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AALENIAN GRYPHAEINAE FROM THE PIENINY KLIPPEN BELT OF POLAND

Abstract. — Gryphaeinae, found in Middle Aalenian deposits from the Pieniny Klippen Belt, are assigned to 4 species of the genus *Gryphaea* Lamarck, 1801. The studies included morphology of shells, their variability and ontogeny and progressive variability of umbo of left valves.

INTRODUCTION

The assemblage of ostreoid pelecypods studied was collected in so-called *Liogryphaea* Beds, outcropping in the vicinity of Frydman near Nowy Targ, Pieniny Klippen Belt (Birkenmajer, 1957, 1963). The species *Gryphaea sublobata* Deshayes, 1830, is far more common than other species. Lumachelle built up of these pelecypod shells intercalate a series of ferruginous sandstones and shales. The material is abundant but poorly preserved. It is practically impossible to remove valves occurring in sandstone layers, whereas those occurring in weathered shale are easy to get them out but are very fragile. In the collection (over 200 specimens) the left valves of adult individuals predominate. Valves occur in clusters or are randomly distributed in rock. The associated fauna is represented by numerous echinoderm fragments (mainly echinoid spines and crinoid fragments) and ostracods, and some foraminifers. Some fragments of wood were also found.

The stratigraphic and tectonic problems concerning the oyster-bearing strata will be discussed separately by Birkenmajer (oral inf.).

My sincere thanks are due to Professor K. Birkenmajer (Polish Academy of Sciences, Cracow) for handed me this material. Mrs. M. Czarnocka, Institute of Palaeozoology, Warsaw, took the photographs.

The material is housed in the collection of the Institute of Palaeozoology, Polish Academy of Sciences, Warsaw (abbreviated as: Z.Pal.).

Table 1
Summary of features of species of the genus *Gryphaea* Lamarck

| Species | Outline of shell and other features | Umbo | Attachment area | Hinge | Muscle scar | Height ratio | Occurrence |
|--|--|--|---|-------------------------------|---|--------------|---|
| <i>Gryphaea dewalquei</i> | triangular; sinus shallow and wide; lateral lobe large | very small, sharp, slightly opisthogyre | very small, up to 1.5 mm in diameter | 2.5-4.0 mm high, 5-6 mm long | flat, rounded, 4 mm in diameter | 0.9-1.25 | uppermost Toarcian -Lower Bajocian (the <i>Dumortieria levesquei-Sonninia sowerbyi</i> Zones) |
| <i>Gryphaea ferruginea chammigneullensts</i> | ovate, asymmetric; sinus weak, wide | not prominent, symmetrical, sometimes slightly opisthogyre | small, up to 2 mm in diameter | 2.5 mm high, 6-8 mm long | swollen, bordered by ventral lip; 8 mm in diameter | 1.1-1.28 | Lower-Middle Aalenian (the <i>Leioceras opalinum-Graphoceras concavum</i> Zones) |
| <i>Gryphaea sublotata</i> | ovate, asymmetric; sinus shallow, wide | prominent to not prominent, opisthogyre | variable in size, 1-4 mm, occasionally 6-7 mm in diameter | 0.5-4.0 mm high, 1-10 mm long | flat or bordered by ventral lip, rounded to ovate, 5-7 mm in diameter | 1.0-1.36 | Aalenian-Lower Bajocian (the <i>Leioceras opalinum-Sonninia sowerbyi</i> Zones) |
| <i>Gryphaea lampada</i> | ovate, weakly asymmetric; sinus narrow deep | prominent overhanging right valve | up to 3 mm | up to 3 mm high, 7-8 mm long | flat, sometimes located on elevation rounded, 5 mm in diameter | 1.28-1.5 | Middle-Upper Aalenian-lower Zone of Upper Bajocian (the <i>Ludwigia murchisonae-Sonninia sowerbyi Stephanoceras humprriesianum</i> Zones) |

P L A T E S

I — II

Plate I

Gryphaea dewalquei Rollier

Figs. 1—3. Three specimens of different individual age in: *a* side, *b* internal, *c* external views (Mo. VI/4—5, 7).

