as in *S. arcuatum*.

Other Lower Cretaceous species of *Scalpellum* in which the intraparietes of the carina are said to be absent are *S. simplex* Darwin (1851, p. 39, pl. i. fig. 9) and *S. accumulatum* Withers §, both of which come from the Aptian (Lower Greensand). The unique carina of *S. simplex* cannot at present be traced, but since the parietes do not reach to the basal margin of the valve (see text-fig. 64, 1) as in those carinae which have intraparietes, it does not appear probable that intraparietes could be present. In

* Communicated by Dr. W. T. Calman, F.Z.S.
† C. R. Darwin, 1851, Pal. Soc Monogr. Foss. Lepadidse, p. 40, pl. i. fig. 7.
‡ For the names of the various valves see text-fig. 65.
S. arcuatum (text-fig. 64, 3) and S. trilineatum (text-fig. 64, 4) the parietes reach to the basal margin, and in my opinion the intraparietes will be found to be developed in S. accumulatum (text-fig. 64, 2) as in those species, since S. accumulatum is similar in its general external form. The only carina known

Text-fig. 64.

![Early types of the Carina of Scalpellum.](image)

1 a-5 a, side view; 3 b, 4 b, 5 b, inner view; 1 c-5 c, transverse section near apex.

of S. accumulatum is embedded in such a hard matrix that it is impossible to expose its inner surface without danger to the specimen, so that the matter must here remain until further specimens are forthcoming.

So far, then, we have proved the existence of intraparietes in
the carina of the two species *S. arcuatum* and *S. trilineatum*, and pointed out the possibility of their presence in *S. accumulatum*. The intraparietes in these species, instead of forming a thin wall on each side of the carina as in the form represented by text-fig. 64, 5, are bent inwards almost at right angles, and the upper regions of their inner margins meet to a greater or less extent (see text-fig. 64, 3b, 4b); the upper part of the valve is solid, and must have projected freely to the extent indicated by the meeting of the intraparietes*. The peculiar development of the intraparietes in the carina of these species is therefore of importance as showing a development of the carina distinct from that in which the intraparietes form a thin wall on each side of the carina.

Three types of carina, all having an apical umbo, were therefore already developed amongst these early forms of *Scalpellum*, and the geologically oldest of these more closely resemble the carina of *Pollicipes*, from which *Scalpellum* is considered to be derived. These are (1) represented by *S. simplex* (text-fig. 64, 7) from the Aptian (Lower Greensand), which has no intraparietes, the tectum being flatly-arched transversely, the parietes bent almost at right angles to the tectum and not extending to the basal margin; this type is distinguished from the *Pollicipes* type of carina only in the parietes being separated from the tectum by a distinct angle; (2) represented by *S. accumulatum* (text-fig. 64, 2) (Aptian, Lower Greensand), *S. arcuatum* (text-fig. 64, 3) (Albian, Gault), and *S. trilineatum* (text-fig. 64, 4) (Cenomanian, Grey Chalk), which have intraparietes, these parts being bent inwards almost at right angles and joining, the upper part of the valve being solid and projecting freely to a considerable extent; in the solidity and free projection of the upper part of the valve this type is allied to *Pollicipes*; (3) represented by *S. hastatum* (text-fig. 64, 5) and other species from the Cenomanian which have intraparietes also, but are characterized by these parts forming a thin wall on each side of the carina, the apex of which projects freely, slightly, or not at all; this latter type is more typical of the genus *Scalpellum*, and, owing to the upward growth of the intraparietes in some forms, subsequently gave rise to the species with an angularly bent carina having the umbo in a subcentral position, a type which is not known below the Upper Senonian. The only species with an angularly bent carina known from the English Chalk is *S. darwinianum* Bosquet†, but this has an early specialized form of carina in which the upward

