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HALINA PUGACZEWSKA

JURASSIC OSTREIDAE OF POLAND

Contents

Abstract. — Thirty five species of oyster pelecypods are described from the Middle and Upper Jurassic of Poland, belonging to 7 genera and 3 subfamilies: Ostreinae, Vialov 1936, Gryphaeinae, Vialov, 1936 and Exogyrinae, Vialov, 1936. Morphology of species, their development and individual variability are investigated. The lithological and geological relationships of the area under investigation, the influence of environment onto the shell morphology, examples of functional and structural adaptations of Ostreidae and shell microstructure are characterized. The remarks on the phylogeny of Ostreidae are completed by an introduction of two development stages: *Catinula* and *Nanogyra*. The systematic position of *Nanogyra nana* Beurlen, 1958 is discussed.

INTRODUCTION

The pelecypods of the family Ostreidae, described in the present paper come from Middle and Upper Jurassic of Poland (Bajocian — Middle Volgian), namely from Mesozoic margin of Holy Cross Mts., from the Polish Lowland and from several outcrops in the Western Pomerania and in the Polish Jura Chain.

The material was collected by the writer in the years 1965—1968 in the field. Some of the material was obtained from the collection of the Institute of Geology, Warsaw University, and from the collection of the Laboratory of the Geology of Young Structures of the Polish Academy of Sciences in Cracow.

The studied material consists of over 2500 specimens, selected from over 8000 of specimens collected in the field. No new species are described in the present paper. Majority of the described forms, are the species known from many countries from the same stratigraphic horizons. Some of them, regarded till now as independent species, were found to be synonyms after the analysis of their morphology.

The most abundant and diversified fauna comes from the Mesozoic margin of the Holy Cross Mts. and from the Western Pomerania, chiefly from the *Ataxioceras hypselocyclum* and *Katroliceras divisum* Zones of the upper part of the Lower Kimeridgian. That of the *Idoceras planula* Zone, which corresponds to the Upper Oxfordian, is less diversified.

The data on the Ostreidae from the Jurassic of Poland so far published, come predominantly from the geological papers, in which they are cited among other fossils. Few works, however, are palaeontological in character. *Ostrea claustrata* and *Gryphaea dilatata* were described and illustrated by Pusch (1837). Those species derived from the vicinities of Przedbórz and Włoszczowa (western margin of the Holy Cross Mts.), but majority of the species described by Pusch came, from the Cretaceous of Poland. Wójcik (1913) has described 8 species of the Ostreidae, and Lewiński (1922) has described and illustrated 10 species of oyster pelecypods, among which 3 new species. These fossils derived from the Middle Volgian of Brzostówka near Tomaszów Mazowiecki. The pelecypods of the genus *Anisomyaria*, coming from the Middle Jurassic of the vicinity of Cracow, were investigated by Krach (1951), who has described and illustrated 16 species of the Ostreidae, among which 8 were new.

The present work is the first monography of pelecypods of the Ostreidae family from the Jurassic of Poland. It has been prepared in the Laboratory of Palaeozoology of the Warsaw University. The writer wishes to express her cordial thanks to Prof. Roman Kozłowski for his kind proposition of the theme to this work, and to Prof. Adam Urbanek, the Director of the Laboratory of Palaeozoology, Warsaw University. Thanks are due also to Prof. Wilhelm Krach of the Laboratory and Museum of the Young Structures, Polish Academy of Sciences, Cracow, for his kind reviewing the manuscript and useful remarks. The writer is also grateful to Prof. Zofia Kielan-Jaworowska, the Director of the Palaeozoological Institute, Polish Academy of Sciences, Warsaw, for a partial financial support from the funds of the Institute.

The writer took advantage also of the materials lent by Dr. W. Szymańska, Dr. E. Roniewicz and Dr. J. Błaszyk of the Palaeozoological Institute, Polish Academy of Sciences, Warsaw, and by Dr. A. Wierzbowski of the Institute of Geology, Warsaw University. To all these persons the writer is grateful, as well as to the Directors of their Institutes. Thanks are due also to Mrs. M. Nowińska, technical assistant of the Palaeozoological Institute, Polish Academy of Sciences, Warsaw, for her help during the field work.

The photos were done by Miss L. Łuszczewska M. Sc. (Institute of Geology, Warsaw University), and the drawings in the text — by Mrs. K. Budzyńska (Palaeozoological Institute, Pol. Acad. Sci.). To both the writer expresses her thanks.

The material is housed in the collection of the Laboratory of Palaeozoology, Warsaw University (abbreviated as Z. Pal. U.W.), and partly in the Palaeozoological Institute of the Polish Academy of Sciences, Warsaw (abbreviated as Z. Pal. P.A.N.).

GENERAL PART

MATERIAL

The collection of oyster pelecypods of Poland so far amounts to about 8000 specimens, however, because of their bad state of preservation and preparation difficulties only about 2500 specimens were worth investigation. These fossils come from various horizons of the Middle and Upper Jurassic comprising the stages from the Bajocian to the Middle Volgian inclusively, and derive from the Western Pomerania, vicinity of Łęczyca, Sulejów, Radom and Tomaszów Mazowiecki, the latter localities in the area of the Polish Lowland, the Mesozoic margin of the Holy Cross Mts., the Polish Jura Chain.

In the Western Pomerania the oyster material was collected from the Upper Oxfordian, Kimeridgian and Middle Volgian deposits comprising the ammonite zones from the *Idoceras planula* to the *Zaraiskites scythicus* inclusively. The excavation works were done in the Czarnogłowy and Świętoszewo quarries. The oyster fauna is relatively rich and diversified there. All known Jurassic genera, except *Arctostrea,* are represented. The species of *Liostrea* are most common. These are: *Liostrea delta* (over 20 specimens), *L. virguloides, L. gryphaeata, L. multiformis, L. plastica* and *L. dubisensis* (several specimens each). *Alectryonia* is less frequent and it is represented by the following species: *Al. gregarea, Al. rastellaris, Al. solitaria* (about 20 specimens each), which occur both in the Upper Oxfordian and Lower Kimeridgian deposits. The representatives of *Exogyra* occur frequently in the Kimeridgian as e. g. *Ex. virgula, Ex. reniformis, Nanogyra nana* (about 30 specimens each), but *Ex. michalskii* and *Ex. decipiens* are seldom found only in the Middle Volgian rocks. *Gryphaea* is represented only by *Gr. dilatata* (about 15 specimens). The shells of the above species are generally well preserved, seldom are they damaged and can be easily prepared what allowed to a detailed analysis of their morphology, variability and the ontogenetic changes.

Five species were found in the zone ore-bearing Bajocian-Bathonian deposits at Łęczyca, among them *Catinula knorri* (40 specimens) and *Liostrea acuminata* (30 specimens) are the most abundant. The shells of both these species are friable, and frequently grown together. Better preserved specimens are those of ribbed surface, belonging to *C. knorri,* whereas the smooth, elongated shells of *L. acuminata* can be separated only exceptionally. The remaining species such as *Alectryonia marshi* and *L. explanata* are either preserved in fragments only, or in small quantities as e. g. *Exogyra crassa.* The determination of these species was easy, because of the characteristic and well traceable ornamentation.

The oysters from the vicinity of Sulejów upon Pilica are exceptionally well preserved. This concerns primarily the Strzałków I/4 bore-hole (12—14 m, 37—39 m), of Lower Kimeridgian. Well preserved shells and valves of the youngest ontogenetic stages of *Nanogyra nana, Exogyra virgula, Ex. reniformis* and *Ex. welschi* allowed to study the morphology, variability and ontogeny and also the hinge evolution of their early growth stages.

Well preserved shells and separate valves of some species of *Alectryonia* occur in the Lower Kimeridgian deposits at the Wierzbica cement plant near Radom. The most frequent are *Al. flabelliformis, Al. pulligera* and *Al. rastellaris.*

An abundant oyster fauna occurs in the vicinity of Tomaszów Mazowiecki in an old clay pit at Brzostówka in the Middle Volgian deposits. Particularly numerous are shells and separate valves of *Liostrea virguloides.* These fossils are badly preserved, friable and frequently firmly cemented with the rock. Nevertheless, about 50 specimens were obtained. The shells of *Exogyra michalskii* and *Ex. decipiens* are better preserved. The latter species is represented also by shells of young growth stages. The shells of other species such as *Liostrea expansa* and *L. cotyledon* are preserved either only in fragments, and hardly can be investigated, or are represented by few specimens only, as e. g. *L. multiformis, L. unci-*

formis and *Nanogyra nana*. The representatives of genera *Alectryonia*, *Gryphaea* and *Arctostrea* do not occur at all there.

Ostreidae are also well represented in the Mesozoic margin of the Holy Cross Mts. in Middle Poland, particularly in the western part (Mokre Mts., vicinities of Przedbórz), and in the south-western part (Oleszno, Gruszczyn, Skorków Żerniki, Brzegi, Sobków, Gołuchów and others). They occur within the deposits ranging in age from the Upper Oxfordian up to the upper zones of the Lower Kimeridgian which comprise the ammonite zones from the *Idoceras planula* up to the *Katroliceras divisum*, inclusively. In the eastern part (Bałtów near Ostrowiec Świętokrzyski), in the uppermost Middle Oxfordian they are less frequent. The state of preservation of the oyster material is not always good. Shells are usually strongly cemented, or are grown together and their separation from the rock causes sometimes serious difficulties. Nevertheless, despite of all these obstacles, it was possible to collect about 1200 specimens the state of preservation of which was quite sufficient to carry a detailed investigation. The most common species are *Alectryonia gregarea* and *Exogyra virgula* and *Nanogyra nana* (over 200 specimens each). Other species, such as *Ex. welschi* and *Alectryonia pulligera*, are less frequent (about 50 specimens each). The remaining species are rare or occur sporadically as e. g. *Alectryonia vallata* (2 specimens) and *Arctostrea hastellata* (1 specimen and several fragments) and *Ex. intricata* (2 specimens).

The oysters occurring in the Middle Jurassic deposits (mainly Callovian) in the Polish Jura Chain are poorly represented. Few right valves of *Nanogyra nana* were found in a quarry at Kłobuck near Częstochowa. This species is more frequent in the vicinity of Cracow (Kozłowiec, Zalas, Sanka). Several species of *Alectryonia* were described from other quarries in the vicinity of Cracow. These are chiefly *Al. gregarea* (Balin, Zalas) and *Al. rastellaris* (Paczołtowice, Czatkowice, Zalas) together counting about a dozen of specimens.

METHODS

In the determination and description of the oyster pelecypods, and in the considerations on their development and specific variability the following characters were taken into account: outline (shape), shell dimensions (height, length, thickness), indices of the pair of corresponding parameters, convexity, and depth of valves, morphology of umbo, ornamentation, attachment area, internal morphology, position, shape and size of muscle scar, character of external and internal valve margin, form of hinge and microstructure.

The terminology here applied is mostly that of Vialov (1948), Kauffman (1966), and in regard to *Exogyra*, of Záruba (1965).

The measurements were taken with a slide caliper and given in millimetres with accuracy to 0.1 mm. Very small specimens were measured under the binocular microscope with millimetre scale. The coiling of umbo of the right valves was measured using angle gauge with an accuracy to 1 degree. The ontogenetic development stages were traced on the youngest parts of valves or of the adult stages and on the well preserved valves of young shells. The shell microstructure was investigated in thin sections cut parallel and perpendicular to their external surface. The sections of muscle scars and hinges were cut in the same manner. The photographed specimens were covered with ammonium chloride. The enclosed schemes explain the applied terminology and mode of research of the mentioned features (Text-fig. 1*a-h*).

TERMINOLOGY

Shape of shell is one of specific characters. Various mode of attachment of shell directly influences the variability of this character, nevertheless these changes are limited. The species of *Liostrea* show the greatest variability of the shell shape.

Size and proportions of a shell change during the development what is best illustrated by the ratios of a pair of parameters. Some species are characterized by a definite size range. One can distinguish species of very small shell size (1—25 mm), medium sized (25—60 mm), large (60—100 mm) and very large (over 100 mm) (Mirkamalov, 1966, p. 25). In the material under investigation, the largest shells are those of *Liostrea* and *Alectryonia*, and the smallest ones — of *Nanogyra* and *Exogyra*. The given size range within numerical intervals concerns the shells of adult specimen, as the youngest ontogenetic stages, regardless of specific classification, fit in the first interval.

Convexity and depth of shells referrs mainly to the left valve, which is attached to the substratum and is considerably dependent on its character. This feature is highly variable, nevertheless, together with other characters it well defines the particular species from the youngest development stages.

The degree of the shell convexity is well defined by a convexity/length ratio. Weakly convex are valves the ratio of which is within 10—20, medium convex — from 20 — to 40, strongly convex 40—70, extremely convex when the ratio is more than 70 (Mirkamalov, 1966). In the investigated material, all the valves fit to the two first intervals. Convexity or depth characterizes species of various genera such as *Catinula* (*C. knorri*, Pl. XXIII, Figs. 1—10), *Liostrea* (*L. gryphaeata*, Pl. XV, Fig. 1—4), *Alectryonia* (*Al. pulligera*, Pl. VIII, Figs. 12—15), *Nanogyra* (*N. nana*, Pl. XXV, Figs. 1—7).

The morphology of umbo is a very characteristic feature, it changes within definite limits. Umbo may be sharp, narrow (*L. unciformis.* Pl. XVI, Figs. 5, 6), or broad, rounded (*Al. solitaria,* Pl. III Figs. 4, 5), straight or asymmetrical, backward turned (*Al. flabelliformis,* Pl. IV, Figs. 9, 10), prominent or low (*Gryphaea dilatata,* Pl. XVIII).

Certain species of *Nanogyra* and *Exogyra* differ from other genera in the character of umbo. Their umbo is always more or less coiled backward, frequently different in both valves. In the left, for instance, it may be trochoidally coiled, and in the right — may form a flat spiral. The degree of coiling of the umbo of the right valve, in the author's opinion, is of primary importance in specific classification (e. g. *Nanogyra nana, Exogyra virgula*). Vialov (1948, p. 22) regarded it as a diagnostic feature for subfamilies. Four types of umbos may be distinguished: gryphaeoid, opisthogyre, prosogyre and exogyre. Only the last one is important as a generic character, and the others show great diversity, then their taxonomic value is insignificant.

Shell ornamentation consists of concentric growth lines, striae, lamellae, wrinkles and radial striae, ribs and folds. Ornamentation may be equally developed on both valves (genera: *Alectryonia, Arctostrea, Liostrea*), or differently (genera: *Nanogyra, Exogyra, Catinula*). In the author's opinion, the taxonomic value of ornamentation was frequently overestimated. Vialov (1948, p. 18) treated ornamentation as the most important diagnostic character for the species. Radial ornamentation may embrace either only the superficial layers of valves, in such cases it is defined as radial striae (*Catinula knorri,* Pl. XXIII; *Exogyra virgula,* Pl. XXX, Figs. 5, 6); or may it concern all the layers, in this case folds or ribs are formed (genera: *Alectryonia, Arctostrea,* some species of *Exogyra*). Ribs may be low, high, of sharp crest, in some cases they show spiny processes (*Alectryonia pulligera,* Pl. VIII, Fig. 14*a*), or may be smooth and rounded dorsally (*Al. rastellaris,* Pl. VI, Fig. 9). The character of the ribs, their number and mode of development together with other features are of great importance in specific diagnosis. In some species of *Alectryonia,* the number of ribs increases in a definite manner, either through a dichotomic division, or through intercalation. In some cases both these modes may be observed in the same specimen (*Al. gregarea,* Pl. VI, Fig. 5*a*). Sometimes the pattern of ribs is very characteristic, namely the ribs may show various length in the various places of the valve and they may run differently (*Al. solitaria,* Pl. III, Fig. 5*a*). Very short ribs occur in *Arctostrea,* and beside that they are high with sharp, dorsal keel, thus forming zigzag commissure of great amplitude (*A. hastellata,* Pl. VII, Fig. 11). In some cases the ornamentation consists of long folds of constant number, which run through the whole surface of the valve and on its margin are marked as an insignificant folding (*Ex. intricata,* Pl. X, Figs. 1, 2). Folds may be regular or irregular (*L. monsbeliar-*

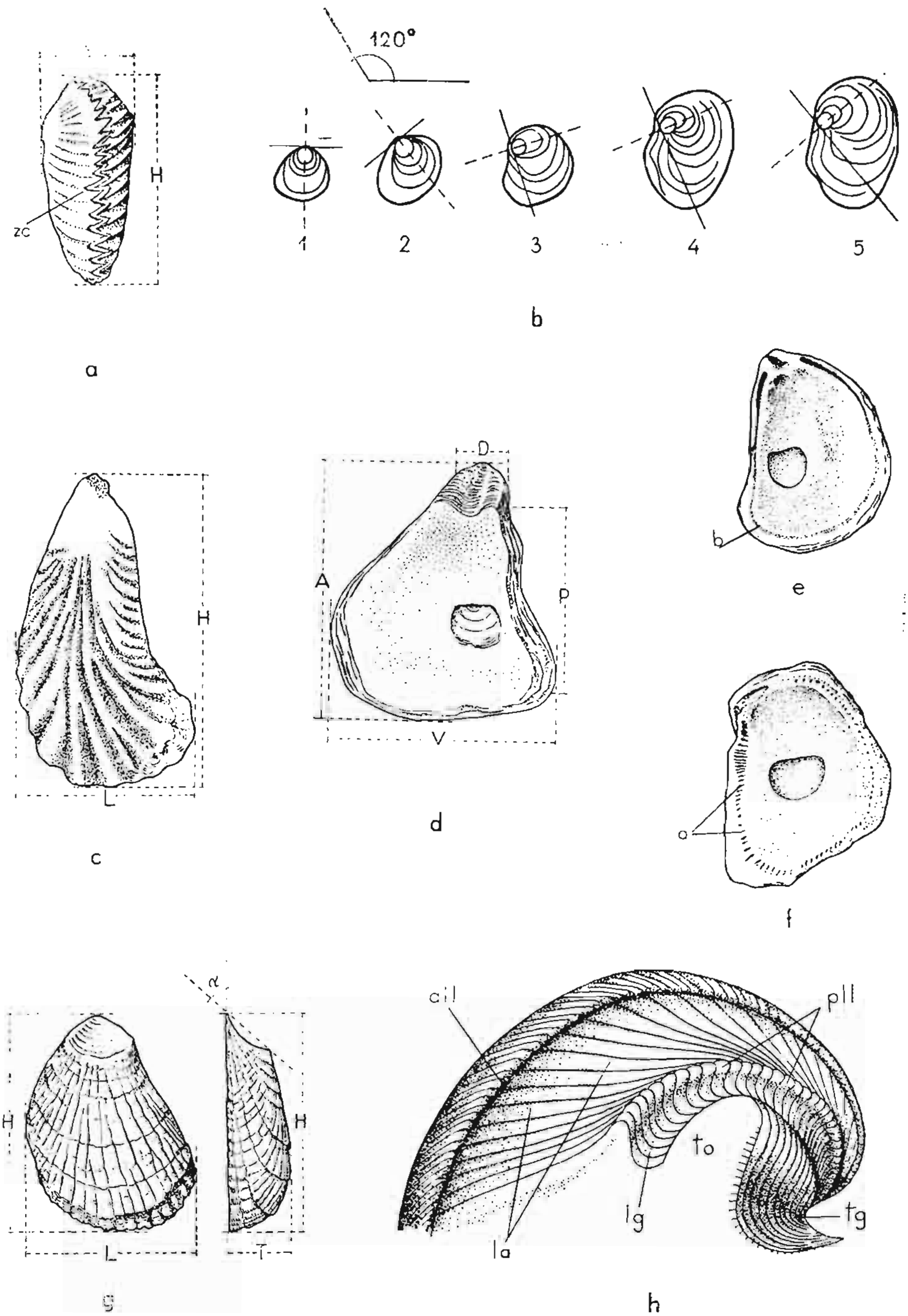

Fig. 1

densis, Pl. XVII, Fig. 5*b*; *A. flabelliformis*, Pl. IV). Concentric ornamentation is usually expressed by minute growth lines, frequently, however, these lines are elevated at definite intervales (*L. virguloides*, Pl. XXI, Figs. 2*a*, 3*a*). Frequently concentric flat or protruding lamellae exist (*L. moreana*, Pl. X, Fig. 6*a*). Sometimes the concentric ornamentation is crowded chiefly near the ventral or dorsal valve margin (*Nanogyra nana*, *Ex. virgula*), in other cases irregular concentric wrinkles and swellings (*L. plastica*, Pl. XIX, Fig. 2*b*). The character of ornamentation, which is different in various species, is an important diagnostic feature, but only together with other characters.

Attachment area is to be found in all the Ostreidae. Its size and position is a subject of considerable changes hence its taxonomic value is small. However, a characteristic constant development of this surface is to be observed in particular species. For example, *Liostrea sequana* show throughout life attachment to the substratum and its attachment area is maximally large (Pl. XVI, Figs. 1, 3). Among the species which are attached only during young stages, this area is very small (genera: *Catinula*, *Exogyra*, and *L. virguloides*). Some species show lateral position of this area (*Ex. intricata*, Pl. X, Figs. 1, 2; *Ex. decipiens*, *Ex. michalskii*, Pl. XXXV, Figs. 2*a*, 4*a*). In some cases a transversely ribbed surface seems to suggest that whorls of ammonites or bundles of serpula tubes served as substratum for their valves (*Ex. decipiens*, *Ex. michalskii*). Other species were attached to narrow objects, most frequently to echinoid spines. Echinoid spines serve almost invariably as a substratum for the shells of *Al. gregarea* and *Al. pulligera*. Shells of other pelecypods or gastropods also served as an attachment base (Pl. XX, Fig. 7). The same can be said about algae of the genus *Goniolina* (Pl. I, Fig. 2). Thus the attachment area may be considered from various points of view such as size, shape, depth, or substratum. It is noteworthy that certain species prefer a definite kind of substratum. The attachment area is observable

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Fig. 1. — Diagrammatic drawing of oyster-shells, indicating the method of measurements and terminology applied.

a side view of shell of the genus *Alectryonia*: *H.* height, *T* thickness, *zc* zigzag commisure;

b right valves of *Nanogyra nana* showing the mode of hinge coiling in the middle nepionic stage;

c external view of the left valve of the genus *Alectryonia*: *H* height, *L* length;

d inside of the right valve of the genus *Liostrea*: *A* anterior margin, *P.* posterior, *D* dorsal, *V* ventral;

e inside of the left valve of the genus *Catinula*: *b* impression of the right valve margin;

f inside of the left valve of the genus *Exogyra*: a marginal elements — grooves and tubercules;

g the left valve of the genus *Catinula* in external and side views: *H* height, *T* thickness, *L* length, *a* the angle between attachment area and plane of commissure (after Bradley, 1956);

h diagram of the hinge structure of *Exogyra sigmoidea* Reuss (after Záruba, 1965): *tg* tooth groove, *to* tooth outgrowth, *lg* ligament groove, *pll* posterior ligament ledge, *la* ligament area, *all* anterior ligament ledge.

only on the left valve, but it is reflected on the right valve as a replica. This fact may be explained by the regular growth process which was simultaneous in both valves. Ribs and folds of one valve have their counterparts in the opposite valve in shape of grooves and depressions, and similarly in this case a depression in one valve is reflected as a negative elevation in the opposite valve.

Internal morphology of shell varies greatly. It is reflected in irregularly distributed depth and is connected with inequivalve and inequilateral forms. In general, the left valve is deep and the right — flat or even concave. The left valves of *Gryphaea* and *Catinula* are extraordinarily deep. A flat right valve which penetrates the left one, leaves on the latter a trace in shape of a concentric line which is a result of a contact of the margins (*Liostrea multiformis*, Pl. XX, Fig. 7*b*; L. *dubisensis*, Pl. XIV, Fig. 7*a; Catinula knorri*, Pl. XXIII, Figs. 3*b*, 10*b*, Text-fig. 1*e*).

A distinct depression over the muscle scar may be observed in some shells. According to Carter (1968), this depression known as "promyal chamber", is regarded as an adaptation to an additional flow which clears away the pseudofaeces from the interior of the shell.

Along the anterior, and also partly ventral margin of the both valves, an elongated, crescent shaped scars of soft parts of animal frequently covered with transversal ribs are visible. These may be impressions of gills, what is suggested by the shape, situation and ribbing (Pl. XIII, Fig. 7; Pl. XX, Figs. 3*b*, 7*b*).

The shape of internal margin and adductor muscle scar are important from the taxonomic point of view. They vary to a great extent. The internal margin of valves may be smooth or covered with a peculiar ornamentation consisting of many minute depressions, grooves and tubercules (Text-fig. 1*f*). They may occur either along the whole periphery of valves (*Ex. virgula, Ex. reniformis*), or in the vicinity of the hinge only (*Alectryonia flabelliformis*). The ornamentation of the internal valve margin is of specific value. It is assumed that the tubercules and grooves have served as a hinge, thus making the shell closure more firm (Vialov, 1948).

The shape of the adductor muscle is an important diagnostic character in some species. This scar is usually transversally elongated or, less frequently, in dorso-ventral direction. It changes to some extent, but its shape, size and position are typical in certain species. Sometimes, it shows a crescent shape of straight or depressed upper margin, usually surrounded by thickened ventral lip. Most frequently it is situated in a half height of the valves, near their posterior margin. Less common is its central situation (*Liostrea quadrangularis* Pl. XIII, Fig. 4*a*), and only exceptionally it lies nearer to the dorsal valve margin (*Arctostrea hastellata*). Its size varies greatly. Its transverse diameter may be 1/5 of the corresponding valve diameter, (*Catinula knorri*, Pl. XXIII, Fig. 10*b*), up to 1/2 (*Nanogyra nana*, Pl. XXV, Figs. 2*b*, 5*b*). In some cases, that scar is marked by a slight depression (*Liostrea virguloides*, Pl. XXI, Figs. 3*b*, 7*b*; *L. acuminata*, Pl. XI, Figs. 1*b*, 4*b*, 18), usually it is strongly depressed in the valve surface (*L. moreana*, Pl. X, Fig. 6*b*). In the cases, in which it shows great variability, its diagnostic value is insignificant (*L. dubisensis*, Pl. XIV, Figs. 1*a*, 3*a*; *Gryphaea dilatata*, Pl. XVII, Figs. 1*a*, 2*a*, 4*a*).

Pedal retractor muscle scar occurs only sporadically. The writer stated its presence among the individuals of *Exogyra virgula* and *Nanogyra nana*. That scar is very small and its transverse diameter is only about 1/4 of the corresponding adductor diameter. Its shape is semi-lunar and it is centrally situated below the hinge margin. The presence of the pedal retractor muscle scar is of high taxonomic value in specific determinations (Pl. 1, Fig. 8*a, b*). It is noteworthy that the youngest ontogenic stages of all species are characterized by round-shaped adductor muscle scar which bears pericentral position. Thus the character of that muscle scar is subject to considerable changes during the ontogeny, and it is similarly developed in the young stages among various species (Pl. XXIV, Figs. 1*a*—6*a*; Pl. XXVIII, Figs. 1*a*—5*a*; Pl. XXXI, Figs. 1*a*—5*a*; Pl. XXXIII, Figs. 1*a*—4*a*).

Commissure is of high taxonomic value but only together with other features, and it is sometimes diagnostic at the specific range. There are straigh, zigzag or folded external margins of valves. *Arctostrea hastellata* is characterized by high zigzag commisure, but several species of *Alectryonia* exhibit a commissure developed in similar way, and such a commissure together with arched shell shape, character of ribs and of umbo determines the specific classification.

The hinge, its structure, position, length and height are useful generic characters. Typical oyster hinge is tripartite. It consists of central ligament pit bordered on each side by two folds. Shift of these hinge elements in regard to the symmetry plane of the valves, changes in depth of ligament pit and folds, frequent disappearance of one of them, formation of outgrowth tooth and tooth groove in the opposite valve and various modifications like changes in the proportion of these elements are of specific range. Three types of hinge were distinguished: ostreoid, gryphaeoid and exgyroid ones. In some cases a hinge of a definite type shows some features of other type which caused erroneous classification of some species to the corresponding genera. As an example may serve the *Liostrea virguloides* which was assigned by Lewiński to *Exogyra* (Pl. XXI, Fig. 7*b*).

A great variability of height and length exists in each of the above mentioned hinge types. The form of the hinge margin that separates the hinge from the external valve surface is also highly variable. This margin may be straight, arched or S-shaped. Folding of the hinge surface results in the formation of several ligament pits instead of one (*Liostrea moreana*). Such a modification is interpreted as a result of attached mode of life, and it is regarded as an anomaly (Vialov, 1948, p. 14.) According to Oria (1933) such hinge structure was developed in results of penetration of a foreign body under the epithelium, thus causing rapid cell division, what caused in turn a quick secretion of skeletal layers in the inflammed place. The present writer is of the same opinion.

Detailed considerations about the variability of the *Exogyra* type hinge are presented on p. 221.

LITHOLOGICAL AND GEOLOGICAL REMARKS

The lowermost Jurassic rocks that furnished rich pelecypod material are of the Bajocian-Bathonian age of Łęczyca. They are developed mainly as shales of brownish, gray and black tint with considerable amount of iron oxides. They represent rather not deep, poorly aerated marine basin. The shells are predominantly crushed. The shell detritus interbeds with iron bearing limestones. Individual oyster shell can be seldom found within the black shales.

The most diversified material comes from the south-western Mesozoic margin of the Holy Cross Mts. A detailed litho-stratigraphic analysis of that area was given by Kutek (1968, 1969). This paper is a basis of the considerations here presented and it served also to definition of facial differentiation and stratigraphic subdivision.

The oysters occur predominantly in the marly-lumachelle Kimeridgian deposits but are seldom found in the underlying oolite rocks and chalky limestones of the Upper Oxfordian. In the latter, the oysters occur chiefly in form of shell detritus or as discontinuous small lumachelle intercalations. The shell detritus composed mainly of *Exogyra* fragments may be found in the Top Clays which are of small thickness, in the vicinity of Staniewice. The thickness of this bed increases slightly toward the SE, particularly near Gołuchów. Lumachelle intercalations consisting of *Exogyra* shells occur also in the vicinity of Brzegi in the Upper Platy Limestones, and within the so called Skorków Lumachelle which crops out between Brzeźno and Bolmin, and where the fauna is more diversified and occurs in two horizons. In the upper part there prevail *Exogyra* valves, and in the lower one — those of *Alectryonia*. Similar differentiation may be observed near Sobków and further southeast. These deposits contain an admixture of ooids and marly shales in their upper part.

In the Przedbórz — Małogoszcz belt, the *Exogyra* lumachelles occur only sporadically within the platy limestones and underlying clays, and are more frequently found in the Skorków Lumachelle, in which the *Alectryonia* shells are the main component. Shell intercalations frequently occur in the pelitic limestones and marls in the Top Clays between Żeleżnica and Dobromierz and Bąkowa Góra. Near Dobromierz they are up to 30 metres thick.

In Radomsko area the oyster lumachelles intercalate with various facies of the Kimeridgian. These are chiefly marly clays and pelitic limestones. The underlaying Platy *Exogyra*- member is about 40 metres thick which aside of limestones, is represented by marly clays. Underlying oolites show a characteristic bipartity with a larger amount of exogyras in the upper part, and more of alectryonias in the lower part. The Platy

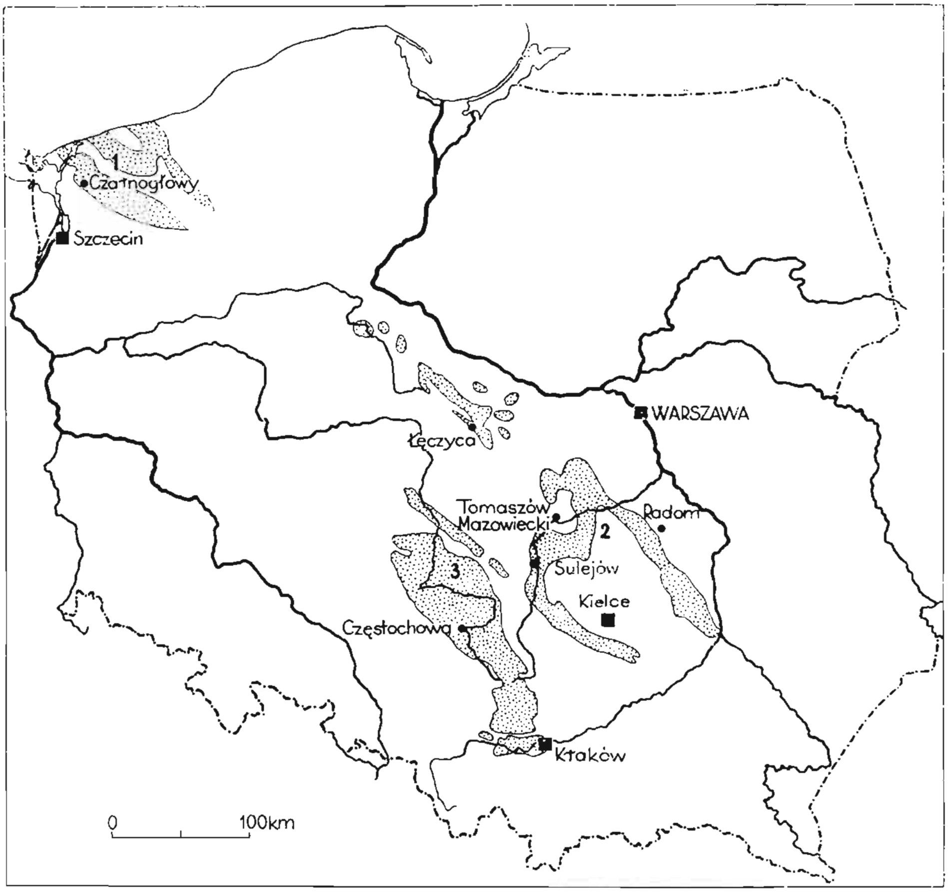

Fig. 2. — Sketch map of Poland showing the distribution of the Middle and Upper Jurassic: *1* Western Pomerania, *2* Holy Cross Mts., *3* Polish Jura Chain.

Exogyra-member and the *Alectryonia*-oolite one correspond to the Platy--limestones and the Skorków Lumachelles of the vicinity of Przedbórz.

A relatively abundant oyster fauna occurs in the strongly differentiated Upper Jurassic deposits (Wilczyński, 1962) in the Western Pomerania. These are marly cl ıys or oolitic clayey limestones. The most abundant oyster fauna occurs in the Lower Kimeridgian rocks, whereas that of the

Middle Volgian is rather poor. The oysters of the latter stage represent chiefly so far unknown species.

Similar fauna is to be found in the Middle Volgian in the vicinity of Tomaszów Mazowiecki. The oysters occur in lumachelles at the top of mostly clayey bed, marly clays and gray clays with mica. The thickness of these deposits is 25 metres.

A rich oyster material comes from the cement plant Wierzbica near Radom. These oyster bearning deposits of the *Katroliceras divisum* Zone are developed here as gray friable marls, partly strongly calcareous.

The above review clearly shows that the oyster shells occur predominantly in lumachelles or as shell intercalations or a noncontinuous coquina complexes. Such a concentration of the oyster shells is connected with their attached mode of life. Several facies are represented reflecting shallow water, sublittoral only occasionally deeper marine conditions of sedimentation.

INFLUENCE OF ENVIRONMENT ONTO THE SHELL MORPHOLOGY

High adaptability of Ostreidae to the variable environmental conditions is fully reflected in the great variability of their shell morphology. Negligence of that variability caused the splitting of species in the past. For example, slightly different shape of the shell, or insignificant differences in its depth, different mode of coiling of umbo among various specimens of *Nanogyra nana* (Sowerby, 1822), have caused a creation of several "species" such as: *Exogyra spiralis* (Goldfuss, 1834—40), *Ex. auriformis* (Goldfuss, 1834—40), *Ex. bathonica* (d'Orbigny, 1850), *Ex. bruntrutana* (Thurmann, 1830), *Ostrea quadrata* Étallon, 1859, which are in fact only morphotypes of *Nanogyra nana*.

The problem of polymorphism among the Ostreidae was considered by Arkell (1932, pp. 177—179), Jourdy (1924, p. 63), Ranson (1943) and Dachaseaux (1945) and others. The conclusions of those authors concern mostly the subfamily Exogyrinae but they can be applied also to all oysters.

Jourdy, who was followed by Arkell, differentiated several morpho--ecological types among oyster shells. These types change in relation to the basin depth and character of the substratum. This interrelation is as follows: 1) more or less thickened shells, round or subrounded in shape, of a relatively flat umbo in the left valve point to subpelagic environment; 2) elongated shells of thinner arched valves, poorly attached with their terminal part of umbo, which is frequently of helicoid spiral in shape, point to sublittoral environment, which is characterized by stronger wave action; 3) narrow shells half flattened with only scarcely salient and, strongly opistogyre umbo would point to a general coral facies;

4) strongly flattened shells with umbo not protruding over the large attachment area, point to littoral environment.

Large variability in length, height and depth of shell may be observed in each of the above mentioned morphotypes. Such a variability depends chiefly on the character of substratum, and its range is illustrated by several transitory forms involved between the extreme morphotypes. As an example of variability of the shell in the same species dependent on the mode of attachment to the substratum, may serve the specimens of *Catinula knorri* (Voltz, 1830) and *Liostrea acuminata* (Sowerby, 1818). Two left valves are attached to the same shell fragment. One of them is attached with its whole surface, and is flat, whereas the other one is deep and attached with only small terminal part of umbo.

The shells of *Nanogyra nana* (Sowerby) are another example of morphotypes of various valve shapes occurring in the same kind of deposits (Pl. XXVI, Figs. 1—6; Pl. XXVII, Figs. 1—4). The same can be said about *Exogyra virgula* (Defrance) (Pl. XXX, Figs. 2—3). Some of those shells are round, while others — strongly elongated. The change in shell shape is connected with other freatures such as formation of keel, folding of the posterior margin, or large coiling of umbo, the spiral of which may exceed 360° (Pl. XXVI, Fig. 5*b*).

The morphoecological types distinguished by Jourdy may apply largely to forms freely lying over the basing floor or attached to the substratum with small area. Usually, however, Ostreidae occur in great quantities, concentrated over the same substratum or grow over one another, with no change to free growth. Their shells are deformed to various degree. The morphological inversion is frequent and the lower valve, which is usually deeper than the upper one, becomes flat, or the umbo which normally hardly protrudes, is strongly elongated and changes its direction of growth (Pl. V, Fig. 7).

The size of shells among the same species may change to some extent depending on the depth in the basin. Generally speaking the shells of species living in deeper basins were larger, whereas those of more shallow basins — were smaller. In the material from Poland, dwarfish *Exogyra* shells occur in marly-argillaceous sediments, e.g. in the vicinity of Oleszno (near Włoszczowa, margin of the Holy Cross Mts.), and the larger ones of the same species are found rather in more calcareous deposits, e.g. in the vicinity of Przedbórz. In general, however, the depth at which exogyras lived was small and never exceeded 20 metres (Kutek, 1969).

The calcium carbonate content in the sea water is another factor controlling the shell thickness, However, the calcium carbonate absorption in the pelecypod organism is limited (Čelcova, 1969, p. 5). Friable shells of *Liostrea virguloides* Lewiński may serve as an example of ostreids coming from sediments poor in calcium carbonate. They occur in great quantities in marls with mica at Brzostówka (near Tomaszów Mazowiecki). Another example is that of *L. acuminata* (Sow.) from ore-bearing argillaceous sediments from Łęczyca.

The shells of the youngest ontogenetic stages are lacking in the sediments of shallow — coastal zones with increased wave action. It may be assumed that smaller salinity of such basins plays an eliminative role for the younger stages and only shells of adult forms can be found there (Dmoch, 1970, p. 14).

STRUCTURAL ADAPTATION OF OYSTER SHELLS

The problem of oxygen and food supply is particularly important to the development of oysters. Passive mode of life on the basin floors of muddy and often turbid waters and gregarious occurrence did not create good living conditions. In response to difficult environmental regime the oysters have developed highly advanced functional adaptations which are reflected first of all in structural peculiarities of the shell. These are: arcuate shape, zigzag commissure, lobe-like enlarged posterior edge of umbo, promyal chamber and also marginal denticles and pedal retractor muscle scar.

The most common arcuate shape of shell reflects an adaptation of efficient respiration, which is best illustrated in the shell morphology of species of *Arctostrea*. Those shells are extremely long, in vertical axis, narrow and strongly arcuated. Broadly convex anterior margin guarantees a good oxygen supply to the gills and high, with sharply cut typical zigzag commissure external valve margin even increases the current inflow. The water current, besides of oxygen supply, furnishes also minute feeding particles, which are then directed by means of complicated internal current to the pelecypod mouth. The gills are strongly arcuated, of large inhalant surface and play also the role of directing the feeding particles thus being a very important organ taking part in the basic living functions. On the other hand, the enlarged inflow surface endangers internal organs with penetrating of sediment particles from the muddy, turbid environment. In such cases, the zigzag commissure acts as an adaptative organ impeding the penetration of larger inorganic particles. A slightly open shell turns the zigzag commissure into a kind of sieve which eliminates the larger feeding particles and sediment. Zigzag commissure plays a well adapted protective function acting jointly with a strongly muscled mantle margin, which bears sensory appendices. Such a commissure occurs among many species of *Alectryonia*; in this case, however, it shows considerably lower amplitude than among the representatives of *Arctostrea*. Possibly its role in the latter case was much smaller. Most probably the environment in which alectryonias lived, must have been more convenient and they lived possibly in waters which were better aerated. Their shells exhibit usually large attachment areas suggesting that they lived in an environment of turbid waters.

A zigzag commissure of high amplitude makes the closure of valves particularly strong when the shell is closed. Its functional importance was broadly discussed by Carter (1968) on the Cretaceous representatives of *Arctostrea*. He also dealt with the adaptive role of various kinds of spines taking as an example pelecypods of other systematic groups and recent oysters. Such spines growing out as prolongations of the dorsal side of the ribs may be funnel shaped, open to the exterior, lined with nictitating epithelium, or serve as attachment organs which make the shell stable and simultaneously preventing its sinking into soft ooze of the bottom (Carter, *l.c.* p. 470). The attachment spines are usually better developed over the upper valves along the anterior valve margin. Despite their supporting role, they may help also to provide an adequate oxygen supply to the animal. Eddy effect inhalant streams along and around them bring water and food supply. Nod-like swellings on the ribs of the upper valves of the Jurassic representative of *Arctostrea* might be regarded as attachment spines (*A. hastellata*, Pl. VII, Fig. 11). Stability of the shell on the sea floor was established by its arched shape, what was particularly justified for individuals which were hardly attached to the substratum. Such an adaptation may be observed in many species which were poorly attached e.g. *Exogyra virgula* and *Ex. reniformis*. A lobe-like broadening of the posterior part of umbo is probably another adaptation serving to stabilize the shell, aside of arched shape and attachment spines which were found in some species only. This is exemplified by *Alectryonia solitaria, A. hastellata* and *Exogyra welschi* (Pl. III, Figs. 4, 5). Shells of many oyster species show smooth external margin, as e.g. the representatives of genera *Liostrea*, which is very common in the Jurassic of Poland, and *Catinula, Nanogyra* and *Gryphaea*. They are characterized by more or less deep lower valves, whereas the upper valve is usually developed as a flat operculum. Arcuate, broad anterior margin ensures sufficient oxygen and food supply. Convex, deep lower valves guarantee stability of the shells which are poorly attached, and the operculi-form upper valve, which in many cases penetrates the lower one, to a considerable depth or closely adjoining it, prevents penetration of impurities carried in by water currents. The scar of valve clasping is visible on lower valves in shape of continuous lines resembling a mantle impression, known in other pelecypods, among others on shells of *Liostrea multiformis, L. dubisensis* and *Catinula knorri*.

Ornamented internal margin of valves is another adaptation and may be observed among *Exogyra* and some species of *Alectryonia*. Several minute, round or elongated grooves occur around internal shell margin and nods or elevated swellings corresponding to grooves occur on the internal opposite shell margin. Those marginal elements, similarly as do the teeth, comprise additional strengthening of closure and clasping of the shell. It may be observed among the species which attached to the substratum during a relatively short period of ontogeny, and which lived in turbid environment. Nevertheless, the role of those marginal denticulation was variously interpreted. Vialov (1948, p. 9) regarded it as a sui generis closing apparatus, whereas Jaworski (1923) treated it as scars of minute mantle musculature. They occur sometimes only near the hinge, as in e.g. *Al. flabelliformis,* what seems to suggest their closing function. They may also be found in some species of weaker adductor muscle and hinge which live in turbid environment, thus need stronger closure of valves.

The above cited adaptations of oysters illustrated by numerous details of the shell morphology allow to fullfill their inhalant-feeding needs. They do not prevent, however, penetration of muddy sediment to the shell interior. Thus a necessity to eject the sediment and pseudofaeces in the quickest possible way is of primary importance. The adaptions developed by oysters in this purpose are reflected in the shell structure. One of such adaptations is a modified foot which takes an active role in cleansing of the mantle cavity. The presence of a second muscle scar was stated on right valves of *Exogyra virgula* and *Nanogyra nana.* It is very small of transverse diameter not exceeding 0.5 mm what is about a quarter of the corresponding diameter of the adductor diameter (Pl. I, Fig. 8*a*). It is semi-lunar in shape, with straight upper margin and subrounded lower one, slightly depressed into the valve. Two to three concentric growth lines are visible on its surface. As a rule, it is situated just below the hinge margin approximately in the centre of valve. Similar position takes this scar in *Crassostrea ameghinoi rocana* Ihering from the Danian of Argentina, what may be seen on a schematic drawing by Carter (1968, p. 473, Text-fig. 8). This scar is observable only on the right valves of the above mentioned species and is referred to as a pedal retractor muscle scar. The existence of that muscle in minute exogyroid forms which do not posess zigzag commissure, seems to be a very valuable adaptation.

Another adaptation serving to effective cleansing of the mantle cavity may be observed among *Alectryonia, Liostrea* and other genera. A more or less distinct cavity situated on the internal side of right valves above the adductor muscle exists in the above mentioned genera. Basing on the investigations of recent genus *Crassostrea* it was found (Carter, *l. c.*, p. 473) that this cavity named by Nelson (1938) promyal chamber, is a peculiar adaptation of oysters allowing them to greater water flow through the shell removing sediment and simultaneously preventing the exhalant chamber from penetration of sediment. The promyal chamber forms an additional passage for exhalant current flowing dorsally to the adductor muscle. It is formed by a local mantle separating it by a fold from the underlying body-tissues. It may occur only among the forms in which the adductor was more away from the dorsal and posterior margin of the valve. In *Arctostrea,* in which the adductor is situated close to the umbo this chamber was not encountered. However, in this latter genus, and among some others, which posess auriculately broadened posterior margin of umbo, another adaptation existed of similar function. Carter illustrates a specimen of *Arctostrea* on which two folds are visible suggesting the presence of "pseudosiphons" in the mantle margin (Carter, *l. c.*, p. 479—480, Pl. 88, Fig. 3). This name was given by Nelson (1938 in Carter, *l. c.*) to the bent, marginal mantle folds of the right valve, that form elongated grooves. Pseudosiphons occur in the recent *Crassostrea,* which lives in estuarine muddy waters. They serve to exhalant current which takes away all the impurities, and passes from the posterior to the adductor muscle. It may be then supposed that also in the fossil species of *Arctostrea* and some *Alectryonia,* similar adaptations might have existed to a muddy environment, and which were preserved in the shell structure. As it was already mentioned, an auricular broadening of the subumbonal part of the right valve might have formed a kind of support ensuring a pelecypod a proper position on the basin floor. No adaptations connected with cleansing of shell were observed among other oyster species. Most probably such adaptations have existed but were not reflected in the shell morphology. Contemporary oysters live in muddy waters and their rich development may prove their good adaptation to such an environment. Observations of their mode of life proved that the cleansing role is performed by the mantle and valves, namely the mantle margin accumulates pseudofaeces mixed with mucus and then exhales them out of the body with sharp snapping of valves, what causes a rapid water flow. It is highly possible that a similar mode of cleansing was in action among the fossil oysters.

REMARKS ON SHELL MICROSTRUCTURE

In order to investigate the shell microstructure of oysters, the following thin sections have been made: transversal section of *Alectryonia gregarea* cut near the ventral valve margin (Pl. III, Fig. 7), section of a hinge of *Al. solitaria,* parallel to its external surface (Pl. III, Fig. 6), and longitudinal section through an adductor muscle scar of the valve of *Al. solitaria* (Pl. III, Fig. 3).

Lamellar structure is a basic type among Ostreidae (Pl. III, Fig. 7). The shell is built up of microcrystals of calcite and aragonite, the arrangement of which and their mutual quantitative relations are of taxonomic value (Čelcova, 1969, p. 11—12). Basing on the variability of microstructure among the oyster genera, several characteristic types of structure have been distinguished. On that basis some amendments were done in the phylogenetic considerations about the family Ostreidae (Čelcova, *l. c.* p. 30).

Longitudinal, lense-like voids are observable in some transversal sections. They occur between the lamellae of a layer and are interpreted as remains after the so-called water chambers, which were filled up with a chalky matter after death of a pelecypod. Such chambers might have developed in result either of diminished calcite secretion under unfavorable environmental conditions, or due to a decrease of the body volume that was probably caused by decreased salinity or after a reproduction period (Čelcova, 1969, p. 23; Taylor and others, 1969, p. 109). Some authors claimed that those chambers were connected with a patology of the mantle, which might have been damaged by penetration of sediment particles. The most proper view was expressed probably by those authors who connect the development of the chambers with a quicker growth of valves (Čelcova, *l. c*), what seems to be supported by the fact that they are more frequently found in the left valve than in the right one, the former being usually larger, more convex, and thicker what was observed on older individuals.

A longitudinal section through the adductor scar and a section through the hinge parallel to its surface show a characteristic trabecular structure. It reflects the subsequent stages of attachment of the soft parts of organism during growth, i. e. of the muscle fibres in the first case, and those of ligament in the second case. The layers which underlie those soft parts, are developed in the form of aragonite crystals (Taylor, *l. c.* p. 106). The prismatic aragonite layer under the muscle is observable in a longitudinal section through the shell over the whole area of the translocation of the muscle (Taylor, *l. c.* Text-Fig. 68). The trabeculae exhibit a fibrous structure. In the basal part (Pl. III, Figs. 3, 6) they are thick and short and the interspaces are relatively small and regular. This regularity becomes distorted during growth, probably due to more rapid and irregular increase in the number of fibres both of the muscle and ligament. They are more numerous in the central parts of the sections than in the basal parts, simultaneously becoming thinner, elongated and frequently anastomose among each other. The interspacing chambers are frequently oblique, and irregular. Still stronger diminution and crowding of the structural elements occurs during the final stages of muscle and ligament growth. Some differences in the growth trends of the structural elements may be seen between the muscle scar and that of ligament. Over the muscle scar the aragonite fibres are parallel to its surface, whereas those of the hinge shift in relation to the initial growth stage, more laterally. Those differences are connected with a change in the position of the fibres of the muscle and ligament during growth (Pl. III, Figs. 3, 6).

ON THE PHYLOGENY OF THE FAMILY OSTREIDAE

The true oysters first appeared in the Uppermost Triassic and continue up to recent times. The Lower Carboniferous *O. nobilissima* from Belgium and *O. patercula* from Java and also *O. matercula* from the Permian of USSR, after closer examination, appeared to be other pelecypods than oysters (Ranson, 1951, p. 187). The recent paper by Nakazawa and Newell (1968), on the Middle Permian fauna of Japan, give description of two pelecypod species tentatively classified as *Lopha* (= *Alectryonia*) but the material was poor and badly preserved thus being insufficient to closer examination. In the light of the above, the problem of earlier appearance of Ostreidae is still open. The probable ancestors of Ostreidae are representatives of the family Aviculopectinidae. Such view was expressed by Douvillé (1910, p. 634), Termier & Termier (1949) and recently Taylor, Kennedy and Hall (Taylor and others, 1969, p. 109) basing on Newell's investigations (1969) concerning the similarity of microstructure of ostracum in the right valves of oysters and those of *Aviculopecten*.

The Rhaetian *Alectryonia* (= *Lopha*) *marcignana* (Martin) and *Liostrea sublamellosa* (Dunker) (Douvillé, 1910, p. 634) are regarded as ancestors of the Ostreidae. At the end of Cretaceous, the species of *Liostrea* die out but the long-lived branch of *Alectryonia* (= *Lopha*) continued. The forms classified as *Arctostrea* Pervinquière, 1910, branch from it during the Middle Jurassic. The latter showed strongly elongated, arcuate shell, and characteristic high zigzag commissure. Pervinquière distinguished such forms as a subgenus of the genus *Alectryonia*, but the different structure of their prodissoconch and microstructure of the shell sufficiently justified the independence of *Arctostrea* (Čelcova, 1969, p. 48), as a genus. This genus developed through the whole Cretaceous and the lastest its representatives died out at the end of this period. In the Middle Cretaceous, the *Alectryonia* branch gave beginning to the proper oysters *Ostrea* s. s., which are actually represented, and from which probably begun also the species of the genus *Fatina* Vialov, 1936 which lasted from the Upper Cretaceous up to the end of Palaeogene. The recent genus *Crassostrea* Sacco, 1897 is a continuation of *Fatina*.

All the mentioned genera: *Alectryonia, Arctostrea, Ostrea* s. s., *Fatina, Crassostrea* and *Liostrea* being characterized by the same structure of prodissoconch and similar microstructure, their classification to one subfamily Ostreinae Vialov, 1936 seems to be fully justified. Prodissoconch of the genera of this subfamily is characterized by equivalve, long and straight hinge edge, on which there are two primitive provincular teeth situated symmetrically on both sides of central ligament pit (Ranson, 1942, p. 161). Foliated structure dominates among the microstructures of the genera of Ostreinae, and only in *Liostrea* a subrhomboidal structure occur aside of the former one (Čelcova, *l. c.* p. 43). On the basis of radial ornamentation of valves, Vialov (1948, p. 29) created a subfamily Lophinae, with one genus *Alectryonia* = *Lopha,* but in the light of the above data, the existence of that subfamily seems not justified.

Another basic branch of the Ostreidae is represented by *Liostrea,* which died out at the end of the Cretaceous. This branch gave start to two subfamilies namely the Gryphaeinae Vialov, 1936, and Exogyrinae Vialov, 1936.

