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CONTRIBUTIONS TO THE PALEONTOLOGY OF THE LEBANON MOUNTAINS, REPUBLIC OF LEBANON

PART I.—A CENOMANIAN PELECYPOD FAUNA FROM HAJULA

By H. E. VOKES

INTRODUCTION

During my study of the comprehensive series of fossils from the Lebanon Mountains in the collection of the Museum of the American University of Beirut, I noted a most interesting fauna from Hajula, which had been collected in 1926 by the late Mr. Alfred Ely Day, formerly Professor of Biology at the University.

This fauna consisting wholly of pelecypods was associated with a fossil flora which is now being studied by Professor Erling Dorf of Princeton University.

The work in the Lebanon Mountains was done in coöperation with the American University of Beirut and was undertaken on a John Simon Guggenheim Memorial Foundation Fellowship. I am greatly indebted to the Guggenheim Foundation for their assistance, to the authorities of The American Museum of Natural History for permitting me to undertake this study and to President Bayard Dodge and the members of the Faculty of the American University of Beirut for their many courtesies and assistance at all times.

OCCURRENCE

Hajula (spelled "Djoula" on some maps) is a mountain village located twenty-two miles northeast of Beirut in a valley six miles east of the Mediterranean Sea. It is particularly noted as being one of the localities from which was obtained the remarkable fossil fish fauna described by Pictet (1850), Pictet and Humbert (1866), Davis (1887), Hay (1903) and others. Professor Day discovered the present fauna while collecting fossil fish, and some of the specimens, notably that of *Inoceramus* cf. *cripsii* Mantell, have isolated fish scales in the matrix.

There is some variation in the matrix in which the fossils occur. The two end types of matrix are: (1) a hard, dense, finely laminated, buff-colored limestone similar to

the one in which the fossil fish are found; (2) a hard, light gray limestone. All gradations between the two types of matrix are present, but the fossil plants are known only from the second type.

The fauna is too small to permit any conclusions as to the probable facies difference indicated by the types of matrix. *Gervillia dodgei*, n. sp., the most abundant species, is represented by specimens in both types, though it is much more common in the second type. *Protocardia* sp. aff. *hillana* (Sowerby) is similarly distributed, while the four specimens of *Pulvinites auriculus*, n. sp., are all from a matrix that is intermediate between the two extremes described. The other species are all represented by but one or two examples.

COMPOSITION AND AGE OF THE FAUNA

Twelve genera are represented in the fauna. Of these, three are not specifically identifiable, and four new species are described. Noteworthy is the occurrence of such rare genera as *Pulvinites* and *Anthonya* both represented by new species. Specimens of a soleniform *Gervillia*, *G. dodgei*, n. sp., far outnumber all other forms represented in the fauna, and matrix samples occur which are almost wholly composed of the remains of this species. The following species have been recognized and are discussed in the systematic part of this report:

Cucullaea (?) sp.

Arceid sp.

Pinna sp.

Inoceramus cf. *cripsii* Mantell

Gervillia dodgei, n. sp.

Pulvinites auriculus, n. sp.

Volsella capitata (Zittel)

Pholadomya syriaca Conrad

Vetericardia cf. *trigonioides* (Stoliczka)

Anthonya dayi, n. sp.

"*Lucina*" *hajulaensis*, n. sp.

Protocardia sp. aff. *hillana* (Sowerby)

The fossil fish fauna from Hajula has long been recognized as being of Cenomanian age and there are no elements in the present invertebrate fauna whose known geological distribution conflicts with such an age assignment. *Inoceramus cripsii* Mantell, *Volsella capitata* (Zittel) and *Pholadomya syriaca* Conrad have been previously reported from Cenomanian deposits. *Vetericardia trigonioides* (Stoliczka) was described from the Trichnipoly Group of southern India which was considered by Stoliczka (1871, p. 510) as of Cenomanian and lower Turonian age. *Protocardia hillana* (Sowerby) is known from the Albian and the Cenomanian of Europe.

SYSTEMATIC PALAEOLOGY

Parallelodontidae

CUCULLAEA LAMARCK

1801, Syst. Anim. sans Vert., p. 116.

GENOTYPE (by subsequent designation, Children, 1823, p. 45).—*Cucullaea auriculifera* Lamarck = *Arca concamerata* Martini. Recent.

Cucullaea (?) sp.

Figure 12

FIGURED SPECIMEN.—A. M. N. H. No. 25217. Length (incomplete), 32.0 mm.; height, 26.7 mm.; thickness (crushed), 7.0 mm.

