

CONTRIBUTIONS TO THE PALEON-
TOLOGY OF THE LEBANON
MOUNTAINS, REPUBLIC
OF LEBANON

PART 3. THE PELECYPOD FAUNA OF THE
"OLIVE LOCALITY" (APTIAN) AT ABEIH

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*PART 3. THE PELECYPOD FAUNA OF THE "OLIVE
LOCALITY" (APTIAN) AT ABEIH*

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INTRODUCTION

THE "OLIVE LOCALITY" AT ABEIH, Republic of Lebanon, has long been known as one of the most prolific fossil localities in the Lebanon Mountains. Earlier authors usually referred to this fauna as being that of the "Gastropod zone at Abeih" (Fraas, 1878; Hamlin, 1884) or of the "*Trigonia* sandstone at Abeih" (Diener, 1887; Noetling, 1886; Blanckenhorn, 1890). The term "Olive Locality" was introduced into the literature by Whitfield in 1891, although it had earlier been used, in collections, by the Reverend William Bird, a missionary from whom the bulk of the collections studied by Hamlin (1884) and Whitfield (1891) were obtained, and whose large collection, now in the museum of the American University at Beirut, is the principal basis for the present study.

Despite the fact that the fauna has long been known and has been collected by many workers who have published lists of species and have occasionally described a few forms from it, no detailed study of any part of it has been attempted in the past. The field work, which forms the principal basis for these studies of the paleontology of the Lebanon Mountains, was conducted during the summer of 1940 as a coöperative investigation participated in by the American Museum of Natural History and the American University at Beirut. The work was financed by a fellowship grant to the writer from the John Simon Guggenheim Memorial Foundation. The present study was begun during the period when the author was a member of the staff of the American Museum of Natural History, and it has been completed during available periods while he was a member of the staff of the Geological Survey, United States Department of the Interior.

I am greatly indebted to the trustees of the John Simon Guggenheim Memorial Foundation and to its Secretary-General, Dr. Henry Allen Moe, for the financial assistance which made this work possible; to the authorities of the American Museum of Natural History for permission to undertake this study; and to the Director of the Geological Survey, Dr. William E. Wrather, for permission to complete it while serving

as a member of the Survey staff. President Bayard Dodge of the American University made available all the facilities of that institution, and he and many other friends among its faculty aided in the field work and afforded the hospitality of their homes in Beirut and in the Lebanon Mountains, as well as extending many other kindnesses which greatly facilitated the work and made memorable the period when it was being carried on. During the course of the present study I have greatly profited by much helpful discussion of the problems involved with Dr. Lloyd W. Stephenson and Dr. John B. Reeside, Jr., of the staff of the Geological Survey.

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LOCATION AND STRATIGRAPHY

The term "Olive Locality" is derived from the fact that the fossils are obtained from the surfaces of the artificially terraced slopes of the south side of the small valley that bounds the northern edge of Abeih, a village near the western edge of the Lebanon Mountains, located about 15 miles southeast of Beirut. The terraces at the locality are cultivated and bear numerous olive trees, and the fossils are found in the regularly plowed soil about the roots of the trees.

The artificial terracing, involving the building of stone retaining walls and the cutting and filling of the hill slope behind them, has made it impossible to observe the exact stratigraphy of the immediate area of the Olive Locality. Furthermore, the locality occurs near the western margin of the mountains, in a region that is involved in the complex faulting marking the border of the range, and structural complications exist which make it difficult to determine the exact position of the locality within the general section at this place.

The valley immediately below the Olive Locality is eroded along a small transverse fault, and another, smaller fault is exposed in a small draw immediately to the west of the locality. The basal slope of the hill, be-

low the locality, is composed of red sandstones of Neocomian age (Vokes, 1941b, p. 1720), and a small outcrop of basalt in a mule trail immediately above the red sands indicates the presence of the thin basalts which at a number of localities are present at the Neocomian-Aptian contact. Unless structural complications have been caused by the nearby faults, the Olive Locality fauna occurs within the basal 150 feet of the Aptian strata. Although a number of the species present in the fauna range throughout the lower member of this zone (Vokes, 1941b, p. 1722), the occurrence of similar, though not so extensive, faunas at other localities (Hadath-al-Jibbah, Klelay, etc.), confirms the fact that the fauna of the Olive Locality occurs toward the base of the Aptian section.

The sedimentary rock at the locality, best observed within the shells of the pelecypods and inside the apertures of the gastropods, is a buff to brown, medium to coarse-grained, argillaceous sandstone. The material is, in general, poorly sorted, with angular quartz grains, but occasional larger grains are moderately well rounded and pitted as though by sand blasting. The argillaceous material is present as fine clay which coats the sand grains and fills the interstices between them, occasionally serving as the sole cementing agent; in general, however, the cementing material is calcareous.

THE PELECYPOD FAUNA

The present study of the pelecypod fauna from the Olive Locality is based upon the examination of almost 5000 specimens, mostly from the collections of the American University at Beirut. The great majority of these were collected by the Reverend William Bird, for many years a missionary of the American Board of Foreign Missions, stationed at Abeih. His home, still the most imposing structure in the community, is located near the northern edge of the village, only a few hundred yards from the locality itself. Although he was apparently an indefatigable and enthusiastic collector, gathering fossils from all parts of the Lebanon area, the vast bulk of his collections is from the Olive Locality and obviously was amassed over a period of several years.

A second large collection, also housed in

the museum of the American University at Beirut, was made by Professor Day during the years he served as Professor of Natural Sciences at this institution. In addition to these two collections, I also had the use of the collections in the American Museum of Natural History, which were the basis for the study made by Professor Whitfield (1891), as well as of the material that I collected while in Lebanon in 1940.

COMPOSITION OF FAUNA

From all of these collections a total of 58 species, referable to 40 genera, were recognized; of these, eight genera and 24 species are described as new, and an additional three species are recognized as being new, but the material available is too poor to permit their description at this time. In addition, one previously described species is renamed, and three genera have been described as new in shorter papers prepared during the course of the present study.

The following new genera are described in this report:

Arcullaea. Type species: *Arcullaea olea*, new species. Arcidae

Palestinarca. Type species: *Palestinarca palestina* (Whitfield). Arcidae

Protocyprina. Type species: *Protocyprina libanotica* (Fraas). Cyprinidae

Amphiaraus. Type species: *Amphiaraus seleniscus*, new species. Astartidae?

Mediraon. Type species: *Mediraon divaricata*, new species. Gouldiidae

Xenocardita. Type species: *Xenocardita lacunaris* (Hamlin). Carditidae

Agapella. Type species: *Agapella rotunda*, new species. Veneridae

Geltena Stephenson MS. Type species: *Geltena subequilatera* Stephenson MS.¹ Mactridae

Genera recognized as new during the study of this fauna, which have been described in previously published papers, include:

Corbulomima Vokes (1945b, p. 10). Type species: *Corbulomima nuciformis* Vokes. Corbulidae

Parmicorbula Vokes (1944, p. 621). Type species: *Parmicorbula neaeroides* (Blanckenhorn). Corbulidae

Protodonax Vokes (1945a, p. 295). Type species: *Protodonax elongatus* Vokes. Donacidae?

¹ For a diagnosis and illustrations of this genus and species, see page 201, plate 10, figures 1-6, of this report.

The proportionately large number of new genera recognized stems mainly from the fact that the exceptionally fine preservation of the fossils at the Olive Locality has permitted the exposure of such features as the hinge structure of nearly all of the species found. As a result, it has been possible to make finer distinctions in generic identification than are usually permitted by the more normal types of preservation encountered among fossils of this age, and to point out the differences delimiting the Cretaceous genera from the Tertiary and Recent ones to which the species are commonly rather uncritically referred.

As would be expected, certain of the 58 species present in the pelecypod fauna are represented by an abundance of individuals, while others are rare. Eleven species are represented each by but a single specimen, six others by but two each; a total of 34 of the species are represented each by 10 or fewer individuals. In contrast, each of seven species is represented by more than 100 specimens, one, *Protocardia judaica* (Hamlin), far outnumbering all the rest with a total of 1678 specimens in the collections studied. Other species represented by numerous specimens include:

Xenocardia lacunaris (Hamlin), 675 specimens
Corbulomima aligera (Hamlin), 565 specimens
Parmicorbula neaeroides (Blanckenhorn), 522 specimens
Trigonia libanotica, new species, more than 400 specimens
Caestocorbula olivae (Whitfield), 229 specimens
Ostrea alicula (Hamlin), 168 specimens

Thus, the representatives of these seven species comprise approximately 85 per cent of the specimens in the collections available for this study.

ECOLOGIC OBSERVATIONS

It is obvious that no certain statements regarding the ecologic conditions that obtained at the Olive Locality during the time when the deposits were being formed can be made on the basis of the study of a portion of the fauna alone. However, certain observations, which seem pertinent to the problem and likely to be confirmed by an examination of the more abundant gastropodous element of the fauna, may be made on the

basis of the results of the study of the pelecypod fauna.

It has been repeatedly noted that a paleontologic fauna is not strictly comparable with a zoologic one, since the former may also include elements that have been transported and incorporated into the fauna following the death of the individuals represented. (See especially Abrard, 1927.) Nevertheless, species that are as abundantly represented as those noted above must be considered as normal faunal elements at the locality during the period of the deposition of the sediments in which they are found. The modern representatives of the families there represented are, for the most part, species found in relatively shallow marine waters, primarily on sandy substrata. This is the case with the Cardiidae, represented by six species in three genera, including *Protocardia judaica*; the Corbulidae, represented by seven species among four genera, including the three noted above; the Carditidae, represented by the form noted above; and among other families present in the fauna, the Veneridae, represented by five species in three genera, and the Tellinidae, represented by three species in two genera. The fact that the vast majority of the representatives of the families mentioned above have the valves in association and are often found to be filled with crystalline calcite rather than with the sandy matrix clearly indicates their entombment in the place where they died.

There are no elements among the fauna whose modern descendants are confined to waters of less than normal salinity, or require a rocky substratum. This statement does not exclude the Ostreidae, species of which are commonly found in waters of normal salinity and are known from depths ranging from 1 to 1000 fathoms (Walther, 1893-1894). Likewise, there are no elements in the fauna whose modern descendants require extremely deep water, and the few forms that are normally found at extremely shallow depths seem most certainly to be introduced elements. The two species of *Volsella*, for example, are both represented by single, small individuals, which might well have fallen from floating algae. *Protodonax*, which seems to have been a genus of shallow-water, shoreline-dwelling forms

(Vokes, 1945a, p. 297), is represented by an immature representative with paired valves (Whitfield's holotype) and separate isolated valves of apparent adult proportions; it seems clearly to be an introduced element in the fauna.

Thus, the ecological observations that may be made on the basis of the pelecypod fauna suggest that the environment at the Olive Locality was that of relatively shallow waters, perhaps not more than 50 fathoms deep, of normal salinity, and with a sandy substratum present.

AGE OF THE FAUNA

The excellent preservation of the fossils, which has permitted the detailed study here made, has at the same time served to make more difficult their use in correlation; it is almost impossible adequately to compare these fine specimens with the internal casts described and figured by Pictet and Renevier from the Perte du Rhône (1854–1858), for example. Nevertheless, if, as believed, *Neitheia* (*Neitheops*) *syriaca* (Conrad) is conspecific with, and the prior name for, *Neitheia* (*Neitheops*) *morrissi* (Pictet and Renevier), a well-known Aptian guide fossil, a correlation is indicated. The Aptian element of the well-known fauna of Tunis described by Pervin-quière (1912) seems to represent a different ecologic facies, since it contains rudistids and other forms not present at the Olive Locality; nevertheless, it likewise contains *Neitheia* (*Neitheops*) "*morrissi*" and is likewise apparently to be correlated with the Olive Locality fauna.

The geographically closer Aptian fauna from the Jebel Moghara area of the Sinai Peninsula contains only 26 species, as reported by Douvillé (1916), 13 of which are pelecypods. Among these are *Trigonia pseudocrenulata* Noetling and *Neitheia morrissi*

(Pictet and Renevier), species which are represented in the fauna of the Olive Locality, and also *Crassatella subregularis* Douvillé, a species which is quite similar to *Pachythaerus similoides*, new species. Eight of the remaining 13 species of the Jebel Moghara fauna are cephalopods, a group that is not represented in the fauna of the Olive Locality, nor, to my knowledge, in the entire fauna of the lower zone of the Aptian in the Lebanon Mountains area. The cephalopods from Jebel Moghara include (Douvillé, 1916, p. 86):

"*Pseudobelus aptiensis* Stolley

Duvalia cf. *Grasi* Duval

Puzosia Matheroni d'Orbigny

—*Angladei* Sayn

Crioceras cf. *C. simplex* d'Orbigny

Douvilleiceras Meyendorffi (d'Orbigny) Sinzow

Nautilus Lallieri d'Orbigny

"Il faut y ajouter

"*Knemiceras priscum* n. sp."

These fossils clearly indicate the Aptian age of the containing strata and in fact point strongly to an upper Aptian age, "oberen Apt-Stufe" of Kilian (1907–1913, p. 304). The evidence for the correlation of the beds of the Olive Locality with those of the Jebel Moghara section is too limited to permit exact correlations, especially since *Trigonia pseudocrenulata* Noetling seems to range throughout the entire Aptian section in the Lebanon area, and forms such as *Terebratula sella* Sowerby and *Orbitolina conoidea-discoidea* Gras, which are associated with the ammonites at Jebel Moghara, occur in the upper zone of the Aptian as developed in Lebanon.

At present, therefore, it can be said only that the pelecypod fauna of the Olive Locality is clearly of Aptian age, but the exact horizon within the Aptian is still problematical.

SYSTEMATIC PALEONTOLOGY

NUCULIDAE

PALAEONUCULA W. QUENSTEDT, 1930

Palaeonucula W. QUENSTEDT, 1930, Geol. Palaeont. Abhandl., Jena, new ser., vol. 18, no. 1, p. 112.

GENOTYPE: By original designation, *Nucula hammeri* DeFrance. Jurassic, Europe.

The question as to the systematic ranking to be accorded this group has been discussed by Schenck (1934, pp. 35-37; 1939, pp. 24-26) and by Cox (1940, pp. 9-12). The former considers it to be a subgenus of *Nuculopsis* Girty, 1911 (genotype, *Nucula ventricosa* Hall, 1858, not Hinds, 1843; renamed *Nuculopsis girtyi* Schenck, 1940), while the latter holds it to be a subgenus of *Nucula* Lamarck, 1799. The available collections are not such as to permit any additional observations on this problem, and it has seemed best at present to accord *Palaeonucula* full generic rank.

The following species is only provisionally referred to this genus. In hinge characters it appears to be more closely related to this group than to any other described genus. Externally, however, it differs from the genotype in a number of minor details and possesses a rather well-developed concentric ornamentation.

Palaeonucula glanstriticea (Whitfield)

Plate 1, figures 1-4

Nucula glanstriticea WHITFIELD, 1891, p. 396, pl. 5, figs. 3-5; BLANCKENHORN, 1934, p. 207; not Shalem, 1937, p. 41, pl. 2, fig. 3a-c.

SYNTYPES: A.M.N.H. No. 16333/1:1; length, 5.5 mm.; height, 3.5 mm.; diameter (both valves), 3.1 mm. (Whitfield, 1891, pl. 5, fig. 3.)

A.M.N.H. No. 16333/1:2; length, 5.8 mm.; height, 3.5 mm.; diameter (both valves, slightly open), 3.9 mm. (Whitfield, 1891, pl. 5, fig. 4.)

A.M.N.H. No. 16333/1:3; length, 5.5 mm.; height, 3.7 mm.; diameter (right valve), 1.9 mm. (Whitfield, 1891, pl. 5, fig. 5.)

TOPOTYPE: A.M.N.H. No. 26029; length, 5.9 mm.; height, 3.8 mm.; diameter (left valve), 2.2 mm.

This species was originally described as follows:

"Shell almost minute, the largest one seen being scarcely 6 mm. long by 4 mm. high and thick; form subcylindrical and very ventricose; beaks small, terminal anteriorly, approximate; hinge line curved, extending almost to the posterior extremity, marked by about twelve highly elevated teeth on the posterior side and by five or six smaller ones on the anterior side of the beak; basal line arcuate, curving upward posteriorly; surface marked by fine, even concentric striae, posterior adductor muscular scar quite deep, the anterior scar obscure.

"This small shell has much the form of a grain of wheat, whence the name."

In the light of the present knowledge of the anatomy of the nuculid animal and its position within the shell, Whitfield had wrongly oriented his specimens while making the above diagnosis, and the terms "anterior" and "posterior" should be substituted, each for each, throughout the above description.

A reëxamination of the three specimens studied by Whitfield, together with three topotypes from the collections of the American University of Beirut, permits the following additions and corrections to the original diagnosis.

The umbones are moderately well inflated, closely approximate, and but slightly opisthogyrous. They are best described as subterminal, since the "escutcheon," which is large and delimited by a narrow depressed area, is strongly inflated and "pouting" in the center, causing the posterior end to be slightly produced.

The surface of the valve is ornamented by fine concentric threads, separated by interspaces of equal to somewhat greater width. The sculpture is not developed on the dorsal or on the posterior areas.

The hinge, which was poorly figured by Whitfield, had been broken transversely through the chondrophore. During the present study a somewhat imperfect hinge was exposed on a left valve. Here the anterior tooth row is essentially straight with 15 to 17 teeth. Those at the anterior end are large

and thick, and they decrease in size regularly toward the umbo where they are so small as to be seen with difficulty even under magnifications up to 15 diameters. The chondrophore is almost horizontal in position, well excavated, and though somewhat broken does not appear to have projected into the body cavity. The posterior tooth row is essentially ventral to the chondrophore. It consists of six teeth. The most dorsally situated of these appears to bound the chondrophore ventrally and is somewhat triangular in shape, whereas the others tend to be elongated in a horizontal direction. This tooth may be subject to interpretation as a "chondrophore tooth" but with some reserve since it is not distinctly separated from the other teeth in the posterior series and the trigonal shape may be ascribed to the crowding of this series against the chondrophore. The specimen whose hinge was figured by Whitfield is a right valve. There seems to be a definite socket for the reception of a tooth similar to that described above. There are four or five teeth on the posterior row and about 17 teeth on the anterior row which here is slightly arched.

The inner margin of the valve is smooth.

The small size and rotund shape of this species appear to make it unique among the described Cretaceous nuculoid species.

The specimen figured by Shalem (1937, pl. 2, fig. 3a-c) differs in all details of shape and proportion and certainly does not represent this species.

LEIONUCULA W. QUENSTEDT, 1930

Leionucula W. QUENSTEDT, 1930, Geol. Palaeont. Abhandl., Jena, new ser., vol. 18, no. 1, p. 112.

GENOTYPE: By original designation, *Nucula albensis* D'Orbigny. Cretaceous (Albian), Dienville, France.

***Leionucula olivensis*, new species**

Plate 1, figures 5-9

HOLOTYPE: A.M.N.H. No. 25989:1; length, 12.3 mm.; height, 8.6 mm.; diameter (both valves), 6.2 mm.

PARATYPES: A.M.N.H. No. 25989:2; length, 12.5 mm.; height, 9.0 mm.; diameter (both valves, slightly crushed), 6.6 mm.

A.M.N.H. No. 25989:3; length, 10.5 mm.;

height, 7.2 mm.; diameter (both valves), 5.0 mm.

A.M.N.H. No. 25989:4; length (incomplete), 10.1 mm.; height, 7.4 mm.; diameter (both valves), 4.9 mm. (Not figured.)

A.M.N.H. No. 25989:5; length, 14.1 mm.; height, 8.5 mm.; diameter (right valve), 3.2 mm.

DESCRIPTION: The shell, of medium size for the genus, is trapezoidal in outline, moderately well inflated, and possesses opisthogyrous, moderately well-incurved, sub-terminal umbones. The anterior dorsal margin is gently arched, becoming more rounded anteriorly, whence it rounds rather sharply to form the short anterior margin which merges into the broadly and regularly rounded ventral margin. The posterior margin is convex, somewhat flattened, and meets the ventral margin in an obtusely rounded angulation. The escutcheon is not prominently developed, but while of moderate width, it is quite long, extending almost to the posterior ventral angulation, being bounded laterally by a low ridge inside of which is an inconspicuous concave arca. There is a well-defined, rather prominent median pout. Anterior to the umbones is an elongate, narrow, dorsolateral area (lunule?) bounded by a shallow concave depression that extends almost to the anterior margin.

The surface of the shell is smooth except for growth rugae, of which there is generally at least one on every specimen. The inner margin of the valve is smooth.

A somewhat imperfect hinge of a left valve shows 17 to 18 teeth on an arched anterior tooth row. These are minute posteriorly where they border the dorsal side of the slightly oblique, spoon-shaped, projecting chondrophore, but become large and prominent anteriorly. The posterior tooth series was short and straight with about six transversely elongated teeth. A low, broad "chondrophore tooth" is present on the posterior ventral margin of the chondrophore.

A more adequate hinge of a right valve has 23 teeth on the arched anterior tooth row and seven on the straight posterior row. Some of the median teeth of this row show a tendency to be slightly chevron-shaped. Between the two teeth rows there is a somewhat flattened area of the hinge plate

against which the "chondrophore" tooth of the left valve seems to have rested. The chondrophore itself is ventral to the minute posterior teeth of the anterior row and, posteriorly, abuts against the flattened area mentioned immediately above. It is spoon-shaped and projected anteroventrally into the body cavity,¹ being bounded posteroventrally by a raised ridge on the margin of the structure.

The anterior and posterior adductor muscles are relatively large and rather deeply impressed; supplementary muscle scars cannot be distinguished. The pallial line is simple; the inner margin smooth.

REMARKS: This seems to be a very stable species with little observable variation. Forty-one specimens from the collections of the American University of Beirut were examined. Of these, two paratypes (A. M. N. H. Nos. 25989:2 and 25989:5) represent the approximate limits of variation in shape. This variation is primarily expressed in the amount of prolongation of the posterior extremity. The slightly more prolonged posterior area of paratype No. 25989:5 gives that specimen a shape somewhat similar to that of the holotype of *Leionucula albensis* D'Orbigny (1844, pp. 172-173, pl. 301, figs. 15-17; refigured with amended description by Schenck, 1934, p. 34, pl. 3, fig. 5, 5a, 5b). In that species, however, the posterior area is relatively longer, the shell is higher in proportion to its length, the median "pout" in the escutcheon is stronger, and the groove bounding the anterior dorsal area is more strongly developed and appears to extend farther down on the body of the shell. The hinge, described by Schenck (1934, p. 34, footnote), has more teeth in both the anterior and posterior series. In the specimens figured by Woods (1899, pl. 4, figs. 9-16) as representing D'Orbigny's species, the sharply rounded anterior extremity is more ventral in position than it is in the figure of the holotype. This is a character which also does not agree with the condition observable on the present specimens.

¹ Unfortunately the anterior portion was broken away and lost during the preparation of the specimen. It was almost 1 mm. longer than is indicated by the present condition of the specimen.

ARCIDAE

EONAVICULA ARKELL, 1929

Eonavicula ARKELL, 1929, Palaeont. Soc., London, vol. 81, p. 36.

GENOTYPE: By original designation, *Arca quadrisculcata* Sowerby. Corallian (Jurassic), England.

Arkell (1929, p. 36) proposed this name as a subgenus of *Navicula* De Blainville, 1825, monotype, *Arca noae* Linnaeus (1758, p. 693). This is the *Arca* (*sensu stricto*) of most authors who had accepted *A. noae* as the type of the genus based on Gray's designation of 1847 (p. 197). Unfortunately, as has recently been shown by Stewart (1930, pp. 83-86) and Reinhart (1935, pp. 14-17) there are at least three designations prior to that of Gray. The earliest of these (Schumacher, 1817, p. 172) indicated *A. antiquata* Linné as the type. Since the acceptance of this designation would result in great taxonomic confusion in this group, a ruling by the International Commission on Zoological Nomenclature fixing *Arca noae* as the type of *Arca* Linnaeus has been requested by Reinhart (Reinhart, 1935, p. 16). Therefore, because the status of *Navicula* is uncertain and the name itself may be held to be preoccupied by a diatom genus (see Hanna, 1932, pp. 118-120), it has been concluded that it is best at the present time to use *Eonavicula* in the full generic sense. When the problem as to the correct generic name for the arcid species typified by *Arca noae* Linné is settled it will be desirable to use *Eonavicula* as a subgeneric term under the accepted name in order to emphasize the apparent close and ancestral relationship of this group to the modern species.²

Eonavicula whitfieldi, new species

Plate 1, figures 10-14

HOLOTYPE: A.M.N.H. No. 25990:1; length, 16.4 mm.; height, 8.9 mm.; diameter (left valve), 4.3 mm.

PARATYPES: A.M.N.H. No. 25990:2; length, 17.5 mm.; height, 9.3 mm.; diameter (both valves), 7.6 mm.

² Opinion 189 of the International Commission on Zoological Nomenclature, issued after this report had gone to press, has, under suspension of the rules, fixed *Arca noae* Linnaeus as type of *Arca* Linnaeus.

A.M.N.H. No. 25990:3; length, 13.8 mm.; height, 7.0 mm.; diameter (both valves), 5.6 mm.

DESCRIPTION: The shell is relatively small, subtrapezoidal in outline, elongate, and inequilateral with umbones situated at the anterior third of the length of the valve. The latter are moderately inflated, orthogyrate, with an umbonal "swelling" extending to the anterior-ventral margin and a broad, prominent, umbonal ridge extending to the posterior ventral margin. A broad, low, median depression separates these two areas. The posterior dorsal area is sharply depressed at the umbonal ridge. It has an indistinct median carina which is delimited dorsally by a moderately sharp, narrow sulcation. The surface of the valve is ornamented by fine, rounded, radial ribs separated by interspaces of approximately twice the width of the rib. A fine, almost microscopical radial rib is present in each interspace. The straight hinge line forms the dorsal margin of the valve, and joins the short, straight to slightly convex ventral margin at an angle of approximately 80 degrees; the anterior ventral margin is rounded, the ventral margin is straight to slightly concave, rounding rather sharply to the slightly concave posterior margin. The cardinal area is relatively broad, and lozenge-shaped; the ligamental area is subcentrally located under the umbones and is approximately one-third as long as the cardinal area.

The inner margins of the valve are smooth. The posterior adductor scar is large, rectangular in outline, and without any bordering flange; the anterior scar, smaller and almost square in outline. The hinge is narrow, with numerous elongate oblique teeth inclined dorsally from a point under the umbo.

REMARKS: There are four specimens in the collection representing this species. Unfortunately, however, it was not possible to secure an entirely satisfactory hinge, and all the details of this structure cannot be determined on the basis of the present material. It appears, however, that all the teeth were inclined and that there were no vertical teeth. The specimens also offer some evidence, which cannot be confirmed, suggesting that there was a slight byssal gape.

The hinge teeth appear to be more

obliquely inclined than are those of the Upper Jurassic and Lower Cretaceous species figured by Arkell (1930).¹ They seem to be most similar to, but perhaps are even more obliquely inclined than, those of the Great Oolite (Bathonian) species *E. eudessi* (Morris and Lycett), as figured by Arkell (1930, text fig. 17, p. 345). They do not, however, parallel the dorsal margin as do those of the externally similar "*Arca*" *carinata* Sowerby, the type (by original designation) of *Nanonavis* Stewart (1930, p. 68), a subgenus of *Parallelodon*. This species has recently been well figured by Reinhart (1937, pl. 27, fig. 6a, b, c).

COMPARISONS: This species somewhat resembles "*Arca*" *carteroni* D'Orbigny (1844, p. 202, pl. 309, figs. 4-8). It differs from that species, as figured by Woods (1899, pl. 6, figs. 4a-c, 5a-c), in being smaller, and higher in proportion to the length of the valve, but with an appreciably smaller relative diameter. The details of the ornamentation differ slightly, and the hinge teeth are more oblique in our form. The specimen of "*Arca*" *sanctae-crucis* Pictet and Campiche (1866, p. 437, pl. 130, figs. 10a, b, 11a, b) shown in Woods' figure 7a-c (1899, pl. 6) is quite similar in general outline but differs from *E. whitfieldi* in details of sculpturing (fig. 7c) and in its proportionally greater diameter. The specimens figured by Pictet and Campiche suggest a considerably larger species than the present one. Insofar as can be determined "*Cucullaea*" *gosaviensis* Zittel (1865, p. 174, pl. 10, fig. 4a-c) is also closely related but has more inflated umbones and a less sharply delimited posterior umbonal ridge.

This species is named in honor of the late Prof. Robert Parr Whitfield, former curator at the American Museum of Natural History, who first discussed the fauna obtained from the Olive Locality (see Whitfield, 1891).

ARCULLAEA, NEW GENUS

GENOTYPE: *Arcullaea olea*, new species. Cretaceous (Aptian), Lebanon Mountains.

¹ *E. carteroni* (D'Orbigny), Lower Greensand; pl. 16, fig. 3, and text fig. 15, p. 345.

E. dorsetensis (Cox), Portlandian; text fig. 16, p. 345.

E. trichordis (De Loriol) Upper Oxfordian; pl. 16, fig. 4.

Two new arcid species in the collections from the Olive Locality appear to differ in the nature of the hinge and in other characteristics from described genera, and the new name *Arcullaea* is here proposed for their reception.

The type species is fully described in the following pages, and it will not be necessary to repeat the description here. However, the following characters are considered to be of importance in the definition of the genus:

1. The hinge plate, which is arched ventrally, bears a few median transverse teeth of typical arcid appearance. Anterior and posterior to these, the teeth tend to become progressively more oblique in position, and all except the final two or three teeth on each end of the structure are chevron-shaped. The above-mentioned anterior and posterior terminal teeth are almost, to quite, parallel to the dorsal margin, but being at the outer end of a curved hinge plate are ventrally removed from that margin and are never approximate to it as in the subgenera of *Parallelodon*, nor are they ever greatly elongated as in that genus.

2. The inner margins of the valve are smooth, and there was no byssal gape. The posterior ventral margin of the left valve was slightly inflected, apparently to permit the passage of a byssus, but the corresponding area on the right valve is produced to the extent that there is no gape visible.

3. The muscle scars are inconspicuous and not delimited from the rest of the interior of the valve.

4. The cardinal area is of moderate size; the ligamental area is sculptured with chevron-shaped grooves.

5. Ornamentation is not prominent over the median part of the valve of the adult shell. Immature specimens, however, show that there was a marked discrepancy in the ornamentation of the opposite valves. The left valve of the genotype possesses a well-developed radial ribbing which persists, greatly reduced, on the adult shell, while this area on the right valve is smooth throughout. In *A. limopsiformis*, new species, radial ribbing is obscurely developed on the median part of the left valve, but there is a rather strong concentric ribbing which particularly marks this part of the valve and is

absent on the corresponding area of the right valve.

In general configuration the hinge of *Arcullaea* is somewhat reminiscent of that of immature stages of *Cucullaea glabra* Parkinson as figured by Woods¹ (1899, pl. 11, figs. 10-12, see esp. fig. 12). The hinge of the adult *Cucullaea*, however, is entirely different from that of the present species (see Woods, *op. cit.*, pl. 12, fig. 1b).

Arcullaea olea, new species

Plate 1, figures 15-22

Cucullaea parallela Conrad, WHITFIELD, 1891, p. 384. Not Conrad, 1852, p. 223, pl. 17, fig. 98.
Pectunculus sp. ? WHITFIELD, 1891, p. 384.

HOLOTYPE: A.M.N.H. No. 25991:1; length 29.1 mm., height, 22.0 mm.; diameter (left valve), 9.5 mm.

PARATYPES: A.M.N.H. No. 25991:2; length 33.3 mm.; height, 26.4 mm.; diameter (both valves), 22.3 mm.

A.M.N.H. No. 25991:3; length, 20.5 mm.; height, 14.5 mm.; diameter (left valve), 5.6 mm.

A.M.N.H. No. 25991:4; length, 19.0 mm.; height, 14.2 mm.; diameter (right valve), 5.6 mm.

A.M.N.H. No. 25991:5; length, 15.0 mm.; height, 10.5 mm.; diameter (both valves), 7.4 mm.

DESCRIPTION: The shell is of medium size, subquadrate in outline, strongly convex, with umbones that are moderately inflated, incurved, orthogyrate, and situated approximately two-fifths the length of the shell from the anterior extremity. A prominent, rounded, umbonal ridge extends from the beak to the posterior ventral margin. This ridge is higher and more prominently developed on the left valve than on the right. A second umbonal ridge of lesser prominence extends to the middle of the posterior margin. The anterior margin is regularly rounded, becoming nearly straight dorsally where it meets the straight dorsal margin at an angle varying between 115 and 125 degrees. The ventral margin is broadly convex and rather sharply rounded posteriorly to the essentially convex posterior margin. This posterior margin, which meets

¹ Hence the generic name *Arcullaea* which is an arbitrary combination of portions of the names *Arca* and *Cucullaea*.

the dorsal margin at an angle of approximately 125 degrees, has a median convex area at the point of the junction of the umbonal ridge and the margin and is concave above and below this region.

The valves are discrepantly ornamented. The features of the ornamentation are best displayed on the immature specimens. In the adult shells the ribbing tends to become somewhat obsolete and the surface of the shell is almost smooth. The following description is based on the younger specimens in the collection. The right valve has five to six relatively prominent, rounded, radiating ribs extending to the anterior margin in the dorsal two-thirds of this extremity. Posterior to this and extending almost to the umbonal ridge, the surface of the shell is marked by microscopic radial and concentric ribs and appears to be smooth to the normal vision. Toward the umbonal rib the radial ribs become faintly visible to the naked eye, and a single relatively strong rib marks the dorsal edge of this ridge. The strongest radial rib on the valve marks the summit of the second umbonal ridge extending to the median posterior margin. Dorsal to this are five strong ribs, while the depressed area between the two ridges is marked by microscopic riblets only. The concentric sculpture consists of growth lines only. On the center of the valve these are inconspicuous, but over the anterior and posterior regions they tend to be pronounced and result in the development of an imbricate, scale-like ridge where they cross the radial ribbing. The essential details of the ornamentation of the left valve are similar to those on the right valve. Here, however, the radial ribbing is more strongly developed and is visible over the entire surface of the valve. Those on the median area of the valve are broad and flat-topped, while those on the anterior and posterior surfaces are round-topped. The concentric sculpture is also more strongly developed and produces a reticulate pattern over the median portion of the valve. The cardinal area is moderately wide, kite-shaped, reaching its greatest width behind the umbones; the ligamental area is slightly more than three-quarters the length of the cardinal area (on the holotype the ligamental area is 13.2 mm. long and the cardinal area is 17.2 mm. in length).

The hinge consists of 23 elongate, oblique teeth. Those on the median part of the structure are almost vertical but tend to be slightly chevron-shaped, and the degree of obliquity progressively increases toward the anterior and posterior ends where the teeth are essentially horizontal in position. The inner margin of the valve is smooth. The anterior adductor scar is moderately large and triangular in shape; the posterior adductor scar is large and trapezoidal in shape and lacks an elevated flange bordering it.

REMARKS: Fifteen specimens represent this species; the details of the hinge are visible on seven. The smallest of these is somewhat less than two-thirds the length of the holotype. All show 23 teeth. All also possess an area immediately below the umbo in which the sequence of the teeth is definitely interrupted. On the holotype this area is marked by two teeth shorter than the others and set obliquely in sharp discordance with the nearly vertical, chevron-shaped adjacent ones. On paratype A.M.N.H. No. 25991:5 there is a single long, markedly chevron-shaped tooth with a minute tooth set in the angle. An unfigured paratype has a single elongated tooth set horizontally on the line of the ventral extremity of the hinge row. No two of the seven specimens agree in the detail of the variation shown in this area.

Except for differences in shape due primarily to a relatively longer dorsal margin, *Grammatodon jurianus* Cox (1940, p. 43, pl. 2, figs. 15a, b, 16a, b, 17a, b, 18, 19, 20a, b) from the Divesian, Jurassic of Kuchh (Cutch), India, is very similar to the right valves of *A. olea* in external features and ornamentation. In gross outline and general proportions *A. olea* also resembles "*Arca*" *saffordi* Gabb (1860, p. 397, pl. 68, fig. 38), the genotype (by subsequent designation, Stewart, 1930, p. 86) of *Breviarca* Conrad, 1872, which has been held by Reinhart (1935, p. 33) to fall within the earlier genus *Striarca* Conrad, 1862 (monotype, "*Arca*" *centenaria* Say, from the Miocene of Maryland). The species referred to this genus are characterized in part by the possession of a transversely striate cardinal area, a feature that is absent in *A. olea*, which also differs in the details of the hinge and in the possession of a secondary, posterior umbonal ridge.

In general proportions, as well as in the nature of the cardinal and posterior areas, the European Aptian species "*Arca*" *fittoni* Pictet and Campiche (1864-1867, p. 455), which has been well figured by Woods (*sub Cucullaea*) (1889, pl. 10, figs. 4a-d, 5, 6, 7), is very similar to *A. olea*. It differs, however, in possessing a strongly developed concentric sculpturing and as figured by Woods (*op. cit.*, fig. 5) the posterior lateral teeth are proportionally more elongate than is typical for *A. olea*. It seems quite probable that adequate material would indicate that this species should be referred to *Arcullaea*.

The specimen upon which Whitfield based his record (1891, p. 384) of the occurrence of *Cucullaea parallela* Conrad (1852, p. 223, pl. 17, fig. 98)¹ in the fauna of the Olive Locality is preserved in the collections of the American Museum of Natural History, No. 2745/1. It is a typical specimen of the present species with both valves well preserved. The length is 19.8 mm.; height, 14.0 mm.; diameter, 10.7 mm. It is difficult to understand Whitfield's assignment of this specimen to the Conrad species, which even on the basis of the poor figure given can be seen to differ entirely in shape and general proportions. The only apparent feature in common is the presence of a secondary umbonal ridge extending to the posterior margin, and even this is much more dorsad in position in "*Cucullaea*" *parallela*, a species which was obtained from the "summit of the Mount of Olives," from strata that are now referred to the uppermost Senonian (Campanian) stage.

The basis for Whitfield's record of *Pectunculus* sp.? at the Olive Locality is a worn and broken right valve of an adult individual of this species.

***Arcullaea limopsiformis*, new species**

Plate 1, figures 23-29

HOLOTYPE: A.M.N.H. No. 25992:1; length, 16.0 mm.; height, 15.6 mm.; diameter (right valve), 4.8 mm.

PARATYPES: A.M.N.H. No. 25992:2; length, 14.0 mm.; height, 13.4 mm.; diameter (both valves), 9.2 mm.

A.M.N.H. No. 25992:3; length, 10.6 mm.;

¹ This species has recently been referred by Cox (1940, p. 47) to *Grammatodon* (*Indogrammatodon*).

height, 10.4 mm.; diameter (both valves), 6.8 mm.