A group represented by *Catinula* Rollier, 1911 stands between the subfamily Ostreinae and the other subfamilies. It is similar to *Gryphaea* Lamarck in gryphaeoid shell shape and straight, ostreoid structure of hinge margin and hinge. These features may be also observed in forms of the genus *Liostrea.* On the other hand, *Catinula* shows some characters similar to *Exogyra* Say, e. g. such as opisthogyre umbo and radial, fine striation of the left valve. The genus *Catinula* appeared in the lower part of the Lower Jurassic hence at time when the whole subfamily Gryphaeinae branched from the *Liostrea.* Some authors tried to derive *Gryphaea* directly from *Catinula,* particularly the Cretaceous gryphaeoid forms of *Pycnodonta* (Arkell, 1934*a,* p. 62). Others connected them with representatives of *Alectryonia* because of radial ornamentation (Rolier, *l. c.*, p. 272). Nevertheless, it was missed that the ribbing of *Catinula* is only superficial, whereas that of *Alectryonia* consists of large costae, reflected also on the inner surface of both valves. Both conceptions presented do not seem to be justified. Only an intermediate position of *Catinula* between Ostreinae and Gryphaeinae may be accepted, i. e. between the subfamilies which form documented, independent taxonomic units. Typical gryphaeas have developed probably from *Liostrea* in relation of an environment change, shaping a shell which rested free on the muddy sea floor.

The occurrence of *Gryphaea* is stratigraphically discontinuous i. e. spaced with large gaps (lowermost Lower Jurassic — middle part of the Lower Jurassic; middle part of the Middle Jurassic — lower part of the Upper Jurassic; Upper Cretaceous). The phenomenon of the repetition of forms very similar to one another in a definite environmental conditions, is regarded as a phenomenon of the so called iterative evolution. It claims a common derivation of the stratigraphically spaced forms from a certain persistent conservative branch (Koken, 1896). Newer investigations proved that the heterochronic gryphaeas belonging to different phylogenetic lines are in fact various species, and small morphologic differences between them allow to treat them as belonging to one genus *Gryphaea* (Trueman, 1929; Zeuner, 1934).

The subfamily Gryphaeinae Vialov, 1936 comprises three genera, namely: *Gryphaea* Lamarck, 1801, *Gryphaella* Čelcova, 1969 and *Pycnodonta* Fischer de Waldheim, 1835. Entity of that subfamily is based on the similarity of prodissoconch structure of the mentioned genera (Ranson, 1951), whereas slightly different microstructure of each of them, aside of other morphologic features, allows to regard them as independent genera (Čelcova, *l. c.* p. 35). Prodissoconch of the Lower Jurassic gryphaeas is equivalve of opisthogyre umbos. Lower Cretaceous ones exhibit unequivalve prodissoconch. Anterior situation of the ligament pit on the hinge margin and the same number of primary teeth, i.e. two on each side makes them similar to the Lower Jurassic gryphaeas. It is noteworthy that *Liogryphaea* established by Fischer de Waldheim (1887) for the Lower Jurassic gryphaeas, is an objective synonym of the genus *Gryphaea* Lamarck, 1801, as having the same type species.

The genus *Gryphaea* lasted from early horizons of the Lower Jurassic up to the Lower Cretaceous, showing an evolution from deep nonattached shells, of medium size with more or less bent umbo of the left valve over the right one, to large dimensions, attached, and with less bent umbo. Such an evolution should be regarded as a regressive one, what was connected with a change of environment.

The genus *Pycnodonta* Fischer de Waldheim, 1855 branched from *Gryphaea* in the Upper Cretaceous and it lasts till now. Vacuolar microstructure is typical among the representatives of that genus, whereas that of *Gryphaea* was subrhomboidal. The changes of prodissoconch in representatives of *Pycnodonta* lead to an elongation of the hinge line and increase of tooth number up to 5. The ligament pit has anterior position, similarly as in *Gryphaea*. Early Jurassic gryphaeas and species of *Pycnodonta* show equivalve prodissoconch but in *Gryphaea* the beaks are slightly opisthogyre and in *Pycnodonta* they are non coiled (Čelcova, *l. c.* p. 54). Common features of both those genera such as similarities of structure in the earliest development stages and considerable convergence in the shell shape allow to classify them to the same subfamily. The mentioned differences and different type of microstructure of shell justify their subdivision into various genera. Some authors include *Pycnodonta* to *Gryphaea* what seems incorrect in the light of the above considerations (Vialov, 1936, 1948; Bobkova, 1961, p. 60—63). A new genus *Gryphaella*, distinguished by Čelcova, (1969) takes intermediate position between the two above mentioned ones. Its occurrence is limited to the Upper Cretaceous. It does not differ from typical gryphaeas in external morphology but its microstructure is mixed, intermediate between the two above ones.

The subfamily Exogyrinae Vialov, 1936 is the next stage in the evolution of Ostreidae. It derives from certain Lower Jurassic gryphaeas through *Nanogyra* Beurlen, 1958. The latter genus is a connecting link between Gryphaeinae and Exogyrinae. Some individuals of *Nanogyra* stand close to representatives of *Gryphaea*, in oyster-type of hinge and shell shape and lack of ornamentation. These features make them similar to *Amphidonta* Fischer de Waldheim, 1829, which is another representative of Exogyrinae. The latter genus branched probably from *Nanogyra* type in the Middle Jurassic and lasted up to the end of Cretaceous. The differences between these genera consist of different sizes of shells, which are considerable in *Amphidonta* and small in *Nanogyra*. The microstructure is also different. Shells of *Nanogyra* are simply foliated and those of *Amphidonta* are of complicated subrhomboidal-subconoidal type (Čelcova, *l. c.* p. 70). New representatives of the subfamily Exogyrinae appeared in Kimeridgian. They are well represented and they lasted till the end of Cretaceous.

The genus *Exogyra* derives from *Amphidonta* differing from it in small dimensions of shell and simplified prismatic-foliated microstructure. Exogyroid type of hinge, the presence of marginal elements in the inner margin and radial ornamentation are common in both genera, but the latter feature is seldom observable in *Amphidonta* and only in its umbonal part. Further simplification of the shell structure may be observed in *Ceratostreon* Bayle, 1878, which is the next stage in the development of subfamily. It branched from *Exogyra* at the Jurassic-Cretaceous boundary and lasted only to the end of Mesozoic. Simple, regular-foliated microstructure makes it similar to the above mentioned genera, but pinnate arranged layers differ it from them.

The evolution of Exogyrinae leading from forms with complicated microstructure (*Amphidonta*) to those of the simple one (*Exogyra, Ceratostreon*) is definitely regressive, what is reflected also in the subfamily Gryphaeinae. At is wa salready mentioned, it leads from nonattached forms, such as *Gryphaea*, to those which are attached with a large surface, as e. g. *Pycnodonta*. Attempts to release from the substratum may be observed in all subfamilies. Among Ostreinae they led to the development of forms weakly attached with their small umbonal part only as e. g. *Arctostrea*. In the Exogyrinae they led also to similar mode of attachment. Such attempts, which were highly adaptable at a certain stage of the development of the Ostreidae were in fact shortlasting and did not remain as constant characters, since there persisted some forms of constant or strong attachment during long individual development. A tendency toward sedentary mode of life is a conservative feature among Ostreidae. The type actually prevailing among Ostreidae is that represented by *Ostrea* s.s., i.e. forms attached with large surface.

The development of each subfamily among Ostreidae starts with least progressive forms which show similarities in the development of some features with succeeding groups specialized in different directions. Forms of *Catinula* type constitute a connecting link between the subfamilies Ostreinae and Gryphaeinae, and those of *Nanogyra* type — between Gryphaeinae and Exogyrinae. Both these forms show some pro-

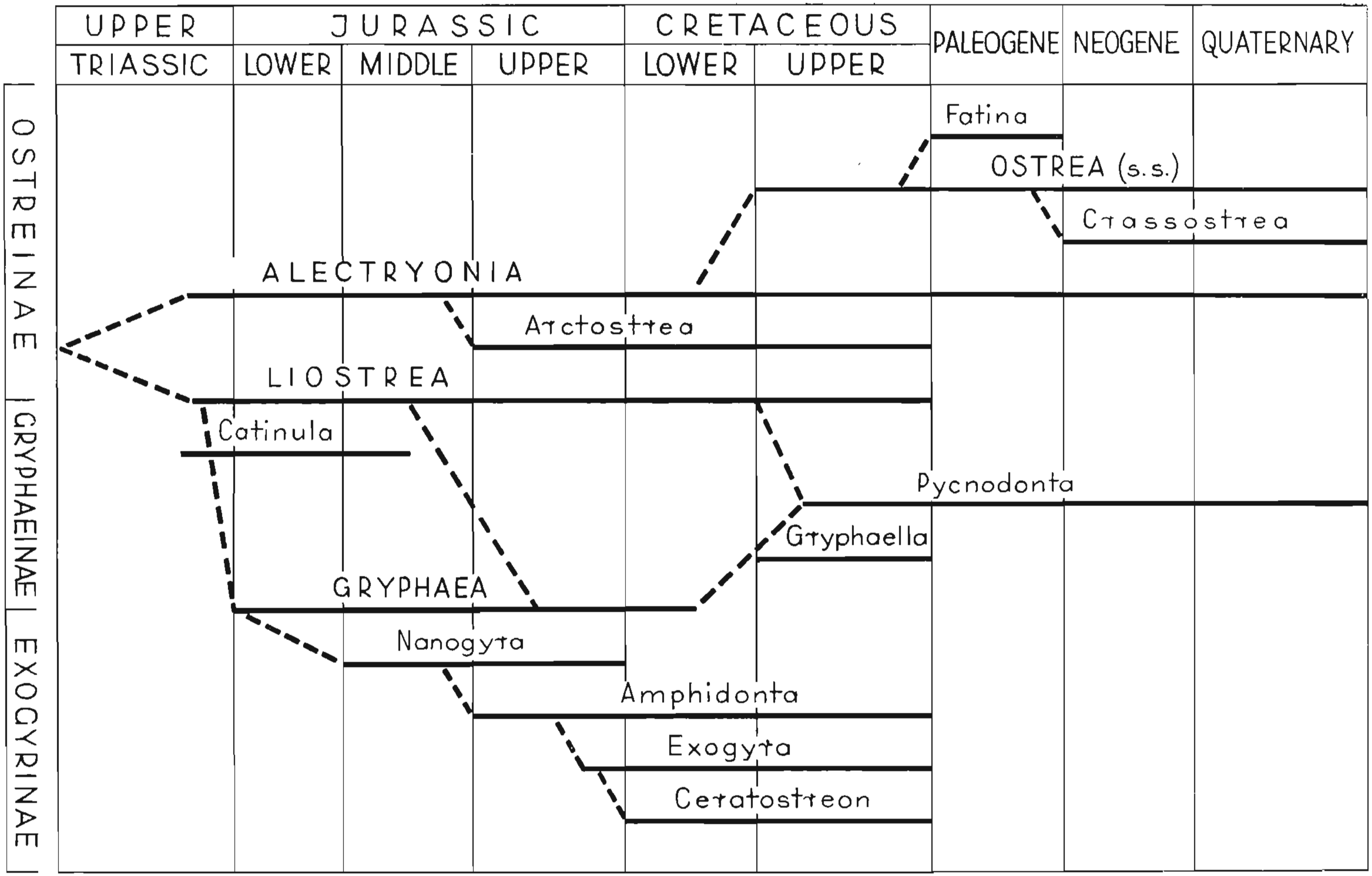

Fig. 3. — Phylogeny of Ostreidae Lamarck, 1818, after Čelcova, 1969, modified by the author.

gressive features subsequently subject to some evolution. The evolution scheme of the family Ostreidae proposed in this paper agrees in its main points with that presented by Čelcova (1969, *l. c.* p. 34—37). It supplements the latter, giving some connecting links between the particular subfamilies.

SYSTEMATIC POSITION OF *NANOGYRA NANA* (SOWERBY, 1822)

Spiral coiling of the umbo of upper valve is one of the main characters of the subfamily Exogyrinae, what was pointed out by Vialov (1948, p. 22), Mirkamalov (1966, p. 29) and others. The spiral coiling of umbo caused some changes in the internal structure of the upper valve what is best pronounced in opisthogyre curving of hinge line. This feature characterizes all the species of the subfamily. The hinge took a transversal position and ligamental pit bordered by elevations on each side have elongated into little ledges and furrow. Disappearance of the posterior fold is another important feature of the subfamily which occur in the majority of species. A development of tooth groove under the ligament area of the lower valve is also an important character of exogyras. A tooth-like outgrowth corresponds to it on the back side of hinge of the upper valve. It was already remarked by Fischer de Waldheim (1837) as an important character in the diagnosis of the genus *Amphidonta,* and other authors regard it as a diagnostic feature for the genus *Exogyra.* This character aside of the two others mentioned above, is typical in the whole subfamily Exogyrinae (Mirkamalov, 1966, p. 30, 33).

In the light of the above statements, the affiliation of *Nanogyra nana* to the Exogyrinae is obvious. This species is characterized by a strong opisthogyre coiling of umbo of the upper valves frequently exceeding 360°., strongly transversally elongated hinge shows exogyroid structure, and subligament groove develops in the lower valve and a tooth-like outgrowth in the upper one (Pl. II, Figs. 1, 2, Pl. XXVI, Fig. 6).

However, some individuals of *Nanogyra nana* differ slightly from the *Exogyra* type. The hinge may in its simple structure be more like *Ostrea* type. Those primary features are particularly well developed in the hinge of the lower valve, in which two distinct side folds may be distinguished.

Nevertheless, the opisthogyre hinge is strongly marked and there occurs a tooth-socket in the lower valve, and tooth outgrowth in the upper one and also a spiral umbonal coiling of umbo in the upper valve. This mixture of progressive and primitive characters in *Nanogyra nana* places this species in a special position among Ostreidae. Strongly convex lower valve of smooth external surface makes it similar to *Gryphaea* but it differs from the latter in the remaining exogyroid features. *Gryphaea* neither shows a spiral coiling of umbo of the right valve, nor has an opisthogyre coiling of hinge. Because of some gryphaeoid characters, some authors place this genus among *Gryphaea,* simultaneously distinguishing forms of *nana* type into a group of "incertae sedis" (Mirkamalov, 1966, p. 34). The present writer is of different opinion. The above differences are quite sufficient to distinguish the genus *Nanogyra* as proposed by Beurlen (1958). On the basis of mixed *Ostrea-Exogyra* characters and external similarity to *Gryphaea*, *Nanogyra nana* should be placed between the subfamilies Gryphaeinae Vialov, 1936 and Exogyrinae Vialov, 1936.

Nanogyra nana may be regarded as a first step in the development of the subfamily Exogyrinae. Other highly specialized genera of that subfamily begun from it. Exogyroid characters appeared to be highly adaptative during the development history of the subfamily and remained stable in the genotype.

Due to its plasticity, *Nanogyra nana* has developed numerous morphotypes which were regarded as separate species. A detailed analysis of *N. nana* carried out by Jourdy (1924, p. 58—65) has showed a close relation between the shell shape and environmental conditions. Numerous "species" of *Nanogyra*, distinguished on the basis of morphologic variability, were placed together by the present author, into one species *Nanogyra nana*, which occurs from the Bajocian up to the Portlandian inclusively showing the same type of internal structure, and the same external characters.

HINGE EVOLUTION IN SOME EXOGYRINAE

The exogyroid type of hinge structure is a very complicated one as compared to ostreoid type which is represented by such genera as *Alectryonia*, *Liostrea* and others from the subfamily Ostreinae. It was a subject to considerable changes and simultaneously showed an appearence of some new elements.

A complete development of the exogyroid type of hinge is represented by *Exogyra sigmoidea* Reuss from the Upper Cretaceous of Czechoslovakia which was in detail analysed by Záruba (1965, p. 25, Text-fig. 6). The terminology presented by that author is clear and univocal so it was accepted by the present author and applied in further considerations (Text-fig. 1*h*).

A close correlation may be observed in the development of the particular hinge elements of the exogyroid type. Opisthogyrity of umbilical parts of the valves caused arcuate bending of hinge with simultaneous backward shift. Ligament area was strongly narrowed and elongated thus taking shape of a very narrow, transversal furrow. Previously convex side-folds of hinge are considerably lowered and further changes lead to disappearance of the posterior one or both of them. In the result of those changes new elements of hinge appeared such as ligament grooves and ligament ledges, cardinal tooth and tooth-groove. These elements in one valve correspond to negative counter-parts in the opposite valve. Analysis of the subsequent evolutionary changes of the hinge structure was exemplified by the Jurassic exogyras, from the most primitive to highly advanced forms in a series: *Nanogyra nana, Exogyra virgula, Ex. reniformis* and *Ex. welschi.* Simultaneously a variability in the development of the particular elements of hinge was illustrated on examples of *N. nana* and *Ex. virgula.*

Nanogyra nana shows several transitory forms leading gradually from more primitive hinges of ostreoid type to a more advanced ones — exogyroid type. It is a long living species, of extensive geographic distribution. Its stratigraphic range is from lower part of the Middle Jurassic up to Uppermost Jurassic, what proves its high plasticity and high adaptability to changing environmental conditions.

The ostreoid type of hinge structure of left valves of *N. nana* is reflected in well developed lateral hinge folds, surrounding broad and poorly yet opisthogyre ligament area. Such structure may be observed in specimens representing young development stages. Progressive tendencies in the hinge structure are reflected in feeble flattening of anterior hinge--fold, shortening and accentuating of the posterior one (Text-fig. 4*a*). Another progressive phase in changes of the hinge structure is primarily feeble and then intensified undulation of its posterior part. This may be observed on the right valves of *N. nana* (Text-fig. 4*b*—*d*). They lead to disappearance of the posterior hinge-fold even stronger flattening and forward shifting of the anterior hinge-fold, strongly accentuated opisthogyrity and to the development of some new elements in the hinge structure such as separated posterior ligament ledge. The tooth-outgrowth situated behind it and adhering it from behind tooth groove socket are still poorly developed (Text-fig. 4*b*). Individual variability reflected in the hinge structure of *N. nana,* is more or less marked with its opisthogyrity and in unequal accentuation of the posterior ligament ledge and tooth outgrowth (Text-fig. 4 *b*, c).

Progressive type of hinge structure of *N. nana* illustrated on Text-fig. 4*d* corresponds largely to the structure of the Upper Cretaceous exogyras (Text-fig. 1*h*). This species is an example of progressive evolution changes reflected in opisthogyre umbo and hinge and in the development of process typical for exogyras (Pl. XXVI, Fig. 6*b*). This progressive structure type of *N. nana* contradicts the views of some authors, who include it to „incertae sedis" group (Mirkamalov, 1966). The examples of hinge structure of the left valve of *N. nana* mentioned above illustrate a progressive trend leading to the *Exogyra* type. Text-fig. 4*e* shows early stage of hinge development, i.e. poorly depressed tooth groove and hardly marked furrow for the ligament ledge of the right valve. These elements

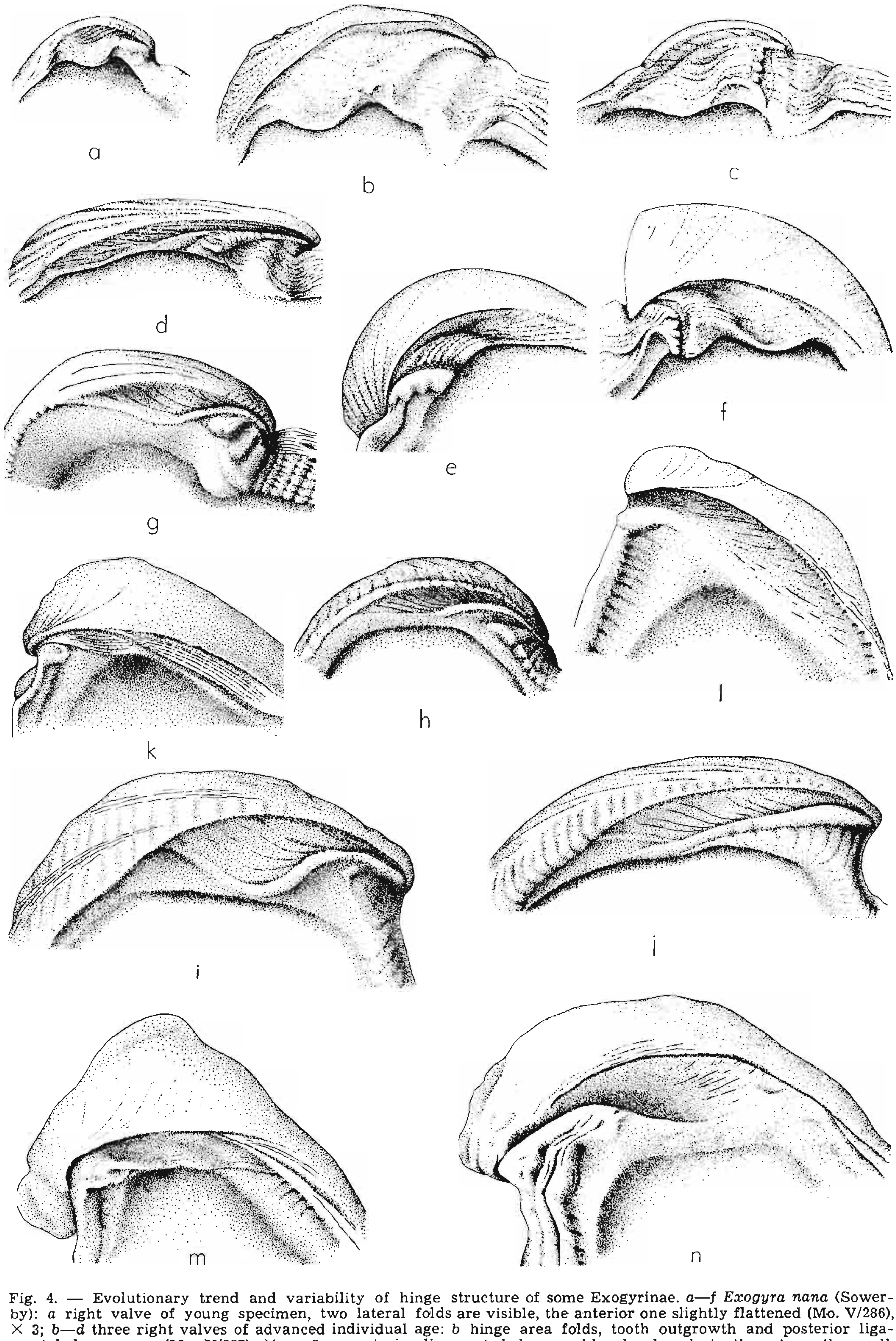

Fig. 4. — Evolutionary trend and variability of hinge structure of some Exogyrinae. *a—f Exogyra nana* (Sowerby): *a* right valve of young specimen, two lateral folds are visible, the anterior one slightly flattened (Mo. V/286), × 3; *b—d* three right valves of advanced individual age: *b* hinge area folds, tooth outgrowth and posterior ligament ledge convex (Mo. V/287), × ca 3, *c* posterior ligament ledge weakly developed, tooth outgrowth small, tooth groove concave (Mo. V/288), × ca 3, *d* hinge opisthogyre, posterior ligament ledge more arched, tooth outgrowth thickened (Mo. V/289); × ca 3; *e—f* two left valves: *e* weakly differentiated hinge, tooth and posterior ligament ledge grooves of opposite valve weakly developed, *f* advanced stage, tooth groove concave, ligament ledge groove more distinct (Mo. V/290—291); × ca 2.5.

g—n Exogyra virgula (Defrance): four right valves of adult specimens: *g* anterior fold strongly flattened, posterior ligament ledge and tooth outgrowth well-developed (Mo. V/292); × ca 8, *h* both anterior and posterior ledges distinct, tooth outgrowth secondarily folded (Mo. V/293); × ca 6.5, *i* the hinge with more primitive structure manifesting the S-shaped arrangement of growth line on ligament area (Mo. V/294); × ca 6.5, *j* progressive structure of hinge, posterior ligament ledge distinct, anterior ligament ledge flattened, tooth outgrowth thickened and covered with marginal elements (Mo. V/295); × ca 6.5; *k—n* four left valves illustrating a great variability of hinge structure: on *k* and *m* ligament area wide in its basal part, tooth groove concave and narrow, the posterior ledge furrow of the opposite valve weakly concave, on *l* and *n* tooth groove and posterior ligament ledge furrow of the opposite valve deep, marginal elements well-developed (Mo. V/296—299); × ca 7.

are yet better developed in a specimen illustrated on Text-fig. 4*f* and Pl. II, Fig. 1.

The stage in which the tooth-outgrowth is distinguished in the right valve is called „monodont". Together with the disappearance of both lateral „slopes" it marks the highest evolution of hinge among the representatives of *Exogyra* (Jourdy, 1924).

Exogyra virgula is the next evolution stage among the Jurassic exogyras. It is very abundant in the Kimeridgian of Poland. Changes in the hinge structure and broad individual variability are shown on schematic drawings at Text-fig. 4 *g—n*. The simplest type of left valve shows broad ligament area, covered with sinusoidal growth lines (Text-fig. 4*i*). The rised lateral lines of this field may be regarded as disappearing lateral hinge folds. Arched posterior ligament ledge, strong tooth-outgrowth and adhering tooth groove but yet poorly developed, are typical exogyroid elements. In result of evolution, ligament ledges become better pronounced and the tooth-outgrowth enlarged. The variability of hinge structure among *Ex. virgula* is pronounced by changes in hinge height, degree of its narrowing and backward coiling and more or less arched and long posterior ledges, what is illustrated in Text-fig. 4 *g—j*. The variability of hinge structure of the left valves of *Ex. virgula* aside of the changes distinguished for the hinges of the right valves, depends chiefly on the degree of flattening and size of the posterior shell margin in its upper part. It is worth of note that some new elements appeared in *Ex. virgula* in comparison to *Nanogyra nana*, which are observable on the internal side of valves, such as lateral grooves and nodes, the so called marginal denticles. Their depth and elongation vary from only hardly accentuated little depressions (Text-fig. 4*m*) to deep transversally elongated grooves, and crenulations or roll-like elevations on right valves (Text-fig. 4 *j, l*). It seems worth of note that the conservative features of hinge structure of *Ex. virgula* occur in specimens with larger attachment area (Text-fig. 4 *k, m*). The umbo of such individuals is high, thickened, the ligament area is broad at base and initially non coiled, but at the end more or less opisthogyre.

Despite of a broad variability in the hinge structure which shows at times some conservative characters, a general tendency among specimens of *Ex. virgula* is rather a progressive evolution leading to free from the substratum and to achieve an exogyroid type of hinge. Some authors contrast the more primitive Jurassic exogyras to the highly advanced Cretaceous ones on the basis of the occurrence among the latter a "monodontic" hinge (Beurlen, 1958, Jourdy, 1924). Such an opinion, however, is groundless because the "monodontic" hinge type is known among *Nanogyra nana* as well (Pl. XXX, Figs. 1*b*, 3*b*, 5*b*, 6*b*; Pl. XXVIII, Pl. XXIX).

Exogyra reniformis (Text-fig. 5 *a—b*) presents another evolution stage of the exogyroid type of hinge. This species is characterized by an addi-

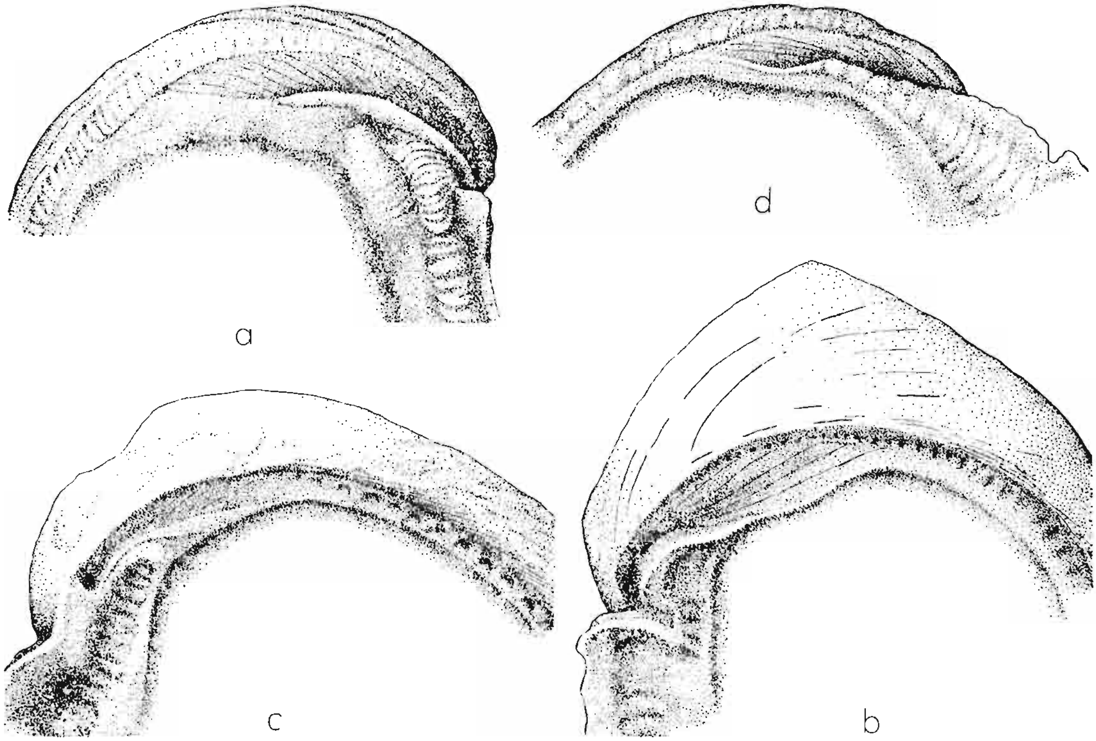

Fig. 5. — Evolutionary trend and variability of hinge structure of some Exogyrinae. *a—b Exgyra reniformis* Goldfuss: *a* right valve of adult specimen, posterior ligament ledge narrow and arcuate, tooth outgrowth covered with marginal elements well-developed, ligament area opisthogyre, uniform, no lateral folds (Mo. V/300); × ca 3, *b* left valve of adult specimen, tooth groove deep, ligament area narrow, uniform, marginal elements well-developed (Mo. V/301); × ca 3.
c—d Exogyra welschi Jourdy: *c* left valve of adult specimen, tooth groove long and wide, covered with marginal elements, the furrow corresponding to posterior ligament ledge of opposite valve arcuate, deep and narrow, ligament area long, narrow, lateral folds absent (Mo. V/302); × 3, *d* the right valve of adult specimen, tooth outgrowth large, long and covered with marginal elements transversally elongated (Mo. V/303); × 3.

tional feature namely as a rule the posterior margin is subject to more or less flattening and broadening. Well-developed marginal denticles occur on the inner surface of that margin. They are more or less long, roll-like little folds on the right valve and corresponding grooves on the left valve. They cover the surface of the tooth-outgrowth and tooth groove (Text-fig. 5 *a, b*). The hinge of that species is devoid of lateral folds. The posterior ligament ledge in the right valve is long and strongly protruding, the tooth-outgrowth is well developed. The tooth groove on the left valve is deep, and surrounded dorsally by a bent, high posterior ligament ledge and adhering to it dorsally ligament furrow which serves to place the posterior ledge of the right valve (Text-fig. 5*b*). A great variability exists in the development of the particular hinge elements among many representatives of *Ex. reniformis*. This concerns some differences in height, length and ornamentation of tooth-outgrowth, width and depth of the subhinge part of posterior margin of valve, length and protrudeness of marginal elements (Pl. XXXI, Pl. XXXII, Figs. 3*b*—7*b*). The type of hinge of *Ex. reniformis* is definitely a "monodont" one hence it attains the highest rank of evolution among exogyras. Majority of the specimens examined attach with a very small surface of umbo, and many of them lack such an attachment area.

Similar hinge type exists among representatives of *Exogyra welschi* (Text-fig. 5 *c*—*d*). The hinge of that species shows also "monodont" structure. The tooth outgrowth of the right valve is large, as a rule lobe-like broadened, and the tooth groove of the left valve which serves to place it, is strongly depressed and long, taking large part of the shell margin. Posterior ligament ledge is narrow, arched, the anterior one shifts toward the anterior margin which limits the hinge from above. The marginal elements are in this species particularly well developed. When compared to the other species of *Exogyra* described above, *Ex. welschi* attained a new progressive character namely a strongly developed external ornamentation consisting of numerous thick, radial folds. The radial ornamentation existed already in *Ex. virgula* but those were minute, superficial ribs. In the opinion of some authors (e.g. Jourdy, 1924), a well pronounced ornamentation and size increase of shells are a progressive features in the evolution of exogyras, what is well illustrated by the representatives of *Ex. welschi*. The variability of the hinge structure in *Ex. welschi* depends chiefly on the change of size, situation both of tooth-outgrowth, tooth groove and marginal elements and on the change of size of lobe-like broadened posterior margin in its subhinge part (Pl. XXXIV, Figs. 2*a*—4*a*, 6*a*, 7*a*).

SYSTEMATIC PART

Family **Ostreidae** Lamarck, 1818
Subfamily **Ostreinae** Vialov, 1836

Revised diagnosis. — Lower valve more or less convex, upper valve flattened or flat, rarely both valves equally convex. Umbo weakly projected, stratight or oblique, sometimes bent backward. Ornamentation radial or concentric on both valves, or radial on the left and concentric on the right valve. Ligament pit triangular, centrally located with a pair of primary denticles on both sides. Prodissoconch equivalve. Microstructure lamellar, sometimes subrhomboidal.

Occurrence. — Triassic-Recent.

Genus *Alectryonia* Fischer de Waldheim, 1807

(Type species: *Ostrea cristagalli* Linné, 1758)

Diagnosis. — Shell inequivalve to almost equivalve, inequilateral, convex. Outline variable, most often triangular or ovate. Umbo of both valves projected or weakly projected. Ornamentation consists of numerous radial ribs. External margin toothed; hinge with simple ostreoid structure.

Remarks. — In paleontological papers, both generic names, *Lopha* Bolten 1919, and *Alectryonia* Fischer de Waldheim, 1807, are used, both genera, having the same type species *Ostrea cristagalli* Linné.

The existing controversy concerning the priority of the name *Alectryonia* was clarified by L. Pervinquière (1912, pp. 200—203). Pervinquière's position has the support of Dechasseaux (1933), Stenzel (1947) and others.

Other genera names, such as *Rastellum* Schroeter, 1782, and *Dentostrea* Swaissen, 1840, were used, and, as Pervinquière indicates, have the same type species and should be included in the genus *Alectryonia*.

Alectryonia marshi (Sowerby, 1814)

1814. *Ostrea Marshii* Sowerby; J. Sowerby, The mineral..., p. 103, Pl. 48, Figs. 7, 8.
1834—1840. *Ostrea Marshii* Sow.; A. Goldfuss, Petrefacta Germaniae, p. 6, Pl. 73, Figs. a—i, k.
1856—1858. *Ostrea Marshii* Sowerby; A. Oppel, Die Juraformation..., p. 493.
1869. *Ostrea Marshii* Sowerby; D. Brauns, Der mittlere Jura..., p. 215.
1929. *Alectryonia Marshi* Sowerby; L. Schäfle, Über Lias..., p. 64, Pl. 6, Fig. 4.
1951. *Lopha Marshi* Sow.; W. Krach, Małże..., p. 353
1955. *Lopha marshii* (Sowerby, 1814); P. A. Gerasimov, Rukovodiaščie iskopaemye..., p. 129, Pl. 31, Figs. 6, 7; Pl. 32, Fig. 1.

Material. — Four fragments of valves.

Description. — The external surface is wrinkled, uneven, with ribs, tubercles and fine granulation, frequently concentric. The growth lines follow a wavy course. Thick ribs begin below the undulated surface and end at the edge of ventral high-zigzag commissure. The ribs of the right valve are less keel-like than those of the left valve, sometimes with rounded dorsal surface. They are covered by growth lines shaped like lamellae protruding from the dorsal keel, and also with fine vertical striae diverging in a fan-like pattern on and between the ribs. The ribs are of uneven height, usually inclined and sometimes lying. The ventral margin is thin, because the younger lamellae are increasingly short as though covered in an imbricating fashion by the longest lamellae of the final growth stages. The posterior margin, is markedly thicker because all the lamellae extend to its edge.

Remarks. — The complex and highly characteristic ornamentation of the external surface of valves of this species is not dealt with in the descriptions of previous authors. It appears that *Al. marshi* has been confused with *Al. flabelliformis* (Nilson), there-by extending the occurence of the species described into the Kimeridgian (Wilczyński, 1962; Barczyk, 1961). *Al. marshi,* exept for the large size (to 140 mm in height), and high ribs with sharp keel, is distinguished by its particular ornamentation, and especially by striae diverging in a fan-like pattern on and between the ribs. *Al. flabelliformis* does not exhibit such ornamentation nor does its height exceed 60 mm.

Occurrence. — Poland, Polish Lowland (Łęczyca): Bajocian-Bathonian, the *Parkinsonia ferruginea* Zone; Polish Jura Chain: Callovian; Germany: Bajocian-Bathonian; Switzerland, France and England: Upper Bathonian.

Alectryonia gregarea (Sowerby, 1816)

(Pl. III, Fig. 7; Pl. V, Figs. 1—8; Pl. VI, Figs. 1—8; Pl. IX, Figs. 2, 3; Pl. X, Fig. 3)

1816. *Ostrea gregarea* Sowerby; J. Sowerby, The mineral..., p. 19, Pl. 111, Figs. 1, 3.
1934—40. *Ostrea gregaria* Sowerby; A. Goldfuss, Petrefacta..., p. 7, Pl. 74, Fig. 2 a—f.
1837. *Ostrea claustrata* Schlotheim; G. G. Pusch, Polens Paläontologie, p. 29, Pl. 4, Fig. 13 a—c.
1851—54. *Ostrea gregaria* Sowerby; H. Bronn, Lethaea geognostica, p. 188, Pl. 18, Fig. 16.
1858. *Ostrea gregaria* Sowerby; F. A. Quenstedt, Der Jura, p. 751, Pl. 91, Fig. 28.
1929. *Alectryonia gregarea* Sowerby; E. Jaworski, Eine Lias-Fauna..., p. 6.
1933. *Lopha gregarea* (Sowerby); W. J. Arkell, A monograph..., pp. 183—185, Pl. 22, Figs. 5, 6; Pl. 23, Figs. 1—4.
1938. *Alectryonia gregarea* Sowerby; A. Chavan & H. Montocchio, Fossiles..., p. 72, Fig. 122a.
1951. *Arctostrea gregaria* Sow. var. n. A, B, sp. aff.; W. Krach, Małże..., pp. 349—350, Pl. 13, Figs. 1—4.
1954. *Lopha karrenbergi* Basse; E. Basse, Fossiles..., p. 664, Pl. 27, Fig. 1 a—d.
1965. *Lopha gregarea* (Sowerby); L. R. Cox, Jurassic Bivalvia..., p. 68, Pl. 9, Fig. 5.

Material. — Approximately 300 well-preserved specimens, mainly complete shells, and about 100 valve fragments.

Description. — Shell attaining medium to large size, ovate to oblique--triangular. Height greater than length. Ornamentation consists of radial keel-like ribs, diverging from umbo or from attachment area. Location and size of attachment area is variable; commissure toothed.

Left valve (Pl. V, Figs. 1*a*, 4, 5; Pl. VI; Pl. IX, Fig. 1*b*) semicircular, slightly larger and more convex than right valve. Maximal convexity is attained at or just over half of valve height, and reaches 25 mm in the case of shell 60 mm height. Umbo rarely prominent, since usually obscured by attachment area. Attachment area is unequally inclined, sometimes tuberculated, and, to various degrees, reflects morphology of substratum. Posterior margin shorter than rounded anterior margin. Posterior ribs short and weakly accentuated but more numerous and lower than anterior ribs. Number of ribs is ususally increased by bifurcation or intercalation. Imbricate growth lines strongly concentrated along ventral margin. The teeth of ventral and anterior margins are the highest.

Measurements (in mm):

Z. Pal. UW. Mo. V/	Height	Length	Height ratio
43	36.0	19.0	1.9
47	36.0	20.0	1.8
307	36.0	24.0	1.5
305	42.0	29.0	1.45
42	44.0	25.0	1.76
306	51.0	30.0	1.7
38	54.0	32.0	1.69
304	61.0	27.0	2.26
36	62.0	32.0	1.94
83	64.0	38.0	1.68

Right valve slightly smaller and less convex (Pl. V, Figs. 1*b*, 2*b*, 3*b*; Pl. VI, Figs. 1*b*, 2*b*, 5*b*, 6*b*, 8*b*). Its umbonal area, irregularly rounded, is a negative of this area from the left valve. Ornamentation consists of ribs with weaker keel than the ribs of left valve.

Internal morphology (Pl. V, Figs. 2*a*, 3*a*, 8*a*; Pl. IX, Fig. 2*a*) uniform except for hinge. Hinge of left valve in form of an isosceles triangle, sometimes slightly bent backward. Hinge margin often swollen and elevated above valve surface, with height often equal to length, maximally attaining 30 mm, but more often, particularly in younger growth stages, height larger than length. Muscle scar ovate to round, concave, deeper on the left valve, mid-posterior in position. Its width attains 12—15 mm, i.e. 1/4 of valve diameter. In younger ontogenetic stages, external ornamentation is reflected internally as radial fine folds. In older stages such folds are visible only along margins. Left valve deeper than right. In both cases the largest depression lies along anterior margin, sometimes in central part or below the hinge, where it may attain 20 mm in depth.

Ontogeny. — Occurrence of nepionic shells was not stated in material studied. The smallest specimen is 28 mm high, 15 mm long and 12 mm wide. Three growth stages may be distinguished on the basis of shell measurements and height ratio, as follows:

Growth stage	Height mm	Length mm	Characteristics
Neanic	25.0—45.0	15.0—25.0	Shell ovate, posteriorly bent; dorsal margin sharp, ventral margin rounded; valves almost equally convex, up to 10 mm; left valve two times deeper; ribs low with sharp keel crest, rarely rounded, radial, sometimes arched; number of ribs increased by intercalation from 18 to 28; sharp zigzag commissure; muscle scar relatively large, up to 12 mm wide, equals to one-half of corresponding valve diameter; height ratio 1.66 to 1.8.
Ephebic	45.1—60.0	25.1—33.0	Shell shape variable — ovate or obliquely triangular; posterior sinus distinct; dorsal margin wide, swollen, sometimes sharpened; valve equally convex, up to 18—20 mm; ribs thicker and higher, often with sharp crest, sometimes rounded on right valve, slightly wavy; their number increases from 26 to 50 by intercalation, sometimes by dichotomy, particularly on right valve; high zigzag commissure; muscle scar higher than long, equals to 1/3 of valve diameter; height ratio slightly increases, from 1.8 to 2.0.
Gerontic	60.0—70.0	34.0—38.0	Oblique-triangular shape prevails; ventral margin strongly swollen; other characteristics undergo typical growth changes; height ratio exceeds 2.0; hinge high, long and swollen.

Variability. — *Al. gregarea* is characterized by high individual variability in shape, dimensions, number and course of ribs, and position and size of attachment area. Four following morphologic types may be distinguished according to shell shape: 1) shells oblique triangular with wide, flat ventral margin (Pl. V, Fig. 4; Pl. VI, Fig. 6); 2) shells similar in shape but with strongly swollen and rounded ventral margin (Pl. V, Figs. 1c, 6); 3) shells ovate, slender, two times higher than long (Pl. VI, Fig. 5); 4) shells rounded, short, thick, with smaller increase of height (Pl. VI, Figs. 1, 2).

Those differences are strongly connected with position and size of attachment area. If attachment area is small and terminally situated, shells grow normally and have ovate shape. With shift of attachment area onto the upper side, shells become obliquely triangular in shape. Depending on the growth habit of shell, ribs may be straight, radial or may diverge in fan-like pattern or unevenly. Posterior ribs usually are shorter.

Al. gregarea occurs often in clusters, so shape and other characteristics of such specimens do not fit within the framework of any division, because in adapting to any free space take on irregular in shapes (Pl. V, Fig. 7).

Remarks. — Polish specimens correspond completely to English specimens of Sowerby and others. Author includes within this species the specimens of *Arctostrea gregaria* Sow. (Krach, 1951), which fit within its limits of variability, and also the specimens of *Ostrea claustrata* Schlotheim (Pusch, 1837), very similar to obliquely triangular exemples with large latitudinal attachment area.

Occurrence. — Poland, Western Pomerania: Lower Kimeridgian, Mesozoic margin of the Holy Cross Mts.: Upper Oxfordian, Polish Jura Chain: Callovian; Europe: commonly, Upper Jurassic; Soviet Union: commonly, Upper Jurassic; Morocco: Bajocian-Bathonian; Madagascar: Upper Bathonian; Yemen: Upper Jurassic.

Alectryonia solitaria (Sowerby, 1825)
(Pl. III, Figs. 1—6; Pl. IX, Fig. 1)

1825. *Ostrea solitaria* Sowerby; J. Sowerby, The mineral..., T. V, p. 105, Pl. 468, Fig. 1.
1868. *Ostrea solitaria* Sowerby; E. Eichwald, Lethaea..., p. 370.
1893. *Ostrea (Alectryonia) solitaria* Sowerby; E. Greppin, Études..., p. 88, Pl. 6, Fig. 21.
1927—37. *Lopha solitaria* (Sowerby); W. J. Arkell, A. monograph..., p. 185, Pl. 22, Figs. 4; Pl. 23, Figs. 5—7 (non Figs. 6, 6a, 6b).
1961. *Lopha solitaria* Sowerby; N. G. Chimšijašvili, Svjaz verchnejurskoj..., p. 192, Pl. 11, Figs. 3, 4.
1965. *Lopha solitaria* (Sowerby); L. R. Cox, Jurassic Bivalvia..., p. 69, Pl. 9, Fig. 4.

Material. — Four complete shells, 3 internal casts and a few single valves, well-preserved.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Height ratio
16	30.0	25.0	1.2
309	42.0	36.0	1.2
308	42.0	33.0	1.3
19	44.0	34.0	1.3

Description. — Shell attaining moderate size, almost equivalve, obliquely triangular. Umbo slightly projecting, posterior. Below umbo on both valves occur a posterior auricular widening and sinus, variable in width and depth. Anterior and posterior margins rounded, toothed, whereas the rest of margin slightly undulated or smooth. Ornamentation uniform on both valves, except for the attachment area of left valve, and smooth, usually convex part of right valve; it consists of radial, low and thick ribs with sharp keel. Below umbo, ribs diverge in fan-like pattern. Number of ribs increases from 20 to 30 by dichotomy and intercalation. Ribs divide shell into 3 fields: posterior, middle and anterior. Posterior part comprises posterior auricle and margin, with 9—11 short, fine, arched ribs deviating from long primary rib, which continues from umbonal part. Two other long ribs, together with short ribs deviating from them backwardly, delimit the middle part. Shorter ribs deviate under angle of 45°. Anterior part is delimited by wide furrow and long rib parallel to it. Two or three secondary short ribs deviate from the latter rib. In the upper part of shell secondary ribs usually begin directly in the sub-umbonal area, without distinct connection with long rib. Those secondary ribs extend normally to primary rib or are arcuate.

Inner valve surface (Pl. III, Figs. 1*b*, 5*b*; Pl. IX, Fig. 3*b*) usually smooth; only weak undulations are developed along ventral margin, reflecting external ornamentation. Edges thicken with age of specimen, maximally to 5 mm on anterior edge. Depth of valves is small; sometimes in more convex examples distinct maximal depression occurs along anterior margin and under hinge.

Muscle scar lies at half of valve height, slightly posteriorly. It is rounded, up to 11 mm in diameter (1/3 of valve diameter), surrounded by thickened ventral lip. Hinge slightly oblique, posterior, 15 to 18 mm long, about 10 mm high, relatively flat; lateral folds and hinge pit (left valve) and corresponding elements (right valve) are weakly accentuated. Hinge margin moderately elevated and thickened.

Ontogeny (Pl. III, Figs. 1, 2, 4, 5). — Number of ribs increases from 18 in younger stages to 24—30 in the oldest stages. Growth ratio remains almost constant through the whole ontogeny.

Variability. — *Al. solitaria* is characterized by slight changes concerning degree of margin roundness, valve shape, muscle scar outline, form of posterior auricle and number of deviating secondary ribs.

Remarks. — Identification of *Al. solitaria* with *Al. pulligera* (Goldfuss *in* Arkell, 1927—37, p. 186) seems invalid, because the latter is inequivalve and has a different type of ornamentation, high spine or lamellar ribs, and no tripartity of valves.

One of Arkell's specimens (Arkell, *l. c.*, Pl. 23, Figs. 6, 6*a*, 6*b*), identified as *Al. solitaria*, seems similar to *Al. flabelliformis* (Nilson) by its irregular course of ribs, developed along external margin only. Both species are characterized by dinstinct concentric growth lines.

Occurrence. — Poland, Mesozoic margin of the Holy Cross Mts.: Upper Oxfordian-Lower Kimeridgian, vicinity of Radom: Lower Kimeridgian, Western Pomerania: Lower Kimeridgian; Soviet Union, Lithuania: Lower Oxfordian, Georgia: Kimeridgian; Switzerland: Kimeridgian; Germany: Oxfordian-Lower Kimeridgian; England: Kimeridgian; Kenya: Upper Oxfordian-Kimeridgian.

Alectryonia rastellaris (Münster, 1833)

(Pl. VI, Fig. 9; Pl. VII, Figs. 1—3, 5—7)

1834—40. *Ostrea rastellaris* Münster; A. Goldfuss, Petrefacta..., p. 8, Pl. 74, Fig. 3*a*—*g*.
1858. *Ostrea rastellaris* Münster; F. A. Quenstedt, Der Jura, p. 625, Pl. 77, Fig. 24.
non 1862. *Ostrea rastellaris* Münster; J. Thurmann & E. Étallon, Lethea..., p. 278, Pl. 39, Fig. 11.
1875. *Ostrea rastellaris* Münster; P. de Loriol & E. Pellat, Monographie..., p. 223, Pl. 24, Figs. 1—3.
1893. *Ostrea rastellaris* Münster; E. Greppin, Études..., p. 86, Pl. 6, Fig. 19.
1951. *Arctostrea rastellaris* Goldf. var. A. Krach; W. Krach, Małże..., p. 350, Pl. 13, Fig. 5 (non var. n. B, C, Pl. 13, Figs. 6—8).

Material. — Fifty well-preserved specimens, mainly complete shells. Ephebic growth stage prevails.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Height ratio
310	24.0	14.0	1.7
50	29.0	16.0	1.8
51	31.0	18.0	1.7
52	40.0	20.0	2.0
311	42.0	21.0	2.0
49	45.0	24.0	1.9
312	50.0	24.0	2.01
313	58.0	22.0	2.2

Description. — Shell attaining moderate size, equivalve, ovate, distinctly elongated; often crescent. Both valves equally convex, ornamented with radial ribs. Zigzag commissure. Attachment area terminal, small.

Left valve (Pl. VI, Fig. 9*a*; Pl. VII, Figs. 1*a*—3*a*, 6, 7) with attachment area terminal, sometimes translocated on flank of upper part of valve. In the latter case, valve arcuate, anterior margin usually convex, posterior margin concave. Specimens with ovate shape ornamented with radial ribs, more or less uniformly long and thick. Ribs of arcuate specimens unequal; slightly wavy posterior ribs longer than anterior. Maximal number of ribs do not exceed 30—40 in late growth stages, usually increasing through dichotomy or, sometimes, by intercalation; ribs usually rounded. Concentric growth lines very fine, distinct, crowded close to posterior and anterior margins.

Right valve (Pl. VI, Fig. 9*b*; Pl. VII, Figs. 1*b*—3*b*) slightly smaller and more flattened than left. Ribs with rounded crests, lower and wavy. Umbonal part irregular, sometimes tuberculated.

Internal surface uniform, smooth, slightly depressed. Maximal depression, up to 5—8 mm, occurs along anterior margin. Ligament pit and lateral folds of arcuate specimens bent backward slightly. Muscle scar at half of valve heigth, fairly deep and surrounded by thickened ventral lip; its width equals to 1/3 of shell diameter. Weak folds, reflecting external ornamentation, continue along ventral margin.

Ontogeny. — Summarized ontogenetic changes are given below. Nepionic stage is not taken into consideration because of obliteration of initial umbonal part.

Growth stage	Height mm	Length mm	Characteristics
Neanic	up to 40.0	up to 20.0	Shell rounded, ovate, height greater than width; margins rounded; posterior sinus weak; left valve convex, up to 12 mm in upper half; right valve flat; ribs, from a few to 20, single, wavy, rounded, forked below convex part of valve; attachment area terminal, posterior; growth ratio 1—1.8.
Ephebic-gerontic	41.0—65.0	21.0—35.0	Shell ovate, strongly elongated, height four or more times greater than length; left valve more convex than right, latter both valves almost equally convex; ribs, 21 to over 40, rounded, forked, radial, slightly arcuate or straight; attachment area relatively smaller; growth ratio increases from 1.8 to 3.0; growth lines strongly protruding; ventral margin thickened (Pl. VII).

Variability. — Individual variability of *Al. rastellaris* relatively low, expressed mainly in shape change, from slightly ovate to rounded or strongly elongated, and in convexity. Attachment area usually terminal, occasionally subumbonal.

Remarks. — Polish specimens well agree with Münster's specimens from the Jurassic of Germany (Goldfuss, 1834—40, Pl. 74, Fig. 3*d*, *f*, *g*).

Al. rastellaris may be distinguished from morphologically similar in shape, size, and type of commissure, *Al. gregarea*, by its ornamentation. In the latter, ribs are sharp, generally straight and rarely dichotomic.

Author excludes specimens of Thurmann (1862, Pl. 39, Fig. 11) from this species, because they correspond rather to *Arctostrea hastellata* (Schlotheim).

Occurrence. — Poland, Western Pomerania: Kimeridgian, Mesozoic margin of the Holy Cross Mts: Lower Kimeridgian, Polish Jura Chain: Callovian; Germany: Upper Jurassic; France: Upper Oxfordian-Lower Kimeridgian.