* A somewhat similar development of the intraparietes can be seen in the carina of *S. maximum* var. *cylindraceum* Darwin (1851, p. 33, pl. ii. fig. 2) from the Upper Senonian (*Beloninitella macronata*-zone) of Norwich, Norfolk, and *S. solidatum* Steenstrup (1839, Kröyer, Naturhist. Tidsskrift, Bd. ii. p. 412, pl. v. figs. 14, 14*; Darwin, 1851, Pal. Soc. Monogr. Foss. Lepadidae, p. 42, pl. i. fig. 8) from the Upper Senonian of Kjuge, Scania.

extension of the valve is due, not merely to the upward growth of the intraparietes, but to the almost equal upward and downward growth of the valve from the umbo, the whole external surface of the valve being ornamented. It is, therefore, probable that species with an angularly bent carina, due to the upward growth of the intraparietes, which is apparently the more primitive type, existed even earlier than in the Upper Senonian.*

Extreme interest attaches to the remarkably complete example of S. arcuatum from the Albian (Gault) of Folkestone, Kent, here described and figured (p. 534, text-fig. 65, 6). To find so many valves of the capitulum in position is a remarkable circumstance, very few specimens of Scalpellum having been discovered with several valves associated. Those known up to the present come from the Upper Senonian, and, with the exception of a single incomplete capitulum of S. maximum, belong to the species S. fossula. This specimen, therefore, represents the only fossil species of Scalpellum obtained from below the Upper Senonian with any considerable number of valves in position. Previously described species of Scalpellum from rocks below the Upper Senonian have all been founded on detached valves, and in most cases on single valves. Neither the upper latus, rostral latus, or rostrum, are included in these descriptions, but are represented in the present specimen. A further example of S. arcuatum (described, p. 533) has furnished some scales of the peduncle, which so far are not known in any species found below the Upper Senonian. S. arcuatum is the only representative of Scalpellum known from the Albian (Gault) of England.

Consequent on the discovery of the intraparietes in the carina of S. arcuatum and S. trilineatum, and since the carina is the typical valve of the genus, it is here proposed to give fresh diagnoses of those species and to describe the new material of S. arcuatum. From the two examples of S. arcuatum it is possible to construct a restoration of the capitulum, to which only two valves are diagrammatically added (see text-fig. 65, 7, p. 534).

**Scalpellum trilineatum** Darwin.

1851, _Scalpellum trilineatum_ C. R. Darwin, Pal. Soc. Monogr. Foss. Lepadidae, p. 38, pl. i. fig. 5.

* Since the above was written, two exceedingly small, angularly bent carinae (length respectively 1.7 mm. and 1.8 mm.) with the umbo subcentral, due to the upward growth of the intraparietes, have been obtained by Mr. F. Möckler from the Cenomanian (Chalk Marl) near Cambridge. The specimens are incomplete and poorly characterized, but of much importance as showing that species with an angularly bent carina existed even so far back in time as the Cenomanian.
This species was founded on a carina and tergum from the Cenomanian (Grey Chalk) of Dover. The tergum cannot now be found, but the carina, which Darwin considered to be the typical valve of the genus and can therefore be regarded as the holotype, is in the British Museum (Natural History) registered 38461.

**Diagnosis.**—Carina with three prominent, rounded, longitudinal ridges on its tectum—one central, and one on each side separating the tectum from the parietes; intraparietes bent inwards almost at right angles, the inner margins meeting a short distance below the apex, upper part of valve solid and projecting freely.

**Description of Carina.**—Carina narrow, widening very gradually from the apex, considerably bowed inwards, basal margin obtusely angular. Tectum flatly-arched transversely, with a central, prominent, rounded ridge extending from the apex to the basal margin, and bounded on each side by a slightly coarser but flatter ridge on the angle separating the tectum from the parietes. Parietes narrow, less than half the width of the tectum, bent almost at right angles to the tectum, slightly concave. Intraparietes very narrow, bent inwards almost at right angles, the inner margins meeting about one-sixth the length of the valve from the apex; the upper part of the valve is solid, and must have projected freely to the extent indicated by the meeting of the intraparietes. Lines of growth plainly marked.