DESCRIPTION: The shell is relatively small in size with an almost round, "glycymeroid" outline except for being slightly produced at the posterior ventral margin. The valves are moderately convex, the left being somewhat more inflated than the right. The umbones, also moderately inflated, are slightly prosogyrate and situated two-fifths the length of the valve from the anterior end, a position which is just in advance of the middle of the length of the cardinal area. There is a low, inconspicuous, rounded umbonal ridge extending to the posterior ventral margin, and a second, even less well-developed, ridge extending to the middle of the posterior margin. Both of these ridges are more strongly developed on the left valve than on the right where they are observed with difficulty.

The surfaces of the valves are discrepantly ornamented, the ornamentation of the left valve consisting of fine radial and concentric ribbing, in which the concentric ribs are low and rounded, about twice the width of the linear interspaces. There are three to four per millimeter on the middle of the valve where this ribbing is almost equally as well developed as it is near the margins. The radial ribbing on the other hand is most strongly developed toward the anterior and posterior margins. Here it consists of narrow threads separated by interspaces of varying width, ranging up to about three times the width of the rib. This radial ribbing tends to be less strongly developed on the posterior margin than it is toward the anterior end of the valve where it is present on the first third of the surface and forms an almost microscopically reticulate pattern on the concentric ornamentation. On the right valve the concentric ribbing is very inconspicuously developed and is not visible without magnification. The radial ribbing is about as equally well developed as on the left valve, with the result that the middle of the valve appears to be smooth.

The cardinal area is narrow in comparison with its length. On the holotype it is 8 mm. long and less than 1 mm. in width. The ligament was amphidetic and situated almost wholly between and posterior to the umbones. The ligamental area is marked by chevron-

shaped grooves. The hinge is typical for the genus, consisting of 16 teeth in the holotype, the central ones being transverse to the hinge plate, the anterior and posterior lateral teeth chevron-shaped and progressively more oblique in position, and the ultimate teeth at each end of the plate straight and parallel to the dorsal margin.

The inner margins are smooth and the muscle scars are inconspicuous, not being delimited in any way from the rest of the interior of the valve.

REMARKS: Six specimens represent this species. The shell externally has a strong resemblance to that of some forms of *Limopsis* and *Glycymeris*, but differs entirely from those genera in the nature of the hinge and cardinal areas. It differs greatly from *Arcullaea olea*, new species, in shape and in the details of the ornamentation, and I am aware of no species with which it might be confused.

PALESTINARCA, NEW GENUS

GENOTYPE: *Trigonarca palestina* Whit-

field. Cretaceous (Aptian), Lebanon Mountains.

Trigonarca maconensis (Conrad), (1860, p. 281, pl. 47, fig. 20), the monotype species of *Trigonarca* Conrad, 1862, has been well figured by Stephenson (1923, pl. 14, fig. 10, pl. 15, figs. 1-3, pl. 16, figs. 1, 2). It is a large, relatively heavy shell ornamented with concentric growth lines only. The umbones protrude prominently above the hinge line and are incurved and approximate. The cardinal area is moderately wide but is, in consequence of the approximate position of the umbones, almost vertical in position. It is marked by three or four chevron-shaped ligamental grooves. The hinge plate is broad and heavy, narrow medially but wider and sharply arched down toward the extremities. The teeth are transverse in the center of the hinge and become oblique near the extremities. The posterior adductor scar is bounded below by a prominent heavy buttress which passes in a regular curve upward toward the apex, and a low, narrow carina marks the inner margin of the anterior scar.

PLATE 1

1-4. *Palaeonucula glanstriticea* (Whitfield)

1. Exterior of left valve, $\times 5$; syntype, A.M.N.H. No. 16333/1:1; figured by Whitfield (1891, pl. 5, fig. 3). 2. Posterior view of conjoined valves, $\times 5$; same specimen as figure 1. 3. Hinge of left valve, $\times 5$; topotype, A.M.N.H. No. 26029. 4. Exterior of right valve, $\times 5$; syntype, A.M.N.H. No. 16333/1:2; figured by Whitfield, (1891, pl. 5, fig. 4).

5-9. *Leionucula olivensis*, new species

5. Exterior of right valve, $\times 1.5$; paratype, A.M.N.H. No. 25989:2. 6. Exterior of left valve, $\times 1.5$; paratype, A.M.N.H. No. 25989:3. 7. Hinge of right valve of an unusually elongate example, $\times 3$; paratype, A.M.N.H. No. 25989:5. 8. Dorsal view of conjoined valves, $\times 1.5$; holotype, A.M.N.H. No. 25989:1. 9. View of right valve of holotype, $\times 1.5$; same specimen as figure 8.

10-14. *Eonavicula whitfieldi*, new species

10. Exterior of right valve, $\times 3$; paratype, A.M.N.H. No. 25990:3. 11. Hinge of left valve, $\times 2$; holotype, A.M.N.H. No. 25990:1. 12. Exterior of left valve, $\times 2$; paratype, A.M.N.H. No. 25990:2. 13. Dorsal view of conjoined valves, $\times 2$; same specimen as figure 12. 14. Exterior of left valve, $\times 1.5$; holotype, same specimen as figure 11.

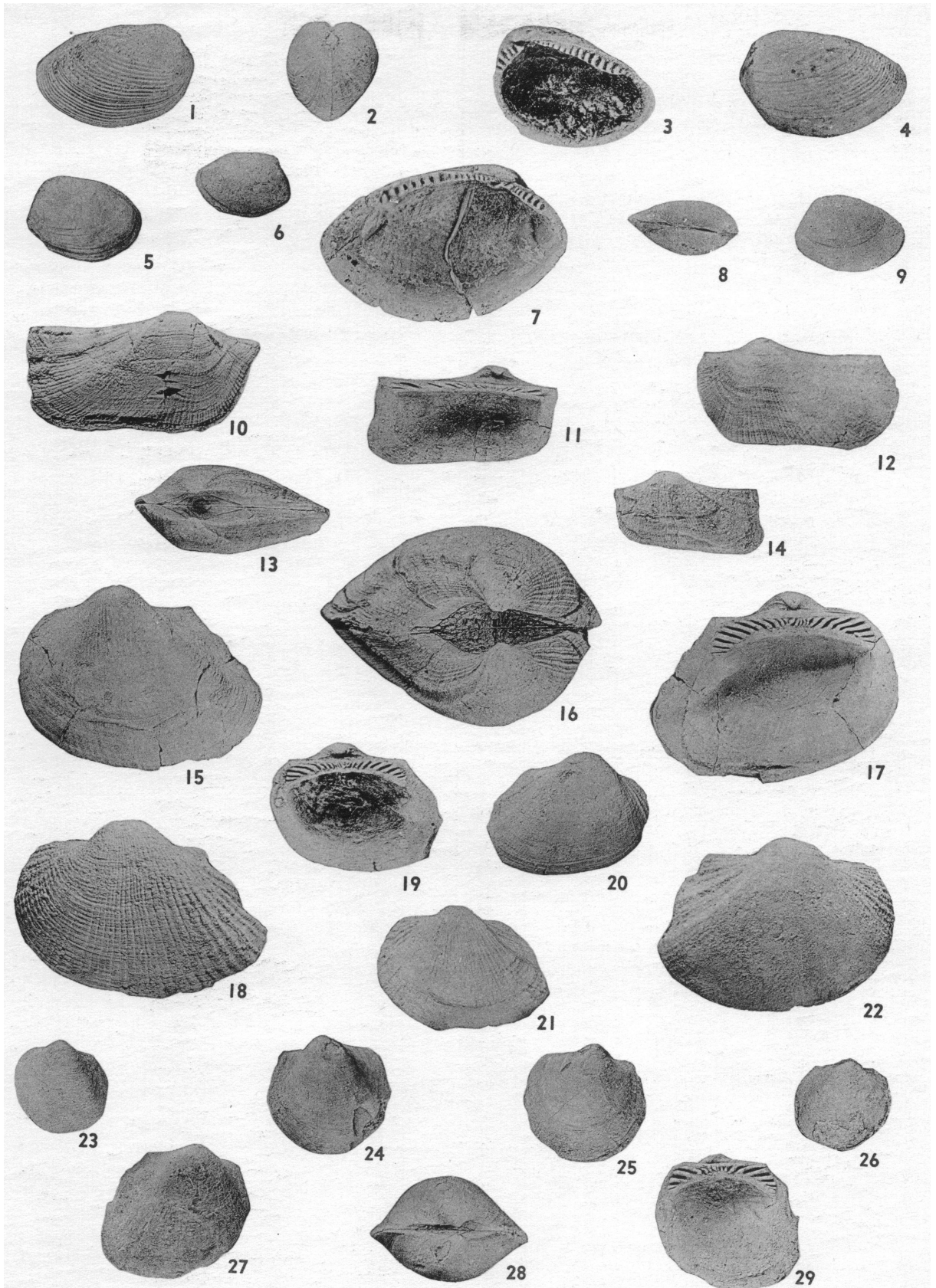
15-22. *Arcullaea olea*, new genus, new species

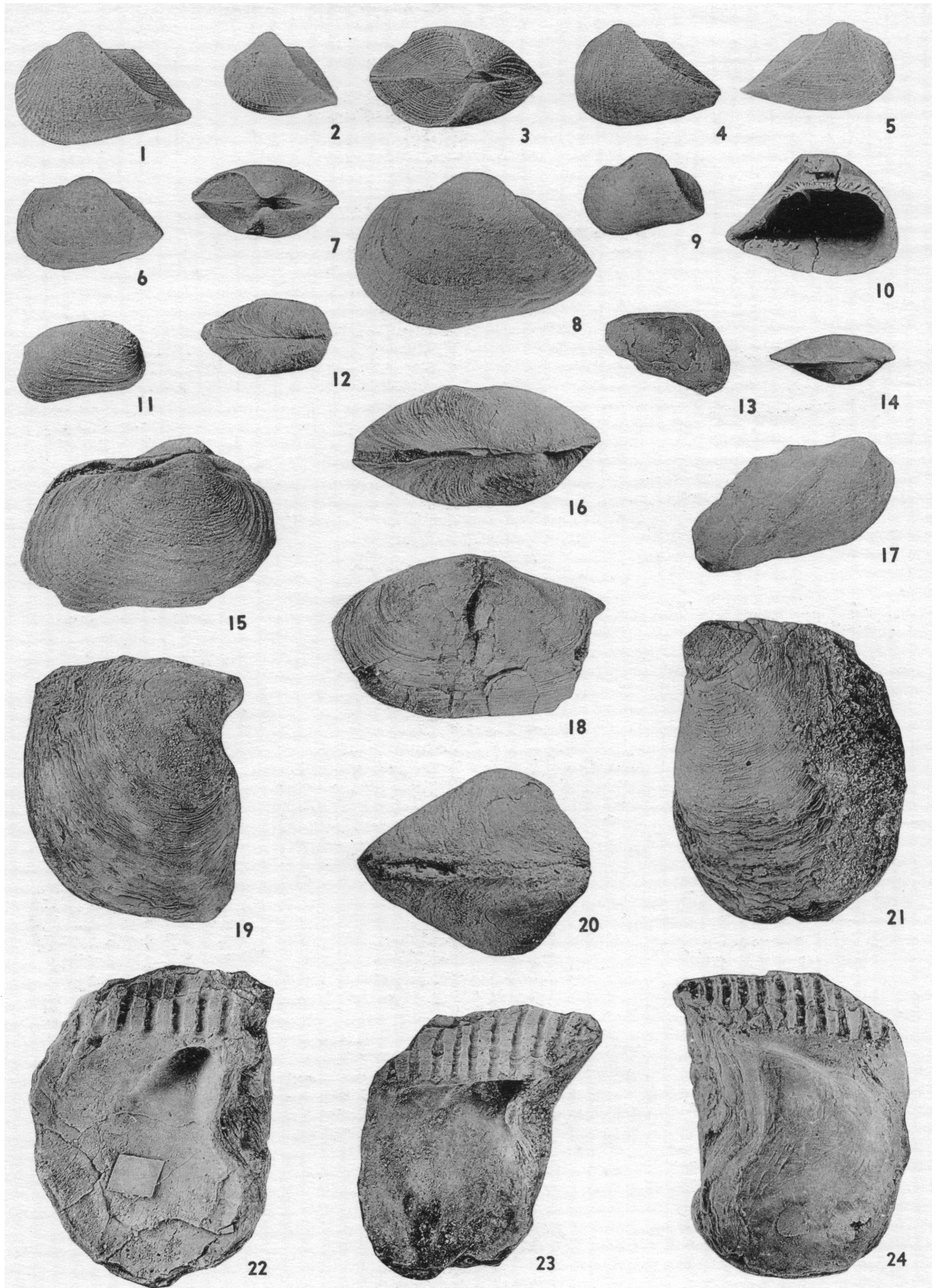
15. Exterior of left valve, $\times 1.4$; holotype, A.M.N.H. No. 25991:1. 16. Dorsal view of conjoined valves, $\times 1.5$; paratype, A.M.N.H. No. 25991:2. 17. Hinge of left valve, $\times 1.4$; holotype, same specimen as figure 15. 18. Exterior of left valve of immature individual, $\times 3$; paratype, A.M.N.H. No. 25991:5. 19, 20. Hinge and exterior of right valve, $\times 1.5$; paratype, A.M.N.H. No. 25991:4. 21. Exterior of left valve, $\times 1.5$; paratype, A.M.N.H. No. 25991:3. 22. Exterior of right valve of immature individual, $\times 3$; same specimen as figure 18; note the discrepant ornamentation of the two valves.

23-29. *Arcullaea limopsiformis*, new species

23. Exterior of left valve, $\times 1.5$; paratype, A.M.N.H. No. 25992:3. 24. Exterior of right valve, $\times 1.5$; paratype, A.M.N.H. No. 25992:2. 25. Exterior of left valve, $\times 1.5$; same specimen as figure 24. 26. Exterior of right valve, $\times 1.5$; same specimen as figure 23. 27. Exterior of right valve, $\times 1.5$; holotype, A.M.N.H. No. 25992:1. 28. Dorsal view of conjoined valves, $\times 1.5$; same specimen as figures 24 and 25. 29. Hinge of right valve, $\times 1.5$; holotype, same specimen as figure 27.

Unless otherwise indicated, all specimens figured in this report are from the Olive Locality. Magnifications in illustrations are approximately as indicated.





"*Trigonarca*" *palestina* Whitfield is a small species with a sharply carinate umbonal ridge and a well-developed radial as well as concentric ornamentation. The umbones are prominent but distant. The cardinal area is horizontal in position, relatively short, widest just posterior to the umbones and marked by microscopic transverse striations. The hinge line is almost straight and is not sharply arched downward at the extremities. There are no structures that serve to delimit the adductor scars from the rest of the interior of the valve.

Thus, in almost every important character this species differs from the genotype of *Trigonarca*, and there seems to be no described generic group to which it can be referred. In addition to *Palestinarca palestina*, I also assign a new species, also found at the Olive Locality, here described as *P. lebanonensis*, new species, to this genus. On

the basis of the illustrations, I believe that "*Trigonarca*" *cuneiformis* Conrad (1869b, p. 98, pl. 9, fig. 1; see also Whitfield, 1885, p. 88, pl. 12, figs. 17-18) is also to be referred to this genus, but I find no statement as to the nature of the ligamental area, and this assignment is therefore a tentative one.

The most noteworthy features of these species are their small size, the sharp, almost carinate angulation at the posterior umbonal ridge, the relatively narrow, straight hinge line, and, in the two Lebanon species at least, the microscopically transversely striated cardinal area.

Palestinarca palestina (Whitfield)

Plate 2, figures 1-5; text figure 1

Trigonarca palestina WHITFIELD, 1891, pp. 384, 395, pl. 5, figs. 1, 2.

Arca (Trigonoarca) palestina Whitf., BLANCKENHORN, 1934, p. 211.

PLATE 2

1-5. *Palestinarca palestina* (Whitfield)

1. Exterior of left valve, $\times 3$; topotype, A.M.N.H. No. 25993:1. 2. Exterior of left valve of specimen with almost centrally located, unusually high umbones, $\times 3$; topotype, A.M.N.H. No. 25993:3. 3. Dorsal view of conjoined valves, $\times 3$; same specimen as figure 1. 4. Exterior of left valve of Whitfield's holotype, $\times 3$; A.M.N.H. No. 16327/1. 5. Exterior of right valve of an elongate specimen, $\times 3$; topotype A.M.N.H. No. 25993:2.

6-10. *Palestinarca lebanonensis*, new species

6. Exterior of left valve, $\times 3$; holotype, A.M.N.H. No. 25994:1. 7. Dorsal view of conjoined valves, $\times 3$; same specimen as figure 6. 8. Exterior of left valve, $\times 5$; same specimen as figures 6 and 7. 9. Exterior of left valve, $\times 3$; paratype, A.M.N.H. No. 25994:2. 10. Hinge of left valve, $\times 5$; paratype A.M.N.H. No. 25994:4.

11, 12. *Botula similoides*, new species

11. Exterior of right valve, $\times 3$; holotype, A.M.N.H. No. 25999. 12. Dorsal view of conjoined valves, $\times 3$; same specimen as figure 11.

13, 14. *Volsella dieneri* (Joh. Böhm)

13. Exterior of left valve, $\times 2$; hypotype, A.M.N.H. 25997. 14. Dorsal view of conjoined valves, $\times 2$; same specimen as figure 13.

15, 16. *Pleuromya* (?) *serotina*, new species

15. Exterior of right valve, $\times 1.5$; holotype, A.M.N.H. No. 26034. 16. Dorsal view of conjoined valves, slightly crushed, $\times 1.5$; same specimen as figure 15.

17. *Volsella* cf. *V. fittoni* (D'Orbigny)

Exterior of right valve, $\times 1.5$; figured specimen, A.M.N.H. No. 25998.

18. *Laternula* (?) , species

Exterior of left valve, $\times 1$; figured specimen, A.M.N.H. No. 26023.

19-24. *Isognomon orientalis* (Hamlin)

19. Exterior of right valve, $\times 1$; topotype ?, A.M.N.H. No. 25995:1. 20. Dorsal view of conjoined valves, $\times 1$; same specimen as figure 19. 21. Exterior of left valve of a specimen showing the "cirrate" ornamentation of Blanckenhorn's "*Perna*" *cirrata* on the posterior portion, and the somewhat lamellose concentric lines of growth of Whitfield's "*Perna*" *palestina* on the median and ventral areas, $\times 1$; topotype ?, A.M.N.H. No. 25995:2. 22. Interior of left valve showing hinge with grooves and interspaces of approximately equal width, $\times 1$; topotype ?, A.M.N.H. No. 25995:4. 23. Interior of left valve showing hinge with grooves narrower than interspaces, $\times 1$; topotype ?, A.M.N.H. No. 25955/1. 24. Interior of right valve showing hinge with grooves wider than interspaces, $\times 1$; topotype ?, A.M.N.H. No. 25995:3.

HOLOTYPE: A.M.N.H. No. 16327/1; length, 8.7 mm.; height, 5.7 mm.; diameter (both valves), 5.2 mm.

TOPOYPES: A.M.N.H. No. 25993:1; length, 10.0 mm.; height, 6.4 mm.; diameter (both valves), 5.8 mm.

A.M.N.H. No. 25993:2; length, 8.5 mm.; height, 4.7 mm.; diameter (both valves), 4.3 mm.

A.M.N.H. No. 25993:3; length, 6.3 mm.; height, 4.5 mm.; diameter (both valves), 4.0 mm.

A.M.N.H. No. 25993:4; length, 6.0 mm.; height, 3.6 mm.; diameter (right valve), 1.7 mm.

Whitfield described this species as follows: "Shell in the adult stage measuring 9 mm. in total length by 6 mm. high at the beaks, and having a thickness through the valves, at the fullest part of the umbonal ridge, of 5 mm. Form subtrapezoidal, the beaks being large, prominent and situated more than one-third the entire length from the anterior end; hinge-line very short; posterior end prolonged, acutely pointed at the basal angle; basal line straight for more than two-thirds of the shell's length, from whence it rounds into the anterior end, which is somewhat sharply rounded; posterior cardinal slope nearly vertical, concave between the posterior margin of the shell and the acutely carinate umbonal ridge. Disc of the shell marked by rounded, radiating ridges, with interspaces on the anterior part of equal width; toward the posterior part the radii are more closely arranged; cardinal slope marked by curved radii, and the whole crossed by finer concentric ridges, which give a finely crenulated structure to the whole surface.

"This shell is of the form and size of *T. cuneiformis* Conrad but is less ventricose, not so cuneiform posteriorly, and has a shorter hinge line."

REMARKS: In addition to the two specimens in the Whitfield collection, 15 topotypes were available for this study. Not only do they reveal inaccuracies in the original description and illustrations, but also a range of variation in shape and relative strength of ornamentation which Whitfield could not have seen in the specimens available to him.

The umbo of the holotype, as well as of

the other specimens now studied, is more inflated and rises higher above the hinge line than is indicated in the original figure (Whitfield, 1891, pl. 5, fig. 1). Furthermore, the radial ribbing is not nearly so prominent over the median surface of the valve as it is represented, and the specimens show that the concentric ornamentation tends to be equally as well developed as the radial over this area.

The holotype is worn and partly broken anteriorly, and the statement in the original description that the "Interspaces on the anterior part" are "of equal width" to the radial ribs is based on the condition observable at approximately the anterior quarter of the length. The well-preserved topotype specimens show that on the anterior slope the interspaces are two to three times the width of the ribs. On the majority of the specimens, two or three fine inter-ribs appear in these interspaces. All the ribs tend to become reduced in strength posteriorly. This tendency first develops on the primary ribs, and on the holotype these primaries and secondaries are of equal strength at the anterior quarter. The concentric ornamentation consists of fine, rounded, raised ribs which are of equal strength over the entire surface of the valve except for the area behind the umbonal carina where they are entirely absent. Over the median area of the valve and posteriorly as far as the umbonal carina the two types of ribbing tend to be of equal strength, and under the microscope a fine reticulate ornamentation can be seen. To the unaided eye this area generally appears to be almost devoid of ornamentation.

There is a considerable degree of variation observable in the shape of the shell. These are mainly differences in the ratio of height and thickness to the total length of the valve. Topotypes A.M.N.H. Nos. 25993:2 and 25993:3 (pl. 2, figs. 2, 5) illustrate these variations.

The hinge and interior of the valve were observed in topotype A.M.N.H. No. 25993:4 only (text fig. 1). The hinge plate is relatively long and but slightly arched below. There are seven small transverse teeth in the median part of the structure. Posteriorly there are four oblique teeth, the last of which is almost horizontally inclined; anterior to the

transverse teeth there are also five oblique teeth, but the last of these is inclined at an angle which is not more than 30 degrees from the vertical.¹ The inner margin of the valve is smooth, and the muscle scars cannot be certainly observed, not being delimited in any way from the rest of the interior of the valve.

The cardinal area is short, less than one-half the length of the valve. Approximately two-thirds the length of the area is posterior to the umbo, and the greatest width is also just behind the umbones. Topotype A.M.N.H. No. 25993:1, which has a total

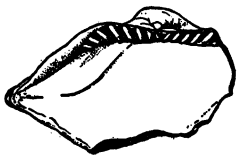


FIG. 1. Hinge of *Palestinarca palestina* Whitfield. Ca. $\times 6$. Paratype, A.M.N.H. No. 25993:4.

shell length of 10.0 mm., has an area 4.8 mm. long and 1.9 mm. wide. The length of that portion, posterior to the umbones, is 3.0 mm. On this specimen there is some evidence suggesting that the ligament may have occupied only the anterior part of the area and was about 2.2 mm. in length.

The ligament appears to have been amphidetic, with the area of attachment minutely striated at right angles to the hinge line.

Palestinarca lebanonensis, new species

Plate 2, figures 6-10

HOLOTYPE: A.M.N.H. No. 25994:1; length, 8.5 mm.; height, 5.2 mm.; diameter (both valves), 4.2 mm.

PARATYPES: A.M.N.H. No. 25994:2; length, 6.9 mm.; height, 4.6 mm.; diameter (both valves), 4.5 mm.

A.M.N.H. No. 25994:3; length, 5.3 mm.; height, 3.3 mm.; diameter (both valves), 3.5 mm.

A.M.N.H. No. 25994:4; length, 6.0 mm.; height, 4.2 mm.; diameter (left valve), 2.3 mm.

DESCRIPTION: The shell is small, subtrape-

zoidal in outline, and tending to be strongly inflated. The opisthogyrate umbones, which are relatively low and inflated, are situated but slightly anterior to the mid-line of the valve. There is a pronounced, sharp, carinate, umbonal ridge extending from the posterior edge of the umbo to the posterior ventral margin. The cardinal margin of the valve is straight, angulate anteriorly to the broad, regularly rounded anterior margin. This passes gradually into the slightly convex, almost straight ventral margin, which in turn tends to be sharply angulate posteriorly. The posterior margin is broadly convex and angulate dorsally. The surface of the valve is strongly concave posterior to the carina. This area is ornamented with fine, sub-microscopic radial riblets. The rest of the surface of the valve appears to be smooth, but under a magnification of 15 diameters a faint ornamentation of closely approximate radial threads was noted.

The cardinal area is moderately long, being more than one-half the length of the valve (being 4.7 mm. long on the holotype which has a total length of 8.5 mm.). Slightly more than one-half the length of the area is anterior to the umbones, with the greatest width of the area immediately below the latter. As in *P. palestina* the ligament occupied the anterior portion of the cardinal area, and the area of attachment is minutely striated at a right angle to the hinge line.

The hinge plate is relatively long and but slightly arched below (paratype A.M.N.H. No. 25994:4). It has approximately 11 small median transverse teeth which tend to become somewhat oblique anteriorly and posteriorly where there are five (?) and six oblique teeth, respectively, the outer teeth being inclined to an almost horizontal position.

The inner margin of the valve is smooth, and the muscle scars are not delimited from the rest of the interior.

REMARKS: The above description is based primarily upon the conditions observable in the holotype. The 19 specimens in the collection exhibit a considerable degree of variation in the general proportions of the valves. Paratype A.M.N.H. No. 25994:2 is representative of the most common type of variant in the collection. Here the valves tend to be

¹ This area of the minute specimen was broken by the artist while preparing it for illustration.

somewhat less elongate and more inflated than in the typical form, a condition that often results in the development of a sharper umbonal carina with a more strongly concave posterior slope.

Palestinarca lebanonensis, new species, can be distinguished from *P. palestina* (Whitfield) by its apparently smooth shell, since all the radial ornamentation is of microscopic fineness. No concentric ribbing was observed. The subcentral umbones give the valves a more equilateral appearance, and the cardinal area is relatively longer in the new species and is situated mainly anterior to the umbones, while it is mostly posterior in position in the genotype.

MYTILIDAE

VOLSELLA SCOPOLI, 1777

Volsella SCOPOLI, 1777, *Introductio ad historiam naturalem*, p. 397.

GENOTYPE: By subsequent designation, Gray, 1847, *Mytilus modiolus* Linnaeus. Recent, circumboreal.

Volsella dieneri (Joh. Böhm)

Plate 2, figures 13, 14

Modiola dieneri JOH. BÖHM, 1900, p. 218, pl. 7, fig. 12a, b; BLANCKENHORN, 1934, p. 206.

HYPOTYPE: A.M.N.H. No. 25997; length, 10.8 mm.; height, 7.5 mm.; diameter (both valves), 4.3 mm.

This species is represented at the Olive Locality by a single immature specimen. In the original description the specimen upon which this species is based is said to have come from Abeih, while in the description of plate 7 it is reported as from Benàh. The latter locality is most probably the correct one, as this species is not rare in the collections from that locality in the American University of Beirut.¹

¹ The village of Benàh is on the east side of the long north-south ridge upon which Abeih, as well as Aleih, Shimlan, Ainab, and Kefr Meta, etc., is to be found. It is almost directly across the ridge from Abeih, on the Ainab-Kefr Meta road. The village itself is situated on strata of upper Aptian age (see Vokes, 1941b) just above the Muraille de Blanche (gray crags). At the south edge of the village is an up-faulted block which brings the sands of the lower Aptian up to road level. In the road cuts through these sands, at a point approximately one-quarter of a mile south of the village, I collected (1940) a rather large fauna containing (in addition to *Volsella dieneri*) *Protocardium judaicum* (Hamlin) and *Trigonia libanotica*, new species.

This species is most abundantly represented in the Beirut collections from Maràh.² Here the beds, which contain a number of species of present fauna, are but a short distance below the massive limestones of the "Muraille de Blanche" and are stratigraphically somewhat higher than those of the Olive Locality. The most diagnostic species of this fauna seems to be *Trigonia distans* Conrad, a species also collected in association with *Nerinea schickii* Fraas near Aitet in beds that overlie strata containing a fauna marked by *Trigonia libanotica*, new species, a common form at the Olive Locality.

It therefore seems probable that this species is to be considered as being essentially a form whose maximum development, in point of numbers at least, occurred subsequent to the time of deposition represented by the strata at the Olive Locality.

Volsella cf. *V. fittoni* (D'Orbigny)

Plate 2, figure 17

FIGURED SPECIMEN: A.M.N.H. No. 25998; length³ (incomplete), 21.5 mm.; height, 15.2 mm.; diameter (both valves, somewhat crushed), 11.7 mm.

A single, somewhat crushed, and incomplete specimen belongs to the group of species which possess a few fine radial ribs immediately anterior to the prominent posteroventral umbonal ridge. It is very similar to the specimen figured by D'Orbigny (1845, pl. 337, figs. 1, 2) as *Mytilus reversa* Sowerby (1836, pp. 241, 342, pl. 17, fig. 13; see Woods, 1900, p. 94, pl. 15, figs. 15, 16, 17a, b, 18a, b, c, pl. 16, figs. 1, 2a, b, 3), but which he later (1850, p. 81) renamed *Mytilus fittoni*. It differs, however, from the specimen figured as this species by Pictet and Renevier (1854-1858, p. 115, pl. 16, fig. 1a, b, c) in its more

² Maràh is the name assigned to a small village, long abandoned, which lies near the southern (or southwestern?) extremity of the same ridge mentioned above. Here the strata have been badly disturbed by faulting and the beds dip steeply. The village was built upon the "Cardium bank" (Albian) (see Vokes, 1941b, p. 1724). The locality from which the principal Beirut collections were obtained seems to be that about one-quarter to one-half a mile north of the village in the crest of a small saddle, almost directly above the village of Klelay which lies near the Damour River. The locality is about 2 miles south of Kefr Meta.

³ Length and height measurements are, respectively, parallel and perpendicular to the straight posterior dorsal margin.

sharply rounded posterior ventral margin, its longer and straight posterior margin, its straighter posterior dorsal margin, and its generally broader posterior area of the valve. The umbones seem also to be slightly more anterior.

Typical *V. reversa* shows a strong tendency toward a posterior and ventral extension of the valve with a marked concave sinuosity in the ventral margin. This feature is well shown in the specimens figured by Woods (*op. cit.*) on his plate 16, and seems to be combined with a broader posteroventral umbonal ridge than that present on *V. fittoni*. There is, however, a wide range of variation in all species of this genus, and the specimen of *reversa* shown by Woods on plate 15, figure 18a and b, is very similar to our specimen except for the fact that the umbones seem to be relatively lower and broader than those of the Lebanon specimen.

BOTULA MÖRCH, 1853

Botula MÖRCH, 1853, *Catalogus conchyliorum* . . . Yoldi, fasc. 2, p. 55.

GENOTYPE: By subsequent designation, Dall, 1898, *Botula fusca* (Gmelin). Recent, Indian Ocean.

The writer is indebted to Dr. Lloyd W. Stephenson for calling to his attention the fact that a large number, probably the majority, of the Cretaceous species that have been in the past referred to the genus *Lithophaga* "Bolten" Roeding, 1798 (genotype, by monotypy, *Lithophaga mytuloides* "Bolten" = *Mytilus lithophagus* Gmelin), are to be referred, more correctly, to the genus *Botula*. Typical *Lithophaga* lacks a median swelling of the valve, and the margins taper very gradually to a wedge-shaped posterior end.

Botula similoides, new species

Plate 2, figures 11, 12

HOLOTYPE: A.M.N.H. No. 25999; length, 7.4 mm.; height, 4.0 mm.; diameter (both valves), 4.1 mm.

DESCRIPTION: The shell is relatively small, rectangular in outline and strongly inflated; the umbones are nearly terminal, full but flattened on their summits, and are prosogyrate. The posterior dorsal margin is gently convex, the posterior broadly rounded dorsally and ventrally, almost straight posteriorly; the ventral margin is gently concave,

and the anterior is rounded. The surface of the valve is marked by a few rugose concentric lines of growth, although a microscopic radial striation, so fine as to be observable only under high magnification, can be seen on some parts of the valve. A broad median umbonal depression extends across the valve to form the concavity in the ventral margin and posteriorly to result in the appearance of an umbonal ridge extending to the posterior ventral margin. Viewed from above, the posterior end of the valve shows a slight twist to the left.

Hinge and interior not seen.

REMARKS: In general aspect this species is a typical example of the genus *Botula*, but it differs in some details, particularly in the slight twisting to the left of the posterior end of the valves, and in the fact that the greatest inflation occurs posterior to the umbones. These make some other generic reference quite probable. The species can be distinguished by the fact that the height and diameter of the paired valves are so nearly equal that, viewed from the anterior end, the shell is almost square in outline. The radiating sculpture is also distinctive, but it is so microscopically fine as to be easily eroded and is difficult to observe.

PLEUROMYIDAE

PLEUROMYA AGASSIZ, 1843

Pleuromya AGASSIZ, 1843, *Études critiques sur les mollusques fossiles (contenant . . . les myes . . .)*, p. 231.

GENOTYPE: By subsequent designation, Herrmannsen, 1847, *Mya gibbosa* J. de C. Sowerby (= "*Donacites*" *aldunini* Brongniart). Upper Jurassic, England.

Pleuromya (?) *serotina*, new species

Plate 2, figures 15, 16

HOLOTYPE: A.M.N.H. No. 26034; length, 28.0 mm.; height (incomplete), 17.4 mm.; diameter (somewhat crushed), 13.4 mm.

DESCRIPTION: The shell is relatively small for the genus, moderately inflated, with the greatest convexity apparently slightly in advance of the mid-length of the valves. The umbones are situated at the anterior third of the length and are moderately inflated, projecting, and relatively prominent. The anterior end is broadly rounded, the ventral margin convex and rather sharply

rounded posteriorly to the slightly convex, subtruncate posterior end. The posterior portion of the valve is but slightly tapering, and the margins did not gape. A low, broad, and rounded posterior umbonal ridge extended to the posterior ventral margin,¹ and a shallow concavity of the shell paralleled the ridge, extending to the middle of the posterior end. The surface of the valve is ornamented by coarse, irregular, concentric ridges which are essentially rough growth lamellae.

REMARKS: The absence of any posterior gape does not seem to be a result of the crushing which the holotype, and only specimen, has undergone. Therefore, this species is referred to the genus *Pleuromya* which, although known from the Triassic to the Lower Cretaceous, is primarily a Jurassic genus. In general, the umbones are somewhat narrower, anteroposteriorly, and the posterior end is less tapering than is the typical condition in the genus, and I know of no other species of the genus possessing a posterior umbonal ridge. The reference to the genus *Pleuromya* is considered to be somewhat uncertain.

The hinge is not known, except that the crushing of the specimen has revealed the posterior dorsal edge of the right valve to show a moderately elongate, tooth-like, nymph plate.

LATERNULIDAE

LATERNULA "BOLTEN" ROEDING, 1798²

Laternula "BOLTEN" ROEDING, 1798, Museum Boltenianum, p. 155.

GENOTYPE: By subsequent designation, Gray, 1847, *Solen anatinus* Linné. Recent.

Laternula (?), species

Plate 2, figure 18

FIGURED SPECIMEN: A.M.N.H. No. 26023;

¹ The shell has been somewhat crushed in such a manner as to accentuate the strength of the posterior ridge, which, judging from the relatively less distorted umbonal region of the valves, was not so prominent a feature of the valve shape as is suggested in the illustrations.

² It should be noted that the majority of the generic names proposed in the Museum Boltenianum are unavailable under strict interpretation of the International Rules of Zoological Nomenclature. (See Vokes, 1945b, p. 7.) This matter is now being presented to the International Commission for consideration; pending their

length (incomplete); 45 mm.; height, 28.3 mm.; diameter (both valves, badly crushed), 10.5 mm.

A single badly crushed specimen is questionably referred to the genus *Laternula*. It is incomplete posteriorly, having probably attained a total length of approximately 48 mm. The shell is very thin, elongate, and somewhat ovate in outline. The umbones, situated slightly posterior to the mid-length of the valve, are low, relatively small, incurved, and opisthogyrate. The umbonal area is rather badly crushed, and it cannot be determined whether or not the characteristic fissure was present in that region. Posterior to the umbones there is an inconspicuous sulcus defining a low, rounded, umbonal ridge which appears to have extended to the posterior ventral margin of the left valve; the right valve is too imperfectly preserved to indicate the presence or absence of this feature. The dorsal margin of the valve is almost straight, the anterior is broadly and regularly rounded, and the ventral margin straight. The posterior margin has been destroyed, but if one can judge from lines of growth it was rounded ventrally, becoming almost straight, though trending obliquely posterodorsally to the rather sharply rounded posterior dorsal edge. The surface of the valve is ornamented by low, rounded, unequally spaced, and inconspicuous concentric ridges upon which can be seen, under a lens, microscopically fine growth lines.

The hinge of the left valve is edentulous; posterior to the umbo there is a well-developed, almost horizontal nymph plate.

The relationships of this form are not readily apparent, and the preservation is such that even the generic identification must remain uncertain. It somewhat resembles *L. royana* (D'Orbigny) (1845, p. 377, pl. 371, figs. 5, 6) but differs in the details of outline and in the less prominent concentric ornamentation.

ISOGNOMONIDAE

ISOGNOMON SOLANDER MS HUMPHREY (?), 1786

Isognomon Solander MS, HUMPHREY (?), 1786, Catalogue . . . Portland Museum, p. 41.³

action on the problem, the accepted "Bolten" (Roeding) names are here adopted.

³ For a discussion as to the probable author of the Portland Catalogue, see Iredale (1916, p. 88).

GENOTYPE: By monotypy, *Ostrea perna* Linné. Recent.

In a report on some California Eocene Mollusca (Vokes, 1939, p. 52), I discussed the use of the generic name *Pedalion* Solander MS, as it appeared in Huddesford's edition of Lister's "Linnaean index" (1770), and indicated at that time that the problem involved in acceptance of the name was "more complicated than one might wish." Reviewing the evidence at the present time I feel obliged to conclude, with Cox (1940, p. 120), that the names "Pedalion" and "Rudder" were used by Huddesford as English vernacular names and, therefore, not acceptable in a generic sense.

Isognomon orientalis (Hamlin)

Plate 2, figures 19-24

Perna orientalis HAMLIN, 1884, p. 59, pl. 6, fig. 1a-c; BLANCKENHORN, 1890, p. 79; WHITFIELD, 1891, p. 384; BLANCKENHORN, 1934, p. 182. Not *Perna orientalis* Hamlin, Newton, 1895, p. 80, pl. 2, figs. 4, 5.

