PALEONTOLOGY.—*The systematic position of the pelecypod genus* Trinacria.[1] F. STEARNS MACNEIL, U. S. Geological Survey. (Communicated by LLOYD W. STEPHENSON.)

During the course of some researches into the structure and evolution of the ligament of arcid pelecypods the writer was fortunate enough to find, in a collection recently acquired by the U. S. National Museum, a few specimens of *Trinacria cancellata* (Deshayes) from the Calcaire Grossier, on which the fibrous ligament was perfectly preserved. These throw new light on the relationships of this genus. In addition some specimens of a new genus from the Upper Cretaceous of Texas, collected and described in manuscript by L. W. Stephenson of the U. S. Geological Survey, were recognized as representing a primitive type of Trinacriinae. It is the purpose of this paper to make the structure of the ligament of *Trinacria* known, to outline briefly the evolution of the genus, and to delimit the subfamily Trinacriinae which was recently proposed by the writer in U. S. Geological Survey Professional Paper 189-A.

The writer is indebted to the authorities of the U. S. National Museum for the privilege of studying Museum collections and to Dr. L. W. Stephenson for making the name of his Upper Cretaceous genus, *Linter*, available under separate title in this publication.

NOMENCLATURE

The availability of the name *Trigonocoelia* Nyst and Galeotti (1835) for the group of shells generally referred to as *Trinacria* Mayer (1868) has been a subject for difference of opinion since Deshayes usage of the former in 1860. Wood and Stoliczka expressed the opinion, which was probably shared by Conrad and Newton, that, inasmuch as the original list for *Trigonocoelia* contained two distinct genera, and one of them, the "pectunculacés" species, belonged to the genus *Limopsis* Sasso (1827) (type by monotypy, *Arca aurita* Brocchi), the name *Trigonocoelia* was still available for the "nuculacés" species. Mayer was apparently unaware that the original list for *Trigonocoelia* was divided into shells of two types, for he accused Deshayes of applying the name to an entirely different type of shell than that for which it was proposed. Mayer believed that Nyst and Galeotti's name was proposed as a substitute for *Limopsis*, because the latter was a hybrid name, and accepted the substitution on that

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ground. He was thus incorrect in suppressing *Limopsis* and for the reasons he gave he was equally incorrect in proposing the new name *Trinacria*. His name is a valid one, however, by virtue of Herrmannsen's designation of *Arca aurita* Brocchi as the type of *Trigonocoelia* in 1849 (1). This is the first and only valid designation of a type for *Trigonocoelia* the writer has been able to find, and curiously enough it appears not to have been mentioned by later authors. On whatever nomenclatorial errors the name *Trinacria* has gained acceptance, Herrmannsen's designation settles the problem unless a contrary designation made between 1835 and 1849 is discovered. Dall raised the question as to whether *Trigonocaelix* Conrad (1865) [a typographical error] was not to have priority over *Trinacria*. Had not Conrad later corrected it to *Trigonocaelia* (2) a telling case might be made for it. Conrad's correction differs from Nyst and Galeotti's spelling by the diphthong *ae* for *oe*. Inasmuch as the name had been spelled indiscriminately before, Deshayes spelling it *ae* in the generic discussion and *oe* in the systematic text, and Chenu spelling it *oe* in his index and *ae* in the text it appears best to disregard both *Trigonocaelix* and *Trigonocaelia*.

RELATIONSHIPS OF TRINACRIA

Type (by subsequent designation, Gardner, U. S. Geol. Survey Prof. Paper 142-A, p. 21, 1926), *Trigonocoelia crassa* (Deshayes). Eocene, Paris Basin.

The almost universal assignment of *Trinacria* to the Limopsidae has been based on its possession of a deep ligamental pit, the assumption being that both *Trinacria* and *Limopsis* possessed a simple ligament connection partly submerged in the shell. A critical study of the structure of the ligament in these genera revealed that they are of two distinct types, that of *Limopsis* being a modification of the chevroned type, whereas that of *Trinacria* is a highly specialized form of the vertically striated type. This knowledge, along with the discovery of the Upper Cretaceous genus *Linter* (Fig. 1*a*), makes it possible to trace almost without interruption the steps in the evolution of *Trinacria* from its ancestral form to the highly specialized Miocene species occurring in the Alum Bluff group of Florida.