Gryphaea ferruginea champigneullensis Charles & Maubeuge

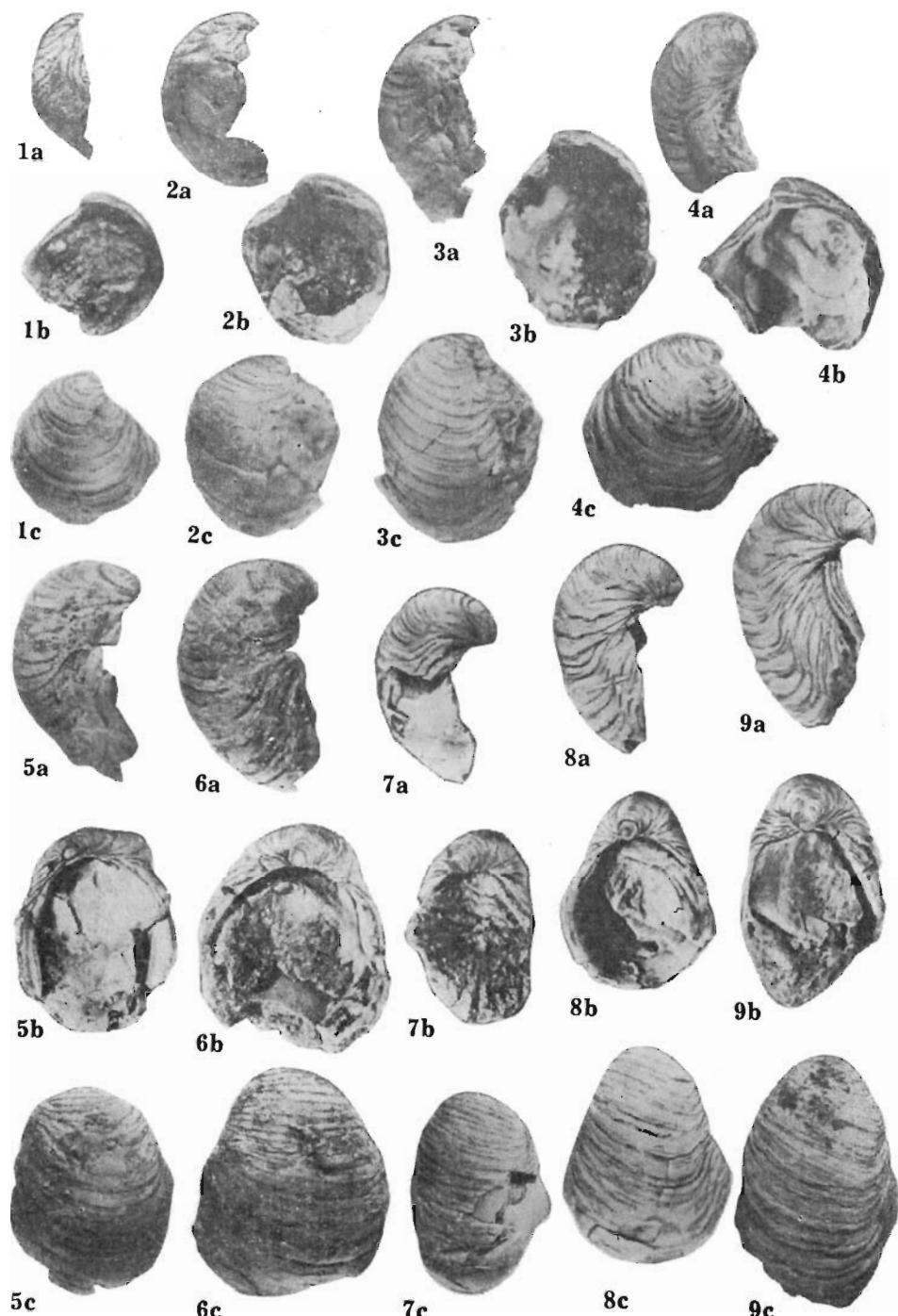
Figs. 4—6. Three specimens of different individual age in: *a* side, *b* internal, *c* external views (Mo. VI/17, 29, 74).

