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# *GRYPHAELIGMUS* N. GEN. (BIVALVIA; MALLEIDAE) FROM THE BATHONIAN OF THE MIDDLE EAST

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ABSTRACT—Strongly inequivalve and inequilateral *Gryphaea*-like malleid bivalves from Bathonian beds in the Middle East are attributed to a new genus *Gryphaeligmus* n. gen., characterized by its close resemblance to both *Gryphaea* and *Eligmus*. A gryphaeid mode of life is suggested for this new genus, supported by its association with *Africogryphaea costellata* (Douvillé).

## INTRODUCTION

CHALKY and marly limestone beds of Middle to Late Bathonian age at Gebel Maghara, northern Sinai (Text-fig. 1) contain abundant well preserved *Africogryphaea costellata* (Douvillé) and some plicate *Africogryphaea*-like smaller bivalves. These latter bivalves turned out to belong to the Malleidae, closely related to *Eligmus*. However, their inequivalve shape, suggesting a gryphaeid mode of life (lying free, motionless on soft bottoms), distinguishes them readily from the equivalve to subequivalve *Eligmus*. Therefore, a new genus is proposed: *Gryphaeligmus* n. gen., a name which indicates the morphological resemblance to both *Gryphaea* (the costate *Africogryphaea*) and *Eligmus*. Young ontogenetic stages of the same form have been recorded from the River Zerqa, Jordan Valley (Jordan; Text-fig. 1) by Cox (1925) as *Ostrea jabbokensis* Cox, probably of Middle to Late Bathonian age (according to the associated *Eudesia cardium* (Lamarck)). Arkell (1952, p. 287, 248, 298) recorded *Eligmus rollandi* Douvillé var. *E. jabbokensis* (Cox) from Late Bathonian rocks of the Upper Dhruma Formation ('Atash Member) at Gebel Tuwaiq in central Saudi-Arabia (Text-fig. 1), associated with *Eudesia* and *A. costellata*. The left, convex valve of the species *jabbokensis* when found separately, may resemble strongly ornamented specimens of *E. rollandi*, but the flat or even concave right valve distinguishes it from the subequivalve *E. rollandi*.

*Ostrea jabbokensis* Cox (1925) was based on young specimens with unexposed internal features. They are identical to young ontogenetic stages of the specimens from Sinai, some of which are well preserved, single valves. These valves enable us to reexamine the systematic position of the species *jabbokensis* Cox (1925) as well as to widen our knowledge on the morphological variability and the possible mode of life of this form.

The described material is reposited in the collections of the Geological Survey of Israel (M 7848 holotype and paratypes of *Gryphaeligmus* n. gen.; M 607 and M 7492).

## SYSTEMATIC PALEONTOLOGY

Superfamily PTERIACEA Gray, 1847 (1820)
Family MALLEIDAE Lamarck, 1819
Genus GRYPHAELIGMUS n. gen.

*Holotype.*—M 7848 *Gryphaeligmus jabbokensis* (Cox) n. gen., from Gebel Maghara, northern Sinai, coord.:9965/0150 (Israel grid).

*Stratigraphic level.*—Upper part of Sherif Formation, middle subunit 64 of Goldberg et al. (1971), (=lower part of Masajid Formation of Al-Far, 1966); Upper Bathonian (together with *Bullatimorphites bullatus* (d'Orbigny)).

*Generic diagnosis.*—Ovate to falcate malleid with an externally convex left valve and a slightly concave right one. Both valves develop radial angular plications, forming a plicate valve commissure. A small auricle-like projection generally occurs on each side of the hinge. The postero-dorsal region of both valves (more pronounced in the left one) is separated from the central part of the valve by an umbonal carina, and forms a low "wall" perpendicular to the commissure plane, ornamented by rather fine plicae almost perpendicular to the umbonal carina. Shell growth proceeds in a crescentic shape back and upwards. Differs from the few other strongly inequivalve malleids (e.g., *Heligmina* Douvillé, 1907, and *Euphenax* Cox, 1931; *in* Moore, 1969, p. N329) by the strong angular plications, and from *Lopha* (Ostreidae) by the byssal notch and lack of umbonal attachment area in the left valve.