Alectryonia pulligera (Goldfuss, 1834)
(Pl. VIII, Figs. 1—15)

1834—40. *Ostrea pulligera* Goldfuss; A. Goldfuss, Petrefacta..., p. 5, Pl. 72, Fig. 11 a—c.
1836. *Ostrea solitaria* Sowerby; A. Roemer, Die Versteinerungen..., p. 58, Pl. 3, Fig. 2.
1858. *Ostrea pulligera ascendens* Quenstedt, F. A. Quenstedt, Der Jura, p. 751, Pl. 91, Fig. 29.
1862. *Ostrea semisolitaria* Étallon; J. Thurmann & E. Étallon, Lethea..., p. 279, Pl. 40, Fig. 1.
1872. *Ostrea pulligera* Goldfuss; P. de Loriol, E. Royer & H. Tombeck, Description..., p. 402, Pl. 24, Figs. 1—6.
1875. *Ostrea pulligera* Goldfuss; P. de Loriol & E. Pellat, Monographie..., p. 221, Pl. 24, Figs. 4,5.
1893. *Ostrea (Alectryonia) pulligera* Goldfuss; E. Greppin, Études..., p. 87, Pl. 36, Figs. 17—18.
1924. *Alectryonia pulligera* Goldfuss; E. Jourdy, Histoire..., p. 17, Pl. 1, Fig. 3, No. 2.
1927. *Ostrea (Alectryonia) pulligera* Goldfuss; V. F. Pčelincev, Fauna..., p. 74.
1933. *Alectryonia pulligera* Goldfuss; C. Dechaseaux, Sur quelques..., p. 110.
1951. *Arctostrea nodosiformis* n. sp. Krach; W. Krach, Małże..., p. 351, Pl. 13, Figs. 9—11, 21.
1970. *Alectryonia pulligera* (Goldfuss, 1834); I. Dmoch, Ślimaki..., pp. 77—78, Pl. 6, Figs. 9, 10.

Material. — Thirty six well-preserved single, mainly right valves and 4 complete shells.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Height ratio
Left valve			
71	16.0	15.0	1.03
72	19.0	18.0	1.05
73	35.0	28.0	1.25
74	37.0	29.0	1.27
75	40.0	36.5	1.1
Right valve			
61	14.0	15.0	0.93
62	16.0	17.0	0.94
63	23.0	18.0	1.27
68	41.0	38.0	1.08
69	48.0	40.0	1.2

Description. — Shell of moderate size, variable in shape, equally convex; external margin toothed; attachment area relatively large.

Left valve (Pl. VIII, Figs. 10*a*—14*a*, 15) usually larger than right, obliquely triangular. Postero-ventral lobe subsquare or irregularly ovate. Dorsal margin rounded, straight or angular; anterior margin rounded; posterior margin straight, sometimes lobe-like elongated or sinusoidally incised. Umbo sometimes projected, straight, often bent backward or spirally coiled (Pl. VIII, Fig. 14*a*). Attachment area irregular, smooth, flat or slightly depressed, terminal or subumbonal. Maximal convexity (14.0—20.0 mm) attained usually in half of valve height, sometimes at upper or lower margin. Ornamentation consists of radial ribs and concentric growth lines and lamellae. Lamellae from the crests of ribs protrude in scaly fashion, or are elongated forming spine processes, or swellings and tubercules. Number of ribs increases to 30 or more, mainly by division of primary rib into two or three shorter secondary ribs. Triplication usually occurs close to postero-ventral margin, strongly lobe-like elongated. Ribs extending to posterior margin are finer, shorter and narrower than antero-ventral ones.

Right valve (Pl. VIII, Figs. 1*a*—7*a*, 8, 9) mainly ovate, higher than long, rarely oblique-triangular, less convex than left. Dorsal margin arcuate, rounded, sometimes irregular, rarely acute; umbo usually indistinct. Margin, except for the umbonal part, weakly toothed. Upper part of valve smooth, sometimes reflecting substratum morphology. Radial ribs developed below this smooth area are similar to those on left valve.

Internal surface of both valves smooth, slightly depressed centrally or closer to dorsal margin. Radial ribs, distinct along ventral margin, reflect external ornamentation (Pl. VIII, Figs. 5*b*, 7*b*, 13*b*).

Muscle scar at half of valve height, slightly posterior, rounded; elevated on left valve, with swollen, protruding ventral lip, more flat in right valve; equals to almost one-third of transversal valve diameter.

Hinge margin long, sometimes occupies the whole dorsal margin; left valve hinge higher and better differentiated than right, and attains 1—10 mm in height and up to 15 mm in length.

Ontogeny. — Many growth stages are available in material studied, but because of their very large variation it is difficult to give their characteristics. Particular stages were distinguished on the basis of shell size. Shell height in the earliest growth stages reaches 14 mm. Later, shell margin thickens and shell height is up to 40 mm. In the late stages, shell is bent and its height attains 55 mm.

Variability. — Individual variability or *Al. pulligera* is relatively high. Shape of specimens of approximately the same age, may vary from ovate, with height exceeding length, to oblique triangular with greater increase in length. In the latter case, a postero-ventral lobe develops (Pl. VIII, Figs. 8, 12, 13). Hinge of triangular shells triangular, high, while hinge of ovate or irregular shells with elongated dorsal margin is low and transversally extended (Pl. VIII, Figs. 11*b*, 12*b*). Attachment area subumbonal, but may be translocated on upper valve surface, or occupy its central part. Convexity of triangular specimens is greatest in central part, whereas on asymmetric ovate or subquadrilateral specimens it is attained at dorsal margin or at subumbonal region.

Remarks. — Polish specimens correspond to those of Goldfuss and Loriol of Germany and France. *Al. pulligera* may be distinguished from the other species of *Alectryonia* by its spine processes on ribs, so inclusion of this species in *Al. solitaria* by Arkell (1927—37, p. 185) is invalid. The latter species is characterized by its relatively constant shape, tripartity of valves enhanced by ribs, and smaller convexity.

Author includes Étallon's specimens, identified as *Ostrea semisolitaria* (Thurmann & Étallon, 1862), in *Al. pulligera*, as corresponding to diagnosis of this species.

Occurrence. — Poland, Western Pomerania: Upper Oxfordian-Kimeridgian, Mesozoic margin of the Holy Cross Mts.: Upper Oxfordian-Middle Kimeridgian, vicinity of Radom: Lower Kimeridgian; Soviet Union, Crimea: Upper Oxfordian-Lower Kimeridgian; Switzerland: Upper Oxfordian; Germany: Kimeridgian; France: Upper Oxfordian-Lower Kimeridgian.

Alectryonia vallata (Étallon, 1862)
(Pl. XIX, Figs. 3 *a*—*b*, 4)

1862. *Ostrea vallata* Étallon; J. Thurmann & Étallon, Lethea..., p. 278.
non 1874. *Ostrea vallata* Dumortier; E. Dumortier, Études..., p. 203, Pl. 45, Figs. 7, 8.
1892. *Ostrea vallata* Étallon; P. de Loriol, Études..., p. 362.
1894. *Ostrea (Alectryonia) vallata* Étallon; P. de Loriol & F. Koby, Étude..., p. 75, Pl. 9, Figs. 5, 6.

Material. — Two left valves of different ontogenetic stages, partly damaged.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Thickness	Height ratio
150	35.0	12.0	15.0	2.9
151	50.0	30.0	22.0	1.7

Description. — Shell inequilateral, narrower in umbonal part, widening towards ventral margin, arched; attachment area large; flanks and attachment area form almost right angle. Ornamentation consists of

30—40 ribs, ununiform in width, with keel-like crests. Fine-toothed commissure. In umbonal region, ribs shorter and finer and margin smooth or slightly undulated and thickest. Interrib spaces primarily narrow, sometimes developed in form of furrows, markedly expand with growth of shell.

Internal surface smooth, except for the anterior part, where radial external ornamentation is reflected. Shell strongly depressed; maximal depression of the smaller specimen reaches 11 mm near anterior margin.

Muscle scar, situated on small elevation below hinge, is ovate and surrounded by antero-ventral thickened lip; its transversal diameter does not exceed 4 mm. Hinge occupies almost the whole hinge margin, lying obliquely to umbo, often inverted in position. Hinge of the smaller shell is 4 mm long and 9 mm high.

Ontogeny. — These two valves represent different ontogenetic stages, varying in proportions, shape and ornamentation, as follows:

	Neanic stage	Gerontic stage
Shape	arcuate with distinct posterior sinus	ovate; weak posterior sinus
Area of attachment	narrow, arcuate	ovate, very wide
Number of ribs	about 30	about 40
Ribs	diverging in fan-like pattern	parallel
Angle between attachment area and flanks	obtuse	right (90°)
Growth index	2.9	1.7

Remarks. — *Al. vallata* is most closely comparable to *Al. rastellaris* (Münster) and *Arctostrea hastellata* (Schlotheim), with its arcuate shape of young specimens. Shells of both latter species are attached to substratum by their umbonal part only in earlier growth stages, whereas *Al. vallata* is attached throughout life. In certain respects *Al. vallata* may be considered as a species intermediary between representatives of genera *Alectryonia* and *Arctostrea.*

Specimens described by Dumortier (1874) as *Al. vallata* Étallon does not belong to this species. Cox, in his revision of Dumortier's identifications (Cox, 1965), proposed for them a new species, *Lopha olimvallata.*

Al. vallata occurs very rarely, a fact stressed by Loriol (1894) and others.

Occurrence. — Poland, Mesozoic margin of the Holy Cross Mts.: Lower Kimeridgian; Switzerland: Upper Oxfordian-Lower Kimeridgian.

Alectryonia flabelliformis (Nilson *in Goldfuss*, 1840)
(Pl. IV, Figs. 1—10)

1840. *Ostrea flabelliformis* Nilson; A. Goldfuss, Petrefacta..., p. 12, Pl. 76, Fig. 1 a—b.
1868. *Ostrea flabelliformis* Nilson; E. Eichwald, Lethaea...., p. 368.

Material. — Twenty one well-preserved specimens, predominantly right valves, in different ontogenetic stages.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Height ratio
Right valve			
314	17.0	17.0	1.0
23	22.0	19.0	1.16
24	23.0	18.0	1.28
25	23.0	23.0	1.0
26	26.0	19.0	1.37
27	26.0	24.0	1.08
28	28.0	31.0	0.9
29	42.0	35.0	1.27
Left valve			
315	25.0	21.0	1.19
31	30.0	25.0	1.2
316	53.0	43.0	1.23
317	56.0	48.0	1.17

Description. — Shell of small to moderate size, inequivalve, inequilateral. Variable in outline: typically rounded, commonly irregularly triangular. Ornamentation consists of radial, single ribs. Umbo projected, often opisthogyre or obscured.

Left valve (Pl. IV, Figs. 9*a*, 10*a*) unevenly convex, with irregular, tuberculated surface, slightly greater than right. Ornamentation consists of concentric growth lines and lamellae, and radial irregular folds or ribs, usually inclined. Subumbonal region often nonornamented. Ribs keel-like, irregularly rounded, crossed by growth lines or lamellae; initially narrow and low, they increase towards anterior and posterior margins; their number varies from 8 to 35 and increases by intercalation. Umbo small, low, straight or inclined outside or backward (Pl. IV, Fig. 9*a*). Attachment area terminal, small, but occasionally very large, and occupies the postero-dorsal part of valve. Margin unevenly undulated, regularly toothed occasionally large posterior lobe and enlarged postero--umbonal auricle are developed.

Right valve (Pl. IV, Figs. 1*a*—8*a*) most convex in subumbonal region. Umbo low, weakly projected, straight or bent backward, opisthogyre. Spherical prodissoconch preserved on some specimens. Valve ornamented with irregularly undulated growth lines, lamellae and concentric folds crossing the radial ribs. Ribs, variable in number and form, begin usually at half-way point of valve height or even closer to margin on some specimens (Pl. IV, Figs. 2*a*, 3*a*). Postero-ventral auricle, sometimes developed, is flat and wide. Postero-ventral margin often lobe-like, elongated.

Inner valve surface of both valves uniform, uneven. Weak radial folds developed close to ventral margin. The greatest concavity is situated in anterior part, often also below hinge. External margin undulated or toothed, usually unequally elongated near postero-ventral or ventral margin (Pl. IV, Fig. 5*b*). On inner margin surface, near hinge, some small marginal elements as pits and tubercles occur, sometimes up to half of valve height. Outline of hinge is variable and depends on its location: low, flat and strongly elevated when subposterior, triangular with apex slightly bent backward and inward, when hinge symmetrically located (Pl. IV, Fig. 6). Hinge margin straight or arcuate to wavy, swollen and overhanging (Pl. IV, Figs. 1*b*—3*b*). Muscle scar subposterior, occurring in half of valve height, transversally elongated, crescent, sometimes flat, concave on upper side and surrounded by swollen ventral lip. Its transversal diameter on adult specimens attains 8—10 mm, equalling one--third of transversal valve diameter.

Ontogeny. — Nepionic shells lack in the collection. Sphaerical prodissoconch, 0.33 mm in diameter, is seen on one specimen only (Pl. IV, Fig. 10*b*). Despite of the variability in shape and ornamentation, some ontogenetic changes may be traced and three growth stages may be distinguished (see the next page).

Variability. — *Al. flabelliformis* is characterized by remarkable individual variability, concerning mainly valve shape, external ornamentation and hinge structure. Shape of valves of approximately equal age is very variable; ovate, rounded, transversally or longitudinally elongated, or even irregularly triangular. Number of ribs and ornamentation also vary significantly. Specimens with 8 ribs, as well as with 17 ribs were noted. Ribs may occupy the lower half of valve only or the whole valve surface (Pl. IV, Figs. 8*a*, 9*a*). Ribs may be interrupted by concentric lamellae and tubercles, more or less undulated, very short and wide, or long and narrow (Pl. IV, Figs. 6*a*, 10*a*). Hinge most often bent backward, sometimes occupies medial position, projected, in other cases is developed in a form of long, subposterior, narrow trough. Hinge margin swollen. Valve margin weakly undulated, with teeth variable in width. Dorsal valve margin straight to arcuate and angular (Pl. IV, Figs. 1*a*—5*a*).

Growth stage	Height mm	Length mm	Characteristics
Early-middle-late-neanic	1.0—15.0	1.0—12.0	Shell rounded to ovate; height slightly greater than length; umbo low, triangular, symmetrically located; lateral auricles small, uniform; ornamentation consists of concentric growth lines; hinge poorly developed; muscle scar weakly marked.
Ephebic	16.0—30.0	13.0—29.0	Shape variable, rounded to longitudinally or transversally ovate; umbo slightly bent backward, variable in height; posterior auricle larger; ornamentation diversified, consists of concentric growth lines and striae, sometimes lamellae, radial ribs, and folds, variable in width and height; number of ribs ranges from 8 to 17; muscle scar strongly depressed, oblique crescent; hinge fully developed with distinct ligament pit.
Gerontic	31.0—56.0	30.0—48.0	Shell oblique-triangular; postero-ventral margin strongly lobe-like elongated; posterior auricle triangular, rounded, of variable size; number of ribs increases to 30; growth lamellae, irregular, detached; rapid increase of valve height and length; other characteristics similar as in the former stage.

Remarks. — Polish specimens correspond well to Goldfuss's specimens from Germany (Goldfuss, *l.c.*) as to morphologic characteristics and individual variability.

Occurrence. — Poland, vicinity of Radom: Lower Kimeridgian; Germany: Lower Cretaceous; Soviet Union, Podole: Cretaceous.

Genus *Arctostrea* Pervinquière, 1910
(Type species: *Ostrea carinata* Lamarck, 1806)

Diagnosis. — Shell almost equivalve, strongly arcuate, inequilateral; left valve more convex than right; height greater than length; left valve attached to substratum by small subumbonal area; ornamentation consists of radial ribs spreading from narrow medium field; medium and lateral fields form right angle; commissure high-toothed; hinge with simple oyster structure bent backward.

Remarks. — Pervinquière (1910) proposed to separate from *Alectryonia* a new genus, *Arctostrea,* with type species *Ostrea carinata* Lamarck, comprising strongly elongated, slender, arcuate forms with high zigzag commissure. These genera differ in a number of features in external and inner structures, but some representatives of genus *Alectryonia* (e.g., *Al. rastellaris* or *Al. gregarea*) are rather elongated and arched. Probably the *Arctostrea* originated from such forms.

Arctostrea hastellata (Schlotheim, 1820)
(Pl. VII, Figs. 4, 8—11; Pl. X, Fig. 4)

1820. *Ostracites cristagalli hastellatus* Schlotheim; E. F. Schlotheim, Die Petrefactenkunde..., pp. 243—244.
1834—40. *Ostrea colubrina* Goldfuss; A. Goldfuss, Petrefacta... pp. 8—9, Pl. 74, Fig. 5 a—e.
1858. *Ostrea hastellata* Schlotheim; F. A. Quenstedt, Der Jura, p. 750, Pl. 91, Fig. 27.
non 1881. *Ostrea hastellata* Schlotheim; P. de Loriol, Monographie..., pp. 97—99, Pl. 13, Figs. 8—9.
1893. *Ostrea* (Alectryonia) *hastellata.* (Schlotheim), Quenstedt; P. de Loriol & E. Koby, Étude..., pp. 346—347, Pl. 36, Fig. 8.
1894. *Ostrea* (Alectryonia) *hastellata* (Schloth.), Quenstedt; P. de Loriol & E. Koby, Étude..., pp. 72—74, Pl. 9, Figs. 1—3.
1896. *Alectryonia hastellata* Quenstedt; B. Semenov, Faune..., p. 67, Pl. 1, Fig. 19 a—c.
1897. *Ostrea* (*Alectryonia*) *hastellata* (Schlotheim), Quenstedt; P. de Loriol, Étude..., p. 134, Pl. 17, Figs. 2—5.
1904. *Ostrea* (*Alectryonia*) *hastellata* (Schlotheim), Quenstedt; P. de Loriol & A. Girardot, Étude..., p. 252, Pl. 25, Figs. 8, 9, 10.
1905. *Alectryonia hastellata* Schlotheim; L. Krumbeck, Beiträge..., p. 107, Pl. 4, Fig. 3a, b.
1914. *Alectryonia hastellata* Schlotheim; K. Wójcik, Jura..., p. 125.

Material. — Two slightly damaged shells and 4 fragments of valves.

Measurements (in mm):

Z. Pal. U.W. Mo./V	Height	Length	Width	Height ratio	Number of ribs
58	28.0	15.0	15.0	1.86	13
59	35.0	13.0	15.0	2.7	25
60	42.0	15.0	20.0	2.8	24
57	65.0	17.0	24.0	3.8	30

Description. — Shell strongly elongated along height, arcuate, weakly attached by lateral umbonal surface. Ornamentation constsis of thick ribs forming sharp-zigzag commisure. Transversal section of shell hexagonal in outline.

Left valve (Pl. VII, Figs. 4*a*; 8—10, 11*a*) deeper than right. Middle part of valves developed in the form of narrow, flat and elevated field, where ribs exhibit fan-like pattern. Ribs sometimes very short and strongly thickened, nodose, particularly along field margins. Ribs thick on a strongly convex anterior valve surface, whereas lower, finer but twice as numerous occur on concave posterior surface and in subumbonal region (Pl. VII, Fig. 11*a*). Flanks and middle part form almost right angle; the ribs on flanks normal to middle part of valve and parallel to each other. It should be stressed, that ribs are always singular on valve flanks; increase in number of ribs in the course of ontogeny was not observed, contrary to other forms with rib ornamentation. Umbo bent backward, nonprojected, obscured by attachment area. Attachment area small, flat to concave, uneven. Below umbo, a small, weakly projected auricle, covered with fine, arcuate ribs, is present. Valve margin in subumbonal region is smooth or slightly wavy. Further from umbo, margin becomes finely-denticulated, and consequently, from the half-way point of valve height the teeth of comissure becomes higher and sharper. In some cases, valve flanks are occupied by high-zigzag comissure, and ribs are marked on middle-field margin as strongly thickened, often sharpened processes (Pl. X, Fig. 4). Growth lines are very fine and closely spaced, except for rib crests from flanks, where free spaces may be discerned (Pl. VII, Fig. 11*c*).

Right valve (Pl. X, Figs. 4*b*, 11*b*) externally similar to left, somewhat smaller, strongly flattened in umbonal region. Small ovate or elongate elevation is visible sometimes in place corresponding to attachment area of left valve (Pl. VII, Fig. 4*b*).

Inner surface and ontogeny were not studied because of insufficient number of specimens.

Variability. — The individual variability of this species primarily involves certain differences in development of ornamentation of middle valve field and size of posterior auricle. There are also some difference in growth ratio of particular specimens. The height of commissure is related to the curvature of shell, so the strongly arched shells have high-zigzag commissure, and vice versa (Pl. VII, Figs. 4*c*, 11*c*).

Remarks. — Specimens described, and particularly the largest of them (Pl. VII, Fig. 11), fully correspond to *O. colubrina* Goldfuss (in Goldfuss, *l.c.*) except for the smaller dimensions. The largest specimen of Goldfuss has height ratio equalling 12, whereas the largest Polish specimen has height ratio equal to almost 4. Some authors exclude fine-ribbed and very convex specimens from this species (e.g. Loriol, 1881, p. 98), but the author considers those examples as representing younger growth stage and still comprehensible in limits of variability. Inclusion of flat, weakly arched specimens with undifferentiated middle field and commissure occupying the whole margin, to this species (Loriol, 1881, Pl. 13, Figs. 8, 9) seems invalid.

Occurrence. — Poland, Mesozoic margin of the Holy Cross Mts.: Upper Oxfordian — Lower Kimeridgian; Soviet Union: Upper Jurassic of the Leningrad region; Switzerland: Oxfordian; Germany: Upper Jurassic; France: Middle-Upper Oxfordian.

Genus *Liostrea* Douvillé, 1904

(Type species: *Ostrea sublamellosa* Dunker, 1846

Diagnosis. — Shell inequivalve to almost equivalve, inequilateral, variable in outline and in size. Left valve slightly more convex than right; right valve flat, slightly convex or concave. Umbo no projected or weakly projecting; attachment area large. Both valves more or less smooth, with concentric ornamentation consisting of growth lines or lamellae, and sometimes striae; external margin smooth; hinge straight or weakly bent backward, with simple ostreoid structure.

Liostrea acuminata (Sowerby, 1816)

Pl. XI, Figs. 1—18)

1816. *Ostrea acuminata* Sowerby; J. W. Sowerby, The mineral..., p. 78, Pl. 135, Figs. 1—2.
1852. *Ostrea acuminata* Sowerby; F. A. Quenstedt, Handbuch..., p. 500, Pl. 40, Fig. 26.
1856—58. *Ostrea acuminata* Sowerby; A. Oppel, Die Juraformation..., p. 493.
1858. *Ostrea acuminata* Sowerby; F. A. Quenstedt, Der Jura, p. 564.
1869. *Ostrea acuminata* Sowerby; D. Brauns, Der mittlere Jura..., p. 277.
1888. *Ostrea acuminata* Sowerby; O. Schlippe, Die Fauna..., p. 109, Pl. 1, Fig. 3—7.
1924. *Liostrea acuminata* Sowerby; E. Jourdy, Histoire..., p. 95, Pl. 5, Fig. 6 c—d.
1929. *Liostrea acuminata* Sowerby: L. Schäfle, Über Lias..., p. 59.
1933. *Ostrea acuminata* Sowerby; G. Gürich, Die Leitfossilien..., p. 217, Pl. 17, Fig. 16 (non Fig. 16a).
1934a. *Ostrea (Liostrea) acuminata* Sowerby; W. J. Arkell, The oysters..., pp. 24—29, Pl. 1, Fig. 1; Pl. 3; Pl. 4.
1946. *Ostrea (Catinula)* sp.; G. Gardet & Ch. Gérard, Contribution..., p. 44, Pl. 7, Figs. 11—12.
1952. *Preexogyra acuminata* Sowerby; R. P. Charles & P. L. Maubeuge, Les huîtres..., p. 118, Pl. 5, Figs. 2—3.
1955. *Ostrea acuminata* Sowerby; P. A. Gerasimov, Rukovodjaščie..., p. 128, Pl. 27, Fig. 1.

Material. — Three shells and 50 single valves, but only 8 well-preserved.

Measurements (in mm):

Z. Pal. U.W. Mo. /V/	Height	Length	Depth	Height ratio
Left valve				
87	7.0	6.0	3.0	1.16
88	12.0	9.0	3.5	1.33
89	13.5	9.0	3.0	1.5
90	17.0	10.5	3.5	1.6
91	18.0	11.0	4.0	1.6
92	18.5	13.0	5.0	1.4
Right valve				
93	10.0	6.0	1.0	1.66
94	12.0	9.0	1.0	1.33
95	13.5	7.0	1.0	1.9
96	14.0	10.0	1.5	1.4
97	14.5	11.0	1.0	1.3

Description. — Shell of small size, ovate to crescent; left valve convex, whereas right valve flat. Attachment area terminal, variable in size.

Left valve (Pl. XI, Figs. 5*a*, 10—14, 15*a*, 16) maximally convex at half-way point of height. Anterior margin arcuate, posterior margin with wide sinus or straight. Umbo constricted, sharp, bent backward, usually obscured by attachment area. Attachment area terminal or shifted on the upper surface of valve, rounded, sometimes irregularly depressed. Angle between commissure and attachment area usually arcute and not exeeding 45° (cf. Text-fig. 1*d*). Ornamentation consists of concentric growth lines, marked stronger in some intervals.

Right valve (Pl. XI, Figs. 1*a*—4*a*, 5*b*, 6—8, 15*b*) flat to concave, variable in outline, and usually sharpened in umbonal part and along postero--ventral margin. In umbonal region, a convexity, sometimes extending to one-half of valve height, is marked, constituting the negative of attachment area. Ornamentation consists of growth lines and lamellae, marked stronger in some intervals, and radial striae (Pl. XI, Figs. 2*a*, 4*a*, 7—8), but convex part of valve remains smooth. Spherical prodissoconch, 0.25 mm in diameter, is seen on some better preserved specimens.

Inner surface of left valve (Pl. XI, Figs. 9, 17, 18) is smooth, glossy. Muscle scar in half of valve height, subposterior, rounded, flat; its transversal diameter ranges from 3 to 4 mm, equalling 1/5—1/6 of transversal valve diameter. Hinge margin slightly thickened, wavy. Hinge is oblique triangular in outline, with apex bent backward. Ligament pit elongated, deep; lateral folds relatively high. Close to external margin, along the whole edge a furrow continues, which delimits the inner swollen valve margin in hinge region (Pl. XI, Figs. 9—18).

Inner surface of right valve (Pl. XI, Figs. 1*b*—4*b*) even, sometimes glittering. Anterior margin slightly elevated in umbonal region, where it attains 1 to 1.5 mm in height. Muscle scar rounded, flat, and located close to sub-posterior margin, on half of valve height or shifted to upper or lower half of valve. Transversal diameter of muscle scar attains approximately 1.5 to 3 mm, equalling almost one-third of transversal valve diameter. Hinge weakly differentiated, low, sub-posterior, often transversally elongated.

Ontogeny. — Incomplete material precluded detailed ontogenetic studies. Generally, valves become progressively crescent with the age of individual; similarly, posterior sinus and convexity increase. For initial growth stages, ornamentation consists of distinct concentric lamellae and folds, regularly spaced, which dissppears at later growth stages.

Variability. — Outline of valves varies from ovate, with height greater than length, to crescent, with anterior margin strongly arched (Pl. XI, Figs. 5, 10). Attachment area terminal or shifted on the upper surface of valve (Pl. XI, Figs. 5, 10, 13). On some right valves, a large convex subumbonal field is marked; whereas, on others an uneven elevation or weak depression develops there (Pl. XI, Figs. 7, 8, 2*a*). Muscle scar usually occurs in half of valve height, but may be shifted above or below, more often than in other species. Location of muscle scar may be related to position of maximal convexity of left valve. Also ornamentation is greatly variable. Valves of more or less equal age may be smooth or are concentrically ornamented with distinct folds, regularly spaced (Pl. XI, Figs. 2*a*, 3*a*). Right valves smooth, concentrically ornamented or covered with radial striae.

Remarks. — Polish specimens of *L. acuminata*, occur is masses in the ore-bearing clays, forming distinct horizons, similarly as in England, where such horizon continuing along 50 miles, is of stratigraphic significance (Arkell, 1934, p. 27). Polish specimens correspond to English, and are also up to 20 mm high.

Hinge has a typical ostreoid structure, so inclusion of *L. acuminata* to genus *Exogyra* (Rollier, 1911, p. 281) is invalid.

Occurrence. — Poland, Polish Lowland: Bajocian-Bathonian; Soviet Union, Ryazanskaya Oblast: lower part of Middle Callovian; France: Lower Bathonian; England: Bajocian-Bathonian.

Liostrea explanata (Goldfuss, 1834)

(Pl. IX, Fig. 5*a*, *b*)

1834. *Ostrea explanata* Goldfuss; A. Goldfuss, Petrefacta..., p. 22, Pl. 80, Fig. 5.
1836. *Ostrea explanata Goldfuss;* F. A. Roemer, Die Versteinerungen..., p. 59.
non 1820. *Ostracites eduliformis* Schlotheim; E. F. Schlotheim, Die Petrefactenkunde..., pp. 233—234.
non 1830. *Ostrea eduliformis* Schlotheim; C. H. v. Zieten, Die Versteinerungen..., p. 60, Pl. 45, Fig. 1 a—d.
1863. *Ostrea Wiltonensis* Lycett; J. Lycett, Supplementary..., p. 108, Pl. 34, Fig. 1 (non Fig. 1*a*).
1888. *Ostrea eduliformis* (Zieten) var. *trigona* Schlippe; O. Schlippe, Die Fauna..., pp. 110—111, Pl. 1, Fig. 1.
1923. *Ostrea explanata* Goldfuss; M. Lissajous, Étude..., p. 136, Pl. 27, Figs. 1—3; Pl. 28, Fig. 1.
1951. *Liostrea explanata* Goldfuss; W. Krach, Małże..., p. 355.

Material. — One shell and 10 fragments of right valves.

Description. — Right valve almost equilateral, irregularly ovate, 80 mm high, 50 mm long and 13 mm deep. Surface uneven, covered with fine, irregular growth lines and concentric lamellae and striae. Dorsal margin about 2—3 mm thick, and ventral 6—7 mm thick. The largest concavity occurs along anterior margin attaining up to 13 mm in depth. Surface smooth, sometimes glittering. Margin smooth, bent outwards, and rised anteriorly. Lobe-like widenings, separated by wide, shallow sinus, are marked along posterior margin. Muscle scar large, rounded, subcentral; its transversal diameter attains 14 mm, equalling one-quarter of transversal valve diameter. Umbo small, weakly opisthogyre. Hinge 12 mm high, 25 mm long, flat, limited laterally by sharp edges.

Remarks. — Polish specimens attain medium size in relation to German and French specimens. Author includes here *Ostrea eduliformis* var. *trigona* Schlippe and, pro parte, *O. wiltonensis* Lycett, as synonymes, on the basis of their morphologic features and stratigraphical range. Whereas, the inclusion in *L. explanata* of *Ostracites eduliformis* Schlotheim by Roemer (1836, p. 59) and *Ostrea eduliformis* Schlotheim, illustrated for the first time by Zieten (1830, Pl. 45, Fig. 1 *a*—*d*) seems invalid, as those forms are quite distinct having regular concentric lamellar ornamentation, narrow hinge located on a slightly projected umbo, and elongated and significantly smaller muscle scar.

Occurrence. — Poland, Polish Lowland: Bajocian-Bathonian, Polish Jura Chain: Dogger; Germany, Württemberg: Lower Callovian; France: Bajocian-Upper Bathonian.

Liostrea delta (Smith, 1817)

(Pl. XII, Figs. 1—8)

1816. *Ostrea deltoidea* Sowerby; J. Sowerby, The mineral... p. 111
1825. *Ostrea laeviuscula* Sowerby; J. Sowerby, *Ibid.*, p. 143, Pl. 488, Fig. 1.
non 1834—40. *Ostrea deltoidea* Lamarck; A. Goldfuss, Petrefacta... p. 27, Pl. 88, Fig. 1.
1970. *Liostrea delta* (Smith); I. Dmoch, Ślimaki..., pp. 83—84, Pl. 8, Figs. 3—5 (earlier synonymy included).

Material. — Sixty well-preserved specimens and some shells, predominantly right valves.

Measurement (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Hinge		Height ratio
			heingth	length	
318	20.	17.0	3.0	3.0	1.18
105*b*	27.0	24.0	6.0	6.0	1.13
319	42.0	42.0	8.0	9.0	1.0
320	44.0	52.0	7.0	11.0	0.84
108	55.0	54.0	8.0	13.0	1.02
321	60.0	72.0	9.0	19.0	0.83
322	64.0	64.0	12.0	20.0	1.0
323	67.0	45.0	17.0	25.0	1.5
324	70.0	75.0	17.0	25.0	0.93
325	77.0	68.0	15.0	20.0	1.13

Description. — Shell almost equivalve, attaining large size, flat, massive. Left valve attached to substratum often by the whole upper surface. Shell outline usually oblique triangular. Umbo sometimes projecting, often truncate, or rounded, bent backwards and outwards. External surface uneven, covered with irregular, concentric growth lines and lammelae. Anterior margin arched, smooth, forming sinus variable in width and depth; postero-ventral margin elongated in form of narrow to wide lobe, while postero-dorsal margin constricted, sometimes sharpened or rounded.

Inner surface of both valves (Pl. XII, Figs. 1*a*—8*a*) is almost uniform, usually smooth, often glittering. Left valve usually deeper than right, deepest along posterior margin and below the hinge (Pl. XII, Figs. 2*a*, 4*a*); right valve sometimes unequally convex in half of valve height, depressed along posterior margin and below hinge. Muscle scar located in half of valve height, sub-posterior, large, rounded to ovate or crescent with transverse diameter longer, up to 6—15 mm, and equalling 1/3—1/4 of transversal valve diameter. Muscle scar usually depressed, and surrounded by thickened ventral lip. Hinge margin slightly swollen and wavy. Hinge eccentric, triangular, bent backward, twice longer than high, or its length and height are equal. Ligament pit of left valve deep; lateral folds highly elevated; posterior fold asymmetric, higher and narrower than anterior (Pl. XII, Figs. 7*a*, 8*a*). Hinge of right valve weakly differentiated; fold low. Posterior valve margin normal to surface, sharp-edged, and strongly thickened because of overlaping growth lamellae. Growth lamellae, particularly in gerontic specimens occur also along antero-dorsal margin.

Ontogeny. — No specimens of earliest growth stages were noted in material studied. The smallest specimen is 20.0 mm high, and 15.0 mm long. Specimens of ephebic stage predominate, comprising 52% of whole collection, whereas neanic and gerontic specimens occur in almost equal amounts. Particular stages differ in shell outline, hinge structure, features of muscle scar and development of umbones (see the next page).

Variability. — *Liostrea delta* is characterized by remarkable individual variability which is confirmed also by changes of growth index. Changes in outline, hinge height and deep of sinus are related primarily to location and size of attachment area. When attachment area is small, outline of shell is more regular, i.e. triangular or rounded (Pl. XII, Figs. 2, 3), whereas large attachment area is connected with greater flattening of valves. At the same time, valves may exhibit various degrees of bending of the umbo. Umbones strongly bent backward are related to oblique location of attachment area (Pl. XII, Fig. 8*a*, *b*). Umbo of valve attached symmetrically is slightly bent backward or not at all (Pl. XII, Figs. 5, 6).

Growth stage	Height mm	Length mm	Characteristics
Neanic	20.0—40.0	15.0—37.0	shell triangular; umbo sharp: posterior sinus weak; margin smoothly rounded; hinge relatively low; attachment area small; valves thin; muscle scar rounded, flat; external ornamentation consists of growth lamellae almost equally spaced;
Ephebic	41.0—60.0	38.0—50.0	shell rounded to oblique triangular; sinus sometimes very narrow and deep; postero-ventral margin lobe-like elongated; attachment area large to very large; valves massive; muscle scar transversally elongated, strongly depressed; growth lamellae irregular, protruding;
Gerontic	61.0—80.0	51.0—75.0	shell delta-shaped; hinge relatively low, long; margins strongly thickened; muscle scar surrounded by ventral lip, deep; external surface irregularly wrinkled, tuberculate.

In the first case a deep sinus is developed, whereas in the second — a shallow posterior sinus.

Remarks. — Polish specimens are smaller than English specimens of Arkell (1932). The size of the largest Polish specimen corresponds to the size of the smallest English ones. Those differences in size are probably related to different environmental conditions. Arkell (*l.c.*, p. 153, Text--figs. 23, 24) tried to correlate the height of hinge with the age of individual specimen, but studies carried out by the present author do not confirm this point of view.

Arkell (1932, p. 149) invalidly included specimens of *L. unciformis* Buvignier to *L. delta*. The former species is distinguished from *L. delta* by its circular muscle scar, narrow, low hinge, commonly bent strongly backward, and by its always very deep sinus.

The author excludes the specimens described and illustrated by Goldfuss, from *Liostrea delta* (Smith), as they differ in the roundness of valves, deep and transversally elongated muscle scar, subumbonal widening of valves and in their broader stratigraphical range. For those specimens, d'Orbigny proposed a new species, *O. goldfussi* (cf. Rollier, 1917, p. 588).

Occurrence. — Poland, Western Pomerania: Lower Kimeridgian, Mesozoic margin of the Holy Cross Mts.: Lower-Middle Kimeridgian; Germany: Lower Kimeridgian; France: Upper Oxfordian; England: Upper Oxfordian-Lower Kimeridgian.

Liostrea oxfordiana (Rollier, 1917)
(Pl. XIII, Figs. 5—9)

1917. *Ostrea oxfordiana* Rollier; L. Rollier, Fossiles..., p. 549, Pl. 40, Fig. 1 a—c.

Material. — One complete shell and 11 well-preserved single valves.

Measurements, in mm:

Z. Pal. U.W. Mo. V/	Height	Length	Height ratio
Left valve			
114	38.0	26.0	1.46
118	52.0	32.0	1.62
326	58.0	41.0	1.41
327	66.0	37.0	1.37
Right valve			
328	40.0	27.0	1.11
117	46.0	33.0	1.4
329	56.0	33.0	1.7
330	60.0	40.0	1.5

Description. — Shell inequivalve, inequilateral, massive, attaining medium to large size, irregularly ovate, higher than long. Attachment area large; umbo unprojected.

Left valve (Pl. XIII, Fig. 9*b*) maximally convex in half of valve height, up to 9 mm. Posterior margin is straight or sinusoidally incised, whereas the whole rest of margin is smoothly rounded. External surface ornamented with concentric growth lines and lamellae, particularly well-developed on the lower half of valve. Lamellae exhibit irregular course, occasionally protruding. Attachment area occupies the upper part of valve, is irregular in outline, often depressed, sometimes flat with reflection of the morphology of substratum.

Right valve minimally convex in subumbonal region, sometimes flat, usually markedly higher than long; growth ratio exeeds 1.5. External margin smooth and rounded, similarly as on left valve. Occasionally ventral margin is slightly bent outwards. Often umbo of right valve is directed backward, in which case the dorsal margin is rectilinear and almost normal to posterior margin. Ornamentation of both valves is uniform.

Inner surface of left valve (Pl. XIII, Figs. 5, 9*a*) smooth; the largest concavity lies along anterior margin and below hinge. Muscle scar is located in half of valve height, near posterior margin, and has rounded outline, or its upper margin is straight and the lower developed in the form of swollen ventral lip. Transversal diameter of muscle scar approximately equals 1/3—1/4 of transversal valve diameter. Hinge margin swollen, wavy; hinge high and long, usually oblique triangular in outline, with sharp apex directed backward. Ligament pit and lateral folds oblique and situated almost at the same level. Sometimes, posterior fold is slightly higher and narrower than anterior.

Inner surface of right valve (Pl. XIII, Figs. 6—8) smooth, with the largest concavity, up to 5 mm, continuing along anterior margin and below hinge. Muscle scar, similar to that of the left valve, lies nearer posterior margin; its transversal diameter attains approximately 12 mm, equalling 1/3—1/4 of transversal valve diameter. Hinge, usually shift to posterior margin, is high and long; its height equals 1/5 of valve height and outline is most often oblique triangular, sometimes transversally elongated.

Ontogeny. — Ontogenetic changes are difficult to study, because of the scarcity of material. Generally, it may be stated, that growth ratio changes with growth of individual, from slightly more than unity in early growth stages to over 1.7 in ephebic and gerontic stages. Other valve features undergo normal growth changes only.

Variability. — Variability in material studied is minor and concerns primarily certain differences in valve outline, location and outline of muscle scar and depth of valves. Those changes seem to be closely related to size and location of attachment area. With increase of attachment area, valves and muscle scar become less depressed and valve outline becomes more regular.

Remarks. — Specimens of this species, rare in Poland, correspond to Swiss specimens of Rollier (1917), differing only in their smaller size. The largest Polish specimen attains 66 mm in heigth, while Swiss specimen is 108 mm high.

Occurrence. — Poland, Mesozoic margin of the Holy Cross Mts. and Western Pomerania: Lower Kimeridgian; Switzerland: Upper Oxfordian.

Liostrea quadrangularis (Arkell, 1927)

(Pl. XIII, Figs. 1—4)

1927. *Ostrea quadrangularis* Arkell; W. J. Arkell, The Corallian..., p. 176, Pl. 1, Fig. 1.
1932. *Ostrea (Liostrea) quadrangularis* Arkell; W. J. Arkell, A Monograph..., pp. 155—157, Pl. 16, Fig. 1; Pl. 17, Fig. 1, 1 a; Pl. 18, Fig. 12.
1965. *Ostrea (Liostrea) cf. quadrangularis* Arkell; L. Karczewski, Fauna..., p. 116, Pl. 7, Fig. 2.

Material. — Nine well-preserved right valves, and 1 left partly damaged.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Height ratio
110	29.0	21.0	1.4
111	34.0	26.0	1.4
112	36.0	30.0	1.2
331	37.0	30.0	1.23
332	41.0	30.0	1.36
113	43.0	34.0	1.26

Description. — Shell attaining moderate size, ovate, higher than long, equally convex. Upper margin relatively long, straight, slightly higher along anterior margin than along posterior. Posterior edge almost normal to upper margin. Umbo terminal, located on postero-dorsal margin, low, nonprojected, slightly rounded or sharpened. Wide sinus is marked in half of posterior margin. Widely rounded anterior margin joints the rounded ventral margin by soft curvature. Ornamentation consists of growth lines and folds, concentric in relation to umbo, and scaly, protruding lamellae. Valve edge along antero-ventral margin is occasionally slightly bent outwards and most often is uniformly rounded; sometimes shallow sinusoidal incision is marked in ventral margin, quite distinct on specimens of older growth stages.

Inner valve surface (Pl. XIII, Figs. 1*a*—4*a*) smooth and uniformly depressed. Sometimes depression is located below hinge, attaining 7—8 mm in depth. Muscle scar large, slightly depressed, ovate or subquadrate in outline, located subcentrally in half of valve height, or somewhat shifted to posterior margin and commonly surrounded by thickened ventral lip. Hinge edge wavy, usually thickened, and rising above valve surface, and 11 to 30 mm long. Hinge is most often similarly long, but may be far shorter; it occupies postero-dorsal margin or the entire hinge margin. Ligament pit and folds located on the same level and equally wide, but, in some cases, anterior fold may be markedly wider than posterior. Muscle scar of inequilateral specimens is shifted to posterior, and upper part of posterior margin in strongly thickened and slightly rised normally to valve surface, or flattens forming weak auricular lobe bent outwards (Pl. XIII, Figs. 1*a*, 2*a*).

Ontogeny. — Only ephebic, ephebic-gerontic and gerontic stages may be distinguished in material studied, and are characterized below. Gerontic specimens are the rarest here.

Variability. — Outline of *L. quadrangularis* highly variable, depending primarily on length and location of hinge. With increment of hinge length the outline changes from ovate to subquadrate. On some specimens, hinge is located in the middle part of hinge margin (Pl. XIII, Fig. 4*a*), on others, it is shifted to posterior, and in some cases in may be translocated on the

Growth stage	Height mm	Length mm	Characteristics
Ephebic	29.0—34.0	21.0—26.0	Shell ovate; umbonal angle equals 90°; ornamentation consists of growth lines and fine concentric folds; muscle scar ovate, with transversal diameter longer than longitudinal and equal to 6—7 mm, subposterior; hinge long, slightly oblique; growth ratio about 1.4.
Ephebic-gerontic	36.0—43.0	30.0—34.0	Shell ovate; umbonal angle over 90°; ornamented with folds and lamellae, equaly spaced; muscle scar rounded to subquadrate, subcentral, 7—8 mm in diameter; hinge variable in length, sometimes short, straight or oblique; growth ratio ranges from 1.36 to 1.23.
Gerontic	over 50.0	over 40.0	Shell ovate or irregular; umbonal angle smaller than 90°; ornamented with irregular growth lamellae, usually protruding; muscle scar rounded, ovate, subcentral, 12 mm in diameter, with straight upper margin; antero-dorsal margin developed as a high lobe; growth ratio equals 1.2.

posterior end of hinge margin (Pl. XIII, Fig. 2*a*). Depth of valve varies only from 2 to 4 mm. When hinge is posterior, the largest concavity of valve is also translocated towards the posterior margin.

Outline and location of muscle scar vary slightly. Muscle scars of specimens of equal age are located near posterior margin or subcentrally. Its outline, usually rounded, may change to ovate, with longer transversal diameter, or subquadrate, with rectilinear dorsal margin.

Remarks. — Polish specimens correspond to English ones, except for the smaller size. Height of Polish specimens ranges from 29 to 55 mm, while English specimens attain 123 to 151 mm. Those differences probably result from environmental conditions, less favourable in Poland. Hitherto, the inner morphology of left valve was not described.

Occurrence. — Poland, Western Pomerania: Lower Kimeridgian, Mesozoic margin of the Holy Cross Mts.: Upper Oxfordian; France: Upper Oxfordian-Lower Kimeridgian; England: Upper Oxfordian.

Liostrea dubisensis (Contejean, 1859)
(Pl. XIV, Figs. 1—7)

non 1836. *Ostrea excavata* Roemer; J. Roemer, Die Versteinerungen..., p. 60, Pl. 3, Fig. 8.

non 1837. *Ostrea multiformis* Koch & Dunker; F. K. L. Koch & W. Dunker, Beiträge..., p. 45, Pl. 5, Fig. 11.

1859. *Ostrea dubiensis* Contejean; C. Contejean, Étude..., p. 320, Pl. 21, Figs. 4—11.
1862. *Ostrea dubiensis* Contejean; J. Thurmann & A. Étallon, Lethea..., p. 272, Pl. 39, Fig. 6.
1872. *Ostrea dubiensis* Contejean; P. de Loriol, E. Royer & H. Tombeck, Monographie..., p. 407, Pl. 24, Figs. 19—25.
1911—17. *Ostrea Dubisensis* Contejean; L. Rollier, Fossiles..., p. 590.
1922. *Ostrea cf. Dubiensis* Contejean; J. Lewiński, Monographie..., p. 65, Pl. 3, Figs. 6—8.
1927. *Ostrea dubiensis* Contejean; V. F. Pčelinčev, Fauna..., p. 78.
1936. *Ostrea dubiensis* Contejean; W. J. Arkell, A monograph..., p. 366. Pl. 55, Figs. 4—5.
1952. *Liostrea (Catinula) dubiensis* (Contejean); A. Chavan, Les Pélécypodes..., p. 40, Pl. 2, Figs. 20, 21, 23, 24.
1955. *Ostrea dubiensis* Contejean; P. A. Gerasimov, Rukovodiaščie..., p. 12, Pl. 28, Fig. 7.

Material. — Twenty four single valves. Numerous additional fragments.

Measurement (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Height ratio
Left valve			
123	7.0	5.0	1.4
333	9.0	7.0	1.28
334	10.0	8.0	1.25
125	13.0	11.0	1.18
335	14.0	11.0	1.27
Right valve			
119	5.5	4.0	1.37
120	6.5	4.5	1.44
336	9.0	7.0	1.28
121	10.0	6.5	1.54
122	12.0	7.0	1.7

Description. — Shell thin, variable in outline, attached by relatively large surface. Left valve more or less convex, whereas right valve is flat to slightly convex.

Left valve (Pl. XIV, Figs. 5*b*—7*b*) maximally convex in half of valve height, sometimes bilobate, divided by shallow through, continuing from umbo towards ventral margin, usually fading in half of valve height. Left valve is sometimes irregularly rounded or triangular, rarely crescent. Attachment area occupies the upper part of valve; it is transversally elongated, depressed or convex, in a form of ridge. Umbo sharpened, symmetrical, occasionally bent backward. Valve surface mainly smooth, without gloss, sometimes uneven and rough, covered with fine growth lines crowded near ventral margin. Sometimes growth lamellae, protruding in scaly-fashion, developed in ventral part. Entire valve margin is even, usually sharp. Anterior margin of asymmetric specimens is arched, whereas weak wide sinus develops on posterior margin.

Right valve (Pl. XIV, Figs. 1*b*—4*b*) ovate, higher than long, or triangular with upper part constricted and lower part widened and rounded. Umbo weakly projected, low, triangular, usually symmetric, and occasionally bent backward. Surface ornamented with growth lines and concentric irregular striae, strongly protruding near the ventral margin. Subumbonal region, sometimes convex, is finely granulated. Margin more or less thickened; ventral margin sometimes bent outward.

Inner surface of left valve (Pl. XIV, Figs. 6*a*, 7*a*) smooth, usually glittering, maximally depressed in half of valve height, up to 7 mm. Maximal concavity of asymmetric specimens lies along anterior margin and below hinge. Flat, rounded or crescent muscle scar is located in almost half of valve height, near posterior margin; its transversal diameter attains 3—3.5 mm exceeding one third of transversal valve diameter. Hinge margin, a little thickened, short, sometimes wavy, usually rised above valve surface. Hinge has an outline of isosceles triangle with short base and apex rarely bent backward. Hinge height equals almost 1/6 of valve height. Ligament pit moderately wide, triangular; folds narrow. In prolongation of those folds, marginal folds continue approximately to half valve height. The latter are separated from margin by relatively deep, narrow grooves. In lower half of valve these folds disappear and only a distinct line, similar to mantle line of other pelecypods, continues along the rest of valve periphery, as a prolongation of grooves. This line continues in some distance from margin and together with marginal folds delimits the boundary to which the operculate right valve contacts with the left one (Pl. XIV, Fig. 7*a*).

Right valve (Pl. XIV, Figs. 1*a*—4*a*) flat or slightly concave. Muscle scar oblique ovate, sometimes rounded, up to 2 mm long, equalling to less than one-third of transversal valve diameter. Hinge terminal, rounded symmetric, sometimes sharpened in its upper part, poorly differentiated and relatively low. Hinge margin somewhat thickened, located on the same level as inner valve surface or slightly elevated.

Ontogeny. — Fragmentary material precluded detailed studies on ontogenetic changes but general increment of depression of initially flat valves was noted. Increment rate of valve height and length also changes with age of individual. Primarily, increment of height is greater; later, in older growth stages both rates equal. This is well-illustrated by height ratio, ranging from 1.5 to 1.4 for younger stages and 1.3 to 1.0 for older stages. Ephebic and gerontic stages are characterized by thickening of external margin of valves, crowding of growth lines, particularly near ventral margin, and asymmetric outline and strong convexity of left valve.

Variability. — Individual variability of *L. dubisensis* is insignificant and primarily concerns thé outline of valves. Outline of specimens of approximately equal age varies from ovate, with height larger than length, to sub-triangular, with umbo sharp or rounded. Differences in shape are related mainly to location and size of attachment area. Attachment area of triangular valves is terminal and symmetrical in position. With its shift towards posterior margin, outline becomes irregular, umbo is bent backward and valve becomes crescent in outline (Pl. XIV, Fig. 6*a*). Outline of muscle scar varies from oblique ovate to rounded.

Remarks. — This species is known in literature under the name *O. dubiensis*. This name is derived from type locality Dubis, near Montbeliard, so it should be "*dubisensis*" and not "*dubiensis*". The author considers the correction of specific name as a necessity, following the suggestion of Rollier (1917, p. 590).

Polish specimens of *L. dubisensis* are similar to specimens of Thurmann (1862) from Swiss Jura and English specimens of Arkell (1936). The author excludes from *L. dubisensis* the species *O. excavata* Roemer and *O. multiformis* Koch & Dunker, as not corresponding to its diagnosis; *O. excavata,* as appears from description and illustrations of Roemer (1836, p. 60), is characterized by massive, subcircular to ovate valves, ornamented with fine concentric growth lines, with small auricles developed on both sides of hinge. Roemer has not mentioned the attachment area, so one may assume that shells of *O. excavata* were lying freely on the bottom. *L. multiformis* is quite distinct from *L. dubisensis* primarily by its radiating sculpture, consisting of fine striae, by larger size, large variability in shape, usually circular or rounded muscle scar and structure of hinge (Koch & Dunker, 1837, p. 45).

Some specimens of *L. dubisensis* are similar to specimens of *L. virguloides* by their size, low hinge and fragile valves. *L. virguloides,* however, is distinguished by crescent shape of valves, circular muscle scar and ornamentation consisting of concentric folds.

Occurrence. — Poland, Western Pomerania and Polish Lowland: Middle Volgian; Soviet Union, Crimea, Caucasus: Upper Oxfordian-Lower Kimeridgian; France: Kimeridgian; Switzerland: Upper Oxfordian; Germany: Middle Kimeridgian; England: Oxfordian; Kenya and Tanganyika: Bathonian, Kimeridgian; Somali: Bathonian-Kimeridgian.

Liostrea gryphaeata (Schlotheim, 1820)

(Pl. XV, Figs. 1—4)

1820\. *Ostracites gryphaeatus* Schlotheim; E. F. Schlotheim, Die Petrefactenkunde..., p. 235.

1874\. *Ostrea gryphaeata* Schlotheim; P. Loriol & E. Pellat, Monographie..., p. 226, Pl. 24, Fig. 17.

1917. *Ostrea (Gryphaea) sporta* Rollier; L. Rollier, Fossiles..., p. 584.
non 1917. *Ostrea (Gryphaea) gryphaeata* (v. Schl. sp.) Rollier; L. Rollier, *Ibid.*, p. 560, Pl. 38, Fig. 1.

Material. — Three left valves and 2 right, partly damaged.
Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Height ratio
Left valve			
126	40.0	36.0	1.11
127	43.0	34.0	1.27
128	58.0	56.0	1.03
Right valve			
337	45.0	35.0	1.3
129	55.0	40.0	1.37

Description. — Shell attaining moderate to large size. Left valve strongly convex, whereas right valve concave-convex. External surface ornamented with numerous growth lamellae. Umbo unprojected.

Left valve (Pl. XV, Figs. 1*b*—3*b*) rounded, subtriangular to oblique-ovate. Maximal convexity of valve is marked in subumbonal region or in half of valve height and attains 16 mm. Margin smooth, even or with wide posterior sinus. Attachment area strongly depressed. Auriform widenings occur on both sides of attachment area.

Right valve (Pl. XV, Fig. 4*b*) rounded, rarely ovate. It is bent in half of its height, so that the upper part is convex and lower part concave. Growth lamellae are nonuniform in width. Umbo directed towards posterior or anterior margin.