Gryphaea lampada Rollier

Figs. 7—9. Three specimens of different individual age in: *a* side, *b* internal, *c* external views (Mo. VI) 74, 78, 82).

Pieniny Klippen Belt (Krzonowe near Frydman), Middle Aalenian

All figures \times 1



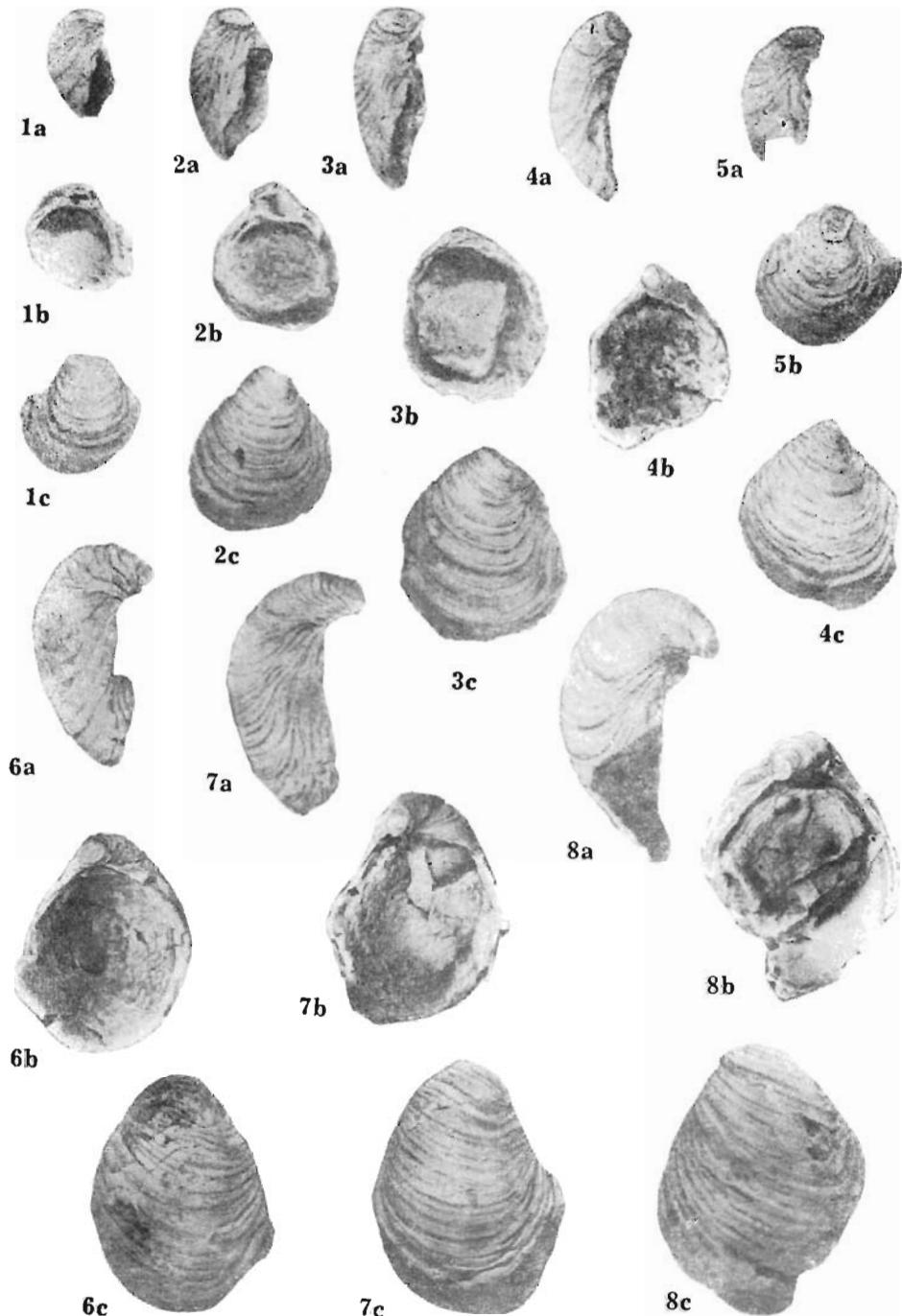


Plate II

Gryphaea sublobata Deshayes

Figs. 1—8. Eight specimens of different individual age in: *a* side, *b* internal,
c external views (Mo. VI/27—28, 31, 35, 40, 43, 55, 59)