Perna tetragona HAMLIN, 1884, p. 60, pl. 6, fig. 2. BLANCKENHORN, 1934, p. 182, pl. 7, fig. 6a, b.

Perna orientalis var. *tetragona* Hamlin, BLANCKENHORN, 1890, p. 80.

Perna cirrata BLANCKENHORN, 1890, p. 80, pl. 5, fig. 3; BLANCKENHORN, 1934, p. 183.

Perna palestina WHITFIELD, 1891, p. 394, pl. 4a, figs. 8-10; BLANCKENHORN, 1934, p. 182.

Isognomon orientalis (Hamlin), VOKES, 1941b, p. 1722.

TOPOTYPES: A.M.N.H. No. 25995:1; length, 39.3 mm.; height, 45.4 mm.; diameter (both valves), 32.7 mm. Locality: "Abeih."

A.M.N.H. No. 25995:2; length, 41.7 mm.; height, 51.8 mm.; diameter (single valve), 17.3 mm. Locality: "Abeih."

A.M.N.H. No. 25995:3; length, 39.0 mm.; height, 53.7 mm.; diameter (single valve), 18.7 mm. Locality: "Abeih."

A.M.N.H. No. 25995:4; length, 40.7 mm.; height, 56.2 mm.; diameter (single valve), 18.6 mm. Locality: "Abeih."

A.M.N.H. No. 25995/1; length, 42.5 mm.; height, 47.4 mm.; diameter (single valve), 11.4 mm. "Olive Locality."

The above synonymy is the result of the examination of more than 200 specimens in the collections of the American University of Beirut. They show that this is a very variable

species not only as to the size and relative proportions of the valves, but also in the extent of the obliquity of the ligamental area and in the relative width of the grooves to the interspaces. In general the grooves tend to be wider than the interspaces, but in some specimens, including the holotype of "*Perna*" *tetragona* Hamlin and topotype A.M.N.H. No. 25995/1, they are narrower. Heinz (1932, p. 4), in his study of Cretaceous species of *Inoceramus*, has attempted to use the relative width of interspaces and grooves as a character to aid in distinguishing between that genus and *Isognomon*. He states that in the latter genus the grooves are generally narrower than the interspaces, while in *Inoceramus* the opposite is the case. The condition found in the present species, which certainly is not to be referred to *Inoceramus*, indicates that this is not a valid character for such use.

Hamlin had three specimens of this genus. Two were made the types of his "*Perna*" *orientalis*; the other, of "*P.*" *tetragona*. He distinguished the latter species on the basis of "the thin, flat, quadrangular form of the valve, the absence of any deep or distinctly limited muscular impression, the hinge margin nearly horizontal in direction, while that of the other specimens is abruptly sloping, and the ligamental grooves narrower than their interspaces. . . ."

An examination of the relatively tetragonally shaped specimens in the collection indicate that none of these characters are constant. Topotype A.M.N.H. No. 25995:3 (pl. 2, fig. 24), for example, has a thick, convex shell, in which, as far as can be observed, the grooves were wider than the interspaces. As for the absence "of any deep, or distinctly limited muscular impression" it may be pointed out that there is no specimen in the entire collection which, regardless of relative shape and proportions, possesses a muscle scar exactly similar to that described and figured by Hamlin for his "*Perna*" *orientalis* (1884, p. 60, pl. 6, fig. 1c). For the most part the muscular impressions are not well delimited and resemble those of "*P.*" *tetragona*. The one specimen in the collection with a muscular impression most nearly resembling that of Hamlin's figure 1c is a large, convex, thick-shelled valve of the *tetragona* shape.

Blanckenhorn's "*Perna*" *cirrata* (1890, p. 80, pl. 5, fig. 3) was based primarily on the presence of cirrate "radial ribbing" on the surface of the valve. Almost one-half the specimens in the collection exhibit this character to a certain degree, though none quite so extensively as on Blanckenhorn's type. Topotype A.M.N.H. No. 25995:2 (pl. 2, fig. 21) shows this cirrate ornamentation, and a small area near the posterior side on the dorsal half of topotype A.M.N.H. No. 25995:1 (pl. 2, fig. 19) also shows worn remnants of this structure. Examination indicates that it is formed from the irregularly raised edges of the growth lamellae of the shell. It seems probable that it was a feature possessed by all specimens of this species, but, living on a sea bottom composed of rather coarse, quartzitic sand, it may well have been commonly abraded off during the life of the individual or before burial and fossilization. It is certain that on many specimens it was worn away during the period when the fossils were weathering out of the rocks.

The "comparatively strong but very regular concentric lines of growth, which are scarcely lamellose" indicated by Whitfield as being a distinguishing characteristic of his "*Perna*" *palestina* are also but a stage in the weathering of the surface of the valve. They are exhibited over a part of the surface of topotype A.M.N.H. No. 25995:2 (pl. 2, fig. 21), the same specimen that shows, on another portion of the surface, the cirrate lamellae of Blanckenhorn's "*P.*" *cirrata*.

I am of the opinion that the present specimens are to be considered as topotypes of *I. orientalis*. Hamlin obtained his specimens from the wife of the Reverend William Bird whose personal collection forms the nucleus of the large collection in Beirut. Hamlin's specimens lacked individual locality information, but were known to have come either from the Jurassic (Oxfordian) at Mejd-el-esh-Shems on the slope of Mount Hermon, or from the vicinity of Abeih.

As Hamlin points out (1884, p. 60), the fact that up to that time no fossil species of this genus had been reported from Syria and in fact appeared to be not common in the Cretaceous in other parts of the world, whereas they were abundant in the Jurassic, led him to consider that his specimens were from

the beds at Mejd-el-esh-Shems. The Bird collection in the American University, however, contains abundant specimens labeled as from Abeih, where I myself have collected it at the "Olive Locality." There is no similar species in the Bird collections from Mejd-el-esh-Shems.

Manuscript notes in the museum at Beirut, made by the late Prof. A. E. Day and dated "Nov. 13, 1896," bear the following notation relative to the occurrence of this species: "Numerous specimens from Abeih, from a bit east of and a little below the Olive Locality. Also from west of the village and higher up, from Klelày, Andrafil, Dakkûn, the Olive Locality, and Nab'laban and Marâh."

PSEUDOPTERA MEEK, 1873

Pseudoptera MEEK, 1873, Ann. Rept. U. S. Geol. Surv. Terr., vol. 6, p. 489.

GENOTYPE: By original designation, *Avicula anomala* Sowerby. Cretaceous, England.

There can be little doubt that many of the forms of the heterogeneous group of species that have been customarily referred to the genus *Gervillia* Defrance cannot be accurately referred to that genus. Cox, recognizing this, has recently proposed a revision of this group (1940, pp. 105-107) which may be summarized as follows:

1. Genus *Gervillia* Defrance, 1820 (genotype, *G. solenoides*, J. A. Eudes-Deslongchamps, *ex* Defrance vernac.)
 - A. Subgenus *Gervillia*, *sensu stricto* (syn., *Gervillioopsis* Whitfield, 1885; *Dalliconcha* White, 1887; *Ensigervilleia* Dietrich, 1910)
 - B. Subgenus *Cultrioopsis* Cossmann, 1904 (type, *G. cultellus* Cossmann; syn., *Angustella* Waagen, 1907)
2. Genus *Bakevella* W. King, 1848 (genotype, *Avicula antiqua* Münster *in* Goldfuss)
 - A. Subgenus *Bakevella*, *sensu stricto* (syn., *Pseudogervilleia* Gillet, 1922)
 - B. Subgenus *Aguileria* White, 1887 (type, *A. cumminsi* White)
3. Genus *Gervillella* Waagen, 1907 (genotype, *Perna aviculoides* J. Sowerby)

The differences distinguishing these groups have been clearly noted by Cox and do not need repeating here. It is worth noting, however, that, while characters other than those of gross outline are involved, the three genera recognized may be essentially distinguished

on this basis alone: *Gervillia* comprises the elongated, soleniform (or ensiform) species; *Bakevella*, the shorter, more quadrate, *Pteria*-form types; and *Gervillella*, the elongate, more trigonial, essentially *Pinna*-form ones.

I am of the opinion, however, that the ventrally elongated, essentially rectangular forms referable to *Aguileria* White differ so markedly from typical *Bakevella*, both in shape and hinge characters, as to be completely distinct from the latter genus.

In addition to these genera discussed by Cox, the genus *Pseudoptera* Meek, 1873 (genotype, by original designation, *Avicula anomala* Sowerby from the Cretaceous of England), seems, on the basis of specimens from the Lewisville formation of Texas which are apparently to be referred to it, to be an additional member of this family. At the time that this genus was described by Meek, the hinge and interior of the valve were unknown, and the genus was based upon the general shape, the presence of radial ribbing, and the absence of a byssal sinus under the anterior wing. Meek considered the group to be a member of the Pteriidae, but (1876, pp. 29, 30) admitted the possibility that it might be a gervilliid. The species in the Texas collection show the characteristic features of the genus, and, in addition, well-preserved interiors show multiple ligamental grooves similar to those of the above genera.

Then, on these bases, the species from the Cretaceous of Lebanon, which have been referred to *Gervillia*, may be re-allocated as follows:

GERVILLIA, SENSU STRICTO

1. *Gervillia dodgei* Vokes (1941a, p. 6, figs. 1-4)
2. *Gervillia hierosolymitana* Blanckenhorn (1934, p. 181, pl. 7, figs. 7-9)
3. *Gervillia* sp. aff. *G. solenoides* Defr. (Blanckenhorn, 1934, p. 182, pl. 7, fig. 10)

AGUILERIA

4. *Gervillia obesa* Whitfield (1891, p. 391, pl. 4A, figs. 5-7)
5. *Gervillia perobesa* Whitfield (1891, p. 392, pl. 5, figs. 6-8)
6. *Gervillia trapezoidalis* Whitfield (1891, p. 392, pl. 4A, figs. 11-12)

In addition to these species, there is a single incomplete specimen from the Olive Locality

which appears to represent an undescribed species of *Pseudoptera*, but which is too inadequate to permit its formal designation at the present time.

Pseudoptera, new species

Plate 3, figure 11

FIGURED SPECIMEN: A.M.N.H. No. 26022; length (incomplete), 9.1 mm.; height (incomplete), 9.4 mm.; diameter (both valves, incomplete), 5.7 mm.

The single fragmentary specimen seems to represent an immature individual. The shell is small, moderately inflated, and markedly inequivalved, the left valve being much more inflated than the right, although the shell has suffered some crushing which may tend to accentuate somewhat the greater inflation of the left valve. In the right valve, the umbo is moderately inflated and apparently terminal, though this latter feature may also be accentuated because of crushing from the anterior end. The posterior wing is well defined and is separated from the body of the shell by a moderately prominent concave area. The umbo of the left valve is subterminal, there being a moderately wide anterior ear whose greatest width, however, is decidedly ventral to the umbo. So far as can be determined, this auricle is semilunar in shape, with a length about four times the greatest width, which occurs at about the middle. The ear is separated from the body of the valve by a shallow, relatively inconspicuous, concave depression. The posterior ear is narrower than that of the right valve and is delimited anteroventrally by a relatively broad, low, rib-like fold marked ventrally by a shallow, very inconspicuous concavity, and dorsally by a similar but sharper depression. Microscopic examination reveals characteristic radial ribbing on the left valve; from 12 to 15 ribs may be observed on the posterior dorsal portion of the valve surface over an area extending from the hinge line down onto the posterior slope of the median umbonal swelling, and a few such ribs may also be observed to be present on the anterior slope of the same area.

The ligament was multivincular, the area being moderately wide, with the ligamental pits narrower than the interspaces.

OSTREIDAE

OSTREA LINNÉ, 1758

Ostrea LINNÉ, 1758, *Systema naturae* . . . , ed. 10, p. 696.

GENOTYPE: By subsequent designation, Children, 1823, *Ostrea edulis* Linné. Recent, coasts of Europe.

Ostrea alicula Hamlin

Plate 3, figures 1-10

(?) *Ostrea succini* FRAAS, 1878, p. 307 (p. 46 of separate), pl. 4, fig. 3.

Ostrea (Alectryonia) alicula HAMLIN, 1884, p. 62, pl. 6, fig. 3a-c.

Ostrea alicula Hamlin, BLANCKENHORN, 1890, p. 71, pl. 3, figs. 16a, b, 17a, b.

Ostrea succini Fraas = *O. alicula* Hamlin, WHITFIELD, 1891, p. 384.

Alectryonia alicula Hamlin, BLANCKENHORN, 1934, p. 197.

Ostrea alicula Hamlin, VOKES, 1941b, p. 1722.

TOPOTYPES: A.M.N.H. No. 26000:1; length, 16.5 mm.; height, 34.7 mm.; diameter (both valves), 11.8 mm.

A.M.N.H. No. 26000:2; length, 14.5 mm.; height, 25.5 mm.; diameter (both valves), 11.6 mm.

A.M.N.H. No. 26000:3; length, 12.0 mm.; height, 20.9 mm.; diameter (both valves), 7.5 mm.

A.M.N.H. No. 26000:4; length, 17.5 mm.; height, 29.5 mm.; diameter (both valves), 7.3 mm.

A.M.N.H. No. 26000:5; left valve: length, 14.0 mm.; height, 27.3 mm.; diameter, 7.0 mm.; right valve: length, 12.7 mm.; height, 22.6 mm.; diameter, 2.3 mm.

This species was described by Hamlin from the "Beirût district," an area which he defines (1884, p. 2) as including "the vicinity of Beirût, Abeih, Dog River (Nahr el Kelb) a few miles north of Beirût and the mountains between this river and the Cedars, a mountainous district which extends more than twenty and not over thirty miles north and south, with Beirût and Dog River as a center." The two type specimens were from the "Bird Coll." presented by the wife of the Reverend William Bird. Since the great majority of the specimens of this species in the Bird collection at Beirut are from the "Olive Locality,"¹ it is safe to assume that

¹ I noted 128 specimens in this collection from this locality and also personally collected many others at that place.

the Hamlin specimens were also from this place. The present specimens are, therefore, designated as topotypes of this species.

The original description was as follows: "Shell obliquely cuneiform; upper valve nearly flat, towards the hinge somewhat convex and concentrically delicately lamellose, for the rest slightly concave and having the lamellae crossed by wide, low, radiating folds, sometimes dichotomous; lower valve highly arched, affixed by an elongated umbo, and furnished with narrow, sharp, close-set dichotomous ribs."

This well-marked little species is one of the least variable and most constant species of *Ostrea* that I have seen. The figured topotypes show all the normal variants encountered.

In specimens in which the umbo is straight, the ligamental area is long and relatively narrow, and the area of attachment is small. Specimens in which the umbo is "grypheoid" all show a large area of attachment, and the ligamental area may be twisted, or broad and short. All such umbones are twisted posteriorly.

The adductor muscle scar is reniform, of moderate size, and is situated near the middle of the height of the valve but is all within the posterior third of the length.

Ostrea succini Fraas (1878, p. 307, pl. 4, fig. 3) which was tentatively identified with this species by Hamlin (1884, p. 63) is based upon a fragmentary left valve which, even though incomplete, is larger than any of the specimens of the present species. Furthermore, the radial ribbing, as shown, does not evidence any tendency toward the typical dichotomous branching of *O. alicula*.

Ostrea dieneri Blanckenhorn

Plate 3, figures 15-19

Ostrea virgata Goldfuss, Nyst, CONRAD, 1852, p. 212 (part), pl. 1, figs. 7, 8 (not pl. 1, fig. 6).

(?) *Exogyra Bousingaultii* d'Orbigny, CONRAD, 1852, pl. 1, fig. 9 (not pl. 2, figs. 10, 11).

Ostrea (Exogyra ?) Dieneri BLANCKENHORN, 1890, p. 72, pl. 3, fig. 18, pl. 4, figs. 1a, b, 2, 3, 4a, b, pl. 5, fig. 1; WHITFIELD, 1891, p. 384.

Ostrea Dieneri Blanck., ZUMOFFEN, 1926, pp. 61, 62, 64, 66, 70, 71, 72, 76, 95; BLANCKENHORN, 1934, p. 197; DUBERTRET AND VAUTRIN, 1937, p. 46; VOKES, 1941b, pp. 1722, 1724.

HYPOTYPES: A.M.N.H. No. 26001:1; length, 24.5 mm.; height, 37.0 mm.; diam-

eter (both valves), 12.2 mm.

A.M.N.H. No. 26001:2; length, 29.3 mm.; height, 33.0 mm.; diameter (left valve), 13.0 mm.

A.M.N.H. No. 26001:3; length, 28.3 mm.; height, 34.2 mm.; diameter (right valve), 6.6 mm.

This species, described in considerable detail and well figured by Blanckenhorn, is not common in the collection from the Olive Locality. There are but six specimens in the Beirut collection and three in the collections described by Whitfield (1891). There are, however, 45 specimens in Beirut from Marâh (footnote 2, p. 158), where they are associated with *Trigonia distans* Conrad, in strata believed to be somewhat younger than that at the Olive Locality. It also occurs in considerable abundance at Abeih in beds stratigraphically above those of the present locality and in the Upper Aptian (? and Albian) at Ain Ksur and Kefr Meta. It is not common in the collections from Hadath-al-Jibbab where, as at the Olive Locality, *Ostrea alicula* is abundantly represented.

EXOGYRA SAY, 1820

Exogyra SAY, 1820, Amer. Jour. Sci., vol. 2, p. 43.

GENOTYPE: By monotypy, *Exogyra costata* Say. Upper Cretaceous, New Jersey.

Exogyra, species

Plate 3, figures 12-14

FIGURED SPECIMENS: A.M.N.H. No. 26002:1; length, 13.7 mm.; height, 17.0 mm.; diameter (both valves), 8.2 mm.

A.M.N.H. No. 26002:2; length, 15.1 mm.; height, 20.3 mm.; diameter (both valves), 8.9 mm.

There are 10 small specimens referable to the genus *Exogyra* in the Olive Locality collections. The two largest of these are here figured. The left valve is very convex with a rounded ridge extending from the umbo to the posterior ventral extremity. This ridge is never carinate and is only the point of maximum convexity of the valve at each part of the height where it may be measured in respect to the lateral areas. Anterior to this ridge a number of rounded radial ribs extend to the margin of the valve; posterior to it the valve tends to be relatively flattened

and the ribbing generally absent, but is inconspicuously developed on one of the figured specimens. The ribs, which may be partially interrupted by growth ridges, give a corrugated appearance to the anterior margin of the shell.

The right valve is almost flat, with a small spiral umbo. It is ornamented by growth lines, though on one specimen a few indistinct rounded radial ribs may be observed near the anterior ventral margin.

These specimens resemble D'Orbigny's figures of "*Ostrea*" *Boussingaultii* (1847, pl. 468, figs. 4-9 [not figs. 1-3, nor D'Orbigny, 1842, pl. 18, fig. 20, pl. 21, figs. 8, 9]). These have been considered by Woods as representing specimens of *Exogyra tuberculifera* Koch and Dunker (for extended synonymy, see Woods, 1913, pp. 404-406). That species, which essentially agrees with the present form in possessing a flat, non-ribbed right valve, is described as having a sharply carinate umbonal ridge on the left valve. None of these Abeih specimens shows any tendency toward the development of such a carina, the umbonal ridge in all examples being broadly rounded.

With the exception of the low folds on the figured right valve, this species differs from the Cenomanian *E. flabellata* Goldfuss (1837 [in Goldfuss and Munster, 1833-1840], vol. 2, p. 38, pl. 87, fig. 6) and its Lower Cretaceous analogue, *E. boussingaulti* D'Orbigny (1842, pl. 18, fig. 20, pl. 21, figs. 8, 9), in lacking well-developed radial ribbing on the left valve, which also shows no tendency to develop the characteristic anterior margin of the latter forms.

PECTINIDAE

NEITHEA DROUET, 1825

Neithea DROUET, 1825, Mém. Soc. Linnéenne Paris, vol. 3, p. 186.

GENOTYPE: By subsequent designation, Chenu, 1862, *Pecten aequicostatus* Lamarck. Cenomanian, France.

SUBGENUS NEITHEOPS STEWART, 1930

Neitheops STEWART, 1930, Special Publ. no. 3, Acad. Nat. Sci. Philadelphia, p. 115.

TYPE: By original designation, *Neithea grandicosta* Gabb. Cretaceous, California. Stewart (1930, p. 115) has shown that

Herrmannsen's (1847, vol. 2, p. 110) [and Gray's (1847, p. 200)] designation of *Neithea quinquecostata* (Sowerby) is not valid, since that species was not cited by Drouet. The next available designation seems to be that of Chenu whose selection of *Neithea aequicostatus* fixes the name to a typically inequivalved, but even-ribbed type. The subgeneric name *Neitheops* was, therefore, proposed for the more abundantly represented type marked by the presence of unequally developed ribs. It seems unfortunate that the type species selected should be one that is rare and known only from imperfect specimens. There can be no doubt, however, that *N. grandicosta* Gabb is congeneric with such well-known species as *N. quinquecostata* (Sowerby), (1814, p. 122, pl. 56, figs. 4-8), *N. quadricostata* (Sowerby), (1814, p. 122, pl. 56, figs. 1, 2), and *N. morrissi* (Pictet and Renevier) (1858, p. 128, pl. 19, fig. 2) [*? = N. syriaca* (Conrad)].

***Neithea* (*Neitheops*) *syriaca* (Conrad)**

Plate 4, figures 1-7

Janira Syriaca CONRAD, 1852, p. 230, App., pl. 1, fig. 6.

Janira quinquecostata d'Orb., FRAAS, 1878, p. 338 (p. 81 of separate); DIENER, 1887, p. 325.

Vola syriaca Conrad sp., HAMLIN, 1884, p. 61, pl. 5, fig. 4a-c.

Vola quinquecostata Sow. non! Lam., BLANCKENHORN, 1890, p. 77.

Vola quinquecostata Sow., sp., WHITFIELD, 1891, p. 384.

Janira Morrissi Pictet, ZUMOFFEN, 1926, pp. 66, 67, 77.

Pecten (*Vola*) *Morrissi* Pictet, DUBERTRET AND VAUTRIN, 1937, p. 46 (after Zumoffen).

Pecten (*Vola*) *quinquecostatus* Sow. non Lam., var. *syriaca* Conrad, BLANCKENHORN, 1934, p. 191.

NEOSYNTYPES: A.M.N.H. No. 25996:1; length, 17.2 mm.; height (incomplete), 17.6 mm.; diameter (both valves), 6.4 mm.

A.M.N.H. No. 25996:2; length (incomplete), 20.0 mm.; height, 23.3 mm.; diameter (right valve), 7.5 mm.

HYPOTYPE: A.M.N.H. No. 25996/1; length, 17.3 mm.; height, 19.1 mm.; diameter (both valves), 6.4 mm. Locality: "Ruweissat Na'mân."

Conrad originally described this species as follows: "Subtriangular, elevated; superior

valve slightly concave, with rather narrow unequal ribs and concentrically wrinkled, about twenty-six in number; inferior valve ventricose, with six large ribs, rounded and finely wrinkled; intervals with generally four rounded unequal ribs."

The original locality was said to be "Abeih." The type specimen is not among the few Conrad types that have been recovered, and therefore the two best specimens from the six present in the collections from the "Olive Locality" are here designated as the neosyntypes of this species. The specimen figured by Hamlin (1884, pl. 5, fig. 4a-c) is more complete than either of these, but though assumed by Hamlin to be from Abeih, is without locality information.

On the basis of these neosyntypes the species may be redescribed as follows:

The shell is of moderate size for the genus, somewhat triangular in outline, with the height greater than the length. Right valve (the "inferior valve" of Conrad's description) moderately convex with slender, incurved umbo. Surface of the valve ornamented by rounded radial ribs, six of which are heavier than the others and project at the ventral margin of the valve, forming angles on the margin separated by concave areas. The interspaces between these main ribs are flattened and generally marked by four ribs in each interspace. The median pair of ribs in each interspace are more strongly developed than are the lateral ones, which tend to be closely approximate, and almost appressed upon the main ribs. This latter condition is particularly seen in the anterior lateral rib in each interspace. Occasionally a fifth riblet develops on the posterior side of the interspaces. The areas between the ribs in the interspaces are rounded and narrower than the ribs. Both ribs and interspaces are crossed by a microscopic concentric ornamentation composed of rounded threads separated by interspaces almost twice the width of the thread. The lateral areas of the valve lack radial ribbing and are marked only by the concentric ornamentation. The ears are small, unequal in size, and triangular in shape, and are ornamented only by concentric threads.

The left valve (the "superior valve" of Conrad's description) is concave, with the

length slightly greater than the height (16.9 mm. high in the figured hypotype). The surface of the valve is ornamented by 26 to 28 radial ribs. The areas opposite the heavy ribs on the right valve are raised and marked by two lateral ribs separated by a relatively wide, rounded, median groove, the bottoms of which are elevated above those between the ribs in the interspaces. These latter areas are generally marked by three rather than four radial ribs. The concentric ornamentation is the same as that of the right valve.

REMARKS: This species has commonly been mistaken for *N. quinquecostatus* (Sowerby) (1814, p. 122, pl. 56, figs. 4-8) but differs from that species in several details, notably (1) in having more slender, less inflated umbones, (2) heavier and relatively more prominent main ribs on the right valve, (3) in lacking radial ribbing on the lateral areas and the ears of the right valve, (4) in the fewer number of radial ribs on the left valve, and (5) in the very different relative arrangement of the radial ribs on that valve.

Neitheia morrissi (Pictet and Renevier) (1858, p. 128, pl. 19, fig. 2a-d) is much more closely related to, and may be identical with, the present species. Present collections do not permit any definite conclusion as to this problem, but if the two forms are conspecific Conrad's name has priority. Judging from Pictet and Renevier's figure 4c, the area on the left valve opposite the main ribs of the right bears a heavy rib. This would distinguish the species from *N. syriaca*, but in the description (p. 129) these ribs are said to be "canaliculées." Such would be an excellent alternative method of describing the condition to be observed on our specimens, and the question as to the relative status of the two species can be decided only when more extensive collections are available.

The excellent illustrations of the right valve identified by Pervinquière as *Pecten* (*Neitheia*) *Morrissi* (1912, pl. 9, fig. 7a-b) from the Aptian at Djouaouda, Tunisia, so greatly resembles those from Syria that I have little hesitation in referring the Tunisian specimen to *N. syriaca*.

Conrad, in the letter to Dr. Anderson accompanying the manuscript of his report (see Conrad, 1852, p. 209), makes the following statements: "It is worthy of remark, that

some species of this family *Ostreidae* and of *Pectinidae* are widely distributed throughout the globe. Thus *Pecten quinquecostatus* and *Ostrea vesicularis* occur in Syria, Europe and America." The basis for his reference to the occurrence of "*Pecten*" *quinquecostatus* in Syria is not known, for the only similar form mentioned in his report is that described as "*Janira*" *syriaca*.

TRIGONIDAE

TRIGONIA BRUGUIÈRE, 1789

Trigonia BRUGUIÈRE, 1789, Encyclopédie méthodique . . . Histoire naturelle des vers, vol. 1, p. xiv.

GENOTYPE: By subsequent designation, Gray, 1847, *Trigonia nodulosa* Lamarck, 1801 = *T. aspera* Lamarck, 1819 (not *T. nodulosa* Lamarck, 1819).

The problems involved in fixing the type of *Trigonia* Bruguière have been discussed by Stewart (1930, p. 88).

Trigonia lewisi Blanckenhorn

Plate 4, figures 15-20

Trigonia lewisi BLANCKENHORN, 1890, p. 83, pl. 5, figs. 6, 7a-c; WHITFIELD, 1891, p. 385; ZUMOFFEN, 1926, pp. 77, 79; BLANCKENHORN, 1934, p. 216, pl. 10, fig. 74; DUBERTRET AND VAUTRIN, 1937, p. 46 (after Zumoffen); VOKES, 1941b, p. 1722.

TOPOTYPES: A.M.N.H. No. 26004:1; length, 30.0 mm.; height, 26.1 mm.; diameter (both valves), 13.7 mm.

A.M.N.H. No. 26004:2; length, 25.7 mm.; height (incomplete), 18.4 mm.; diameter (both valves), 10.7 mm.

A.M.N.H. No. 26004:3; length, 12.1 mm.; height, 10.2 mm.; diameter (right valve), 3.1 mm.

A.M.N.H. No. 26004:4; length (incomplete), 17.2 mm.; height, 19.4 mm.; diameter (left valve), 5.6 mm.

Blanckenhorn's types of this species were received through the Reverend Mr. Lewis, and the original locality was uncertain, being stated to be "Abeih?" (explanation to pl. 5). The collections at Beirut contain 37 specimens of this species from the Olive Locality. In addition there is an undescribed variety represented by a few specimens from Marâh and one (in the A.M.N.H. collection) from B'wirty, but all the specimens that I have

seen that appear to be certainly identifiable with Blanckenhorn's species are from the Olive Locality, and therefore the present specimens are here considered to be topotypes.

The type specimens are incomplete, both being broken posteriorly. The present, complete specimens show that the ribbing becomes so obsolete that it is virtually absent on the posterior portion of the dorsal area. The ribs are not strictly concentric in relation to the shape of the valve, being slightly oblique, extending posteroventrally. Immediately anterior to the areal angulation, the ventral sides of the roof-shaped ("dachförmig") ribs are marked by fine, irregularly spaced, radial threads. These are the "zarte Radiallinien" of Blanckenhorn's description, but I am unable to find any structures either in his figures or in the present specimens on the anterior part of the shell with which to identify his "schwachen Kerben."

The original figures are somewhat incorrectly oriented. This is probably due to the slight obliquity of the ribbing, which Blanckenhorn could not observe on his imperfect specimens. As a result the posterior dorsal margin is shown as almost parallel to the ventral margin, whereas the two tend to approach at a rather acute angle. This same feature is probably responsible for the rather excessive length which he considers as probable for his larger specimen (44 mm.). On the basis of the present material it was probably not more than 35 or 36 mm. long.

***Trigonia pseudocrenulata* Noetling**

Plate 4, figures 13, 14

Trigonia crenulata Lamk., FRAAS, 1878, p. 326 (p. 70 of separate).

Trigonia pseudocrenulata NOETLING, 1889, p. 862, pl. 25, fig. 5, 5a; BLANCKENHORN, 1890, p. 84; WHITFIELD, 1891, p. 385; DOUVILLÉ, 1916, pl. 168, p. 21, figs. 11, 12; ZUMOFFEN, 1926, pp. 69, 77, 79; BLANCKENHORN, 1934, p. 218; DUBERTRET AND VAUTRIN, 1937, p. 46.

TOPOTYPE: A.M.N.H. No. 26005; length, 44.6 mm.; height, 43.0 mm.; diameter (both valves, right somewhat worn), 31.6 mm., (left valve only), 17.6 mm.

This species is represented in the Beirut collections by nine specimens from the Olive Locality, together with a number of others from various localities in the Aptian deposits.

As indicated by the specific name, this species most closely resembles *T. crenulata* Lamarck (1819, p. 63), a species that has been well figured by D'Orbigny (1843-1847, pl. 295, figs. 1-4). It is generally relatively smaller than that species; the costae are more distant, especially anteriorly, and are not so sinuate. In outline, the anterior margin is straighter and less broadly rounded, and there is a distinct depressed area immediately in advance of the carinate anterior margin of the posterior area, which results in a prominent concavity on the ventral margin just anterior to the posterior ventral angulation. The surface of the area is ornamented by three or four rounded radial ribs, absent in *T. crenulata*, and the "escutcheon" is relatively narrower and less deeply impressed.

***Trigonia libanotica*, new species**

[*Trigonia syriaca* Fraas, not Conrad]

Plate 4, figures 8-12

Trigonia undulata From. [Fromberg], LYCETT, 1877, p. 200, text fig., p. 201.

Trigonia syriaca Conr., FRAAS, 1878, p. 299 (p. 43 of separate), pl. 5, figs. 2-5; HAMLIN, 1884, p. 54; WHITFIELD, 1891, pp. 385, 396.

Not *Trigonia syriaca* Conrad, 1852, p. 214, pl. 3, figs. 19-21, 23, App., p. 232.

Trigonia syriaca Fraas (not Conrad), NOETLING, 1886, pp. 856-860, pl. 24, figs. 1, 2, 3, 4, 4a, 4b, pl. 25, figs. 1-3; BLANCKENHORN, 1890, p. 81; BLANCKENHORN, 1934, p. 216.

(?) *Trigonia syriaca* Fraas, ZUMOFFEN, 1926, pp. 48, 101; DUBERTRET AND VAUTRIN, 1937, p. 48 (after Zumoffen).

Trigonia syriaca Conrad (Fraas), VOKES, 1941b, p. 1722.

HOLOTYPE: A.M.N.H. No. 26006:1; length, 46.6 mm.; height, 45.4 mm.; diameter (both valves), 29.8 mm.

PARATYPES: A.M.N.H. No. 26006:2; length, 24.7 mm.; height, 23.3 mm.; diameter (both valves), 13.4 mm.

A.M.N.H. No. 26006:3; length (slightly incomplete), 27.6 mm.; height, 28.5 mm.; diameter (right valve), 8.4 mm.

Conrad's original figures of his *Trigonia syriaca* represented poorly preserved internal molds of doubtful specific identity. It has long been recognized, however, that they were not conspecific with the form identified by Fraas as that species (see Noetling, 1886, pp. 856-860, and Whitfield, 1891, p. 396),

and, if Conrad's own later interpretation of the species in the Appendix to Lynch's report (1852, App., pl. 4, fig. 26) is to be accepted, he considered that it represented the species at present known as *Trigonia undulatocostata* Blanckenhorn¹ (1890, p. 83, pl. 5, fig. 5). Nevertheless, since the species has become widely known under Fraas' interpretation, subsequent authors have refrained from renaming it, usually following Noetling in referring to it as *Trigonia syriaca* Fraas (not Conrad). This procedure is, however, inadmissible under the International Rules of Zoological Nomenclature, and I therefore here designate the form as *Trigonia libanotica*, new species. It does not seem desirable simply to rename Fraas' form, since the status of his collections is not known and his types may have been lost or destroyed, especially during the past few years of war. The excellent and minute description given by Noetling of his "*Trigonia syriaca* Fraas (non Conrad)" (1886, pp. 856-860) cannot be improved upon and may be taken as the type description of this new species. The specimens here chosen as the types are from the Olive Locality and are believed to be topotypes of those illustrated by Fraas.

There are more than 400 specimens referred to this species among the collections from the Olive Locality.

ANOMIIDAE

ANOMIA LINNÉ, 1758

Anomia LINNÉ, 1758, *Systema naturae* . . . , ed. 10, pp. 700-703.

GENOTYPE: By subsequent designation, Schmidt, 1818, *Anomia ephippium* Linné. Recent, Mediterranean?

Anomia subobliqua (Conrad)

Plate 4, figures 10, 21-24

Orbicula subobliqua CONRAD, 1852, p. 219, pl. 10, fig. 61½. (Genus listed as *Orbicula*?)

(?) *Orbicula* ? *syriaca* CONRAD, 1852, p. 232, App., pl. 3, fig. 24.

¹ Blanckenhorn (1934, pp. 177, 217), however, interprets this figure as representing a specimen of *Trigonia sinuata* Parkinson, a species of the European Cenomanian and Lower Turonian, which has not otherwise been reported from the Lebanon area. Conrad's specimen was from Aleih, a locality where the Cenomanian is not well represented, and from which Blanckenhorn himself reports *T. undulatocostata*.

Anomia subobliqua Conrad sp., BLANCKENHORN, 1890, p. 76.

Orbiculoidea (?) *subobliqua* Conrad sp., BLANCKENHORN, 1934, table A.

(?) *Orbiculoidea* (?) *syriaca* Conrad sp., BLANCKENHORN, 1934, p. 265, table A.

Anomia subobliqua (Conrad), VOKES, 1941b, p. 1722.

HYPOTYPES: A.M.N.H. No. 26003:1; length, 6.5 mm.; height, 7.0 mm.; diameter (left valve), 2.0 mm.

A.M.N.H. No. 26003:2; length, 8.8 mm.; height, 8.4 mm.; diameter (left valve), 2.4 mm.

A.M.N.H. No. 26003:3; length, 11.6 mm.; height, 10.5 mm.; diameter (left valve), 2.8 mm.

A.M.N.H. No. 26003:4; length, 16.7 mm.; height, 15.8 mm.; diameter (not accurately determinable).

This species, described as "Oval, slightly oblique and somewhat ventricose, smooth with indistinct lines of growth," was based upon a single valve from "Bhamdûn." The type appears to be lost. However, it seems desirable that a neotype be selected from topotypic material, and as this is not available at the present time, the selection of a neotype must await the arrival of the rest of the collections, delayed by the war.

The collection from the "Olive Locality" contains 23 specimens referable to this species. All are left valves, but Professor Day mentions in a note, dated November 28, 1896, that he had two specimens from Abeih village showing both valves, and that "the lower [right] valve is flat or slightly concave with a depression near the beak which may be a place of attachment. In this depression the shell substance is obscured by matrix so that . . . the perforation is concealed."

The left valves in the collection permit the following description: Shell moderately thick, subequilateral; more or less irregular in outline, but in general subcircular to subelliptical; varying in ventricosity from relatively flat to strongly convex; umbones small, compressed, inconspicuous, generally submarginal. Hinge edentulous, not well delimited. The muscle scars are moderately impressed; the dorsal (anterior) retractor scar is small and pit-like, and situated above the large reniform byssal scar. The posterior

retractor scar is approximately one-half the size of the byssal and is almost centrally located below it, while the adductor scar is but little smaller than the posterior retractor and is situated immediately behind, and slightly ventral to, that scar. The byssal, and posterior retractor and the retractor and adductor scars are so closely approximate each to each as to seem to be partially merged together.

There is no satisfactory basis, either in the original figures or in the descriptions, both of which are inadequate, upon which to separate the forms described by Conrad as *Orbicula ? subobliqua* and *Orbicula ? syriaca*. The types of both species are lost, and as the slight difference in shape is fully embraced within the limits of variation shown by the present material, the two are tentatively considered as synonymous. Since "*O. ?*" *subobliqua* has page priority and a locality reference, which is lacking for "*O. ?*" *syriaca*, the former term is employed for this species.

CYPRINIDAE

PROTOCYPRINA, NEW GENUS

GENOTYPE: *Astarte libanotica* Fraas [+ *Cyprina* (*Venilicardia* ?) *abeiensis* Hamlin]. Aptian, Cretaceous, Lebanon Mountains, Lebanon.