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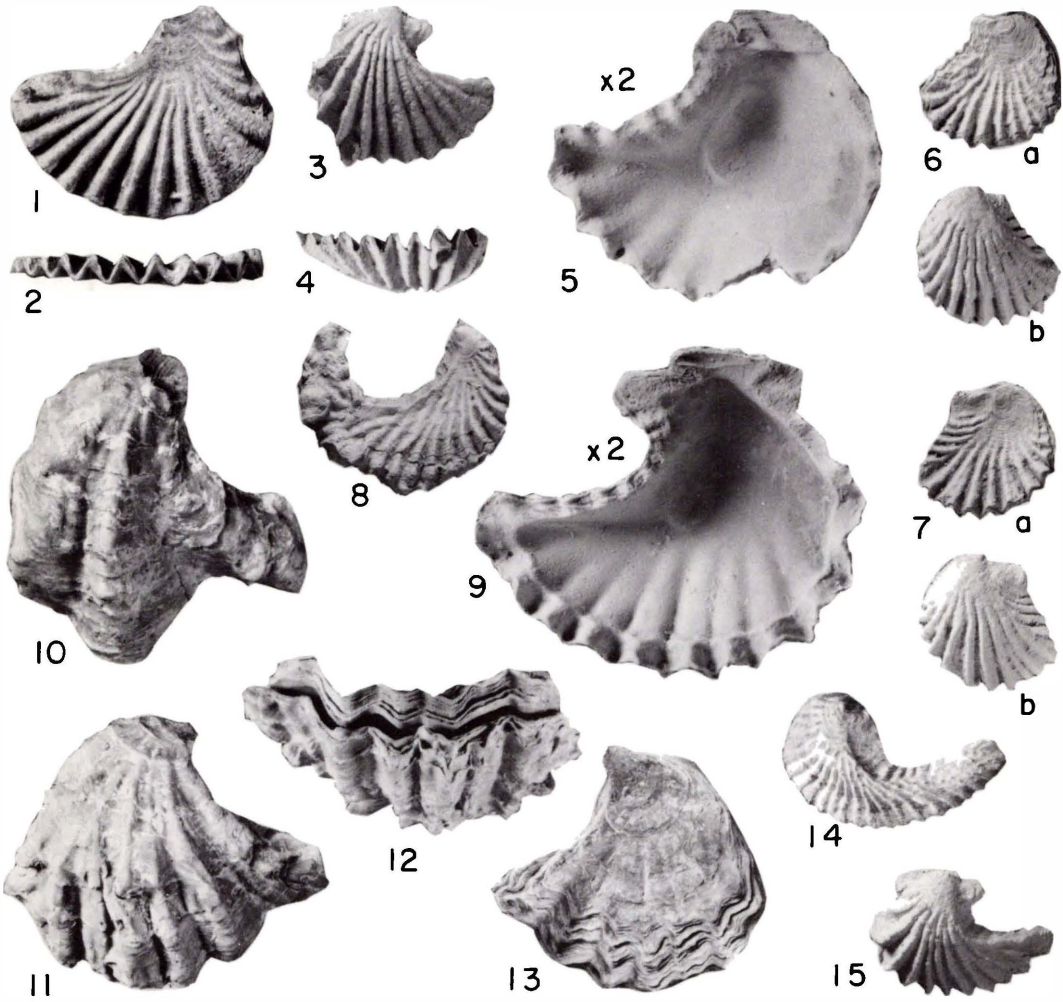



EXPLANATION OF PLATE 1

FIGS. *1–9,15*—*Gryphaeligmus jabbokensis* (Cox) n. gen., Middle to Late Bathonian age, from Gebel Maghara, northern Sinai (*1–2* sample M 7492; *3–5,8,9,15* sample M 7848). *1–2,* right valve with radial, angular costations forming a strongly plicate valve commissure. *3–5, 9,15,* left valves. *5,9* (×2), inner view of the hinge with the narrow byssal notch and the valve marginal band (commissural shelf in oysters). *6–7* (sample M 607), from River Zerqa, Jordan. *6a* and *7a*, right valves; *6b* and *7b*, left valves; note the gradual development of the ornament after the smooth early stage. *8,* strongly crescentic growth pattern and the prominent umbonal carina of a right valve. *15,* tilted view of a left valve showing the postero-dorsal region (×1 except *5,9,* ×2). Holotype (M 7848) left valve *3,4,9,15*.

*10–13*—*Africogryphaea costellata* (Douvillé), ×1 (sample M 7848), from Gebel Maghara, northern Sinai. *10,* coarsely plicate specimen with a long, well differentiated posterior flange. *11–13,* two valves of the same specimen showing a more plicate variety with a less differentiated posterior flange; note the morphological similarity of this form with *Gryphaeligmus* n. gen.

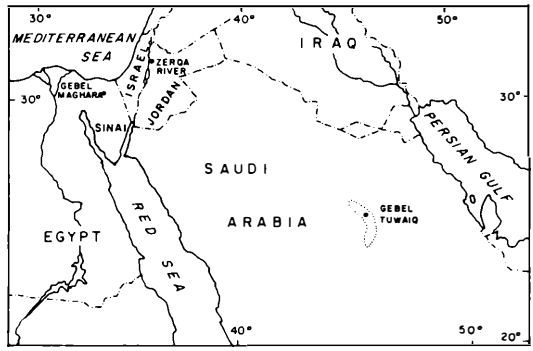
*14*—*Eligmus aualites* (Stefanini), ×1 (sample M 5422), Upper Callovian, Makhtesh Hatira (Kurnub anticline), southern Israel. Note the umbonal carina, growth pattern and ornament similar to *Gryphaeligmus* n. gen. in *8*.