**Scalpellum arcuatum** Darwin. (Text-fig. 65.)


The species *S. arcuatum* was founded on three detached valves, namely, carina, scutum, and tergum, from the Gault of Folkestone, Kent. These valves were considered by Darwin to belong to the same species, and the material now to be described proves such to be the case. Darwin further stated that these valves were in the Bowerbank Collection. This collection was acquired in 1865 by the British Museum (Natural History), and among the specimens are three valves, a carina (I. 13796), a scutum (I. 13797), and tergum (I. 13798), mounted together on Bowerbank's original tablet, and labelled in Darwin's handwriting "*S. arcuatum.*" The carina has been much broken, presumably since Darwin described it, but the scutum and tergum are in good
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condition. These specimens are also exactly half the size of Darwin’s figures, which are enlarged to two diameters, and in these circumstances there seems little doubt that they are the original valves figured by Darwin. The carina, since Darwin considered it to be the typical valve of Scalpellum, is consequently regarded as the holotype.

Two specimens in the British Museum (Natural History) add considerably to our knowledge of this species.

One, registered (I. 13577), text-fig. 65, 6, first appeared to consist of a carina with fragments of the scuta and terga. Careful clearing away of the matrix and the abundance of gum which covered the specimen showed, however, that several of the valves of the capitulum were preserved. These consist of the carina, the paired scuta, the paired terga, an upper latus, a rostral latus, and the rostrum. The left side of the capitulum is uppermost, and the carina is so exposed that the intraparietes can readily be seen. Portions of the inner surfaces of the right scutum and tergum are also exposed owing to the fact that the upper valves are somewhat displaced and broken.

The second specimen (I. 13580) has not so many valves preserved and those present are somewhat broken. The right side is uppermost, and the plates shown are the carina, the pair of terga, the upper portion of the left scutum showing its inner surface, and the left upper latus. This last valve showed only its inner surface, but on removal from the matrix it was found to be the left upper latus. This specimen is of interest since it furnished eighteen scales of the peduncle. A supposed shell-fragment was removed from between the two terga, and on being cleaned was found to be a peduncle scale. On removing and washing the remaining matrix from the same position, the number of scales was increased to eighteen. There is little doubt that these scales belong to S. arrouatum, since it is the only species of Scalpellum known to occur in the Gault. Moreover, they are ridged like the valves of the capitulum of that species, and the fact that they were found in such close association is prima facie evidence that they belonged to the same individual, and were washed into the position in which they were found. They are somewhat similar in shape to the scales of the peduncle of the Upper Senonian species S. maximum and S. fossula as figured by Th. Marsson *, but are easily distinguishable from them by their longitudinal ridging.

Diagnosis. — Capitulum composed probably of fourteen valves †, which are ornamented with numerous fine ridges radiating from their apices; umbo of all valves apical. Carina with tectum flatly arched transversely, parietes rectangularly inflected.

* Th. Marsson, 1880, “Die Cirripeden und Ostracoden der weissen Schreibkreide der Insel Rügen,” Mitth. naturwiss. Vereine Neu-Vorpommern und Rügen, xii. pl. i. figs. 2 b, c, d, 3 d, e.
† It is possible that this species had a subcavina, in which case the number of valves would be fifteen. A higher number of valves is not likely.
Fig. 6. *Scalpellum arcuatum* Darwin. Nearly complete capitulum showing the left side uppermost, with the valves somewhat displaced and broken. $\times 2$ diam. Albian, Gault; Folkestone, Kent. Brit. Mus. (Nat. Hist.), I, 13577. 

c. carina, showing the inflected intraparietes; t. 1, outer portion of left tergum; t. 2, inner view of right tergum near apex, showing the ridges evidently connected with the firm attachment of the corium; s. 1, outer portion of left scutum; s. 2, inner view of right scutum showing the pit for the adductor scutorum; r. 1, upper latus; r. 2, rostral latus with upper portion broken off; r., rostrum.