Pieniny Klippen Belt (Krzonowe near Frydman), Middle Aalenian

Figs. 1—3 × 2

Figs. 4—8 × 1

SPECIFIC EVOLUTIONARY TRENDS OF THE GENUS GRYPHAEA

Analysis of features typical of particular species of the genus *Gryphaea*, occurring in Middle Aalenian deposits of the Pieniny Klippen Belt in Poland, made possible observation of some directional and non-directional changes in the *Gr. dewalquei* — *Gr. ferruginea champigneulensis* — *Gr. sublobata* — *Gr. lampada* series.

Directional variation in that series primarily concerns the form of umbo and the growth rate of valves. It leads from strongly opisthogyre species with low, unprojected umbo to weakly opisthogyre species with umbo and the growth rate of valves. It leads from strongly opisthogyre of valves of ephebic stages of species under discussion, increases consequently from 1.25 to 1.5.

Non-directional variation in series under discussion concerns primarily the size and location of attachment area, and size of hinge and adductor-muscle scar. Attachment area, initially small (approximately 1.5 mm in diameter), later increases up to 2—4 mm in diameter, attaining 7 mm in extreme cases, and finally decreases to about 3 mm in the last links of the series. The measurements of hinge undergo similar changes. Its height increases from 2.5 to 5 mm on the beginning of series to decrease to 3 mm in the last links. Respectively, the hinge length increases from 5 to 10 mm to decrease up to 8 mm. Muscle scar initially attains 4 to 8 mm in diameter, diminishing in the last links of series to 5 mm.

DESCRIPTIONS

Diagnosis of the genus *Gryphaea* Lamarck, 1801 — *vide* Pugaczewska, 1971.

Gryphaea dewalquei Rollier, 1917

(Pl. I, Figs. 1—3)

1917. *Ostrea (Gryphaea) Dewalquei* Rollier; L. Rollier, Fossiles..., p. 578.1951. *Liogryphaea Dewalquei* Rollier; R. P. Charles & P. L. Maubeuge, Les Liogryphées..., p. 347, Texte-pl. 4, Fig. 7.

Material. — Eight left valves of various individual ages, poorly preserved.

Measurements (in mm):

| Z.Pal.Mo.VI/ | Height | Length | Convexity | Height ratio |
|--------------|--------|--------|-----------|--------------|
| 3 | 18.— | 20.— | 10.— | 0.9 |
| 4 | 21.— | 22.— | 8.— | 0.9 |
| 5 | 26.— | 22.— | 13.— | 1.13 |
| 6 | 26.— | 22.— | 14.— | 1.18 |
| 7 | 30.— | 21.— | 14.— | 1.25 |

Description. — Valves almost equivalve, oblique-triangular in shape, with maximal convexity in half of height and along ventral margin. Umbo low, narrow and acute. Attachment area terminal, rounded, approximately 1.5 mm in diameter. External surface of valves covered with fine growth lines, at intervals of 1.5 mm forming projected striae. In the lower half of valve these striae are modified into flat lamellae. Valve is sub-divided by sinus into larger, more convex anterior part and smaller, lobe-like expanded posterior part. The shallower and broader the sinus, the larger the posterior lobe, whereas when sinus is narrow and deep, the posterior lobe disappears and posterior part becomes more convex (Pl. I, Fig. 1c).