Inner surface of left valve (Pl. XV, Figs. 1*a*—3*a*) is concave; the maximal concavity occurs below hinge. Muscle scar rounded to semicircular (horseshoe-shaped); its transversal diameter attains up to 12 mm, equalling to about 1/4 of transversal valve diameter. Hinge low or very low; its height equals from 1/6 to 1/9 of valve height. Elements of hinge are usually equal in width, poorly developed.

Inner surface of right valve (Pl. XV, Fig. 4*a*) slightly depressed in upper part, convex in lower part. Muscle scar rounded, subcentral; its transversal diameter (12 mm) equals one-third of transversal valve diameter.

Ontogeny. — Only neanic and ephebic stages are represented in material studied. They differ in rate of increment of height and length. Left valve primarily increases more rapidly in height, whereas in later growth stages increments in both directions equalize. Those differences are well-illustrated by growth ratio, decreasing with age of individual from 1.27

to 1.03. Growth ratio of right valves slightly increases with age of specimen from 1.3 to 1.37. Close to the end of ontogenetic development, growth lamellae become more irregular and vertical fine striae appear on them.

Remarks. — Polish specimens are similar to French specimens of Loriol (1874). The author includes *O. (Gryphaea) sporta* Rollier to this species. The species of Rollier comprises specimens described by Loriol, because of misinterpretation of the diagnosis for *L. gryphaeata,* given by Schlotheim. As a result, the specimens undoubtedly belonging to other species were included to *O.* (*Gryphaea*) *gryphaeata.* Those specimens are very large, massive and have small terminal attachment area, projected umbo and short, arcuate and subcentral hinge margin, and oblique-ovate muscle scar.

Occurrence. — Poland, Western Pomerania: Lower Kimeridgian; Switzerland, France: Upper Oxfordian.

Liostrea sequana (Thurmann, 1862)

(Pl. XVI, Figs. 1—4)

1862. *Ostrea sequana* Thurmann; J. Thurmann & A. Étallon, Lethea..., pp. 270—271, Pl. 39, Fig. 1.
1917. *Ostrea sequana* Thurmann; L. Rollier, Fossiles..., p. 589.

Material. — Ten single, predominantly left valves, well-preserved, in clusters.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Depth
Left valve			
338	27.0	20.0	5.0
131	36.0	35.0	8.0
339	39.0	25.0	9.0
340	40.0	34.0	13.0
131a	53.0	24.0	10.0
Right valve			
133	26.0	24.0	3.0
341	26.0	26.0	4.0
342	31.0	32.0	1.2

Description. — Shell attaining moderate size, massive. Left valve depressed, whereas right valve is flat or irregularly bent.

Left valve variable in outline, from irregularly triangular, rounded, to irregularly ovate, ventrally widened. Attachment area occupies the whole or almost the whole valve surface. Umbo weakly projecting, low, usually deformed. Specimens partly attached are maximally convex (up to 20 mm) in half of valve height or closer to ventral margin. Surface of valve is wrinkled irregularly, and tuberculated, or sometimes ornamented with lamellae, irregular in width, and fine growth lines. Lamellae are more crowded near anterior margin than ventral.

Right valve (Pl. XVI, Fig. 2) usually smaller than left, subtriangular, with postero-ventral margin elongated. Umbo poorly projected, with upper margin usually rounded. Ornamentation mainly consists of irregular growth lines and, occasionally, growth lamellae, which occur near anterior and ventral margins.

Inner surface of left valve (Pl. XVI, Figs. 1, 3) concave with maximal depression lying near antero-posterior margin and under hinge, where it attains 10—13 mm in depth. Antero-ventral margin raised and almost normal to external valve surface; posterior margin low, sometimes flattened or thickened. Muscle scar subcentral or subposterior, rounded or crescent, and strongly depressed; its diameter is up to 12 mm, equalling 1/3—1/2 of transversal valve diameter. Hinge margin thickened and wavy. Hinge is most often short, triangular in outline, with apex bent backward or, rarely, onward (Pl. XVI, Fig. 3) and attains 13 mm in height, equalling 1/3 of valve height; sometimes low, attaining up to 4.5 mm in height, only.

Inner surface of right valve (Pl. XVI, Figs. 2a, 4) flat or slightly depressed near postero-ventral margin, lobe-like elongated. Surface of valve is smooth or uneven. Muscle scar ovate or crescent, slightly depressed and located at half of valve height, near posterior margin or subcentrally; its transversal diameter attains 12 mm, exceeding 1/2 of transversal valve diameter. Hinge margin thickened. Hinge long and relatively high, poorly differentiated, triangular, with apex truncated and more or less bent backward.

It was impossible to study ontogenetic trends in material collected, because of scarcity of specimens of the younger growth stages and lack of the youngest forms. Ephebic and gerontic forms are deformed primarily due to attachment by the whole valve surface.

Variability. — Individual variability of this species is very large because the specimens occur in clusters adapting their shape and size to free space. Variable features were also taken into consideration in the above description.

Remarks. — Polish specimens are similar to specimens described by Thurmann. Thurmann noted that right valves of his specimens are thin, but no measurements are given. Right valves from Polish material are relatively thick, up to 2 mm near ventral margin and almost 4 mm in subumbonal region, whereas left valves are as much as 7.9 mm thick.

However, one left valve, illustrated by Thurmann is still thicker, and attains 10 mm near anterior margin. In Poland this species is rare, contrary to Switzerland.

Occurrence. — Poland, Mesozoic margin of the Holy Cross Mts.: Upper Oxfordian-Lower Kimeridgian; Switzerland: Upper Oxfordian.

Liostrea moreana (Buvignier, 1852)
(Pl. X, Figs. 5—6)

1839. *Ostrea suborbicularis* Roemer; F. A. Roemer, Die Versteinerungen..., p. 24.
1852. *Ostrea Moreana* Buvignier; A. Buvignier, Statistique..., p. 26, Pl. 16, Figs. 41—43.
1862. *Ostrea suborbicularis* Thurmann & Étallon;; A. Étallon & J. Thurmann, Lethea..., p. 269, Pl. 38, Fig. 4.
1874. *Ostrea Moreana* Buvignier; P. de Loriol & E. Pellat, Étages..., p. 224, Pl. 25, Fig. 1.
1892. *Ostrea Moreana* Buvignier; P. de Loriol & E. Koby, Étude..., p. 241.
1917. *Ostrea Moreana* Buvignier; L. Rollier, Fossiles..., p. 585.
1917. *Ostrea Laufonensis* Rollier; L. Rollier, *Ibid.*, p. 586.
1932. *Ostrea moreana* Buvignier; W. J. Arkell, A monograph..., p. 157, Pl. 15, Figs. 4—5, Text-fig. 27.

Material. — Two left and 1 right valves, well-preserved and representing ephebic-gerontic stage.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Height ratio
Left valve			
85	50.0	62.0	0.8
343	60.0	65.0	0.9
Right valve			
86	65.0	70.0	0.9

Description. — Left valve (Pl. X, Fig. 5*a*) attaining large size, flat, attached by the whole surface, rounded to subtriangular or trapezoidal in outline. Valve margin is bent upward almost normally to attachment area. The maximal height of valve, up to 20 mm, is attained near ventral margin. Umbo nonprojected, situated on the same level as upper rounded valve margin. Occasionally, lobe-like widening of dorsal margin develops in its anterior or posterior part.

Right valve (Pl. X, Fig. 6*a*) flat to slightly depressed in central part, rounded. Umbo is very small, acute and shifted posteriorly. Valve margin uniformly rounded, except for lobe-like widening of postero-dorsal margin, similarly as that of left valve. Surface ornamented with concentric growth lines and lamellae. The distance between particular lamellae ranges from 7 to 8 mm. Subumbonal convex part of valve is ornamented with fine concentric wrinkles and very fine radial striae; the latter also occur on lamellae, particularly on their ventral margins.

Inner surface of left valve (Pl. X, Fig. 5*b*) is maximally concave along anterior and ventral margins. Muscle scar is located in central part of valve; usually is horseshoe-shaped or rounded, deep and surround by thickened postero-ventral lip; transversal diameter of muscle scar ranges from 15 to 20 mm, equalling 1/3—1/4 of transversal valve diameter. Valve margin is bent outward at an almost right angle. Hinge margin slightly wavy, slightly raised above valve surface; its length is sometimes equal to length of valve; the whole hinge margin is occupied by strongly flattened hinge, 12—14 mm high. Only in the case of asymmetric valve, small depression, probably an additional support of hinge, is developed in its posterior part.

Inner surface of right valve (Pl. X, Fig. 6*b*) is unequally convex. Both ventral and antero-ventral margins are bent outward approximately at a 140° angle. Muscle scar subcentral, surrounded by swollen dorsal lip. Along anterior side of muscle scar a wide semicircular depression is marked. Shape and location of those semicircular structures on both valves may suggest that they are impressions of gills. Hinge margin arched and slightly undulated posteriorly and completely occupied by hinge. Hinge apex is bent backward. Additional posterior depression in hinge is distinct, insufficient amount of material precluded studies on ontogeny and variability.

Remarks. — Polish specimens are smaller than French, being almost 1/3 shorter. Height to length ratio is common for both and equals 1.24.

Occurrence. — Poland, Mesozoic margin of the Holy Cross Mts.: Lower Kimeridgian; France: Upper Oxfordian-Lower Kimeridgian; England: Lower Kimeridgian.

Liostrea monsbeliardensis (Contejean, 1859)
(Pl. XVII, Figs. 5—9)

1859. *Ostrea Monsbeliardensis* Contejean; Ch. Contejean, Étage..., p. 321, Pl. 26, Figs. 1—4.

1862. *Ostrea Monsbeliardensis* Contejean; J. Thurmann & A. Étallon, Lethea..., p. 272, Pl. 38, Fig. 8.

Material. — Eight left and 1 right, poorly preserved valves.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Height ratio
Left valve			
140	27.0	17.0	1.6
142	34.0	28.0	1.21
Right valve			
344	30.0	26.0	1.15

Description. — Shells attaining moderate size, ovate to irregularly rounded; left valves (Pl. XVII, Fig. 5*b*) usually convex in half of valve height (up to 18 mm) and larger than nearly flat right valves. External surface uneven, rough or tuberculated, with concentric, wavy growth lines and striae, and with folds and lamellae near external margin. Attachment area variable in size; if small, valves are rounded to ovate, with height slightly exceeding length. Anterior margin is arcuate and nonuniformly undulated; occasionally, the whole shell is undulated. Occurrence of folds is not a specific feature; they are variable in length and width, and sometimes disappear.

Inner surface of valves (Pl. XVII, Figs. 5*a*, 7, 8, 9*a*) smooth; maximal concavity lies in half of valve height and along anterior margin. Muscle scar rounded, subcentral or shifted a little to posterior and near hinge, 8—9 mm i diameter, and equal to 1/2—1/3 of transversal valve diameter. Hinge and hinge margin strongly bent backward; occasionally, small tubercle and adjoining pit are developed in posterior part of hinge. This pit may continue in a form of moderately deep furrow along posterior margin and disappears at some distance from hinge. Similar type of hinge was noted in exogyras. Margins are sharp, with relatively thin edge, up to 2.3 mm in thickness, except for ventral margin. A line corresponding to the trace of contact of both valves in closed shell is continuing on inner surface of left valve at some distance from its margin. Right valve, usually operculate, is rounded, and has postero-ventral lobe slightly elongated, and usually bent outward. Muscle scar, transversally elongated, occurs in half of valve height, near posterior margin; its transversal diameter attains 7 mm, equalling about one-third of transversal valve diameter. Elements of hinge are wide and relatively flat. Hinge is 5 mm high and 15 mm long. Umbo rounded, strongly prosogyre in contrast to that of other oysters (Pl. XVII, Fig. 9*a*).

Ontogeny. — Material studied was insufficient for detailed study of ontogenetic stages. However, an equalization of growth and length increments with age of specimen is confirmed by gradual decrease of growth ratio from 1.6 to 1.15.

Variability. — Specimens attached by their whole external surfaces exhibit marked individual variability. They occur in clusters so their shape is determined by free space. Along with shape, other features, such as size of hinge, location and outline of muscle scar, and depth of valves, vary. Specimens attached for shorter period, are more regular in shape and their variability is smaller.

Remarks. — Polish specimens are similar to Swiss ones. Right valve was hitherto unknown.

Occurrence. — Poland, Mesozoic margin of the Holy Cross Mts.: Lower Kimeridgian; Switzerland: Lower Kimeridgian.

Liostrea brasili Chavan, 1952
(Pl. IX, Fig. 4)

1952. *Liostrea Brasili* Chavan; A. Chavan, Les Pélécypodes..., p. 43, Pl. 2, Fig. 22.

Material. — One well-preserved right valve.

Description. — Valve (Pl. IX, Fig. 4*a*) attaining moderate size, inequilateral, oblique-triangular in outline, 24 mm high and 38 mm long. Umbo projected, triangular with sharp apex, quite distinctly translocated posteriorly, overhanging. Posterior margin of valve is short and almost rectilinear, whereas anterior margin is longer, rounded and elongated in lobe-like fashion in antero-ventral part. Valve surface uneven, tuberculated and ornamented with irregular concentric growth lines and lamellae, marked stronger in some intervals. In half of its height, valve is slightly depressed.

Inner surface (Pl. IX, Fig. 4*b*) is smooth and strongly depressed under hinge, where wide cavity originates. Hinge margin short, swollen, and up to 10 mm long. Hinge outline commonly triangular with sharp apex slightly overhanging, 4.5 mm high. Valve margin smooth and relatively even, slightly thickened in subumbonal region. Muscle scar subcentral, transversally elongated, 7 mm in diameter, bordered ventrally by raised lip.

Remarks. — *Liostrea brasili* was proposed by Chavan on the basis of one left valve, and is distinguished from species similarly ornamented, by its oblique-triangular shape, overhanging umbo, and position, outline and size of muscle scar. Chavan compared *L. brasili* with gerontic stage of *L. dubisensis*, but is seems doubtful, because such features of *L. dubisensis*, as gondola-like depression throughout life, and very small ligament pit, straight umbo, are not developed on both available specimens of *L. brasili*, and the latter is characterized by larger size.

Occurrence. — Poland, Western Pomerania; Lower Kimeridgian; France: upper part of Upper Oxfordian.

Liostrea polymorpha (Münster, 1833)
(Pl. XIX, Figs. 5—8)

1834—40. *Gryphaea polymorpha* Münster; A. Goldfuss, Petrefacta..., p. 31, Pl. 86, Fig. 1 a, b.
1858. *Ostrea Römeri* Quenstedt; F. Quenstedt, Der Jura, p. 625, Pl. 77, Figs. 22—23.
1881. *Ostrea Roemeri* Quenstedt; P. de Loriol, Monographie..., pp. 96—97, Pl. 13, Fig. 7.
1917. *Ostrea polymorpha* (Münster) Goldf. (*Gryphaea*); L. Rollier, Fossiles..., p. 592.
1965. *Liostrea polymorpha* (Münster); L. R. Cox, Jurassic..., p. 72, Pl. 9, Figs. 3, 7 a, b.

Material. — One complete shell and 4 left valves, well-preserved.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Depth	Height ratio
Right valve				
156	36.0	25.0	5.0	1.44
Left valve				
152	29.0	29.0	13.0	1.0
155	40.0	31.0	15.0	1.3
153	42.0	38.0	18.0	1.1

Description. — Shell ovate to rounded or irregularly triangular. Left valve is maximally convex in half of its height, whereas right valve is convex in subumbonal region and near postero-ventral edge. Concavity occurring in lower half of right valve, continues towards ventral margin (Pl. XIX, Fig. 8*b*). Umbo of left valve is obliterated by large attachment area, whereas umbo of right valve is strongly opisthogyre, low and oblique-triangular with sharp apex. Rectilinear dorsal margin is almost normal to lateral margins. Posterior margin in the middle part forms weak sinus, whereas its lower part expands in form of lobe.

Valve surface is ornamented with fine growth lines, thickened in some intervals, and developed in form of weakly projecting lamellae near external margin. Furthermore, fine striae appear on right valve; in convex subumbonal region those striae bend in sinusoidal pattern. Similar sinusoidal bend of growth lines and lamellae is observed on the surface of elongate depression in lower part of valve.

Inner surface of left valve (Pl. XIX, Figs. 5, 6, 8*a*) is strongly concave, up to 18 mm in central part or closer to posterior margin. Position of large muscle scar is variable, but commonly in half of valve height and subcentrally; muscle scar is usually weakly depressed and bordered ventrally or postero-ventrally by thickened lip; sometimes slightly elevated. Transversal diameter of muscle scar attains 10 mm and equals one-third of transversal valve diameter. Hinge outline triagular. Apex usually more or less bent backward. Hinge is 9—13 mm high and 15—17 mm long. Ligament pit prolongates in form of a groove towards umbo, and similar in width as thickened lateral folds. Hinge is seperated from valve margins on both sides by narrow short furrows.

Right valve (Pl. XIX, Fig. 8c) is weakly concave in umbonal part and slightly convex below. Lateral margins of upper part of valve are sharp and slightly raised; in lower part they are smooth and inclined outward. Muscle scar rounded, weakly depressed, situated subcentrally in lower part of valve, bordered ventrally by a little thickened lip; diameter up to 9 mm, approximately equaling 1/3 of transversal valve diameter. Hinge is 14 mm long and 8 mm high, distinctly bent backward; apex overhanging. Hinge elements weakly differentiated; lateral ridges and ligament pit are situated on the same level. Valves massive; thickness greatest in vicinity of umbo, exceeding 5 mm, thinning to 2—3 mm ventrally.

Ontogeny. — Earlier growth stages may be generally characterized on the basis of observations on valves of adult specimens. Valves of early growth stages already exhibit strong asymmetry; left valve is quite deep; hinge straight; umbo and hinge gradually shift backward.

Remarks. — Polish specimens are similar to specimens of Münster, except for their slightly smaller size. Particularly large specimens of this species were found in the Lower Kimeridgian of Tanganyika (Cox, 1965); they are up to 70 mm high, i.e. almost two times higher than Polish.

The author includes *O. roemeri* Quenstedt to this species. Swiss specimens of *O. roemeri* have smaller attachment area, relatively sharp umbo of left valve and low, short hinges. It may be assumed that Loriol's illustration presents specimen of younger growth stage, although this form is 85 mm high.

Hitherto only left valves of *L. polymorpha* were described. Right valves were not found or their inner structure was obliterated. Polish specimen is perfectly preserved and makes possible to complete the characteristics of *L. polymorpha.*

Occurrence. — Poland, Mesozoic margin of the Holy Cross Mts.: Lower Kimeridgian; Switzerland: Lower Kimeridgian; Germany: Lower Kimeridgian; Tanganyika, Kenya: Upper Oxfordian-Lower Kimeridgian.

Liostrea multiformis (Koch & Dunker, 1837)

(Pl. XX, Figs. 1—7)

1837. *Ostrea multiformis* Koch & Dunker; L. Koch & W. Dunker, Beiträge..., p. 45, Pl. 5, Fig. 11 a—e, k, m, n (non Pl. 5, Fig. 11 f, h, i, l).

1836. *Ostrea* indet. Roemer; F. A. Roemer Versteinerungen..., p. 62, Pl. 3, Fig. 7 (non Pl. 3, Figs. 10—12).
1862. *Ostrea multiformis* Koch & Dunker; J. Thurmann & A. Étallon, Lethea..., p. 272, Pl. 39, Fig. 5.
1865. *Ostrea multiformis* Dunker & Koch; A. Sadebeck, Die oberen..., p. 665.
1872. *Ostrea multiformis* Koch & Dunker; P. de Loriol, E. Royer & H. Tombeck, Description..., pp. 404—406, Pl. 23, Figs. 16—20.
1874. *Ostrea multiformis* Koch & Dunker; P. de Loriol & E. Pellat, Monographie..., p. 213, Pl. 24, Figs. 6—10.
1917. *Ostrea multiformis* Koch & Dunker; L. Rollier, Fossiles..., p. 589.
1922. *Ostrea multiformis* Koch & Dunker; J. Lewiński, Monographie..., p. 64.

Material. — Eight right and 1 left valves, well-preserved.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Depth	Height ratio
Right valve				
157	12.0	12.0	2.5	1.0
158	15.0	12.0	1.5	1.25
159	15.0	14.0	2.5	1.07
160	17.0	15.5	4.0	1.13
161	17.0	18.0	3.5	0.94
162	22.0	19.0	4.0	1.15
Left valve				
163	20.0	16.0	7.0	1.25

Description. — Left valve (Pl. XX, Fig. 7*a*) slightly inequilateral, oblique-ovate, constricted in umbonal part, widening ventrally. Umbo weakly projected, sharp. Valve margin even and rounded, except for weak sinus on posterior margin. Maximal convexity, up to 7 mm, in one-third of length from ventral margin. Ornamentation consists of fine, weak growth lines, more distinct near external margin. Valve thickness smallest (up to 1 mm) near posterior margin and in vicinity of umbo, thickening to over 2 mm on the rest of valve.

Right valve (Pl. XX, Figs. 1*a*—6*a*) asymmetric, variable in outline: from rounded triangular to subsquare. Margin uniformly rounded or, occasionally, weak sinus is developed on posterior margin. Ventral margin bent outward on some specimens. Subumbonal part slightly convex. Ornamentation consists of fine, weak growth lines and concentric, irregular folds. On some specimens, also fine radial striae, continue from umbo to ventral margin or only near this margin (Pl. XX, Figs. 1*a*, 5*a*). Valve thickness variable, greatest near ventral margin, attaining 4 mm.

Inner surface of left valve (Pl. XX, Fig. 7*b*) maximally concave along anterior margin. A longitudinal convexity, corresponding to the negative of attachment area of left valve, develops below hinge. Rounded muscle scar located in half of valve scar, near posterior margin, attains 4.5 mm in diameter, equalling approximately a quarter of transversal valve diameter. Hinge, developed in form of triangle with sharp apex and narrow base, situated slightly eccentrically and bent backward. Ligament pit shallow; lateral folds low, continuing along external margin of valve and are separated from it by longitudinal furrows, narrow and deep in vicinity of hinge. Hinge margin wavy, slightly thickened. Semicircular gill scars are marked near anterior margin.

Inner surface of right valve (Pl. XX, Figs. 1*b*—6*b*) smooth on most specimens, sometimes uneven. Some valves are uniformly depressed, other only in sub-hinge region. Greatest concavity of asymmetric specimens lies along anterior margin, not exceeding 4 mm in dept. Similarly as on left valve, marginal ridge and shallow furrow parallel to it, continue along ventral margin. Muscle scar occurs in half of the valve height, near posterior margin; its diameter (6 mm) exceeds one-third of transversal valve diameter; muscle scar crescent, sometimes rounded. Valve in this part is very thin and almost translucent. Hinge margin typically short and thickened, sometimes equal to the length of valve, and almost normal to its upper margins. Hinge occupies the whole length of hinge margin or its middle or posterior part; triangular with sharp apex, bent backward in asymetric valves. In the latter case, ligament pit is strongly shifted backward; its front is limited by fold, strongly elongated and flattened, whereas back is limited by short thickened fold. Gill scar is distinct in anterior part (cf. Fig. 3*b*).

Ontogeny. — Insufficient number of specimens precluded detailed ontogenetic studies. Some ontogenetic changes may be traced on the basis of morphology of adult specimens. Earliest stages (shells up to 7 mm in height) are characterised by symmetric valves, rounded shape, hinge centrally located, smooth margin and ornamentation consisting exclusively of concentric growth lines. With growth of shell up to 10— 17 mm in height, shape changes to ovate, with height exceeding length, hinge is shifted slightly backward and radial striae appear. In adult stage, outline of valves varies greatly: oblique triangular, subsquare or rounded; hinge strongly shifted backward; also external sculpture is strongly differentiated and consists of concentric growth lines and folds; radial striae are discrete, and often occur only near margin.

Variability. — Speciment of *L. multiformis* are characterised by wide individual variability, particularly in shape, and increments of height and length/height ratio of specimens equal in age ranges from 0.94 to 1,25, external ornamentation, particular elements of which may be incompletely developed. Other features, as muscle scar, width of marginal ridge or thickness of valve margin are variable in a small range.

Remarks. — Polish specimens are very similar to French specimens of Loriol, except that they are twice as small. The author includes to *L. multiformis* one of unidentified specimens of Roemer (1836, Pl. 3, Fig. 1), characterized by convex left valve with weak radial folds and flattened right valve with concentric striae. The author excludes a number of varieties, previously included to this species by Koch & Dunker (*l.c.*, 1837, pp. 45—46), and a few specimens unidentified by Roemer (*l.c.*, p. 62, Pl. 3, Figs. 10—12), from this species. This too wide range of *L. multiformis* resulted in difficulties with univocal interpretation of its diagnosis, what was pointed by Thurmann & Étallon (1862, p. 272) and Rollier (1917, p. 589).

Occurrence. — Poland, Western Pomerania: Lower Kimeridgian, vicinity of Tomaszów Mazowiecki: Middle Volgian; Germany: Upper Jurassic; France: Lower Kimeridgian.

Liostrea sorlinensis (Loriol, 1904).
(Pl. II, Figs. 5, 6)

1904. *Ostrea sorlinensis* Loriol; P. de Loriol & A. Girardot, Étude..., p. 246, Pl. 25, Figs. 22—24.

Material. — One shell and 1 left valve, well-preserved.

Measurements (in mm)

Z. Pal. U.W. Mo. V/	Height	Length	Depth of left valve	Height ratio
Left valves				
14	24.0	22.0	20.0	1.09
13	32.0	27.0	24.0	1.33

Description. — Shell (Pl. II, Figs. 5—6) inequivalve, massive, irregular in shape, commonly triangular or rounded. Attachment area located on upper or lateral part of valve, is uneven, tuberculated or strongly wrinkled. Maximal convexity of valves (up to 28 mm) is reached in half of valve height. Flanks of left valve almost normal to attachment area. Umbo weakly projected, subcentral or shifted backward. In the latter case, umbo is relatively high, up to 7 mm. Ligament pit well developed, depressed; lateral folds relatively rised. When umbo is opisthogyre, hinge bents backward and posterior fold is strongly thickened. Right valve flat to slightly concave, occasionally strongly depressed in the middle or ventral margin (Pl. II, Fig. 5*a*). Ornamentation consists of concentric growth lines; additionally, uneven radial folds appear on left valve (Pl. II, Fig. 5*b*).

Remarks. — Both Polish specimens are similar to French specimens figured by Loriol.

Occurrence. — Poland, Holy Cross Mts.: Upper Oxfordian-Lower Kimeridgian; France: Middle Oxfordian.

Liostrea unciformis (Buvignier, 1852)
(Pl. XV, Fig. 5; Pl. XVI, Figs. 5, 6)

1852. *Ostrea unciformis* Buvignier; A. Buvignier, Statistique..., p. 26, Pl. 16, Fig. 44.
1872. *Ostrea unciformis* Buvignier; P. de Loriol, E. Royer & H. Tombeck, Description..., p. 408, Pl. 25, Fig. 1.
1922. *Ostrea unciformis* Buvignier; J. Lewiński, Monographie..., pp. 64—65, Pl. 3, Fig. 3.
1955. *Ostrea unciformis* Buvignier; P. A. Gerasimov, Rukovodiaščie..., p. 124, Pl. 29, Fig. 1.

Material. — One complete shell, 2 almost complete valves and some additional fragments, well-preserved.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Thickness	Height ratio
345	90.0	95.0	6.0	0.94
346	100.0	115.0	4.0	0.86
130	155.0	165.0	8.0	0.93

Description. — Shell (Pl. XV, Fig. 5) equivalve, attaining large to very large size; outline irregularly triangular to subquadrangular; posterior margin sinusoidal, whereas anterior rounded. Valve lengt slightly exceeds height. Valves very closely adjoin each other; one of them is concave, other convex in the same degree. Ornamentation consists of thick concentric folds, passing into flat, generally wrinkled lamellae. Growth lines fine and weakly marked. Umbo projected, more or less sharpened, bent backward. Rounded elongated lobe develops on postero-ventral margin.

Inner surface of valves (Pl. XVI, Figs. 5—6) smooth, glittering, concave-convex. Muscle scar, located in half of valve height, rounded, slightly depressed in upper part, bordered antero-ventrally by lip and posteriorly by ridge-like margin, continuing upward and wedging out on posterior subumbonal margin. Transversal diameter of muscle scar attains 24 mm, equalling about 1/4 of transversal valve diameter. Hinge margin swollen, wavy. Hinge terminal, bent strongly backward, subtriangular in outline with sharp apex bent backward and narrow base, higher (max.

to 26 mm) than longer (up to 17 mm). Posterior hinge fold slightly higher and shorter than anterior. Ligament pit through-like depressed, long and wide. Numerous, imbricate, progressively shorter lamellae, representing suceeding valve margins, are exposed along with coiling of umbo, along posterior and anterior margins in upper part of valve (Pl. XVI, Figs. 5, 6). Thickness of valve, primarily small, increases with age of specimen; greatest in anterior and posterior parts, attaining 12 mm, thinning to 5—8 mm ventrally.

Ontogeny. — Specimens collected represent ephebic, ephebic-gerontic and gerontic stages. The youngest stage is characterized by sharp umbo and poorly differentiated hinge; posterior fold, very short and insignificantly thickened, may be discerned; ligament pit and anterior fold are strongly flattened and marked by curvature of growth lines only; hinge margin thickened, slightly bent in its middle part; valve flat, thin; thickness greatest in subumbonal part, attaining up to 3 mm. Ephebic-gerontic stage is characterized by greater concavity of valve in sub-hinge part, rounded umbo, distinct tripartity of hinge and increase of its height to 12 mm with the same length as in former stage. Gerontic stage is characterized by increment of dimensions, typical pattern of growth lamellae along posterior and anterior margins in upper half of valve, what results in increase of its thickness.

Variability. — Individual variability of Polish specimens is small, limited mainly to smaller or greater curvature of middle part of valves.

Remarks. — Polish specimens are very similar to French specimens of Buvignier and others, cited above. Specimens of younger growth stages resemble *L. delta* (Smith) in outline, but other features, as round and shallow muscle scar, remain different. *L. unciformis* is quite distinct from *O. expansa,* contrary to statement of Lewiński (1922, p. 65), as the latter form is mostly ovate to triangular, very rarely deltoidal, its length and height are almost equal and hinge is longer.

Occurrence. — Poland, vicinity of Tomaszów Mazowiecki: Middle Volgian; Soviet Union: Upper Jurassic, the *Virgatites virgatus* Zone; France: Upper Oxfordian-Lower Kimeridgian; the *Streblites tenuilobatus* Zone.

Liostrea plastica (Trautschold, 1860)

(Pl. XIX, Figs. 1, 2)

1860. *Ostrea plastica* Trautschold; H. Trautschold, Recherches..., p. 339.
1868. *Ostrea plastica* Trautschold; E. Eichwald, Lethaea..., p. 376.
1872. *Ostrea Bononiae* Sauvage & Rigaux; E. Sauvage & E. Rigaux, Description..., p. 175, Pl. 10, Fig. 8.

1872. *Ostrea Matronensis* P. de Loriol; P. de Loriol, E. Royer & H. Tombeck, Monographie..., p. 396, Pl. 23, Figs. 5—7.
1874. *Ostrea Bononiae* Sauvage & Rigaux; P. de Loriol & E. Pellat, Monographie..., p. 212, Pl. 23, Fig. 9; Pl. 24, Fig. 16.
1917. *Ostrea Bononiae* Sauvage & Rigaux; L. Rollier, Fossiles..., p. 593.
1955. *Ostrea plastica* Trautschold; P. A. Gerasimov, Rukovodiaščie..., p. 125, Pl. 27, Figs. 6—13.

Material. — Two valves; left valve poorly preserved.

Description. — Left valve (Pl. XIX, Fig. 2*b*) flat, rounded, attached to substratum by almost whole surface; only external edge rises upward along its whole margin normally to valve surface.

Valve height equal to 31 mm. Ornamentation consists of numerous, very fine growth lines, slightly wavy. In upper half of valve those lines assume form of striae, disrupted, irregular, sometimes forming concentric granulation. Upper part of valve weakly concave, separated from lower by a stronger concentric striae. Valve thin, up to 1 mm thick.

Right valve (Pl. XIX, Fig. 1*b*) is 31 mm high, 29.0 mm long, maximally convex in its upper part. Umbo projecting, sharpened, shifted to posterior, up to 5 mm high. Wide, shallow sinus is developed in upper part of posterior margin. Valve ornamented with concentric, slightly wavy striae, finer and disrupted on upper part, and wider, continuous in lower. Thickened growth lamellae divides valve into two parts. Valve thin, np to 1 mm thick.

Inner surface of right valve (Pl. XIX, Fig. 1*a*) smooth and glittering, somewhat scaly. Upper part depressed and separated from shallow lower part by concentric fold. Muscle scar, located on this fold, is shallow, rounded; its transversal diameter equals 10 mm (1/3 of transversal valve diameter). Hinge oblique triangular, shifted posteriorly.

Remarks. — Polish specimen differs from those of Switzerland and Russia by its smaller size; some described specimens attain 85 or even 100 mm in height. Loriol (1872, 1874) and Gerasimov (1955) stated a great variability of this species, resulting from reflection of morphology of substratum, which often is an ammonite shell.

Occurrence. — Poland, Western Pomerania: Middle Volgian; Soviet Union: Upper Kimeridgian (The *Dorsoplanites panderi* Zone) — Lower Neocomian; Switzerland: Portlandian; Germany: Middle Kimeridgian.

Liostrea virguloides (Lewiński, 1922)
(Pl. XXI, Figs. 1—7)

1922. *Exogyra virguloides* Lewiński; J. Lewiński, Monographie..., p. 66, Pl. 3, Figs. 9—11.
1962. *Exogyra virguloides* Lewiński, R. Wilczyński, Stratygrafia..., p. 48.

Material. — Very numerous valves is marly matrix, poorly preserved. Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Height ratio
Left valves			
167	7.0	5.0	1.4
168	10.0	8.0	1.2
169	15.0	10.0	1.5
170	16.0	8.0	2.0
Right valve			
164	6.5	5.0	1.3
165	10.0	7.5	1.3
166	11.0	8.0	1.4

Description. — Left valve (Pl. XXI, Figs. 4*a*—7*a*) crescent or virguloid. Postero-ventral margin constricted or lobe-like widened. Valve ununiformly convex, maximally in half of valve height or nearer anterior margin, ranging from 1 to 8 mm; less than 1 mm thick. Ornamentation consists of very fine, concentric growth lines and folds; occasionally lamellae, distinctly protruded, occur along ventral and posterior margins. Umbo low, sharp, often obliterated by attachment area, and strongly shifted backward. Attachment area commonly terminal, small, depressed, often furrow-like.

Right valve (Pl. XXI, Figs. 1*a*—3*a*, 4*b*—5*b*) flat to slightly concave in central part, crescent, sometimes triangular or ovate (Pl. XXI, Fig. 5*b*). External surface uneven, sometimes tuberculated along ventral and posterior margin. Ornamentation consists of growth lines, folds and lamellae. Fine radial striae are marked on some specimens. Umbo not prominent, acute, bent posteriorly. Irregular convexity, being negative of attachment area of left valve, is distinct in subumbonal region.

Inner surface of left valve (Pl. XXI, Figs. 6*b*, 7*b*) uniformly, gondola--like, depressed or irregularly concave with depression greatest along anterior margin, varying from 7 to 8 mm in length. Anterior margin sharp, bent upward along its edge; posterior margin bent downward. Muscle scar, lying in half of valve height, near posterior margin, is rounded to transversally ovate, and equals 1/4 of transversal valve diameter. Hinge terminal, triangular with acute apex. Ligament pit is trough-like, and bordered by low, elongate lateral folds. Lateral folds run along valve margins up to the half of valve height, being separated from them by narrow furrows.

Inner surface of right valve (Pl. XXI, Figs. 1*b*—3*b*) commonly flat or slightly convex in half of valve height. Small concavity is marked below hinge and occasionally, along anterior margin. Hinge narrow, triangular, subposterior with elements poorly differentiated. Muscle scar located below the half of valve height, subposteriorly, rounded to ovate, relatively small, equals to 1/4—1/5 of transversal valve diameter. Margins rounded, except for acute posterior.

Ontogeny. — Only insignificant changes in ratio of height and length increments with growth of individual, are observed. In younger stages those increments are equal; later, height increment exeeds markedly length, what is illustrated by change of height ratio for left valves from 1.5 to 2.0 and from 1.0 to 1.7 for right. Typical features, as crescent shape and strong posterior shift of umbo, are distinct already in earliest growth stages.

Variability. — Individual variability of *L. virguloides* primarily concerns a small changes in shape of valves, particularly right, and position and shape of muscle scar. Muscle scar exhibit a distinct tendency for shifting from central towards dorsal part of left valve and ventral part of right. Its outline changes from circular to transversally elongate (Pl. XXI, Fig. 3*b*).

Remarks. — Such features, as typical ostreoid structure of hinge and valve surface ornamented with concentric growth lines and folds only, preclude inclusion of this species to genus *Exogyra*, as has been proposed by Lewiński. The author considers inclusion of *E. virguloides* to the species *Exogyra nana* by Gerasimov (1955, p. 151) as invalid, because those species differ in structure of hinge and in number of other features.

Occurrence. — Poland, vicinity of Tomaszów Mazowiecki, Western Pomerania: Middle Volgian.

Genus *Catinula* Rollier, 1911

(Type-species: *Ostrea knorri* Voltz, 1828)

Revised diagnosis. — Shell inequivalve, inequilateral, attaining small size, ovate with height exeeding length; left valve weakly convex and attached by small subumbonal surface; right valve flat; left valve ornamented with very fine, numerous radial striae and growth lines; right valve concentrically ornamented with growth lines and lamellae and, occasionally, with very fine radial striae; hinge with ostreoid structure; external margin smooth.

Remarks. — In discussion on position of genus *Catinula* in phylogenesis of oysters, Arkell (*l.c.*) suggests that forms of the "*Gryphaea*" type originated from forms of the "*Catinula*" type, similar in shape, convexity of both valves and structure of hinge. The latter forms Arkell derives from the genus "*Liostrea*", through acquisition of ribbing by primarily smooth valves. He proposes that the genera *Liostrea, Catinula* and *Gryphaea* be recognized as stages in the development of oyster shell, through which numerous independant lines of development pass in various periods (Arkell, 1934*a*, p. 61). However, newer studies of Čelcova (1969), carried out on microstructure of shells of those three genera do not confirm the suggestions of Arkell. Recently, the independence of every of them is generally accepted. It should be stressed, that position of the genus *Catinula* is particularly important, because this genus is the link jointing two sub-families Ostreinae Vialov and Gryphaeinae Vialov in phylogenesis of family Ostreidae.

Catinula knorri (Voltz, 1828)

(Pl. XXII, Figs. 1—13; Pl. XXIII, Figs. 1—10)

1830. *Ostrea Knorri* Voltz; C. H. Zieten, Die Versteinerungen..., p. 60, Pl. 45, Fig. 2 *a—d*.
1858. *Ostrea Knorri* Voltz; Fr. A. Quenstedz, Der Jura, p. 497, Pl. 66, Figs. 37—42.
1888. *Ostrea Knorri* (Voltz) Zieten, 1833; O. Schlippe, Die Fauna..., p. 111, Pl. 1, Figs. 8—10.
1923. *Ostrea (Catinula) Matisconensis* (Lissajous); M. Lissajous, La faune..., p. 144, Pl. 28, Figs. 9—12.
1929. *Liostrea Knorri* Voltz; L. Schäffer, Über..., p. 60, Pl. 2, Fig. 1.
1934*a*. *Ostrea (Catinula) knorri* Voltz; W. J. Arkell, The Oysters..., p. 35—44, Pl. 2, Figs. 6—27.
1946. *Ostrea (Catinula)* sp.; G. Gardet & H. Gérard, Contribution..., p. 44, Pl. 7, Figs. 26—27.
1952. *Catinula Knorri* Voltz; R. P. Charles & P. L. Mobeuge, Les huîtres..., p. 116, Pl. 4, Figs. 28—30.
1958. *Ostrea (Catinula) knorri* Voltz; P. C. Sylvester-Bradley, The description..., pp. 227—235, Text-figs. 5—9, 10—15.

Material. — Four shells and 130 poorly preserved valves, predominantly right.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Depth	Height ratio
Left valve				
184	8.0	6.0	3.5	1.33
185	11.0	9.0	5.5	1.22
186	13.0	11.0	6.0	1.18
187	16.0	14.0	6.0	1.14
188	20.0	15.0	8.0	1.33
Right valve				
172	9.0	7.5	1.0	1.2
174	11.5	9.0	1.5	1.27
178	13.0	10.0	1.5	1.3
182	14.0	12.0	2.0	1.16
183	17.0	11.0	1.5	1.54

Description. — Shell with umbo projected, acute and bent backward.

Left valve (Pl. XXIII, Figs. 1*a*—10*a*) oblique triangular, with convex anterior margin and concave posterior. Maximal convexity is attained in about 1/3 of length from ventral margin. Umbonal part commonly strongly constricted, whereas ventral part widened. Umbo terminal, sometimes obliterated by attachment area, variable in size, commonly depressed, circular to irregular. Valve surface ornamented with very numerous, fine radial striae. Their number increases by intercalation or by dividing of one primary stria into 2 to 4 secondary striae. Small groups of striae appear simultanously in the ends of growth phases marked by thickened growth lines (Pl. XXIII, Fig. 5*a*), whereas single striae, primarily very fine, gradually thicken until the end of particular phase, and continue in the next one, as striae normally developed. Increment in number of striae by intercalation occurs in specimens growing normally, whereas division of primary stria into 2—4 secondary ones prevails in specimens with rapid increase of length (Pl. XXIII, Figs. 10*a*, 5*a*).

Right valve (Pl. XXII, Figs. 1*a*—13*a*) variable in shape from rounded to ovate or oblique triangular. Dorsal margin of circular and ovate valves is rounded; umbo of such valves is unprojected; umbo of oblique triangular valves is protruding, strongly constricted, acute and triangular in outline, and bent backward (Pl. XXII, Figs. 12*a*, 13*a*). Spherical prodissoconch, about 0.25 mm in diameter, is distinct on umbones of some better preserved specimens. Anterior margin commonly arcuate, whereas posterior is rectilinear, often rounded, occasionally with weak sinus. In subumbonal region, a smooth, convex circular negative of attachment area is marked, being separated from the rest of valve with normal ornamentation, by more or less deep concentric furrow. Growth lines are marked stronger in some intervals, sometimes developed as a growth lamellae, protruding in scaly fashion along margins. Radial ornamentation is also apparent, and developed in form of relatively flat striae and wrinkles, wider than those from left valve. Both those types of ornamentation, superimposed on each other produce a fine reticular pattern (Pl. XXIII, Figs. 8*a*, 12*a*).

Inner surface of left valve (Pl. XXIII, Figs. 1*b*, 3*b*, 4*b*, 6*b*, 9*b*, 10*b*) smooth, occasionally glittering. Maximal concavity in one-third of height from ventral margin, ranges from 3 to 8 mm. Muscle scar circular, flat, located in half of valve height, subposteriorly and attains 3—4 mm in diameter, equalling approximately 1/3 of transversal valve diameter; sometimes it is relatively deep and surrounded by thickened ridge. Hinge occupies upper part of thickened hinge margin and is bordered ventrally by wavy margin; oblique triangular in outline, with apex directed backward; its height, 2—2.5 mm, occasionally 1.5 mm, is related to size and position of attachment area. Line, marking the contact of both valves in closed shell, distinctly continues along valve margin (Pl. XXIII, Figs. 7*b*, 10*b*; Text fig. 1*e*).

Inner surface of right valve (Pl. XXII, Figs. 1*b*—13*b*) smooth, often glittering. Maximal convexity, approximately 1.5 mm deep, lies along anterior margin. Muscle scar, circular to longitudinally ovate, depressed, and located in half of valve height, subposteriorly; bordered ventrally or postero-ventrally by thickened lip. Transversal diameter of muscle scar increases together with growth of valve and attains from 1.5 to 3.5 mm, equalling 1/3—1/4 of transversal valve diameter. Edge of ventral margin commonly turned outward. Hinge, 1.5—3 mm high, with apex bent backward and outward. Hinge elements are poorly differentiated and may be distinguishable on the basis of direction of sinuous curvature of succeeding growth lines. More or less deep pit occurs in center of valve, below hinge margin; it may represent impression of pedal retractor muscle well-distinct on right valves of *Exogyra virgula* (Pl. I, Fig. 8*a*).

Ontogeny. — Ontogenetic series may be traced in material studied. Nepionic stage is represented by spherical prodissoconch, equivalve and equilateral, approximately 0.25 mm in diameter. Ontogenetic changes in further stages concern increase of shell convexity and lateral twist of umbo, mode of increment in number of radial striae and position and size of attachment area. Particular stages are characterized below:

Growth stage	Height mm	Length mm	Characteristics
Neanic	3.0—12.0	3.0—9.0	Valve circular to ovate, symmetric external surface wrinkled; initially concentric ornamentation well-developed, later radial; number of ribs up to 20, increased most often by intercalation and dichotomy; umbo not bent backward; commissure almost normal to attachment area; hinge triangular, weakly bent backward; muscle scar of right valve circular.
Ephebic	13.0—16.0	10.0—14.0	Valve oblique ovate, posterior sinus weak; mixed ornamentation, often primary rib divided into a few secondary ribs,; number of ribs increased to 60; umbo bent backward; commissure and attachment area form an acute angle; hinge oblique triangular, strongly bent backward; convexity of left valve attains about 6 mm and is shifted ventrally; muscle scar of right valve is oblique ovate.
Gerontic	17.0—22.0	11.0—16.0	Valve oblique triangular, posterior sinus stronger not marked; mixed ornamentation, ribs are fine, and numerous; other features as above; thickening of valve margin; depth maximal; commissure and attachment area form often extremly acute angle.

In the course of ontogeny the increment of valve height is more rapid, which is confirmed by increasing, although irregular, growth ratio, from 1.0 to 1.5.

Variability. — Individual variability particularly concerns the size and position of attachment area and as a result, the magnitude of angle formed by it and commisure, and height of hinge and depth of left valve. Attachment area of specimens equal in age may be terminal or shifted on upper surface of valve. In the former case, hinge is significantly higher and valve deeper than in the second (Pl. XXIII, Figs. 9, 10). Individual variability also concerns thickness and number of ribs (Pl. XXIII, Figs. 7*a*, 8*a*, 10*a*).

Remarks. — Polish specimens correspond to English ones from NW England, which are characterized by similar variability of features and occurrence in masses in so-called Fuller's Earth Clay, being an important facial index and of stratigraphic importance. Polish specimens also exhibit close similarity to French ones from the Paris Basin (Charles & Maubeuge, 1952) in external morphology, e.g. reticular ornamentation.

Occurrence. — Poland, Łęczyca: Bajocian-Bathonian, the *Parkinsonia wuerttembergica-ferruginea* Zone; Germany: Aalenian-Bathonian; France: Upper Bathonian-Lower Callovian; England: Bajocian-Bathonian.

Subfamily **Gryphaeinae,** Vialov, 1936

Revised diagnosis. — Lower valve more or less convex, rarely concave, smooth, upper valve flat or concave, sometimes ornamented with fine radial striae. Umbones straight; umbo of left valve projected and overhanging above right valve or obliterated by attachment area; umbo of right valve unprojected. Hinge of ostreoid type. Prodissoconch equivalve; 4 primary denticles, 2 on each side of ligament pit, or 5 denticles equally spaced, occur on provinculum. Ligament pit shifted posteriorly. Valve microstructure variable, from primitive subrhomboidal, to progressive, vacuolar.

Occurrence. — Liassic-Recent.

Genus *Gryphaea* Lamarck, 1801
(Type species: *Gryphaea arcuata* Lamarck, 1801)

Diagnosis. — Shell inequivalve, inequilateral, attaining moderate to large size, variable in shape; left valve more or less convex, with smooth surface, and umbo more or less projected, straight or obliterated by attachment area; umbo often overhanging above right valve; concavity continues from umbo towards ventral margin; right valve flat or concave, smooth, with umbo weakly projected or not at all; external margin smooth; hinge with oyster structure.

Gryphaea dilatata Sowerby, 1816
(Pl. XVII; Pl. XVIII, Figs. 1—3)

1834—40. *Gryphaea gigantea* Sowerby; A. Goldfuss, Petrefacta..., p. 31, Pl. 85, Fig. 5 *a—b*.
1850—51. *Gryphaea dilatata* Sowerby; H. G. Bronn, Lethaea Geognostica, p. 199, Pl. 19, Fig. 2.
1852. *Ostrea dilatata* Sowerby; A. Buvignier, Statistique..., p. 25, Pl. 5, Figs. 10—11.
1869. *Gryphaea dilatata* Sowerby; D. Brauns, Der mittlere..., p. 279—280.
1917. *Ostrea (Gryphaea) dilatata* Sowerby; L. Rollier, Fossiles..., p. 582.
1917. *Ostrea (Gryphaea) controversa* Roemer; L. Rollier, *Ibid.*, p. 552, Pl. 35, Fig. 2 a—b; Pl. 36, Fig. 1.
1917. *Ostrea (Gryphaea) exaltata* Rollier; L. Rollier, Fossiles *Ibid.*, ..., p. 547, Pl. 35, Fig. 1 *a—c*.
1924. *Gryphaea dilatata* Sowerby; E. Jourdy, Histoire..., p. 95.
1932. Gryphaea dilatata Sowerby; W. J. Arkell, A monograph..., p. 160, Pl. 14, Fig. 1; Pl. 19, Fig. 1, 1*a*; Pl. 20; Pl. 22; Pl. 23, Figs. 1—2; Text-figs. 28—42.
1955. *Gryphaea dilatata* Sowerby; P. A. Gerasimov, Rukovodiaščie..., pp. 129—130, Pl. 33, Figs. 1—3.

Material. — Thirty five single valves, predominantly right.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Depth of valve	Apical angle	Height ratio
Left valve					
145	47.0	50.0	17.0	60°	0.94
347	62.0	64.0	20.0	100°	0.97
348	67.0	82.0	25.0	110°	0.81
349	70.0	62.0	22.0	—	1.13
350	72.0	84.0	26.0	85°	0.85
351	90.0	82.0	30.0	—	1.1
Right valve					
352	24.0	19.0	—	—	1.26
353	24.0	27.0	—	—	0.89
136	33.0	28.0	—	—	1.18
354	36.0	36.0	—	—	1.0
355	40.0	38.0	—	—	1.05
137	47.0	40.0	—	—	1.17
139	50.0	45.0	—	—	1.11
356	65.0	71.0	—	—	0.91

Description. — Left valve (Pl. XVIII, Figs. 1*a*—3*a*) irregularly triangular in outline, longer than high, rarely equal. Umbo low, unprojected, obliterated by attachment area; attachment area terminal, occupying posterior part of umbo or large part of upper valve surface, commonly concave, sometimes convex. Maximal convexity, exceeding 30 mm, commonly occurs in middle part of valve or closer to umbo. Depression, dividing surface of valve into two uneven parts: narrower, middle-posterior and wide, middle-anterior parts, continues from umbo towards ventral margin. Posterior part expands along ventral or ventro-posterior margin (Pl. XVIII, Figs. 2*a*, 3*a*). Small, rounded auricles develop along dorsal margin; posterior auricle commonly larger. Ornamentation consists of fine, concentric growth lines and thick folds spaced in 5—7 mm intervals, commonly irregularly bent; surface irregular, tuberculate. Margin thickened, smooth, sometimes slightly wavy along posterior edge or turned outward in form of wide, rounded fold (Pl. XVIII, Fig. 3*a*). Apical angle commonly high, attaining 110°.

Right valve (Pl. XVII, Figs. 1*b*—4*b*) rounded or irregularly quadrilateral, flat or convex to convex-concave. In the latter case, convexity occupies upper part of valve and is separated from the lower one by transversal depression. Margin sometimes turned outward, rounded, often rectilinear along dorsal margin. Umbo very small or indistinct. Ornamentation consists of concentric growth lines and folds. Fine, radial folds are distinct on some valves in subumbonal region. Posterior subumbonal auricle commonly weakly developed, but sometimes very large (Pl. XVII, Figs. 1*b*, 2*b*).

Inner surface of left valve (Pl. XVIII, Figs. 1*b*—3*b*) smooth. Concavity greatest in half of valve height, attaining 10 to 25 mm in depth. Muscle scar located on the same height and subcentrally, rounded, and attains 12—15 mm in diameter in mature specimens, equalling 1/4—1/6 of transversal valve diameter. Hinge margin commonly very long, up to 12—15 mm, straight to arcuate, sometimes slightly wavy. Hinge low, its maximal height varies from 2—7 mm; oblique triangular in outline, with apex bent backward or truncated. When posterior auricle is strongly developed, hinge is eccentrically located. Ligament pit shallow, trough--like elongated and slightly narrower than lateral folds; those folds are very rarely rised up to 1 mm. Thickness greatest near posterior auricle up to 10 mm, but commonly attains 3—4 mm, being almost constant along the rest of margin.

Inner surface of right valve (Pl. XVII, Figs. 1*a*—4*a*) is smooth, flat to unequally concave or, occasionally, concave-convex. Muscle scar located in half of valve height, subcentrally, is deeper than that of left valve, and bordered ventrally by thickened lip; commonly it is rounded, only in valves irregular in shape it is transversally elongated and located obliquely, near posterior margin (Pl. XVII, Fig. 2*a*), attaining 6—15 mm in diameter and equalling 1/3—1/6 of transversal valve diameter. Hinge margin arcuate, sometimes straight, slightly rised. Hinge occupies small part of hinge margin, and is distinctly lower and shorter than in left valve; its is 1—4 mm high, rarely more, and up to 12 mm long, often shifted posteriorly, flat; its elements are weakly differentiated, and distinguishable by course of growth lines. Margin even and acute; only weak sinus develops in dorso-posterior part, separating small posterior auricle (Pl. XVII, Figs. 3*a*, 4*a*). A callosity, corresponding to the line of contact of valves, is distinct along margin, on some better-preserved specimens.

Ontogeny. — Only single valves were obtainable. The youngest growth stages were not observed. Great variability of features precludes characteristics of particular growth stages. However, it may be stated, that along with normal growth changes, valves of older stages become massive, posterior auricle more separated, external margin of right valves stronger turned outward, folds on valves more rised and sometimes developed as irregular lamellae.