Stoliczka (1870-1871, pp. xviii, 190) proposed the name *Venilicardia* [genotype, by original designation (p. xviii), *Cyprina bifida* Zittel (1865, p. 137, pl. 5, fig. 1a-e)] for a subgenus of *Veniella* Stoliczka (1870-1871, pp. xviii, 189), new name for *Venilia* Morton (1833, p. 294), not Duponchel, 1829 (Lepidoptera). The hinge of *Venilicardia bifida* (Zittel) is, however, so very different from that of *Veniella conradi* (Morton), the genotype of *Veniella*, which has been well figured by Wade (1926, p. 77, pl. 24, figs. 14, 15, 16), that most authors have considered *Venilicardia* to be a subgenus of *Cyprina* Lamarck, 1818 (= *Arctica* Schumacher, 1817, *non* Moehring, 1758). Meek (1876, pp. 149-152), on the other hand, while pointing out that Stoliczka had apparently misinterpreted Morton's figure and had wrongly characterized *Veniella conradi* as having only two cardinal teeth in each valve, nevertheless considered *Venilicardia* to be a section of *Veniella*, although recognizing that it might "possibly be generically distinct."

The hinge of *Venilicardia bifida*, as figured by Zittel, is described by Stoliczka (1870, p. 190) as follows: "the supero-posterior cardinal teeth are as usually more or less bifid, the one in the right valve with a very easy curve at the anterior end, the antero-inferior cardi-

PLATE 3

1-10. *Ostrea alicula* Hamlin

1. Exterior of left valve of specimen with high, straight umbo, $\times 1.5$; topotype, A.M.N.H. No. 26000:1. 2. Same specimen viewed from right, showing hinge area and exterior of right valve, $\times 1.5$. 3. Exterior of left valve of specimen with twisted umbo, $\times 1.5$; topotype, A.M.N.H. No. 26000:3. 4. Exterior of left valve with twisted, somewhat distorted umbo, $\times 1.5$; topotype, A.M.N.H. No. 26000:4. 5. Same specimen as figure 4 showing exterior of right valve, $\times 1.5$. (Note that the hinge area is not exposed.) 6. Exterior of exceptionally well-preserved right valve showing details of ornamentation, $\times 1.5$; topotype, A.M.N.H. No. 26000:5. 7. Interior of same specimen as figure 6, $\times 1.5$. 8. Exterior of left valve of specimen showing large attachment area, $\times 1.5$; topotype, A.M.N.H. No. 26000:2. 9. Interior of left valve, $\times 1.5$; same specimen as figures 6 and 7. 10. Exterior of left valve, $\times 1.5$; same specimen as figures 6, 7, and 9.

11. *Pseudoptera*, new species

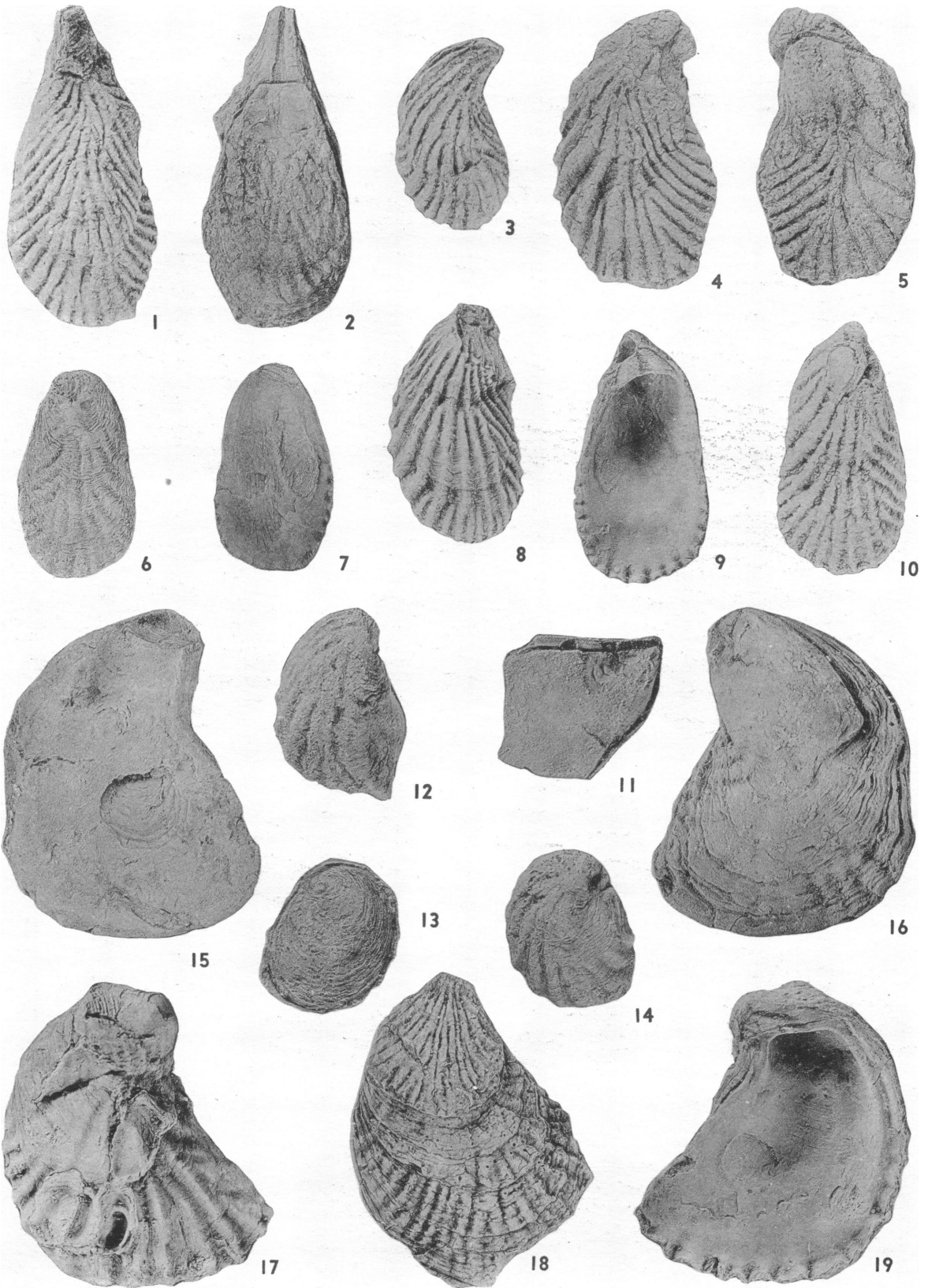
Exterior of right valve of small specimen tentatively referred to this genus, $\times 3$; figured specimen, A.M.N.H. No. 26022.

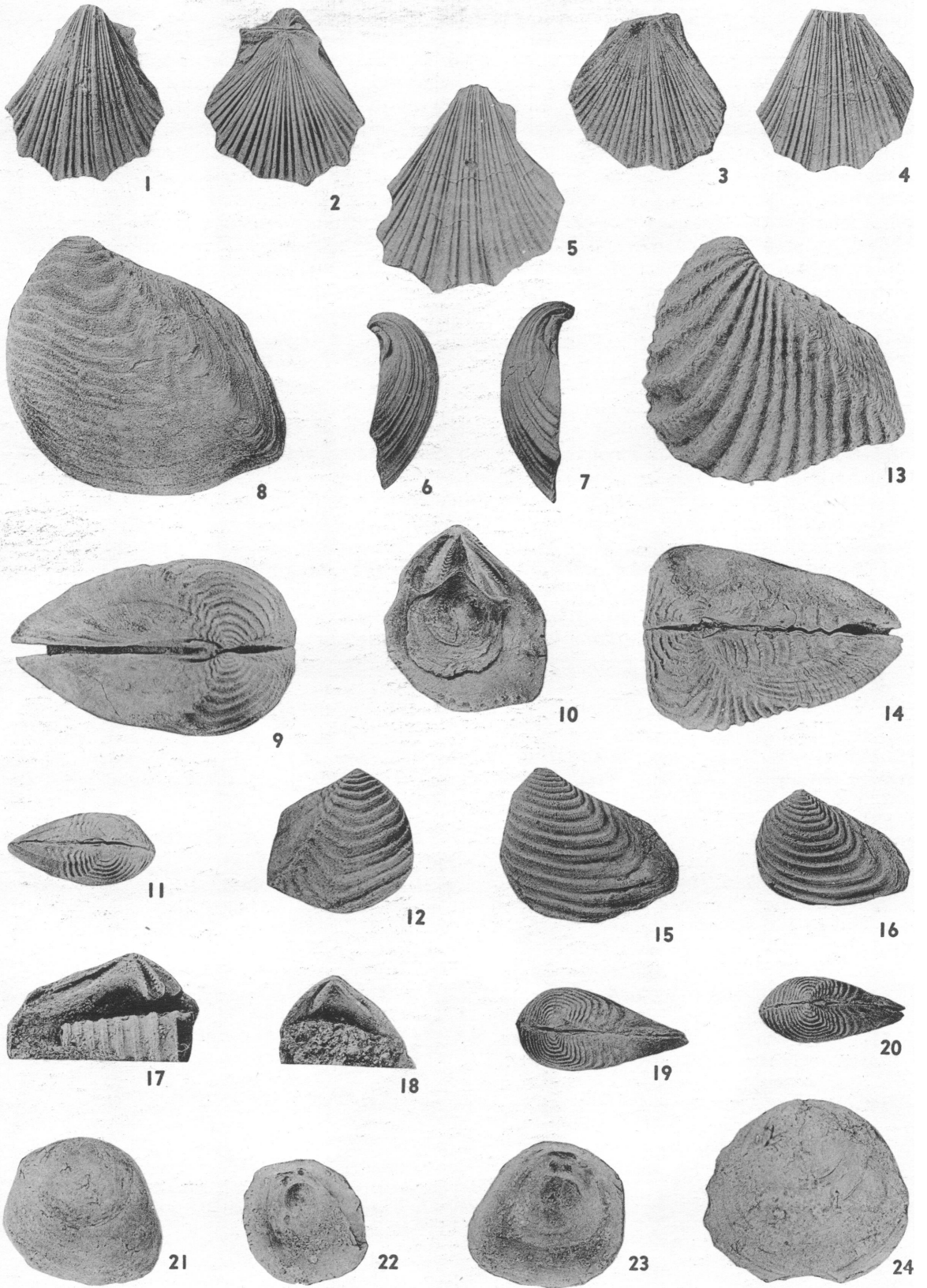
12-14. *Exogyra*, species

12. Exterior of left valve of the largest specimen in the collections, $\times 1.5$; figured specimen, A.M.N.H. No. 26002:2. 13, 14. Exterior of right and left valves of a typical specimen, $\times 1.5$; figured specimen, A.M.N.H. No. 26002:1.

15-19. *Ostrea dieneri* Blanckenhorn

15. Interior of right valve, $\times 1.5$; hypotype, A.M.N.H. No. 26001:3. 16. Exterior of right valve, same specimen as figure 15. 17. Exterior of left valve showing typical sculpture pattern, $\times 1.5$; hypotype, A.M.N.H. No. 26001:2. 18. Exterior of left valve of specimen with unusually fine ribbing, $\times 1.5$; hypotype, A.M.N.H. No. 26001:1. 19. Interior of left valve, $\times 1.5$; same specimen as figure 17.





nal teeth of both valves are long, flexuous, and the posterior ends are in both cases strongly thickened and tubercular." It should also be noted that the curved anterior end of the posterior cardinal tooth extends downward toward the anterior cardinal which parallels and almost lies on the ventral margin of the hinge plate, only the thickened posterior end extending about half the distance up the plate toward the end of the posterior cardinal. In many ways it strongly suggests an anterior lateral tooth. In addition there is a rather heavy tubercular posterior lateral situated almost at the posterior end of the nymph plate.

While the several hinges of "*Astarte libanotica* Fraas that were exposed during this study show some minor variations among themselves, they nevertheless differ strikingly from the hinge of Zittel's species and, in general, approach more closely to the hinge of *Cyprina islandica* (Linnaeus), the genotype of *Cyprina*, from which, however, they may also be separated by well-marked and constant differences. The posterior cardinal tooth of the right valve is but obscurely bifid, a character which distinguishes it from both

of the other species, and there is no curvature in the dorsal end of the anterior portion of this tooth. The anterior cardinal tooth is somewhat tubercular in shape and, as in *Cyprina*, has its greatest development toward the dorsal part of the hinge plate. It is, however, never undercut and confined to the dorsal part of the plate as in *C. islandica*. The most striking features of the present hinges are the prominent, long, anterior and posterior "lateral" grooves along the dorsal margins of the valve, and the exceptionally heavy nymph plate which carries a rather heavy ridge on the dorsal two-thirds of its anterior edge. There is commonly a distinct swelling of the posterior end of the ridge forming the ventral border of the anterior "lateral" groove. In some specimens this swelling assumes the proportions of a distinct tubercle, but it is always smooth, never corrugated as in *C. islandica*.

There are no hinges of the left valve available for study that are entirely adequate for the complete description of their characters. Some important features can, however, be noted with certainty. There is no tendency for the posterior cardinal to be bifid, as is

PLATE 4

1-7. *Neithea (Neitheops) syriaca* (Conrad)

1. Exterior of right valve, $\times 1.5$; hypotype, A.M.N.H. No. 25996/1; "Ruweissat Na'amân." 2. Exterior of left valve, $\times 1.5$; same specimen as figure 1. 3. Exterior of left valve, $\times 1.5$; neosyn-type (topotype), A.M.N.H. No. 25996:1. 4. Exterior of right valve, $\times 1.5$; same specimen as figure 3. 5. Exterior of right valve, $\times 1.5$; neosyn-type (topotype), A.M.N.H. No. 25996:2. 6. Posterior view of right valve, $\times 1.5$; same specimen as figures 1 and 2. 7. Anterior view of right valve, $\times 1.5$; same specimen as figure 5.

8-12. *Trigonia libanotica*, new species (*T. syriaca* Fraas, not Conrad)

8. Exterior of left valve, $\times 1$; holotype, A.M.N.H. No. 26006:1. 9. Dorsal view of conjoined valves, $\times 1$; same specimen as figure 8. 10. Interior of right valve, $\times 1$; paratype, A.M.N.H. No. 26006:3. (Note specimen of *Anomia subobliqua* Conrad [hypotype, A.M.N.H. No. 26003:4] attached within the valve.) 11. Dorsal view of conjoined valves of immature individual, $\times 1$; paratype, A.M.N.H. No. 26006:2. 12. Exterior of right valve of immature individual, $\times 1$; same specimen as figure 11.

13, 14. *Trigonia pseudocrenulata* Noetling

13. Exterior of left valve, $\times 1$; hypotype, A.M.N.H. No. 26005. 14. Dorsal view of conjoined valves, $\times 1$; same specimen as figure 13.

15-20. *Trigonia lewisi* Blanckenhorn

15. Exterior of left valve, $\times 1$; topotype, A.M.N.H. No. 26004:1. 16. Exterior of left valve of more elongate individual, $\times 1$; topotype, A.M.N.H. No. 26004:2. 17. Hinge of left valve, $\times 2$; topotype, A.M.N.H. No. 26004:4. 18. Hinge of right valve, $\times 2$; topotype, A.M.N.H. No. 26004:3. 19. Dorsal view of conjoined valves, $\times 1$; same specimen as figure 15. 20. Dorsal view of conjoined valves, $\times 1$; same specimen as figure 16.

21-24. *Anomia subobliqua* (Conrad)

21. Exterior of left valve, $\times 3$; hypotype, A.M.N.H. No. 26003:2. 22. Interior of left valve, $\times 3$; hypotype, A.M.N.H. No. 26003:1. 23. Interior of left valve, $\times 3$; same specimen as figure 21. 24. Exterior of left valve, $\times 3$; hypotype, A.M.N.H. No. 26003:3.

the case, according to Stoliczka (as quoted above), in the hinge of *Venilicardia bifida* (Zittel). In this connection it should be noted that in the hinge figured by Zittel (1865, pl. 5, fig. 1c) this tooth does not seem to be bifid. Furthermore, there is no evidence suggesting such a condition in any of the species referred by Stoliczka to this group.¹ In adult specimens of "*Astarte*" *libanotica* this left posterior cardinal becomes approximate to, and almost fused with, the nymph plate toward its ventral end, but it is separated from it dorsally by a groove for the reception of the ridge that is present on the nymph plate of the right valve. In immature examples, this cardinal is separated from the nymph throughout its entire length.

The anterior cardinal is straight and moderately heavy. It is separated from the posterior cardinal by a rather broad socket that has a flat or rounded bottom which does not have any trace of adaptation to fit the bifid right posterior cardinal. In *Cyprina islandica* this socket bears a prominent median ridge complementary to the bifid cardinal. The most striking feature of this valve is the presence of a long ridge paralleling the anterior dorsal margin of the valve which fits into the long socket-like groove of the right valve. It is distinctly raised above the margin of the valve and apparently functioned as an anterior lateral tooth, though there is no evidence suggesting that in its origin it is actually a greatly modified lateral tooth. All the specimens available were broken posteriorly so that none of them indicate the nature of the posterior ridge, or lateral tooth, complementary to the well-developed, socket-like groove on the right valve.

¹ The hinge of "*Cyprina*" *crassidentata* Zittel, as figured by that author (1865, pl. 5, fig. 2a), is defective, but the posterior cardinal certainly is not bifid. Specimens of "*Cyprina*" *tumida* Nyst, from the Pliocene of Antwerp, in the collections of the American Museum do not show this to be bifid, and furthermore the hinge is sufficiently different from that of *Venilicardia bifida* to make the reference of the former species to this genus very questionable. Stoliczka also refers to *Venilicardia* "our *Ven. Arcotica*, n.sp." but does not describe any such form. He does describe a single new species as "*Veniella* (*Venilicardia*) *obtruncata*" and this, presumably, is the same as his "*Ven. Arcotica*." The hinge of this form (1870, pl. 8, fig. 8) also shows no bifid posterior cardinal in the left valve.

In addition to the distinctive features of the hinge of the present species, it is marked by the presence of an exceptionally large, wide, and excavated escutcheon and a broad, long lunule which is only moderately impressed, becoming somewhat obscure on worn or on gerontic specimens. Another characteristic of this species, which may prove to be of generic importance, is the presence of *Astarte*-like concentric ridges on the umbonal region of the valves. These vary considerably in the area over which they are developed; in the majority of the specimens they are present for a distance of about 10 to 15 mm. from the umbo, but specimens in which they extend only 7 mm. are found, as is one exceptional case where they are present over an area from the umbo to a distance of 28 mm. Furthermore, there is a great variation in the distance between the separate ridges on any one specimen.

As has been pointed out in the discussion above, there are a number of points in which this species differs sharply from the genotypes of *Venilicardia* and *Cyprina*, and it is therefore here considered to represent a distinct generic group, although at the present time it seems to be an entirely monotypic one. Thiele, however, has figured a hinge of *Cyprina islandica* (1934, p. 856, fig. 819) which differs from any visible on the specimens in the collections of this Museum in the extension of the anterior lateral socket of the right valve into a groove paralleling the dorsal margin of the valve in a manner reminiscent of, though not entirely equivalent to, that shown on the right valves of the present species. This would seem to permit the suggestion that *Protocyprina* may be considered to be ancestral to, or very near the ancestral line of, *Cyprina* itself, although that genus shows no traces of the prominent escutcheon, or other characters which distinguish the Lebanon form.

Protocyprina libanotica (Fraas)

Plate 5, figures 1-12

Astarte libanotica FRAAS, 1878, p. 301 (p. 45 of separate), pl. 5, fig. 1a, b.

Cyprina (*Venilicardia* ?) *abeihensis* HAMLIN, 1884, p. 45, pl. 4, fig. 2a, b, c.

Cytherea libanotica Fraas sp., NOETLING, 1886, p. 869, pl. 26, figs. 1, 1a, 1b, 2, 3, 4; BLANCKENHORN, 1890, p. 91; WHITFIELD, 1891, p. 386;

ZUMOFFEN, 1926, pp. 77, 79, 81, 100; BLANCKENHORN, 1934, p. 252; DUBERTRET AND VAUTRIN, 1937, pp. 46-48 (after Zumoffen); VOKES, 1941b, p. 1722.

TOPOTYPES: A.M.N.H. No. 16390/1:1, length, 77.6 mm.; height, 69.8 mm.; diameter (right valve), 22.5 mm. Duccûn, Lebanon.

A.M.N.H. No. 16390/1:2, length, 36.9 mm.; height (incomplete), 27.0 mm.; diameter (right valve), 10.0 mm. Duccûn, Lebanon.

A.M.N.H. No. 16390/1:3; length (incomplete), 67.2 mm.; height (incomplete), 61.0 mm.; diameter (left valve), 25.5 mm. Duccûn, Lebanon.

HYPOTYPES: A.M.N.H. No. 26010:1; length (incomplete) 66.0 mm.; height (incomplete), 52.4 mm.; diameter (right valve), 25.0 mm. Olive Locality.

A.M.N.H. No. 26010:2; length, 32.8 mm.; height, 30.0 mm.; diameter (both valves), 18.4 mm. Olive Locality.

A.M.N.H. No. 26010:3; length, 24.4 mm.; height, 21.3 mm.; diameter (left valve), 6.8 mm. Olive Locality.

A.M.N.H. No. 26010:4; length, 7.5 mm.; height, 5.9 mm.; diameter (both valves), 2.7 mm. Olive Locality.

While Fraas' original description of this species is short and generalized, his mention of the "6-8 strong *Astarte*-like wrinkles next to the umbones," together with the recognizable illustrations, leaves no doubt that this is the species that was fully described and figured by Noetling (1886, p. 869, pl. 28, figs. 1, 1a, 1b, 2, 3, 4).

The range of variation is very great, particularly as to the ratio between the height and length of valves, and as to their relative diameter. Similar variation is also to be observed in the relative position of the umbones, in the strength of the posterior umbonal angulation, and therefore in the degree of truncation observable at the posterior margin of the valve. In view of this variability no effort has here been made to give varietal designations to the differences noted, except that one, unfortunately immature, specimen which is noteworthy for its exceedingly great length as compared to its height is formally designated below as the variety *elongata*. This seemed especially desirable in view of the fact that among the 73 specimens of the

typical form from the Olive Locality there was none that approached it in its relative elongation.

Protocyprina libanotica (Fraas) *elongata*,
new variety

Plate 5, figures 13, 14

HOLOTYPE: A.M.N.H. No. 26011; length, 19.5 mm.; height, 13.8 mm.; diameter (both valves), 9.5 mm. Olive Locality.

A single, immature specimen in the collection from the Olive Locality is so much longer in proportion to its height than are the other, typical specimens in the collection that, despite the great range of variation in shape and proportions noted for this species, it seems advisable to distinguish it from them under the new varietal name proposed above. In all other characteristics it agrees with the typical forms of this species.

VENILICARDIA STOLICZKA, 1870-1871

Venilicardia STOLICZKA, 1870-1871, *Palaeont. Indica*, ser. 6, vol. 3, pp. xviii, 190.

GENOTYPE: By original designation, *Cyprina bifida* Zittel. Cretaceous, Austria.

This genus has been discussed in detail with the preceding.

Venilicardia olivensis, new species

Plate 6, figures 12-15

HOLOTYPE: A.M.N.H. No. 26012:1; length, 39.5 mm.; height, 30.5 mm.; diameter (right valve), 14.2 mm.

PARATYPES: A.M.N.H. No. 26012:2; length, 39.4 mm.; height, 32.0 mm.; diameter (both valves), 26.5 mm.

A.M.N.H. No. 26012:3 length, 32.4 mm.; height, 28.3 mm.; diameter (left valve), 14.6 mm.

DESCRIPTION: The shell is of medium size, inflated, inequilateral, with prominent, though low, strongly inflated, opisthogyrous umbones which are situated at, or slightly in advance of, the anterior quarter of the length of the valve. In the holotype and in paratype A.M.N.H. No. 26012:3 the anterodorsal margin is convex, passing gradually into the rather sharply rounded anterior end. In paratype A.M.N.H. No. 26012:2 it is straight, and the anterior end is more sharply rounded, appearing as a result as though shorter than that on the holotype. On all

specimens the ventral margin is very broadly curved, though it is somewhat worn posteriorly on the holotype. The posterior ventral margin rounds sharply into the broadly convex posterior and posterodorsal edges. There is a low inconspicuous umbonal ridge extending to the posterior ventral margin. Dorsal to this ridge the surface of the valve tends to be somewhat flattened, though not so markedly so as in many of the Cretaceous species of this genus. This umbonal ridge is more strongly developed on the paratype than on the holotype. In addition, there is a broad and inconspicuous median depression or groove extending from behind the umbo to a point near the dorsal third of the posterior margin of the paratype. Neither the lunule nor the escutcheon is well defined. Ornamentation consists only of somewhat rugose growth lines.

The hinge is exposed on the holotype, a right valve. It is, essentially, typical of the genus, save that what is usually considered to be the median cardinal is here only the end of the strongly curved anterior element of the bifid posterior cardinal. It is not swollen or in any other way delimited from the rest of the curved portion of the posterior tooth as in *V. angulata* (Sowerby) or *V. lineolata* (Sowerby). (See Woods, 1907, pl. 22, figs. 2 and 6b.) In this respect it agrees more closely with the genotype, *V. bifida* (Zittel). The anterior cardinal is located anteroventral to the "median" one and is situated at the ventral side of the hinge plate, immediately below the posterior end of the anterior lateral socket. The posterior lateral socket is located near the posterior end of the dorsal margin. The ridge bounding its ventral side is well developed but does not possess the tooth-like tubercle found in *V. bifida*, *V. angulata*, or *V. lineolata*.

REMARKS: Both the hinge and the rather generalized external characters of this species are essentially typical of the genus. The anterior lateral¹ of the left valve is relatively long, narrow, and straight, rather than sinuous, as in *V. bifida* (Zittel).

¹ Stoliczka (1870, p. 190) refers to this tooth as an "antero-inferior cardinal" one, but its position below the lunular area and distinctly anterior to the umbo is such as to make the term "lateral" seem much more appropriate than "cardinal" for its designation.

Externally, the broad, swollen, relatively low umbones and their anterior location are the most distinguishing features of this species. Of the several species from the English Cretaceous figured by Woods, *V. angulata* (Sowerby) is the only one that is at all comparable in this respect, and that species is much higher in proportion to its length than the present one.

The hinge of *V. lagamensis* Douvillé (1916, p. 154, pl. 19, figs. 8a, b, 8 bis) from the Aptian at Bir Lagama, Massif of Moghara, Sinai Peninsula, is very similar to that of our specimens, but externally it differs in being narrower posteriorly so that the swollen umbones are relatively much higher.

"Venilicardia" turgida, new species

Plate 6, figures 19-21

HOLOTYPE: A.M.N.H. No. 26030; length, 24.9 mm.; height, 20.0 mm.; diameter (both valves), 16.0 mm.

DESCRIPTION: The single specimen in the collection is markedly ovate in outline as well as in profile; the ventral, anterior, posterior, and posterodorsal margins are broadly rounded, the anterior somewhat more sharply so than the posterior; discounting the slight projection of the umbones the dorsal and ventral margins are almost exactly of equal convexity. The valves are strongly inflated and swollen, but the umbones are, nevertheless, essentially low, and are approximate and prosogyrate. The surfaces of the valves are almost smooth, but under the microscope are seen to bear fine, concentric striations.

The hinge of the right valve consists of a strong, deeply bifid posterior cardinal and a short anterior cardinal which is parallel to the lunular margin of the valve. There is a peculiar, horizontally placed "median" cardinal almost centrally located in the socket separating the anterior and posterior cardinals. This tooth is posteroventrad from the anterior cardinal, but is contiguous with the ventral lamina of the anterior lateral socket, being separated from this lamina only by a distinct constriction. The lateral socket is moderately long, broad, and deep. A long posterior lateral socket is located immediately behind the equally long nymph plate, which is rather deeply excavated above.

Muscle scars and pallial line not seen.

REMARKS: It seems very probable that this unusual species is representative of an undescribed genus, but as the holotype is the only specimen in the collection, it has not been possible to compare it with other examples in order to make certain that the peculiar, horizontally placed "median" cardinal is not an individual anomaly or a pathologic feature in this specimen. The most nearly comparable example that I have been able to find is the diagrammatic figure of the hinge of "*Venilicardia*" *oblonga* D'Orbigny, from the Cenomanian, given by Douvillé (1921, p. 121, text fig. 15). In this species Douvillé indicates a small cardinal (1) situated almost immediately below the anterior end (3a) of the elongate superior cardinal (3b); this median cardinal tooth is, however, apparently entirely situated on the ventral margin of the hinge plate and is slightly elongated vertically rather than horizontally. There seems to be little doubt that the present hinge is derived from that of a *Venilicardia*-like form and that the species is most closely related to that genus.

The presence of this peculiar tooth, together with the inflated valves, the ovate outline, and the absence of any posterior umbonal ridge, will serve to distinguish the present species.

ANISOCARDIA MUNIER-CHALMAS, 1863

Anisocardia MUNIER-CHALMAS, 1863, Jour. de Conchyl., Paris, vol. 11, p. 288.

GENOTYPE: By monotypy, *Anisocardia elegans* Munier-Chalmas. Kimmeridgian, Jura, France.

The hinge of the sole imperfect specimen in the collection is too poorly preserved to permit of certain generic identification.

***Anisocardia* (?) *cardiomorpha*, new species**

Plate 6, figures 16-18

HOLOTYPE: A.M.N.H. No. 26013; length, 39.5 mm.; height (incomplete), 36.5 mm.; diameter (left valve), 14.9 mm.

DESCRIPTION: The shell is relatively large, almost circular in outline, with a prominent, moderately high and inflated, centrally located umbo whose termination is slightly prosogyrous. The surface of the valve is smooth, ornamented solely by lines of growth. The imperfect hinge of the left valve shows

a distant, rather weak, posterior lateral and two or three cardinals. The anterior cardinal is relatively thin, elongate, and markedly curved. Its anterior end is parallel to, and situated upon, the anteroventral edge of the hinge plate. The posterior cardinal is also somewhat curved, moderately thin and elongate, with the ventral half of the base of its posterior border fused to the relatively short nymph plate, the outer portion of the tooth being separated from the nymph by a distinct groove. Between the anterior and posterior cardinals, but closer to the anterior one, there is a broken base of what seems to have been a relatively short, lamellar, median cardinal.

REMARKS: The single broken specimen representing this species was found among the specimens determined by Whitfield as representing his "*Cardium*" *bewertense* (= *Integricardium*). Externally, it does resemble that species, but the hinge is entirely different. If the broken tooth does represent a median cardinal, as suggested above, this species cannot be correctly identified as *Anisocardia* and may represent an undescribed genus. There is a possibility, however, that this base represents the posterior portion of a deeply bifid anterior cardinal, whose anterior portion is strikingly elongated parallel to the margin of the hinge plate. This portion of the tooth forms the ventral margin of an elongate, socket-like depression which probably receives a short anterior lateral tooth on the right hinge plate.

ASTARTIDAE ?

AMPHIARAUS,¹ NEW GENUS

GENOTYPE: *Amphiarauus seleniscus*, new species. Aptian, Cretaceous, Lebanon Mountains.

The generic name *Eriphyla* Gabb, 1864, proposed for *E. umbonata* Gabb (1864, p. 180, pl. 24, fig. 162, 162a) has been widely and somewhat indiscriminately used for all those Cretaceous pelecypods of general discoidal shape and somewhat *Astarte*-like hinge. But as originally proposed by Gabb, the genotype was characterized by the presence of "two primary teeth in the right valve, and

¹ Etymology: "Amphiarauus," the husband of Eriphyla (= *Eriphyla*).

one in the left, and an anterior and posterior lateral tooth in each valve," to which Gabb adds, "On the left valve there is a rudiment of a second cardinal tooth, which enters a depression on the opposite side, behind the large, posterior, cardinal tooth of that valve." Unfortunately the original specimens showing the hinge seem to be lost (Stewart, 1930, p. 175), but Popenoe (1937, p. 387) states that hinges of *E. lapidis* (Packard) (1922, p. 423, pl. 30, fig. 4a, b) "agree fully . . . with hinges of specimens from Clover Creek, Shasta County [near Gabb's type locality] believed to represent *E. umbonata* Gabb." As figured by Popenoe (1937, pl. 46, figs. 11, 12) the right valve shows a heavy, subtrigonal, posterior cardinal tooth, and a thin anterior cardinal situated near the lunular margin of the valve. The ventral end of this anterior cardinal seems to be continuous with the ventral lamella bordering the anterior lateral socket, and I do not believe that either the ventral or the dorsal lamellae bordering this socket could correctly be interpreted as an anterior lateral tooth as was done by Gabb. The posterior lateral tooth is moderately heavy, elongate, and situated almost exactly on the valve margin, the hinge plate being very tenuous posteriorly. The left posterior cardinal tooth is thin and lamellar, fused to the nymph plate, and the anterior cardinal tooth is moderately strong and almost vertical in position. The anterior lateral tooth is long and quite heavy, and there is a moderately long posterior lateral socket, but no left posterior lateral tooth.

The hinge of *Eriphyla striata* (Sowerby) as figured by Woods (1906, pl. 17, figs. 2-7) from the Upper Greensands at Blackdown, England, agrees very closely with this diagnosis. This species shows a somewhat sinuous pallial line, and Popenoe (1937, p. 387) reports that specimens from Clover Creek, Shasta County, California, probably representing *E. umbonata*, show a similarly sinuous pallial line. The internal margins of both species are smooth.

Specimens figured by Woods (*op. cit.*, pl. 16, figs. 5a, b, c, 6a, b, 7a, b) as *Astarte* (*Eriphyla*) *laevis* (Phillips), from the Claxby Ironstone of England, have a heavier, compressed hinge and also show strongly denticulate internal margins. This latter feature is, however, of questionable value as a factor in

generic determinations among the Astartidae.

Eriphyla lenticularis (Goldfuss), a widespread species of the European and African Senonian deposits, is very similar to *E. umbonata* and *E. striata* in its general hinge characters, except that, as figured by Holzapfel (1889, pl. 14, figs. 5a, b, 6, 7a, b), the right posterior cardinal is rather deeply notched and the left posterior cardinal is proportionally heavier than that of *E. umbonata*. The internal margins of the valve are not denticulate, and the pallial line is sinuous. It is the type of *Dozyia* Bosquet *in* Dewalque, 1868, and this name should probably be used, at least subgenerically, for it.

The collections from the Olive Locality contain two representatives of an *Eriphyla*-like species that differs, however, from the typical *Eriphyla* in the nature of the posterior portion of the hinge area. The new generic name *Amphiaraus* is here proposed for this species, in which the hinge plate is perceptibly narrowed at the posterior end of the nymph plate but tends to become slightly broader again to accommodate a moderately deep, narrow, and elongate groove bordered ventrally by a pronounced, tooth-like ridge that extends to the posterior end of the dorsal margin and, broadly curving, passes a short distance down the inner margin of the posterior end of the valve. The posterior end of the dorsal margin of the left valve is received within the groove on the hinge plate, and the ventral ridge fits within the margin of the valve, as there is no socket on the left valve for its reception. Other characters that distinguish this genus from *Eriphyla* are: the nymph plate is proportionally much shorter and is deeply excavated; the lunule, while being impressed and well marked by an incised line, is not deeply excavate and prominent; the escutcheon is pronounced, excavated, and deep, extending the full length of the posterior dorsal margin, and is bounded by a sharp, carinate, posterior umbonal ridge.

The genotype is the only species known at this time that is referable to this genus.

***Amphiaraus seleniscus*, new species**

Plate 6, figures 22-24

HOLOTYPE: A.M.N.H. No. 26035; length, 29.6 mm.; height, 26.9 mm.; diameter (right valve), 7.2 mm.

DESCRIPTION: The shell is of normal size for the genus, moderately inflated, and sub-circular in outline, with a long, broadly arched, posterior dorsal margin and broadly rounded posterior, ventral, and anterior margins. The umbo is low and strongly prosogyrate. The lunule is long and lanceolate, delimited by a well-impressed line; the escutcheon is pronounced, excavated, and deep, extending the full length of the posterior dorsal margin, and bounded by a sharp, carinate, posterior umbonal ridge. The surface of the valve was ornamented by a few low, concentric ridges in the umbonal area, but these soon become submerged, and over the greater part of the surface the only ornamentation consists of fine lines of growth.

The hinge of the right valve consists of a relatively broad and heavy trigonal posterior cardinal with a small anterior cardinal which extends only about one-half the way across the hinge plate, being delimited ventrally by a broad, shallow, anterior lateral groove which extends for approximately two-thirds the length of the lunular margin. The nymph plate was relatively heavy and excavated to form a sharply impressed ligamental groove. Posterior to this the valve margin is deeply grooved with a tooth-like lateral ridge bounding its inner margin. This ridge occupies the posterior third of the posterior dorsal margin and extends, with a broad curve, a short distance down the posterior margin. The edge of the left valve fitted into the groove that was just dorsal to this ridge, and the ridge fitted into the valve itself, with no comparable depression or socket present in the left valve for its reception.

Pallial line and muscle scars not observed.

REMARKS: The nature of the posterior portion of the hinge area, the long, deep escutcheon bounded by a carinate posterior umbonal ridge, and the unusually long posterior dorsal margin of the valve, together with the non-excavate lunule, will serve to distinguish this species from those that have been referred to *Eriphyla*, as well as from a number of somewhat superficially similar forms that have been identified as "*Lucina*."

CRASSATELLIDAE

PACHYTHAERUS CONRAD, 1869

Pachythaerus CONRAD, 1869, Amer. Jour. Conch., vol. 5, p. 47.

GENOTYPE: By original designation, *Crassatella "vindiemensis"* (= *vindinnensis*) D'Orbigny. Turonian, Cretaceous, France.

This name has been rather thoroughly neglected by taxonomists since its proposal by Conrad in 1869, yet it seems to include a rather distinctive group of small, moderately elongated and subtrigonal crassatellid species characterized by a prominent concentric ribbing over the main surface of the valve, and with a prominent umbonal ridge or angulation extending to the posterior ventral margin. The posterior dorsal surface of the valve is usually flattened and marked by concentric sculpture which is normally more lamellose than that on the rest of the valve.

The hinge is marked by the presence in the left valve of a long, narrow, lateral (or pseudolateral) tooth situated on the lunular margin of the valve. At the upper end of this tooth and fused with the valve margin is a thin anterior cardinal. This is followed by a moderately broad, triangular, cardinal socket, bounded posteriorly by a cardinal tooth which tends to expand below to margin the relatively long and narrow cartilage pit that is immediately adjacent. A long posterior lateral tooth is bordered dorsally by a relatively narrow groove above which is a low, thin ridge. I have not seen an adequate hinge of a right valve, but it must include an anterior lateral groove or small claspers, a narrow anterior cardinal socket, followed posteriorly by a moderately heavy cardinal tooth. The socket for the posterior cardinal of the left valve cannot be separated anteriorly from the cartilage pit except possibly by the greater depth of the socket itself. The posterior lateral tooth must be long and narrow, and may possibly form the dorsal side of a socket for the reception of the lateral of the right valve.