GRYPHAELIGMUS JABBOKENSIS (Cox, 1925)
Pl. 1, figs. 1–9, 15

*Ostrea jabbokensis* Cox, 1925, p. 172, Pl. 14, figs. 1A, B.
*Eligmus rollandi* Douvillé var. *jabbokensis* Cox, ARKELL, 1952, p. 247–248, 298.
*Gryphaea* sp. HIRSCH, 1980, Pl. 4, figs. 6–7.
*Lopha* sp. HIRSCH, 1980, Pl. 4, figs. 8–9.

*Description.*—Small, up to 35–40 mm in length, inequivalve and inequilateral shells. The left valve is externally convex and the right valve is flat or slightly concave. The postero-dorsal region of the valves is characterized by a different growth pattern and ornament than the central surface. This posterior region forms a low wall at an angle up to approximately 90° to the commissure plane and is separated from the central surface of the valve by an umbonal carina, extending from the umbo to the postero-dorsal corner. The postero-dorsal part of the valves is ornamented by low, angular plications directed almost perpendicular to the carina.

Both valves are smooth and flattened during the early ontogenetic stages (3–5 mm of height; Pl. 1, figs. 1, 6, 7). Thereafter, weak radial plications develop, becoming angular and more prominent with growth. Most are simple throughout ontogeny, a few at the posterior and anterior regions may bifurcate, or shorter secondaries are intercalated between the primaries (Pl. 1, figs. 1, 6). The number of plications in adult specimens ranges from 12 to 21, being higher in elongated, crescent forms. The plications are discernible on the interior surface of the valves (Pl. 1, figs. 5, 9) although with growth partly filled out by secondary thickening of the valves through calcite deposition by the mantle surface. The valve commissure is strongly plicate. The inner margins of the closed valves are in contact along a 1–1.5 mm band (commissural shelf in oysters; Stenzel, 1971) which bears fine (hardly discernible), radial ridgelets, resembling the ostreid chomata. They are somewhat tuberculated in the dorsal region of the periphery and form elongated ridgelets pointing backwards at the postero-ventral angulation (Pl. 1, fig. 9). An analogy with ostreids suggests a similar feature as for the exhalant pseudosiphons in the oysters (Stenzel, 1971, N1018–N1019). The backward orientation of the ridgelets suggests its functional morphology in connection with (exhalant?) currents at the postero-ventral angulation.




TEXT-FIG. *1*—Occurrences of *Gryphaeligmus* n. gen. in the Middle East (black points).

At both sides of the hinge small auricle-like projections may occur, the posterior one larger and slightly lower (more ventral) than the anterior (Pl. 1, figs. 3, 9, 15).

The single posterior muscle scar is shallow (lacking the aragonitic myostracum of the oysters) and oval or circular in shape (Pl. 1, fig. 5).

The hinge comprises the ligamental groove, which attains quite variable shapes and dimensions. It is slightly dorsal to the posterior "auricle" and separated from it by a narrow and shallow slit (Pl. 1, figs. 5, 9) which seems to be the degenerated byssal notch of the adult stage.

The mode of growth is crescentic backwards, varying in intensity of curvature from specimen to specimen (Pl. 1, figs. 1, 3, 6–8). Some narrow, long and crescent *Gryphaeligmus* shells (Pl. 1, fig. 8) may resemble *Eligmus aualites* (Stefanini) (Pl. 1, fig. 14), but the complete bivalve exhibits its inequivalve nature, thus differing externally from *Eligmus*.

*Discussion.*—The single incomplete specimen described by Cox (1925) as *Ostrea jabbokensis* is a strongly inflated, oval left valve "ornamented with 16–20 costae radiating from the umbo and curving posteriorly, non-dichotomising, rounded in cross-section, producing a crenulated margin" (Cox, 1925, p. 172–173). However, his figures (Cox, 1925, Pl. 14, fig. 1A, B) show some rib bifurcation in the anterior part. Two complete specimens from the same outcrop at the River Zerqa (Jordan; Text-fig. 1) in the collections of the Geological Survey of

Israel (M 607) are figured here in Pl. 1, figs. 6, 7. Both specimens preserve the slightly concave right valve which was missing in Cox's material, and due to their excellent state of preservation they exhibit the posterior dorsal "auricle" and the almost angular shape of the costation. These two specimens, as well as the one described by Cox (1925) represent a rather high, oval young ontogenetic stage, similar to the young stages of the specimens in Pl. 1, figs. 1, 3, 5. These latter adult specimens show the crescentic mode of growth which is much less pronounced in the earlier ontogenetic stages. Thus the material from Sinai represents more advanced ontogenetic stages than the smaller and younger specimens from the Bathonian of the River Zerqa outcrop, all showing the characteristic morphological features and the same ontogenetic development. Therefore, the adult specimens from Sinai are attributed to the species *O. jabbokensis* Cox (1925) within the new genus *Gryphaeligmus* n. gen.