Variability. — *Gr. dilatata* is characterized by great individual variability. Changes of particular features are interrelated, and primarily depending on location and size of attachment area. Left valves with small terminal attachment area are more regularly triangular in shape and are maximally convex in middle part; longitudinal sulcus, typical for this species, continues in posterior part; hinge high and with distinct tripartity. Translocation of attachment area on upper surface of valve results in far reaching deformations: umbo completely deformed; hinge strongly compressed, up to 1 mm high in extreme cases, and shifted posteriorly; posterior auricle abnormally expanded, and posterior sulcus completely translocated to posterior margin (Pl. XVIII, Fig. 2*a*, *b*). Translocation of attachment area to latero-posterior surface of valve results in significant increment of valve length, downward shift of posterior lobe and turning of its margin outward; longitudinal sulcus disappears and only sinusoidal depression is marked in postero-ventral margin (Pl. XVIII, Fig. 3*a*, *b*).

Right valves broadly convex, with rectilinear dorsal margin and posterior margin twice folded are probably an equivalent of left valves with abnormal development of posterior auricle. In this case, muscle scar of the right valve is located obliquely in postero-dorsal half obtaining a crescent outline (XVII, Figs. 2*a*, *b*). Right valves with equalized increments of height and lenght, probably correspond to left ones with small, terminal attachment area; muscle scar of such valves is rounded, subcentral; hinge slightly shifted to posterior part of dorsal margin (Pl. XVII, Figs. 3—4).

Remarks. — Polish specimens are very similar to English ones of Arkell (1932), with large terminal attachment area. They are also similar to Swiss specimens, included by Rollier (1917) to *Ostrea* (*Gryphaea*) *con-*

troversa Roemer. Specimens with umbo of left valve strongly coiled and overhanging the right valve, such as those illustrated by Buvignier (1852, Pl. 5, Figs. 10—11), Gerasimov (1955, Pl. 33, Figs. 1—3) and others, were not stated in Polish material. On the other hand, right valves flat or bent, with length exceeding width, and which were illustrated by Arkell (*l.c.*, Pl. 21) are almost identical with forms occurring in Poland.

Occurrence. — Poland, Western Pomerania, Holy Cross Mts.: Lower Kimeridgian, Polish Jura Chain: Upper Oxfordian, the *Idoceras planula* Zone; Soviet Union, vicinity of Moscov: Middle Callovian, Ryazań and Kostrom districts: Middle Callovian and Lower Oxfordian; Germany: Middle-Upper Oxfordian; Switzerland, France, England: Upper Oxfordian.

Subfamily **Exogyrinae,** Vialov 1936

Revised diagnosis. — Lower valve more or less convex, commonly with keel-like crest, smooth or ribbed; upper valve commonly flat or weakly convex with radial or concentric ornamentation. Umbones of both valves bent backward or more or less opisthogyre. Ligament pit narrow, arched. Tooth groove developed on hinge margin of left valve, whereas tooth outgrowth and anterior and posterior ligament ledges are developed on right valve. Prodissoconch inequivalve; pairs of primary denticles occur on anterior and posterior end of ligament pit. Primary ligament pit situated closer to anterior end of hinge margin. Inner margin of valves often with marginal elements, such as denticles and grooves. Microstructure complex: lamellar, often with featherly pattern, subrhomboidal or subconical.

Occurrence. — Lower Jurassic-Cretaceous.

Genus *Nanogyra* Beurlen, 1958

(Type species: *Gryphaea nana* Sowerby, 1822)

Revised diagnosis. — Shell inequivalve, inequilateral, attaining small size; left valve attached by small to large attachment area, more or less convex, smooth; right valve commonly flat, occasionally weakly convex, ornamented with spiral growth lines and lamellae; umbo of left valve projected, often opisthogyre; umbo of right valve spiraly coiled up to 360°; hinge with variable ostreoid-exogyroid or exogyroid structure; external margin smooth; marginal elements not recorded on inner valve edge.

Nanogyra nana (Sowerby, 1822)
(Pl. I, Figs. 1, 3—5, 7; Pl. II, Figs. 1—4; Pls. XXIV—XXVII)

1822*a*. *Gryphaea nana* Sowerby; J. Sowerby, The mineral..., p. 114, Pl. 383, Fig. 3.
1833. *Exogyra auriformis* Goldfuss; A. Goldfuss, Petrefacta..., p. 33, Pl. 86, Fig. 5 a,b.
1836. *Exogyra spiralis* Goldfuss; F. A. Roemer, Die Versteinerungen..., p. 65, Pl. 18, Fig. 18 (var. B).
1837. *Gryphaea nana* Sowerby; G. G. Pusch, Polens Paläontologie, p. 40.
1858. *Exogyra spiralis* Goldfuss; A. Quenstedt, Der Jura, p. 752, Pl. 91, Fig. 32 (non Fig. 31).
1862. *Ostrea spiralis* d'Orbigny; J. Thurmann & A. Étallon, Lethea..., p. 274, Pl. 39, Fig. 3.
1862. *Ostrea subnana* Étallon; J. Thurmann & A. Étallon, *Ibid.*, p. 276, Pl. 39, Fig. 4.
non 1862. *Ostrea nana* Étallon; J. Thurmann & A. Étallon, *Ibid.*, p. 275, Pl. 39, Fig. 7.
1862. *Ostrea quadrata* Étallon; J. Thurmann & A. Étallon, *Ibid.*, p. 227, Pl. 39, Fig. 8.
1865. *Exogyra Bruntrutana* Thurmann; A. Sadebeck, Die oberen..., p. 651.
1872. *Ostrea Bruntrutana* Thurmann; P. Loriol, E. Royer & H. Tombeck, Description géologique..., p. 399, Pl. 24, Figs. 7—18.
1882. *Exogyra reniformis* Roeder; H. Roeder, Beitrag..., p. 36, Pl. 1, Fig. 3; Pl. 2, Fig. 1.
1893. *Ostrea Bruntrutana* Thurmann; Ed. Greppin, Étude..., p. 90, Pl. 6, Figs. 12, 14, 20.
1924. *Exogyra nana* Sowerby; E. Jourdy, Histoire naturelle..., pp. 58—65, Pl. 2, Figs. P, R, C, B; Pl. 5, Figs. 2—5, 7, 9—12; Pl. 6, Figs. 1—3, 5; Pl. 7, Fig. 6; Pl. 8, Figs. 7, 8; Pl. 9, Fig. 1.
1927. *Ostrea (Exogyra) quadrata* Étallon; V. F. Pčelincev, Fauna..., p. 77.
1927. *Ostrea (Exogyra) bruntrutana* Thurmann; V. F. Pčelincev, *Ibid.*, p. 77.
1929—37. *Exogyra nana* (J. Sowerby); W. J. Arkell, A monograph..., p. 175, Pl. 17, Figs. 2—21; Pl. 18, Figs. 3—11; Pl. 19, Figs. 4, 4a, Text-fig. 48,
non 1929—37. *Exogyra reniformis* Goldfuss; W. J. Arkell, *Ibid.*, p. 175.
1951. *Exogyra nana* Sowerby; W. Krach, Małże..., p. 353, Pl. 13, Figs. 15, 16.
1954. *Exogyra nana* (Sowerby); E. Basse, Fossiles..., p. 664, Pl. 27, Fig. 3a—c.
1954. *Gryphaea balli* (Stefanini); E. Basse, *Ibid.*, p. 665, Pl. 27, Fig. 2 a—c.
1955. *Exogyra nana* (Sowerby); P. A. Gerasimov, Rukovodiaščie..., p. 131, Pl. 30, Figs. 1—14.
1965. *Nanogyra nana* (Sowerby); L. Karczewski, Fauna..., p. 116, Pl. 7, Fig. 3.
1965. *Exogyra nana* (Sowerby; L. R. Cox, Jurassic Bivalvia..., p. 73, P. 11, Figs. 5, 6 a—b.
1965. *Nanogyra nana* (Sowerby); S. Fréneix, Les bivalves..., p. 41, Pl. 5, Figs. 2—6.
1970. *Exogyra nana* (Sowerby); J. Dmoch, Ślimaki i małże..., p. 80, Pl. 7, Fig. 24.

Material. — Twenty complete shells and over 500 single valve, predominantly right, well-preserved.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Height ratio	Heinght of umbo
Left valve				
357	4.0	3.0	1.33	0.5
201	9.0	7.0	1.28	3.0
202	17.0	12.0	1.41	3.0
9	19.0	15.0	1.26	5.0
205	21.0	17.0	1.23	5.0
11	30.0	20.0	1.5	5.0
358	40.0	29.0	1.38	8.0
Right valve				
194	1.5	1.4	1.07	—
359	3.0	2.2	1.36	—
360	8.0	5.5	1.6	—
361	14.0	13.0	1.07	—
213	18.0	10.5	1.71	—
362	19.0	16.0	1.19	—
363	24.0	15.0	1.6	—
364	26.0	20.0	1.3	—
365	40.0	22.0	1.8	—

Description. — Left valve (Pl. XXV, Figs. 1*a*—7*a*; Pl. II, Fig. 3*a*, 4) variable in shape, normally ovate with transversal diameter larger, sometimes rounded or irregular. Convexity greatest in half of valve height. Anterior margin convex, rounded and longer than posterior; margin commonly rounded or with weak subumbonal sinus, often lobe-like extended. Umbo projected, 2—3 mm high on concave specimens, and 9—11 mm high on others, commonly strongly coiled outward (Pl. XXV, Fig. 5*a*) or spiral (Pl. II, Fig. 4). Attachment area varying in depth, outline and size, and located terminally or on posterior part of umbo or shifted on upper surface of valve. Valve surface commonly uneven, ornamented with concentric, very fine growth lines; weak furrow, distinct on some specimens, continues from umbo towards ventral margin, dividing the valve into two unequal parts: narrower posterior part and wider anterior. In this way, so called "bilobate forms" originate. Margin more or less even, and nonfolded.

Right valve (Pl. XXIV, Figs. 1*b*—6*b*; Pl. XXV, Figs. 3*b*, 4*b*, 7*b*; Pl. XXVI, Figs. 1*b*—6*b*; Pl., XXVII, Figs. 1*b*—6*b*) smaller than left, flat or weakly convex close to anterior margin, where keel-like crest, parallel to anterior margin, sometimes is developed. Valve outline varies from ovate, with height exceeding length to rounded, irregularly triangular or quadrangular. Umbo opisthogyre, up to 360° or more (Pl. XXVI, Figs. 3*b*, 5*b*). In proximal part of umbo, a relatively large prodissoconch, 0.35—0.40 mm in diameter, is distinct (Pl. XXIV, Figs. 1*b*—6*b*). Ornamentation consists of concentric lamellae, more or less protruding and forming thick, convex marginal belt along anterior margin due to overlapping. Lamellae occasionally are inequally spaced (Pl. XXV, Fig. 3*b*), whereas on high-valved specimens they are flexuous and spaced in greater intervals along ventral margin than postero-dorsal (Pl. XXVII, Figs. 3*b*, 4*b*). Valve of young specimens is sometimes longitudinally or transversally folded. Posterior margin rounded or lobelike extended in subumbonal region, occasionally with wide, shallow sinus (Pl. XXVII, Figs. 1*b*—4*b*).

Inner surface of left valve (Pl. XXV, Figs. 1*b*, 2*b*, 5*b*, 6*b*) smooth, concave along anterior margin and subcentrally or below umbo. Ridge-like callosity continues along margin towards hinge and joints hinge margin, and is particularly convex near posterior margin. Hinge margin thickened, wavy or arcuate; tooth outgrowth thickened and projected, occurs on its posterior side and adjoins deep and commonly elongate tooth groove; tooth groove is bordered ventrally by ridge-like callosity, described above, and dorsally by arcuate posterior ligament ledge. Hinge oblique triangular with apex bent backward. Ligament pit and its lateral folds are similarly bent. Occasionally, anterior fold is flattened or both folds disappear. All transitions, from primitive, distinctly tripartite structure of hinge of the ostreoid type, to progressive exogyroid hinge devoided of lateral folds, and with such new elements as posterior ledge, tooth outgrowth and tooth groove, may by traced in *Nanogyra nana* (Text-fig. 4*a*—*f*; Pl. II, Figs. 1, 2).

Muscle scar located in half of valve height, subposterior, strongly depressed, bordered ventrally by thickened lip, sometimes flat; its diameter attains 2—8 mm, equalling 1/2—1/3 of transversal valve diameter. Inner margin smooth, up to 2 mm thick, rounded.

Inner surface of right valve (Pl. XXIV, Figs. 1 *a*, *c*—6 *a*, *c*; Pl. XXVI, Figs. 1*a*—6*a*; Pl. XXVII, Figs. 1*a*—6*a*) more or less compressed, slightly concave along anterior margin; sometimes weak, glittering depression continues along anterior margin, occupying space between anterior margin and muscle scar, and is marked with transversal, slightly bent lines, probably an impression of gill lamellae, what is pointed by their course and location (Pl. XXVII, Fig. 4*a*). Hinge margin arcuate or wavy. Hinge up to 3—4 mm high. Tooth outgrowth commonly low, thick and rounded or transversally folded, rarely high (Pl. XXVI, Fig. 6*a*, *b*). Weakly convex ledge is located anteriorly, near tooth outgrowth and is parallel to posterior fold or, when it disappears, to posterior edge of ligament pit. Muscle scar similarly located as in left valve, more depressed, often elongated transversally and bordered ventrally by thickened lip. Muscle scar of specimens abnormally elongated or rounded, is also ovate, higher than long, or circular (Pl. XXVI, Figs. 5*a*, 6*a*; Pl. XXVII, Figs. 2*a*—4*a*). Its transversal diameter commonly attains 8—10 mm, equalling 1/2—1/3 of transversal valve diameter. External margin of concave forms is mildly folded outward, smooth and rounded, sometimes slightly transversally folded near posterior margin (Pl. XXVII, Fig. 4*a*).

Ontogeny. — All growth stages are represented in material studied. These stages differ in development of a number of features, as shape of valves, hinge structure, location and size of muscle scar, external ornamentation and magnitude of angle of umbonal spire of right valve (Text-fig. 1*b*). On the basis of those changes, the growth stages may be characterized as follows:

Growth stage	Height mm	Length mm	Characteristics
Nepionic	0.35	—	Prodissoconch spherical, terminal and directed upward; smooth.
Early-neanic	0.4—0.6	0.36—0.5	Prodissoconch slightly bent backward; valve is increased by one growth lamella; shape rounded.
Middle-late-neanic	1.0—4.0	0.8—3.0	Prodissoconch gradually bent backward; umbonal spire attains an angle of 120—180°; shell inequivalve and inequilateral; growth lines sinusoidal, up to 10 in number; muscle scar rounded, subcentral; hinge opisthogyre, low and elongated; ligament pit shallow; tooth outgrowth well-marked, convex, arcuate.
Ephebic	5.0—20.0	4.0—17.0	Prodissoconch located inside of umbonal coil; umbonal spire attains an angle of 270°, and overpass it significantly later; valve shape variable; growth lamellae numerous, overlapping along anterior margin, flexuous over rest of valve; left valve attains maximal convexity, upper surface irregularly wrinkled; structure of hinge typical.
Gerontic	21.0—40.0	18.0—22.0	Progressive translocation of prodissoconch; umbonal spire attains an angle of 360°; umbo of left valve often helicoidal, high; further change lead to origin of "bilobate forms", thickening of anterior margin and increase of shell dimensions; posterior lobe expands; muscle scar very large, shifted posteriorly.

Height ratio changes independently from age of specimens, what points on the variability of shape of shell in every growth stage.

Variability. — *Nanogyra nana* is characterized by very wide individual variability, mainly in shape and depth of valves and in structure of hinge. These changes are particularly distinct on right valves. Two extreme morphotypes may be distinguished on the basis of those features differently developed: one characterized by rounded valves, the other —

by strongly elongated valves, significantly higher than long (Pl. XXVI, Figs. 1—6; Pl. XXVII, Figs. 1—4, 6).

First morphotype. Valve circular, flat and ornamented with spiral growth lines and lamellae; umbo subcentral; angle of spire equal 360°; hinge strongly compressed, shifted on posterior margin; sometimes tooth outgrowth very strongly developed, flat; muscle scar large, circular, subposterior (Pl. XXVI, Fig. 6*a*), flat, occasionally depressed in upper part.

Second morphotype. Valve ovate, strongly elongated along the height axis, sometimes even two times higher than long. Ornamentation consists of concentric, strongly flexuous lamellae; umbo small, spirally coiled and located in upper part of valve, posteriorly. Angle of spire below 360°. Marginal belt well-developed due to overlapping of succeeding lamellae parallelly to anterior margin. Valves concave along anterior margin. Hinge high, postero-dorsal; tooth outgrowth low, thickened. Muscle scar ovate, higher than long, marked by postero-ventral lip. Anterior margin rounded, whereas posterior straight, with weak subumbonal lobe (Pl. XXVII, Figs. 1*b*—4*b*). Transitional forms with particular features of mixed character may be distinguished. It should be stressed that there exists a close relation of dimensions, shape and internal structure of valve to size and location of attachment area. This relation was discussed above.

Remarks. — Large variability in *Nanogyra nana* was the reason that previous authors proposed several species, taking into account shape of valve, but not the inner structure. The author, on the basis of abundant material, arrived to the conclusion that several formerly proposed species represent only different morphologic types of *Nanogyra nana*. Similar point of view was held by Jourdy (1924) and Arkell (1929—37). Polish specimens are very similar to specimens described by Jourdy and Arkell and several other authors. The author considers the inclusion of *Ex. reniformis* Goldfuss to *N. nana* by Arkell (*l.c.*) as invalid, because the former species differs in occurrence of marginal elements on the inner edge of valve and a small angle of umbonal spire, attaining maximally 180°. The author excludes from *N. nana* the specimens of Étallon (1862), occurring in clusters, and characterized by hinge of oyster type, and umbones not coiled.

Occurrence. — Poland, Łęczyca: Bathonian, Polish Jura Chain: Callovian, Upper Oxfordian-Kimeridgian, Mesozoic margin of the Holy Cross Mts.: Upper Oxfordian-Kimeridgian, Western Pomerania: Upper Oxfordian-Kimeridgian, Middle Volgian, of Tomaszów Mazowiecki: Middle Volgian; Soviet Union: Middle Callovian-Upper Volgian; Germany, France, Switzerland: Upper Jurassic; England: Bajocian-Kimeridgian; India: Bathonian-Lower Oxfordian; Yemen: Upper Jurassic.

Genus *Exogyra* Say, 1820

(Type species: *Exogyra costata* Say, 1820)

Diagnosis. — Shell inequivalve, inequilateral, attaining small to large size, variable in shape, attached by subumbonal or umbonal part; left valve convex, right valve flattened; left valve ornamented with radial striae, ribs or folds; right valve covered with concentric growth lines and lamellae; umbones of both valves opisthogyre. Margin smooth, vavy; marginal elements usually developed.

Exogyra crassa (Smith, 1817)

(Pl. II, Fig. 7)

1863. *Ostrea (Exogyra) lingulata* Walton; J. Lycett, Supplementary..., p. 108, Pl. 32, Figs. 2, 2a, 2b.
1913. *Ostrea bathonica* d'Orbigny; M. Boule & A. Thévenin, Types..., p. 166, Pl. 29, Figs. 4—6.
1923. *Exogyra lingulata* Walton; M. Lissajous, Étude..., p. 146, Pl. 29, Figs. 1, 1a, 2—4.
1925. *Ostrea Albertina* d'Orbigny; M. Boule & J. Cottreau, Types..., p. 30, Pl. 41, Figs. 16—18.
1948—50. *Exogyra crassa* (Smith); L. R. Cox & W. J. Arkell, A survey..., Pt. II, p. 20.

Material. — One right valve of young ontogenetic stage, well-preserved.

Description. — Valve 31 mm high, 15 mm long, irregularly rectangular. Upper margin rectlinear, slightly depressed in posterior part, almost normal to posterior and anterior margins. Ventral margin rounded and lobe-like expanded near posterior margin. Umbo unprojected, rounded. External surface uneven and covered with weak growth lines, developed as fine concentric lamellae on lower half of valve. Near ventral margin, valve is turned outside along concentric depression.

Inner surface of valve (Pl. II, Fig. 7*a*) smooth, concave in upper part and convex in lower part. Muscle scar ovate, depressed in its upper part and convex in lower, shifted postero-ventrally; its transversal diameter slightly shorter than longitudinal and attains 6 mm, equalling approximately 1/4 of transversal valve diameter. Fold, bordering posteriorly muscle scar, continues upward and joints with hinge margin. Hinge margin thickened, arcuate, obliquely situated, distinctly lowering towards posterior. Hinge is 6 mm high and 10 mm long, parallel to hinge margin. Umbo lowered, with rounded postero-dorsal margin, placed on posterior side of hinge. Longitudinal ridge adjoins hinge on its anterior side. Weakly differentiated elements of hinge, as ligament pit and folds, may be discerned only by curvature of growth lines. Thickness of valve equals 2 mm increasing to 4 mm in region of hinge.

Remarks. — The only specimen from Poland is very similar to English specimens included to *Exogyra crassa* (Smith). This species is quite distinct from other Jurassic exogyras by its rectangular shape, massive structure, large and depressed muscle scar and separate structure of hinge. Polish specimen is relatively small, whereas valves of *Ex. crassa* usually attain up to 77 mm in height. Presumably it represents young growth stage.

Occurrence. — Poland, Łęczyca: Bajocian-Bathonian; France: Bathonian-Callovian; England: Upper Bathonian.

Exogyra virgula (Defrance, 1820)
(Pl. I, Fig. 8; Pls. XXVIII—XXX)

1820. *Gryphaea virgula* Defrance; M. Defrance, Dictionnaire..., T. 22, p. 26.
1836. *Exogyra denticulata* Roemer; F. A. Roemer, Die Versteinerungen... (pars) p. 65, Pl. 3, Fig. 13 a—c (non Fig. 13 d, e).
1837. *Gryphaea virgula* Defrance; G. G. Pusch, Polens Paläontologie, p. 40.
1834—40. *Exogyra virgula* Goldfuss; A. Goldfuss, Petrefacta..., p. 33, Pl. 86, Fig. 3 a—c.
1851—52. *Exogyra angustata* Bronn; H. G. Bronn & F. A. Roemer, Lethaea..., p. 202, Pl. 18, Fig. 15.
1852. *Ostrea virgula* Defrance; A. Buvignier, Statistique..., p. 25, Pl. 20, Figs. 12, 13.
1862. *Ostrea virgula* Defrance; A. Thurmann & A. Étallon, Lethea..., p. 275, Pl. 39, Fig. 10.
1970. *Exogyra virgula* (Defrance 1825); I. Dmoch, Ślimaki..., p. 81, Pl. 7, Figs. 5—6 (vide synonymy).

Material. — Sixty complete shells and over 600 single valves well--preserved.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Height ratio
226	2.0	2.0	1.0
228	4.0	3.0	1.33
237	7.5	4.5	1.7
366	8.5	5.0	1.7
238	10.0	7.0	1.42
244	11.0	6.0	1.8
242	15.0	8.5	1.8
8	17.0	10.0	1.7
380	20.0	11.0	1.8
235	23.0	11.0	2.1
367	29.0	16.0	1.8

Description. — Shell of small size, arched; valves uniform in shape and ornamented with concentric growth lines and lamellae and fine radial striae. External margin smooth. Inner edge with marginal elements.

Left valve (Pl. XXIX, Figs. 1*a*—6*a*; Pl. XXX, Figs. 1*a*, 4*a*—6*a*) with maximal convexity, up to 11 mm, in half of its height. Rounded or keel--like arcuate crest continues medially across that convexity, dividing valve commonly into narrower anterior part, quite steeply inclined anteriorly, and posterior part, gradually sloping towards posterior margin. Anterior margin broadly rounded and significantly longer than sinusoidal posterior. Umbo commonly constricted, sometimes widened and deformed by terminal attachment area, and bent backward. Postero-ventral edge usually narrow, sometimes lobe-like expanded. While postero-ventral edge is sinuous, its projected part extends only as far as umbo (Pl. XXX, Fig. 4*a*). Along with growth lamellae undergo changes in direction — every succeding lamella turns back under a certain angle. Radial striae exhibit fan pattern, are often wavy, and sometimes continue across few lamellae or are disrupted on their edges and alternate; their number increases rapidly due to intercalation. Secondary striae are finer, lower and narrower.

Right valve (Pl. XXVIII, Figs. 1*b*—5*b*; Pl. XXX, Figs. 2*a*, 3*a*, 7*a*) strongly flattened as a rule, and with bipartity distinct, similarly as on the left one. Narrow marginal belt runs distinctly along broadly rounded anterior margin. This belt is formed by overlapping of growth lamellae, progressively longer towards anterior margin. The rest of valve is covered with sinuous growth lines, modified into scaly lamellae along posterior and postero-ventral margins, and sometimes by radial, fine striae (Pl. XXX, Fig. 7*a*). Keel-like or rounded crest of marginal belt forms a boundary between differently ornamented parts of valve. Umbo commonly very low, opisthogyre, up to 180°, with a tendency to ventral shift. Prodissoconch small, spherical, always directed ventrally and up to 0,25 mm in diameter (Pl. XXVIII, Figs. 1*b*—5*b*).

Inner surface of left valve (Pl. XXIX, Figs. 1*b*, *c*, 2*b*, *c*, 4*b*, 5*b*, *c*, 6*b* *c*; Pl. XXX, Figs. 1*b*, 5*b*, 6*b*) ununiformly concave; concavity greatest below umbo and in central part of valve. Margin smooth, sharp and unfolded. Marginal ornamentation, consisting of small alternating grooves and tubercules, particularly distinct in subumbonal region, and elongating towards ventral margin, occur along the whole margin (Pl. XXX, Fig. 5*b*). Elongated tubercules and grooves are parallel to each other and normal to external margin. Muscle scar located almost in half of valve height, and subposteriorly, is flat, ovate, with rectilinear upper margin and rounded lower one; its transversal diameter attains almost 4 mm, equalling approximately 1/3 of transversal valve diameter. Hinge margin arcuate, bent backward and slightly rised above valve surface. Tooth groove (Pl. XXX, Figs. 5*b*, 6*b*) developed under hinge margin, posteriorly, sometimes in the form of slit or rounded hole and corresponds to the tooth outgrowth of other valve; tubercules and grooves, mentioned above, are marked also on the surface of tooth groove. Hinge bent backward, oblique triangular, with broad base, arched sides and acute apex, which often is obscured by overhanging umbo; hinge is bordered dorsally by overhanging, strongly arcuate valve margin.

Inner surface of right valve (Pl. XXVIII, Figs. 1*a*, *c*—5*a*, *c*; Pl. XXX, Figs. 2*b*, 3*b*, 7*b*) shallow or slightly convex in posterior part and concave below umbo and along anterior margin, where it attains up to 2 mm in depth. Marginal elements are translocated onto the margin along the whole periphery of valve, resulting in its denticulate form, except for posterior margin where they occur on the inner surface. Hinge oblique elongated and bordered ventrally by thickened hinge margin. Hinge margin higher and broader posteriorly, with terminal tooth outgrowth. Tooth outgrowth covered with elongated tubercules and grooves on its posterior surface, and bordered dorsally by furrow corresponding to ligament ledge of left valve. This furrow is broad at its base and wedges out close to umbo. Muscle scar located subposteriorly in half of valve height, ovate and deeper than that of the left valve and similar to it in size and outline; bordered ventrally by lip. On better-preserved specimens, below hinge margin, subcentrally, an impression of retractor muscle crescent in outline is marked, with upper margin rectilinear, and lower rounded (Pl. 1, Fig. 8*a*). Its transversal diameter attains 0.5 mm, equalling a quarter of transversal diameter of adductor muscle.

Ontogeny. — Abundant material enabled analysis of succeeding ontogenetic stages, listed below, and particularly of the earliest ones. The earliest nepionic stage is represented by spherical prodissoconch, 0.25 mm in diameter, terminal, directed upward. Appearance of first growth lines marks nepionic-neanic boundary. Features of particular stages are summarized below:

Growth stage	Height mm	Length mm	Height ratio	Characteristics
Nepionic			1.0	Spherical prodissoconch
Early-middle-late neanic	0.35	0.35—3.0	1.0—2.0	Prodissoconch directed backward; umbo forms spiral of angle of 45—90°; shell inequivalve, inequilateral; left valve convex; right valve flattened; hinge opisthogyre; ligament pit elongated transversally tooth outgrowth large, arcuate, tuberculated and grooved; muscle scar rounded; development of radial ornamentation; 6—15 growth lines; attachment area terminal, deep.

cd page 289

Growth stage	Height mm	Length mm	Heigth ratio	Characteristics
Ephebic	4.1—10.0	3.1—8.0	1.2—2.0	Prodissoconch shifted downward; umbo coiled up to 180° in late ephebic stage; quicker increment of valve height; gradual development of furrow above tooth outgrowth, and transversal ligament ledge; muscle scar outline changes to ovate; posterior margin increasingly sinuous; anterior margin arcuate.
Ephebic-gerontic, gerontic	10.1—30.0	8.1—18.0	1.2--2.5	Quicker increment in valve height; spiral angle sometimes exeeds 180°; strong thickening of anterior margin; left valve strongly arcuate; muscle scar ovate, higher than long, commonly with truncated upper margin.

Height ratio significantly varies due to large variability in outline of valves.

Variability. — *Exogyra virgula* is characterized by large individual variability primarily in shape and size of valves and in development of particular elements of hinge. Three basic morphotypes may be distinguished on the basis of different shape of valves, as follows: 1) "virguliform" shell, strongly elongate, more or less constricted near postero-ventral margin; increment in height distincly exceeds increment in length (Pl. XXX, Figs. 1, 4, 5, 6); 2) valve ovate, elongated, with postero-ventral margin rounded; equal increments in heigth and length (Pl. XXX, Figs. 2, 3); 3) shell triangular to oblique-triangular; increment in height smaller (Pl. XXX, Fig. 7). Shells with greater increment in height have ovate muscle scar and anterior margin more arcuate than other forms. Shells of the third morphotype are commonly characterized by rounded muscle scar and weaker arch of anterior margin. Changes in rates of shell increment in particular types are well-illustrated by height ratio, which equals 1.5 to 2.5 for the first type, 1.4—1.7 for the second and 1.2—1.5 for the third. Changes in structure of hinge (cf. Text-fig. 4 *g*—*n*) concern primarily the length and thickness of posterior ligament ledge, size and degree of isolation of tooth outgrowth, depth of tooth groove of left valve and height and width of ligament furrow.

Occurrence. — Poland, Western Pomerania, Mesozoic margin of the Holy Cross Mts: Lower-Upper Kimeridgian; Switzerland; Soviet Union: Kimeridgian; Germany: Kimeridgian, Portlandian; France: Upper Oxfordian, Portlandian.

Exogyra reniformis Goldfuss, 1834—40
(Pls. XXXI—XXXII)

1834—40. *Exogyra reniformis* Goldfuss; A. Goldfuss, Petrefacta..., p. 34, Pl. 86, Fig. 6, (non Fig. 7).
non 1834—40. *Ostrea reniformis* Münster; A. Goldfuss, *Ibid.*, p. 20, Pl. 79, Fig. 4.
1874. *Exogyra reniformis* Goldfuss; D. Brauns, Der obere Jura..., p. 355.
non 1822. *Exogyra reniformis* Roeder; H. Roeder, Beitrag..., p. 36, Pl. 1, Fig. 3; Pl. 2, Fig. 1.
1913. *Exogyra reniformis* Goldfuss; K. Wójcik, Jura..., p. 31.
1924. *Exogyra reniformis* Goldfuss; E. Jourdy, Histoire..., p. 71.

Material. — Approximately 50 single valves and 4 complete shells, well-preserved.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Height ratio
Left valve			
253	12.0	9.0	1.33
368	13.0	10.0	1.3
255	17.0	10.0	1.7
257	19.0	12.5	1.52
254	20.0	13.0	1.53
258	24.0	14.0	1.71
Right valve			
369	8.0	7.0	1.14
259	10.0	7.5	1.33
370	12.0	10.0	1.2
260	14.0	9.0	1.55
261	17.0	10.0	1.7
262	18.0	12.0	1.5

Description. — Shell attaining moderate size and ornamented with fine growth lines. Umbo unprojected, opisthogyre, and forms a flat spiral with angle exceeding 180°. Attachment area terminal or located on upper surface of valve.

Left valve (Pl. XXXII, Figs. 3*a*—5*a*, 7*a*) maximally convex in half of its height or subanteriorly, up to 8—9 mm. Crest, rounded or keel--like, runs from umbo towards ventral margin. Surface smooth; only occasionally growth lines are thickened near ventral margin or developed in the form of protruding lamellae. Height ratio increases from 1.2 to 1.8 along the age, pointing to uniform growth of valve.

Right valve (Pl. XXXI, Figs. 1*b*—5*b*; Pl. XXXII, Figs. 1*a*—2*a*, 6*a*), similar in shape to left one, but usually smaller. Anterior margin rounded and thicker than posterior. Posterior margin develops weak sinus or is lobe-like elongated. Fine radial striae sometimes are marked on growth lines near ventral margin. Prodissoconch spherical, equal 0,25 mm in diameter. Increments of height and length almost equal, what is confirmed by height ratio changing from 1.1 to 1.6.

Inner surface of left valve (Pl. XXXII, Figs. 3*b*—5*b*, 7*b* maximally concave along anterior margin, where it attains 6—8 mm in depth, and below hinge. Muscle scar lies in half of valve height or slightly above, subcentrally, or occasionally is shifted closer to posterior margin; rounded or ovate with height exceeding length; its transversal diameter varies from 3 to 4 mm, equalling approximately a quarter of transversal valve diameter; usually flat or slightly concave close to dorsal and posterior margin, sometimes a little thickened ventral lip is developed; dorsal margin of muscle scar is rectilinear, weakly rounded or slightly concave. On some specimens and particularly in the late growth stages, posterior margin of muscle scar exhibits apparent duplication, resulting from shift of scar towards posterior margin of valve. Hinge margin swollen and wavy, rised. Hinge strongly opisthogyre, located in postero-dorsal part of valve, and consisting of ligament pit elongated transversally and posterior ligament ledge, which is short and arcuate. Deep tooth groove located below hinge, posteriorly. Commonly, posterior lobe folded transversally and flat, develops below hinge margin; its surface, similarly as the rest of inner edge of valve, is ornamented with marginal elements. These elements are developed as elongated furrow and ridges along posterior margin, and as grooves and tubercules along the rest of inner edge (Pl. XXXII, Figs. 3*b*—5*b*).

Inner surface of right valve (Pl. XXXI, Figs. 1*a*, *c*—5*a*, *c*; Pl. XXXII, Figs. 1*b*, 2*b*, 6*b*) significantly less concave than of left valve. Concavity greatest along anterior margin, reaching from 1 to 3 mm in depth. Sometimes valve slightly convex in half of its height; in such case, muscle scar lies on that convexity. Valve margin turned outside along posterior and anterior margin, sometimes along the whole margin. Muscle scar subcentral, sometimes located subposteriorly in half of valve height, occasionally obliquely (Pl. XXXII, Fig. 1*b*), ovate with height exceeding length, and sightly depressed, particularly near dorsal edge; muscle scar attains about 4 mm in diameter, equalling approximately a quarter of transversal valve diameter. Hinge occupies postero--dorsal margin of valve and is strongly shifted backward. Ligament pit elongated transversally, narrow and separated from large tooth outgrowth by arched posterior ligament ledge (Text-fig. 5*a*, *b*). Marginal elements maximally developed along posterior valve margin; on the rest of margin they are shifted onto the edge, which becomes finely-denticulate (Pl. XXXI, Figs. 1*c*—5*c*). Marginal elements covers also the posterior surface of tooth outgrowth.

Ontogeny. — All growth stages are represented in material studied. The earliest neanic stage was mainly studied on right valves. In ontogeny, shape of valves, position and shape of muscle scar and structure of hinge change most distinctly. Particular stages are characterized below:

Growth stage	Height mm	Length mm	Characteristics
Nepionic	0.25	0.25	Prodissoconch spherical, non-ornamented, equilateral and equivalve;
Early-middle-late-neanic	1.0—3.5	1.0—2.5	Prodissoconch directed backward; umbonal spiral equal 45°; shell inequivalve, inequilateral increments in height and length equal; in late neanic stage, height increment greater; muscle scar flat, circular, subcentral; hinge arquate; ligament pit narrow; lateral fold well-developed; tooth outgrowth covered with transversal furrows, low, arcuate; posterior lobe developed; left valve attached with its whole surface;
Ephebic	4.0—15.0	3.0—10.0	Prodissoconch directed backward and downward; umbonal spiral equal 90°; height increase quicker than length; muscle scar slightly depressed dorsally, dorsal margin rectilinear; position of muscle scar variable, outline ovate; hinge more differentiated; tooth outgrowth thickened, higher; posterior fold arcuate; posterior and ventral margins of right valve turned outside in late ephebic stage, valve detaches from substratum.
Gerontic	16.0—25.0	11.0—15.0	Umbonal spiral exceeds often 180°; left valve attains maximal concavity; external margins thickened up to 2 mm; hinge well-developed, tooth groove of left valve is deep, tooth outgrowth of right valve is thick, high and often elongated along posterior margin; marginal elements secondarily become shallow, occasionally granulation is obliterated; surface covered with protruding lamellae close to ventral margin.

Variability. — *Exogyra reniformis* is characterized by small individual variability, manifested mainly in changes in shape of shell, size and position of attachment area and in some changes in degree of development of particular elements of hinge and in shape of muscle scar.

Shape of shells commonly ovate, with height exceeding length, changes into asymmetric rounded or arcuate. Arcuate shape is closely related to size and position of attachment area, and shell becomes stronger arcuate with an increase of attachment area and its postero-dorsal shift.

Differences in development of posterior lobe or sinus, as well as in depth of valves, particularly left ones, are related to differences in rates of height and length increments; the quicker is the increase in lenght the more prominent the posterior lobe, and conversely — wide and deep posterior sinus develops and valves are deeper, when height of valve increases quicker. These differences are related to position and size of attachment area; if small and terminal, then valves are ovate with height exceeding length; whereas attachment area large and translocated onto the upper surface of valve is connected with broader, compressed forms with quicker increase of length. Spiral umbo usually characterized by 180° angle, rarely greater. In hinge, commonly size of tooth outgrowth and tooth groove, corresponding to it, undergo some changes.

Remarks. — Polish specimens are identical to German ones, illustrated by Goldfuss (1834, Pl. 86, Fig. 6), except for specimens from his Pl. 79, Fig. 4 and Pl. 86, Fig. 7, which the present author excludes from that species; the former specimen was found in the Middle Triassic deposits, whereas the latter differs from *Ex. reniformis* and seems related closer to *Ex. welschi* in its folded valve, whereas valves of *Ex. reniformis* have smooth external surface. The author excludes also specimens of *Ex. reniformis* Goldfuss in Roeder (*l.c.*, p. 36) being synonym of *Nanogyra nana*; the Roeder's forms are similar to Goldfuss's species in their external features but differ in lack of marginal elements.

Ex. reniformis is somewhat similar to *Ex. virgula* in its outline, but distinctly differs in ornamentation and mode of valve growth.

Occurrence. — Poland, Western Pomerania: Upper Kimeridgian; Germany: Kimeridgian; France: Middle-Upper Oxfordian.

Exogyra welschi Jourdy, 1924
(Pls. XXXIII—XXXIV)

1924. *Exogyra welschi* Jourdy; E. Jourdy, Histoire..., p. 70, Pl. 6, Fig. 7; Pl. 8, Fig. 11, o; Pl. II, Fig. 5, s.

Material. — Five complete shells and 40 single valves, well-preserved

Measurements (in mm):

No. Z. Pal. U.W. Mo. V/	Height	Length	Height ratio
Left valve			
371	9.0	7.0	1.28
274	11.0	8.5	1.3
372	13.5	10.0	1.35
277	15.0	10.0	1.5
275	17.0	14.0	1.21
276	18.0	12.0	1.5
Right valve			
271	7.0	6.0	1.16
373	8.0	6.5	1.23
272	10.0	9.0	1.11
273	13.5	10.0	1.35
374	15.0	13.0	1.15
375	17.0	12.0	1.4

Description. — Left valve (Pl. XXXIV, Figs. 4*b*, 5*a*, 6*b*, 7*b*) larger than right, oblique triangular to ovate or irregularly rounded; convexity maximal in half of valve height, up to 7 mm. Attachment area large, terminal or shifted backward. External edge commonly folded, except for posterior margin, where it forms broad and shallow sinus or lobe-like widening, rarely straight, commonly short; anterior edge long, broadly rounded. Occasionally, an arcuate ridge continues acros middle part of valve. Ornamentation consists of fine concentric growth lines, sometimes flexuous, and radial striae and folds, broad and high near ventral and postero-ventral margins. Intervals between folds commonly wide in upper part of valve, are progressively narrower and deeper towards the lower part, reaching furrow-like appearance. Growth lines, commonly in the forms of protruding lamellae, are developed at crests of folds.

Right valve (Pl. XXXIII, Figs. 1*b*—5*b*; Pl. XXXIV, 1*b*—3*b*, 5*b*) smaller than left, commonly more or less rounded and flattened, sometimes irregularly ovate with height exceeding length. Posterior margin straight or lobe-like expanded. Umbo opisthogyre, with umbonal spiral over 180°. Spherical prodissoconch distinct, directed downward or to anterior margin. Ornamentation consists of concentric growth lines and low folds, prominent near posterior margin (Pl. XXXIV, Figs. 2*b*, 3*b*).

Inner surface of left valve (Pl. XXXIV, Figs. 4*a*, 6*a*, 7*a*) maximally concave below hinge, or, in the case of arcuate forms, subcentrally where it attains 7—8 mm in depth. Marginal elements developed along the whole periphery of valve and posterior surface of hinge in forms of small elongated grooves. Hinge, oblique triangular with broad, wavy base, arcuate sides and apex strongly opisthogyre. Ligament pit is furrow-like and bordered anteriorly by arcuate, inflated long ledge, and ventrally by short, thickened posterior ledge. Further from posterior part of hinge margin, a tooth outgrowth, more or less prominent and arcuate, is developed and adjoins elongated or rounded tooth groove. Surface of tooth groove is covered with small marginal elements. Muscle scar subcentral, rounded and relatively weakly concave; up to 3—4 mm in transversal diameter, slightly exceeding one-third of transversal valve diameter.

Inner surface or right valve (Pl. XXXIII, Figs. 1 *a*, *c*—5 *a*, *c*; Pl. XXXIV, Figs. 1*a*—3*a*) commonly flat; weak concavity lies along anterior margin and below hinge. Rounded muscle scar located in half of valve height, subposteriorly, about 3 mm in transversal diameter, equalling 1/2—1/3 of transversal valve diameter. Valve margin slightly thickened and turned outside, except for posterior margin, thin, flat and irregularly folded. Marginal elements of dorsal margin developed in the forms of tubercules, and on tooth outgrowth and lobe-like widening, as small ridges. They occur just on margin of some young forms, giving a finely--denticulate appearance (Pl. XXXIII, Figs. 4c, 5c). Hinge strongly opisthogyre, up to 1.5 mm high, oblique triangular with strongly arcuate sides and short, thickened base, and consists of ligament furrow, bordered posteriorly and ventrally by large tooth outgrowth.

Ontogeny. — Complete ontogenetic series is represented in material studied. Spherical prodissoconch, representing earliest stage, is shifted along umbonal spiral under angle of 180° in relation to its initial position, with growth of individual. Particular stages are characterized below:

Growth stage	Height mm	Length mm	Characteristics
Nepionic	0.33	0.33	Spherical prodissoconch, terminal
Neanic	0.4—7.0	0.35—6.0	Prodissoconch directed backward; umbo opisthogyre; umbonal spiral forms an angle of 45°; shell inequilateral, inequivalve; left valve convex, right valve flat or slightly convex anteriorly; height and length increments equal, later the former greater; hinge poorly differentiated, all elements, except for posterior ledge marked in late neanic stage; marginal elements developed on posterior sub-hinge margin in form of a few small ridges; anterior and ventral margins denticulate; marginal elements of left valve shifted onto inner edge; muscle scar circular height ratio 0.85—1.15.
Ephebic	7.1—9.0	6.1—8.5	Prodissoconch directed backward under angle of 90°; increase of height prevails; overlapping of growth lines rises anterior margin; modification of hinge, tooth outgrowth raised; muscle scar subcentral, deeper than previously; inequality of valved increases; left valve ornamented with fine radial striae; folds marked along postero-ventral margin; height ratio increases from 1.2 to 1.3; other features without changes.

Growth stage	Height mm	Length mm	Characteristics
Gerontic	10.0—18.0	9.0—13.0	Prodissoconch bent under angle of 180° or more; umbo opisthogyre, obliterated by large attachment area; height increase often prevails, sometimes equal to length increase; anterior margin of left valve rounded; posterior margin deeply incised; hinge completely differentiated; tooth outgrowth large, prominent; posterior ledge arcuate, short, whereas anterior compressed, low; tooth groove elongated, deep; marginal elements well-developed; muscle scar large, rounded to ovate with transversal diameter greatest; ornamentation consists of folds and fine radial striae and concentric growth lines, unequally spaced; growth lamellae occur along postero-ventral margin; height ratio increases up to 1.5.

Variability. — Individual variability relatively small and primarily concerns some interrelated features. If attachment area is terminal, than left valve is arcuate and strongly convex, sinus is developed along posterior margin and ventral margin is lobe-like expanded. Shift of attachment area backward results in change of valve shape into rounded and irregular or asymmetric triangular. In such a case, posterior sinus disappears, height and length increments equalize and postero-ventral widening decrease, whereas umbo is more opisthogyre and umbonal and spiral angle exceeds 180° (Pl. XXXIV, Fig. 5*b*). Ornamentation is also variable, some specimens are covered with folds variable in height, thickness and number, whereas others with fine striae, and folds are distinct only along ventral or postero-ventral margins. Development of muscle scar depends to a degree of valve convexity; the more convex is the valve, the deeper is muscle scar and located closer to posterior margin.

Remarks. — Polish specimens are very similar to the French ones. Concerning the ornamentation this species is similar to Ex. *catalaunica* Loriol, but differs in other features.

Occurrence. — Poland, Western Pomerania: Upper Kimeridgian, the *Aulacostephanus pseudomutabilis* Zone, Mesozoic margin of the Holy Cross Mts.: Lower Kimeridgian, the *Katroliceras divisum* Zone; France: Kimeridgian.

Exogyra intricata (Contejean, 1859)

(Pl. X. Fig. 1—2)

1859. *Ostrea intricata* Contejean; Ch. Contejean, Étage..., p. 323, Pl. 25, Figs. 6—8.
1914. *Exogyra intricata* Contejean; K. Wójcik, Jura..., p. 128, Pl. 33, Fig. 6.
1965. *Lopha cf. intricata* (Contejean); L. R. Cox, Jurassic..., p. 69, Pl. 9, Fig. 8 a, b.

Material. — Two left valves, well-preserved.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Lenght	Depth	Height ratio
81	34.0	16.0	8.0	2.1
82	47.0	37.0	15.0	1.2

Description. — Valve (Pl. X, Figs. 1*b*, 2*b*) attaining moderate size, oblique ovate or triangular, strongly asymmetric. Umbo strongly opisthogyre, unprojected, flattened by attachment area. Attachment area sometimes occupies almost whole posterior part, deforming it significantly. Crest oblique, irregularly folded or keel-like, continues from umbo towards postero-ventral margin (Pl. X, Fig. 1*b*), dividing valve into larger antero-ventral part, gently sloping towards margin, and smaller posterior part, steeply inclined. Anterior margin broadly rounded and gradually joints folded ventral margin. Posterior margin sinusoidally incised; postero-ventral margin lobe-like expanded. Surface ornamented with radial folds, oblique to crest, and growth lines. Folds are low and narrow in subumbonal region and their width and height increase toward the ventral margin (up to 4 mm in height and over 9 mm in width), conversely then interspaces separating them. On the basis of differentiation of folds, 3 zones may be distinguished on valve; anterior zone, with 10 low folds divided in places into finer secondary folds, middle zone, delimited by the longest and the most prominent folds, and posterior, with single fold lobe-like expanded and attaining 10 mm in width along ventral margin. This fold of posterior zone is a prolongation of crest, which runs obliquely across the valve. On adult specimens, a ring-like concentration of growth lines in some distance from ventral margin is marked, probably due to arrest of increase in height. Zones of ornamentation do not continue below that ring and amount of folds decreases from 15 do 7 by joining of folds in anterior zone.

Inner surface (Pl. X, Figs. 1*a*, 2*a*) smooth, except for 4 folds continuing from middle part of ventral edge towards the half of valve height. Concavity greatest along anterior margin, up to 15 mm. Muscle scar large, transversally elongated, with straight upper margin and rounded, thickened lower margin, located subposteriorly, below hinge; 10 mm in transversal diameter, equalling approximately a quarter of transversal valve diameter. Umbo strongly opisthogyre, 13 mm high. Hinge is 15 mm long and 5 mm high. Hinge margin thickened, slightly wavy. In posterior part of hinge margin, below ledge obliquely located, an elongate tooth groove is marked.

Insufficient amount of material precluded studies on variability and ontogeny.

Remarks. — Polish specimens are similar to French ones. In Poland this species is very rare. Previously, Wójcik (1914) described one large specimen, 60 mm high and 40 mm long.

Occurrence. — Poland, Mesozoic margin of the Holy Cross Mts.: Lower Kimeridgian, the *Ataxioceras hypselocyclum* Zone, Kruhel Wielki near Przemyśl: Oxfordian; France: Kimeridgian; Africa; Lower Kimeridgian.

Exogyra michalskii Lewiński, 1922
(Pl. XXXV, Figs. 6—8)

1922. *Exogyra Michalskii* Lewiński; J. Lewiński, Monographie..., pp. 66—67, Pl. 4, Figs. 1—3.

Material. — Four right valves; one well preserved.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Height ratio
376	15.0	10.0	1.5
285	20.0	11.0	1.8
283	50.0	25.0	2.0
284	80.0	36.0	2.2

Description. — Valves massive, compressed, ovate, higher than long. Umbo unprojected, flat, forming a spiral with angle of 180°. Spherical prodissococh attains 1 mm in diameter. Surface of valve ornamented with fine concentric sinusoidal growth lines developed below umbo as protruding lamellae. Only 6 lamellae were noted on specimen 50 mm high. Posterior margin is thin and wavy, anterior thickened. Growth laminae, distinct on anterior margin, parallel to one another and to external margin; sometimes external laminae are strongly folded whereas subcentral are more straight (Pl. XXXV, Fig. 7*b*). External part of valve, near anterior margin, forms distinct marginal belt, often separated by keel-like, acute crest from middle part of valve, and occasionally almost vertical to it.

Inner surface (Pl. XXXV, Figs. 6*a*—8*a*) smooth, commonly flat, sometimes weakly concave along antero-dorsal margin and below hinge. Muscle scar located subcentrally, in half of valve height, large, ovate; its longitudinal diameter equals 18 mm and transversal 10 mm, corresponding approximately to one-third of transversal valve diameter; muscle scar is slightly concave in its upper part and bordered by its straight to rounded dorsal margin; lower part of muscle scar is flat and bordered ventrally by thickened lip and posteriorly by sharp margin. This margin continues upwards, reaching dorsal surface of tooth outgrowth. Hinge occupies the whole hinge margin and is terminally located with distinct bent backward, sometimes is shifted onto posterior part of valve. In the former case hinge is two times higher than in latter. Commonly, its height equals approximately 1/10 of the valve height, whereas its length exceeds one-third of valve length. On its posterior side, a prominent tooth outgrowth and tooth groove, close to it, are developed. Ligament furrow and anterior ledge are weakly developed.

Ontogeny. — Insufficient amount of material precluded detailed studies on ontogeny and individual variability, nevertheless, some characteristic growth changes were noted. Twist of umbo is already marked in early stages; umbonal spiral of the youngest specimens exceeds 90°. Along with growth, height ratio undergoes significant changes, from 1 to 2.2. On one valve of gerontic stage, features typical for this stage, as strong thickening along anterior margin, folding of succeding growth laminae with age, thickening of tooth outgrowth, distinct eccentricity of growth lines on muscle scar and increasing convexity and sharpening of inner margin of valve, are observable.

Variability. — Individual variability of this species is relatively small. Some changes in development of marginal belt may be observed. This belt is a prolongation of flat surface of valve or is inclined to it under on obtuse to right angle.

Remarks. — This species is very similar to *Ex. decipiens*, except for some differences in shape of muscle scar, external ornamentation and in dimensions. Comparison of specimens of *Ex. michalskii* with *O. thurmanni* Étallon, made by Lewiński, seems unjust, because the latter species is characterized by thin-shelled, entirely attached, crescent valves and markedly smaller size (cf. Thurmann & Étallon, 1862, p. 273, Pl. 28, Fig. 7).

Occurrence. — Poland, Western Pomerania, vicinity of Tomaszów Mazowiecki: Middle Volgian.

Exogyra decipiens Lewiński, 1922
(Pl. XXXV, Figs. 1—5)

1922. *Exogyra decipiens* Lewiński; J. Lewiński, Monographie..., p. 67, Pl. 5, Figs. 2—4.

Material. — Four shells, 15 poorly preserved left valves, 1 right and some additional fragments.

Measurements (in mm):

Z. Pal. U.W. Mo. V/	Height	Length	Thickness	Height ratio
280	6.5	5.0	4.5	1.3
278	8.0	4.2	3.5	2.0
377	16.0	10.0	6.0	1.6
378	18.0	14.0	10.0	1.3
379	32.0	23.0	12.0	1.4
279	36.0	30.0	20.0	1.2
282	42.0	28.0	18.0	1.5

Description. — Shell strongly thickened, attached by relatively large surface; left valve (Pl. XXXV, Figs. 1*a*—4*a*) attaining moderate size, irregularly ovate, strongly convex. Greatest convexity continues from umbo across middle part of valve, towards ventral margin, in the form of non-uniformly folded crest. Attachment area large, markedly concave and ornamented with reflections of substratum; it occupies large area of posterior part of valve. Anterior part smooth, sometimes unequally folded or covered with protruding ribs, most distinct along antero-ventral margin. Ribs, 2—12 in number, are radial, commonly leaning and up to 6 mm high. Lobe-like widening or weak broad sinus is developed on posterior margin. Growth lines are very fine, wavy and strongly bent in concave posterior part of valve, where they are often developed in form of protruding lamellae, concentrated in subumbonal region. Umbo strongly opisthogyre, sometimes projected or inflated and obscured by attachment area.

Right valve (Pl. XXXV, Figs. 4*b*, 5*b*) irregularly ovate to rounded or asymmetrically triangular. In the latter case, umbo is translocated on the widened posterior margin, forming flat opisthogyre spiral; angle of twist reaches almost 360°. Posterior margin sinusoidal, anterior margin arcuate; antero-ventral margin folded. External surface is uneven, tuberculated and covered with sinusoidal growth lines, marked stronger in some intervals, wavy and markedly concentrated along anterior and dorsal margins, forming wide and somewhat convex marginal belt. This belt is almost vertical to flat surface of dorsal part of shell.