Presumably *Linter* was derived from some early member of the Striarcinae. It differs from *Breviarca* principally in being considerably lighter and in being strongly opisthogyrate, with a sharp umbonal keel and a small ligament area, nearly all of which is restricted to the part of the cardinal area anterior to the beaks. The cardinal area is

also well developed posterior to the beaks but devoid of ligament except for a narrow, sub-umbonal wedge. This posterior cardinal area appears to be slightly out of the plane of the ligament area. The vertical ligament elements of *Linter* are delicate, being of about the same texture as in *Breviarca.*

Development of *Trinacria* from *Linter* consisted of the beaks becoming more opisthogyrate and nearer the hinge line so as to cut off the anterior extension of the ligament. The posterior end of the cardinal area became shorter and more out of the plane of the ligament area, merging directly with the posterior slope. With the anterior part of the area cut off and the posterior end obsolete the narrow, subumbonal, posterior wedge of ligament remaining had to become thickened and submerged to retain strength. The central teeth on the types of *Linter* are not well preserved but there appears to be a break between the anterior and posterior rows. In *Trinacria,* owing to a much shortened hinge line, the two rows often come together but are sharply divided by a difference in direction.

Two species referable to *Trinacria* have been described from the Cretaceous, *Trinacria galeata* (Müller) (3) from the Greensands of Vaals, Aachen; and *Trinacria cor* Popenoe (4) from the Upper Cretaceous of California. A line drawing of the latter made from specimens kindly loaned the writer by W. P. Popenoe is shown in Fig. 1*b*. This species shows the characters mentioned above for early forms of *Trinacria.* The beaks are completely opisthogyrate, the umbonal keel very sharp, the ligament restricted and slightly entrenched, the cardinal area narrow and indistinct posteriorly, and the hinge line short.

Evolution within the genus *Trinacria* consisted of a secondary lengthening of the shell, orthogyration of the beaks and greater removal of them from the hinge line, lessening angulation and final rounding of the umbonal ridge, deeper entrenchment of the ligament with a tendency to grow more to the anterior in later species, and a greater separation of the anterior and posterior rows of teeth.

Trinacria deltoidea (Lamarck) (Calcaire Grossier) (Fig. 1*c*, drawn from a specimen from Houdan, France) shows the secondary orthogyration of the beaks with the consequent widening of the anterodorsal growth lines. The ligament is more deeply entrenched and extends more to the anterior than in the extremely opisthogyrate Cretaceous species. This species is very similar to *T. cuneus* (Conrad), from Claiborne, Alabama.

Trinacria cancellata (Deshayes) (Calcaire Grossier), the species in

which a perfectly preserved ligament was found, is very similar to *T. deltoidea*, differing mainly in being less inflated, more elongate, and in having more pronounced radial sculpture.