This hinge corresponds very closely with that observed in *Gouldia conradi* Whitfield (1885, p. 125, pl. 18, figs. 1-3), the type of *Uddenia* Stephenson (1941, p. 180). This genus is apparently very closely related to *Pachythaerus*, differing principally in having a short, high outline with relatively long, straight anterior and posterior dorsal margins, and in lacking the pronounced posterior umbonal angulation or ridge. The most distinctive feature separating the two groups, however, lies in the fact that the anterior,

ventral, and dorsal margins of the valves of *Pachythaerus* are rather strongly denticulate, while those of *Uddenia* are grooved.

The forms described by Wade from the Ripley group at Coon Creek, Tennessee, as *Vetericardia subangulata* (1926, p. 78, pl. 24, figs. 10, 11) and as *Vetericardia gregaria* (Meek and Hayden)? (1926, p. 79, pl. 25, figs. 1-3) are to be referred to *Pachythaerus*. The latter form is not conspecific with that described by Meek and Hayden (1856, p. 84) as *Astarte*. A comparison of the types of "*Astarte*" *gregaria* (see Meek, 1876, p. 124, text figs. 6 and 7, pl. 17, fig. 9, a, b) with the specimens and figures of "*Crassatellites*?" *conradi* (Whitfield), illustrated by Stephenson in the volume on the Cretaceous formations of North Carolina (1923, p. 274, pl. 67, figs. 10-16), suggests the close relationship of Meek and Hayden's species to *Uddenia*. The hinges prepared by Meek are, however, a bit too imperfect to permit certain generic reference.

***Pachythaerus similoides*, new species**

Plate 7, figures 10-13

HOLOTYPE: A.M.N.H. No. 26009:1; length, 12.1 mm.; height, 9.3 mm.; diameter (both valves), 5.3 mm.

PARATYPE: A.M.N.H. No. 26009:2; length, 15.5 mm.; height, 11.0 mm.; diameter (left valve), 4.0 mm.

DESCRIPTION: The shell is relatively small for the genus, subtriangular, and but moderately inflated. The umbones are situated approximately at the anterior third of the length of the valve and are prosogyrate. The posterior dorsal margin is almost straight; the anterior, slightly concave; the anterior margin is rounded; the ventral very broadly convex and sharply angulate posteriorly to the relatively short, straight, truncated posterior end. A pronounced angulation of the surface of the valve extends from the umbo to the posterior ventral margin. Anterior to this angulation the surface of the valve is ornamented by moderately strong, rounded, concentric ribs separated by interspaces of approximately one-half to one-third the width of the ribs. A much finer, secondary concentric ribbing is superimposed upon both the primary concentric ribs and the interspaces. Posterior to the angulation of the

valve surface, the ornamentation consists of slightly lamellose concentric ribbing which appears to be formed by the junction of adjacent pairs of primary concentric ribs from the area anteriorly. The secondary ribbing does not cross the angulation. The lunule is lanceolate, moderately broad, and well impressed. The anterior, ventral, and posterior internal margins are rather coarsely denticulated.

REMARKS: The only hinge available for examination, that of a left valve, had been distorted and somewhat crushed. It agrees very well, however, with that of the genotype species as figured by D'Orbigny (1844, pl. 266, fig. 3, as *Crassatella*), and also with that of "*Crassatella*" *subregularis* Douvillé (1916, p. 162, pl. 21, figs. 3a, b, 4) described from the Aptian of the Massif du Moghara, east of the Isthmus of Suez.

This latter species and "*Crassatella*" *regularis* D'Orbigny (1844, p. 80, pl. 266, figs. 4-6) are both apparently closely related to *Pachythaerus similoides* and should be referred to this genus. All three species show a similar general sculpture pattern, in which pairs of primary concentric ribs tend to unite on crossing the umbonal ridge.¹ However, the fine, superimposed, secondary ribbing seems to be unique in the present species, which also differs from the others in having somewhat more central beaks, a broader anterior end, and a shorter truncated posterior margin.

GOULDIIDAE

MEDIRAON, NEW GENUS

GENOTYPE: *Mediraon divaricatum*, new species. Aptian, Cretaceous, Abeih, Lebanon Mountains.

Shell moderately small, equivalved, produced posteriorly, and strongly compressed, with a distinct posterior emargination. The umbones are low and flattened, and there is a deeply excavated, elongate lunule and escutcheon. The hinge of the right valve consists of a rather slender, slightly curved, anterior cardinal tooth, separated by a deep

¹ Douvillé made this "réunion deux à deux des bourrelets d'accroissement dans la région siphonale" one of the principal bases for separating his form from that of D'Orbigny, but the latter's figure 4 clearly shows that such a condition does occur over at least a portion of the valve.

and moderately wide socket from a heavier, subtrigonal posterior cardinal. Both anterior and posterior cardinals are transversely striated along their sides. Behind the posterior cardinal tooth there is a rather narrow socket, bounded posteriorly by a low, thin, shelly ridge which delimits the anterior side of a long, narrow chondrophore. The anterior and posterior dorsal margins of the valves are thinned and projecting, with a distinct, elongate, lateral socket ventral to each. The anterior socket is bordered ventrally by a heavy anterior lateral tooth; the posterior lacks a strong ventral tooth, being essentially a broad platform. The left valve bears two strong, elongate, cardinal teeth, the anterior being separated from the anterior margin of the valve by a moderately wide triangular socket. The posterior cardinal tooth is composed of a long, rather thin, anterior tooth and a posterior segment that is only about one-half as high as the tooth and is flattened into a sort of platform. The anterior segment fits into the socket, which is behind the posterior cardinal of the right valve, and the posterior platform seems to rest upon the shelly ridge that bounds the chondrophore on the right valve. A similar, narrow chondrophore is also present on the left valve immediately behind the posterior cardinal tooth. The anterior and posterior dorsal margins of this valve are also thinned and projecting with a distinct lateral socket ventral to the margins; the posterior socket is bordered ventrally by a prominent lateral tooth, while the anterior lacks a strong ventral tooth and is essentially a broad platform. When the two valves are in association, the thinned projecting anterior dorsal margin of the left valve is received within the socket formed between the projecting dorsal margin and the anterior lateral tooth of the right valve. Posteriorly the reverse condition exists, the projecting margin of the right valve being received within the socket created by the projecting margin and the lateral tooth of the left.

This genus is clearly closely related to *Remondia* Gabb, 1869 (p. 270, pl. 36, fig. 17, 17a), monotype species, *R. furcata* Gabb from the Lower Cretaceous of Mexico, and to *Stearnsia* White, 1887 (pp. 32-34, pl. 2, figs. 7-9), type species, by original designation, *S.*

robbinsi White from the Lower Cretaceous of Texas. Stanton (1897, pp. 299-301, pl. 26, figs. 1-8) held *Stearnsia* to be a synonym of *Remondia*, but the differences in outline and in hinge characters, shown both in his and in the original illustrations, are sufficient to justify, in modern usage, the separation of the two forms.

In general, *Mediraon* is intermediate in position between these two genera. It has the general outline and the crenulate internal margins of *Remondia*, and a hinge that is more like that of *Stearnsia*, although differing in some details. The hinges of the right valve of *Mediraon* and *Remondia* appear to be identical in character, and those of the left valve are quite similar even to the possession by both genera of the essentially bipartite posterior cardinal with the posterior platform-like projection described above. In addition to the two cardinals, however, the hinge of *Remondia* carries a peculiar tooth-like ridge crossing the area which, in *Mediraon*, is occupied by the chondrophore (see Stanton's excellent figure, 1897, pl. 26, fig. 5). Stanton does not mention this feature in his discussion of the genus, but apparently did not consider that it represented a cardinal tooth, and its significance is not apparent. The entire absence of any trace of this structure in the present species seems to justify their generic separation from *Remondia*.

In addition to the present species, "*Remondia*" *ferrissii* Cragin (1889, p. 68), from the Lower Cretaceous of Kansas, is referred to *Mediraon*. (See pl. 6, figs. 10, 11.)

Mediraon divaricatum, new species

Plate 6, figures 1-8

HOLOTYPE: A.M.N.H. No. 26008:1; length, 21.2 mm.; height, 13.5 mm.; diameter (both valves), 6.6 mm.

PARATYPES: A.M.N.H. No. 26008:2; length, 18.9 mm.; height, 13.1 mm.; diameter (both valves), 6.4 mm.

A.M.N.H. No. 26008:3; length, 18.3 mm.; height, 11.7 mm.; diameter (both valves), 5.9 mm.

A.M.N.H. No. 26008:4; length, 22.0 mm.; height, 15.0 mm.; diameter (right valve), 3.6 mm.

DESCRIPTION: The shell is small, equivalved, and sub-trapezoidal in outline, com-

pressed and produced posteriorly; the umbones are small, flattened, and closely approximate, situated at the anterior quarter of the length of the shell. The anterior dorsal margin is markedly concave. The anterior margin is rounded to the straight ventral edge, and the posterior edge is truncate, concave, and angulate ventrally and dorsally. The posterior dorsal margin is straight to slightly convex. Both the lunule and escutcheon are prominent, broad, and impressed. The surface of the valve is marked by two posterior umbonal ridges, one forming the posterior dorsal margin separated from the other, which extends to the posterior ventral margin, by a broad concave area. The ornamentation consists of seven to nine strong concentric undulations on the umbonal portion of the valve. These undulations occupy slightly more than the dorsal third of the valve and are most strongly developed on the posteroventral umbonal ridge and just anterior to it. The ventral surface anterior to the posteroventral umbonal ridge is marked by a strongly divaricate ribbing reminiscent of that present in *Acila* or *Divaricella*. This ribbing is absent on the posterior dorsal slope which is marked by somewhat rugose lines of growth.

The inner edge of the escutcheon on the right valve is received in a longitudinal groove in the left, and the same condition seems to hold for the lunule, but this cannot be absolutely confirmed on the basis of the present material. The interior margins of the valve are minutely crenulated; the pallial line is entire. The anterior and posterior adductor scars are small and impressed. The features of the hinge have been described in the diagnosis of the genus.

REMARKS: Seven specimens represent this species in the present collection. The shell material is relatively thick for the size of the shell. In paratype A.M.N.H. No. 26008:4, which has a diameter of 3.6 mm. for the single valve, the shell material has a thickness of 2.1 mm., so that in this specimen the shell, complete, would have a diameter of 7.2 mm., while the body of the animal would be but 3 mm. in width.

The divaricate sculpture on the ventral portion of the shell will at once distinguish this species from both *M. ferrissii* (Cragin)

Conrad and *M. secundum* (Whitfield). These species also differ in shape in possessing more elevated umbones and, as a result, a concave posterior dorsal margin.

***Mediraon secundum* (Whitfield)**

Plate 6, figure 9

Scambula secunda WHITFIELD, 1891, p. 402, pl. 6, fig. 1; BLANCKENHORN, 1934, p. 222.

HOLOTYPE: A.M.N.H. No. 16361/1; length (incomplete), 15.7; height, 12.2 mm.; thickness (both valves), 3.5 mm.

Whitfield described this species as follows: "Shell small, irregularly trapezoidal in outline and very compressed, almost flat; beaks small, closely appressed, situated a little nearer the anterior than to the posterior end of the shell; anterior end rounded, gradually passing into the basal border, which is broadly and nearly regularly curved; posterior end truncate, very slightly emarginate near the middle, posterior cardinal margin concave or excavated between the beaks and the posterior end, the cardinal face, or escutcheon, concave. Disc of the valves marked by a distinct umbonal ridge, and the posterior cardinal slope concave. Surface of the shell marked by concentric undulations, very much coarser on the posterior portions than on the anterior portions of the shell, strongly bent on the umbonal angle and retrally undulated as they cross the postero-cardinal slope. Besides the undulations, fine concentric striae can be observed under a glass, which are independent of the undulations and cross them, showing that the undulations are not quite parallel to the margin of the shell. Interior unknown."

The holotype is the only known representative of this species. An examination of the collections at the American University at Beirut, at the American Museum of Natural History, and the material collected by the writer failed to reveal any additional specimens.

The hinge and internal characters are unknown, and the generic reference can be considered to be provisional only. However, the external shape is identical with that of the genotype and of *M. ferrissii* (Cragin), and there is no basis for doubt as to the validity of this assignment.

CARDITIDAE

XENOCARDITA, NEW GENUS

GENOTYPE: *Cardita lacunar* Hamlin. Cretaceous, Lebanon Mountains.

The genotype of *Cardita* Bruguière, 1792 (Encyclopédie méthodique, Histoire naturelle des vers, vol. 1, pp. 401-413) is (by subsequent designation, Children, 1823, p. 316, pl. 6, fig. 60), *Cardita sulcata* Bruguière = *Chama antiquata* Linné, a Recent species from the fauna of the Mediterranean Sea. The hinge is marked by the presence, in the right valve, of two cardinals. The anterior one (3a) is small, slender, almost vertical in position, and fused to the margin of the lunule. The posterior one (3b) is long, oblique, and slightly curved with a tendency to be grooved, though this latter feature is very variable (see Stewart, 1930, p. 150). The hinge of the left valve shows a small anterior cardinal, the dorsal edge of which is generally distinctly below the mid-line of the anterior cardinal (3a) of the right valve. The left posterior cardinal (4b) is elongate and relatively narrow. In this valve the anterior margin of the small lunule is so deeply incised as to seem to intrude upon the hinge plate. Immediately ventral to this end of the lunule is a small raised area that may be interpreted as an obscure anterior lateral. It has the appearance of a bit of shell that has been displaced by the ingrown edge of the lunule. A slight depression on the right valve tends to confirm the interpretation of this structure as a lateral tooth.

In general, these hinge structures are very similar to those observed in "*Chama*" *calyculata* Linné, the genotype (by subsequent designation, Stewart, 1930, p. 149) of *Arcinella* Oken, 1815, and also (by subsequent designation, Bucquoy, Dautzenberg, and Dollfus, 1892, p. 277) of *Mytilicardita* Anton, 1839.

The species from Lebanon described by Hamlin as "*Cardita lacunar*" has a very different hinge structure. The right valve is characterized by a large, trigonal, cardinal tooth with a deep, laterally elongate socket immediately anterior to it, and a broad, obliquely elongate socket posterior to the cardinal tooth. The apex of this socket extends above the posterior dorsal edge of the tooth. There is, in addition, a long, narrow, posterior

cardinal tooth closely approximate to the margin of the valve, though separated by a shallow, very narrow, groove-like socket for the reception of the long, slender, posterior lateral tooth of the left valve. Anterior to these structures and entirely off the hinge plate is a long, shallow, and inconspicuous groove in the valve margin below the anterior two-thirds of the large lunule. In general appearance it resembles the grooved valve margins found in some venerid species for the reception of the beveled edges of the opposite valve. In the present species, however, the left valve shows a distinctly raised, very elongate and curved ridge which certainly cannot be interpreted as a beveled valve margin. Functionally, this structure seems to resemble an anterior lateral tooth, though unlike any such tooth that I have ever observed. Posterior to the hinge plate, this left valve does bear a pair of long, raised ridges extending to the posterior dorsal margin, between which is received the beveled edge of the right valve. In addition to these structures this valve has an elongate tooth that is presumably the anterior cardinal, though strongly suggestive in appearance of an anterior lateral, save that it is closely approximate to the socket for the reception of the large trigonal cardinal of the right valve. Behind this are the deep cardinal socket; an elongate, curved, posterior cardinal tooth; a long, curved, posterior cardinal socket; and the long, thin, posterior lateral tooth mentioned above.

Some features of this interpretation may be somewhat open to question, since, as described above, it is a virtual transposing of the hinge elements seen in the typical *Cardita*. If they were to be interpreted strictly in the light of the elements of *C. antiquata*, then it would seem that the small anterior cardinal (3a) of the latter form is entirely absent in the present species. The large median cardinal would be homologous with the large posterior cardinal (3b), while the tooth, considered above as representing a narrow posterior cardinal, would be a posterior lateral, and the narrow groove, interpreted as a lateral socket, would receive either the dorsally situated very long slender posterior lateral, as interpreted above, or a raised ventral margin bounding the ligamental area.

The relatively large lunule, which has a median "pout" similar to that shown by some species of *Nucula*, also serves to distinguish *Xenocardita lacunaris* from typical *Cardita*, where the lunule is small, and so very deeply depressed as to be almost vertical in position.

***Xenocardita lacunaris* (Hamlin)**

Plate 7, figures 1-8

Cardita lacunar HAMLIN, 1884, p. 53, pl. 5, fig. 1a-e; BLANCKENHORN, 1890, p. 84, pl. 6, fig. 2b; WHITFIELD, 1891, p. 385; ZUMOFFEN, 1926, pp. 63, 77; BLANCKENHORN, 1934, p. 218; DUBERTRET AND VAUTRIN, 1936, p. 46 (after Zumoffen); VOKES, 1941b, p. 1722.

TOPOTYPES: A.M.N.H. No. 26007:1; length, 7.8 mm.; height, 7.0 mm.; diameter (both valves), 5.8 mm.

A.M.N.H. No. 26007:2; length, 8.7 mm.; height, 7.1 mm.; diameter (both valves), 5.8 mm.

A.M.N.H. No. 26007:3; length, 6.9 mm.; height, 6.5 mm.; diameter (both valves), 5.5 mm.

A.M.N.H. No. 26007:4; length, 9.0 mm.; height, 7.5 mm.; diameter (right valve), 3.4 mm.

A.M.N.H. No. 26007:5; length, 8.0 mm.; height, 7.3 mm.; diameter (left valve), 2.7 mm.

Hamlin's original description of this species is as follows:

"Shell small, roundish-quadrangular, a little longer than high, tumid, inequilateral, furnished with oblique, incurved, closely approximate antemesial umbones: anterior margin insinuate, rounded, the posterior one abruptly truncate, the hinge margin gently sloping backward, the ventral regularly arcuated: surface elegantly sculptured with fourteen radiating, compressed scaly ribs; the scales sub-erect, round at the end, imbricate; interspaces of the ribs wide and deep, the hinder two upon the left valve divided by transverse lamellae after the manner of lucunaria: lunule small, cordate, excavated on each side, elevated in the middle. Characters of the interior unknown.

"Five examples, almost uniform in size, and all retaining the test entire. Length 8½ mm., height, 7½ mm., thickness, 6 mm.

"In all the specimens the posterior cardinal margin of the left valve is conspicuously

higher than that of the right; and the interspace of the hindermost two ribs of the same valve is divided by delicate and flexuous transverse lamellae into four-sided pits, panels, or compartments, widest in proportion to their length toward the beaks and narrowing downward. This structure, which suggested the specific name, is upon the right valve barely indicated, never complete. Coll. Bird."

The original specimens were said to be "probably from the vicinity of Abeih," and those from Olive Locality are here considered to represent topotypes. There are two reasons which justify this reference: first, this is one of the most abundant fossils at this locality, as there are 675 specimens in the Beirut collections whereas it is relatively rather rare at other localities; and, second, these specimens are the only ones at Beirut that are free and retain "the test entire" as required by the original description.

These specimens closely agree with Hamlin's diagnosis save that all show more numerous radial ribs; there are 18 or 19 ribs on the right valve and 18 to 20 on the left valve, whereas Hamlin reports but 14. It is a coincidence that there are, almost constantly, 14 ribs on the anterior and median slopes of the valve up to the angulation bounding the posterior area of the shell. These ribs are elevated, with steeply sloping sides, and are separated by almost flat-bottomed interspaces which are approximately twice the width of the rib. Anteriorly the ribs are somewhat triangular in section, with the result that the interspaces appear to be wider, though actually they are of the same relative width as those on the middle of the valve. All these ribs tend to be rather strongly imbricated by raised lamellar scales present only on the top of the rib.

The most striking and diagnostic feature of this species is the unusual ornamentation developed on the posterior slope of the left valve. A detailed view of this region is given on plate 7, figure 7. Here there are three slender, distant, radial ribs separated by broad interspaces which are ornamented by sharp transverse "lamellae." The anterior one extends to the posterior ventral angulation and is closely approximate to the posterior radial rib on the median part of the valve.

The posterior of these three ribs extends to the dorsal end of the short, straight, truncate posterior margin. Contrary to Hamlin's description, there are three ribs separated by "lamellae" and, furthermore, there is another major rib posterior to these and parallel to the raised posterior dorsal margin of this valve, with a fine riblet in the interspace between the two. The raised lamellae in the interspaces between the three posterior ribs are remarkable in the fact that they are of distinctly separate origin in each of the two interspaces. Those of the anterior interspace arise at small nodes on the anterior rib and join the median rib opposite an inter-lamellar area of the second interspace. The lamellae of the latter area form nodes on both the median and posterior ribs and tend somewhat to override the latter rib, but die out before reaching the riblet in the posterior dorsal interspace.

CARDIIDAE

INTEGRICARDIUM ROLLIER, 1912

Integricardium ROLLIER, 1912, Mém. Soc. Palaeont. Suisse, vol. 38, p. 127.

GENOTYPE: By original designation, *Cardium dupinianum* D'Orbigny. Cretaceous (Albian), France.

The peculiar, essentially non-cardiid external shape of the genotype is well shown in D'Orbigny's figures (1843-1847, pl. 242 bis, figs. 1-3). "*Cardium (Serripes ?)*" *bewertense* Whitfield and "*Caryates*" *globulus* Whitfield, here referred to *Integricardium*, agree in possessing distinctly prosogyrate umbones and in lacking any suggestion of radial ornamentation. In general shape, however, they are not so greatly elongate as is D'Orbigny's species, the umbones are not so far anterior, and the posterior ends are higher and more truncate. In these characters they more nearly resemble the Recent *Serripes groenlandicum* (Bruguière), the monotype of *Serripes* Beck MS (*in* Gould) (1841, p. 93). That species, however, has a definite, though superficial tendency toward the development of radial ribbing, a character that suggests that it has an entirely different phylogenetic origin. The resemblance is here considered to be an entirely fortuitous one.

It is clear from Rollier's original description of this [sub]genus (1912, pp. 127-129) that

the name was proposed to include all those cardiids which are "caractérisé par l'absence complète de stries rayonnantes." An examination of the 15 species that he refers to it shows that there is a great range of variation in the outline of the valves and in the relative position of the umbones. This variation fully embraces the differences separating the present species from the genotype.

Integricardium bewertetense (Whitfield)

Plate 7, figures 26-28

Cardium (Serripes ?) bewertetense WHITFIELD, 1891, pp. 386, 404, pl. 6, figs. 11-14.

Cardium bawiriense Whitfield, ZUMOFFEN, 1926, p. 62; DUBERTRET AND VAUTRIN, 1937, p. 49 (after Zumoffen).

Cardium bewertetense Whitfield, BLANCKENHORN, 1934, p. 238.

"*Cardium*" *bewertense* Whitfield, VOKES, 1941b, p. 1722.

SYNTYPES: A.M.N.H. No. 16379/1:1; length, 36.6 mm.; height, 34.8 mm.; diameter (both valves), 25.3 mm. "Bewerty." (Whitfield, 1891, pl. 6, figs. 11, 12.)

A.M.N.H. No. 16379/1:2; length, 42.5 mm.; height, 41.0 mm.; diameter (left valve), 14.8 mm. "Bewerty." (Whitfield, 1891, pl. 6, fig. 13.)

A.M.N.H. No. 16379/1:3; length, 24.5 mm.; height, 22.7 mm.; diameter (right valve), 9.5 mm. "Duccûn." (Whitfield, 1891, pl. 6, fig. 14.)

HYPOTYPE: A.M.N.H. No. 26014; length, 26.0 mm.; height, 22.8 mm.; diameter (right valve), 9.0 mm. Olive Locality.

Whitfield originally described this species as follows:

"Shell attaining a diameter of 5 cm. or over; subquadrangular in general outline, with moderately large, slightly incurved beaks, situated a little anterior to the middle of the shell; valves only moderately ventricose, the casts being depressed convex only; umbonal ridge subangular, with a flattened cardinal slope and almost squarely truncated posterior end. Surface of the shell marked only by fine concentric lines of growth. In the interior the hinge plate is rather narrow posteriorly, anteriorly it is very well-developed with a proportionately large antero-lateral tooth, the postero-lateral being distinct, but not large. Cardinal teeth well-developed. Muscular scars, as shown on in-

ternal casts, of large size, but of moderate depth.

"This shell resembles *Hemicardium Hilanum*, Sow., in its quadrate and nearly equilateral outline, but differs materially in being less ventricose, and entirely so in wanting the surface markings, there being only the fine concentric lines of growth.

"Localities.—In the clayey limestone of the Bewerty beds, at Bewerty, preserving the shell in good condition; and as casts only at Naaman, about $5\frac{1}{2}$ miles east of Aithath, Beirut district, Syria. A single valve of smaller size, but having characters too similar to be separated from it, has been obtained from the Abeih sandstone at Duccân, near Abeih."

The identity of the casts from Naaman with the types from "Bewerty" is open to serious question. They are certainly referable to the genus *Cardium*, *sensu lato*, but the largest, which has a length of 55 mm., bears very indistinct traces of radial ribbing on the posterior slope and seems more likely to be conspecific with the similar, but better preserved casts from the upper Aptian (Vokes, 1941b, pp. 1723–1724) which have been referred to *Protocardia biseriata* (Conrad) (Vokes, 1942, p. 2).

Six specimens representing this species occur in the collections from the Olive Locality. They are, in general, smaller than the adult specimens from "Bewerty." The umbones tend to be more nearly central in position, and the posterior slope is less sharply truncate. These characters are, however, also to be observed in the smaller, less mature individuals from the type locality.

The transliteration of some of the Arabic names for the mountain villages is one that seems subject to a great amount of individual interpretation. One of the more difficult of these transliterations is that of the name of the village which is referred to by Whitfield as "Bewerty" and by Zumoffen as "Baouirteh" and as "Bawirte." It is, however, clear that Whitfield's spelling of this specific name is not a *lapsus*, and therefore it should stand as proposed.

***Integricardium globulum* (Whitfield)**

Plate 7, figures 29–32

Caryates globulus WHITFIELD, 1891, pp. 386, 410, pl. 7, fig. 10, 11.

Venus ? globulus Whitfield, BLANCKENHORN, 1934, p. 250.

HOLOTYPE: A.M.N.H. No. 16386:1; length, 23.6 mm.; height, 22.1 mm.; diameter (both valves), 14.9 mm. Locality, "Klelay."

HYPOTYPES: A.M.N.H. No. 26037:1; length, 19.6 mm.; height, 18.6 mm.; diameter (both valves), 15.0 mm.

A.M.N.H. No. 26037:2; length, 19.2 mm.; height, 17.8 mm.; diameter (right valve), 6.6 mm.

A.M.N.H. No. 26037:3; fragmentary left valve showing hinge.

This species was originally referred by Whitfield to the genus *Caryates* (= *Pitar*) and described as follows:

"Shell below a medium size, globular in form when not distorted; the rather strong beaks being subcentral and directed anteriorly, but not remarkably so. Ligament small, but distinct. Surface marked only by concentric lines of growth, but these are rather strong, very distinctly marked and often gathered into indistinct groups.

"The distinctly globular form of this shell, together with the moderately strong subcentral beaks will serve to distinguish it from any of the associated species. I have not seen the interior of the hinge, but there can be but little doubt of its generic relations."

The preparation of the hinge shows, however, that this species is not a member of the Veneridae, but is to be referred to the Cardiidae, being quite closely related and very similar to Whitfield's "*Cardium (Serripes?)*" *bewertense* (= *Integricardium*). These species are to be separated on the basis of the relatively smaller size and greater inflation of the valves of *I. globulum*, together with certain minor details in the nature of the hinge which, so far as can be determined from the few examples available, seem consistently to differ in the following characteristics: (1) the anterior lateral socket of the right valve of *I. globulum* is proportionally much heavier and broader than the socket in *I. bewertetense*; (2) the anterior cardinal socket of this valve is not well delimited anteriorly in *I. globulum*; (3) the posterior lateral socket is somewhat shorter and more removed from the cardinal teeth, being located on the angle between the posterior end of the dorsal margin and the posterior end

of the valve in *I. globulum*, whereas it is entirely on the dorsal margin in *I. bewertense*; (4) the right anterior lateral tooth is longer, and its posterior end more closely approaches the cardinal teeth in *I. bewertense*; (5) the anterior cardinal tooth is a little less strongly developed, and the socket posterior to it is slightly broader in *I. globulum* than in *I. bewertense*.

NEMOCARDIUM MEEK, 1876

Nemocardium MEEK, 1876, Rept. U. S. Geol. Surv. Territories (Hayden), vol. 9, pp. 167, 173.

GENOTYPE: By virtual monotypy and subsequent designation, Sacco, 1899, *Cardium semiasperum* Deshayes. Eocene, France.

Nemocardium is a genus whose species are chiefly of Eocene and Oligocene age. They are characterized by the presence of fine radial riblets over the anterior and median surfaces of the valve, with coarser radial ribs on the posterior surface. These latter ribs bear prominent tubercles which are on the ribs rather than in the interspaces as in *Brevicardium* Stephenson (1941, p. 203). Both types of radial ribs are reflected in the crenulate internal margins of the shell, the strength of the crenulations being in agreement with that of the ribbing. The hinge is characterized by the unequal development of the cardinal teeth, with the anterior right and posterior left cardinals greatly reduced and the opposite cardinals very large.

NEMOCARDIUM, SENSU LATO

Cardium (*Protocardium* ?) *birdanum* Whitfield, from the Aptian deposits of the Lebanon Mountains, agrees with the typical *Nemocardium* in all the above characteristics, although the tubercles on the posterior ribs tend to be weak and are usually eroded away. It is, however, distinguished by the possession of a very prominent callosity immediately anterior to the umbones. This callosity is unequally developed, being much larger on the right valve than on the left, but when the valves are closed it has a nearly circular outline.

The significance of this feature, both from the morphologic and the taxonomic points of view, is not known. A somewhat similar, though more elongate, callosity is present on our specimens of *Protocardia judaica*

Hamlin from the same localities, and one appears to be present on the specimen of "*Cardium*" *cottaldinum* D'Orbigny figured by Woods (1908, p. 203, pl. 32, fig. 11a-e), although it is not mentioned in his abbreviated description, nor is it described by D'Orbigny (1843-1847, p. 22, pl. 242, figs. 1-4), whose illustrations do not permit any determination as to its presence on the type specimens.

It does not seem to be present on "*Cardium*" *ibbetsoni* Forbes (1845, p. 243, pl. 2, fig. 9; see also Woods, 1908, p. 201, pl. 32, figs. 7a-f, 8, 9, 10), which otherwise appears to be rather closely related to "*C.*" *cottaldinum*. "*C.*" *raulinianum* D'Orbigny (1843-1847, p. 25, pl. 242, figs. 7-11), which resembles both these species, has "pointed projections" in the intercostal areas, and is probably to be referred to *Brevicardium* Stephenson (*op. cit.*)

It should also be noted that, while *Protocardia judaica* Hamlin possesses a callosity, none can be observed on the specimens of *P. hillana* (Sowerby), the genotype of *Protocardia* Beyrich.

Nemocardium birdanum (Whitfield)

Plate 7, figures 22-25

Cardium (*Protocardium* ?) *Birdanum* WHITFIELD, 1891, pp. 385, 405, pl. 6, figs. 7-10.

Protocardia (?) *birdana* Whitfield, BLANCKENHORN, 1934, p. 241, pl. 13, figs. 131, 132a, b.

HYPOTYPES: A.M.N.H. No. 26015:1; length, 27.9 mm.; height, 29.0 mm.; diameter (both valves), 24.7 mm.

A.M.N.H. No. 26015:2; length, 27.3 mm.; height, 25.5 mm.; diameter (left valve), 10.1 mm.

A.M.N.H. No. 26015:3, length (incomplete), 25.4 mm.; height, 26.3 mm.; diameter (right valve), 10.0 mm.

Whitfield's description of this species is as follows: "Shell below a medium size, the largest one observed having a length of 27 mm., and of equal height, including the beaks, or 24 mm. from the base of the shell to the top of the hinge line; valves very ventricose, with large, prominent subcentral beaks which are strongly enrolled. Anterior end narrower than the opposite, rounding into the basal line; posterior end obliquely truncate, squarish on the postero-cardinal

angle, the posterior slope slightly concave. Surface marked by very fine radiating lines, and on the posterior end and slope by somewhat coarser radii, which are more deeply marked; those on the anterior end and disc being scarcely impressed. Very fine microscopic transverse lines of growth cancellate the radii. Shell margin finely crenulated. The callosity in front of the beaks is proportionally quite large, very much elevated, and when the valves are united presents a nearly circular outline."

An examination of the syntypes and of the unfigured paratypes in the Whitfield collection shows that all had been sufficiently eroded to destroy the fine tubercles present on the posterior ribs. These specimens are all from Duccdn, near Abeih. Among the 28 examples from the Olive Locality, these tubercles are also but seldom preserved, and in fact were found only on those specimens in which the posterior area was still covered with matrix which had protected them from erosion.

Such tuberculation is, as mentioned above, much finer than that present on the typical lower Tertiary forms of *Nemocardium*. In view, however, of the relative geologic position of the present species, it seems possible that this is to be considered as an ancestral condition with the more strongly developed tuberculation a product of evolutionary development.

PROTCARDIA BEYRICH, 1845

Protocardia BEYRICH, 1845, *Zeitschr. f. Malakozool.*, p. 17.

GENOTYPE: By subsequent designation, Herrmannsen, 1847 (p. 336), *Cardium hillanum* Sowerby. Cretaceous, Europe and Asia?

Protocardia judaica Hamlin

Plate 8, figures 1-7

Cardium biseriatum CONRAD, 1852, *App.*, p. 234, *App.*, pl. 5, fig. 45 (not 1852, p. 216, pl. 6, figs. 38-40).

Protocardium hillanum Sow., FRAAS, 1878, p. 326 (p. 70 of separate) (Abeih record only).

Cardium (Protocardia) judaicum HAMLIN, 1884, p. 50, pl. 4, fig. 5a, b, c, d; WHITFIELD, 1891, p. 385.

Protocardia biseriata Conrad sp., NOETLING, 1886, pp. 864-867, pl. 27, fig. 1, a, b.

Protocardia judaica Haml., BLANCKENHORN, 1890, p. 89; ZUMOFFEN, 1926, pp. 76, 77, 78; VOKES, 1941b, p. 1722; VOKES, 1942, p. 6, figs. 9-11.

Protocardia biseriata Conr. *emend.* Noetl., BLANCKENHORN, 1934, p. 242.

Protocardium biseriatum Noetling (*pars* Conr.) (= *P. judaicum* Hamlin), DUBERTRET AND VAU-TRIN, 1937, p. 46 (after Zumoffen, 1926).

TOPOTYPES: A.M.N.H. No. 25376:1; length, 23.8 mm.; height, 22.8 mm.; diameter (both valves), 17.5 mm.

A.M.N.H. No. 25376:2; length, 32.5 mm.; height, 26.6 mm.; diameter (right valve), 10.6 mm.

PLATE 5

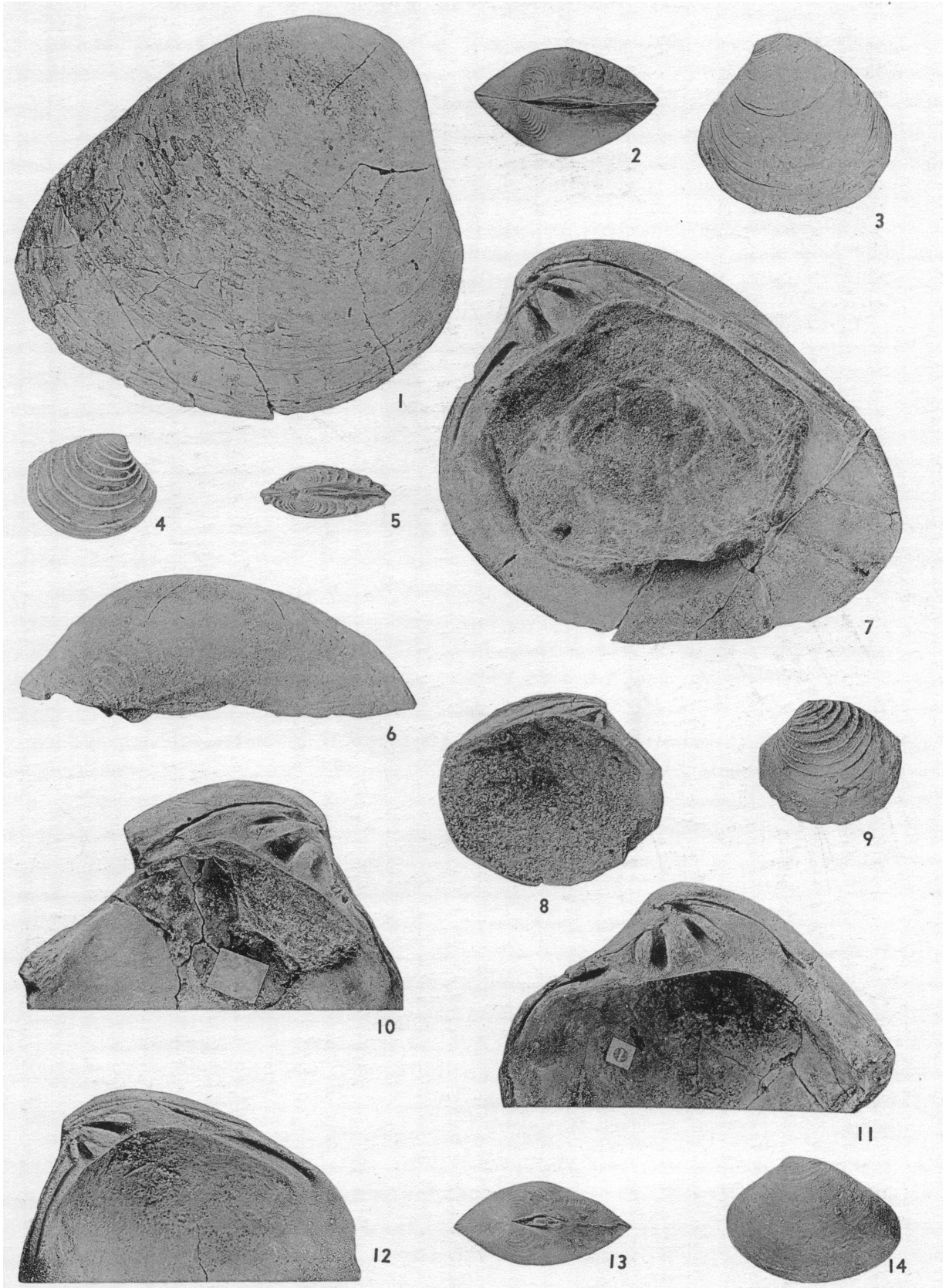
1-12. *Protocyprina libanotica* (Fraas)

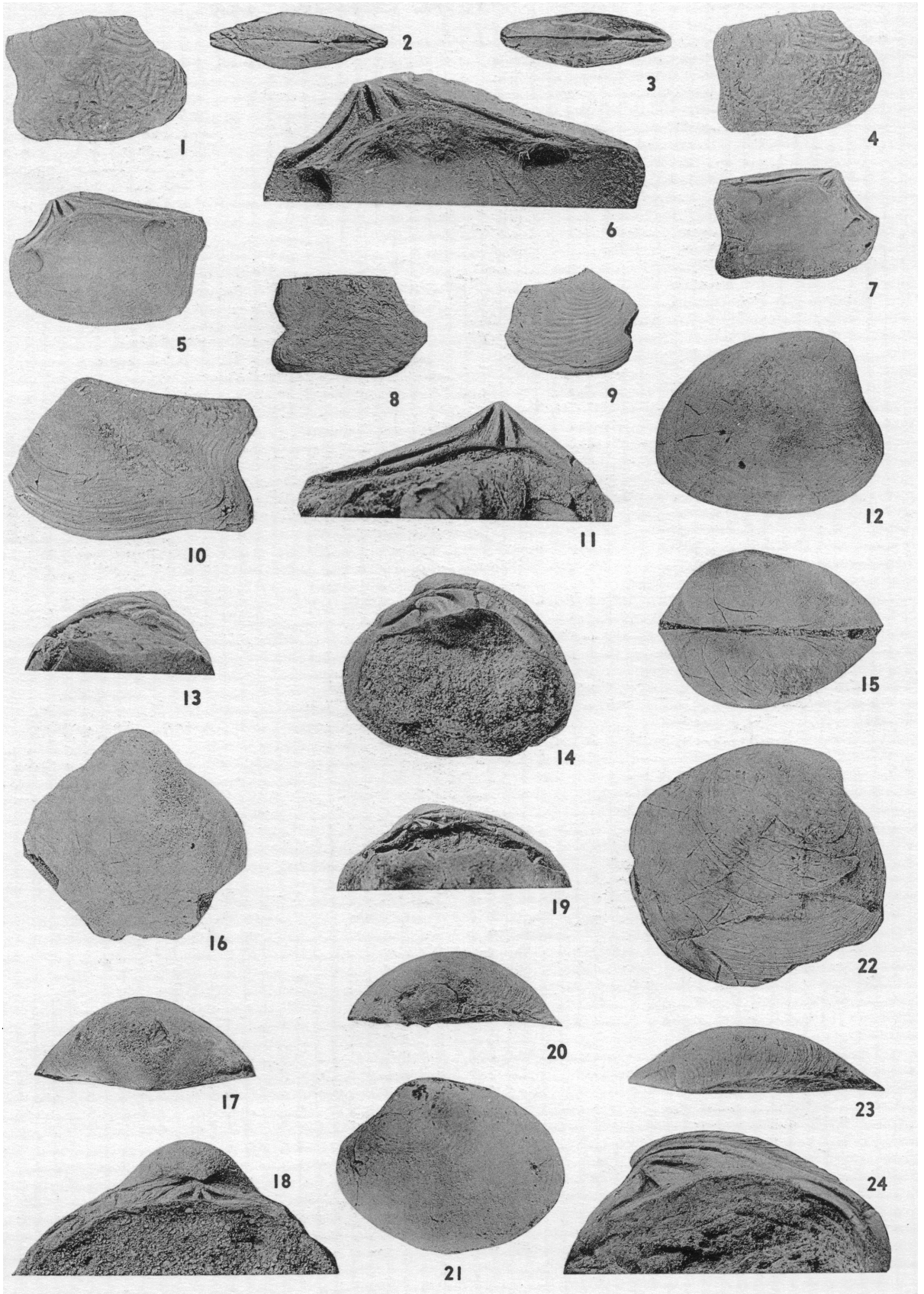
1. Exterior view of right valve of adult individual, $\times 1$; topotype, A.M.N.H. No. 16390/1:1; Duccdn, near Abeih. 2. Dorsal view of conjoined valves of an immature individual, $\times 1$; hypotype, A.M.N.H. No. 26010:2. 3. Exterior of left valve of immature individual, $\times 1$; same specimen as figure 2. 4. Exterior of right valve of very immature individual, $\times 3$; hypotype, A.M.N.H. No. 26010:4. 5. Dorsal view of conjoined valves of very immature individual, $\times 3$; same specimen as figure 4. 6. Dorsal view of right valve of adult individual, $\times 0.85$; same specimen as figure 1. 7. Hinge and interior of right valve of adult individual, $\times 1$; same specimen as figures 1 and 6. 8. Hinge and interior of left valve of immature individual, $\times 1.5$; hypotype, A.M.N.H. No.