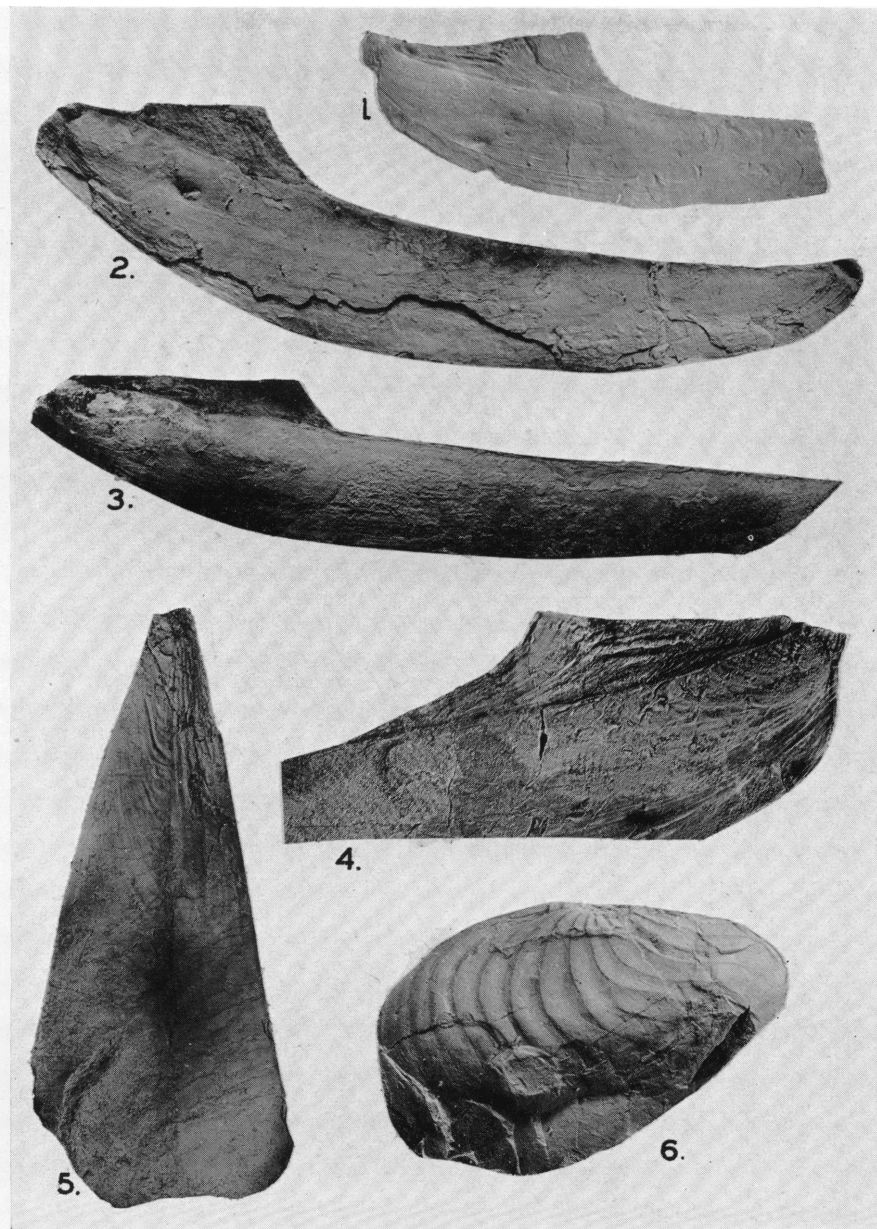
A single mold of the left valve of a very oblique species is questionably referred to this genus. The anterior and posterior ends of the hinge are exposed and show 6 or 7 anterior and 3 posterior lateral teeth parallel to the hinge line. The valve is rhomboidal, convex, markedly oblique being highest posteriorly. The anterior margin is short, gently convex and rounds broadly to the ventral margin. This margin has a considerable slope posteriorly and appears to have sharply rounded to the relatively long, oblique and slightly convex posterior margin. The posterior ventral margin of the valve is absent and the remarks con-

cerning this region are inferred from the trend of the sculpture pattern which is impressed on the surface of the specimen.

The umbo was moderately inflated and slightly anterior to the center of the hinge line. There is a distinct umbonal carina extending to the postero-ventral margin. The surface of the valve was ornamented by low, concentric ridges separated by interspaces of slightly more than one-half the width of the ridges. These were marked by faintly developed fine, radial ribbing which extended over the entire surface of the shell.

In addition to the umbonal carina there is a slight swelling of the median region of the posterior end of the valve which suggests the probability that a low umbonal ridge extended to the middle of the posterior margin.

The degree of the obliquity of the valve is the most striking feature of this species. This is a very variable factor in the genus *Cucullaea*, nevertheless the development of it here would seem to be of specific importance. Woods' figure (1899, Pl. 13, fig. 4) of *C. mailleana* (d'Orbigny) (1844,



- Fig. 1. *Gervillia dodgei*, n. sp. Holotype, A. M. N. H. 25079. $\times 1$
 Fig. 2. *Gervillia dodgei*, n. sp. Paratype, A. M. N. H. 25082. $\times 1$
 Fig. 3. *Gervillia dodgei*, n. sp. Paratype, A. M. N. H. 25081. $\times 1$
 Fig. 4. *Gervillia dodgei*, n. sp. Holotype, A. M. N. H. 25079; cast of hinge. $\times 2$
 Fig. 5. *Pinna* sp. Figured specimen. A. M. N. H. 25086. $\times 1$
 Fig. 6. *Inoceramus* cf. *cripsii* Mantell. Figured specimen, A. M. N. H. 25083. $\times 1$

p. 229, Pl. 318, figs. 3-7) is the only illustrated specimen I have found which is comparable in this feature. This species, however, lacks the radial ribbing on the central portion of the surface of the valve.