Inner surface of valves is smooth; maximal depression, up to 14 mm, lies in half of valve height and along sinus. Adductor muscle scar is ovate in outline and located in half of valve height, subposteriorly, and attains 4—5 mm in transversal diameter, equalling approximately, one-fifth of transversal valve diameter. Hinge with ostreoid structure, subtriangular in shape and bordered ventrally by slightly elevated wavy hinge margin. Hinge is 4 mm high and 6 mm long in earlier growth stages, decreasing up to 2.5 mm in height and 4 mm in length in later growth stages. Because the ligament pit and lateral ridges are somewhat opisthogyre, the anterior ridge is longer and broader than posterior. Increments in height and length are unequal in ontogeny. In earlier growth stages increment in height is slightly smaller than in length; in later stages the height is greater. Variation of *Gr. dewalquei* is small and primarily concerns some differences in width of sinus and size of lateral lobe.

Remarks. — Specimens from Poland are smaller than French specimens.

Occurrence. — Poland, Pieniny Klippen Belt: Middle Aalenian; France Upper Toarcian (the *Ammonites levesquei* Zone) — Lower Bajocian.

Gryphaea ferruginea champineullensis Charles & Maubeuge, 1951
(Pl. I, Figs. 4—6)

1951. *Gryphaea (Liogryphaea) ferruginea* Terqu. var. *champigneullensis* Charles & Maubeuge; R. P. Charles & P. L. Maubeuge, Les Liogryphées..., p. 340, Text-pl. 2, Figs. 2—4.

Material. — Approximately 20 specimens of different age, predominantly left valves, poorly preserved.

Measurements (in mm):

| Z.Pal.Mo.VI/ | Height | Length | Convexity | Height ratio |
|--------------|--------|--------|-----------|--------------|
| 10 | 25.— | 24.— | 12.— | 1.1 |
| 12 | 27.— | 22.— | 16.— | 1.2 |
| 14 | 27.— | 24.— | 17.— | 1.12 |
| 13 | 30.— | 30.— | 18.— | 1.0 |
| 19 | 34.— | 28.— | 20.— | 1.2 |
| 20 | 36.— | 28.— | 20.— | 1.28 |

Description. — Shell strongly inequivalve, almost equilateral, rounded to ovate, much higher than long. Maximal convexity, up to 20 mm, marked in half of valve height. Umbo symmetrical, not prominent, commonly opisthogyre. Attachment area terminal, less than 2 mm in diameter. External surface of left valve marked with fine growth lines, modified into lamellae in subposterior part; posterior sinus wide and shallow; lateral posterior lobe small. Surface of right valve marked with very numerous fine growth lines in its subumbonal part and with flat lamellae on the rest of valve area. Axes of these parts of right valve form an right or acute angle (Text-fig. 1). Prodissococonch approximately 0.14 mm in diameter.

Inner surface of both valves smooth; left valve is concave in half of its height, whereas right valve is slightly convex. Muscle scar located

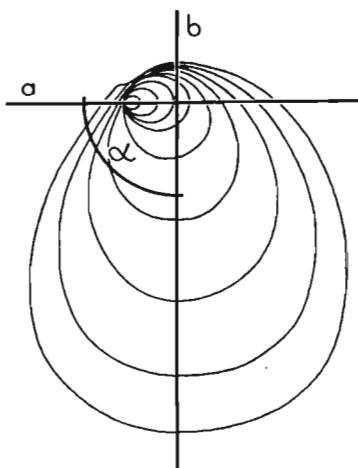


Fig. 1. — Gradual changes in the growth direction on the right valve of *Gryphaea*; α — angle between older (a) and the youngest (b) parts of the valve.

subposteriorly in half of valve height, rounded to ovate, is bordered ventrally by thickened lip; its surface is marked with growth lines and concentric folds; longer transversal diameter of muscle scar attains about 6—8 mm in transversal diameter, equalling approximately one-quarter of transversal valve diameter. Hinge oblique triangular in outline, with opisthogyre apex; hinge margin swollen. Opisthogyrity of umbo and hinge increases with valve growth. Posterior ridge is shorter and higher than anterior. Hinge size increases in ontogeny; length from 6 to 8 mm, height from 2 to 5 mm. Increment in height primarily equal to increment in length, becomes greater in gerontic stages (cf. height ratio).