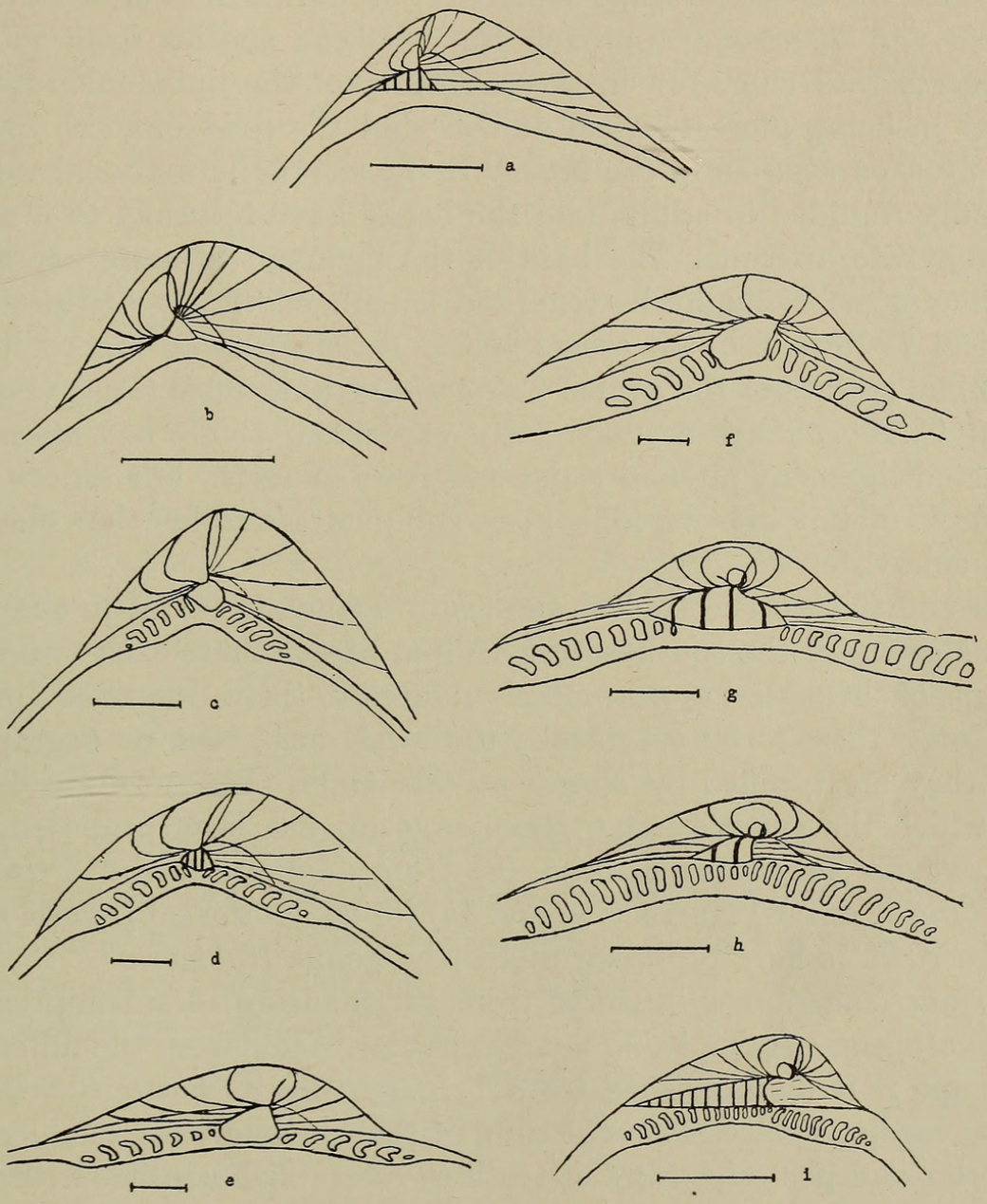

Fig. 1.—*a. Linter acutata* Stephenson. *b. Trinacria cor* Popenoe. *c. Trinacria deltoidea* (Lamarck). *d. Trinacria media* (Deshayes). *e. Trinacria meeki* Dall. *f. Trinacria pectuncularis* (Lea). *g. Halonanus* (*Trinacriella*) *cossmanni* (Dall). *h. Halonanus* (*Trinacriella*) *perplana* (Conrad). *i. Halonanus pulchra* (Gabb). The lengths indicated by the straight lines below the individual figures are over-all dimensions of the shell, natural size.

Remnants of the fibrous layer have also been observed in specimens of *T. media* (Deshayes) (Fig. 1*d*, Bartonian, Ezanville, France), a species closely related to *T. ledoides* (Meyer) from Claiborne. In these specimens the ligament material is somewhat disarranged but three ligament grooves are quite clearly indicated on one specimen.

This species is more elongate than *T. deltoidea* and the beaks are more orthogyrate. The umbonal ridge is not sharply carinate but sharply rounded and approaches that of *T. crassa* (Deshayes), the genotype, in which the umbonal ridge is definitely rounded in adults. *Trinacria media* and *T. crassa* approach the Miocene species from Florida, *T. meeki* Dall (Fig. 1*e*), in the rotundity of the umbonal ridge but differ in being more trigonal and in that the rows of teeth are not widely separated as in the latter. In *T. meeki* the umbonal ridge is broadly rounded in adults and the beaks have returned to a nearly orthogyrate attitude. The base of the ligament is more expanded. *Trinacria meeki* might be regarded as subgenerically distinct from typical *Trinacria*, but it seems just as satisfactory to regard it as a terminal species of the genus. *Trinacria pectuncularis* (Lea) (Fig. 1*f*) from Claiborne has a moderately expanded, somewhat anteriorly directed ligament pit and separated rows of teeth, but differs from *T. meeki* mainly in being higher and subquadrate rather than elongate and subovate.

In addition to the typical species of *Trinacria* found in the Claiborne group of the southeastern United States there exist two other groups of shells that appear closely related to them. It will be difficult to discuss these forms specifically until they have been monographed, but they are typified by *Noetia pulchra* Gabb (Fig. 1*i*) from Texas, for which the generic name *Halonanus* (5) has been proposed, and *Pectunculus perplanus* Conrad (6) from Claiborne; and *Trinacria perplana* (Conrad) Harris (7) (Fig. 1*h*) for which the subgeneric name *Trinacriella* is here proposed under the genus *Halonanus*.

Trinacriella ranges in shape from subquadrate to subelliptical or subovate, some forms being nearly circular. Aside from the difference in shape it is distinguished from *Trinacria* by its heavier shell and wider cardinal plate. The widening of the cardinal plate enabled the anterior and posterior rows of teeth to reestablish contact with each other and a series can be seen ranging from *T. cossmanni* Dall (Fig. 1*g*), in which the rows are well separated, to *T. perplana* (Conrad) (Fig. 1*h*) in which they run together. In addition the ligament pit exhibits a series ranging from nearly equilateral in *T. cossmanni* to more anteriorly directed as in *T. perplana* and *T. ellipsis* (Lea). The former pattern is regarded as aberrant whereas the latter bears resemblance to that of some species of *Trinacria*, especially the Claiborne species *T. pectuncularis* (Lea), through which the two genera may be connected. The ligament pattern of *T. perplana* also approaches that of typical *Halonanus*.