Hirsch (1980) determined as *Gryphaea* sp. and *Lopha* sp. two specimens from the Upper Bathonian of Gebel Maghara, northern Sinai (Text-fig. 1). Additional specimens recently collected by the author at the same locality enabled their taxonomic revision, unfortunately too late to be considered by Hirsch (1980).

*Material and occurrence.*—Sixteen specimens (some fragmentary) were collected at Gebel Maghara, northern Sinai (M 7492 coll. F. Hirsch; M 7848 coll. Z. Lewy), upper part of Sherif Formation, subunit 64 of Goldberg et al. (1971); M 607, two specimens from River Zerqa (Jordan Valley, Jordan), level of *Eudesia cardium* (Lamarck), Middle to Upper Bathonian.

## PALEONTOLOGICAL CONSIDERATIONS IN COMPARISON WITH *AFRICOGRYPHAEA COSTELLATA* (DOUVILLÉ)

Being byssate, closely attached bivalves, most malleid genera tend to have rather smooth, hydrodynamically streamlined shells, enabling life in a shallow marine, high-energy environment (Kauffman, 1969, p. N147). However, among the fossil malleids occur a few coarsely costated forms such as the Mid-Jurassic *Eligmus,* associated with shallow marine faunas. We may assume several advantages of this costation in addition to strengthening the valves. The orientation of the costation of *Eligmus aualites* (Stefanini) seems to separate the streamlined currents into several weak, turbulent currents around the whole commissure (Pl. 1, fig. 14) as an advantage in obtaining drifted food particles. This orientation also may stabilize the byssate bivalve when hanging single (not in a cluster) on the byssus in the turbulent water. On the other hand the costations form a plicated valve commissure, increasing the length of the commissure and providing a filter against large sedimentary particles.

*Gryphaeligmus* n. gen. is the most inequivalve and coarsely plicated malleid genus. Although it has a very small, probably degenerated byssal notch, a byssate mode of life for the adult stage is doubtful from the morphological point of view. On the basis of its morphological similarity to the costate *Africogryphaea costellata* (Douvillé) with which it is associated, a gryphaeid mode of life (Stenzel, 1971; Lewy, 1976) is suggested for the adult *Gryphaeligmus* n. gen.

*Africogryphaea costellata* (Pl. 1, figs. 10–13) with a minor attachment area developed a similar shape to that of *Gryphaeligmus* n. gen., differing from the latter by its larger dimensions and coarser plications (Pl. 1, figs. 11–12). These two bivalve genera dominate the biota in addition to abundant brachiopods (*Eudesia cardium* (Lamarck) and rhynchonellids). Most of these bivalves and all brachiopods are excellently preserved with both valves, embedded in marl within a marl and limestone sequence of the Sherif Formation at Gebel Maghara, northern Sinai (Goldberg et al., 1971). The fossiliferous marl beds suggest a rather calm, shallow marine environment due to the lack of disarticulated bivalves and brachiopods or coarse clastic (and bioclastic) material. This low-energy environment enabled the unattached bivalves to lie free on the soft bottom sediment.

The equivalve, smooth young shells of *Gryphaeligmus* n. gen. seem to represent the only byssate stage (similar to attached young ontogenetic stages of *Africogryphaea*). Thereafter the bivalve probably detached itself from the substrate and fell onto the bottom, starting to grow in a gryphaeid pattern towards an externally convex left valve and a flat to concave right one. The commissural plane was almost horizontal and elevated from the muddy bottom sediment. The plications of the valves en-

larged the commissure, thereby providing a long gap for water exchange as well as protecting the bivalve from large sedimentary particles entering in between the valves (Kauffman, 1969, p. N146).

According to the present hypothesis, both *Africogryphaea* and *Gryphaeligmus* n. gen. have an early attached stage followed by an unattached mode of life, lying free, but motionless on the soft bottom. Both protected themselves from the intrusion of sedimentary particles by a gryphaeid mode of growth and a plicate valve commissure in addition to a higher growth rate of the shell backwards, perhaps towards a better separation between the inhalant and the exhalant currents or for better stability on the soft bottom, both as a function of water energy.

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