26010:3. 9. Exterior of left valve of immature individual, $\times 1$; same specimen as figure 8. 10. Hinge of left valve of adult individual, $\times 1$; topotype, A.M.N.H. No. 16390/1:3; Duccdn. 11. Hinge of right valve of adult individual, $\times 1$; hypotype, A.M.N.H. No. 26010:1. 12. Hinge of right valve of immature individual, $\times 1.5$; topotype, A.M.N.H. No. 16390/1:2; Duccdn. (Note that the hinge of the adult individuals becomes proportionally much shorter, broader, and heavier than that of the immature individuals.)

13, 14. *Protocyprina libanotica* (Fraas) *elongata*, new variety

13. Dorsal view of conjoined valves, $\times 1.5$; holotype, A.M.N.H. No. 26011. (Note portion of ligament preserved in place.) 14. Exterior of left valve, $\times 1.5$; same specimen as figure 13.





A.M.N.H. No. 25376:3; length, 20.4 mm.; height, 18.7 mm.; diameter (both valves), 14.0 mm.

A.M.N.H. No. 25376:4; length, 16.8 mm.; height, 14.2 mm.; diameter (both valves), 10.0 mm.

A.M.N.H. No. 25376:5; length, 19.6 mm.; height, 18.7 mm.; diameter (right valve), 7.4 mm.

A.M.N.H. No. 25376:6; length, 22.0 mm.; height, 19.6 mm.; diameter (left valve), 8.0 mm.

The Beirut collections contain almost 1700 specimens representing this species, which is by far the most common form in the fauna. There is a certain degree of variation in the relative proportions of the shell and in the strength of the concentric ribbing, though the number of radial ribs on the posterior area is quite constant, there being 11 or 12 of these ribs on the majority of the specimens. I have seen none with fewer than 10 or more than 13. The typical variants are illustrated here.

For a more detailed synonymy of this species, see Part II of the present series (Vokes, 1942).

Protocardia olea, new species

Plate 8, figure 8

HOLOTYPE: A.M.N.H. No. 26016; length, 14.8 mm.; height, 11.5 mm.; diameter (both valves, somewhat crushed), 7.4 mm.

The single specimen representing this species, though rather badly crushed, differs so greatly from the other described species of this genus from this region as to merit its formal description at this time.

DESCRIPTION: The shell is of slightly less than average size for the genus. The valve is relatively elongate, and the umbones are inflated, although both these features have been somewhat accentuated by the crushing, which, however, as can be seen by an examination of the accompanying illustration, has mainly affected the diameter of the valves. The distinguishing feature of the species is the ornamentation, which is very

PLATE 6

1-8. *Mediraon divaricatum*, new genus,
new species

1. Exterior of right valve, $\times 1.5$; holotype, A.M.N.H. No. 26008:1. 2. Dorsal view of conjoined valves, $\times 1.5$; same specimen as figure 1. 3. Dorsal view of conjoined valves, $\times 1.5$; paratype, A.M.N.H. No. 26008:2. 4. Exterior of right valve, $\times 1.5$; same specimen as figure 3. 5. Hinge and interior of right valve; note minute denticulation of valve margin, $\times 1.5$; paratype, A.M.N.H. No. 26008:4. 6. Hinge of right valve, $\times 3$; same specimen as figure 5. 7. Hinge and interior of left valve, $\times 1.5$; the anterior cardinal tooth has been lost; paratype, A.M.N.H. No. 26008:3. 8. Exterior of right valve, $\times 1.5$; opposite valve of same specimen as figure 7.

9. *Mediraon secundum* (Whitfield)

Exterior of right valve, $\times 1.5$; holotype, A.M.N.H. No. 16361/1.

10-11. *Mediraon ferrissii* (Cragin)

10. Exterior of left valve, $\times 1.5$; topotype, U.S.N.M. No. 103760; Belvidere, Kiowa County, Kansas. 11. Detail of hinge of left valve, $\times 2$; same specimen as figure 10.

12-15. *Venilicardia olivensis*, new species

12. Exterior of right valve, $\times 1$; paratype, A.M.N.H. No. 26012:2. 13. Hinge of left valve, $\times 1$; paratype, A.M.N.H. No. 26012:3. 14. Hinge of right valve, $\times 1$; holotype, A.M.N.H. No. 26012:1. 15. Dorsal view of conjoined valves, $\times 1$; same specimen as figure 12.

16-18. *Anisocardia* (?) *cardiomorpha*,
new species

16. Exterior of left valve of somewhat broken individual, $\times 1$; holotype, A.M.N.H. No. 26013. 17. Dorsal view, $\times 1$, of same specimen. 18. Hinge, $\times 1.6$, of same specimen as figures 16 and 17.

19-21. "*Venilicardia*" *turgida*, new species

19. Hinge of right valve, $\times 1.6$; holotype, A.M.N.H. No. 26030. 20. Dorsal view of right valve, $\times 1.6$; same specimen as figure 19. 21. Exterior, $\times 1.6$, of same specimen as figures 19 and 20.

22-24. *Amphiaraus seleniscus*, new species

22. Exterior of right valve, $\times 1.5$; holotype, A.M.N.H. No. 26035. 23. Dorsal view, $\times 1.5$, of same specimen as figure 22. 24. Hinge, $\times 2$, of same specimen as figures 22 and 23.

fine over the entire surface of the shell. The anterior and median portions of the valve are marked by numerous approximate concentric ribs which are separated by narrow, almost linear interspaces. There are 18 concentric ribs within a 5-mm. interval near the ventral margin of the median part of the right valve. The posterior portion of the valve is ornamented by numerous, finely crenulated radial ribs. The exact number of these ribs is somewhat uncertain, owing to the crushed condition of the posterior dorsal margin of the valve. However, 26 ribs were counted on the incomplete left valve, and there appear to be 28 to 30 on the right. The crenulate condition of these ribs is clearly due to the raised growth lamellae and reflects the serrate nature of the posterior ventral margin.

The interior of the valve and the hinge cannot be studied.

The fineness of both the radial and concentric sculpturing at once distinguishes this species from species previously described or reported from this general region. The following comparisons illustrate this feature:

	NO. OF CON- CENTRIC RIBS PER 10-MM. INTERVAL	NO. OF POSTERIOR RADIAL RIBS
<i>P. olea</i> , new species	42	28-30
<i>P. judaica</i> Hamlin	12 ^a	10-13
<i>P. hillana</i> (Sowerby)	15-19 ^b	10-15
<i>P. densilineata</i> Hoppe	21	? ^c
<i>P. biseriata</i> (Conrad)	8-10	13-18
<i>P. bella</i> (Conrad)	14 ^d	?
<i>P. silicea</i> Blanckenhorn	14 ^e	9
<i>P. beiha</i> , new species	13 (in 2-mm. interval)	8

^a Measured on a specimen with a height approximately equal to that of *P. olea*.

^b *Fide* Woods, 1908 (p. 201). Measured on topotypes from Blackdown, England.

^c The original description (1922, p. 128, pl. 3, fig. 9) and illustration of this species are too poor to permit adequate determination not only of the number of radial ribs, but also of the species itself.

^d Measured on Lartet's poor drawing of his *P. hillana* var. *moabitica*, from 5 to 15 mm. from the umbo (1872, pl. 12, fig. 9). This illustration is probably entirely diagrammatic, and no reliance can be placed on the above number. No statement as to the number of radial ribs can be found.

^e Blanckenhorn, 1934 (p. 245, pl. 13, figs. 133, 134). This figure was obtained by counting the number of concentric ribs between 5 and 15 mm. from the umbo. The number of radial ribs is as stated by Blanckenhorn.

Protocardia beiha, new species

Plate 8, figures 9-12

HOLOTYPE: A.M.N.H. No. 26017:1; length, 7.6 mm.; height, 7.9 mm.; diameter (right valve), 2.6 mm.

PARATYPE: A.M.N.H. No. 26017:2; length, 5.9 mm.; height, 5.9 mm.; diameter (both valves), 3.4 mm.

Two specimens, the holotype and the paratype, are the only representatives of this little species. The shell is small, almost oval in outline with moderately inflated umbones which do not greatly project above the hinge line and are subcentral in position. The anterior dorsal, anterior, and ventral margins are broadly and regularly rounded, the posterior margin is subtruncate to almost straight and is rather sharply rounded dorsally to the short, straight, posterior dorsal margin.

To the unaided vision the anterior and median surfaces of the valve appear to be smooth save for growth rugae, but when viewed under a microscope they prove to be ornamented by numerous fine concentric ribs, there being 13 ribs in a 2-mm. interval near the center of the holotype valve. The posterior area is ornamented by eight strong radial ribs, triangular in section, each of which is rather coarsely crenulate on the top and has a finer secondary rib on the sides. The posterior secondaries are more strongly developed than the anterior ones. The interspaces are relatively broad and rounded.

The hinge plate is relatively broad and heavy, and the anterior and posterior lateral teeth are well developed, the sockets being wholly upon the hinge plate. The posterior internal margin of the valve is crenulated by the posterior radial ribs; otherwise the inner edge is smooth.

The strong, triangular, posterior radial ribs, each of which bears a finer secondary riblet on its anterior and posterior slopes, appear to be unique features as developed on this species. The reduction in strength of the concentric ribbing is observable on a number of species, including *P. anglica* Woods (1908, p. 194, pl. 30, fig. 7a, b, pl. 31, fig. 1) and *P. impressa* (Deshayes) (see D'Orbigny, 1844, pl. 240), but on these species the radial ribbing appears to be of the more simple type characteristic of this genus.

The specific name is formed as an anagram of Abeih, the type locality.

LUCINIDAE

LUCINA LAMARCK, 1799

Lucina LAMARCK, 1799, Mém. Soc. Hist. Nat., Paris, p. 84.

GENOTYPE: By monotypy, *Venus edentula* (Linné) Gmelin. Recent, Caribbean Sea?

The name *Lucina* was first used by Bruguière (1797, pls. 284–286) as a generic name at the head of three plates bearing excellent illustrations, but lacking both a description of the genus and the names of the species illustrated. It has been widely accepted as of Bruguière (see Stewart, 1930, pp. 175 *et seq.*) with the type, *Venus pennsylvanica* Chemnitz, by subsequent designation by Schumacker, 1817. Nevertheless, the lack of any text makes it impossible for this use of the name to fulfill any of the requirements for validity set up by Article 25 of the International Rules of Zoological Nomenclature (see also Opinion 1), and, as pointed out by Winckworth (1930, p. 15), the name is a *nomen nudum*.

As used by Lamarck in 1799, however, the name is validly proposed, despite the fact that the type species does not conform with the original diagnosis of the genus which is said to possess "two lateral teeth." Chavan, in his recent "Essai critique de classification des lucines" (1937–1938), rejects *Lucina edentula* as the genotype on this ground, a procedure which is clearly not sanctioned by the International Rules, and accepts instead *Lucina jamaicensis* Lamarck, cited as example in the latter's "Système des animaux sans vertèbres." (See Opinion 79.)

The acceptance of *Lucina* Lamarck, with *Venus edentula* as genotype, reduces *Pegophysema* Stewart (1930, p. 185), with *Lucina schrammi* Crosse as genotype, to a position as a synonym of *Lucina*, *sensu stricto*. *Loripinus* Monterosato, 1883, genotype (by subsequent designation, Crosse, 1885), *Lucina fragilis* Philippi; and *Eophysema* Stewart, 1930, genotype, *Lucina subvexa* Conrad, appear to be valid subgenera. The generic name *Linga* De Gregorio, 1885, genotype (by subsequent designation, Sacco, 1901), *Lucina columbella* Lamarck, seems to be available for the group of species included in *Lucina* Bruguière, with *L. pennsylvanica* as genotype.

CALLUCINA DALL, 1901

Callucina DALL, 1901, Proc. U. S. Natl. Mus., vol. 23, p. 806.

GENOTYPE: By original designation, *Lucina radians* Conrad. Miocene and Pliocene, Middle Atlantic states.

Despite the fact that, as noted above, Chavan's discussion is based on an erroneous interpretation of the genotype of *Lucina*, it is nevertheless the most complete discussion of the superspecific groups of this genus that has yet been published.

The collections from the Olive Locality contain two representatives of a species of lucinid pelecypod which, under Chavan's interpretation, would be referred to the genus *Callucina*. In discussing this genus Chavan distinguishes two groups of species, one ranging from the Lias into the early Tertiary, including the following Mesozoic species:

Cretaceous: "*Lucina*" *subnummismalis* D'Orbigny

"*Lucina*" *zonaria* Quenstedt

Jurassic: Upper, "*Lucina*" *pulchra* Zittel and Goubert

"*Lucina*" *circumcisa* Zittel and Goubert

Middle, "*Lucina*" *cardioides* D'Archiac

Lower (Liassic), "*Phacoides*" *tenuilimatus* Cossmann

The second group of Chavan may be designated the group of *Callucina*, *sensu stricto*, and is held to begin with the Tunisian Maestrichtian species "*Lucina*" *calmoni* Pervinquière and to be represented in the Recent faunas by several species. This group is distinguished by the following features: it possesses slightly lamellar external sculpturing, the areas are but feebly indicated, the lunule is moderately impressed and slightly dissymmetric; internally, the inner margins of the valve are finely denticulate, and the hinge of the right valve has but a single cardinal tooth (3b), which, is however, somewhat bifid. The dental formula may be expressed: AI; 3b; PI; and for the left valve: AIV/II; 2, 4b; PII.

An examination of the published illustrations of the Mesozoic species included by Chavan in his first group indicates, so far as figures of the hinge characters have been available, that this is a heterogeneous group of species, which are not congeneric and

which, in part at least, are certainly not to be referred to *Callucina*, *sensu stricto*. The hinge of the right valve of "*Lucina*" *subnummismalis* D'Orbigny, as figured by Holzapfel (1889, pl. 19, fig. 3) from the Greensand at Vaals, clearly shows two divergent cardinal teeth, presumably 3a and 3b. It seems unwise at this time, therefore, to attempt to present a new name for this group. The collections from the Olive Locality contain two representatives of a species which seems to be most closely related to *Callucina*, although it differs in the fact that the single cardinal tooth of the left valve is entire without suggestion of any tendency to be bifid. It is, therefore, here referred to *Callucina*, *sensu lato*.

***Callucina olea*, new species**

Plate 7, figures 14-17

HOLOTYPE: A.M.N.H. No. 26018:1; length, 28.5 mm.; height, 27.3 mm.; diameter (both valves), 14.5 mm.

PARATYPE: A.M.N.H. No. 26018:2; length, 22.7 mm.; height, 21.4 mm.; diameter (right valve), 5.0 mm.

DESCRIPTION: The shell is of moderate size, a little higher than wide, but almost subcircular in outline. The posterior dorsal margin and the long posterior margin are almost straight and are sharply angulate at their junction; the posteroventral, ventral, and anterior margins are broadly and regularly rounded, the anterior margin rounding into the slightly concave anterior dorsal margin. The umbones are low, small, and inconspicuous, acutely pointed at their tips, prosogyrate, and approximate. The moderately impressed lunule is relatively narrow, sublanceolate, and somewhat unequally divided between the two valves. The posterior area of the valve is feebly delimited by a low ridge extending to the posterior ventral margin; the anterior area is not defined. The surface of the valves is marked by a coarse concentric sculpture of a type that may best be described as resembling a series of concentric plates of gradually increasing size overlapping shingle-like away from the umbones; toward the posterior margin the edges of these "plates" are raised to form distinct lamellae.

The hinge of the right valve consists of a

single, moderately strong, inclined cardinal tooth which is entire and shows no tendency toward the development of any bifid characteristic. A distant, short, but broad posterior lateral tooth occurs toward the inner side of the hinge plate just at the end of that plate at the angulation between the posterior dorsal and posterior margins. The hinge plate is moderately broad and heavy, the nymph long and well developed. Unfortunately, the anterior portion of the valve has been broken, and the nature of the anterior cardinal tooth cannot be determined. No left hinge has been observed, but from the nature of the sockets observed on the right the anterior cardinal of the left hinge must be short and peg-like, the anterior portion being crowded out by the edge of the impressed lunule.

REMARKS: This is a well-marked species, quite different from any of the forms referred to "*Lucina*" that have been reported from the eastern Mediterranean Cretaceous faunas. The peculiar nature of the concentric sculpture is distinctive and will serve to distinguish it, as will the general outline, with the straight posterior dorsal and long straight posterior margins being sharply angulate at their junction.

"*Lucina*" *percancellata* Whitfield

Plate 7, figure 9

Lucina percancellata WHITFIELD, 1891, pp. 385, 403, pl. 6, fig. 6; BLANCKENHORN, 1934, p. 234.

TOPOTYPES: A.M.N.H. No. 26038:1; length, 7.6 mm.; height, 6.4 mm.; diameter (both valves, crushed together), 1.9 mm.

A.M.N.H. No. 26038:2; length, 6.0 mm.; height, 5.3 mm.; diameter (both valves), 2.4 mm. (Not figured.)

I have been unable to prepare from the eight additional specimens in the collections of the American University any hinge sufficiently complete to permit the more exact generic assignment of this little species. There seem to have been relatively small, remote, anterior and posterior laterals, and two small cardinal teeth, but even these features have not been certainly observed.

The original diagnosis, as given by Whitfield (1891, p. 403), contains a number of inaccurate statements: "Shell quite small, scarcely exceeding 5 or 6 mm. in height, and but little longer than high; being nearly

circular in outline and a little lower behind than in front of the beaks; beaks small, nearest to the anterior end, surface of the valves depressed convex, marked by proportionally strong, radiating and concentric elevated striae and ridges, the radiating lines more numerous than the concentric ones, but of about equal strength, forming by their combination a very deeply cancellated surface structure, which extends over the entire shell."

The umbones are, as shown in the original figure (1891, pl. 6, fig. 6), almost central or slightly posterior in position, and the dorsal margin in front of them is distinctly lower than the posterior one. There is a pronounced, long, depressed, and excavated lunule extending the full length of the anterior dorsal margin, and an equally long and depressed escutcheon, with the small external ligament occupying the anterior third of this latter structure.

The ornamentation consists of distinct concentric and radiating ribs, not of striae. The concentric ribbing is in the form of almost equidistant, raised lamellae which, on the middle area of the valve, are separated by distances approximately equal in width to that of three of the radiating riblets and their intermediate interspaces. Posterior to a line trending approximately from the umbo to the posterior ventral corner of the valve, the radiating riblets are much heavier and more distant than those on the median area of the valve, and the concentric ribbing tends to be somewhat reduced in strength but is not lost. There is also a tendency toward the reduction of the concentric ornamentation and the increase in strength of the radial ornamentation toward the anterior dorsal margin, but this is not so marked as on the posterior area of the shell. On the median surface the cancellation produced by the two types of ribbing forms depressed rectangles which are normally approximately three times as long (dorsoventrally) as they are wide; on the posterior area the rectangles are approximately as long as wide. In this respect the original illustration is decidedly misleading in that it appears as if the concentric and radial ornamentations on the median portion of the surface are approximately equidistant, and that the cancellate

result forms small squares over all portions of the valve surface.

The inner margins of the valve appear to be smooth; the muscle scars have not been observed.

CORBIDAE

MUTIELLA STOLICZKA, 1871

Mutiella STOLICZKA, 1871, Palaeont. Indica, ser. 6, vol. 3, pp. xix, 247.

GENOTYPE: By original designation, *Corbis rotundata* D'Orbigny. Cretaceous, Cenomanian of France and England.

Mutiella olivensis (Whitfield)

Plate 7, figures 18-21

Maetra ? olivensis WHITFIELD, 1891, pp. 386, 412, pl. 7, figs. 16, 17.

Maetra ? olivae Whitfield, BLANCKENHORN, 1934, p. 258.

HOLOTYPE (?): A.M.N.H. No. 16398:1; length, 13.3 mm.; height, 13.0 mm.; diameter (both valves), 9.5 mm.

PARATYPES: A.M.N.H. No. 16398:2; length, 11.4 mm.; height (incomplete), 9.0 mm.; diameter (right valve), 4.5 mm.

A.M.N.H. No. 16398:3; length, 8.3 mm.; height, 7.9 mm.; diameter (both valves), 5.7 mm.

This species was described by Whitfield as follows:

"Shell small, triangular; height and length about equal; very ventricose with small, sub-central approximate beaks, scarcely curved anteriorly; anterior end of the shell a trifle the longest, and the posterior very slightly truncated vertically; basal line regularly curved. Surface of the shell under a magnifier sometimes showing faint radiating lines, which seem almost as if due partly to a form of exfoliation, as it does not appear on all examples.

"I am not certain that this shell ought to be placed under *Maetra*, although there is but one external feature that does not agree well with the characters of that genus, viz., the apparently striated surface. I have not seen the interior, consequently cannot feel sure."

REMARKS: Whitfield's uncertainty concerning the presence of striations on the surface of the shell arose from the fact that he had included in his material representing this

species several specimens of *Geltena mactri-forma*, new species, a non-striated form of quite similar external appearance that differs in its hinge characters. Not observing these latter features he included both forms in his *Mactra ? olivensis*. Peculiarly enough his selection of his holotype fixes his specific name upon the non-mactroid specimens in his collection and, incidentally, on the form which is much more rarely represented in both his and the American University of Beirut collections than is the truly mactroid species. There are three specimens in the Whitfield collection and two in the American University of Beirut collection.

A well-preserved hinge of a right valve was exposed on one of the paratype specimens in the Whitfield collection. It is typical of that of *Mutiella*, except that the single cardinal tooth is entire, not bifid as in *M. rotundata* (D'Orbigny), the genotype. I am uncertain as to the significance to be attached to this character since *M. coarctata* (Zittel) (1865, p. 148, pl. 7, fig. 5a-h, as *Fimbria*) was referred to *Mutiella* by Stoliczka and later also by Zittel himself. The right cardinal in this species, judging by Zittel's illustrations, is entire, as is that of *M. ? canaliculata* Sowerby as figured by Woods (1907, p. 160, pl. 25, figs. 4a-d, 5a-c, 6a-c). The raised lunular margin in our specimen, though slightly broken, is typical and bears faint corrugations similar to those shown by D'Orbigny in his figures of the genotype (1844, pl. 280, figs. 1-4). The posterior portion of the hinge area is somewhat broken, but a portion of a low posterior lateral tooth may be observed there.

Externally the species has a strongly cardioid appearance, especially resembling Woods' figures (1907, p. 203, pl. 32, fig. 11a-e) of *Cardium cottaldinum* D'Orbigny, a species which has a lunular swelling very similar to that exhibited by the present species. Similar swellings have already been noted as present in specimens of *Nemocardium birdanum* (Whitfield) and *Protocardia judaica* Hamlin, so that their presence does not invalidate the generic reference given by Woods, but the fact that they are not to be observed in D'Orbigny's original figures (1844, pl. 242, figs. 1-4) of this species permits the suggestion that it may possibly be also referable to *Mutiella*.

VENERIDAE

EOCALLISTA DOUVILLÉ, 1921

Eocallista DOUVILLÉ, 1921, Bull. Soc. Géol. France, ser. 4, vol. 21, p. 123.

GENOTYPE: By original designation, *Venus brongniarti* Roemer. Portlandian, Jurassic of western Europe.

Eocallista beiha, new species

Plate 8, figures 13-16

HOLOTYPE: A.M.N.H. No. 26031:1; length, 14.9 mm.; height (incomplete), 9.6 mm.; diameter (both valves), 6.3 mm.

PARATYPES: A.M.N.H. No. 26031:2; length, 11.5 mm.; height, 7.8 mm.; diameter (right valve), 2.5 mm. (Not figured.)

A.M.N.H. No. 26031:3; length, 15.1 mm.; height, 10.6 mm.; diameter (right valve), 3.0 mm.

A.M.N.H. No. 26031:4; length (slightly incomplete), 10.6 mm.; height, 7.8 mm.; diameter (left valve), 2.4 mm.

DESCRIPTION: The shell is relatively small for the genus, elongate veneriform, with moderately prominent, inflated umbones situated approximately at the anterior fourth of the length of the valve. The anterior dorsal margin of the valve is almost straight, although the anterior edge of the inflated umbones rising above it give it a somewhat concave appearance. The anterior end of the valve is rounded; the ventral margin is broadly convex; the posterior end sharply rounded to subangular, and the posterior dorsal margin is rather strongly convex posteriorly, becoming almost straight anteriorly. The surface of the valve is marked by a strong posterior umbonal angulation extending to the posterior ventral margin of the shell. Ornamentation consists of sharply incised concentric lines that are stronger on the anterior portion of the valve than they are posteriorly, where they are almost completely lost.

The hinge is quite typical of the genus; in the right valve there is a rather strong, elongate, trigonal posterior cardinal, a well-developed median cardinal, and a thin anterior cardinal that is almost parallel with the lunular margin of the shell against which it is appressed. Both the anterior and posterior lateral teeth are relatively stronger than in most Jurassic species of the genus;

both are elongated and serve to form the ventral side of a socket for the laterals of the left valve. The anterior dorsal margin is distinctly grooved from the umbo to a point opposite the anterior end of the anterior lateral tooth; this groove seems to have been for the reception of the margin of the left valve.

The hinge of the left valve consists of a thin, lamellar, posterior cardinal tooth which seems to be situated on the inner edge of the nymph plate. The median cardinal is heavy and triangular, the anterior one of normal strength and is almost confluent, antero-ventrally, with the posterior end of the anterior lateral tooth. The lateral teeth are relatively strong and elongate. The lunular margin of the valve is slightly projecting, forming a pseudo-socket between it and the anterior lateral tooth.

Muscle scars and pallial line were not observed.

REMARKS: *Eocallista* seems to be essentially an Upper Jurassic genus, being particularly abundant in the Portlandian faunas. (See Cox, 1929, pp. 186-191.) Its presence, therefore, in an Aptian fauna is not wholly unexpected. The present species may be distinguished by its relatively strong anterior and posterior lateral teeth. The elongate form is also somewhat rare in this genus; the only comparable form with which I am acquainted is *E. implicata* (De Loriol) and its variety *elongata* (Blake). The umbones of both species are less anterior in position than in *E. beiha*, and both lack the characteristic stronger posterior umbonal angulation.

***Eocallista olea*, new species**

Plate 8, figures 17-19

HOLOTYPE: A.M.N.H. No. 26041:1; length, 24.5 mm.; height, 23.0 mm.; diameter (both valves), 14.7 mm.

PARATYPES: A.M.N.H. No. 26041:2; length, 18.9 mm.; height, 19.6 mm.; diameter (left valve), 6.7 mm.

A.M.N.H. No. 26041:3; length (slightly incomplete), 18.5 mm.; height, 20.0 mm.; diameter (right valve), 6.0 mm.

DESCRIPTION: The shell is of average size, moderately inflated, and subtriangular in outline. The umbones are not strongly inflated, but are prominent and situated but

slightly in advance of the mid-length of the valve. The anterior dorsal margin is long and almost straight, the anterior end short and sharply rounded to the broadly and regularly rounded ventral margin which in turn passes gradually into the somewhat straightened posterior end. The posterior dorsal margin is almost straight, and subangulate to the posterior end of the valve. The lunular area of the valves is large and lanceolate, but is not delimited from the rest of the valve surface. Ornamentation of the valve surface consists of fine, regular, slightly lamellose lines of growth.

The hinge, so far as observed, is typical of that of *Eocallista*, differing from that of *E. (?) hamlini* (Whitfield) in that neither of the median cardinal teeth is bifid. Only an imperfect hinge of the right valve was exposed, lacking the posterior lateral area and a portion of the lunular margin. As a result it is not possible to determine whether or not the posterior lateral socket is typically developed. The anterior cardinal tooth and the dorsal margin of the anterior lateral socket are also missing. The projection margining the ventral side of the anterior lateral socket is minutely transversely striated.

The muscle scars and pallial line have not been observed.

REMARKS: The subcentrally located umbones, long, straight anterior dorsal margin, sharply rounded anterior end, and the relatively short posterior end of the valves serve to distinguish this species from others of the same genus present in the fauna. It most closely resembles some of the shorter variants of *E. (?) hamlini* (Whitfield) but differs in the above characters as well as in the fact that the median cardinals are entire, rather than bifid.

Only six representatives of the species are present in the collections.

***Eocallista (?) hamlini* (Whitfield)**

Plate 8, figures 20-23

Corbicula (Batissa ?) hamlini WHITFIELD, 1891, pp. 386, 407, pl. 6, figs. 17-22.

Cyrena hamlini Whitfield, sp., BLANCKENHORN, 1934, p. 245 (? pl. 13, fig. 135).

HYPOTYPES: A.M.N.H. No. 26040:1; length, 23.7 mm.; height, 21.0 mm.; diameter (both valves), 13.7 mm.

A.M.N.H. No. 26040:2; length, 34.1 mm.; height, 20.7 mm.; diameter (left valve), 7.9 mm.

A.M.N.H. No. 26040:3; length, 22.6 mm.; height, 19.0 mm.; diameter (right valve), 6.6 mm.

An examination of several hinges of this species shows that Whitfield misinterpreted this structure, and that the species is more closely related to the genus *Eocallista* and the family Veneridae than to *Corbicula* (*Batissa* ?). It was originally described as follows: "Shell transversely subelliptical, oval or subquadrate in outline, the latter form being most common. In size varying from 25 to 30 mm. long, and moderately ventricose, with rather strong, but not prominent beaks, directed anteriorly and generally situated at about the anterior third of the length, but often near the anterior end; sometimes the posterior end is subtruncate and the umbonal ridge perceptible. No lunule visible, and the ligamental depression is narrow and frequently indistinct. Surface of the shell marked by strong concentric lines of growth only.

"In the interior the hinge is corbiculoid, the right valve has two subequal cardinal teeth only, near each other, and directly beneath the beak; a long lateral groove occurs on each side; left valve with two cardinal teeth, the anterior very thin, the posterior thickened; antero-lateral long and slender, postero-lateral apparently formed by the margin of the valve only; muscle scars large, submarginal and remote; pallial line not observed."

As is suggested in the original description, there is a considerable degree of variation evident in the shape of this species; the specimen shown in Whitfield's original figures 17 and 18 is proportionally longer than is the case with the representatives from the Olive Locality, and is also generally somewhat more inflated than the average of our specimens. The figured hypotype and the specimen shown in Whitfield's original figures 19 and 20 represent the more normal proportions of the species. There is, likewise, a considerable degree of variation in the ornamentation of the valves. In general, Whitfield's statement that the "surface of the shell [is] marked by concentric lines of growth only"

is true, but there is one specimen in the original lot from Duccùn, and two others in the collections from the Olive Locality, in which there is a relatively strong concentric ornamentation of rounded ribs separated by interspaces of approximately equal width. The ribbing is more pronounced on the anterior end of the valve than on the median surface or the posterior portion.

A careful examination of the hinge figured by Whitfield, together with several other well-preserved hinges exposed during the present study, clearly indicates the relationship of this species to *Eocallista*. The thin anterior cardinal tooth which is situated near the lunular margin of the valve had been broken or eroded away from the specimen shown in the original figure 19; its base is still present, however, and may be seen in Whitfield's figure. As shown in this same illustration, the median cardinal tooth is indicated as trending more anteriorly than it actually does, the posterior side of the tooth being almost vertical in position, the whole tooth somewhat more triangular in shape than is shown. It is obscurely bifid, the groove dividing the tooth being slightly posterior to its mid-length so that the posterior sector is narrower than the anterior one. The right hinge figured in this report is somewhat better preserved than that shown by Whitfield; the small anterior cardinal tooth is present, and the median cardinal is somewhat narrower and less triangular in shape. A well-marked groove is present on the lunular margin paralleling the dorsal side of the long anterior lateral socket. This groove, which is similar to that present in *E. beiha*, has been almost entirely destroyed by erosion on Whitfield's specimen and is not shown in his figure. The posterior lateral socket is long, broad, and deep, but there is no comparable posterior lateral tooth on the left valve, and the valve margin, which seems to have fitted into the socket, is not strongly projecting.

There are also three cardinal teeth in the left valve rather than two as indicated by Whitfield. The posterior cardinal is long, very thin, and is situated on the edge of the nymph plate. The median cardinal is relatively broad, and distinctly bifid; the anterior cardinal moderately heavy, short, and almost

continuous with the posterior end of the strong, elongate, anterior lateral tooth.

Neither the muscle scars nor the pallial line could be certainly observed.

The median cardinals of both the right and left valves in this species are bifid; that of the right valve is but obscurely divided, while that of the left is quite deeply so. This character would seem to distinguish the species from the typical forms of *Eocallista*, in all of which, so far as I am aware, these teeth are entire. It may be that the present species should be referred to a new genus,¹ but lack of adequate comparative material representing other species which have been assigned to *Eocallista* makes it seem inadvisable to erect a new generic group for this species until the nature of the hinge in that genus is more clearly understood.

PLATOPIS WHITFIELD, 1891

Platopis WHITFIELD, 1891, Bull. Amer. Mus. Nat. Hist., vol. 3, p. 399.

GENOTYPE: Here designated, *Platopis plicata* Whitfield. Aptian, Cretaceous, Lebanon Mountains.

Inadequate preparation of the hinges figured, together with a misinterpretation of Conrad's species, led Whitfield to several errors in his original description of this genus. In erecting it Whitfield listed as "Types" "*P. undata* and *P. obrutus*, Conrad's sp." The former species was described and figured by Conrad (1852, p. 222, pl. 17, fig. 87) from the Mount of Olives, where it occurs in strata now known to be of Maestrichtian age (Picard, 1930, p. 531, pl. 21, fig. 23a, b). It has been several times noted that this species is a *Roudairia* and is, in fact, synonymous with, and a prior name for, the form variously called *R. auresensis* and *R. drui* (Blanckenhorn, 1890, p. 82; Picard, *op. cit.*; Blanckenhorn, 1934, p. 221). The specimen which Whitfield misidentified as this species and whose hinge he figured (1891, p. 400, text fig. 1), was from Marahh, from deposits of Aptian age.

¹ The hinge of this species seems almost intermediate in position between that of typical *Eocallista* and that shown in the recently proposed genus *Fulpia* Stephenson (1946, Jour. Paleont., vol. 20, no. 1, p. 69), genotype, by original designation, *Fulpia pinguis* Stephenson (1946, *ibid.*, vol. 20, no. 1, p. 69, pl. 12, figs. 1-4) from the Lewisville formation, Cenomanian, of Texas.

Platopis obrutus (Conrad) (1852, p. 231, App., pl. 2, fig. 12), the second species included by Whitfield as a type of the genus, is based on a very poor internal cast, and Conrad's description is completely inadequate. Blanckenhorn (1934, p. 176) found it wholly unidentifiable, and there can be no doubt that the specimens figured by Whitfield (1891, p. 400, text figs. 2, 3) as this species are misidentified. They are described below as *P. whitfieldi*, new species.