Individual variation is small and manifested mainly in location of muscle scar and degree of opisthogyrity of umbo. The more opithogyre the umbo, the deeper the posterior sinus and larger the lateral lobe, muscle scar is more depressed, located closer to posterior margin, and ventral lip is more swollen. These relations are reversed when umbo is located more symmetrically.

Remarks. — Polish specimens are similar but smaller than French specimens.

Occurrence. — Poland, Pieniny Klippen Belt: Middle Aalenian; France: Lower and Middle Aalenian (the *Dumortieria levesquei* — *Leioceras opalinum* Zones).

Gryphaea sublobata Deshayes, 1830
(Pl. II, Figs. 1—8)

- 1830. *Ostrea sublobata* Deshayes; G. P. Deshayes, Description..., p. 307.
- 1900. *Gryphaea sublobata* Deshayes; Ed. Greppin, Description..., p. 149, Pl. 16, Fig. 7.
- 1910. *Ostrea Phaedra* d'Orbigny; A. Thévenin. In: M. Boule, Type..., p. 98, Pl. 19, Figs. 18—20.
- 1917. *Ostrea (Gr.) sublobata* Deshayes; L. Rollier, Fossiles..., 578.
- 1951. *Idogryphaea Phaedra* d'Orbigny; R. P. Charles & P. L. Maubeuge, Les Liogryphées..., p. 347, Texte-pl. 4, Fig. 8.
- 1951. *Liogryphaea sublobata* Deshayes; R. P. Charles & P. L. Maubeuge, Les Liogryphées..., p. 347, Texte-pl. 4, Fig. 6.

Material. — Over 50 poorly preserved specimens; left valves predominate.

Measurements (in mm) — see page 395.

Description. — Shell strongly inequivalve, almost equilateral, rounded to ovate, higher than long. Left valve maximally convex in half of its height, up to 18—20 mm. Umbo slightly prominent and weakly opisthogyre or not prominent; attachment area terminal, subcircular and approximately 5 mm in diameter in the first case, shifted to dorsal subumbonal part and exceeding 5 mm in diameter in the second case. Right valve

rounded in outline, concave, rarely flat, except for concave umbonal part, which is the negative of attachment area. Spherical prodissoconch, about 0.1 mm in diameter, is observable on better preserved specimens. Axes of convex and flat parts of valve, form 90° or acute angle.

| Z.Pal.Mo.VI/ | Height | Length | Conveity | Height ratio |
|--------------|--------|--------|----------|--------------|
| 21 | 4.— | 4.— | 2.5 | 1 |
| 22 | 6.— | 5.5 | 2.— | 1.1 |
| 28 | 10.— | 9.— | 4.— | 1.1 |
| 31 | 13.— | 10.— | 5.— | 1.3 |
| 47 | 17.— | 15.5 | 8.— | 1.1 |
| 34 | 21.— | 18.— | 11.— | 1.16 |
| 39 | 24.— | 21.— | 12.— | 1.14 |
| 45 | 27.— | 25.— | 16.— | 1.1 |
| 44 | 32.— | 26.— | 17.— | 1.23 |
| 55 | 34.— | 25.— | 17.— | 1.36 |
| 62 | 34.— | 28.— | 15.— | 1.21 |
| 66 | 37.— | 30.— | 20.— | 1.23 |
| 59 | 38.— | 28.— | 18.— | 1.35 |

External surface of left valve marked with fine growth lines, concentric folds and striae. Flat lamellae are developed along external margin. Folds and striae are irregular, oblique and vary in height and width. More irregular ornamentation of left valve is marked on specimens with deep posterior sinus and large lateral lobe. Right valve is ornamented with growth lines, very fine on convex umbonal part, and flat lamellae close to external margin.

Inner surface of left valve smooth, commonly glittering, maximally depressed, up to 18 mm, in half of valve height and below hinge. Right valve is weakly convex or flat: its inner surface is also smooth, occasionally glittering. Muscle scar located subposteriorly in half of valve height, rounded in outline and attains about 5—7 mm in diameter, equalling 1/5 to 1/7 of transversal valve diameter. Hinge subtriangular with slightly opisthogyre apex, located commonly on slightly elevated hinge field. Its dimensions increase during ontogeny; its height increases from 1 mm in earliest growth stages to 10 mm in adult stages, height increases from 0.5 to 4 mm respectively.