Inner surface of left valve (Pl. XXXV, Figs. 1*b*, 2*b*) maximally convex in its middle-posterior part, where it attains 12 mm in depth. Posterior and anterior margins are commonly folded. Fold of ventro-posterior part is particularly prominent. Muscle scar rounded, flat, attains 7—8 mm in transversal diameter, equalling approximately a quarter of transversal valve diameter; it is bordered by postero-ventral lip. Hinge margin short, slightly thickened, arched. Hinge arched, opisthogyre, 5 mm high, equalling 1/9 of valve height.

Inner surface of right valve (Pl. XXXV, Fig. 5*a*) maximally convex along antero-dorsal margin and below hinge. Rounded lobe expands along postero-ventral margin. Muscle scar subcentral, weak, rounded to crescent. Hinge opisthogyre, long and arched, occupying dorsal valve margin; 2 mm in height; bordered dorsally by thickened margin and posteriorly by thickened ligament ledge.

Ontogeny (Pl. XXXV, Figs. 1—5). — Ontogenetic changes were studied on mature and young specimens and are characterized by increasingly stronger folding of valve margin and opisthogyre twist of umbo. Twist of umbo in nepionic-neanic stage is already significant and attains 180°, reaching 360° in gerontic stage. Marginal belt appears in ephebic-gerontic stage.

Variability. — Individual variability of *Ex. decipiens* is mainly expressed in changes of position and degree of valve convexity, development of folding of anterior margin and height of folds and development of umbo on left valve. If attachment area is subcentral, than umbo of the left valve is strongly thickened and projected and folds are higher and not inclined. With shift of attachment area backward, umbo gradually decreases and is thinner, and folds becomes inclined stronger.

Remarks. — *Ex. decipiens* Lewiński is a well defined species. The most similar species, *Ex. michalskii,* which holotype was found in the same exposure and in the same deposits, differs from it in its larger size, more elongate shape, ovate muscle scar and different development of umbo of left valve. *Ex. decipiens* is quite distinct from any other Jurassic species.

Occurrence. — Poland, vicinity of Tomaszów Mazowiecki: Middle Volgian.

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HALINA PUGACZEWSKA

MAŁŻE OSTRYGOWATE Z JURY POLSKI

Streszczenie

W niniejszej pracy opisane zostały małże z rodziny Ostreidae z utworów jurajskich Polski, od bajosu-batonu do środkowego wołgu włącznie, pochodzące z obrzeżenia mezozoicznego Gór Świętokrzyskich, Pomorza Zachodniego (Czarnogłowy, Świętoszewo), z Łęczycy, okolic Tomaszowa Mazowieckiego (Brzostówka), okolic Radomia (Wierzbica), z wiercenia „Strzałków" (okolice Sulejewa n/Pilicą), Jury Krakowsko-częstochowskiej (Zalas, Sanka, Kozłowiec, Kłobuck).

Zebrany materiał wynosił ponad 8000 okazów, z których tylko 2500 nadawało się do szczegółowych opracowań.

W rodzinie Ostreidae wyróżniono 3 podrodziny (Ostreinae, Gryphaeinae, Exogyrinae), 7 rodzajów (*Alectryonia, Arctostrea, Liostrea, Catinula, Gryphaea, Nanogyra, Exogyra*) i 35 gatunków. Najliczniej reprezentowany jest rodzaj *Liostrea*, do którego zaliczono 17 gatunków. Rodzaje *Gryphaea, Nanogyra* i *Catinula* są reprezentowane każdy przez jeden gatunek.

Małże ostrygowate zebrane zostały przez autorkę w czasie prac terenowych w latach 1965—1968. Autorka korzystała również z materiałów przekazanych jej przez doc. J. Kutka z Zakładu Geologii Podstawowej Wydziału Geologii Uniw. Warszawskiego oraz prof. W. Kracha z Pracowni Młodych Struktur Geologii Zakładu Nauk Geologicznych PAN w Krakowie.

Ostreidae występują zwykle masowo tworząc zlepy muszlowe. Często tworzą mniej lub bardziej ciągłe ławice o miąższości dochodzącej do 18 m, występujące na dużych przestrzeniach, jak np. ławica alektrioniowa w Górach Świętokrzyskich, która ciągnie się od Chmielnika do Przedborza, tj. na przestrzeni około 100 km.

Najbogatsze ilościowo i gatunkowo Ostreidae występują w górnych poziomach dolnego kimerydu, w osadach udokumentowanych stratygraficznie amonitami: *Ataxioceras hypselocyclum* i *Katroliceras divisum.* Niektóre Ostreidae mogą stanowić dla pewnych poziomów skamieniałości przewodnie. Do takich należą *Catinula knorri* i *Liostrea acuminata,* występujące w olbrzymiej ilości egzemplarzy w utworach iłów rudonośnych bajosu-batonu Łęczycy, a także *Exogyra decipiens, Ex. michalskii* oraz *Liostrea virguloides*, charakterystyczne dla środkowego wołgu wy-

kształconego w facji marglisto-wapiennej w Brzostówce i w kamieniołomach na Pomorzu Zachodnim. *Liostrea virguloides* przepełnia w Brzostówce niektóre warstwy. *Ex. decipiens, Ex. michalskii* i *L. virguloides* znane są dotychczas tylko z terenów Polski i zostały opisane po raz pierwszy przez Lewińskiego w 1922 r.

Szczególnie cenne materiały pochodzą z dolno-kimerydzkich margli wiercenia „Strzałków". Zachowane tu muszle i pojedyncze skorupki najmłodszych stadiów rozwojowych kilku gatunków egzogyr umożliwiły obserwacje zmian ontogenetycznych, morfologii wewnętrznej i zewnętrznej, budowy zawiasów u tych gatunków, a także wykazanie, że różnice między nimi pogłębiają się wraz z rozwojem osobniczym.

W osobnym rozdziale przeprowadziła autorka szczegółową analizę budowy zawiasów u kilku przedstawicieli podrodziny Exogyrinae, co pozwoliło na wyjaśnienie stanowiska systematycznego *Nanogyra nana*, budzącego dotychczas wiele kontrowersji, a także na wykazanie konsekwentnego następstwa form w szeregu ewolucyjnym: *Nanogyra nana — Ex. virgula — Ex. reniformis — Ex. welschi — Ex. decipiens — Ex. michalskii.* Ewolucja zawiasów u tych gatunków przejawia się w coraz większej komplikacji ich budowy, aż do wytworzenia się wyrostka zębopodobnego w skorupce prawej i odpowiadającej mu jamki w lewej skorupce. Na początku tego szeregu rozwojowego stoi *N. nana* — forma długowieczna, plastyczna, która wykazuje szereg pośrednich cech między przedstawicielami podrodziny Gryphaeinae, mniej zaawansowanymi w rozwoju, a przedstawicielami podrodziny Exogyrinae o cechach postępowych.

W uzupełnieniu rozważań filogenetycznych autorka przedyskutowała również stanowisko systematyczne form rodzaju *Catinula* i zaproponowała, aby uznać je za szczebel pośredni pomiędzy podrodziną Ostreinae a Gryphaeinae.

Małże ostrygowate znane są powszechnie jako formy przytwierdzające się, wskutek czego są w wysokim stopniu uzależnione od warunków środowiska. Osiadły tryb życia, występowanie w dużych nagromadzeniach, często w zanieczyszczonych wodach, stały się przyczyną wykształcenia szeregu przystosowań, umożliwiających im egzystencję. Często te funkcjonalne przystosowania znajdują swe odbicie w odpowiednich zmianach skorupek form kopalnych. Jednym z przykładów przystosowania do środowiska o wodzie niosącej dużo cząstek terrygenicznych, jest szew zygzakowaty o wysokiej amplitudzie. Występuje on u wszystkich przedstawicieli rodzaju *Alectryonia*, a w doskonały sposób wykształcony charakteryzuje przedstawicieli rodzaju *Arctostrea*. Szew ten o dużej amplitudzie działa jak pewnego rodzaju sito, zabezpieczając jamą płaszczową przed zanieczyszczaniem jej cząstkami osadu. Selekcyjna rola szwu zygzakowatego wzmocniona jest działaniem silnie umięśnionych brzegów płaszcza.

Innym przystosowaniem do środowiska jest tzw. komora nadmięśniowa, widoczna na skorupkach szeregu gatunków w postaci podłużnego zagłębienia pomiędzy odciskiem mięśnia zwieracza a grzbietowym brzegiem skorupki. Komora nadmięśniowa interpretowana bywa (Menzel, 1955 *in* Carter, 1968, p. 473) jako dodatkowe przejście dla prądu wynoszącego, oczyszczającego ją z osadu i gromadzących się zanieczyszczeń.

Przykładem przystosowania funkcjonalnego organizmu, znajdującego swój wyraz w budowie skorupki, jest wieczkowata forma skorupki prawej. Rola tej skorupki jest podobna do roli, jaką spełnia szef zygzakowaty. Taka skorupka występuje w muszlach o prostym brzegu zewnętrznym, np. u przedstawicieli rodzajów *Liostrea, Gryphaea* i *Catinula*. Płaska, denkowata skorupka prawa szczelnie przylega do głębokiej zwykle skorupki lewej, albo wnika w nią na pewną głębokość. Na lewej skorupce widoczny jest ślad zetknięcia się obu skorupek w postaci koncentrycznej linii. Niektórzy autorzy nazywają ten ślad linią płaszczową. Termin ten jednak jest nieodpowiedni, sugeruje bowiem przyrastanie brzegów płaszcza do skorupek, a jak wiadomo, brzegi płaszcza u ostryg są wolne.

Na kilku skorupkach rodzajów *Exogyra* i *Nanogyra* autorka zaobserwowała odcisk drobnego mięśnia wciągającego nogę. Obecność tego odcisku świadczy o czynnej roli nogi u niektórych Ostreidae, której funkcja została przystosowana do oczyszczania jamy płaszcza z zanieczyszczeń.

ГАЛИНА ПУГАЧЕВСКА

ПЕЛЕЦИПОДЫ СЕМЕЙСТВА OSTREIDAE ИЗ ЮРСКИХ ОТЛОЖЕНИЙ ПОЛЬШИ

Резюме

В настоящей работе описаны пелециподы семейства Ostreidae Lamk., распространенные в юрских отложениях Польши с байосса-бата по средневолжский ярус включительно. Они были добыты в следующих районах и местностях: мезозойское обрамление Свентокшиских гор, Западное Поморье (Чарногловы, Свентошево), Лэнчица, окрестности г. Томашув-Мазовецки (Бжостувка), окрестности г. Радом (Вежбица), буровая скважина „Стшалкув" (район г. Сулеюв на Пилице) и Краковско-Ченстоховская Юра (Заляс, Санка, Козловец, Клобуцк).

Собранный материал включал свыше 8000 экземпляров, из числа которых лишь 2500 экземпляров были пригодны для детальных исследований.

В семействе Ostreidae определены три подсемейства (Ostreidae, Gryphaeinae, Exogyrinae), 7 родов (*Alectryonia, Arctostrea, Liostrea, Catinula, Gryphaea, Nanogyra, Exogyra*) и 35 видов. В самом большом количестве представлен род *Liostrea*, к которому относится 17 видов. Роды *Gryphaea, Nanogyra* и *Catinula* включают по одному виду.

Ostreidae были собраны автором во время полевых работ в 1965—1968 г.г. Автор использовал также материалы, полученные от доц. Е. Кутека из Института Оснований Геологии Варшавского университета и от проф. В. Краха из

Лаборатории юных геологических структур Отделения геологических наук ПАН в Кракове.

Ostreidae встречаются, как правило в массовых скоплениях, образуя ракушечные банки. Часто они слагают более или менее выреджанные слои мощностью до 18 м, распространяющиеся на большой площади, как, например, алектриониевый слой в Свентокшиских горах, простирающийся на протяжении около 100 км, от Хмельника по Пшедбоже.

Наиболее обильно в количественном и видовом отношениях Ostreidae представлены в верхних горизонтах нижнего кимериджа, в отложениях, охарактеризованных по аммонитам *Ataxioceras hypselocyclum* и *Katroliceras divisum.* Некоторые Ostreidae могут служить в качестве руководящих окаменелостей некоторых горизонтов. К ним относятся *Catinula knorri* и *Liostrea acuminata*, представленные огромным количеством экземпляров в рудоносных аргиллитах байосс-батского возраста в Лэнчице, а также *Exogyra decipiens, Ex. michalskii* и *Liostrea virguloides*, характ?рные для средневолжского яруса, представленного мергелисто-известковой фацией в местности Бжостувка и в карьерах на территории Западного Поморья. В с. Бжостувка *Liostrea virguloides* представлена в некоторых слоях в большом изобилии. *Ex. decipiens, Ex. michalskii* и *L. virguloides* до сих пор известны лишь на территории Польши и были описаны впервые Левиньским в 1922 г.

Особенно ценные материалы получены из мергелей нижнего кимериджа, пройденных скважиной „Стшалкув". Благодаря сохранившимся здесь раковинам и отдельным створкам нескольких видов экзогир на ранних стариях развития удалось проследить онтогенетические измененния, развитие внутренней и внешней морфологии, замков, а также сделать заключение, что отличительные особенности между отдельными видами усугубляются по мере индивидуального развития.

Отдельная глава посвящена детальному рассмотрению строения замков у нескольких представителей подсемейства Exogyrinae, что позволило установить систематическую позицию *Nanogyra nana*, которая до сих пор вызывала ряд разногласий, а также определить последовательность форм в эволюционном ряду: *Nanogyra nana — Ex. virgula — Ex. reniformis — Ex. welschi — Ex. decipiens — Ex. michalskii.* Эволюция замка у этих видов выражена все большим усложнением строения, вплоть до появления зубовидного выступа на правой створке и соответствующего ему желобка под связочной площадкой левой створки. В начале этого эволюционного ряда находится *N. nana*, долгоживущая, переменная форма, характеризующаяся рядом промежуточных признаков между менее развитыми представителями подсемейства Gryphaeinae и представителями подсемейства Exogyrinae, отличающимися прогрессивными признаками.

В дополнение к филогенетическим замечаниям автор рассмотривает систематическую позицию форм рода *Catinula*, и предлагает признать их промежуточной ступенью между подсемействами Ostereinae и Gryphaeinae.

Пелециподы семейства устричных повсеместно известны как прикрепляющиеся формы, в сильной степени зависящие, таким образом, от условий среды обитания. Неподвижный образ жизни, обитание в больших скоплениях, часто в загрязненной воде, явились причиной развития у них ряда особенностей, позволяющих приспособиться им к окружающим условиям. Часто такие признаки приспособления сказываются на видоизменения створок ископаемых форм. Одним из таких примеров приспособления к водной среде, характеризующейся переносом большого количества терригенного материала, является зигзагообразная комиссура с высокой амплитудой. Она наблюдается у всех представителей рода *Alectryonia*, а также является прекрасно выраженным, характерным признаком представителей рода *Arctostrea*. Такая комиссура с большой амплитудой представляет своего рода сито, защищающее мантийную полость от загрязнения частицами осадка. Селективное действие зигзагообразной комиссуры дополняется сильно развитыми мускулами мантийного края.

Другой формой приспособления к среде является субмускульная полость, заметная на створках у ряда видов в форме продольного углубления между отпечатком мускула-аддуктора и спинным краем створки. Субмускульная полость, по мнению некоторых исследователей (Менцель, 1955, в Картер, 1968, стр. 473), бывает интерпретирована как дополнительный проход для выходящего потока, очищающего раковину от осадков и загрязнений.

Примером функционального приспособления организма, отразившегося в строении раковины, является крышечкообразная форма правой створки. Она играет роль сходную с предназначением зигзагообразной комиссуры. Такая створка наблюдается у раковины с ровным внешним краем, например у представителей родов *Liostrea*, *Gryphaea* и *Catinula*. Уплощенная, крышечкообразная правая створка плотно примыкает к левой, как правило углубленной, створке или проникает в нее на некоторую глубину. На левой створке заметен след соприкосновения створок в виде концентрической линии. Некоторые авторы называют этот след мантийной линией, однако такое употребление этого термина неправильно, так как оно укнзывает на прирастание мантийного края к створкам, а у устриц, как известно, край мантии свободен.

На нескольких створках родов *Exogyra* и *Nanogyra* автором был замечен отпечаток небольшого ножного мускула. Этот отпечаток свидетельствует о действующей ноге, которая у некоторых Ostreidae была приспособлена для очистки мантийной полости от загрязнений.

PLATES

Plate I

Nanogyra nana (Sowerby)
Gruszczyn (Holy Cross Mts.), Lower Kimeridgian

Figs. 1, 3, 4, Right valves: *1* ovate in outline (Mo. V/1), *3* auriform in outline (Mo. V/3, *4* with extremely spiral umbo (Mo. V/4); × 3.

Figs. 5, 7. Left valves: *5* completely cemented (Mo. V/5), *7* with trochoid umbo (Mo. V/7); × 3.

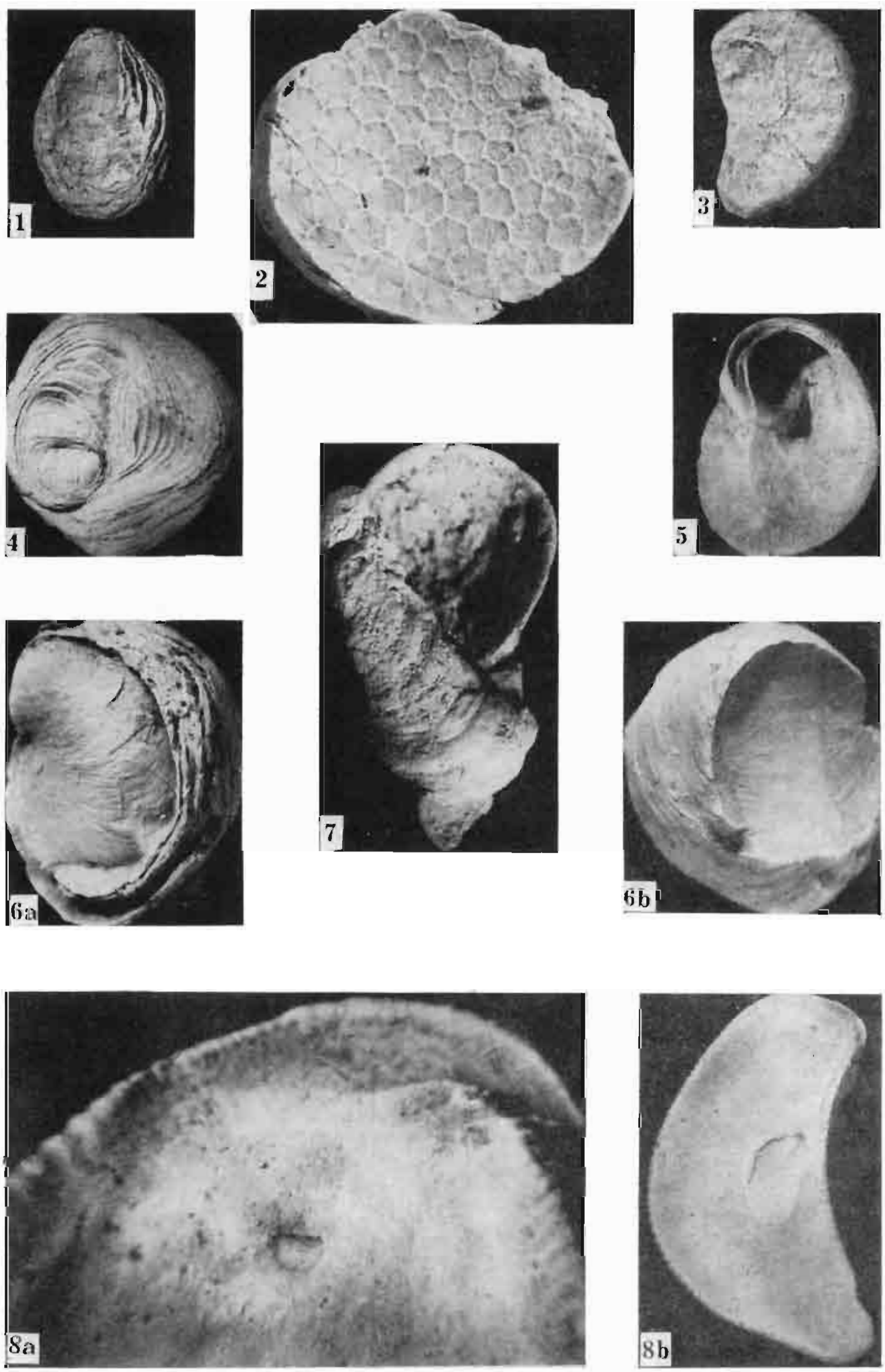
Exogyra welschi Jourdy
Góry Mokre (Holy Cross Mts.) Lower Kimeridgian

Fig. 2. Left valve showing the reprinted ornamentation of Goniolina geometrica (Mo. V/2); × 3.

Fig. 6. Shel viewed from: *a* the concave right valve, *b* the convexe left valve (Mo. V/6); × 5.

Exogyra virgula (Defrance)
Góry Mokre (Holy Cross Mts.), Lower Kimeridgian

Fig. 8. Right valve: *a* pedal retractor muscle scar visible; × 14, *b* the same valve with two muscle-scars (Mo. V/8); × 3.


1
2
3
4
5
6a
6b
7
8a
8b

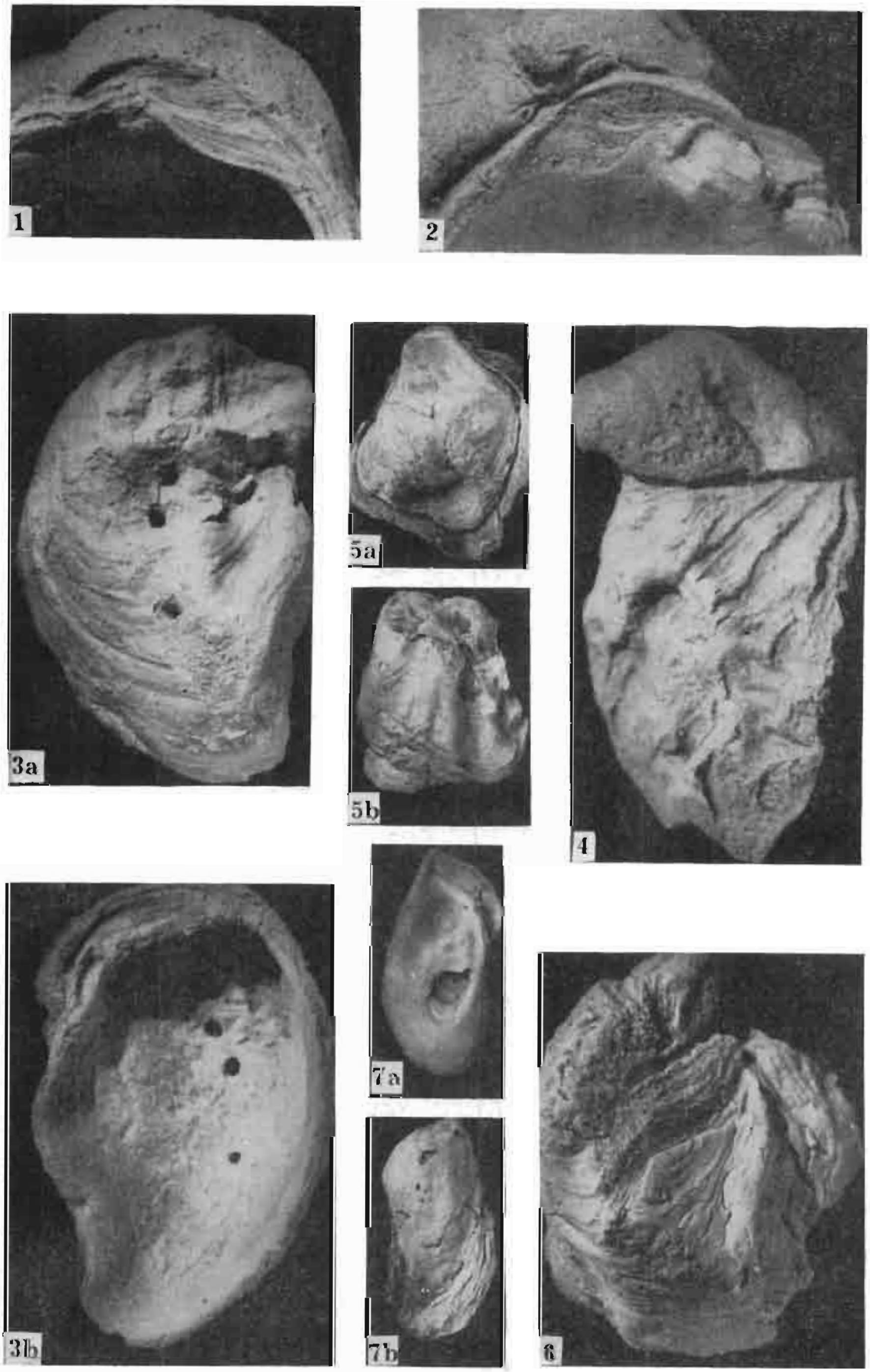


Plate II

Nanogyra nana (Sowerby)
Gruszczyn (Holy Cross Mts.), Lower Kimeridgian

Figs. 1—3. Three valves with a different structure of the hinge: *1* left valve the more differentiated hinge in progressive development (Mo. V/9); ×5; *2* right valve--hinge exogyroid (Mo. V/10); × 5; *3* left valve viewed from: *a* exterior, *b* interior, hinge exogyroid (Mo. V/11); × 2.

Fig. 4. Left valve, side view, umbo trochoidal (Mo. V/12); × 5.

Liostrea sorlinensis (Loriol)
Skorków (Holy Cross Mts), Upper Oxfordian-Lower Kimeridgian

Fig. 5. The shell: *a* right valve, *b* left valve (Mo. V/13); × 1.

Fig. 6. The shell with wrinkled attachment area (Mo. V/14); × 2.

Exogyra crassa (Smith)

Łęczyca, Bojocian-Bathonian

Fig. 7. Right valve in: *a* internal, *b* external views (*Mo.*/15); × 1.

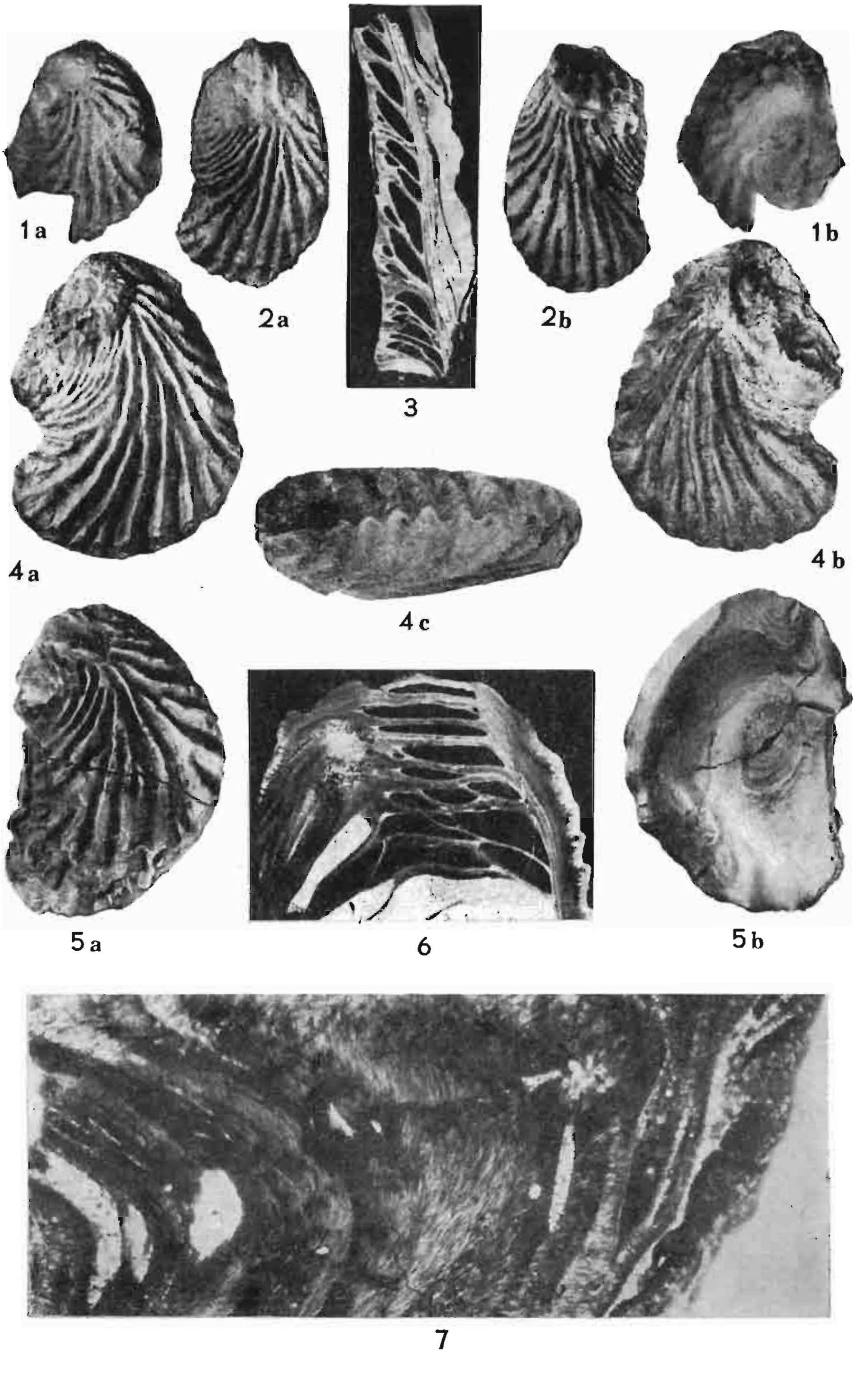
Plate III

Alectryonia solitaria (Sowerby)
Gruszczyn (Holy Cross Mts.), Lower Kimeridgian

Figs. 1, 5. Two right valves of different individual age: *a* external surface, *b* internal surface (Mo. V/16—17); × 1.
Figs. 2, 4. Two shells of different individual age in: *a* right valve, *b* left valve views (Mo. V/18—19); × 1.
Fig. 3. Longitudinal thin section through adductor muscle scar of the left valve (MO. V/20); × 3.
Fig. 6. Thin section of the hinge parallel to its external surface (Mo. V/21); × 3.

Alectryonia gregarea (Sowerby)
Wierzbica (near Radom), Lower Kimeridgian

Fig. 7. Thin section through ventral margin of the left valve (Mo. V/22; × 45.


1a
2a
3
2b
1b
4a
4c
4b
5a
6
5b
7

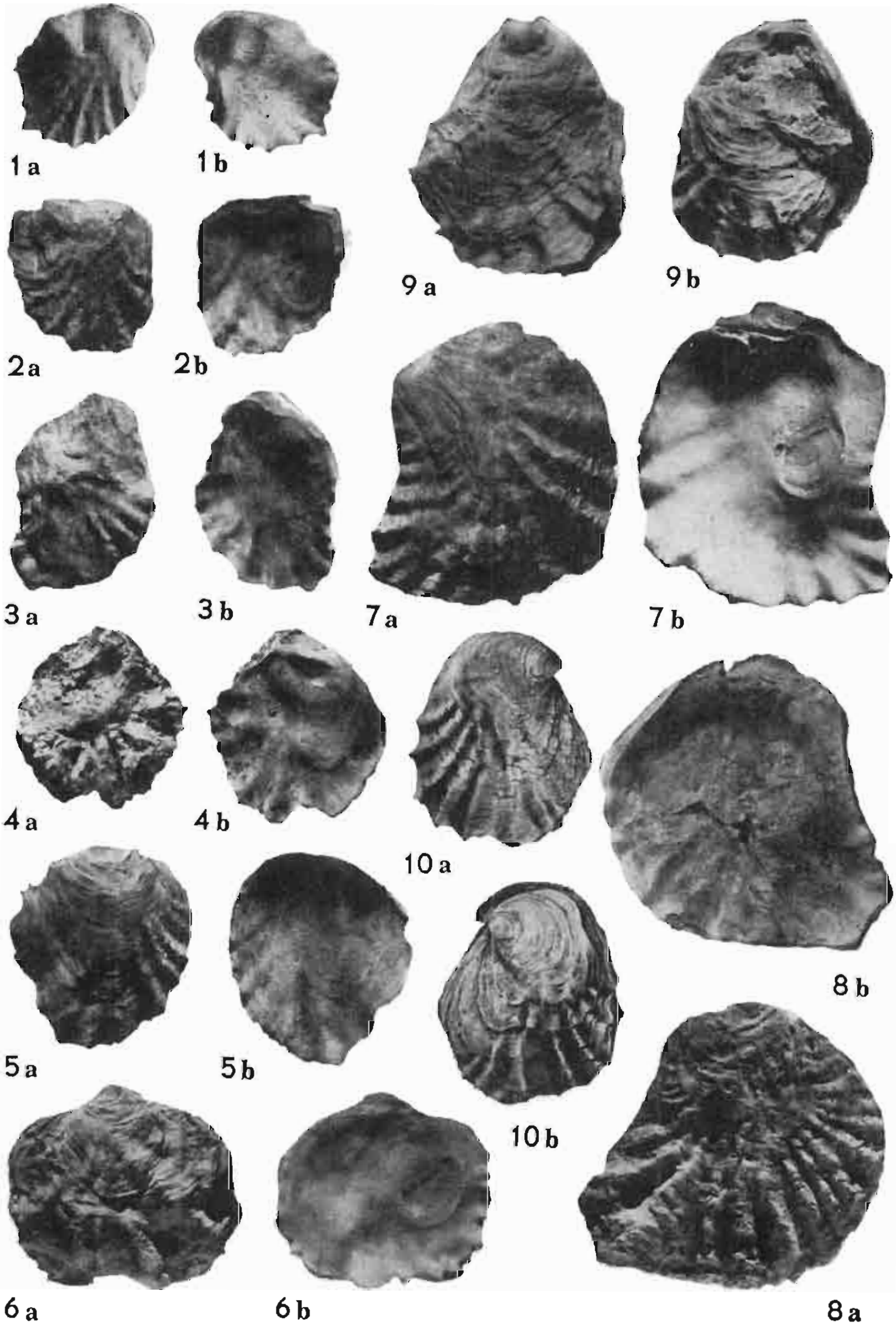

1a
1b
9a
9b
2a
2b
3a
3b
7a
7b
4a
4b
10a
8b
5a
5b
10b
6a
6b
8a

Plate IV

Alectryonia flabelliformis (Nilson)
Wierzbica (near Radom), Lower Kimeridgian

Figs. 1—8. Eight right valves of different individual age in: *a* external, *b* internal views (Mo. V/23—30).

Figs. 9—10. Two shells: *a* left valve, *b* right valve (Mo. V/31—32).

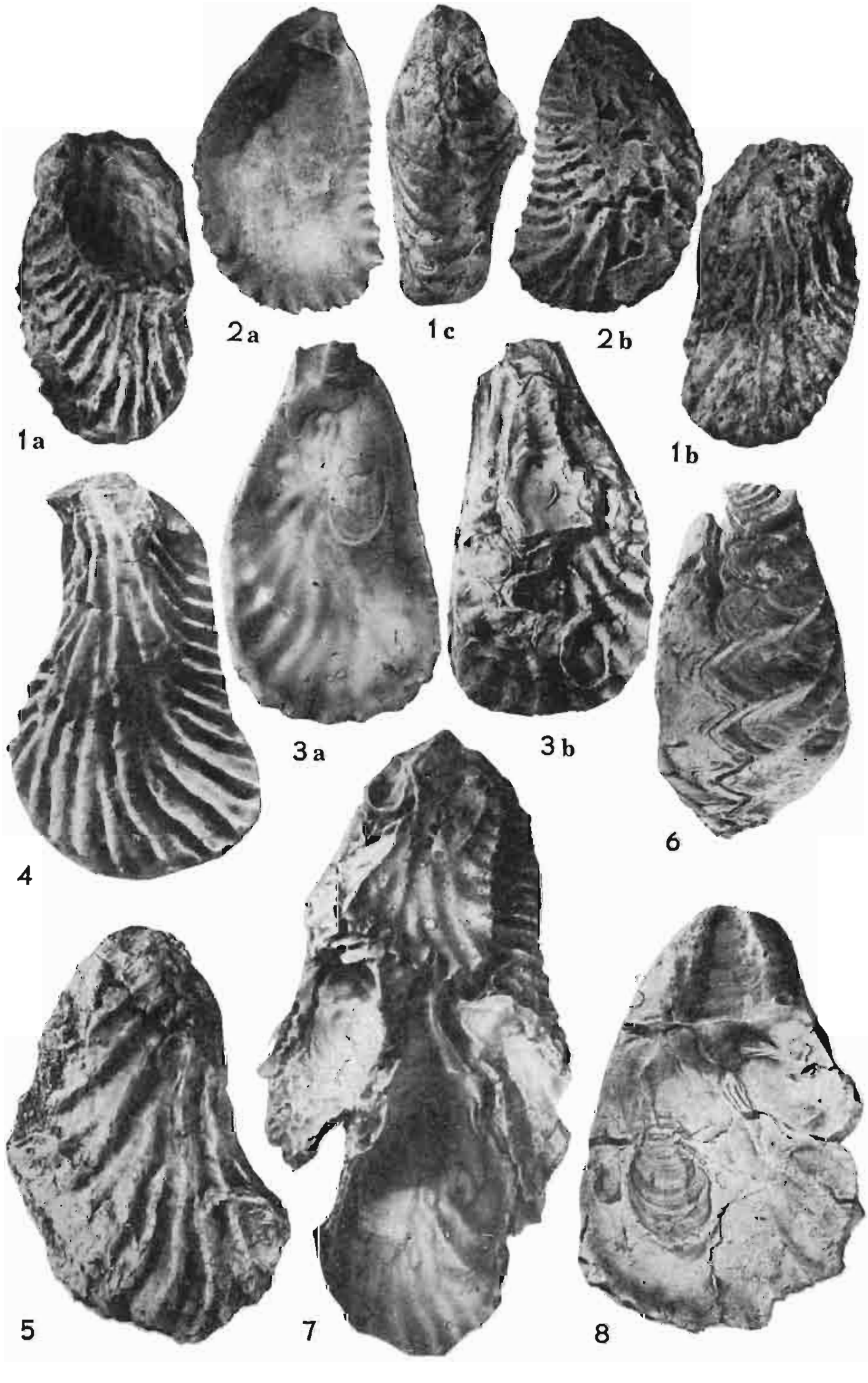
All figures × 1

Plate V

Alectryonia gregarea (Sowerby)
Sobków (Holy Cross Mts), Lower Kimeridgian

Fig. 1. The shell in: *a* left valve, *b* right valve, *c* side views (Mo. V/33).
Figs. 2, 3. Right valves in: *a* internal, *b* external views (Mo. V/34—35).
Figs. 4, 5. Two left valves in the same individual age differently shaped (Mo. V/36—37).
Fig. 6. The shell in side view; high-toothed commissure visible (Mo. V/38).
Fig. 7. Few valves attached to the same substratum (Mo. V/39).
Fig. 8. Left valve: high hinge with triangular ligamental pit and high lateral folds visible (Mo. V/40).

All figures × 1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1c
2a
2b
3a
3b
4
5
6
7
8

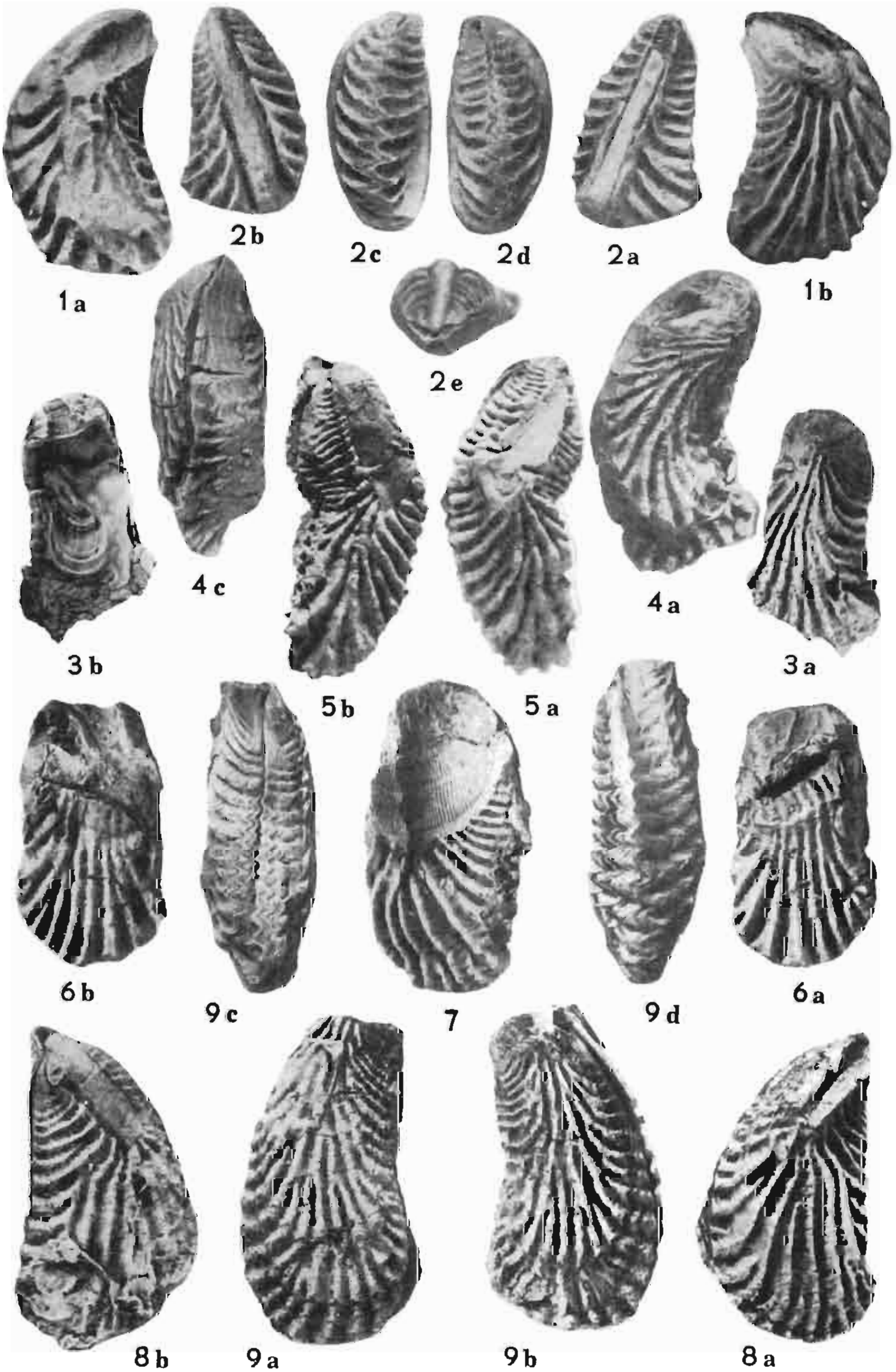

1a
2b
2c
2d
2a
1b
2e
4c
3b
4a
3a
5b
5a
6b
9c
7
9d
6a
8b
9a
9b
8a

Plate VI

Alectryonia gregarea (Sowerby)
Gruszczyn (Holy Cross Mts.), Lower Kimeridgian

Fig. 1, 8. Two adult shells in young age attached to echinoids spine: *a* left valve, *b* right valve (Mo. V/41—42).
Fig. 2. The shell attached during the life to echinoids spine: *a* left valve, *b* right valve, *c* side view from the anterior margin, *d* side view from posterior margin, *e* left valve from the umbo (Mo V/43).
Fig. 3. Left valve in: *a* external, *b* internal views (Mo. V/44).
Figs. 4, 5. Two shells anormal in shape: *a* left valve, *b* right valve, *c* side view from anterior margin (Mo. V/45—46).
Fig. 6. The shell: *a* left valve, *b* right valve (Mo. V/47).
Fig. 7. The ribbing surface of substratum on the left valve (Mo. V/48).

Alectryonia rastellaris (Münster)
Wierzbica (near Radom), Lower Kimeridgian

Fig. 9. Adult shell: *a* left valve, *b* right valve, *c* side view from posterior margin, *d* side view from anterior margin (Mo. V/49).

All figures × 1

Plate VII

Alectryonia rastellaris (Münster)
Góry Mokre (Holy Cross Mts.), Lower Kimeridgian

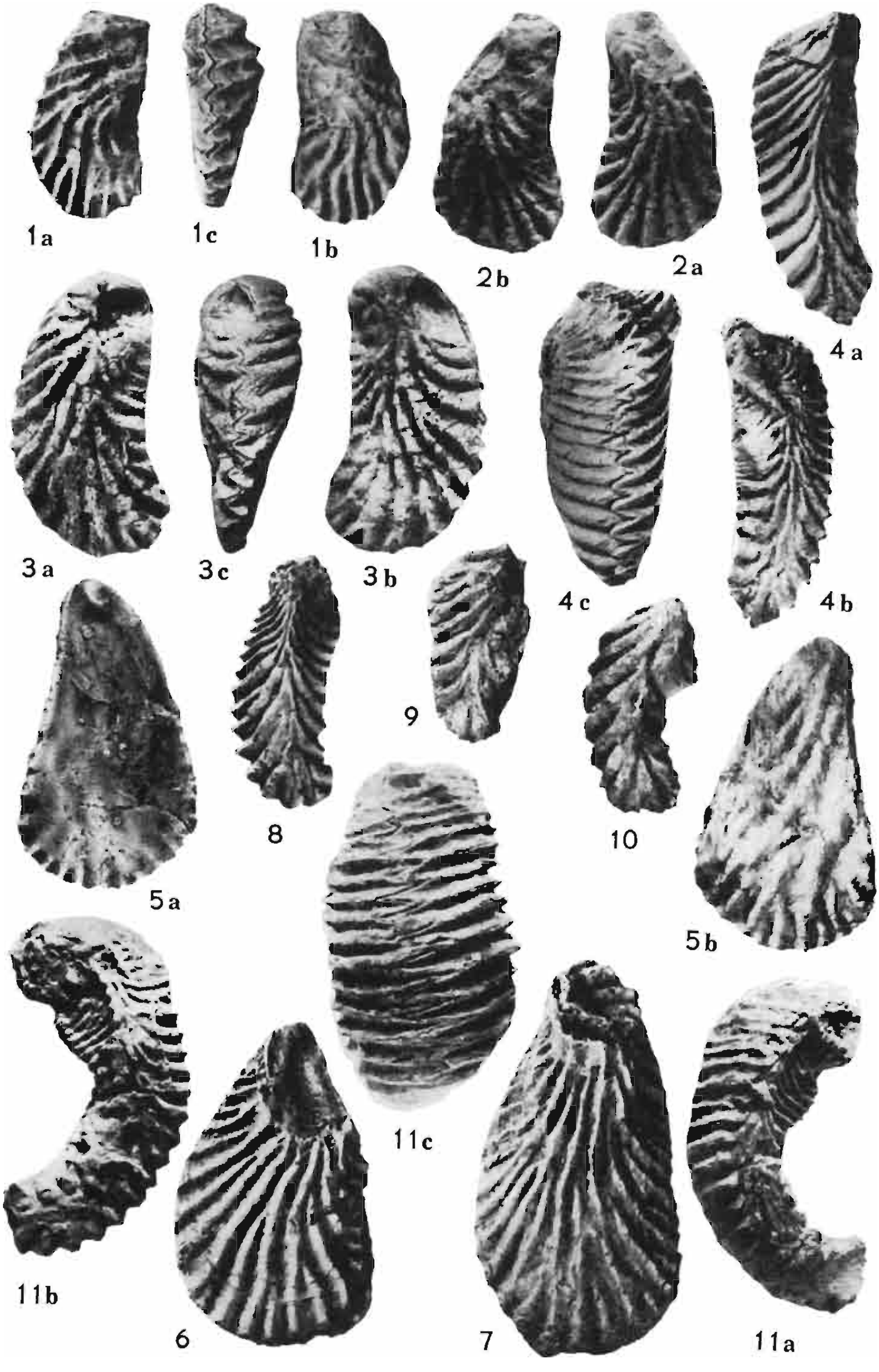
Figs. 1—3. Three shells of different individual age: *a* exterior of the left valve, *b* exterior of the right valve, *c* side view from anterior margin (Mo. V/50—52).
Fig. 5. Right valve flattened: *a* internal view, *b* external view, (Mo. V/53).
Figs. 6, 7. The adult right valves (Mo. V/54—55).

Arctostrea hastellata (Schlotheim)

Figs. 4, 11: Bałtów (Holy Cross Mts.), Middle Oxfordian
Figs. 8—10: Raciszyn (Polish Jura Chain), Upper Oxfordian

Figs. 4, 11. Twe shells of different individual age: *a* left valve, *b* right valve, *c* side view with hight-toothed commissure (Mo. V/56—57).
Figs. 8—10. Three fragmentary left valves in different individual age (Mo. V/58—60).

All figures × 1



1a
1c
1b
2b
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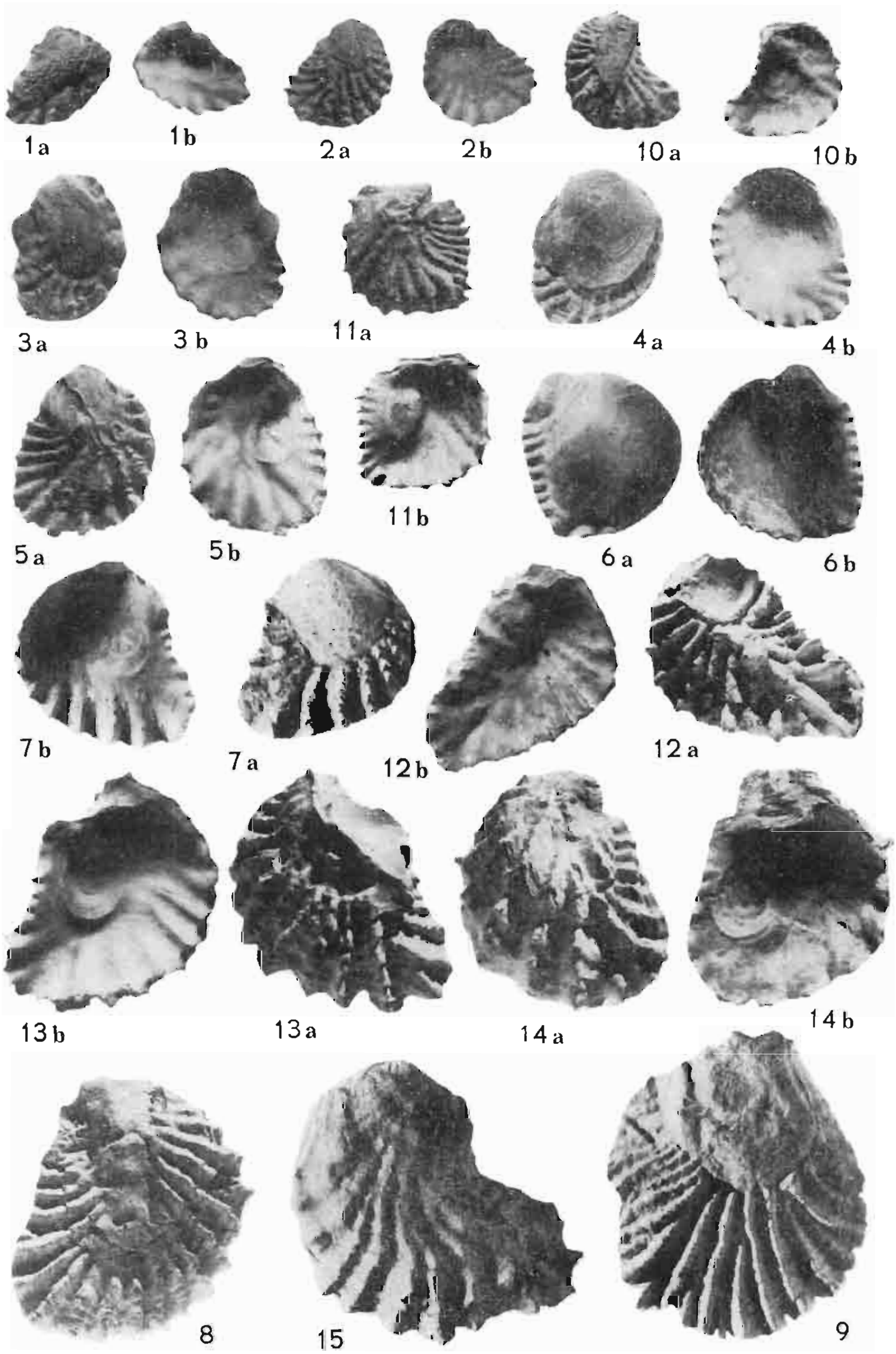
7
11a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7b
7a
12b
12a
13b
13a
14a
14b
8
15
9

Plate VIII

Alectryonia pulligera (Goldfuss)
Wierzbica (near Radom), Lower Kimeridgian

Figs. 1—9. Nine right valves of different individual age in: *a* external, *b* internal views (Mo. V/61—69).

Figs. 10—15. Five left valves of different individual age in: *a* external, *b* internal views (Mo. V/70—74).