Fig. 6 a. Id. Outer view of incomplete rostral latus.
Fig. 6 b. Id. Inner view of same.
Fig. 6 c. Id. Outer view of rostrum.
Fig. 6 d. Id. Hypothetical transverse section of same.
Fig. 6 e. Id. Side view of same.

Fig. 7. Restored capitulum of *Scalpellum arcuatum* Darwin. This figure is based on the nearly complete capitulum represented by fig. 6, with the addition of a carinal latus and an infra-median latus. These two valves have not yet been discovered in the Gault. $\times 2$ diam. Albian, Gault; Folkestone, Kent. c. l., carinal latus; i. l., infra-median latus.

Fig. 8. *Scalpellum arcuatum* Darwin. Two scales of the peduncle, a, outer view, b, inner view; c, outer view; d, inner view. $\times 8$ diam. Albian, Gault; Folkestone, Kent. Brit. Mus. (Nat. Hist.), I, 13580.
intraparietes bent inwards and meeting for about one-fourth the length of the valve from the apex, upper part of valve solid and freely projecting. Scutum with tergo-lateral angle almost in line with the middle of the valve. Tergum subrhomboidal, a delicate furrow extending from the apex to the basal angle. Upper latus subtriangular, apex acutely angular, slightly bowed towards scuta, basal margin rounded. Rostral latus acutely angular transversely, about 2\(\frac{1}{2}\) times as long as wide. Rostrum subtriangular, with a strong median keel extending from the apex, widening towards the convex basal margin.

**Description of valves.**—Carina narrow, widening gradually from the apex, considerably bowed inwards, basal margin obtusely V-shaped. Tectum flatly-arched transversely, obscurely carinate, and ornamented with numerous fine longitudinal ridges. Parietes narrow, less than half the width of tectum, not longitudinally ridged, bent almost at right angles to the tectum, slightly concave. Intraparietes very narrow, bent inwards almost at right angles, the inner margins meeting about one-fourth the length of the valve from the apex, above which the valve is solid and must have projected freely.

Scutum moderately convex, divided unequally by a prominent ridge running from the apex to the basi-lateral angle, the basi-lateral angle being slightly produced. Apex acuminate. Basal margin sinuous, about two-thirds the length of the valve; occludent margin slightly convex and nearly parallel to the lateral margin; tergal and lateral margins of almost equal length and forming an angle of about 145°, either margin being about half the length of the valve. Surface of valve ornamented with fine, closely-set, longitudinal ridges; a narrow slip along the tergal margin is somewhat bent downwards and is devoid of ridges.

Tergum sub-rhomboidal in general outline, slightly convex, with a delicate furrow extending from the apex to the basal angle. Apex and basal angle acuminate, more so than is indicated in Darwin's original figure; scutal angle somewhat protuberant, Carinal margin convex; scutal margin sinuous, longer than the occludent margin, which is nearly straight. Surface of valve ornamented with numerous fine longitudinal ridges. Inner surface, in the region of the apex, is marked on its edges with oblique lines of growth, these indicating the extent to which the valve projected freely. A little below the apex, nearer to the occludent margin, are three or four small ridges ending abruptly about one-fourth the length of the valve from the apex. These ridges were evidently connected with the firm attachment of the corium, or membrane which lined the inner surfaces of the valves, and are homologous with the series of tubercles on the inner surfaces of the terga of *S. darwinianum* Bosquet.

Upper latus subtriangular, slightly curved towards the scuta, almost flat transversely, convex longitudinally; umbo slightly projecting, with a thick ledge formed beneath it, which thins out towards the lateral angles; tergal margin slightly convex; scutal
margin slightly concave and about the same length as the tergal margin, the two margins if represented by lines from the apex to the lateral angles would enclose an angle of about 55°; basal margin rounded, and indistinctly marked off into three lines; a portion of the valve on either side, parallel with the scutal and tergal margins, is somewhat raised, and the lines of growth on these parts are upturned sharply towards the umbo. Surface of valve between the raised portions ornamented with several longitudinal ridges.