Since, however, the designation by Whitfield of two species as "types" is, in effect, no designation at all, it would seem that all the species originally included in the genus by Whitfield are available for possible designation at this time. As *Platopis plicata* Whitfield is the only species mentioned by Whitfield the identity of whose characters with those of the genus is beyond doubt, it is here formally designated the type of the genus *Platopis*.²

The hinge, as originally described by Whitfield, was said to consist of "diverging cardinal teeth, two in the right and one strong central tooth and two deep sockets with high bordering ridges in the left valve; right valve with lateral sockets, into which the edges of the left fit as teeth." An examination of the hinge of the right valve of the specimen figured by Whitfield as *Platopis "obrutus"* (1891, p. 400, text fig. 2), together with the hinges of *P. triangularis* prepared during this study, clearly shows that there are three cardinal teeth in each valve, with well-developed anterior and posterior laterals in the left valve. The number, relative position, shape, and proportions of the teeth are in fact identical with those of *Eocallista* Douvillé, and the only characters that seem to separate the two genera are the strongly triangular outline and the sharp, generally carinate posterior umbonal ridge of *Platopis*. There is also no grooved lunular margin of

² Whitfield lists (1891, p. 385) the following species as members of his genus: *Platopis abrupta* [= *Nucula abrupta* Conrad], *P. obruta* [= *Opis obruta* Conrad], *P. plicata* Whitfield, *P. triangularis* Whitfield, *P. undata* [= *Opis undata* Conrad]. "*Nucula*" *abrupta* Conrad (1852, p. 232, App., pl. 3, fig. 20) is, like "*Opis*" *obruta*, an unidentifiable internal cast; *Platopis triangularis* was described by Whitfield (1891, p. 401) as "*Platopis*?"; it is, however, an undoubted member of this genus.

the right valve which in *Eocallista beiha* and *E. (?) hamlini* receives the corresponding margins of the left.¹

Whitfield considered his genus to be a member of the Astartidae, but it clearly belongs near *Eocallista* and is here referred to the Veneridae.

***Platopis triangularis* Whitfield**

Plate 9, figures 6-9

Platopis ? triangularis WHITFIELD, 1891, p. 401, pl. 5, figs. 16, 17; BLANCKENHORN, 1934, p. 221, pl. 11, fig. 82a, b, c.

Platopis triangularis WHITFIELD, 1891, p. 385; VOKES, 1941b, p. 1722.

Astarte (Platopis) triangularis Whitfield, DUBERTRET, 1937, pp. 31, 37.

TOPOTYPES: A.M.N.H. No. 26032:1; length, 14.2 mm.; height, 12.7 mm.; diameter (both valves), 8.8 mm.

A.M.N.H. No. 26032:2; length, 9.3 mm.; height, 8.0 mm.; diameter (left valve), 2.5 mm.

A.M.N.H. No. 26032:3; length, 10.0 mm.; height (incomplete), 7.9 mm.; diameter (right valve), 2.8 mm.

Whitfield originally described this species as follows: "Shell rather small, almost equilaterally triangular in outline, the greatest antero-posterior length very little greater than the height; beaks central, slightly incurved and pointing anteriorly, not enrolled; postero-cardinal slope vertical, or very slightly depressed between the very angular posterior umbonal ridges; anterior end a little more rounded than the posterior, and the basal margin very regularly curved; disc of the valves very gently convex, and the surface marked by fine, rather even growth lines. Ligament quite small."

The posterior cardinal of the right valve is elongate, moderately heavy, and very slightly curved; the median cardinal is relatively short and trigonal, separated from the posterior tooth by a broad, deep, triangular socket; the anterior cardinal is very thin and lamellar and is situated parallel to, and almost directly on, the lunular margin of the

valve; the anterior and posterior lateral sockets are long and deep, the posterior being bounded, ventrally, by a strong, tooth-like lamina.

The left hinge is marked by a broad, heavy, trigonal, median cardinal, with a thin, almost laminar posterior cardinal situated on the ventral side of the nymph plate, and a moderately long anterior cardinal, the ventral end of which is contiguous with the posterior end of the anterior lateral tooth, the two being separated only by a slight constriction. The posterior lateral tooth is situated on the posterior dorsal edge of the valve; it is relatively long, round-topped posteriorly and divided anteriorly into two progressively weakening ridges separated by a rounded groove.

The muscle scars are not impressed and could not be satisfactorily observed; the posterior adductor seems, however, to have been rather exceptionally large. The pallial line also was not preserved sufficiently for adequate study but appears to have been entire.

The equilaterally triangular outline of this species, together with its relatively low umbones, will distinguish it from both *P. plicata* and *P. whitfieldi*. *Platopis ? gracilis* Blanckenhorn (1934, p. 222, pl. 11, figs. 83, 84) does not seem to be a member of this genus. The original figures are poor, but so far as they can be interpreted seem to represent specimens of *Corbulomima aligera* (Hamlin).

***Platopis whitfieldi*, new species**

Plate 8, figures 24-26

Platopis obruta Conrad sp., WHITFIELD, 1891, p. 400, text figs. 2, 3.

Not *Opis obruta* Conrad, 1852, p. 231, App., pl. 2, fig. 12.

HOLOTYPE: A.M.N.H. No. 16355/1; length, 12.4 mm.; height, 12.9 mm.; diameter (right valve), 3.9 mm. Duccûn, Lebanon.

The holotype of this species is the specimen figured by Whitfield (1891, p. 400, text fig. 2) as the hinge of the right valve of *P. obruta* (Conrad). The holotype of that species, an internal cast from Aleih, has a quite different outline, with a very short anterior end, a longer posterior end, an umbo which seems to have been opisthogyrate, rather than prosogyrate as in the present species, and a

¹ I have not been able to study a hinge of *E. brongniarti*, the genotype species of *Eocallista*, and do not know whether this groove is also present in that form. Douville's (1921, p. 123) figures are diagrammatic and furnish no evidence regarding this feature.

posterior umbonal angulation which was almost straight to slightly concave rather than somewhat strongly convex dorsally and almost straight through the ventral half of its length. The profile, as shown in outline by Conrad, indicates that his species was also more inflated than the present one. Since, therefore, there can be no doubt that Whitfield had misidentified his species, it is here renamed *Platopis whitfieldi*, new species.

The species is, at present, known only from Ducchn, a village near Abeih, and occurs in strata of approximately the same age as those at the Olive Locality. It may be distinguished from *P. triangularis*, the most closely related form, by its higher, more prominent umbones and sharper, more carinate posterior umbonal angulation.

AGAPELLA,¹ NEW GENUS

GENOTYPE: *Agapella rotunda*, new species.

The generic name *Agapella* is proposed for a species of venerid mollusk characterized by its inflated, rotund form and by certain unusual characters in its hinge structure. The hinge of the right valve bears a long, relatively slender posterior cardinal, a thin vertical median cardinal, and a very short, incipient anterior cardinal which appears to branch from, and to be continuous with, the dorsal end of the median cardinal. There is a moderately long, deep, and broad anterior lateral socket. In the left valve the posterior cardinal is thin and appressed to the long nymph plate; the median cardinal is very heavy and so deeply notched below as to resemble two short diverging teeth. The anterior cardinal is short and thin and is closely approximate to the posterior end of the anterior lateral tooth. The lunular margin in both valves is swollen or inflated in a manner reminiscent of that of *Mutiella*. The inner margin of the swelling was rather weakly corrugated.

The unique features of the hinge are, of course, the heavy, divided median cardinal tooth of the left valve and in the right valve the relatively slender, non-bifid posterior cardinal together with the short, poorly developed anterior cardinal tooth.

¹ Etymology: "Agape" (Greek, "love") plus the diminutive "ella."

The phylogenetic relationships of this genus are not clear at present, but it would seem most probable that it was developed from some form of *Eocallista*. In that genus the right posterior cardinal tends to be rather slender and is entire, while the right anterior cardinal is thin and dorsal in position; the median cardinal of the left valve, while entire, tends to be unusually heavy and trigonal in shape, and the anterior cardinal is essentially continued to form the anterior lateral. If we may conceive of the heavy median cardinal as being deeply notched, and the anterior lateral migrating slightly dorsad to a position contiguous with the anterior dorsal side of the anterior cardinal tooth, together with the entire loss of the posterior lateral teeth and sockets, we may develop the hinge of the genus *Agapella* from that of *Eocallista*. I am, however, not aware of any species of the latter genus that shows a swollen lunular margin similar to that of the present form.

Agapella rotunda, new species

Plate 9, figures 1-5

HOLOTYPE: A.M.N.H. No. 26036:1; length, 22.6 mm.; height, 23.2 mm.; diameter (both valves), 17.5 mm.

PARATYPES: A.M.N.H. No. 26036:2; length, 23.2 mm.; height, 22.5 mm.; diameter (right valve), 7.5 mm.

A.M.N.H. No. 26036:3; length (slightly incomplete), 22.3 mm.; height (slightly incomplete), 21.3 mm.; diameter (left valve), 7.2 mm.

DESCRIPTION: Shell of medium size, inflated, almost circular in outline, with relatively high, inflated, prosogyrate umbones. The anterior, ventral, and posterior margins are broadly and equally rounded. The posterior dorsal margin is strongly convex, and the anterior dorsal margin is slightly convex, almost straight to the short, swollen, lunular margin which is immediately below the termination of the umbones. The surface of the valve was marked by two low, rounded, and inconspicuous posterior umbonal ridges, one extending in a broad sweeping curve to the posteroventral margin, the other extending to the dorsal end of the posterior margin and delimiting a slightly depressed, escutcheon-like posterior dorsal area of the valve. Surface

of the shell ornamented solely by lines of growth.

The hinge has been described above, in the diagnosis of the genus.

Muscle scars and pallial line could not be observed.

REMARKS: The available collections contain but six samples of this species, one of which was found among the type material of Whitfield's "*Caryates*" *globulus*, a species here referred to *Integricardium*, which, while almost equally inflated, differs in details of outline as well as of hinge structure. I know of no other venerid species that has a lunular swelling similar to that of the present species.

TELLINIDAE

TELLINA LINNAEUS, 1758

Tellina LINNAEUS, 1758, *Systema naturae* . . . , ed. 10, pp. 674-678.

GENOTYPE: By subsequent designation, Children, 1823, *Tellina radiata* Linné. Recent, West Indies.

No representatives of the genus *Tellina*, *sensu stricto*, have been recognized in the fauna of the Olive Locality. The genus is commonly reported as ranging from the Jurassic to the Recent, but I have not seen any Cretaceous species that combines the distinctive hinge characteristics with the extraordinarily deep pallial sinus, and am inclined to believe that, strictly interpreted, the genus *Tellina* is not a member of the Cretaceous faunas. It seems probable that, when their hinge and pallial characters are known, many of the Cretaceous forms now referred to *Tellina* will be found to belong to *Hercodon* Conrad.

The following species is, I believe, representative of an undescribed generic group. However, the present material is not adequate to permit a generic diagnosis at the present time. It does not belong to *Tellina*, *sensu stricto*, or to *Hercodon* or *Linearia*.

"*Tellina*" *elliptica* (Whitfield)

[*non* Brocchi, 1814]

Plate 9, figures 18-21

Veleda elliptica WHITFIELD, 1891, p. 406, pl. 7, figs. 1, 2; BLANCKENHORN, 1934, p. 249.

HOLOTYPE: A.M.N.H. No. 16384/1; length, 19.4 mm.; height, 12.7 mm.; diameter (both valves), 6.0 mm.

TOPOTYPES: A.M.N.H. No. 26019:1; length, 20.4 mm.; height, 13.4 mm.; diameter (both valves, slightly crushed and opened), 8.2 mm.

A.M.N.H. No. 26019:2; length (incomplete), 17.6 mm.; height, 12.6 mm.; diameter (right valve), 3.2 mm.

Whitfield described this species as follows:

"Shell small, 20 to 25 mm. in length, transversely subelliptical in outline, the beaks breaking the elliptical outline on the cardinal border by projecting a little beyond the regular line. Valves very depressed convex on the disc, and strongly incurved on the postero-cardinal margins; beaks small, slightly pointed, situated a little in advance of the center and directed anteriorly; anterior end scarcely narrower than the posterior; lunular area very slightly impressed on the larger specimens, while the posterior cardinal border is strongly inflected; ligament short, situated close to the beaks. Surface marked by proportionally strong concentric lines of growth, strongest on the posterior end of the valves.

"These shells are small, and like the American types of the genus, rather obscure, although very *Tellina*-like in their general features; they are, however, equivalve, want the twist of the valves of *Tellina* and the posterior sulcation common in that genus."

REMARKS: Whitfield referred this species to *Veleda* Conrad, 1870, page 74 (not Blackwall, 1859, Arachnida) = *Cymbophora* Gabb, 1869, page 181 (genotype, by monotypy, *Mastra ashburnerii* Gabb, 1864, p. 153, pl. 22, fig. 127). However, he had not seen the hinge, which proves to be somewhat *Tellina*-like, and entirely different from that of *Cymbophora* which is closely related to that of *Spisula* Gray, 1837, page 372 (genotype, by subsequent designation, Gray, 1847, *Cardium solidum* Linné).

It has been possible to expose only a somewhat imperfect hinge of a right valve of the present species. This hinge is characterized by the presence of two cardinal teeth as well as by anterior (?) and posterior laterals. At first glance the anterior cardinal appears to be very long, but under magnification it shows a deep V-shaped separation which seems to divide it into two teeth, here interpreted as an anterior cardinal and an anterior

lateral. The edges of the separation are rounded and apparently are entirely natural. There is no doubt that this separation is not a result of fracturing subsequent to the death of the individual. It is possible that it may be due to some pathologic condition during the life period, though there is no other evidence of such a condition to be seen on the specimen. The combination extends across the hinge line, pointing very obliquely forward, and is separated from the posterior cardinal by a broad triangular socket. The latter cardinal is almost transverse in position, entire and moderately thick. It is separated from the heavy nymph plate by a deep, moderately broad socket. Immediately posterior to the nymph plate there are two raised lateral lamellae. The dorsal lamella, which is situated immediately below the dorsal edge of the shell, is only about one-half the length of the ventral one, which is itself but 1.4 mm. long in the present specimen. Posterior to these lamellae there is a narrow, submarginal platform that extends to the posterior dorsal end of the valve. It has not been possible to obtain a hinge of a left valve in order to determine whether the posterior lateral is so greatly elongated as to be adjacent to this platform throughout its entire length. Certainly, however, in the right valve the platform appears to be a prolongation of the lateral socket, as it is delimited anteriorly by the lamellae. An examination of the specimens in which the two valves are in association offers no evidence indicating that this platform is for the reception of the posterior dorsal margin of the left valve. It must be added, however, that in all specimens available the two valves are partially opened so that the dorsal margins are not united.

The specimens studied by Whitfield and identified as of this species contain representatives of at least three different forms. As a result he failed to note that there is a distinct, long, and narrow posterior gape.

The specific name *elliptica* has been preoccupied in *Tellina* by several authors (Brocchi, 1814; Lamarck, 1818; Brown, 1827; Scacchi, 1833, etc.).

The Cretaceous species *Hercodon ellipticus* Conrad (1875, p. 10, pl. 2, figs. 2, 8) was referred to *Tellina* by Stephenson (1923, p.

322, pl. 81, figs. 1-4, pl. 82, figs. 7, 8). Dr. Stephenson writes¹:

"I have compared the shell, *Tellina elliptica* (Conrad), shown on Pl. LXXXI, figs. 3 and 4, of my North Carolina book (vol. 5) with examples of *Tellina radiata* Linné, the genotype *Tellina* Linné, from the West Indian region, and am convinced of their close family relationship. There are, however, differences that may (and probably do) justify treating Conrad's Cretaceous species as *generically* distinct. The cardinal dentition is somewhat different although the bifid posterior cardinal in the right valve is very similar in the two species. In Conrad's species the lateral dentition is present but is very weak, almost obscure, and the pallial sinus is much shorter than are the corresponding features in *radiata*. The pallial sinus of *radiata* extends nearly to the anterior adductor scar, in contrast to the sinus in *elliptica*, which just about reaches the mid-length.

"Conrad introduced the name *Hercodon* and described *Hercodon ellipticus* in the same paper. This species is, therefore, the genotype of *Hercodon* by monotypy. No mention was made of the relationship of *Hercodon* to *Tellina*; the specific name *ellipticus* was, therefore, valid, if *Hercodon* was valid. If I was in error in transferring the species to *Tellina* (and I am now inclined to think that I was), it would be unjust to consider the name *ellipticus* as preoccupied. Any other view of this matter would mean that an author could be robbed of a specific name that was perfectly valid when he proposed it. I understand that the International Commission has made rulings in similar cases, and has taken the view herein expressed. If the species is to be retained in *Tellina* it will be necessary of course to rename it. But my present inclination is to recognize *Hercodon* as a valid genus, retain the specific name *ellipticus* and thus correct the error.

"You may have noticed that my *Tellina simplex* described in the North Carolina book (p. 324) was found to be preoccupied by A. E. Salisbury, who renamed it *Tellina stephensoni* (Malac. Soc. London, vol. 21, pt. 2, p. 89, 1934). This species should be referred to

¹ In a letter dated March 19, 1942.

Hercodon, I think, if *Hercodon* is to be accepted as a separate genus."

Since, however, the present species is certainly not congeneric with any of the above forms, I have not proposed a new specific name for it, pending the recovery of additional specimens which may permit its certain allocation among the genera of the Tellinidae, and allow the retention of Whitfield's specific name for the species.

Six specimens, only, occur in the material from the Olive Locality.

LINEARIA CONRAD, 1860

Linearia CONRAD, 1860, Jour. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 4, p. 279.

GENOTYPE: By monotypy, *Linearia metastrata* Conrad. Cretaceous, Alabama.

Stephenson (1941, p. 224) has shown that there are all gradations from the smooth forms, such as the present species, which were given the subgeneric name *Liothyris* by Conrad (1875, p. 9; monotype species, *L. carolinensis* Conrad), to those with a strong radial striation as in the typical *Linearia*. The hinge characters of the two groups are the same.

***Linearia olea*, new species**

Plate 9, figures 10-16

HOLOTYPE: A.M.N.H. No. 26020:1; length (incomplete), 20.0 mm.; height, 14.1 mm.; diameter (both valves), 5.9 mm.

PARATYPES: A.M.N.H. No. 26020:2; length, 24.8 mm.; height, 17.1 mm.; diameter (both valves, slightly crushed), 6.3 mm.

A.M.N.H. No. 26020:3; length (incomplete), 17.0 mm.; height, 12.8 mm.; diameter (both valves), 4.4 mm.

A.M.N.H. No. 26020:4; length, 25.1 mm.; height, 18.0 mm.; diameter (right valve), 3.4 mm.

DESCRIPTION: The shell is moderately small, subelliptical in outline, depressed convex. Umbones small, slightly prominent, prosogyrous, situated slightly posterior to the mid-line of the length, approximately three-fifths of the length from the anterior end of the shell. The anterior and posterior dorsal margins diverge from the umbones at an angle of about 135 degrees. The anterior

dorsal margin is straight to slightly convex and subparallel to the ventral margin, giving the anterior end a broad, produced appearance; the posterior dorsal margin is slightly concave and slopes rather steeply to the broadly rounded, subtruncate posterior end, resulting in the appearance of a much shorter posterior part of the valve than is actually the case. The anterior end of the valve is very broadly and regularly rounded; the ventral is slightly concave.

The surface of the valves is ornamented by microscopically fine incised concentric lines, which are so fine and inconspicuous as to permit the valve to appear as though entirely smooth.

The lunule is narrow and deeply impressed and is almost one-half the length of the anterior end of the valve. The nymph is narrow and distinct; the ligamental groove is deep and about one-half the length of the posterior extremity.

The hinge plate is very narrow. The right valve has two long, strongly oblique cardinal teeth that are united directly under the umbo, project sharply forward, and tend to diverge from each other anteriorly. The anterior one is joined to the base of the lunule throughout most of its length. The right posterior cardinal is broken away, but appears to have been small and directly under the beak. There is a strong, well-developed anterior lateral socket and a small short socket immediately posterior to the nymph. No adequate hinge of a left valve was obtained.

The inner margins of the valves are smooth. The pallial sinus is moderately long, ascending, and bluntly rounded anteriorly.

This species is very similar to *Linearia carolinensis* Conrad (1875, p. 9, pl. 1, figs. 20, 23, 24), the type of *Liothyris*, a species that has been well figured by Stephenson (1923, p. 326, pl. 83, figs. 4-12). In gross outline they are almost identical, although the present form lacks the faint umbonal ridge exhibited by the North Carolina species. In hinge characters the form from Lebanon differs in that the anterior cardinal socket of the right valve is proportionally longer and more anteriorly removed from the end of the oblique cardinals than in Conrad's species.

Linearia, species

Plate 9, figure 17

FIGURED SPECIMEN: A.M.N.H. No. 26021; length (incomplete), 14.5 mm.; height, 11.5 mm.; diameter (both valves, somewhat crushed), 4.0 mm.

There is a single imperfect specimen in the collection which is tentatively referred to the genus *Linearia*. The surface of the valve is smooth save for a small area, extending not more than 2 mm. immediately below the umbones, which is ornamented by very fine, microscopic, radial riblets. These soon die out, and there is no trace of them over any of the remaining area of the shell.

Although the anterior end of the specimen is lost, the growth lines indicate that the umbones were distinctly posterior, almost at the posterior third of the length. They are prosogyrous and relatively low and inconspicuous. The anterior and posterior dorsal margins diverge from the umbo at an angle of approximately 130 degrees; both margins were slightly convex. The posterior margin was broadly rounded and not delimited from the convex ventral margin.

The lunule is narrow and deeply incised. It is relatively much shorter than that of *L. olea*, being certainly less than one-third the length of the anterior dorsal margin. The ligamental groove is deep and distinct, being about one-half the length of the posterior dorsal margin.

The hinge and interior of the valve were not observed.

This species is easily distinguished from *L. olea* by the presence of the faint umbonal radial ornamentation, by its more posterior umbones, its different shape, and shorter lunule.

Since the hinge cannot be observed, the reference of the present species to the genus *Linearia* can be provisional only. It differs from the normal observable trend of the species of that genus in that the radial ribbing seems to have persisted longer over the median part of the valve, rather than near the anterior and posterior dorsal margins where it is present on many forms in which the body of the valve is entirely smooth.

DONACIDAE ?**PROTODONAX** VOKES, 1945

Protodonax VOKES, 1945, Jour. Paleont., vol. 19, p. 295.

GENOTYPE: By original designation, *Protodonax elongatus* Vokes. Colorado group, Upper Cretaceous, Wyoming.

Protodonax minutissimus (Whitfield)

Plate 9, figures 26-28

Donax minutissimus WHITFIELD, 1891, pp. 386, 411, pl. 7, figs. 12, 13.

Donax ? minutissimus Whitfield, BLANCKENHORN, 1934, p. 257.

Protodonax minutissimus (Whitfield), VOKES, 1945a, p. 307, pl. 46, figs. 16-18.

HOLOTYPE: A.M.N.H. No. 16400/1; length, 5.2 mm.; height, 4.0 mm.; diameter (both valves), 2.5 mm.

TOPOYPES: A.M.N.H. No. 25988:1; length, 12.3 mm.; height, 8.2 mm.; diameter (left valve), 3.1 mm.

A.M.N.H. No. 25988:2; length, 16.4 mm.; height, 11.9 mm.; diameter (left valve), 5.0 mm.

Two well-preserved topotype left valves show that this species attains a much larger size than that of Whitfield's holotype. The species has been discussed in an earlier report (Vokes, 1945a, p. 307).

MACTRIDAE**GELTENA** STEPHENSON MS, NEW GENUS

GENOTYPE: *Geltena subequilatera* Stephenson MS, new species.

The fauna of the Lewisville formation of the Upper Cretaceous of Texas and that of the Olive Locality contain a large number of pelecypod generic units in common. This is particularly noticeable among what may be considered the more unusual forms, such as *Parmicorbula* Vokes, *Protodonax* Vokes, and the present genus, which had been described by Dr. L. W. Stephenson during the course of his present study of the Lewisville fauna. Through his courtesy I have been permitted to avail myself of his new generic name in advance of the publication of his report.

"The genus is characterized by its subtriangular to broadly subovate outline, its moderate to strong inflation, its nearly

direct beaks, its smooth surface, which on the main part of the valve presents only fine concentric lining, a long and broad lunule bounded by a weakly impressed line and with fine, sharp, concentric surface markings, a weak umbonal ridge, a posterodorsal slope somewhat roughened by stronger concentric lining, the presence of two cardinal teeth in each valve, of which the anterior one in the left valve is bifid, well-developed lateral teeth, a shallow pallial sinus, a smooth inner margin, a well developed external ligament seated on a strong nymph, and a weak, or incipient, resilifer" (Stephenson).

The genotype species, *Geltena subequilatera* Stephenson MS, is described by Dr. Stephenson as follows (see pl. 10, figs. 1-6):

"Shell of medium size for the genus, broadly subovate in outline, subequilateral,

equivalve, rather strongly inflated, with the greatest inflation about midway of the length at two-thirds the height. Umbonal ridge weakly developed, making a broad subobtuse angle in cross-section; antero- and posterodorsal slopes of nearly equal steepness. Beaks moderately prominent, nearly direct, incurved, about half a millimeter apart on the holotype, situated slightly in advance of the mid-length. Anterior margin rather narrowly rounded; posterior margin somewhat variable, ranging from equal in curvature to the anterior margin to somewhat more fully rounded, with a slight tendency to subtruncation. Lunule long, rather wide, outlined by a weakly impressed line. Main surface smooth and polished, marked only by very fine growth lines and gentle undulations; on the lunule and on the posterodorsal

PLATE 7

1-8. *Xenocardita lacunaris* (Hamlin)

1. Exterior of right valve, $\times 3$; topotype, A.M.N.H. No. 26007:3. 2. Exterior of left valve, $\times 3$; topotype, A.M.N.H. No. 26007:1. 3. Exterior of left valve of an elongate specimen, $\times 3$; topotype, A.M.N.H. No. 26007:2. 4. Hinge and interior of left valve, $\times 3$; topotype, A.M.N.H. No. 26007:5. 5. Hinge and interior of right valve, $\times 3$; topotype, A.M.N.H. No. 26007:4. 6. Dorsal view of conjoined valves, $\times 3$; same specimen as figure 2. 7. Detail of ornamentation near posterior end of left valve, $\times 5$; same specimen as figures 2 and 6. 8. Dorsal view of conjoined valves, $\times 3$; same specimen as figure 3.

9. "*Lucina*" *percancelata* Whitfield

Exterior of left valve, $\times 3$; topotype, A.M.N.H. No. 26038:1.

10-13. *Pachythaerus similoides*, new species

10. Exterior of left valve, $\times 1.5$; paratype, A.M.N.H. No. 26009:2. 11. Exterior of left valve, $\times 1.5$; holotype, A.M.N.H. No. 26009:1. 12. Dorsal view of conjoined valves, $\times 1.5$; same specimen as figure 11. 13. Hinge and interior of left valve, $\times 3$; same specimen as figure 10.

14-17. *Callucina olea*, new species

14. Dorsal view of conjoined valves, $\times 1.5$; holotype, A.M.N.H. No. 26018:1. 15. Hinge of right valve, $\times 3$; paratype, A.M.N.H. No. 26018:2. 16. Exterior of right valve, $\times 1.5$; same specimen as figure 14. 17. Exterior of right valve, $\times 1.5$; same specimen as figure 15.

18-21. *Mutiella olivensis* (Whitfield)

18. Exterior of left valve, $\times 1.5$; holotype (?), A.M.N.H. No. 16398:1. 19. Hinge of right valve, $\times 3$; paratype, A.M.N.H. No. 16398:2. 20. Dorsal view of conjoined valves, $\times 1.5$; paratype, A.M.N.H. No. 16398:3. 21. Exterior of right valve, $\times 1.5$; same specimen as figure 20.

22-25. *Nemocardium birdanum* (Whitfield)

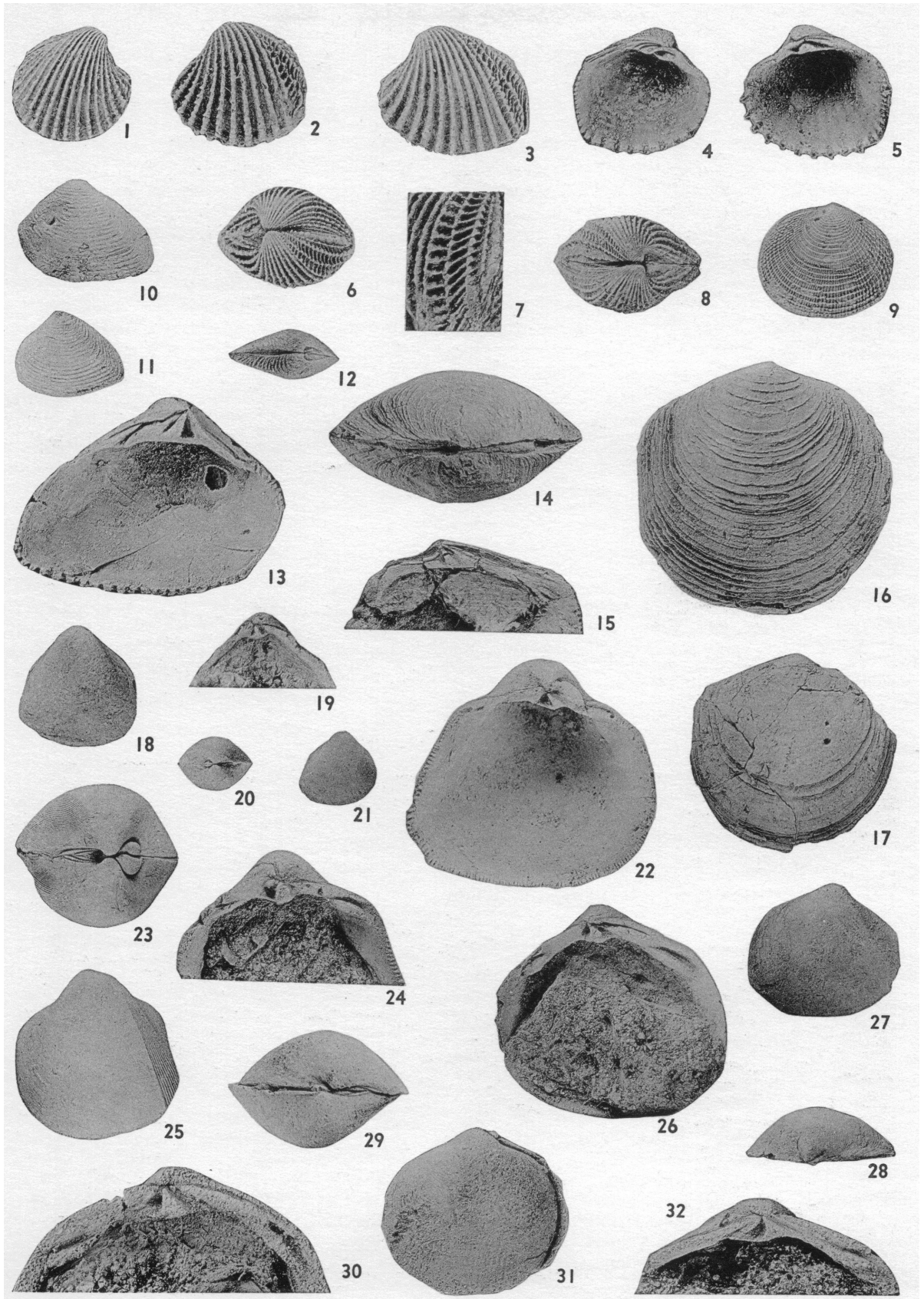
22. Hinge and interior of left valve, $\times 1.5$; hypotype, A.M.N.H. No. 26015:2. 23. Dorsal view of conjoined valves, $\times 1$; note the strong callosity immediately posterior to the umbones; hypotype, A.M.N.H. No. 26015:1. 24. Hinge of right valve, $\times 1.5$; hypotype, A.M.N.H. No. 26015:3. 25. Exterior of left valve, $\times 1$; same specimen as figure 23.

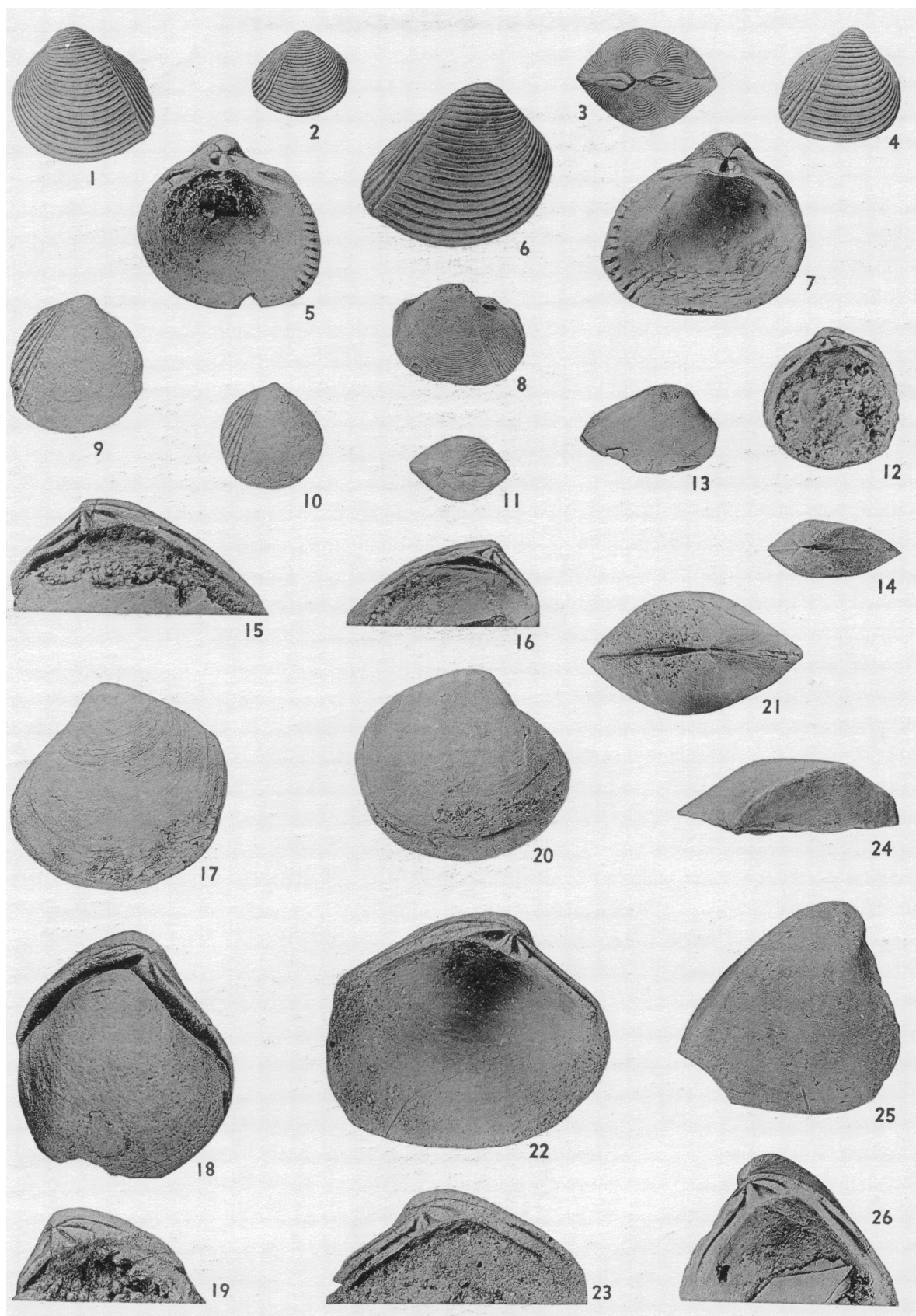
26-28. *Integricardium bewertense* (Whitfield)

26. Interior of right valve, $\times 1.5$; hypotype, A.M.N.H. No. 26014. 27. Exterior of right valve, $\times 1$; same specimen as figure 26. 28. Dorsal view of right valve, $\times 1$; same specimen as figures 26 and 27.

29-32. *Integricardium globulum* (Whitfield)

29. Dorsal view of conjoined valves, slightly distorted, $\times 1.5$; hypotype, A.M.N.H. No. 26037:1. 30. Hinge of right valve, $\times 3$; hypotype, A.M.N.H. No. 26037:2. 31. Exterior of right valve, $\times 1.5$; same specimen as figure 29. 32. Hinge of left valve, $\times 3$; hypotype, A.M.N.H. No. 26037:3.





slope the growth lines become sharper and coarser.

"Dimensions of the holotype: length 20 mm.; height 17.8 mm.; thickness 11.8 mm. Dimensions of a smaller paratype: length 17.4 mm.; height 15.5 mm.; thickness 10.3 mm. The largest individuals attain a length of about 24 mm.

"Ligament external, short; groove narrow, deeply impressed. Below the anterior end of the groove is a shallow, spoon-shaped depression that may be a resilifer. Hinge narrow but dentition sharply developed. Left valve with two cardinals separated by a deep, triangular socket; anterior cardinal thick, triangular, bifid, directed downward and slightly forward; posterior cardinal narrow, non-prominent, oblique. Anterior and posterior laterals about equally distant from the beaks, strong, short, finely striated in the direction of movement, each separated from the margin by a moderately deep channel. Hinge of the right valve with two cardinals separated by a wide, deep, triangular socket;

anterior cardinal, long, narrow, strongly oblique; posterior cardinal rather thick, directed downward and a little backward, with a deep, very narrow socket behind it. Well developed claspers receive the laterals of the left valve. Pallial line not seen well preserved throughout, but on the right side of the holotype, the pallial sinus is exposed and forms a shallow, gently arched indentation. Inner margins entire."

In addition to the Lewisville species and the new species from the Olive Locality, here described, "*Maetra*" *angulata* Sowerby (1836, pp. 241, 341, pl. 16, fig. 9; see Woods, 1907, p. 177, pl. 27, figs. 19-23), from the Upper Greensands at Blackdown, England; and "*Maetra*" *gracilis* Meek and Hayden (1860, p. 179; see Meek, 1876, pl. 17, fig. 18a, b), from the Montana group of the Central Plains states certainly belong to this genus. From the illustrations, one can judge that "*Maetra*?" *dubia* Kitchin (1908, p. 156, pl. 8, figs. 2, 2a, 3, 3a), from the Uitenhage series (Neocomian) of South Africa, is also probably

PLATE 8

1-7. *Protocardia judaica* Hamlin

1. Exterior of left valve, $\times 1$; topotype, A.M.N.H. No. 25376:1. 2. Exterior of right valve of a relatively elongate individual, $\times 1$; topotype, A.M.N.H. No. 25376:4. 3. Dorsal view of conjoined valves, $\times 1$; note elongate callosity posterior to the umbones; same specimen as figure 1. 4. Exterior of right valve of specimen with high umbones, $\times 1$; topotype, A.M.N.H. No. 25376:3. 5. Hinge and interior of right valve, $\times 1.5$; topotype, A.M.N.H. No. 25376:5. 6. Exterior of right valve of coarsely sculptured individual, $\times 1$; topotype, A.M.N.H. No. 25376:2. 7. Hinge and interior of left valve, $\times 1.5$; topotype, A.M.N.H. No. 25376:6.