Halonanus differs from both *Trinacria* and *H.* (*Trinacriella*) in being definitely noetiform with a well developed cardinal area, although *H. decisa* (Conrad) (not figd.) appears to be intermediate between the typical form and *Trinacriella perplana*. *Halonanus* differs from the Noetinae in that its sculpture consists of only one set of ribs whereas the Noetinae are characterized by both primary and secondary ribs. Its ligament differs from that of *Noetia* in that in that genus there is an initial vertical element beginning directly beneath the umbo whereas in *Halonanus pulchra* there is an initial anterior diagonal groove which later develops into a vertically striated ligament. This condition has been observed nowhere else among the prionodont bivalves and is accounted for by the fact that the cardinal area of *Halonanus* is a secondary structure analogous to the primary cardinal area of *Linter*, the initial anterior diagonal ligament groove being a remnant of the anteriorly directed ligamental pit observed in *Trinacriella* and still well developed in *Halonanus decisa*. The ligament material is usually lost in specimens of *Trinacriella* and *Halonanus decisa* but a few specimens seen by the writer retain enough to show that the ligament contained vertical elements, even in the forms with more oblique pits. The secondary cardinal area of *Halonanus, sensu stricto*, is foreshadowed in the incipient cardinal area observed in some species of *Trinacriella*, particularly *T. perplana*.

CLASSIFICATION[2]

A partial classification of arcid Pelecypoda to include the subfamily Trinacriinae follows. This arrangement is based primarily on ligament structure but is correlated with dentition, orientation, sculpture, and other shell characters.

Order FILIBRANCHIA Pelseneer
Suborder PRIONODONTA MacNeil
Superfamilies CYRTODONTACEA, PARALLELODONTACEA, GLYCYMERACEA, ARCACEA
Superfamily GLYCYMERACEA MacNeil
Families GLYCYMERIDAE, CUCULLAEIDAE, NAVICULIDAE, LIMOPSIDAE, NOETIDAE

The superfamily Glycymeracea exhibits much less stability in ligament structure than the Parallelodontacea and Arcacea, and most of the aberrant types of ligaments are found here. It is interesting to note that all

[2] This classification is based on *Arca antiquata* as type of *Arca*. If the Commission should accept a recommendation before it at the present time to regard *Arca noae* as type, the following changes would become necessary: *Glycymeracea* would become *Arcacea; Arcacea* would become *Anadaracea;* and *Naviculidae* would become *Arcidae*.

opisthogyrate shells and all shells bearing a flange on the muscle scars fall in this superfamily.

Family NOETIDAE MacNeil

Subfamilies STRIARCINAE, TRINACRIINAE, NOETINAE

The family Noetidae includes all of the forms having vertical ligament elements.

Subfamily TRINACRIINAE MacNeil

This subfamily includes the three genera, *Linter* Stephenson, *Trinacria* Mayer, and *Halonanus* Stewart, and the subgenus *Trinacriella* MacNeil (under *Halonanus*).

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PALEOBOTANY.—*On the presence of the fern* Weichselia *in Colombia, South America.*[1] Edward W. Berry, Johns Hopkins University.

Some months ago I received from Phillip L. Merritt, under the label of the Ministerio de Industrias y Trabajo, Bogota, Colombia, a package of fossil plants. These were collected near Mutiscua, which is between 10 and 11 miles slightly south of west of Pamplona in the northern part of the Department of Santander, and is shown on Hettner's map of the Cordillera of Bogotá.[2]

This material is of considerable interest and comprises 6 specimens which are covered with the impressions of the rachis and fronds of the fern known as *Weichselia*, which was almost world-wide in its distribution during the Mesozoic. The matrix is a rather soft, grayish mudstone, very similar to the shales on the Island of San Lorenzo, off the port of Callao, Peru, which are also packed with *Weichselia*, the only apparent lithologic difference being that the shales from Peru are slightly lighter in color.

The Colombian matrix has not been studied petrographically, but from its somewhat soapy feel, and its general similarity to that containing the Peruvian fossils, I regard it as probably representing a carbonaceous pyritiferous mudstone in which, because of tectonic

[1] Received August 23, 1937.

[2] Hettner, Alfred. *Die Kordillere von Bogotá.* Petermann's Mitt. Ergänzung Bd. **22**, No. 104, 1891.