Rostral latus.—This valve is imperfect, the upper portion being broken off. Valve very narrow, acutely angular transversely, about $2\frac{1}{2}$ times as long as wide, widening gradually from the inner acute extremity to the rostral margin, which is abruptly truncate; umbo apical; the inner extremity is marked by a strong rounded keel; outer (rostral) half of valve ornamented with fine longitudinal ridges, two fine ridges close together almost dividing the basal margin into two equal portions. At the point where these two ridges reach the basal margin the valve is somewhat convex, no doubt indicating the extent to which the valve was bounded by the inframedian latus.

Rostrum sub-triangular, strongly convex transversely, bowed inwards; lateral margins bounded by strong ridges; basal margin convex; a strong median rounded keel extends from the apex, widens considerably towards the basal margin, and is bounded on either side by indistinct longitudinal ridges.

Peduncle scales varying in shape from semilunar to trapezoidal, the basal margin of the former being straight, while that of the latter is somewhat concave; immediately below the apex the trapezoidal scales are slightly constricted, the truncated top appearing to overhang; scales thickest at one-third from the base, below which, on the inner surface, they are somewhat excavated, this indicating the extent to which the scales were covered by the corium, the upper two-thirds no doubt overlapping the contiguous scales. Outer surface ornamented similarly to the valves of the capitulum with a number of longitudinal ridges. These ridges number about seven on the larger scales, and four or five on the smaller scales.

Measurements.—Owing to the fact that the valves in these two specimens of *S. arcuatum* are broken, it is impossible to give their accurate measurements. Since, however, it is desirable that we should have some idea of the relative sizes of the valves in an individual, approximate measurements are given where the correct measurements cannot be obtained.

Specimen I. 13577.

Carina. Length circa 21 mm.

Scutum (right valve). Length (from apex to rostral angle) 13·5 mm.; breadth 7·4 mm.

Tergum. Length circa 17 mm.; breadth 8·2 mm.
Upper latus. Length 6·8 mm.; breadth circa 7·5 mm.
Rostral latus. Length 6·3 mm.; breadth 2·6 mm.
Rostrum. Length 3·4 mm.; breadth 2·2 mm.

Specimen I. 13580.

Carina. Length circa 20 mm.
Tergum. Length circa 17 mm.; breadth 7·5 mm.
Upper latus. Length 5·9 mm.; breadth circa 4·2 mm.
Scales of peduncle. Length from 0·5 mm. to 1·2 mm.; breadth 1·3 mm. to 2 mm.

Remarks, and comparison with other Species.—The restoration of *S. arcuatum* (text-fig. 65, 7) is based on the nearly complete capitulum figured on the same page, and, to complete the capitulum, a carinal latus and an inframedian latus have been added. The carinal latus figured in the restoration was found amongst a number of detached plates of *S. arcuatum* from the Cambridge Greensand, and is longitudinally ridged as in the valves of *S. arcuatum*. It possibly belongs to the same species. In any case the only carinal latera known to the writer from the Lower Cretaceous rocks are of the type figured, although they evidently belong to several different species. Judging from the hiatus between the carinal latus and rostral latus, an inframedian latus was undoubtedly present, and was probably very like the homologous valve in *S. fossula* from the Upper Senonian.

The specimen of *S. arcuatum* here figured (text-fig. 65, 6) is, up to the present, the oldest fossil *Scalpellum* from which one can gain any idea of the appearance of the complete capitulum. It comes from the Albian (Gault) of Folkestone, Kent, and the only undoubted valves of *Scalpellum* older than this occur in the Aptian (Lower Greensand)*. These Lower Greensand forms comprise only three species, two of which—*S. simplex* Darwin and *S. accumulatum* Withers—are respectively represented by a single carina; the third, *S. comptum* Withers, is represented by two detached terga.