The surface ornamentation of young specimens of *Cucullaea glabra* Parkinson (1811, III, p. 171) is similar to that on the present form, but that species lacks the pronounced umbonal ridge and is not as oblique. Zittel's figures (1865, Pl. 10, figs. 3a-g) of *Cucullaea chiemiensis* Gumb. indicate a species quite similar to the Lebanon form, except that the concentric sculpture does not seem to be well developed. No examples are available for detailed comparisons.

It must be noted that all the species mentioned in comparison with our form seem to possess a thick shell, whereas the fact that the features of the sculpturing are so well impressed on the present specimen, which is essentially a mold, would suggest that it had had a thinner shell. In this feature it more closely approaches the Recent *Cucullaea concamerata* (Martini) the genotype of *Cucullaea*. Unfortunately, the ligamental area on our specimen is obscured and the presence or absence of diagonal grooves cannot be determined. The thicker shell and the presence of diagonal grooves on the ligamental area of most Cretaceous species suggest their reference to the subgenus *Cyphoxis* Rafinesque.¹

Arcid sp. indet.

A poorly preserved partial cast of a species of an arcid genus is distinguished by the possession of a very short, truncate posterior margin and a sharp umbonal ridge extending to the angulate posterior ventral margin. No details of the ribbing are preserved on the cast, which is too imperfect to permit provisional identification.

Pinnidae

PINNA LINNAEUS

1758, Syst. Nat., 10th Ed., p. 707.

GENOTYPE (by absolute tautonymy).—*Concha pinna* Hasselquist, 1757 = *Pinna muricata* Linnaeus, 1758 (fide Grant and Gale, 1931, p. 145). Recent. East Indies?

¹ Stewart, 1930, pp. 74-75.

Pinna sp.

Figure 5

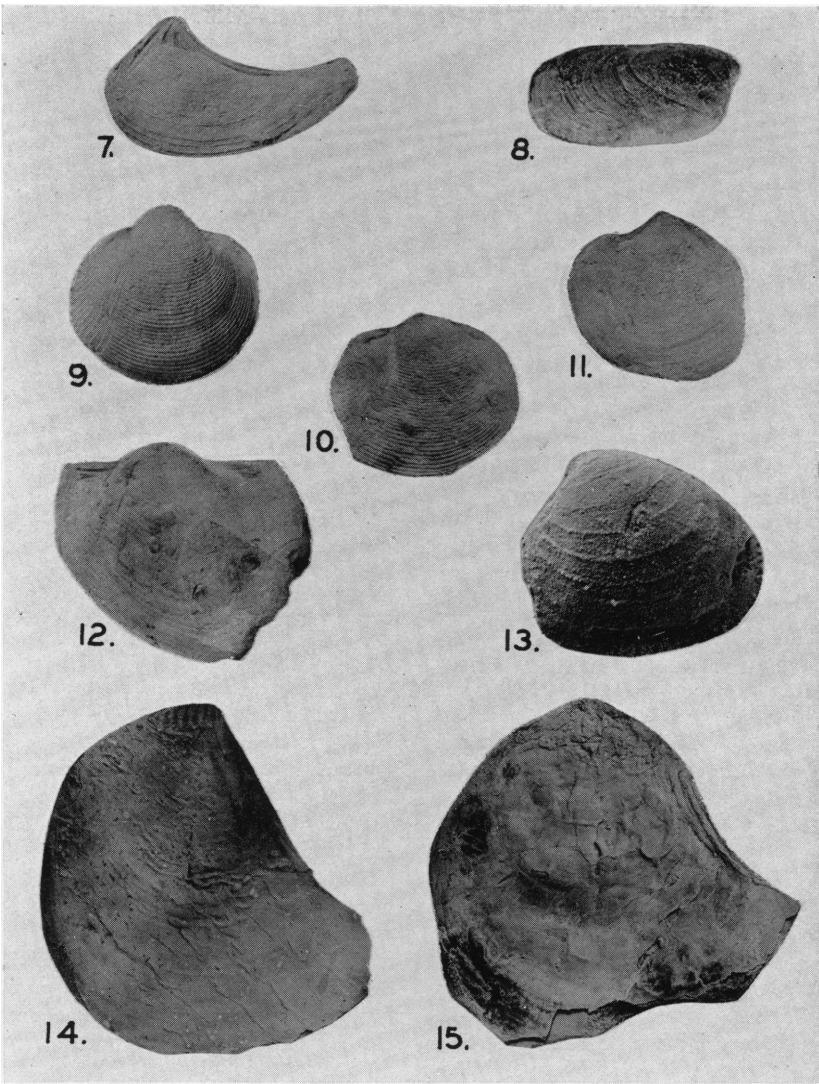
FIGURED SPECIMEN.—A. M. N. H. No. 25086. Length (incomplete), 76.0 mm.; altitude (crushed), 33.4 mm.