8. *Protocardia olea*, new species

Exterior of left valve, $\times 1.5$; holotype, A.M.N.H. No. 26016.

9-12. *Protocardia beiha*, new species

9. Exterior of right valve, $\times 3$; holotype, A.M.N.H. No. 26017:1. 10. Exterior of right valve, $\times 3$; paratype, A.M.N.H. No. 26017:2. 11. Dorsal view of conjoined valves, $\times 3$; same specimen as figure 10. 12. Hinge of right valve, $\times 3$; same specimen as figure 9.

13-16. *Eocallista beiha*, new species

13. Exterior of right valve, $\times 1.5$; holotype, A.M.N.H. No. 26031:1. 14. Dorsal view of conjoined valves, $\times 1.5$; same specimen as figure 13. 15. Hinge of right valve, $\times 3$; paratype, A.M.N.H. No. 26031:3. 16. Hinge of left valve, $\times 3$; paratype, A.M.N.H. No. 26031:4.

17-19. *Eocallista olea*, new species

17. Exterior of left valve, $\times 1.5$; holotype, A.M.N.H. No. 26041:1. 18. Exterior of right valve and hinge of left, $\times 2$; paratype, A.M.N.H. No. 26041:2. 19. Hinge of right valve, $\times 2$; paratype, A.M.N.H. No. 26041:3.

20-23. *Eocallista* (?) *hamlini* (Whitfield)

20. Exterior of right valve, $\times 1.5$; hypotype, A.M.N.H. No. 26040:1. 21. Dorsal view of conjoined valves, $\times 1.5$; same specimen as figure 20. 22. Hinge and interior of left valve, $\times 2$; hypotype, A.M.N.H. No. 26040:2. 23. Hinge of right valve, $\times 2$; hypotype, A.M.N.H. No. 26040:3.

24-26. *Platopis whitfieldi*, new species

24. Dorsal view of right valve, $\times 3$; holotype, A.M.N.H. No. 16355/1; Duccûn, near Abeih. 25. Exterior of right valve, $\times 3$; same specimen as figure 24. 26. Hinge of right valve, $\times 3$; same specimen as figures 24 and 25.

to be referred to this genus, but the hinge is not known, and the reference cannot be made with certainty at this time.

The systematic position of the genus is not entirely clear. In general aspect of the dentition it is essentially mactrid, but the heavy nymph plate and the small, very weak, or incipient resilial (?) depression, which is located on the nymph near its anterior dorsal end, are entirely unlike that shown by any of the modern mactras. If, as Bernard (1895) has indicated, the Mactridae are to be thought of as being derived from the "Cyrenidae" (= Corbiculidae),¹ the present genus would seem to be a primitive mactrid form in which the first step toward the development of a large resilifer, and the loss of the nymph, is indicated by the small resilial (?) depression on the nymph plate.

Geltena mactriforma, new species

Plate 9, figures 22-25

HOLOTYPE: A.M.N.H. No. 26039:1; length 11.2 mm.; height, 9.4 mm.; diameter (both valves), 5.8 mm.

PARATYPES: A.M.N.H. No. 26039:2; length, 12.9 mm.; height, 11.0 mm.; diameter (left valve), 3.6 mm.

A.M.N.H. No. 26039:3; length (incomplete), 11.1 mm.; height, 10.6 mm.; diameter (right valve), 3.8 mm.

DESCRIPTION: The shell is relatively small for the genus, the largest specimen in the collection attaining a length of 16.5 mm. It is equivalved and subtriangular in outline, with relatively high, but small, direct umbones situated in advance of the mid-length of the valve. The lunule is large, broad, and lanceolate, outlined by a relatively wide, but shallow, rounded, impressed line. The central portion of the lunular area tends to develop a small "pout" reminiscent of that seen in some nuculid species. The amount of this "pout" is variable; where strong, the anterior dorsal outline is strongly convex; where weakly developed, the outline may be almost straight. This anterior dorsal margin passes gradually into the moderately long, broadly rounded anterior end, which in turn rounds rather

sharply into the relatively long, slightly to moderately convex, ventral margin. The posterior ventral margin is sharply rounded, almost subangulate; the posterior end is almost straight, though generally slightly convex. The posterior dorsal margin is convex. A low, very inconspicuous umbonal ridge extends to the posterior ventral margin. In some specimens this is accentuated by a complementary depression paralleling the dorsal side of this ridge and extending to the median portion of the posterior end. Where this depression is present, the posterior end is straighter than in those specimens in which it is not developed. The surface of the valves is smooth, almost polished, ornamented by concentric lines of growth which are much more prominent on weathered surfaces. In some specimens a faint ornamentation of radial striations also becomes visible on weathered surfaces. The median portion of the lunular area seems to be at all times smooth.

The hinge is typical of the genus. That of the right valve consists of two cardinals, the anterior thin, elongate, parallel, and closely appressed to the lunular margin of the valve; the posterior cardinal is vertical in position, moderately heavy, and almost parallel-sided. The dorsal ends of these two cardinal teeth are almost fused directly below the top of the umbo; between and below them there is a broadly triangular and deep socket for the reception of the anterior cardinal of the left valve. Immediately behind the posterior cardinal there is a much shallower, narrow socket for the reception of the posterior cardinal of the left valve. This socket is essentially developed on the anterior end of the heavy nymph plate which extends completely across the hinge plate. The groove for the external ligament is moderately long, narrow, and incised. Immediately below its anterior end there is a very shallow, incipient depression on the face of the nymph which is interpreted by analogy with the similarly located but somewhat more strongly developed depression on the face of the genotype species as an incipient resilial pit. If the development of this groove has an evolutionary significance, its less strongly developed condition on the present Aptian species as compared with the Cenomanian genotype species may indicate

¹ The designation by Children (1823, p. 310) of *Cyrena cor* Lamarck as type of *Cyrena* Lamarck, 1818, makes that genus a synonym of *Corbicula* Megerle, 1811.

the more primitive evolutionary position of the present form.

The anterior and posterior lateral sockets of the right valve are relatively long and deep and are strongly transversely striated. The corresponding teeth in the left valve are strong, transversely striated, and are located on the ventral edge of the hinge plate.

The anterior cardinal tooth of the left valve is broadly triangular, heavy; its posterior end is almost vertical in position, and the tooth is directed anteroventrally along the hinge plate. The anterior and posterior edges of the tooth are generally more or less prominently raised above the central and anteroventral portions of the tooth. The result has an appearance suggesting that the tooth is formed by the union of two separate lamellar teeth, whose posterodorsal ends are fused together to form an inverted "V" with the area between the two teeth filled with a supplementary secondary callus deposit. The posterior cardinal tooth of this valve is low, rounded, and not strongly developed. It is separated from the anterior cardinal by a deep, narrow, trench-like socket. The nymph is similar to that of the right valve and also bears an incipient resilial (?) depression.

The muscle scars and pallial line have not been observed.

REMARKS: The present species is smaller, more triangular in outline than the genotype species and differs from it both in the details of the ornamentation and in the extent of the development of the resilial (?) depression. *Geltena angulata* (Sowerby) has more posteriorly located umbones, more strongly developed concentric ornamentation, and a more broadly rounded ventral margin. If one can judge from Woods' illustrations, the umbonal ridge may be more strongly developed and sharper; otherwise the two species seems to be quite similar. *Geltena dubia* (Kitchin) has a broader valve and a somewhat rounder outline.

CORBULIDAE

CORBULINAE

CORBULOMIMA VOKES, 1945

Corbulomima VOKES, 1945, Bull. Amer. Mus. Nat. Hist., vol. 86, p. 10.

GENOTYPE: By original designation, *Corbulomima nuciformis* Vokes. Aptian, Cretaceous Lebanon.

Corbulomima nuciformis Vokes

Plate 10, figures 14-17

Corbulomima nuciformis VOKES, 1945b, p. 10 pl. 2, figs. 5-8.

HOLOTYPE: A.M.N.H. No. 25932:1; left valve, length, 9.5 mm.; height, 7.8 mm.; diameter, 4.6 mm.

PARATYPES: A.M.N.H. No. 25932:2, right valve, length (slightly incomplete), 8.2 mm.; height, 7.7 mm.; diameter, 5.0 mm.

A.M.N.H. No. 25932:3; both valves, length, 10.5 mm.; height, 9.0 mm.; diameter, 9.0 mm.; left valve, length, 9.2 mm.; height, 8.3 mm.

The genus *Corbulomima* and the type species *C. nuciformis* were described in detail in a recent study of the supraspecific groups of the pelecypod family Corbulidae (Vokes, 1945b). At present it is known only from the "Olive Locality," and is represented by 19 specimens in the collections studied.

Corbulomima aligera (Hamlin)

Plate 10, figures 7-13

Corbula aligera HAMLIN, 1884, p. 38, pl. 4, fig. 6a, b, c, d; NOETLING, 1886, p. 839; BLANCKENHORN, 1890, p. 97; WHITFIELD, 1891, p. 386; BLANCKENHORN, 1934, p. 263; VOKES, 1941, p. 1722.

Corbulomima aligera (Hamlin), VOKES, 1945b, p. 11.

? *Platopsis ? gracilis* BLANCKENHORN, 1934, p. 222, pl. 11, figs. 83, 84.

TOPOTYPES: A.M.N.H. No. 26024:1; length, 10.9 mm.; height, 7.1 mm.; diameter (both valves), 4.6 mm.

A.M.N.H. No. 26024:2; length, 9.1 mm.; height, 6.2 mm.; diameter (both valves), 4.7 mm.

A.M.N.H. No. 26024:3; fragmentary right valve showing hinge.

A.M.N.H. No. 26024:4; fragmentary left valve showing hinge.

Hamlin's original description of this well-marked little species is as follows:

"Shell small, triangular, inequilateral, perfectly closed at the margins; right valve a little larger than the left, and tightly overlapping it; posteriorly acuminate, strongly

angled; anterior margin sinuated above and rounded below; umbones a little in front of the middle point of the shell, obtuse above as if pressed downward, involute and bent forward: surface covered with thick, irregular concentric plaits or varices; lunule undefined below; hinge area very narrow, lanceolate, slightly excavated. A sharp, wing-like keel, running straight from the beaks to the postero-inferior extremity, divides from the lateral surface the subconcave hinder area, which is marked by radial riblets.

"The concentric plaits are much narrower than the intervals which separate them. They stop short upon the thin and elevated keel, and are wholly distinct from the numerous radiating riblets which adorn the nearly flat posterior area."

Externally this species differs so greatly from *C. nuciformis* as to seem entirely unrelated; internally, however, in the details of the hinge, muscle scars, and marginal groov-

ing the two are so similar as to be considered congeneric. The writer is aware of no better example of the importance of the internal characters in making generic determinations in the family Corbulidae.

There is considerable variation in the relative length of the valves in this species, and also in the number and width of interspaces of the concentric ornamentation. The figured topotypes show relative extremes in both characteristics. The concentric ornamentation is usually most strongly developed on the anterior third of the valve area, weakening perceptibly over the median part of the shell. Often secondary plaits appear on the posterior portion, extending to the alate posterior keel. The "radiating riblets" of the posterior area are actually parallel to the straight posterior margin and are to be considered as concentric rather than radial ornamentation.

There are 565 specimens representing this

PLATE 9

1-5. *Agapella rotunda*, new genus, new species

1. Exterior of left valve, $\times 1.5$; holotype, A.M.N.H. No. 26036:1. 2. Dorsal view of conjoined valves, $\times 1.5$; same specimen as figure 1. 3. Exterior of right valve, $\times 1.5$; paratype, A.M.N.H. No. 26036:2. 4. Hinge of right valve, $\times 2$; same specimen as figure 3. 5. Hinge of left valve, $\times 2$; paratype, A.M.N.H. No. 26036:3.

6-9. *Platopsis triangularis* Whitfield

6. Hinge and interior of left valve, $\times 3$; topotype, A.M.N.H. No. 26032:2. 7. Exterior of left valve, $\times 1.5$; topotype, A.M.N.H. No. 26032:1. 8. Dorsal view of conjoined valves, $\times 1.5$; same specimen as figure 7. 9. Hinge and interior of right valve, $\times 3$; topotype, A.M.N.H. No. 26032:3.

10-16. *Linearia olea*, new species

10. Exterior of left valve, $\times 1$; paratype, A.M.N.H. No. 26020:2. 11, 12. Exteriors of left and right valves of holotype, $\times 1.5$; holotype, A.M.N.H. No. 26020:1. 13. Exterior of right valve, $\times 1$; paratype, A.M.N.H. No. 26020:4. 14. Dorsal view of conjoined valves, $\times 1.5$; same specimen as figures 11 and 12. 15. Hinge of right valve, $\times 1.5$; same specimen as figure 13. 16. Dorsal view of fragmentary conjoined valves, showing ligament preserved in position, $\times 1.5$; paratype, A.M.N.H. No. 26020:3.

17. *Linearia*, species

Exterior of right valve, $\times 1.5$; figured specimen, A.M.N.H. No. 26021.

18-21. "*Tellina*" *elliptica* (Whitfield) [non Brocchi, 1814]

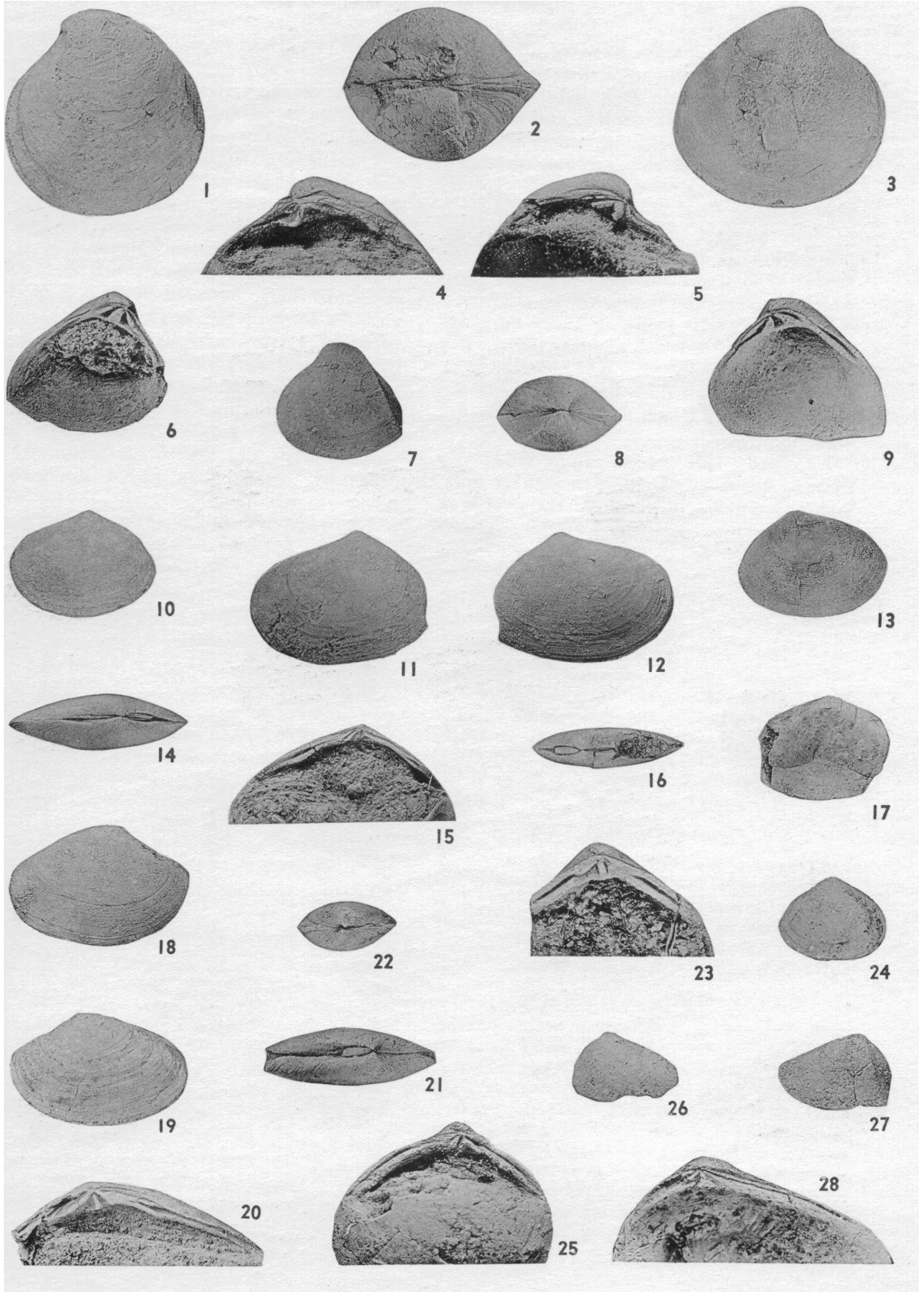
18. Exterior of right valve, $\times 1.5$; topotype, A.M.N.H. No. 26019:1. 19. Exterior of left valve, $\times 1.6$; holotype, A.M.N.H. No. 16384/1. 20. Hinge of right valve, $\times 3$; topotype, A.M.N.H. No. 26019:2. 21. Dorsal view of conjoined valves, $\times 1.5$; same specimen as figure 19.

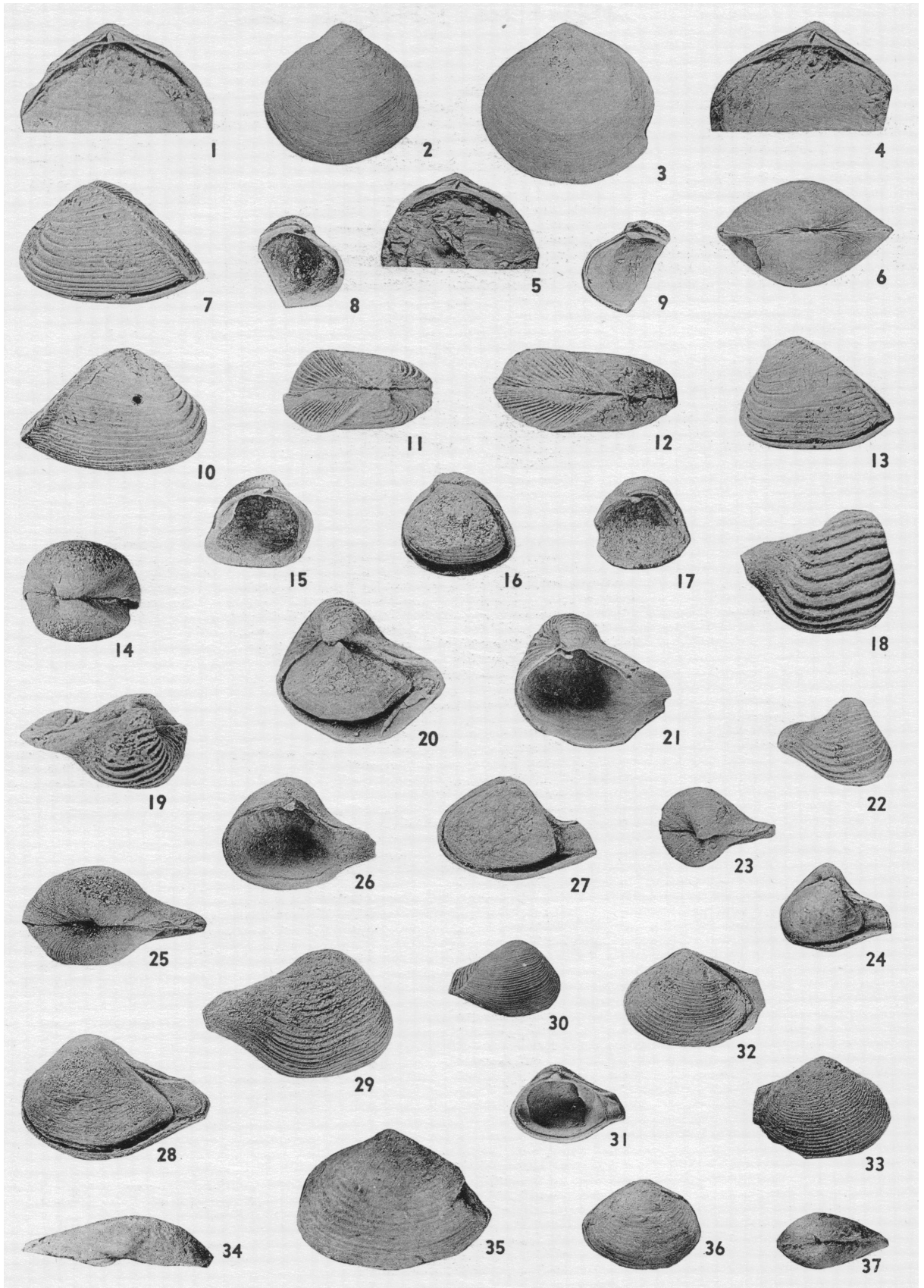
22-25. *Geltena mactriforma*, new species

22. Dorsal view of conjoined valves, $\times 1.5$; holotype, A.M.N.H. No. 26039:1. 23. Hinge of right valve, $\times 3$; paratype, A.M.N.H. No. 26039:3. 24. Exterior of right valve, $\times 1.5$; same specimen as figure 22. 25. Hinge of left valve, $\times 3$; paratype, A.M.N.H. No. 26039:2.

26-28. *Protodonax minutissimus* (Whitfield)

26. Exterior of right valve, $\times 4$; holotype, A.M.N.H. No. 16400/1. 27. Exterior of left valve, $\times 1.5$; topotype, A.M.N.H. No. 25988:1. 28. Hinge of left valve, $\times 4$; topotype, A.M.N.H. No. 25988:2.





species in the collection from the Olive Locality.

CAESTOCORBULINAE

CAESTOCORBULA VINCENT, 1910

Caestocorbula VINCENT, 1910, Ann. Soc. Roy. Zool. Malac. de Belgique, vol. 44, p. 141.

GENOTYPE: By original designation, *Corbula henckeliusi* Nyst (error for *C. henckel-iusiana* Nyst). Wemmelian, Eocene, Belgium.

The writer has recently discussed the his-

tory and the validity of this genus in some detail (Vokes, 1944).

Caestocorbula olivae (Whitfield)

Plate 10, figures 18–21

Corbula olivae WHITFIELD, 1891, pp. 386, 413, pl. 7, figs. 19–21; BLANCKENHORN, 1934, p. 263, pl. 14, fig. 168 (? not fig. 169); VOKES, 1941, p. 1722.

?*Corbula olivae* Whitfield, VAN INGEN, 1905, p. 365, pl. B, fig. 3.

Caestocorbula olivae (Whitfield), VOKES, 1944, p. 620.

PLATE 10

1–6. *Geltena subequilatera* Stephenson MS, new species

1. Hinge of right valve, $\times 2$; paratype, U.S.N.M. No. 103762. 2. Exterior of left valve, $\times 1.5$; paratype, U.S.N.M. No. 103762. 3. Exterior of left valve, $\times 1.5$; holotype, U.S.N.M. No. 103761. 4. Hinge of left valve, $\times 2$; paratype, U.S.N.M. No. 103762. 5. Hinge of left valve, $\times 2$; paratype, U.S.N.M. No. 103762. 6. Dorsal view of conjoined valves, $\times 1.5$; same specimen as figure 3. All specimens from the Lewisville formation (Upper Cretaceous), Johnson (=Trading House) Creek, 1 mile east of Arlington, Tarrant County, Texas.

7–13. *Corbulomima aligera* (Hamlin)

7. Exterior of left valve, $\times 3$; topotype, A.M.N.H. No. 26024:1. 8. Fragment showing hinge of left valve, $\times 3$; topotype, A.M.N.H. No. 26024:4. 9. Fragment showing hinge of right valve, $\times 3$; topotype, A.M.N.H. No. 26024:3. 10. Exterior of right valve, $\times 3$; same specimen as figure 7. 11. Dorsal view of conjoined valves, $\times 3$; topotype, A.M.N.H. No. 26024:2. 12. Dorsal view of conjoined valves, $\times 3$; same specimen as figures 7 and 10. 13. Exterior of left valve, $\times 3$; same specimen as figure 11.

14–17. *Corbulomima nuciformis* Vokes

14. Dorsal view of conjoined valves, $\times 2$; paratype, A.M.N.H. No. 25932:3. 15. Hinge and interior of left valve, $\times 2$; holotype, A.M.N.H. No. 25932:1. 16. Conjoined valves viewed from left, $\times 2$; same specimen as figure 14. 17. Hinge and interior of right valve, $\times 2$; paratype, A.M.N.H. No. 25932:2.

18–21. *Caestocorbula olivae* (Whitfield)

18. Exterior of right valve, $\times 3$; topotype, A.M.N.H. No. 26025:1. 19. Dorsal view of conjoined valves of the specimen figured by Whitfield (1891), $\times 3$; holotype, A.M.N.H. No.

16404:1. 20. Conjoined valves viewed from left, $\times 3$; same specimen as figure 19. 21. Hinge and interior of right valve, $\times 3$; same specimen as figure 18.

22–24. *Caestocorbula semina*, new species

22. Exterior of right valve, $\times 3$; holotype, A.M.N.H. No. 26026. 23. Dorsal view of conjoined valves, $\times 3$; same specimen as figure 22. 24. Conjoined valves viewed from left, $\times 3$; same specimen as figures 22 and 23.

25–29. *Parmicorbula neaeroides* (Blanckenhorn)

25. Dorsal view of conjoined valves, $\times 1.5$; topotype, A.M.N.H. No. 25933:1. 26. Hinge and interior of right valve, $\times 1.5$; topotype, A.M.N.H. No. 25933:2. 27. Conjoined valves, viewed from left, showing siphonal plate in position; immature individual, $\times 4$; topotype, A.M.N.H. No. 25933:3. 28. Conjoined valves of adult individual viewed from left, $\times 1.5$; same specimen as figure 25. 29. Exterior of right valve, $\times 1.5$; same specimen as figures 25 and 28.

30–33. *Parmicorbula aequilineata*, new species

30. Exterior of right valve of immature individual, $\times 3$; paratype, A.M.N.H. No. 26027:2. 31. Hinge and interior of right valve of immature individual, $\times 3$; same specimen as figure 30. 32. Conjoined valves of adult individual, viewed from left, $\times 1.5$; holotype, A.M.N.H. No. 26027:1. 33. Exterior of right valve, $\times 1.5$; same specimen as figure 32.

34–37. *Caryocorbula prima*, new species

34. Dorsal view of left valve, $\times 3$; holotype, A.M.N.H. No. 26028:1. 35. Exterior of left valve, $\times 3$; same specimen as figure 34. 36. Exterior of left valve of immature individual, $\times 3$; paratype, A.M.N.H. No. 26028:2. 37. Dorsal view of conjoined valves of immature individual, $\times 3$; same specimen as figure 36.

HOLOTYPE: A.M.N.H. No. 16404:1; length, 9.7 mm.; height, 8.0 mm.; diameter (both valves), 5.5 mm.

TOPOTYPE: A.M.N.H. No. 26025:1; length, 9.2 mm.; height, 7.5 mm.; diameter (right valve), 4.6 mm.

Whitfield's original description of this species is as follows:

"Shell of medium size, one fragment of a right valve giving positive evidence of a length of 12 mm.; a smaller, but perfect shell exceeds one centimeter very slightly, with a height of right valve of 8 mm., and a thickness of the two valves, in place, of 6 mm. Right valve very ventricose, subtrapezoidal; beak large and enrolled, overhanging the hinge line, terminal anteriorly; posterior end caudate on the line of the hinge, which is straight; anterior end truncate, abrupt, impressed below the beaks; disc of the valve with strong, rounded, concentric undulations, extending anteriorly and posteriorly. Right [sic=left] valve small, convex, destitute of concentric furrows, but with several obscure radii on an otherwise smooth surface; anterior umbonal ridge strongly marked.

"The peculiar trapezoidal form of the right valve, coupled with its strong, rounded concentric undulations and the faint raised radiating lines of the smaller valve will distinguish this species. The right valve is heavy and dense, and the hinge is marked by a strong tooth and a very deep pit, which extends beneath the large enrolled beak. The left valve has not been obtained separated."

Contrary to the implication, though not the exact wording, of this description, the concentric undulations die out posteriorly and do not extend across the posterior rostrum of the valve. Superficially this area appears to be smooth, but under a microscope it is seen to be marked by low, rounded, concentric ribs which are much more numerous and closer together than those on the body of the valve. In addition, there is a strong, chordate, umbonal ridge paralleling the posterior dorsal margin and situated but slightly below it. The valve is sharply angulated at this ridge, and the surface between it and the dorsal margin lies almost at right angles to the remainder of the valve.

Internally, the anterior and posterior dorsal margins of the valve are deeply grooved for the reception of the margins of the left. The

posterior dorsal groove dies out along the posterior margin; there is no groove ventrally.

There is considerable variation in the ornamentation of the left valve. The umbonal ridge extending to the anterior ventral margin is always present, but is often accompanied by a second, weaker ridge extending to a point about mid-length of the anterior end. The radial lines on the body of the valve are often almost absent, but when present the most strongly developed will extend to a point on the ventral margin at approximately the posterior fourth of the length of the valve, and there will be pronounced angulation of the valve margin at this place. A weak concentric ornamentation is almost universally present.

REMARKS: There are a number of very similar forms of *Caestocorbula*, particularly in the Upper Cretaceous deposits. The forms from the *Turritella reyi* (Campanian-Maestrichtian) beds of Palestine figured by Van Ingen (1905, pl. B, fig. 3) and by Blanckenhorn (1934, pl. 14, fig. 169) as *Corbula olivae* seem to belong to one of these latter, most probably to that described and figured by Picard (1930, p. 535, pl. 22, fig. 8) as *Corbula* cf. *C. paracrassa* Wade, a species from the Ripley formation on Coon Creek, Tennessee.

The collections from the Olive Locality contain 229 specimens of this species. In addition, two specimens are known from beds of the same age at Duccûn.

Caestocorbula semina, new species

Plate 10, figures 22-24

HOLOTYPE: A.M.N.H. No. 26026; length, 6.6 mm.; height, 5.0 mm.; diameter (both valves), 4.5 mm.

DESCRIPTION: The shell is small, inflated, and posteriorly rostrate, in general shape and proportions very similar to *Caestocorbula olivae*. It differs from that species, however, in its smaller size, less strongly enrolled umbones on the right valve, which is ornamented by less strongly developed and more widely spaced concentric plications. The posterior rostrum is relatively longer and broader at the posterior end. The left valve is much more inflated and lacks all trace of the prominent anterior umbonal ridges that characterize Whitfield's species. The surface is ornamented with low, inconspicuous, concentric ribbing, and there is no trace of radial ornamentation. The anterior and median areas of this valve

are strongly inflated. Posteriorly the valve flattens out sharply to the posterior end which is inserted at the anterior end of the rostral prolongation of the right valve.

REMARKS: During the early stages of this study this little species was included among the immature examples of *C. olivae*. More careful examination, however, disclosed that it could readily be separated on the basis of the absence of the umbonal ridge on the left valve, the more pronounced rostrate posterior end, and the less sharply enrolled umbones of the right valve. In *C. olivae* the umbonal ridge of the left valve is much more strongly developed in the juvenile stages of the development when it results in a pronounced angulation of the surface of the valve, a feature that is lacking in the present specimen.

The shape of the left valve is suggestive of that of *C. elegans* (Sowerby) (1827, vol. 6, p. 139, pl. 572, fig. 1; see Woods, 1908, p. 216, pl. 34, figs. 23-28b), but that species may be distinguished by its stronger concentric sculpture, the shorter and broader rostrum, and the more enrolled beaks on the right valve.

There are six specimens in the collection that have been referred to *Caestocorbula semina*.

PARMICORBULA VOKES, 1944

Parmicorbula VOKES, 1944, Amer. Jour. Sci., vol. 242, p. 621.

GENOTYPE: By original designation, *Corbula neaeroides* Blanckenhorn. Aptian, Cretaceous, Lebanon.

***Parmicorbula neaeroides* (Blanckenhorn)**

Plate 10, figures 25-29

?*Neaera* sp., NOETLING, 1886, p. 839.

Corbula neaeroides BLANCKENHORN, 1890, p. 96, pl. 7, fig. 3; WHITFIELD, 1891, p. 386; BLANCKENHORN, 1934, p. 263; VOKES, 1941, p. 1722.

Parmicorbula neaeroides (Blanckenhorn) VOKES, 1944, p. 621, pl. 1, figs. 7, 10-12, 14, 15; VOKES, 1945b, p. 21, pl. 4, figs. 5-10.

TOPOTYPES: A.M.N.H. No. 25933:1; length 21.1 mm.; height, 14.6 mm.; diameter (both valves), 11.0 mm.; left valve, length, 16.5 mm.; height, 12.2 mm.

A.M.N.H. No. 25933:2; right valve, length, 17.5 mm.; height, 12.9 mm.; diameter, 6.5 mm.

A.M.N.H. No. 25933:4; left valve, length, 12.3 mm.; height, 9.6 mm.; diameter, 4.3 mm.

A.M.N.H. No. 25933:3; juvenile specimen, length, 7.1 mm.; height, 4.4 mm.; diameter (both valves), 3.6 mm.

This species has been described in detail in two recent papers by the present writer (Vokes, 1944, p. 621, pl. 1, figs. 7, 10-12, 14, 15; 1945b, p. 21, pl. 4, figs. 5-10). The type as figured by Blanckenhorn differs from the more normal form of the species, as shown by the 522 specimens in the collection studied, in that the anterior dorsal margin, as shown in his figure, is quite evenly convex; in most of the specimens it is straight to slightly concave so that the umbonal area has the appearance of being more vertical in position and more strongly inflated, the greatest inflation of the valve being above the mid-height. Furthermore, in the type the concentric ornamentation of the right valve seems to extend onto the rostrum with almost undiminished strength. In the normal example it is greatly reduced in strength, and the rostral area is almost smooth, save for occasional rugose lines of growth on some specimens.

There are seven specimens in the collection, all immature, in which the siphonal plate characteristic of this genus is preserved. The structure is very fragile and was apparently easily lost after the death of the animal.

***Parmicorbula aequilineata*, new species**

Plate 10, figures 30-33

HOLOTYPE: A.M.N.H. No. 26027:1; length (incomplete posteriorly), 15.6 mm.; height (slightly incomplete ventrally), 11.2 mm.; diameter (both valves), 6.8 mm.; left valve, length, 13.7 mm.; height, 10.5 mm.

PARATYPE: A.M.N.H. No. 26027:2; length, 6.4 mm.; height, 4.4 mm.; diameter (right valve), 2.3 mm.

This species may be distinguished from *P. neaeroides* by its less inflated, more centrally located umbones. The ratio of the inflation of the right valve to the height of the valve is 1:3.24 in the present form (assuming that it had a height when complete of 12 mm.), while the same ratio in *P. neaeroides* (measured on a dozen specimens) varies between 1:1.9 to 1:2.23. The umbones are not strongly curved and do not overhang the left valve as they do in the latter form.

The concentric sculpture is equally developed on both the right and left valves and

consists of relatively low, rounded concentric ribs separated by interspaces from two to three times the width of the ribs. From one to five microscopically fine ribs are to be found in each interspace. On the right valve this ornamentation tends to die out at a moderately prominent chordate umbonal ridge which extends to the posterior ventral margin of the rostral "snout." This umbonal ridge is much more sharply delimited from the rest of the valve than that on *P. neaeroides*, and the rostral "snout," though broken, seems to have been shorter and broader than that of the more commonly represented species.

The siphonal plate is missing from the two specimens in the collection from the Olive Locality.

CARYOCORBULINAE

CARYOCORBULA GARDNER, 1926

Caryocorbula GARDNER, 1926, *Nautilus*, vol. 40, p. 46.

GENOTYPE: By original designation, *Corbula alabamiensis* Lea. Eocene, Claiborne group, Alabama.

Three specimens in the collection represent a species that is tentatively referred to this genus. It differs somewhat from the typical species, but the material is inadequate for the diagnosis of a separate subgeneric group.

Caryocorbula prima, new species

Plate 10, figures 34-37

HOLOTYPE: A.M.N.H. No. 26028:1; length, 11.5 mm.; height, 8.4 mm.¹; diameter (both valves), 5.5 mm.

PARATYPE: A.M.N.H. No. 26028:2; length, 6.6 mm.; height, 5.2 mm.; diameter (both valves), 3.3 mm.

DESCRIPTION: The shell is of average size for the genus, with moderately inflated, sub-central umbones situated between the anterior third and the mid-length of the valve.

¹ This is the height of the left valve. The umbo of the right valve had been badly damaged by erosion and was further destroyed during the exposure of the hinge. The umbo of the right valve slightly overtops that of the left, as shown by paratype A.M.N.H. No. 26028:2, and it seems probable that the height of the right valve of the holotype was approximately 9 mm.

When viewed from above, the shell is seen to be somewhat pyriform in shape, with the greatest inflation at approximately the anterior third of the length, and both valves become progressively less inflated to the rather sharp posterior area. The anterior dorsal margin is straight to very slightly concave, the anterior end rounded, the ventral margin broadly and regularly rounded, the posterior ventral margin rather sharply rounded, the posterior end almost straight, and the posterior dorsal margin broadly convex. The surface of both valves is ornamented with broad, rounded, concentric ribs. The right valve of the paratype has a low, inconspicuous, umbonal ridge extending to the posterior ventral margin and ventrally delimiting a broad, moderately prominent concave area that extends to the posterior margin.

The hinge of the right valve has not been seen. That of the left consists of a moderately deep, broad, and triangular socket for the reception of the right cardinal with, posteriorly, a typical bipartite chondrophore similar to that to be seen in *C. alabamiensis*, the genotype of *Caryocorbula*.²

Muscle scars and pallial line not seen.

REMARKS: In gross outline this species is quite similar to that shown by Conrad's poor figure of his *Corbula aleihensis* (1852, p. 235, App., pl. 8, fig. 53), except that in that form the umbo seems to be relatively higher and more prominent. The original description is too imperfect to permit any comparison, and unfortunately the type seems to be lost. Blanckenhorn (1934, p. 249) questionably refers Conrad's species to *Cyprina blanckenhorni* Peron and Fourtau (*in* Fourtau, 1904, p. 333, pl. 3, figs. 17, 18), and it does resemble the original figures of that species as closely as it does the present form.³

² Unfortunately this was damaged during preparation, the anterior "spoon-like" concave area being broken away and lost.

³ The 10 specimens figured by Blanckenhorn (1934, pl. 13, figs. 139-149) as Peron and Fourtau's species may be distributed among five or six species, and apparently almost as many genera. Figures 139 and 140 seem to show the peculiar internal markings that characterize the species of the genus *Thetironia* Stoliczka, a genus that has not been reported from the Lebanese Cretaceous faunas.

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