Our knowledge of these early forms of *Scalpellum* is therefore not very extensive, and the fact that they are represented by such a small number of valves, and those only of carine and terga, serves to emphasize the importance of this fine example of *S. arcuatum* (text-fig. 65, 6).

A comparison of the carina and tergum of *S. arcuatum* with the corresponding valves of *S. solidulum* Steenstrup, as figured by Darwin (1851, p. 42, pl. i. fig. 8), shows how closely these two species resemble each other. They are evidently related. The

* This statement is made with full knowledge that certain valves from the Paleozoic and Jurassic rocks have been referred by various authors to the genus *Scalpellum*. There is, however, not sufficient evidence to justify the reference of these valves to the genus *Scalpellum*. Notwithstanding this, it is possible that some of the Mesozoic Cirripedes referred to *Pollicipes* may eventually be shown to be ancestral forms of *Scalpellum*, but this cannot be done until more is known of the various valves comprising the capitulum.

carinae are easily distinguished, for whilst in \textit{S. arcuatum} the tectum is flatly-arched transversely, and the intraparietes are bent inwards almost at right angles, the tectum in \textit{S. solidulum} is strongly convex, and the intraparietes join to form a prominent crest. Darwin considered the scutum of \textit{S. solidulum} to be like that of \textit{S. arcuatum}, with the exception of the longitudinal ridges being proportionally broader and further apart, closely resembling those in the carina of \textit{S. solidulum}.

Unfortunately the only known complete capitulum from the Cretaceous rocks with which that of \textit{S. arcuatum} can be compared is that of the Upper Senonian species \textit{S. fossula}. In the relative positions of the valves both species are alike, but in the structure of the carina and scutum there are important differences. The intraparietes of the carina of \textit{S. arcuatum} are sharply bent inwards, the upper part of the valve is solid and must have projected freely to some considerable extent. The carina of \textit{S. fossula}, on the contrary, projected freely but little, and the intraparietes form a thin wall on each side of the carina. In \textit{S. arcuatum} the tergo-lateral angle of the scutum is situated much further from the apex than in \textit{S. fossula}, and in this respect is further removed from the more advanced scuta which have the tergo-lateral angle almost in line with the apex, above which the valve is added to, the umbo consequently being sub-central. The valves of \textit{S. arcuatum} are longitudinally ridged, while those of \textit{S. fossula} are smooth.

\textbf{Affinities of the Species mentioned.}

\textit{S. arcuatum} is no doubt an ancestral form of a group of almost exclusively deep-sea species, which Dr. P. P. C. Hoek\textsuperscript{*} has separated as a sub-genus under the name \textit{Arcoscalpellum}. \textit{S. trilineatum}, \textit{S. accumulatum}, \textit{S. comptum}, \textit{S. maxinum} var. \textit{cylindrical}, and \textit{S. solidulum}, which appear to be related to \textit{S. arcuatum}, possibly belong to the same group, but we know too little of these species to say much about them. \textit{S. simplex} probably does not belong here.

The species embraced by the sub-genus \textit{Arcoscalpellum} have no sub-carina, and it is impossible at present to say whether \textit{S. arcuatum} had a sub-carina or not. The Senonian species \textit{S. fossula} also comes nearest to the subgenus \textit{Arcoscalpellum}, but this species is said by Ed. Hébert\textsuperscript{†} to have a sub-carina, and in view of this it is possible that the Albian \textit{S. arcuatum} also may have had one. Assuming this to be the case, we have two forms agreeing in all essential characters with the forms of \textit{Arcoscalpellum}, except that they (possibly) have a sub-carina. Moreover, the two species differ in the form of the carina, \textit{S. arcuatum} having the intraparietes bent inwards at right angles and

\textsuperscript{†} Ed. Hébert, 1855, Mem. Soc. Géol. France, 2e sér. vol. v. p. 356, pl. xxviii. fig. 1 (\textit{S. gallicum} = \textit{S. fossula}).

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