A single specimen represents this genus. It is so flattened that it is not possible to determine with certainty as to whether the longitudinal sulcus divided the valve into dorsal and ventral parts as in most of the Cretaceous species. Such evidence as may be observed suggests that such a sulcus did occur and that it divided the valve at a point where the dorsal side was marked by moderately strong radial ribbing and the ventral side by growth ridges which curve rapidly in the direction of the umbo on the ventral margin. There are about 8 narrow rounded radial ribs on the dorsal side. Near the umbo these are separated by interspaces of approximately equal width, but the interspaces tend to be much wider posteriorly. Near the upper margin of the ventral side there is evidence of one or two radial ribs strongly interrupted by the growth folds, but the nature of the preservation does not permit a definite statement as to their nature.

The great majority of Cretaceous species which are ornamented by radial ribbing possess a greater number of such ribs than are represented on the present specimen and these tend to be strongly developed not only on the dorsal side but also on the upper portion of the ventral side of the valve.² In so far as can be determined from the inadequate illustrations, our specimen somewhat resembles *P. renauxiana* d'Orbigny (1843-1847, page 252, Pl. 330, figs. 4-6), said to be a Turonian form, which has six radial ribs on the dorsal side of the valve, and apparently none on the ventral side.

² See:

- P. cretacea* (Schlotheim) well figured by Zittel (1866, Pl. 13, figs. 1a, b) and Geinitz (1873, Pl. 14, figs. 2, 3).
- P. decussata* Goldfuss (1837, Pl. 128, figs. 1, 2).
- P. Reynesi* Hebert and Munier-Chalmas (1875, Pl. 5, fig. 10).
- P. robinaldina* d'Orbigny (1843-1847, Pl. 330, figs. 1-3).
- P. tegulata* Etheridge (1881, Pl. 1, fig. 2).
- P. tetragona* Sowerby (1821, Pl. 313, fig. 1).



- Fig. 7. *Anthonya dayi*, n. sp. Holotype, A. M. N. H. 25078. $\times 1$
 Fig. 8. *Volsella capitata* (Zittel). Hypotype, A. M. N. H. 25088. $\times 3.2$
 Fig. 9. *Protocardia* sp. aff. *hillana* (Sowerby). Figured specimen, A. M. N. H. 25091. $\times 1$
 Fig. 10. *Protocardia* sp. aff. *hillana* (Sowerby). Figured specimen, A. M. N. H. 25089. $\times 1$
 Fig. 11. "*Lucina*" *hajulaensis*, n. sp. Holotype, A. M. N. H. 25080. $\times 1$
 Fig. 12. *Cucullaea* (?) sp. Figured specimen, A. M. N. H. 25217. $\times 1$
 Fig. 13. *Vetericardia* cf. *trigonioides* (Stoliczka). Figured specimen, A. M. N. H. 25087. $\times 3.2$
 Fig. 14. *Pulvinites auriculus*, n. sp. Holotype, A. M. N. H. 25084. $\times 1$
 Fig. 15. *Pulvinites auriculus*, n. sp. Paratype, A. M. N. H. 25085. $\times 1$

Inoceramidae

INOCERAMUS PARKINSON

1819, Trans. Geol. Soc., V, p. 55.

GENOTYPE (by subsequent designation, Stoliczka 1871).—"*Inoceramus cuvierianus* Sowerby" (= *Inoceramus cuvieri* "Sowerby" Parkinson). Cretaceous (Turonian-Senonian). England.

Stoliczka's "*Inoceramus cuvierianus*" is without doubt a *lapsus calami* for *I. cuvieri* "Sowerby" Parkinson. As shown by Steward (1930, p. 104) Sowerby did not publish his description or figure of this species until 1822 (Sowerby, 1822, p. 457, Pl. 25) and it was not available for designation as a type unless Parkinson's statements (1819, pp. 55, 59) regarding this form be considered as constituting a recognizable description.

Inoceramus cf. *cripsii* Mantell

Figure 6

Cf. *Inoceramus cripisii* MANTELL, 1822, p. 133, Pl. 27, fig. 11.

FIGURED SPECIMEN.—A. M. N. H. No. 25083. Length (incomplete), 56.5 mm.; height (incomplete), 38 mm.; diameter (single valve, crushed), 7 mm.

A single crushed specimen and a partial counterpart are tentatively referred to this widespread protean species.

Pedalionidae

GERVILLIA DEFRANCE

1820, Dict. Sci. Nat., XVIII, p. 502.

GENOTYPE (by monotypy).—*Gervillia solenoides* DeFrance. Cretaceous. Ile d'Aix or Le Manche.¹

Gervillioopsis Whitfield (1885, p. 73) (genotype, by original designation, *Gervillia ensiformis* Conrad) is synonymous, and Wade (1926, p. 51) goes so far as to refer DeFrance's species to this genus.