All figures × 1

Plate IX

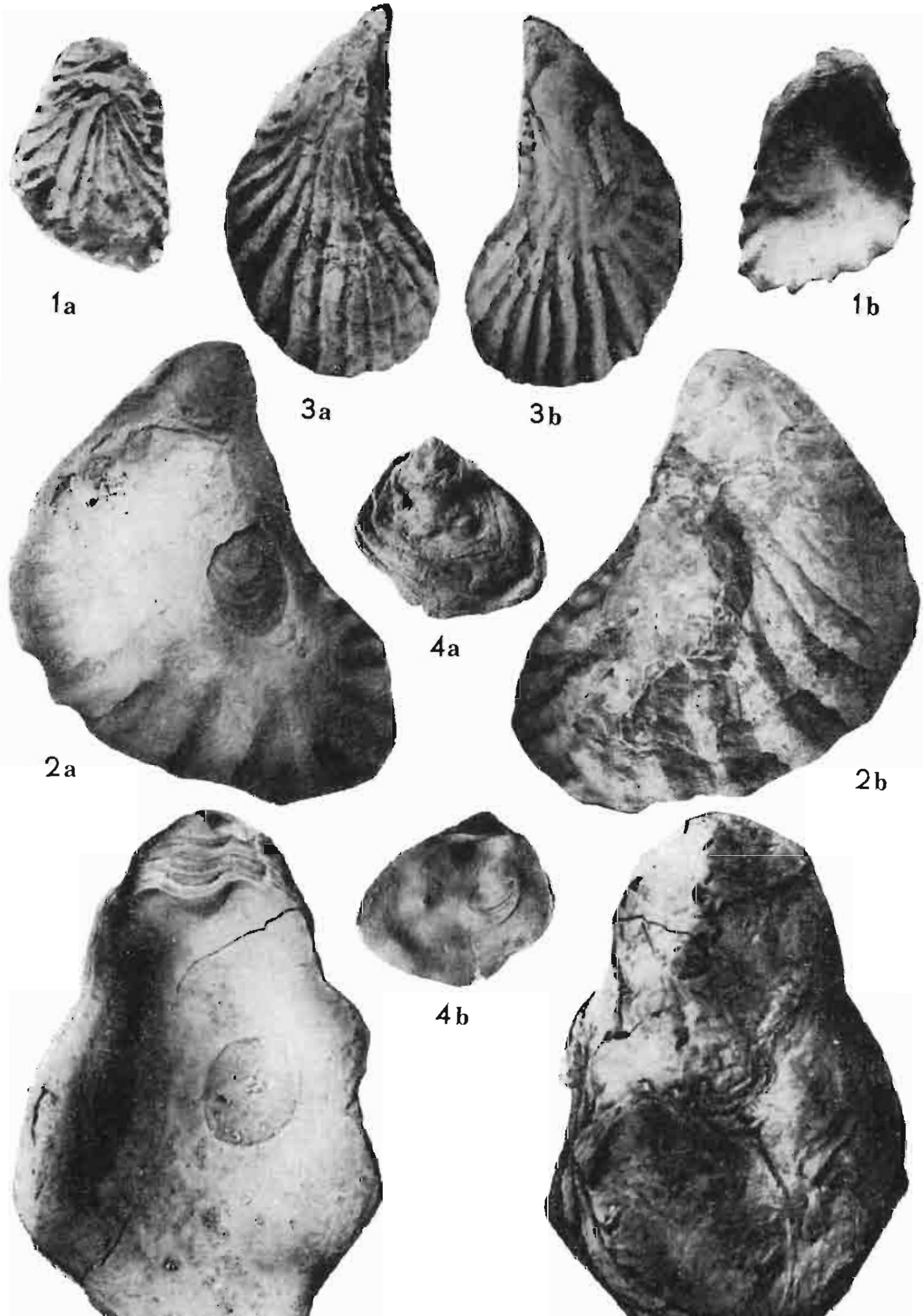
Fig. 1. *Al. solitaria* (Sow.), Left valve in: *a* external, *b* internal views (Mo. V/78); Wierzbica (near Radom), Lower Kimeridgian.

Figs. 2, 3. *Alectryonia gregarea* (Sow.). *1* the shell strongly flattened along the ventral side: *a* right valve, *b* left valve (Mo. V/76), *2* right valve with extremely wide ribs in: *a* internal, *b* external views (Mo. V/77); Gruszczyn (Holy Cross Mts.), Lower Kimeridgian.

Fig. 4. *Liostrea brasilii* Chavan. Right valve in: *a* external, *b* internal views (Mo. V/79); Czarnogłowy (Western Pomerania), Lower Kimeridgian.

Fig. 5. *L. explanata* (Goldfuss). Right valve in: *a* internal, *b* external view, with ovate traces of boring *Cirripedia* (Mo. V/80); Łęczyca, Bajocian-Batonian.

All figures × 1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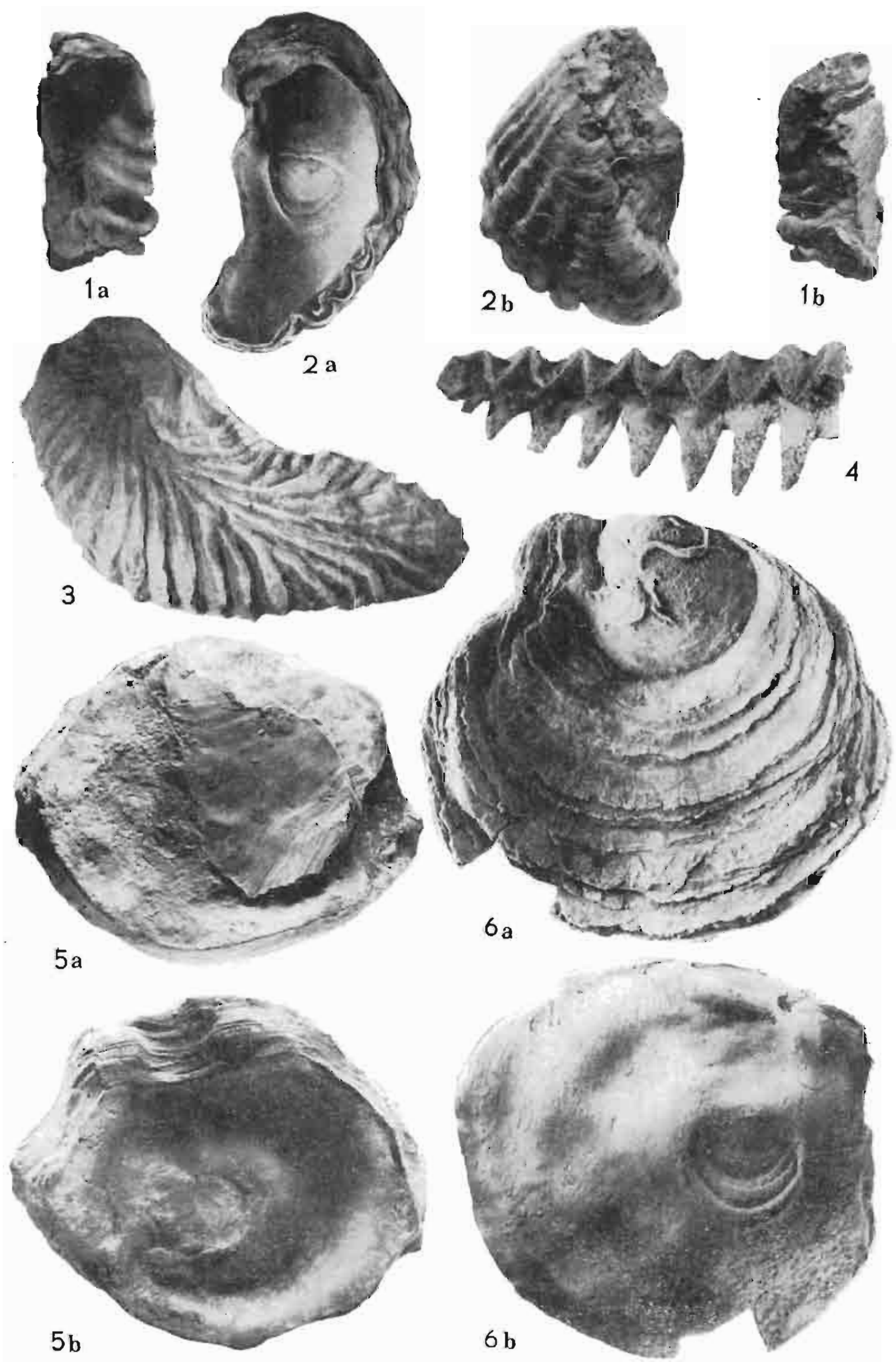
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Plate X

Exogyra intricata (Contejean)
Góry Mokre (Holy Cross Mts.), Lower Kimeridgian

Fig. 1. Young left valve in.: *a* internal, *b* external views (Mo. V. 81).
Fig. 2. Adult left valve in: *a* external, *b* internal views (Mo. V./82).

Alectryonia gregarea (Sowerby)
Przemianki (Holy Cross Mts.), Lower Kimeridgian

Fig. 3. Adult left valve arcuate in outline (Mo. V/83).

Arctostrea hastellata (Schlotheim)
Bałtów (Holy Cross Mts.), Middle Oxfordian

Fig. 4. Left valve with high-toothed commissure (Mo. V/84).

Liostrea moreana (Buvignier)
Skorków (Holy Cross Mts.), Lowermost Kimeridgian

Fig. 5. Left valve in: *a* external, *b* internal views (Mo. V/85).
Fig. 6. Right valve in.: *a* external, *b* internal views (Mo. V/86).

All figures × 1

Plate XI

Liostrea acuminata (Sowerby)
Łęczyca, Bajocian-Bathonian

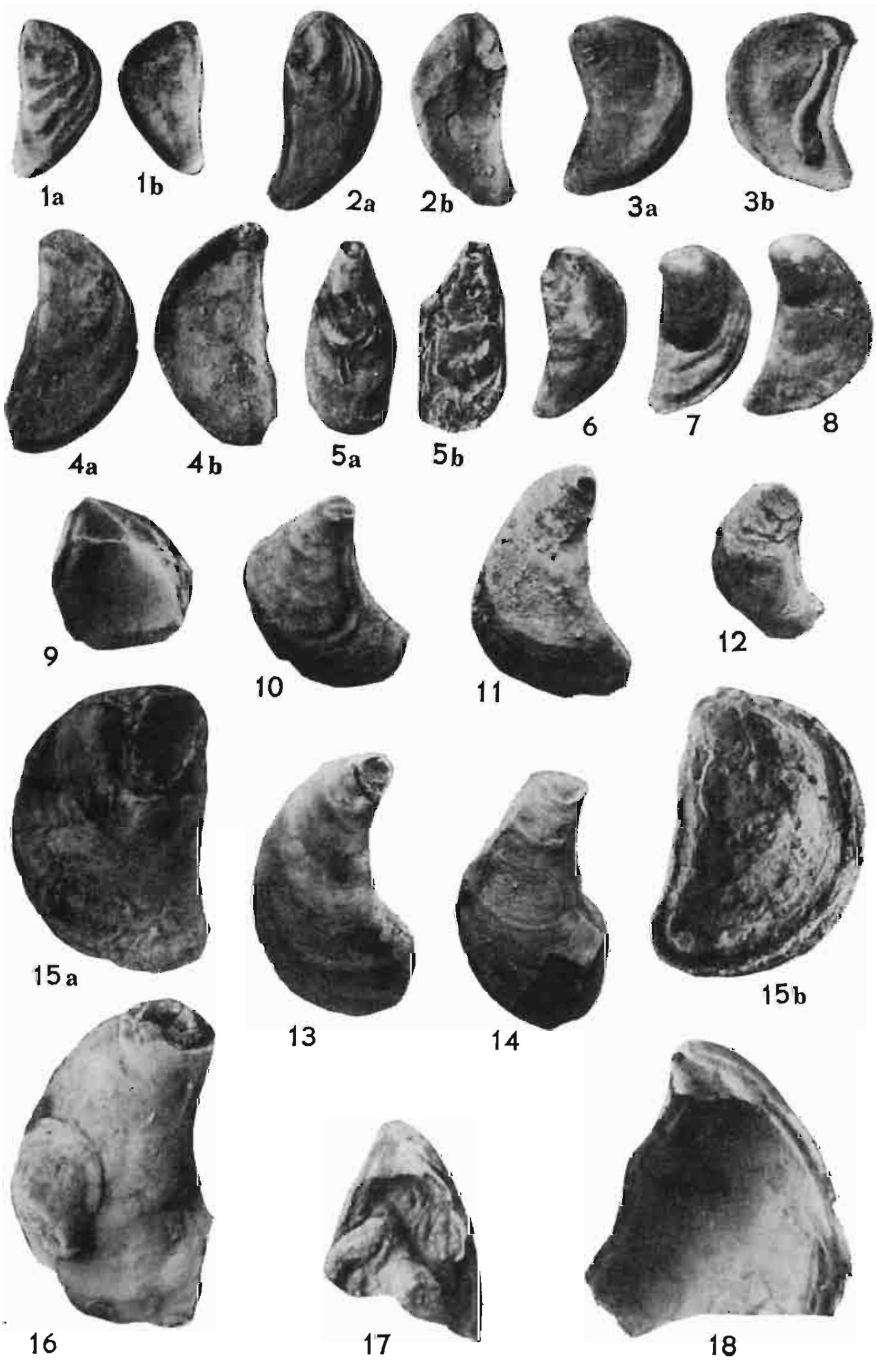
Figs. 1—4, 6—8. Seven right valves of different individual age in: *a* external, *b* internal views (Mo. V/87—93).

Figs. 5, 15. Shells of different individual age: *a* left valve, *b* right valve (Mo. V/94—95).

Figs. 9, 17, 18. Internal view of three left valves (Mo. V/96—98).

Figs. 10—14, 16. External view of six left valves of different individual age (Mo. V/99—104).

All figures × 1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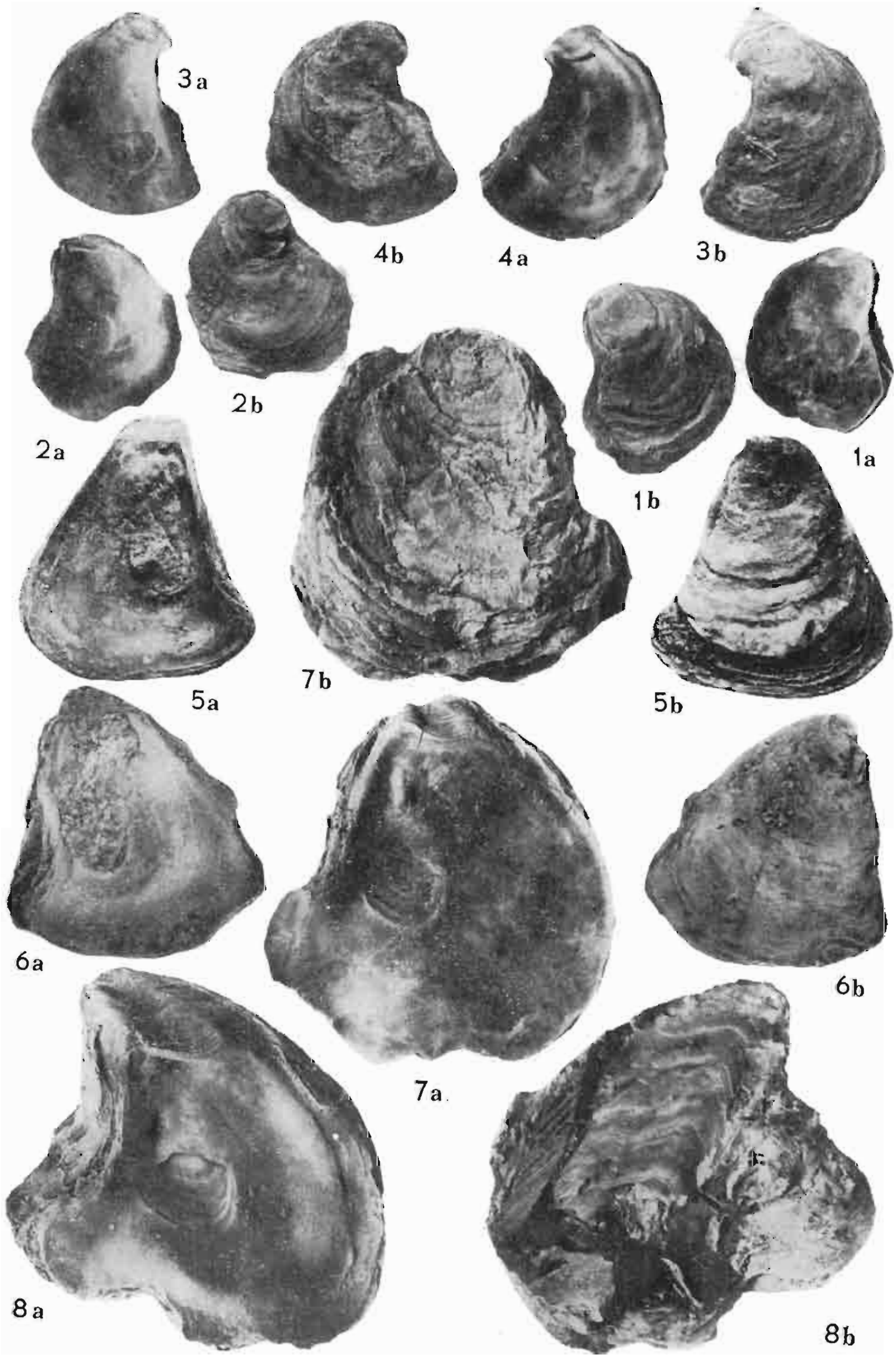
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6b
8a
8b

Plate XII

Liostrea delta (Smith)
Czarnogłowy (Western Pomerania), Lower Kimeridgian

Figs. 1, 2. Young shells. *1* right valve in: *a* internal, *b* external views (Mo. V/105a), *2* left valve in: *a* internal, *b* external views (Mo. V/105b).

Figs. 3, 4. Young shells. *3* right valve in: *a* internal, *b* external views (Mo. V/106a), *4* left valve in: *a* internal, *b* external views (Mo. V/106b).

Figs. 5, 6. Young shells. *5* right valve in: *a* internal, *b* external views (Mo. V/107a). *6* left valve in: *a* internal, *b* external views (Mo. V/107b).

Figs. 7, 8. Two left valves in advanced adult stage in: *a* internal, *b* external views (Mo. V/108—Mo. V/109).

All figures × 1

Plate XIII

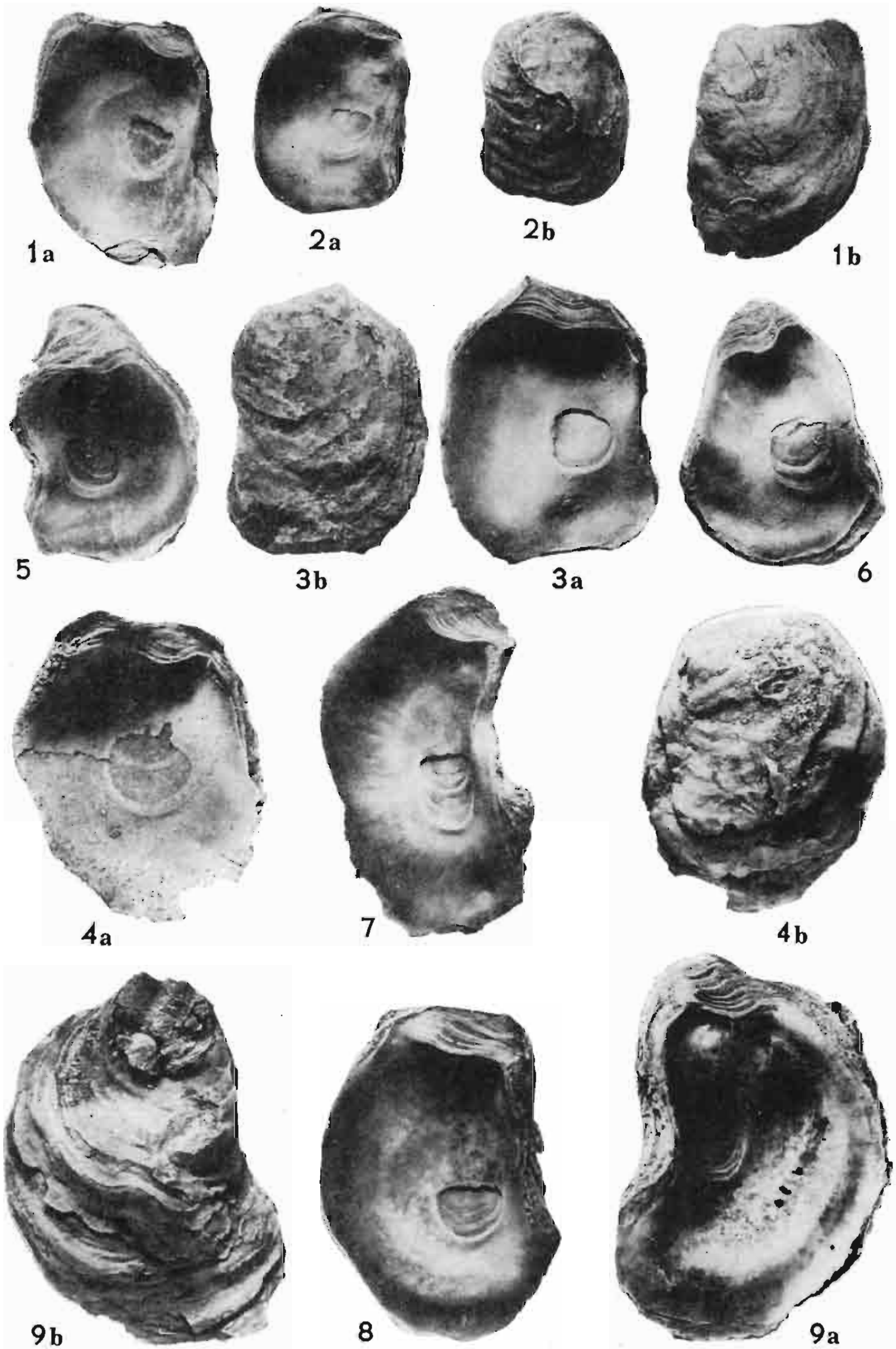
Liostrea quadrangularis Arkell
Czarnogłowy (Western Pomerania), Lower Kimeridgian

Figs.. 1—4. Four right shells of different individual age in: *a* internal, *b* external views (Mo. V/110—113).

Liostrea oxfordiana (Rollier)
Czarnogłowy (Western Pomerania), Lower Kimeridgian

Fig. 5. Internal view of left valve (Mo. V/114).
Figs. 6—8. Internal view of three right valves showing in 7 the gill scars (Mo. V/115—117).
Fig. 9. Adult left valve in: *a* internal, *b* external views (Mo. V/118).

All figures $\times$ 1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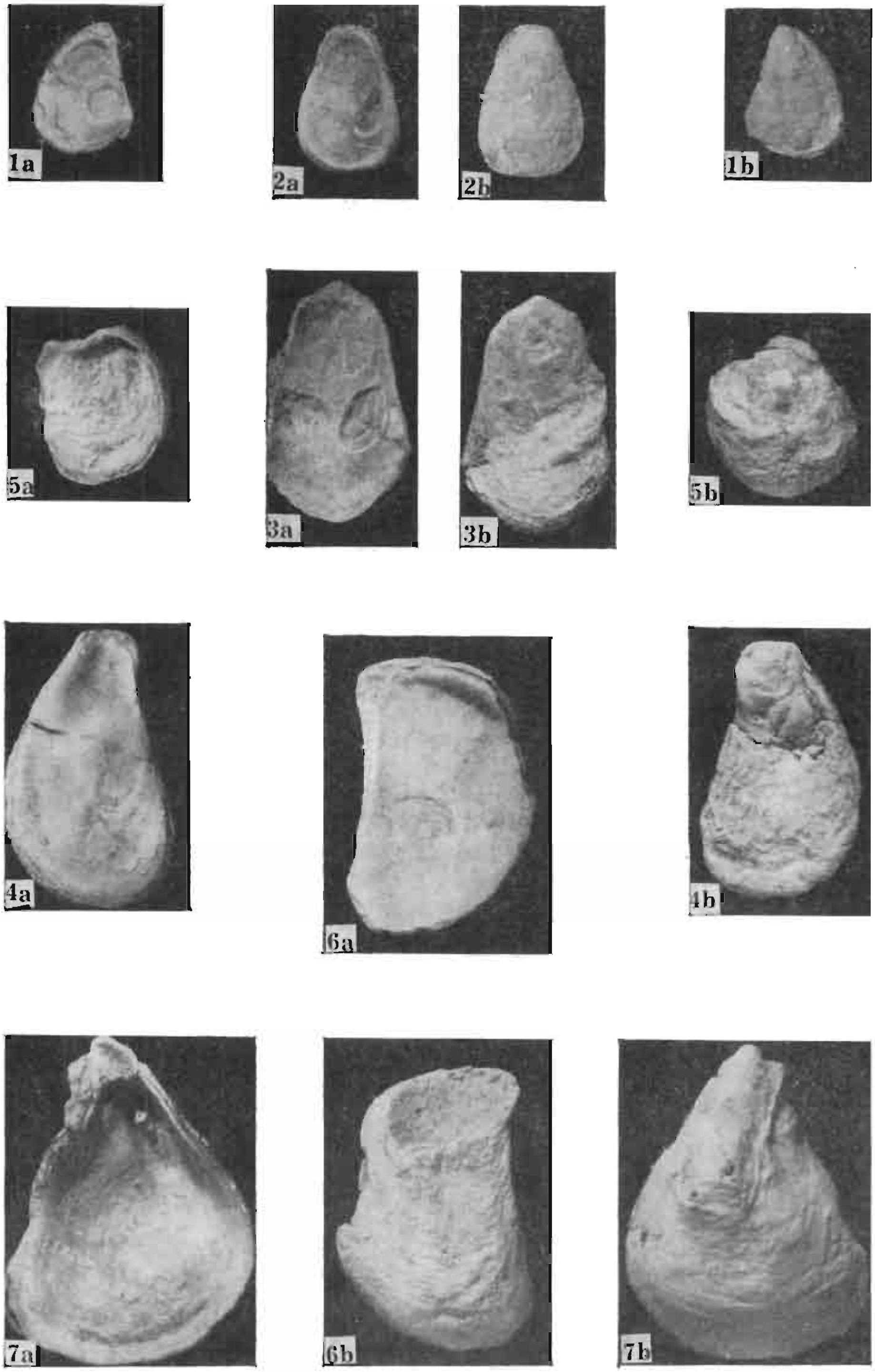
9a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4b
7a
6b
7b

Plate XIV

Liostrea dubisensis (Contejean)
Brzostówka (near Tomaszów Mazow.), Middle Volgian

Figs. 1—4. Four right valves of different individual age in: *a* internal, *b* external views (Mo. V/119—Mo. V/122).
Fig. 5. The shell with large attachment area: *a* right valve, *b* left valve (Mo. V/123).
Figs. 6, 7. Two adult left valves in: *a* internal, *b* external views (Mo. V/124—125).

All figures × 3

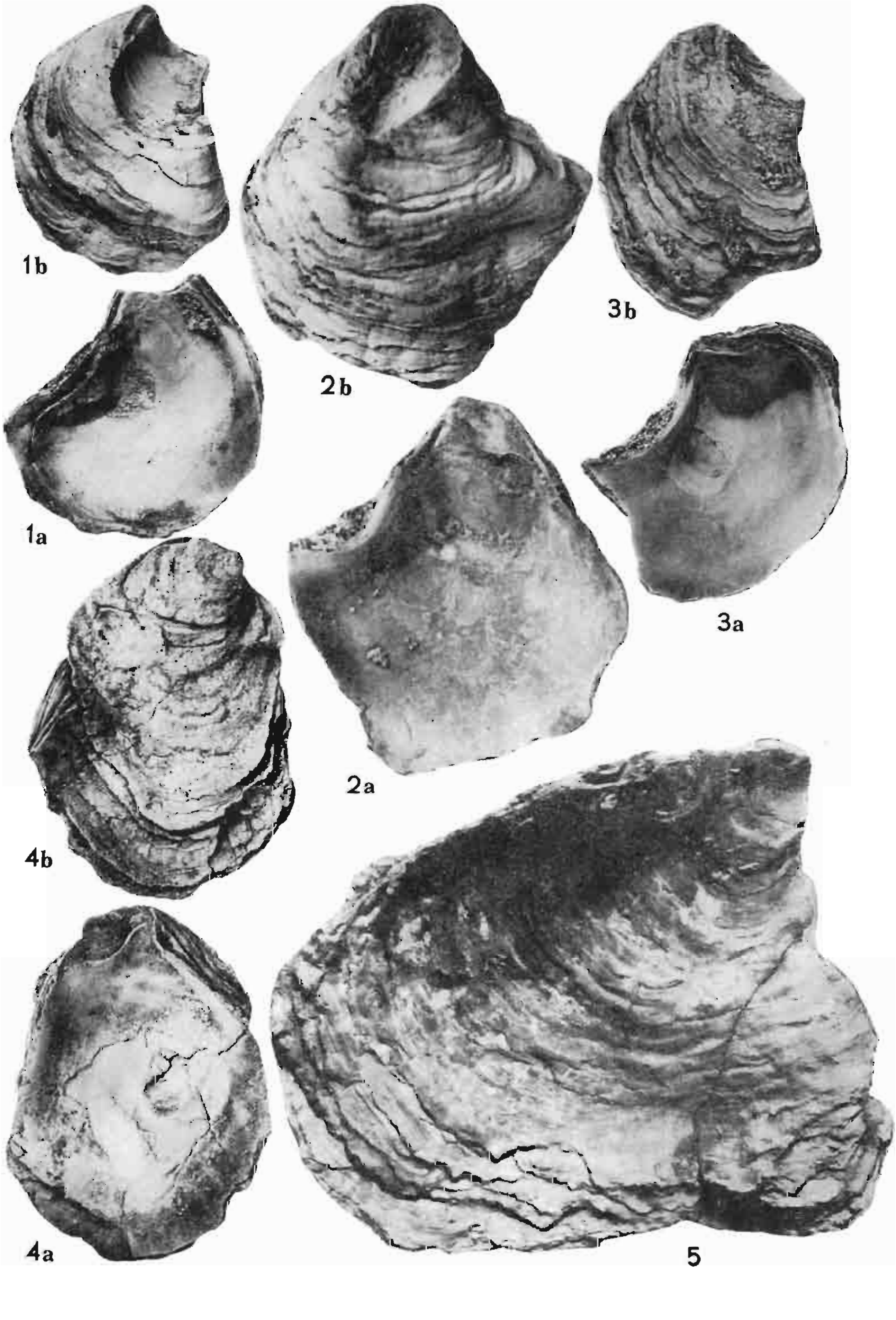
Plate XV

Liostrea gryphaeata (Schlotheim)
Czarnogłowy (Western Pomerania), Lower Kimeridgian

Figs. 1—3. Three left valves of different individual age in: *a* internal, *b* external views (Mo. V/126—128).
Fig. 4. Right valve in: *a* internal, *b* external views (Mo. V/129); × 1.

Liostrea unciformis (Buvignier)
Brzostówka (n. Tomaszów Mazow.), Middle Volgian

Fig. 5. External view of the adult left valve (Mo. V/130a); 2/3 nat. size.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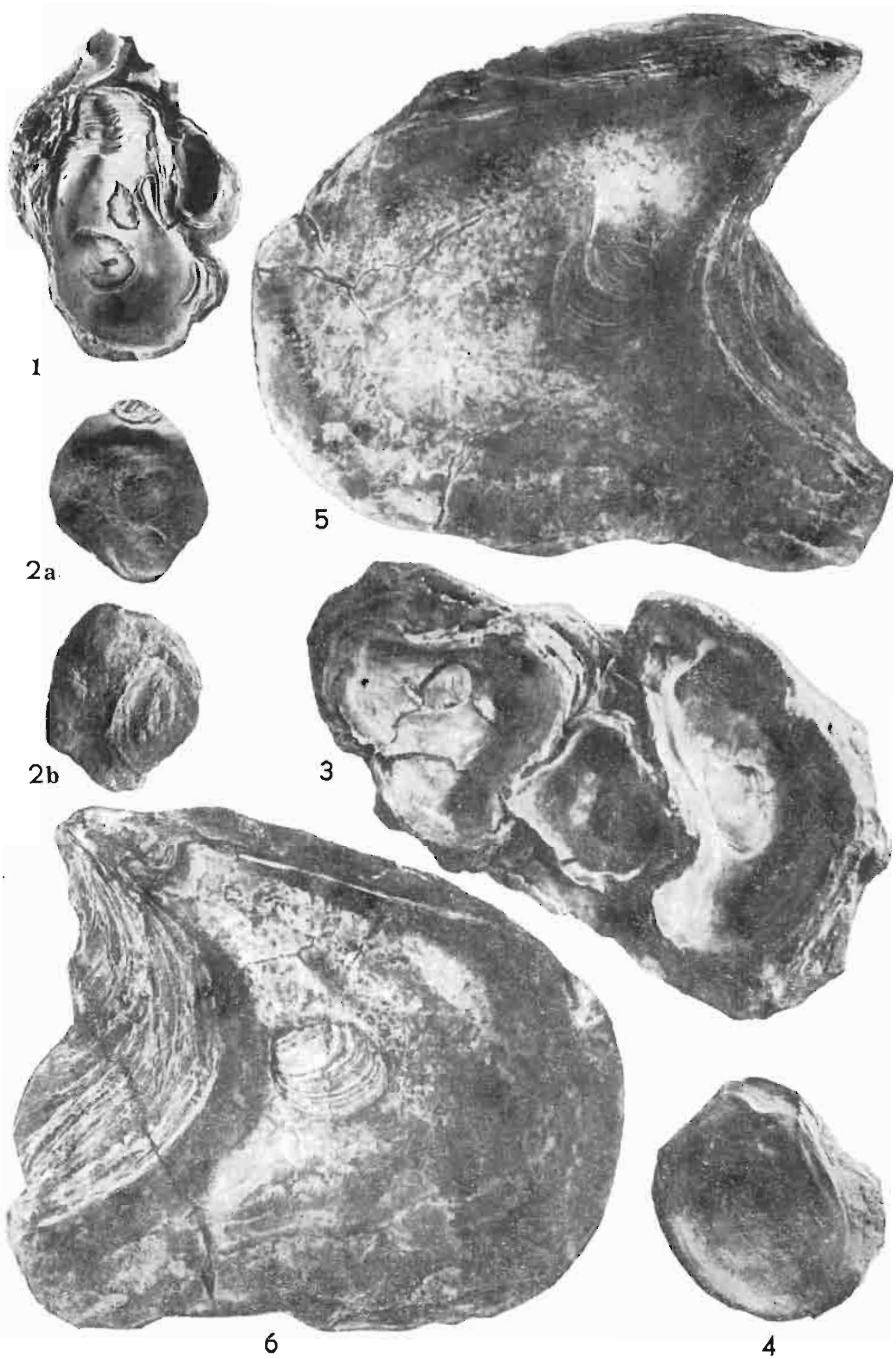
5


1
2a
2b
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3
6
4

Plate XVI

Liostrea sequana (Thrumann)
Skorków (Holy Cross Mts), Upper Oxfordian-Lower Kimeridgian

Figs. 1, 3. Internal view of left valves of completely attached shells (Mo. V/131—132); × 1.
Fig. 2. Right valve in: *a* internal, *b* external views (Mo. V/133); × 1.
Fig. 4. Internal view of the right valve (Mo. V/134); × 1.

Liostrea unciformis (Buvignier)
Brzostówka (near Tomaszów Mazowiecki), Middle Volgian

Figs. 5, 6. Two valves of the same specimen internal view: *5* left valve (Mo. V/130*b*), *6* right valve (Mo. V/135); 2/3 nat. size.

Plate XVII

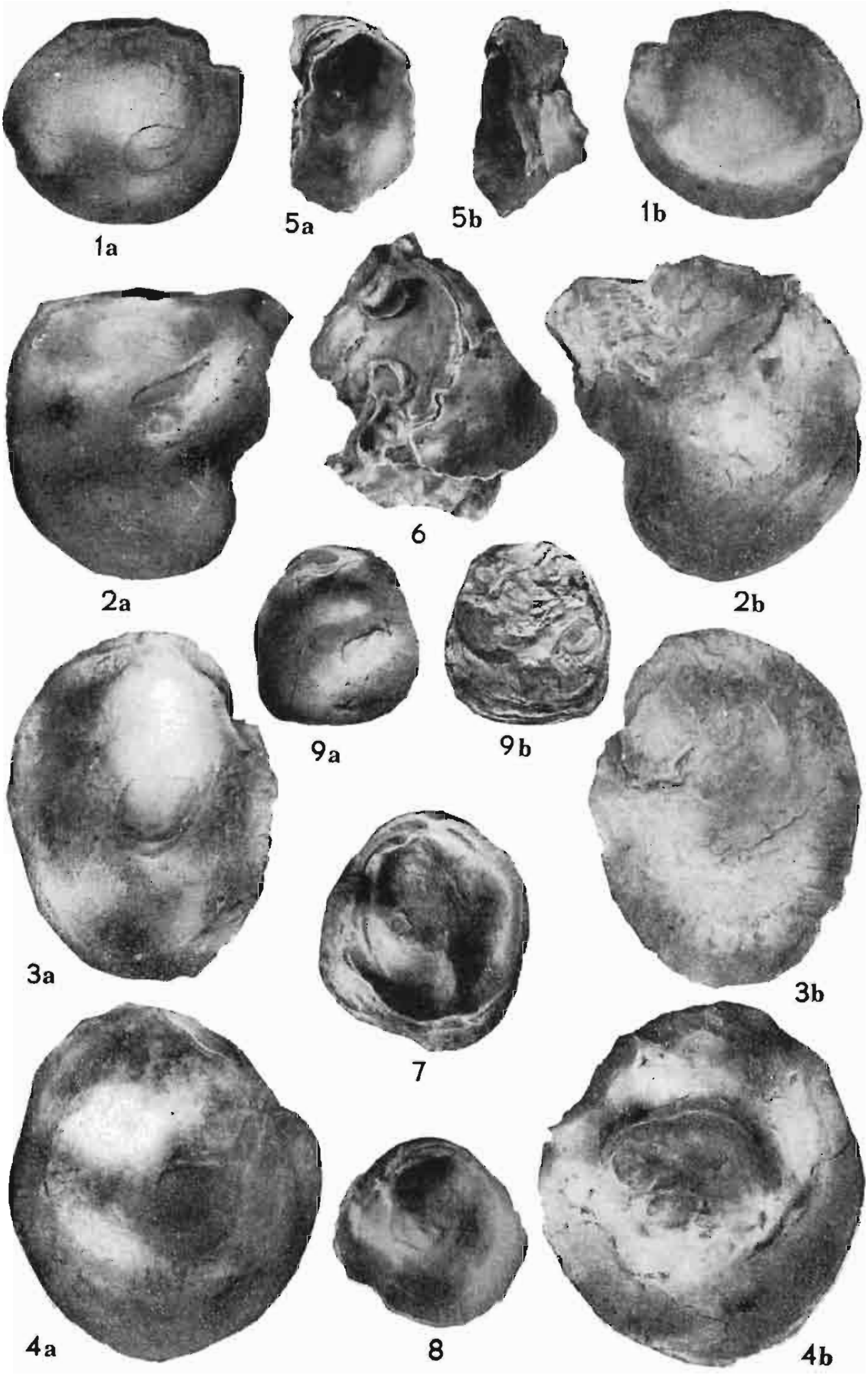
Gryphaea dilatata (Sowerby)
Skorków (Holy Cross Mts.), Lower Kimeridian

Fig. 1—4. Four left valves of different individual age in: *a* internal, *b* external views (Mo. V/136—139).

Liostrea monsbeliardensis (Contejean)
Skorków (Holy Cross Mts.), Lower Kimeridgian

Fig. 5. Left valve: *a* internal view, *b* side view from anterior margin (Mo. V/140).
Figs. 6—8. Internal view of three valves (Mo. V/141—143).
Fig. 9. Right valve in: *a* internal, *b* external views (Mo. V/144).

All figures × 1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4b

1a

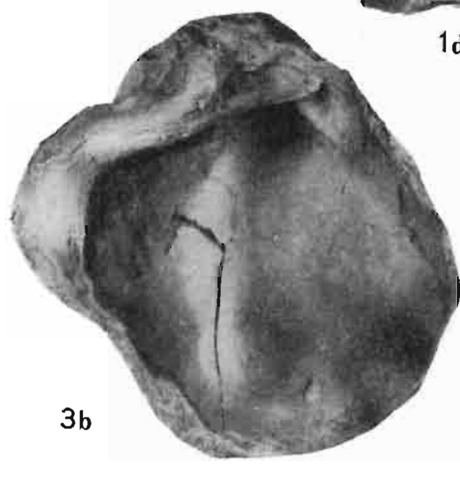
1b

1c

2a

2b

1d



3b

3a

Plate XVIII

Gryphaea dilatata (Sowerby)
Skorków (Holy Cross Mts.), Lower Kimeridgian

Fig. 1. Adult left valve in: *a* external, *b* internal views, *c* the valve with internal mould, *d* the mould in side view (Mo. V/145—145a).
Figs. 2, 3. Two adult left valves in: *a* external, *b* internal views (Mo. V/146—147).

All figures × 1

Plate XIX

Liostrea plastica (Trautschold)
Czarnogłowy (W. Pomerania), Middle Volgian

Fig. 1. Right valve in: *a* internal, *b* external views (Mo. V/148).
Fig. 2. Left valve in: *a* internal, *b* external views (Mo. V/149).

Alectryonia vallata (Étallon)
Sobków (Holy Cross Mts.), Lower Kimeridgian

Fig. 3. Young left valve in: *a* internal, *b* external views (Mo. V/150).
Fig. 4. Adult left valve (Mo. V/151).

Liostrea polymorpha (Münster)
Gruszczyn (Holy Cross Mts.), Lower Kimeridgian

Figs. 5, 7. Two adult left valve: *5* internal view (Mo. V/152), *7* external view (Mo. V/153).
Fig. 6. Internal view of the left valve (Mo. V/154).
Fig. 8. The shell viewed from: *a* internal side of the left valve, *b* external side of the right valve, *c* internal side of the right valve (Mo. V/155—156).

All figures × 1

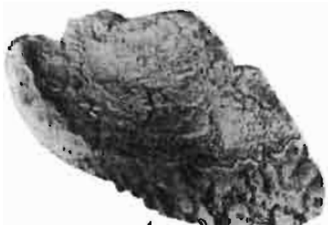

1a


2a


2b


1b


3a


4


3b


5


6


7


8a


8c


8b

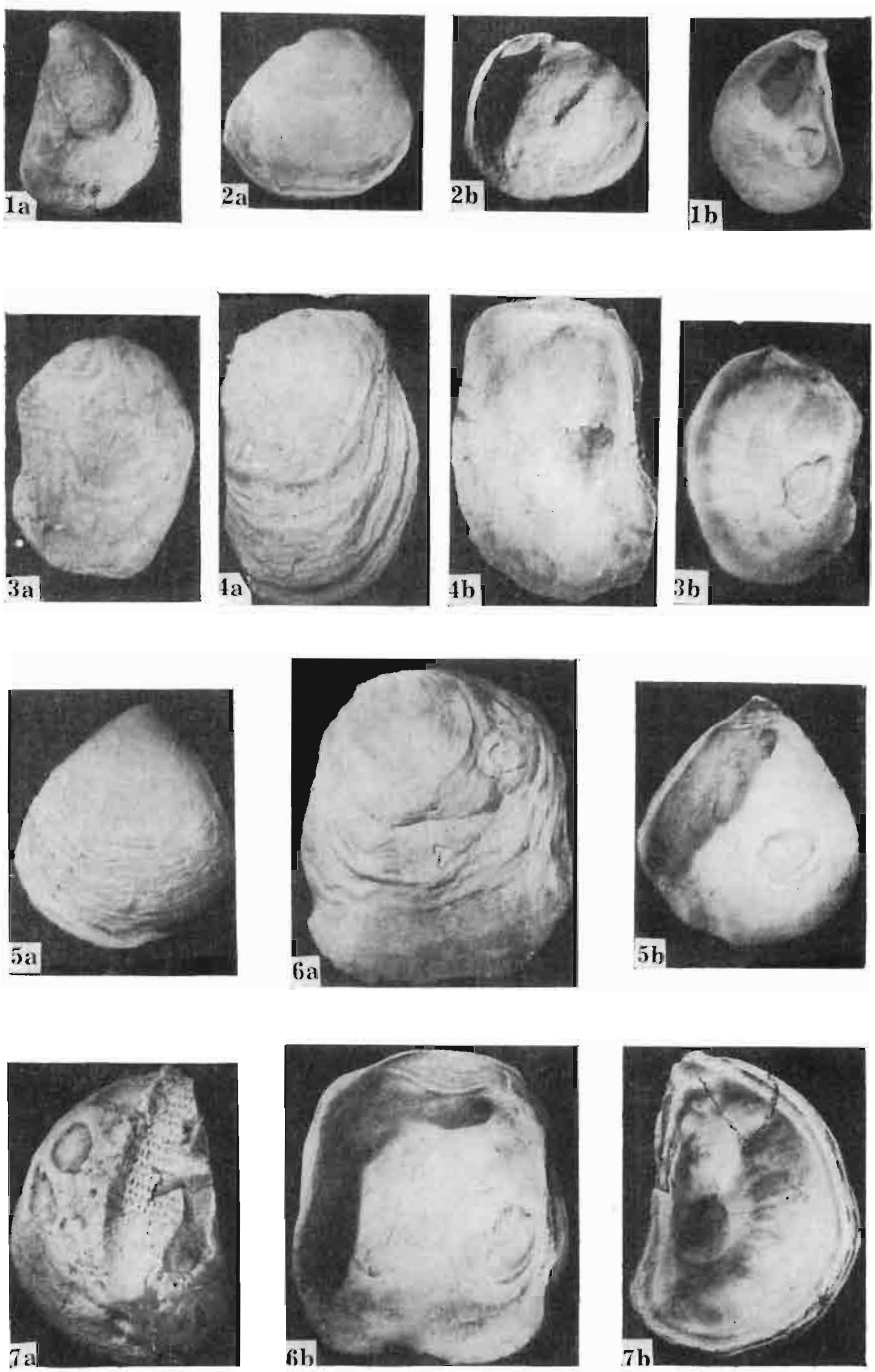

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Plate XX

Liostrea multiformis (Koch & Dunker)
Czarnogłowy (Western Pomerania), Lower Kimeridgian

Figs. 1—6. Six right valves of different individual age in: *a* external, *b* internal views (Mo. V/157—162).

Fig. 7. Left valve in: *a* external, *b* internal views, the gill scars visible along the anterior margin (Mo. V/163).

All figures × 2

Plate XXI

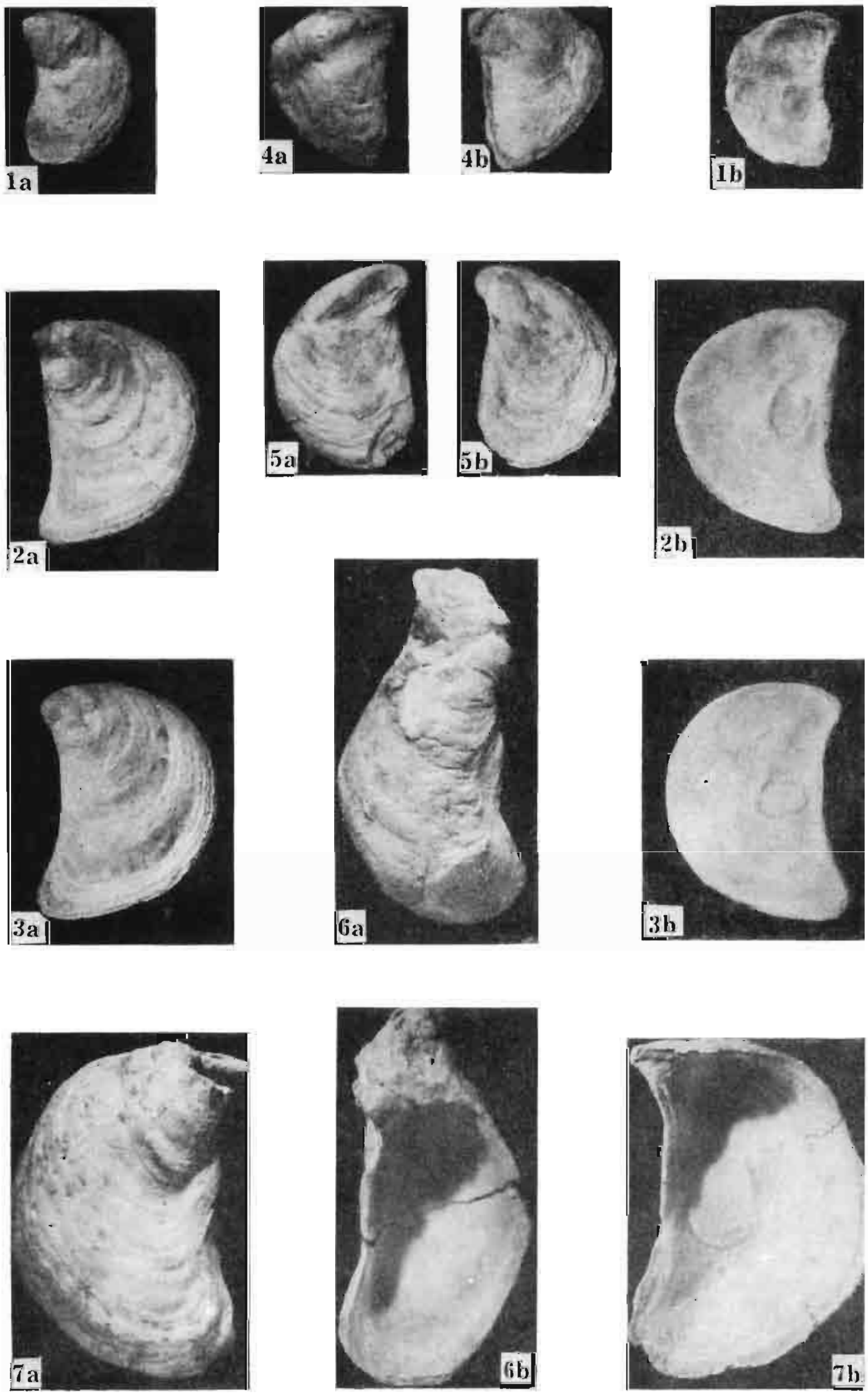
Liostrea virguloides (Lewiński)
Brzostówka (near Tomaszów Mazowiecki) Middle Volgian

Figs. 1—3. Three right valves of different individual age in: *a* external, *b* internal views (Mo. V/164—Mo. V/166).

Figs. 4, 5. Two young shells: *a* left valve, *b* right valve (Mo. V/167—168).

Figs. 6, 7. Two adult left valves in: *a* external, *b* internal views; ostreforme, acute hinge visible (Mo. V/169—170).

All figures × 3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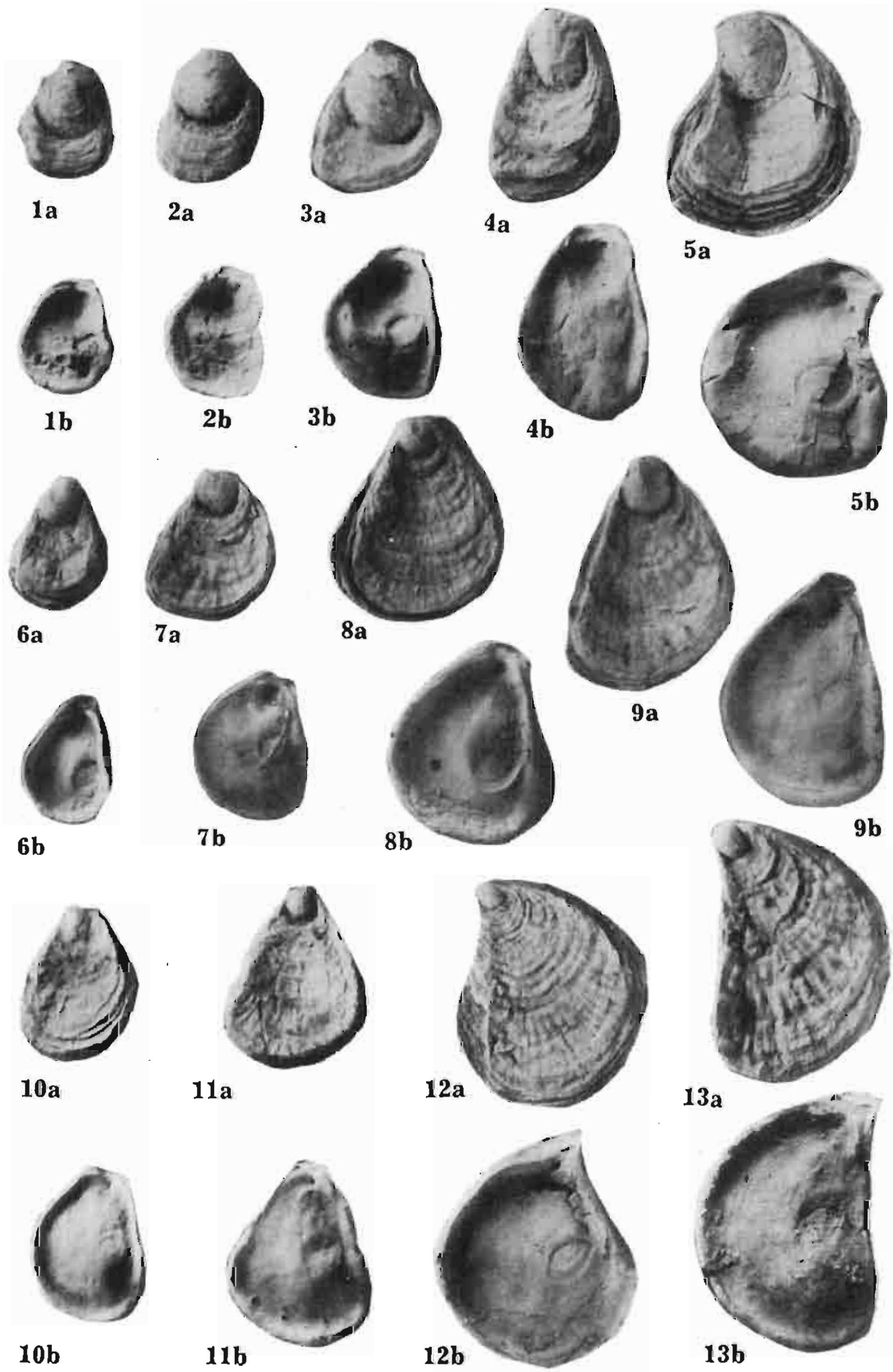


1a 2a 3a 4a 5a
1b 2b 3b 4b 5b
6a 7a 8a 9a
6b 7b 8b 9b
10a 11a 12a 13a
10b 11b 12b 13b

Plate XXII

Catinula knorri (Voltz)
Łęczyca, Bajocian-Bathonian

Figs. 1—13. Thirteen right valves of different individual age in: *a* external, *b* internal views (Mo. V/171—183).