Increments in height and length are equal in the earliest growth stages, later increment in length is greater.

Ontogeny. — Ontogenetic changes in *Gr. sublobata* are expressed in decrement of attachment area, as well as differentiation and gradual increase of overhanging of umbo. Ontogeny of this species may serve as example of change in life habit in neanic and ephebic stages. This

change concerns the gradual detachment of individuals from substratum. In early growth stages they were attached by large area, whereas adult forms were lying freely on the bottom (Pl. II, Figs. 1a—8a).

Variability. — *Gr. sublobata* is characterized by distinct individual variability, expressed mainly in changes of convexity of left valves, opisthogyrity of umbo and hinge, position of attachment area, and location and depth of muscle scar. When valves are strongly convex, umbo is prominent, attachment area terminal and about 4 mm in diameter. With decrease of convexity umbo becomes lower and not prominent, attachment area is shifted onto upper surface of valve and attains up to 7 mm in diameter. Position and convexity of muscle scar is related to symmetry of left valve; in symmetric specimens with opisthogyrity of umbo and hinge weakly marked, muscle scar is subcentral and flat and without lip, whereas in asymmetric specimens with umbo more opisthogyre, muscle scar is subposterior, convex and bordered by ventral lip.

Remarks. — Polish specimens are very similar to French specimens illustrated by Thevenin (l.c.) as *Ostrea phaedra*, and to Swiss specimens.

Occurrence. — Poland, Pieniny Klippen Belt: Middle Aalenian; France: Aalenian — Lower Bajocian; Switzerland: Lower Bajocian (the *Sonninia sowerbyi* Zone).

Gryphaea lampada Rollier, 1917

(Pl. I, Figs. 7—9)

1917. *Gryphaea lampada* Rollier; L. Rollier, Fossiles..., p. 579.

1952. *Liogryphaea lampada* Rollier; R. P. Charles & P. L. Maubeuge, Les Liogryphées..., p. 193, Texte-pl. 1, Figs. 14—16.

Material. — Over 20 specimens, well-preserved; ephebic growth stage predominate.

Measurements (in mm):

| Z.Pal.Mo.VI/ | Height | Length | Convexity | Height ratio |
|--------------|--------|--------|-----------|--------------|
| 67 | 4.5 | 3.5 | 2.— | 1.28 |
| 68 | 6.— | 4.— | 2.5 | 1.5 |
| 70 | 9.5 | 6.5 | 4.— | 1.45 |
| 72 | 15.— | 10.— | 8.— | 1.5 |
| 75 | 27.— | 20.— | 15.— | 1.35 |
| 74 | 29.— | 19.— | 17.— | 1.5 |
| 78 | 30.— | 21.— | 16.— | 1.43 |
| 80 | 33.— | 25.— | 18.— | 1.3 |
| 82 | 36.— | 25.— | 20.— | 1.4 |

Description. — Shell strongly inequivalue, almost equilateral, strongly convex. Left valve almost orbicular, from profile more rounded in upper part than in lower. Umbo of left valve prominent, more or less opisthogyre and overhanging (Pl. I, Figs. 7a—9a). Attachment area terminal, rounded and up to 3 mm in diameter. External surface marked with growth lines, striae and lamellae. In upper part of valve, striae are strongly protruding and irregular. Small lateral lobe demarcated by narrow and deep posterior sinus. Right valve flat to concave, with umbo strongly opisthogyre. Convex subumbonal part of valve, a negative of attachment area, forms an obtuse angle with the rest of valve surface.

Inner surface of both valves is smooth. Left valve is maximally concave in its upper half; right valve slightly convex. Adductor muscle scar subcircular, subcentral, up to 5 mm in diameter, equalling 1/5 of transversal valve diameter; surface of adductor scar marked with concentric flattened folds. Hinge triangular with apex opisthogyre, up to 3 mm high and 7—8 mm long.