Gervillia dodgei, new species

Figures 1-4

? *Gervillia* sp. aff. *solenoides* DeFr., BLANCKENHORN, 1934, p. 182, Pl. 7, fig. 10.

HOLOTYPE.—A. M. N. H. No. 25079. Length (incomplete), 60.5 mm.; height, 22.0 mm.²

¹ As noted by Woods (1905, p. 86), DeFrance first gave "Ile d'Aix" as the locality from which he derived his specimens of *G. solenoides*, but in later remarks (Dict. Sci. Nat., XXIV, p. 316) he states that they came from the department of Le Manche.

² Length and height measurements are taken perpendicular and parallel, respectively, to the straight dorsal margin of the posterior auricle.

PARATYPE.—A. M. N. H. No. 25081.—Length, 115 mm.; height, 28.7 mm.

PARATYPE.—A. M. N. H. No. 25082.—Length (incomplete), 117.0 mm.; height, 25.4 mm.

DESCRIPTION.—Shell greatly elongated, slender, sabre-shaped to soleniform, tapering posteriorly to a rounded extremity. Dorsal margin slightly concave, ventral margin convex with a greater curvature than the dorsal. Umbones subterminal. Anterior ear small and rounded. Posterior ear large, triangular; dorsal margin straight, four times as long as the greatest height of the auricle; posterior margin curving posteriorly to join the dorsal margin of the valve. The ear is marked by growth lines parallel to its posterior margin. Surface of valve marked by lines of growth and low growth-ridges, which are more prominent near the dorsal margin.

Hinge with two to three small transverse teeth at the anterior end. Immediately posterior are two or three small, shallow and inconspicuous ligamental grooves immediately followed by two long, narrow "lateral" teeth subparallel to the dorsal margin of the ear. Posterior and somewhat dorsal to these "lateral" teeth are six or seven narrow inconspicuous, oblique and somewhat irregular teeth which decrease in length posteriorly and tend to assume a more dorsal position.

REMARKS.—Representatives of this species far outnumber all other types in the Hajula collection. Matrix samples occur which are composed almost wholly of the matted shells of this form. So abundant are they that it was difficult to secure undamaged specimens for study.

A considerable number of soleniform gervillias have been referred by various writers to *G. solenoides* DeFrance (1820, p. 503; 1824, p. 316; Planches, Pl. 12, figs. 2a, b, c, d, 4).³ Judging solely from their illustrations these are not all conspecific. But it is difficult to determine from the poor illustrations in the "Dictionnaire" just which of the various forms, subsequently figured, may be correctly interpreted as representing the true *G. solenoides*. The original illustrations of that species are, however, sufficient to indicate that our Lebanon specimens differ markedly in the nature of the hinge. *G. solenoides* appears

³ A number of writers, including Holzappel (1889, p. 223), Woods (1905, p. 86) and Scupin (1913, p. 215) have indicated this as Fig. 6. In the copy of the plates in the Library of The American Museum of Natural History, dated 1816-1830, and believed to represent a first edition, "*Gervillie solenoide* (Def.)," is Fig. 4 and there is no Fig. 6 on Plate 86. Most authors appear to have also overlooked the figures said to represent this species on Pl. 12.

to possess strongly developed and impressed ligamental grooves with small oblique teeth between them. In *G. dodgei* these grooves are small and inconspicuous and there is no suggestion of oblique teeth between them.

The hinge of *G. forbesiana* d'Orbigny (1846, p. 486, Pl. 396, figs. 5, 6) as figured by Woods (1906, Pl. 12, fig. 5) has six or seven transverse teeth at the anterior end, while *G. dodgei* has but two or three. Furthermore, the English species does not possess the long, transverse "lateral" teeth shown on our specimens. The anterior auricle seems to be generally absent and when present is very small. All specimens of the present form in which the anterior end is complete show an anterior ear, though it varies greatly in degree of development.

The nature of the ligamental pits on our specimens is reminiscent of that shown in Fig. 11c of Holzapfel's illustrations of the species which he has referred to *G. solenoides* (1889, Pl. 24, Figs. 11a, b, c, 12a, b). This specimen also shows a tendency toward the formation of the elongate "lateral" teeth which are so well developed in our species.

Blanckenhorn has figured (1934, Pl. 7, fig. 10) a fragment of the anterior end of a *Gervillia* which he has identified as *Gervillia* sp. aff. *solenoides* Defr. The illustration is too poor to permit any definite conclusions, but the hinge appears to consist mainly of small oblique teeth. If the retouched line indicates the true shape of the ventral margin the specimen would seem to be much shorter than either *G. solenoides* or *dodgei*.

I take great pleasure in naming this species in honor of President Bayard Dodge of the American University of Beirut.

Anomiidae (?)

PULVINITES DEFRANCE

1824, Dict. Sci. Nat., XXXII, p. 316.

GENOTYPE (by monotypy).—*Pulvinites adansonii* DeFrance. Geological position unknown. Fréville, Dept. Le Manche.