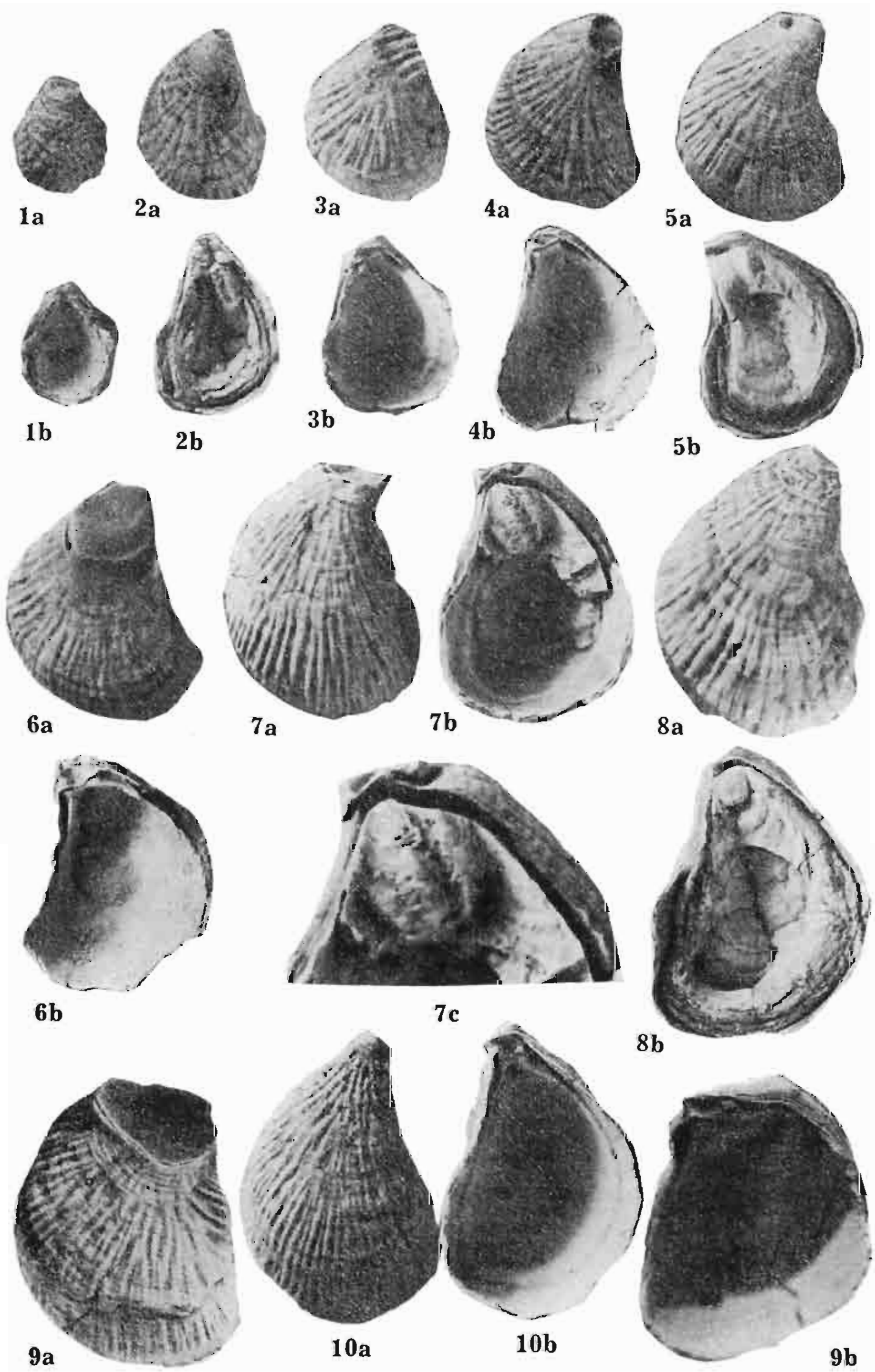
All figures × 2

Plate XXIII

Catinula knorri (Voltz)
Łęczyca, Bajocian-Bathonian

Figs. 1, 3, 4, 6, 9, 10. Six left valves of different individual age in: *a* external, *b* internal views (Mo. V/184—189).
Figs. 2, 5, 7, 8. Four shells of different individual age in: *a* external, *b* internal views (Mo. V/190—193).

All figures × 2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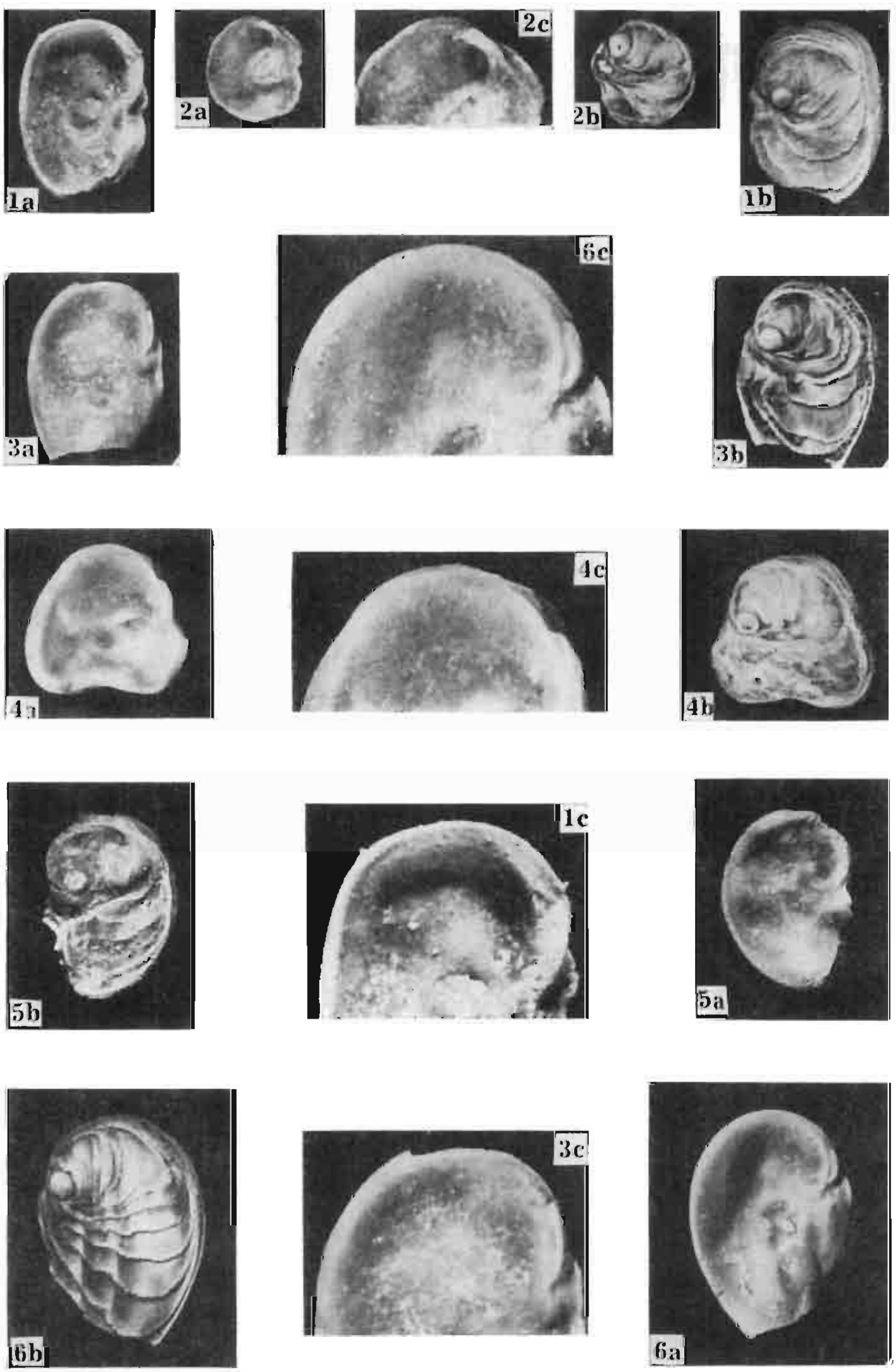
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3c
6a

Plate XXIV

Nanogyra nana (Sowerby)
„Strzałków I" bore-hole (near Sulejów), Lower Kimeridgian

Figs. 1—6. Six juvenile right valves viewed from: *a* internal, × 10; *b* external, × 10; *c* hinge-area, × 20 (Mo. V/194—199).

Plate XXV

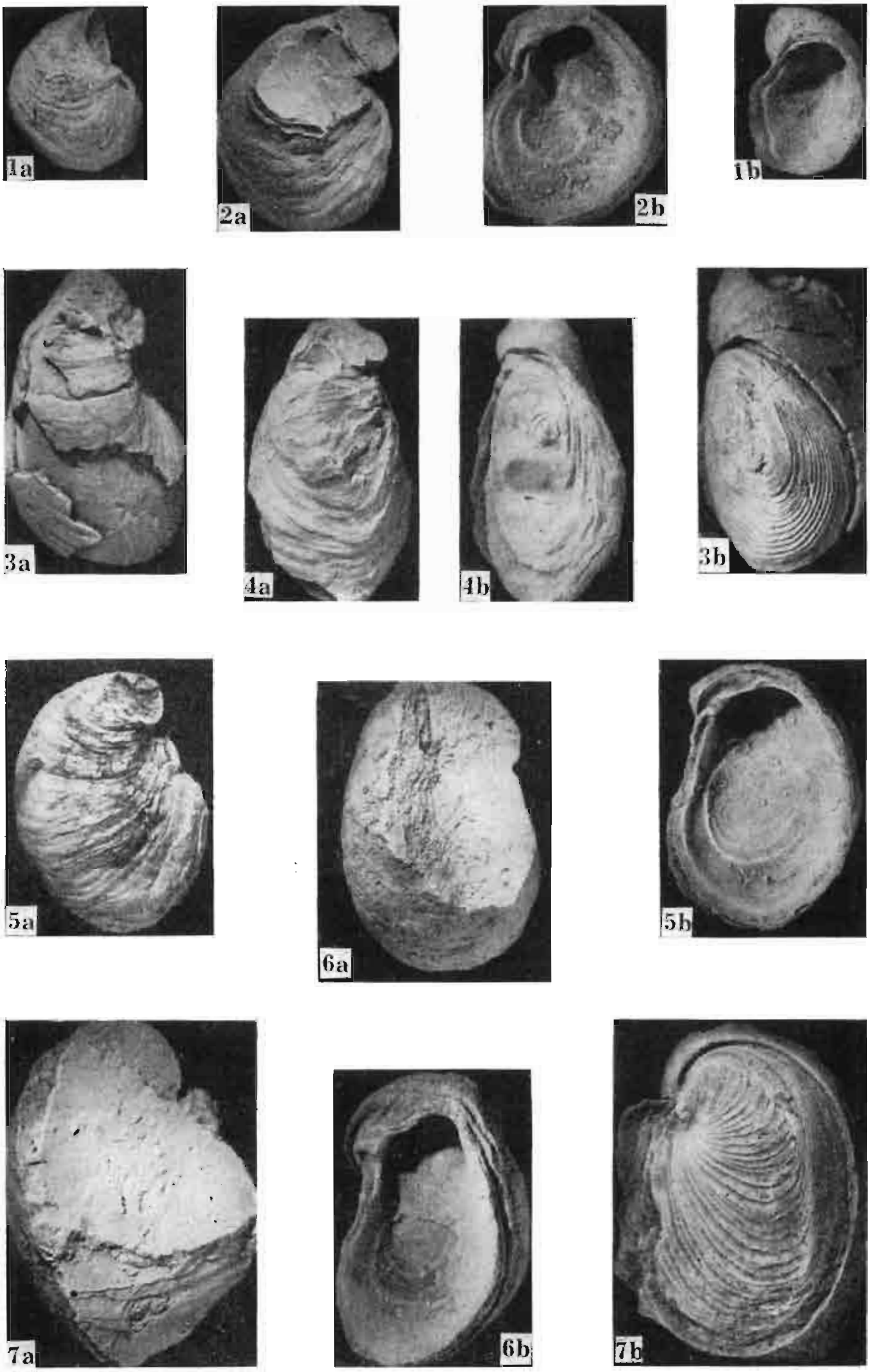
Nanogyra nana (Sowerby)

Bąkowa Góra (Holy Cross Mts.), layers between middle and upper part of Lower Kimeridgian

Figs. 1, 2, 5, 6. Four left valves of different age in: *a* external, *b* internal views (Mo. V/200—203).

Figs. 3, 4, 7. Three shells of different age viewed from: *a* left valve, *b* right valve (Mo. V/204—206).

All figures $\times$ 2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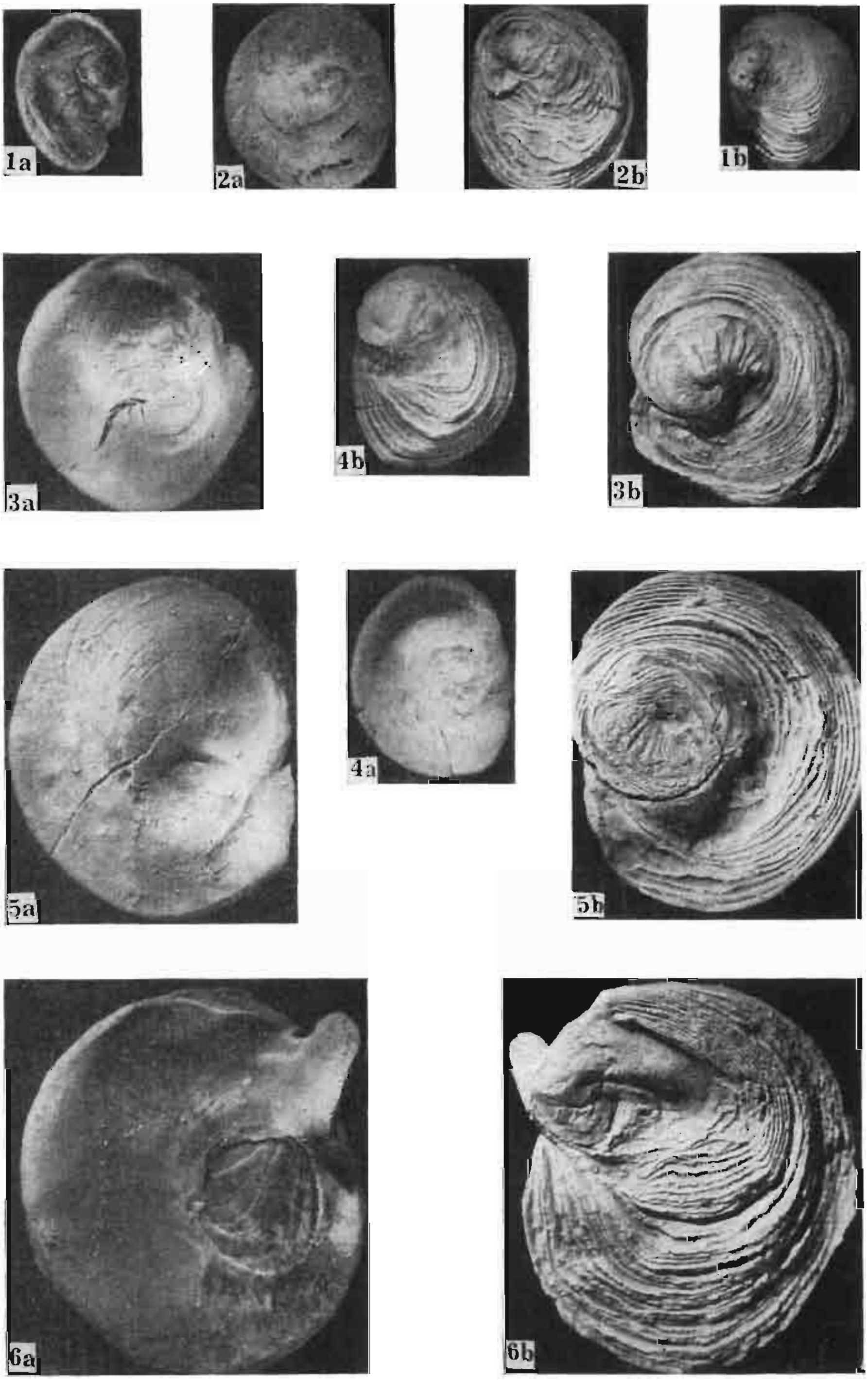
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Plate XXVI

Nanogyra nana (Sowerby)
Gruszczyn (Holy Cross Mts.), uppermost part of Lower Kimeridgian

Figs. 1—6. Six strong rounded in outline right valves of different individual age. *a* internal, *b* external views (Mo. V/207—212).

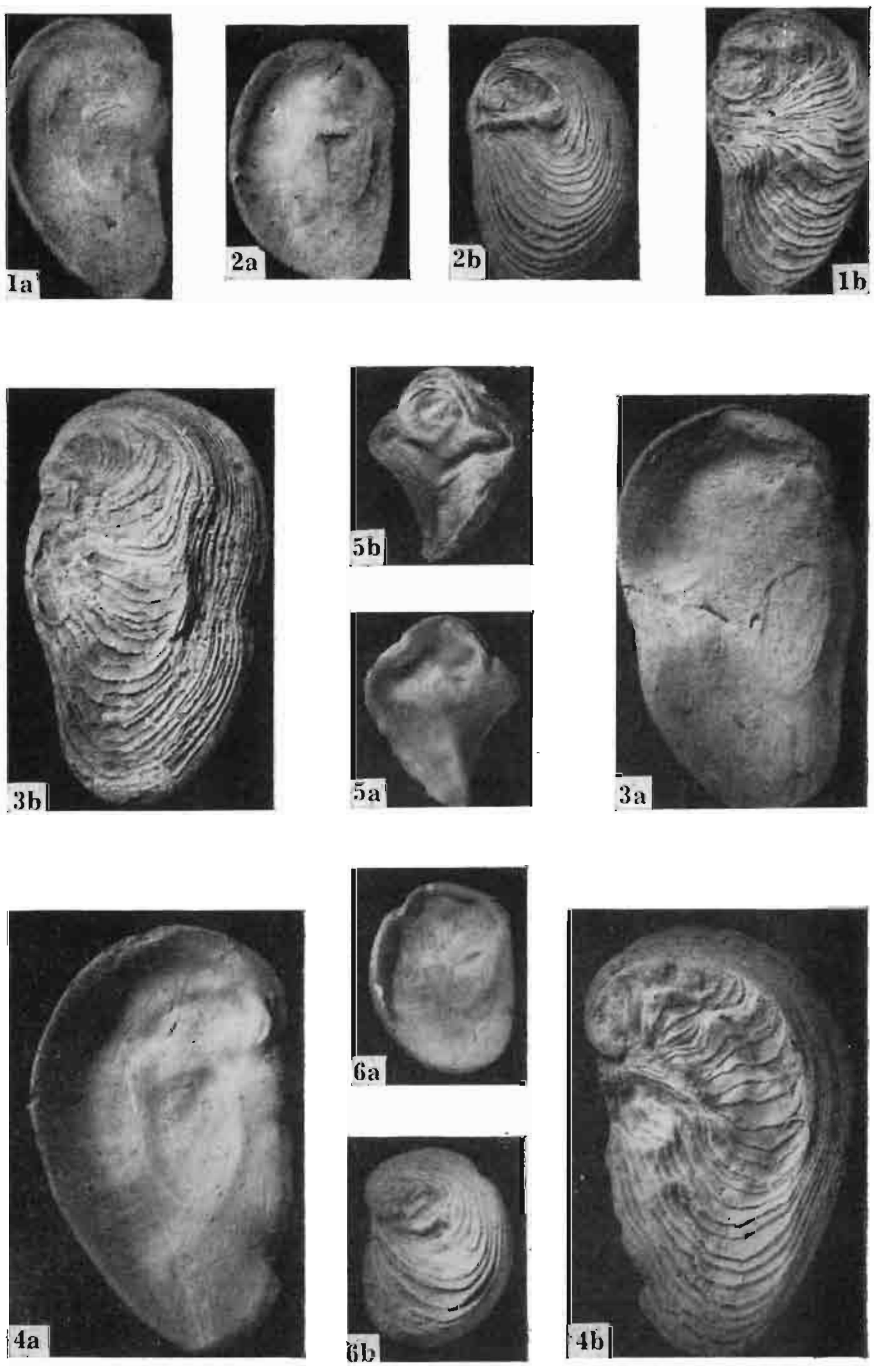
All figures × 3

Plate XXVII

Nanogyra nana (Sowerby)

Figs. 1—4, 6: Gruszczyn (Holy Cross Mts.), uppermost Lower Kimeridgian
Fig. 5: Wierzbica (near Radom), Lower Kimeridgian

Figs. 1—4. Four extremely ovate in outline right valves of different individual age in: *a* internal, *b* external views (Mo. V/213—216); × 3.
Figs. 5, 6. Two right valve of different shape in: *a* internal, *b* external views Mo. V/217—218); *5* × 1; *6* × 3.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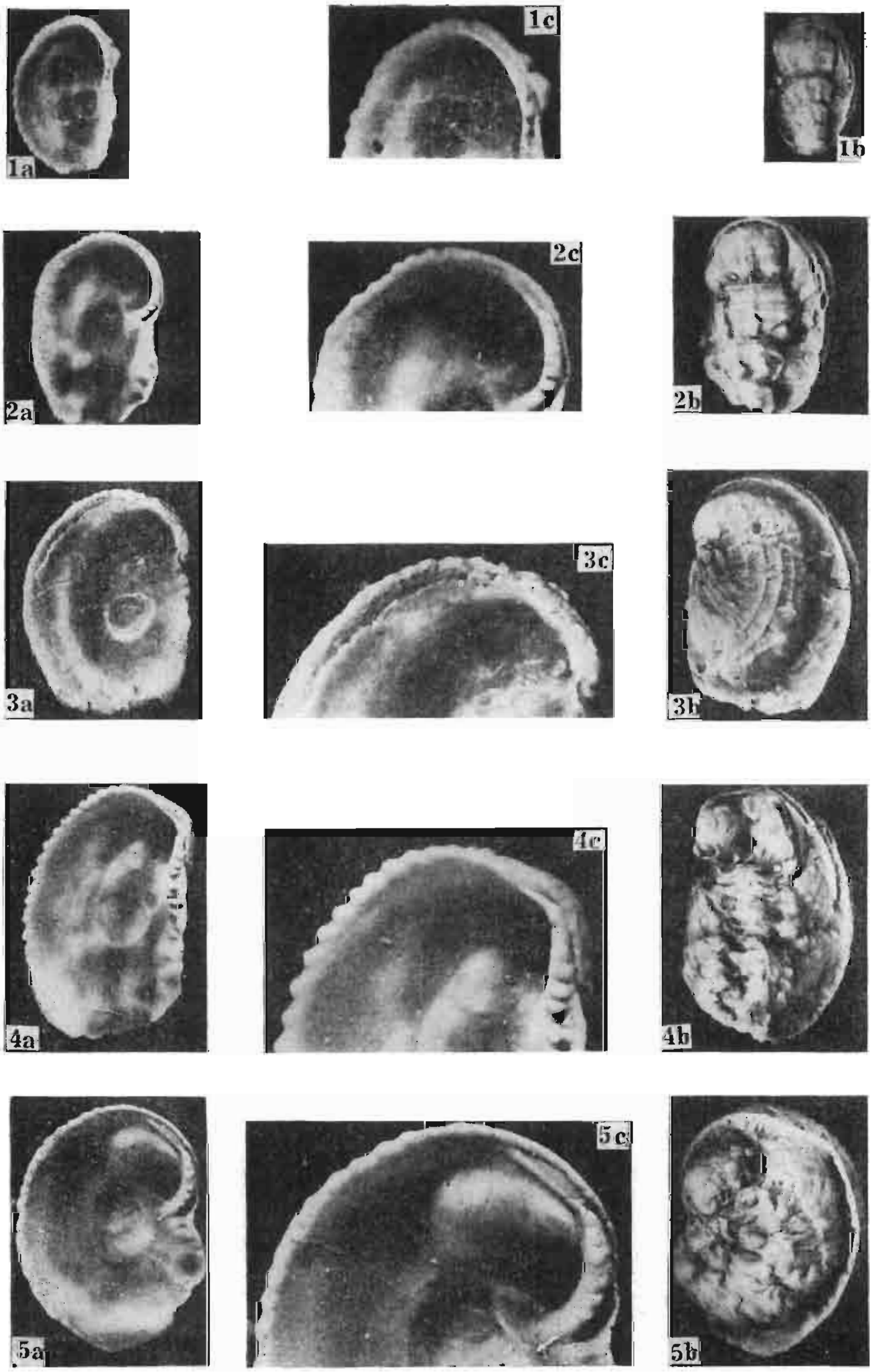
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Plate XXVIII

Exogyra virgula (Defrance)
„Strzałków I" bore-hole (near Sulejów), Lower Kimeridgian

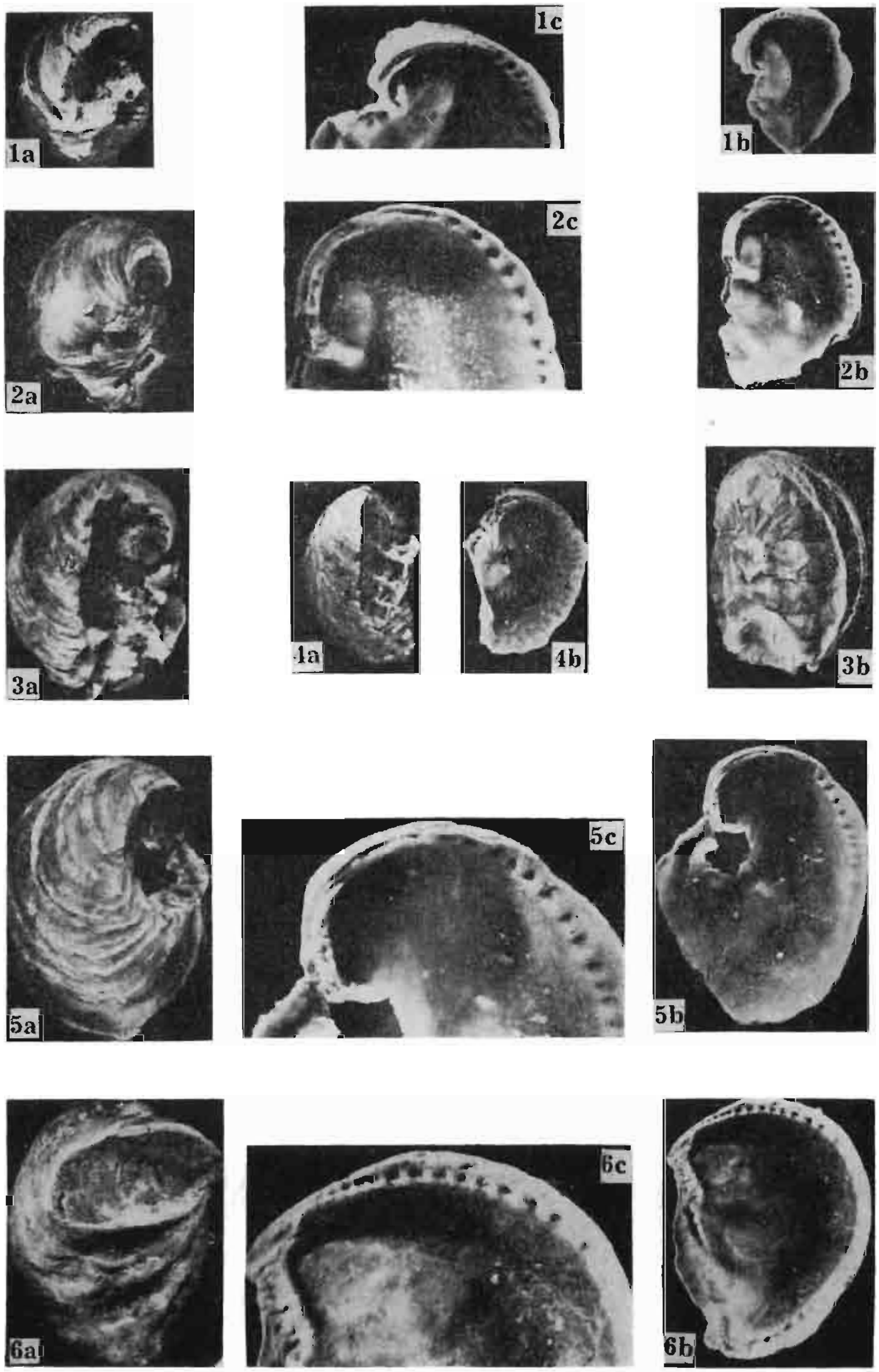
Figs. 1—5. Five juvenile right valves in: *a* internal, *b* external views, × 10; *c* hinge area, × 20, (Mo. V/219—223).

Plate XXIX

Exogyra virgula (Defrance)
„Strzałków I" bore-hole (near Sulejów), Lower Kimeridgian

Figs. 1, 2, 4—6, Five juvenile left valves in: *a* external, *b* internal views, × 10; *c* hinge area, × 20 (Mo. V/224—228).

Fig. 3. The juvenile shell viewed from: *a* left valve: *b* right valve (Mo. V/229); × 10.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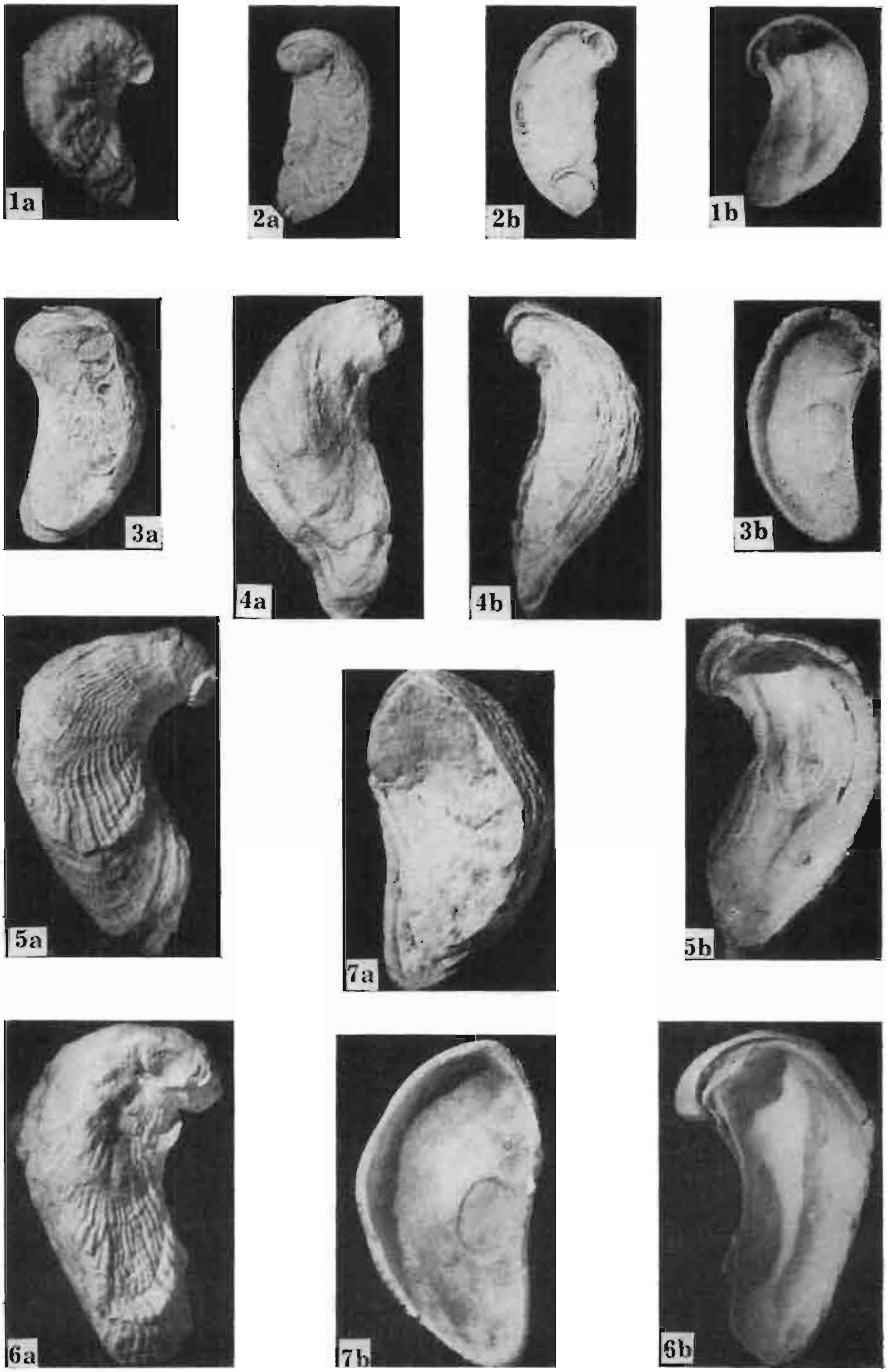
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6b

Plate XXX

Exogyra virgula (Defrance)

Oleszno, Gruszczyn, Góry Mokre (Holy Cross Mts.), Lower Kimeridgian

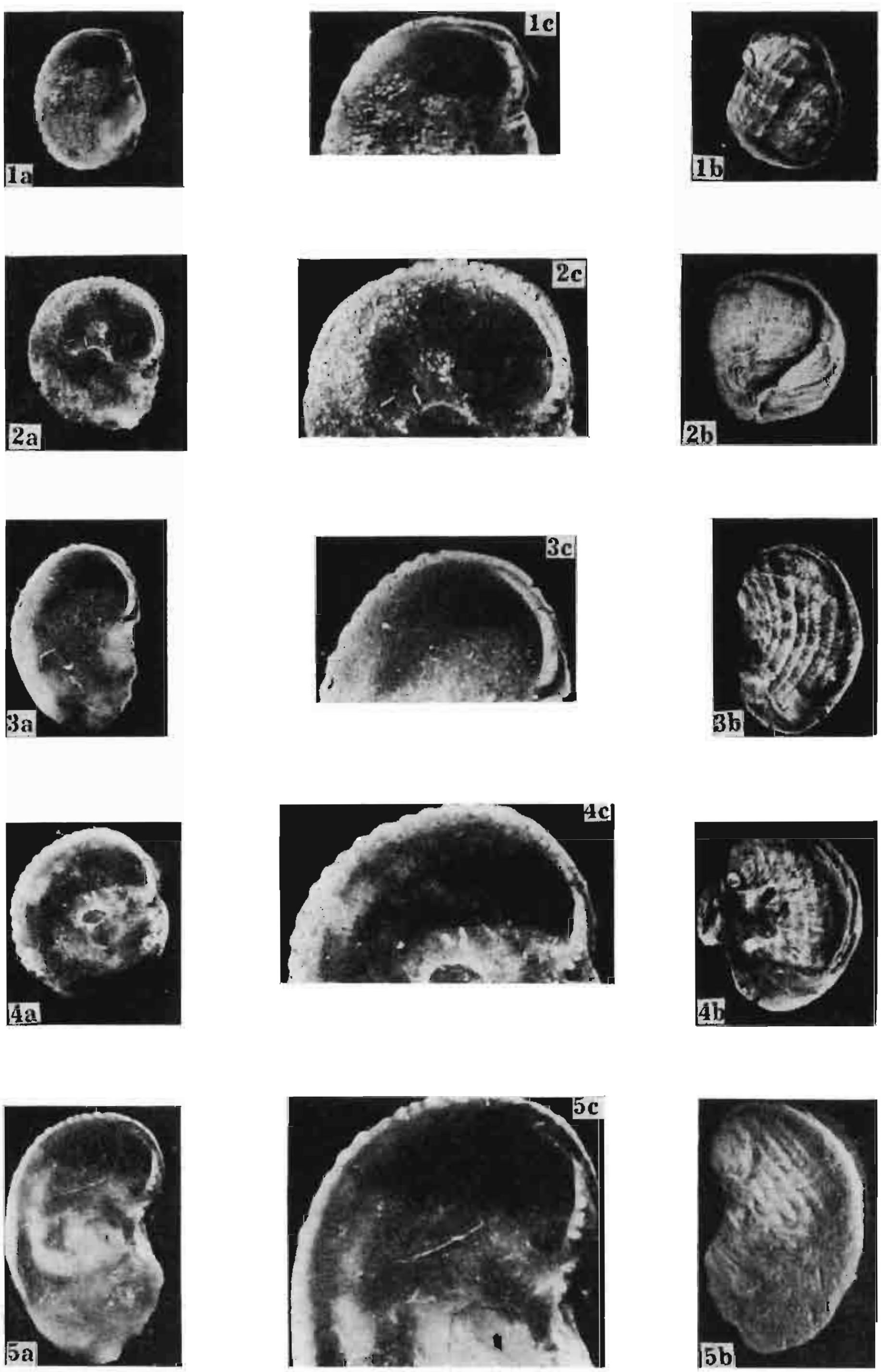
Figs. 1, 5, 6. Three left valves in: *a* external, *b* internal views (Mo. V/230—232).
Fig. 4. An adult shell from: *a* left valve, *b* right valve (Mo. V/233).
Figs. 2, 3, 7. Three right valves in: *a* external, *b* internal views (Mo. V/243—245).

Figs. 1, 4—7 ×2
Figs. 2, 3 × 3

Plate XXXI

Exogyra reniformis Goldfuss
„Strzałków I" bore-hole (near Sulejów), Lower Kimeridgian

Figs. 1—5. Five juvenile right valves in: *a* internal, *b* external views, × 10; *c* hinge area view, × 20 (Mo. V/248—252).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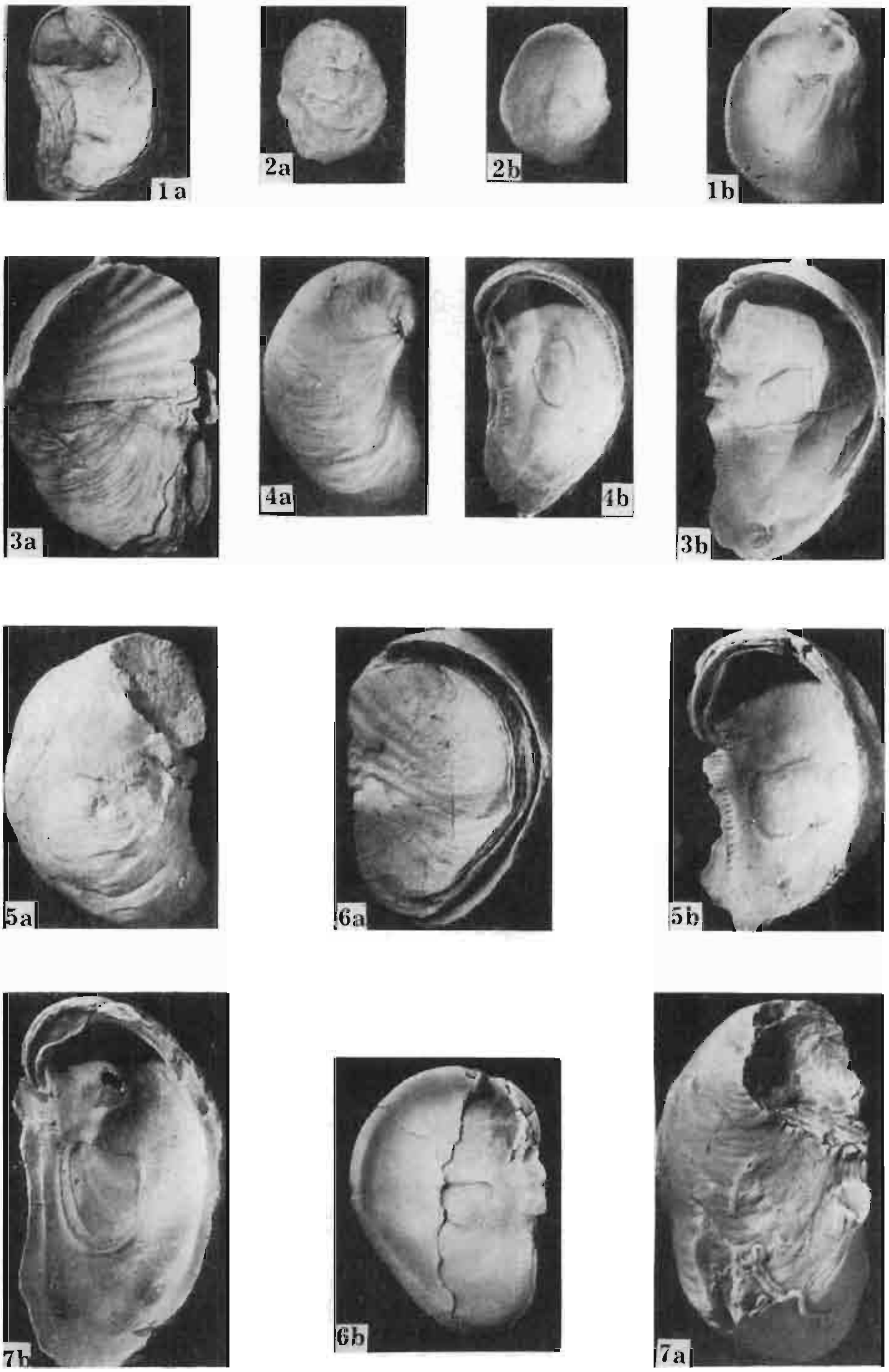
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Plate XXXII

Exogyra reniformis Goldfuss
Czarnogłowy (Western Pomerania), Lower Kimeridgian

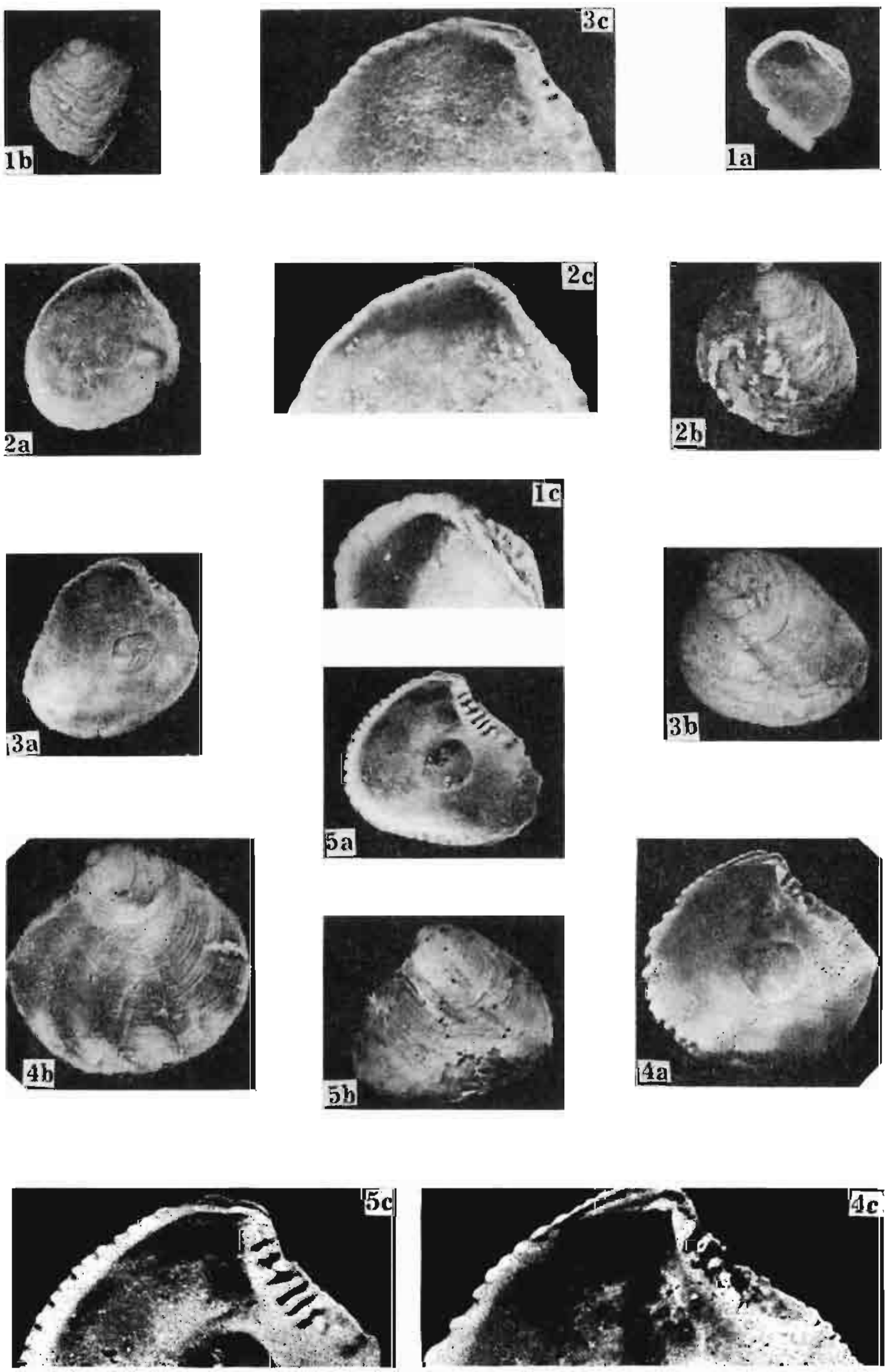
Figs. 1, 2, 6. Three right valves of different individual age in: *a* external, *b* internal views (Mo. V/253—255).
Figs. 3—5, 7. Four left valves of different individual age in: *a* external, *b* internal views (Mo. V/256—259).

All figures × 2

Plate XXXIII

Exogyra welschi Jourdy
„Strzałków I" bore-hole (near Sulejów), Lower Kimeridgian

Fig. 1—5. The juvenile right valves in: *a* internal, *b* external views, × 10; *c* hinge area, × 20 (Mo. V/266—270).


1b
3c
1a
2a
2c
2b
1c
3a
3b
5a
4b
5b
4a
5c
4c

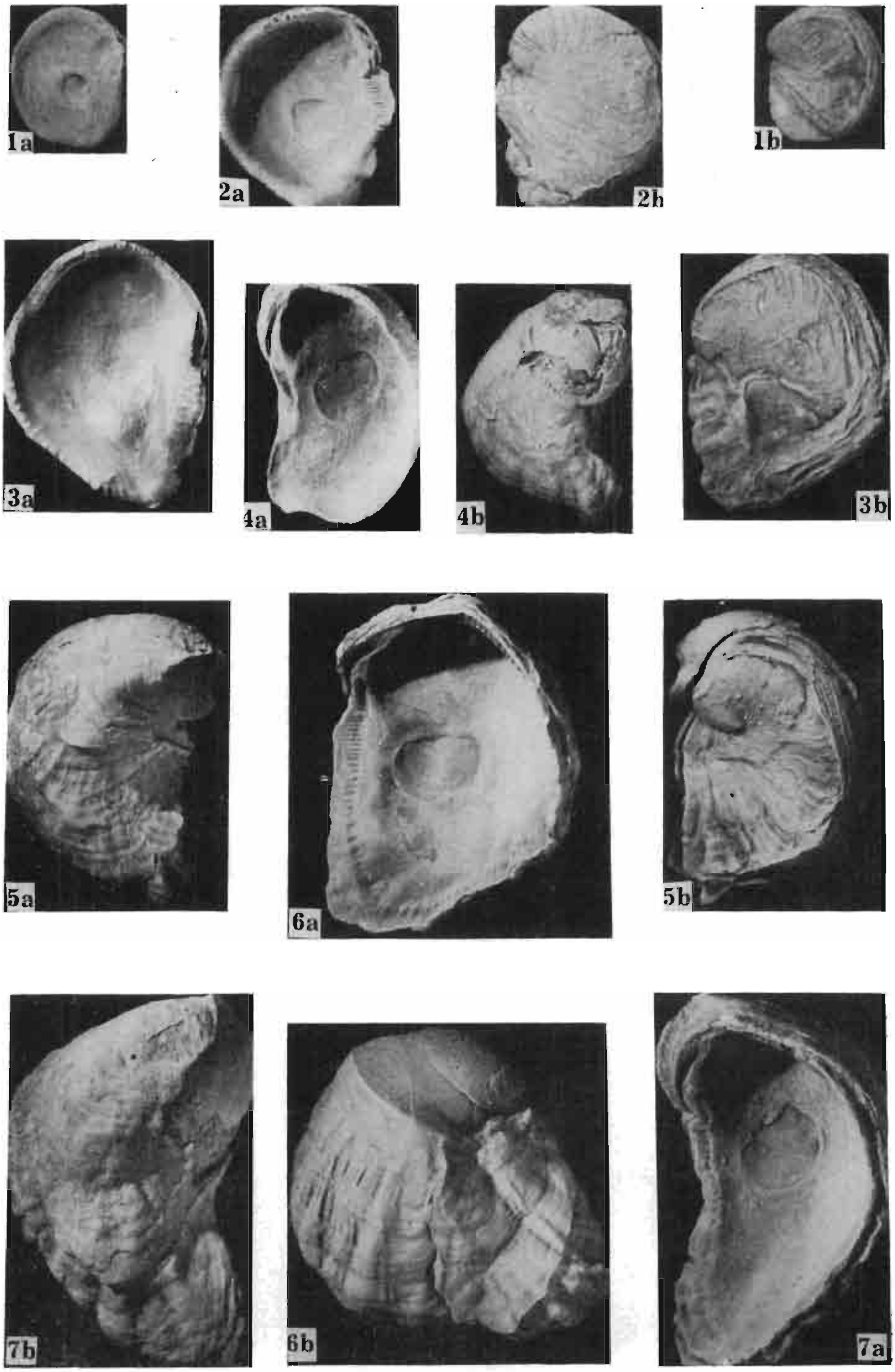

1a
2a
2b
1b
3a
4a
4b
3b
5a
6a
5b
7b
6b
7a

Plate XXXIV

Exogyra welschi Jourdy
Figs. 1—3: Oleszno (Holy Cross Mts.)
Figs. 4—7: Czarnogłowy, (Western Pomerania)
Lower Kimeridgian

Figs. 1—3. Three right valves of different individual age in: *a* internal, *b* external views (Mo. V/271—273).
Figs. 4, 6, 7. Three adult left valves in: *a* internal, *b* external views (Mo. V/274—276).
Fig. 5. The shell of adult individual age viewed from: *a* left valve, *b* right valve (Mo. V/277).

All figures × 3

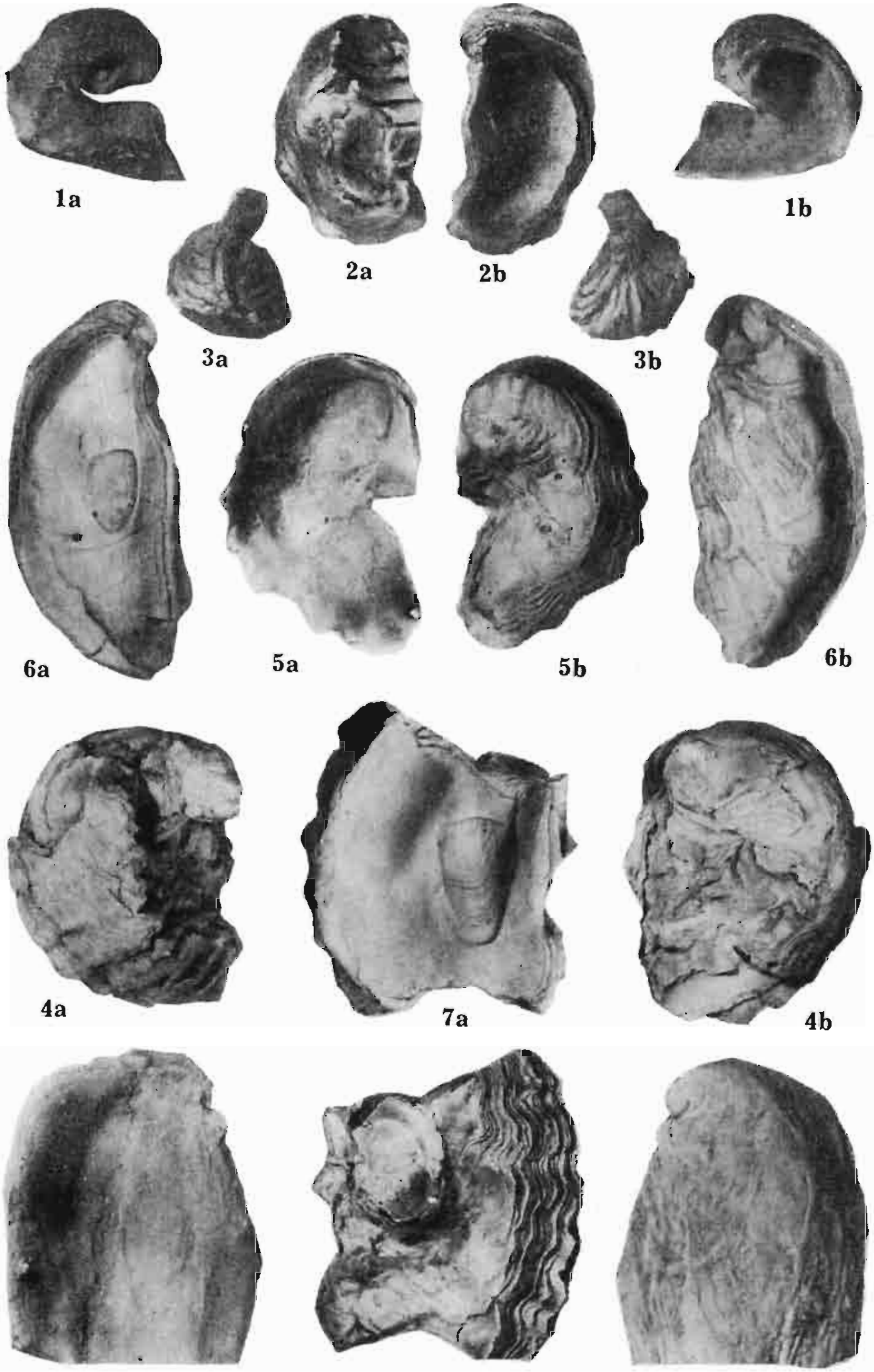
Plate XXXV

Exogyra decipiens Lewiński
Brzostówka (near Tomaszów Mazowiecki), Middle Volgian

Fig. 1. Young left valve: *a* external view; spherical prodissoconch visible, *b* internal view (Mo. V/278); × 3.
Fig. 2. Adult left valve in: *a* external, *b* internal views (Mo. V/279); × 1.
Fig. 3. Young shell, side view from: *a* anterior margin, *b* posterior margin, (Mo. V/280); × 3.
Fig. 4. Adult shell viewed from: *a* left valve, *b* right valve (Mo. V/281); × 1.
Fig. 5. Adult right valve in: *a* internal, *b* external views (Mo. V/282); × 1.

Exogyra michalskii Lewiński
Brzostówka (near Tomaszów Mazowiecki), Middle Volgian

Figs. 6—8. Three right valves of different individual age in: *a* internal, *b* external views (Mo. V/283—285); *6, 7* × 1; *8* × 3.



1a 1b 2a 2b 3a 3b 6a 5a 5b 6b 4a 7a 4b 8a 7b 8b