Increment of left valve in height is greater than in length since early stages, which is confirmed by height ratio distinctly exceeding 1.

Ontogeny. — Among specimens at hand, some representing early growth stages were noted. However, material is too scarce for precise characteristics of ontogenetic changes. Left valves of early stages exhibit typical features for this species: they are narrow, ovate, with umbo strongly bent. Besides normal changes, in later growth stages, umbo becomes opisthogyre and shell becomes asymmetric; the asymmetry is small in comparison to other species under discussion. External ornamentation, consisting exclusively of fine growth lines in early growth stages, undergoes differentiation later due to appearance of thick striae and lamellae. Contact-line of both valves, not marked in earliest stages, becomes progressively more distinct with age, up to formation of lateral furrows in gerontic stage, occurring outside of lateral hinge ridges.

Variability. — Variability in *Gr. lampada* is small and manifested in changes in degree of hanging of left valve umbo over right valve and its length and opisthogyre bending.

Remarks. — Polish specimens are similar to French specimens. In overall shape they are similar to specimens of *Gr. calceola* Quenstedt, but differ in width of valve, in shorter and less overhanging umbo, ornamentation with striae, and are distinctly more inequivalue and smaller in size.

Occurrence. — Poland, Pieniny Klippen Belt; Middle Aalenian: Germany: Middle and Upper Aalenian (the *Ludwigia murchinsonae* and

Sonninia sowerbyi Zones); Switzerland: Middle Aalenian-Bajocian; France: Bajocian (the *Witchellia laeviuscula* — *Stephanoceras humphriesi* Zones).

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HALINA PUGACZEWSKA

AALENJSKIE GRYPHAEINAE Z PIENIŃSKIEGO PASA SKAŁKOWEGO W POLSCE

Streszczenie

Opisano cztery gatunki rodzaju *Gryphaea* Lamarck, 1801 z serii braniskowej pienińskiego pasa skałkowego, z Krzonowego w pobliżu wsi Frydman (pow. Nowy Targ). Osady te, złożone z żelazistych piaskowców i łupków z miką, zawierają wkładki muszlowców, składających się z gruboskorupowych małżów rodzaju *Gry-*

phaea. Materiał jest bardzo liczny, lecz źle zachowany. Zbadano ponad 200 okazów. Opisano ich morfologię, zmienność i ontogenezę. Stwierdzono w ontogenezie, jak i w szeregu *Gr. dewalquei* — *Gr. ferruginea champigneullensis* — *Gr. sublobata* — *Gr. lampada*, że wierzchołek skorupki lewych zmienia się progresywnie od niewystającego do silnie wystającego i zaginającego się nad skorupką prawą. Inne cechy gatunków, jak płaszczyzna przytwierdzenia, kształt muszli, wymiary zawiąsów, zarys i głębokość odcisku mięśnia adduktora nie wykazują ukierunkowanych zmian.

ХАЛИНА ПУГАЧЕВСКА

ААЛЕНСКИЕ GRYPHAEINAE ИЗ ПЬЕНИНСКОЙ ЗОНЫ УТЕСОВ В ПОЛЬШЕ

Резюме

В работе описаны четыре вида из рода *Gryphaea* Lamarck, 1801, добытые из браниской серии Пьенинской зоны утесов в местности Кшонове близ с. Фридман (повят Новы-Тарг). Отложения этой серии представлены железистыми песчаниками и сланцами со слюдой, которые включают прослои ракушечника, сложенного толстостворчатыми пелециподами рода *Gryphaea*. В исследованном богатом, но плохо сохраненном материале изучено свыше 200 экземпляров. Описаны их морфология, видовые различия и онтогенезис. В онтогенезисе и в ряду *Gr. dewalquei* — *Gr. ferruginea champigneullensis* — *Gr. sublobata* — *Gr. lampada* отмечено, что макушка левых створок меняется прогрессивно от невыступающей до выступающей и наклоненной над правой створкой. Другие видовые особенности, как плоскость прикрепления, форма раковины, размеры замков, очертания и глубина отпечатка мускула-замыкателя не проявляют закономерных изменений.