Species and specimens referable to this genus seem to be very rare. *Pulvinites adansonii* DeFrance, the genotype, was de-

scribed from Fréville, department of Le Manche. In 1826, DeFrance (1826, XLIV, p. 107) states "Je n'ai vu de ces coquilles que des débris de moules de valves, qui paraissent avoir été un peu bombées; mais M. de Gerville annonce qu'il en possède une qui est plate." D'Orbigny does not describe this species in his Paléontologie Française, stating (1843-1847, p. 522) that he had no specimens. He mentions, however, that he has a form from the Oxfordian of Rochelle which he names *Pulvinites oblonga*, without description or figure.

In the Prodrôme (1850, II, p. 24) he indicates that the genus "is now well known, being an '*Anomya*' with the hinge of a *Perna*." He describes a species from the Corallian of La Rochelle, naming it *P. rupellensis*. This is probably the same as his earlier nomen nudum, *P. oblonga*, which species, however, he does not mention.

Later (1853, p. 432) he has concluded that DeFrance's species, of which he has seen no specimens, is a *Perna* and proposes the generic name *Hypotrema* for his *P. rupellensis* and a new species *H. triangularis*, also from the Corallian of La Rochelle.

The specimens of the latter species show (1853, Pl. 10, figs. 6-12) that it possessed an *Anomya*-like foramen on the lower valve, which is said to be flat or concave. This is the basis for creating the genus *Hypotrema*. Since DeFrance mentions that his specimens were "bombées," but that "M. de Gerville annonce qu'il en possède une qui est plate," it seems probable that he had only upper valves in his possession and had not seen the (presumably) lower valve of de Gerville which may have had a foramenal opening. It thus is probable that more material will indicate that *Hypotrema* d'Orbigny, 1853, is a synonym of *Pulvinites* DeFrance, 1824.

One species, *Pulvinites argentea*, was described by Conrad (1858, p. 330, Pl. 34, fig. 5), from the Ripley formation Upper Cretaceous of the southeastern United States. It has been well figured and the muscle impressions described by Wade (1926, p. 52, Pl. 13, figs. 5, 6, 8, 9).

Pulvinites auriculus, new species

Figures 14, 15

HOLOTYPE.—A. M. N. H. No. 25084. Length, 43.0 mm.; height, 43.2 mm.; valve flattened on matrix.

PARATYPE.—A. M. N. H. No. 25085. Length, 51.3 mm.; height, 47.2 mm.; valve flattened on matrix.

DESCRIPTION.—Valve of medium size, flattened, produced posteriorly; anterior and ventral margin broadly and regularly rounded, posterior arcuate; shell thin, surface apparently ornamented only by irregular lines of growth; umbos anterior of mid-line of the valve; the cardinal plate of the holotype showing six shallow, rounded ligamental grooves which are slightly wider than the interspaces.

REMARKS.—There are four specimens of this species in the collection. All are rather badly flattened on the matrix and it is not possible to determine with certainty the characters of the foramen or of the muscle scars. On the holotype there is a suboval area immediately below the cardinal plate which seems to represent the foramen. This area has a greatest diameter of 3.3 mm. However, the shell substance is so thin that it is not possible to ascertain with certainty whether the apparent opening is not due to the loss of the shell in collecting rather than being a structural feature of the valve. The umbonal region on the figured paratype is too poor to permit any conclusions as to its nature.

P. auriculus resembles the figure of *P. adansonii* in general outline, but in detail it differs in being more regularly rounded anteriorly and ventrally, and in being somewhat more produced posteriorly. The shape of the anterior and ventral margins of *P. argentea* Conrad is similar to that in our species, but the former has a straight posterior dorsal margin and is not as markedly produced posteriorly. It also has about twice as many ligamental grooves on the hinge plate. Both of d'Orbigny's Corallian species differ in outline and proportions.

Mytilidae**VOLSELLA** SCOPOLI

1777, Intro. Hist. Nat., p. 397.

GENOTYPE (by subsequent designation, Gray, 1847).—*Mytilus modiolus* Linnaeus. Recent. Circumboreai.

In 1867 Meek (pp. 69–71) pointed out that *Volsella* Scopoli has priority over *Modiolus* Lamarck, 1799 (p. 87), and it seems certain that Gray (1847, pp. 129 and 198) had come earlier to this same conclusion. Stewart (1930, p. 98) has stated: "Inasmuch as *Mytilus modiolus* was the first species cited by Scopoli and the only Linnaean species, it is certainly eligible as type of *Volsella* as selected by Gray, even though it does not correspond to the original diagnosis of the genus. Scopoli did not realize that *Mytilus modiolus* was edentulous. The name *Volsella* was not accepted by Dall (1898, p. 786) nor by Jukes-Brown (1904, p. 102) on the grounds that *Mytilus modiolus* of Scopoli was a misidentification. However, since the genus *Volsella* was not based on any particular specimens it is to be assumed that the species cited was correctly determined and available for type species by subsequent designation. (Int. Rules, Op. 65.)"

Volsella capitata (Zittel)

Figure 8

Modiola capitata ZITTEL, 1866, p. 80, Pl. 12, figs. 1a–d.

HYPOTYPE.—A. M. N. H. No. 25088. Length, 8.7 mm.; height, 4.2 mm.; diameter (both valves, slightly crushed), 4.0 mm.

A single immature volsellid in the collection agrees well with Zittel's figures of this rather generalized and widely distributed species. It rather closely resembles his Fig. 1a and it differs from that form figured by Pervinquiere (1912, Pl. 8, figs. 10a, b) only in being slightly higher in proportion to the length of the valve.

Pholadomyidae**PHOLADOMYA** G. B. SOWERBY

1825, Gen. Rec. Foss. Shells, pt. 19.

GENOTYPE (by subsequent designation, Gray, 1847).—*Pholadomya candida* G. B. Sowerby. Recent. West Indies.

Pholadomya syriaca Conrad

Pholadomya syriaca CONRAD, 1852, p. 231, Appendix, Pl. 2, fig. 17.—BLANCKENHORN, 1934, p. 261

Pholadomya vignesi LARTET, BLANCKENHORN, 1890, p. 94 (in part ?), Pl. 5, figs. 15, 16 (? not 14, 17).

There are two crushed specimens of this species in the collection.

If we accept Blanckenhorn's (1934, p. 261) revision of *P. syriaca* to include those forms with 7-14 sharp radial ribs and of *P. vignesi* Lartet (1877, p. 126, Pl. 11, fig. 9) to those with 16-24 small radial ribs the larger of our specimens is to be referred to Conrad's species. The smaller shows 17 radial ribs near the umbo and 14 on the central part of the valve. Since both Conrad's and Lartet's species are known to be from deposits of Cenomanian age it is quite probable that an adequate series of specimens, at present lacking, will indicate that the two are but varieties of the same species.

Astartidae

VETERICARDIA CONRAD, 1869 (EMENDED 1872)

GENOTYPE (by monotypy).—*Astarte crenil-rata* Conrad. Cretaceous. Alabama.

This name was first proposed and used in at least two different places by Conrad (1869) as "*Vetocardia*." Later in 1872 (p. 52) he stated that this spelling was in error and changed it to "*Vetericardia*."

Vetericardia cf. *trigonioides* (Stoliczka)

Figure 13

Cf. *Gouldia trigonioides* STOLICZKA, 1871, p. 290, Pl. 10, figs. 4-8.

FIGURED SPECIMEN.—A. M. N. H. No. 25087. Length, 9.9 mm.; height, 8.4 mm.; diameter (single valve), 1.7 mm.

A single cast in the collection is very similar to the forms figured by Stoliczka (especially his Fig. 8) from the Trichinopoly group of India. The cast shows well the raised concentric ribbing and the fine marginal crenulations of this species.

Gouldiidae

ANTHONYA GABB

1864, Geol. Surv. Calif., Paleont., I, p. 181.

GENOTYPE (by monotypy).—*Anthonya cultriformis* Gabb. Cretaceous. California.

Anthonya dayi, new species

Figure 7

HOLOTYPE.—A. M. N. H. No. 25078. Length, 33.3 mm.; height, 18.9 mm.; flattened on matrix; specimen with counterpart.

DESCRIPTION.—Shell elongate, produced pos-

teriorly, inequilateral; anterior margin slightly convex, ventral margin long, broadly and regularly convex, posterior margin short, truncate, sharply angulate dorsally and ventrally, posterior dorsal margin broadly arcuate. Umbos acute, slightly in advance of the anterior third of the length of the shell. Surface of valve ornamented by narrow concentric ribs separated by broad interspaces of much greater width, near the umbos and at the ventral margin the ribs are much closer together, on the center of the valve the interspaces are as much as five times the width of the ribs.

The hinge, impressed on the cast of the holotype, is typical for the genus and shows two moderately strong and slightly curved cardinal teeth, with long slender anterior and posterior teeth parallel and closely approximate to the margins of the valve.

COMPARISONS.—This species most closely resembles the Neocomian species *A. cornueliana* d'Orbigny (1843-1847, p. 74, Pl. 264, figs. 7-9) but differs in possessing a more strongly arcuate posterior dorsal margin and a more prominent and slightly recurved umbo. The posterior end is shorter and more sharply truncate. *A. cantiana* Woods (1906, p. 130, Pl. 19, figs. 4, 5) from the Albian of England, differs in outline and the concentric ribs are more numerous with much narrower interspaces.

REMARKS.—With the exception of two species described from the Upper Cretaceous of the Pacific basin: *A. cultriformis* Gabb (1864, p. 182, Pl. 30, figs. 236, a) from deposits of uncertain age (Cenomanian-Senonian) in California and the somewhat aberrant *A. elongata* Woods (1917, p. 29, Pl. 15, figs. 11-13; Pl. 16, figs. 1-3) from the "Upper Senonian" of New Zealand, this is the youngest recognized species of this genus.

"*Crassatellites*" *subhercyna* Maas (1895, p. 261, Pl. 5, fig. 7, text fig. 2) referred by Gillet (1924, p. 110) to this genus is not so produced nor constricted posteriorly and is probably a *Scambula* Conrad (1869, p. 48, monotype *S. perplana* Conrad). As pointed out by Gabb (1876, p. 311) and Stewart (1930, pp. 147-149) the principal difference between *Scambula* and *Anthonya* is that the posterior end is not produced in the former genus. It should also be noted, however, that the internal margins of *S. perplana* are finely crenulated (see Wade, 1926, Pl. 25, figs. 11, 12, 15, 16), a condition

not noted on our specimen nor shown in any of the published figures of species referred to *Anthonya*.

This species is named in honor of Professor A. E. Day, late Professor of Biology at the American University of Beirut, who collected the specimens upon which this study is based.

Lucinidae

LUCINA BRUGUIÈRE

1797, Tabl. Encyl. Meth., I, pls. 284–286.

GENOTYPE (by subsequent designation, Schumacher, 1817, p. 165).—*Venus pensylvanica* Linné.

The problems involved in fixing the type of *Lucina* Bruguière have been fully discussed by Stewart (1930, pp. 175–178).

“*Lucina*” *hajulaensis*, new species

Figure 11

HOLOTYPE.—A. M. N. H. No. 25080. Length, 24.0 mm.; height, 22.6 mm.; diameter (one valve), 2.5 mm.

DESCRIPTION.—Shell of moderate size, subovate, compressed, umbo slightly posterior to the mid-line of the valve; anterior dorsal margin slightly concave, anterior and ventral margins broadly rounded, subangulate to the short, straight posterior, posterior dorsal margin straight. Ornamentation consisting of distant, raised, fine concentric ribs, with a relatively prominent posterior umbonal ridge extending to the posterior ventral margin. The escutcheon was apparently moderately long and deep and a lunule was present. Hinge unknown.

REMARKS.—Although represented by a single, somewhat poorly preserved specimen, this species is so distinctive as to merit description. The straight posterior and posterior dorsal margins distinguish it from *L. safedensis* Conrad (1852, p. 226, Pl. 19, fig. 113). This is the only species of *Lucina* listed by Blanckenhorn (1934, pp. 234–237) as occurring in this region with which our form might be confused.

The three specimens figured by Blanckenhorn as *L. safedensis* (Pl. 13, figs. 119–121) do not appear to be conspecific with each other. Judging solely from these illustrations, the specimen represented by Fig. 119 appears to be *L. safedensis*. The umbos of the specimens shown in the other figures are too anterior to be conspecific with that form illustrated by Conrad. Figure 121

represents a species much more elongate in proportion to its height and one that apparently possessed a relatively straight posterior margin which is lacking on the more rounded species shown in Fig. 120.

Cardiidae

PROTCARDIA BEYRICH

1845, Zeitschr. f. Malakozool., p. 17.

GENOTYPE (by subsequent designation, Herrmannsen, 1847, p. 336).—*Cardium hillanum* Sowerby (1812, p. 41, Pl. 14). Cretaceous. Europe and Asia?

Protocardia sp. aff. *hillana* (Sowerby)

Figures 9, 10

FIGURED SPECIMEN.—A. M. N. H. No. 25091. Length, 25.3 mm.; height, 23.0 mm.; thickness (one valve, compressed), 5.5 mm.

FIGURED SPECIMEN.—A. M. N. H. No. 25089. Length, 24.4 mm.; height, 21.7 mm.; thickness (one valve, compressed), 4.0 mm.

There are five specimens of a relatively small species of *Protocardia* in the collection. They rather closely resemble the common European Cretaceous species *P. hillana* (Sowerby) (1812–1846 [1813], p. 41, Pl. 14, upper figure), but a comparison with topotype specimens in the American Museum collection and with Woods' excellent figures (1908, Pl. 31, figs. 6a–c; Pl. 32, figs. 1–6) indicates that the present form differs somewhat in possessing a slightly coarser concentric ribbing and in having radial ribbing which tends to be of equal strength over the entire posterior surface of the valve and is minutely echinated, particularly on the farthest posterior ribs. *P. hillana* shows no tendency toward the development of spines on these ribs and the first four to five ribs are often more strongly developed than the more posterior ones.

The preservation of the present specimens does not permit any conclusions as to the nature and extent of the smooth area on the posterior dorsal slope, save that it must have been small, apparently more so than in the typical *hillana*.

These differences would seem to be sufficient to justify the separation of these specimens as a distinct species to which would also be referred the specimen figured

by Stoliczka as *Protocardium hillanum* (1870, Pl. 12, figs. 9, a; ? not figs. 8, a; not figs. 10, a, b). There is, however, a great range of variation exhibited in the forms referred by European authors to this species, a range of variation which fully embraces the differences seen in the present forms. This variation is not well exhibited in the specimens from the type locality at

Blackdown, a condition which is attributed by Woods (1908, p. 201) to the uniformity of the conditions under which the species lived in that area. It will require a much larger comparative collection than at present available to determine whether the differences noted in the present specimens are sufficiently constant to require the separation from the Blackdown species.

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