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Part H BRACHIOPODA

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PART H

BRACHIOPODA

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VOLUME 2

PENTAMERIDA

By THOMAS W. AMSDEN and GERTRUDA BIERNAT

[Oklahoma Geological Survey and Polska Akademia Nauk, Warszawa, Polska]

Order PENTAMERIDA Schuchert & Cooper, 1931

[*nom. transl.* MOORE in MOORE, LALICKER, & FISCHER, 1952, p. 220 (ex suborder Pentameroidea SCHUCHERT & COOPER, 1931, p. 247)] [Diagnosis prepared by T. W. AMSDEN]

Generally biconvex shells with pedicle spondylium; delthyrium may be unmodified or at least partly closed by deltidium. Brachial valve with brachial processes, commonly braced at their posterior end by supporting plates and terminating blindly except in Enantiosphenidae (Pentameracea) where they end in a loop. Shell impunctate. *M.Cam.-U.Dev.*

SYNTROPHIIDINA

[Materials for this suborder prepared by GERTRUDA BIERNAT]

The Syntrophiidina are a very interesting but uncommon group of brachiopods. They are difficult to find and not well known. They include forms placed for many years in the genus *Triplesia*. In 1932 SCHUCHERT & COOPER described them as a superfamily of the Pentameroidea, suggesting relationships with the Orthacea and Pentameracea. In 1936 they were separated by ULRICH & COOPER as the suborder Syntrophiodea. As presently known, they start in the Middle

Cambrian with *Cambrotrophia* and range into the Devonian. The last-known representative is *Anastrophia* from the Lower Devonian.

MORPHOLOGY

The syntrophiid shell is subcircular, elliptical to subelliptical in outline, widest at the hinge or near mid-valve. In profile it is invariably biconvex, with convexity of the valves moderately to strongly unequal, the brachial valve usually being more convex. Some shells are nearly globular (e.g., *Camarella*, *Porambonites*). Both umbones are incurved, the brachial commonly more so. In a few genera (e.g., *Parastrophina*, *Anastrophia*) the brachial umbo is strongly swollen and incurved, covering the delthyrium.

The fold and sulcus are significant features, present in all specimens but developed to different degrees from very distinct to obscure. These variations appear in representatives of all families. Usually the sulcus is wide and shallow, the fold wide and low, both originating generally a little behind the mid-length. Toward the anterior margin they widen rapidly and occupy one-third to slightly more than half of the shell

(H523)

width. In some forms (e.g., *Cambrotrophia*) the sulcus is narrow and deep, with rounded bottom, the fold being prominent and in some forms angular (e.g., *Syntrophina*). The sulcus and fold may be weakly developed, nearly obscure, conspicuous at the front margin only or expressed as a central depression on the pedicle valve (e.g., *Tetra-lobula*).

The degree of folding of the **anterior commissure** is related to variations in appearance of the sulcus and fold. The anterior commissure is invariably uniplicate, very distinct in some Camerellidae but obscure in other forms (e.g., *Syntrophia*, *Idiostrophia*).

Interareas are usually present on both valves, commonly reduced and scarcely visible. In *Diaphelasma* they are very short and narrow. In some shells the pedicle interarea is weakly developed and that of the brachial valve is absent (e.g., *Neostrophia*).

Only a few types of ornament are distinguished in the syntrophiids. Some are smooth, with delicate concentric growth lines only; others exhibit concentric lamellae or they are finely costellate to distinctly costate. Ornamentation of the earlier forms usually is costellate but in some late forms (e.g., *Anastrophia*) costate. The shells of some genera (e.g., *Punctolira*) are ornamented by both radial costellae and distinct concentric lines, giving a fenestrate surface. In a few forms (e.g., *Syntrophopsis*, *Xenelasma*, *Syntrophia*) strong concentric lines or concentric lamellae only are present and the surface is lamellose or imbricate (e.g., *Imbricatia*). Smooth forms with delicate concentric growth lines are rare (e.g., *Cambrotrophia*). Some families (e.g., Camerellidae) have both smooth and costate representatives. Ornament is variable and has generic and specific value.

A **spondylium** is usually present. In a few genera only (e.g., *Xenelasma*) is it absent, having subparallel, discrete dental plates uniting with the valve floor. Some genera of the Huenellidae are provided with a transverse platform in the delthyrial cavity; this platform, usually called **pseudo-spondylium**, bears the muscles. The spondylium is common in syntrophiids and few types may be differentiated. In earlier forms

it is sessile for nearly all its length (e.g., *Syntrophopsis*); for its posterior half or third it is elevated anteriorly on a median septum which usually is low (e.g., *Tetra-lobula*, *Syntrophinella*). The **median septum** or ridge supporting the spondylium reaches nearly to mid-valve. Its length, thickness, and height are variable. In some shells the septum is so short that the spondylium appears to be completely free. This structure was observed in *Syntrophia torynifera* ULRICH & COOPER, 1938, and recognized as a free spondylium. In some genera (e.g., *Syntrophinella*, *Clarkella*, *Yangtzeella*) short, obscure, accessory septa in addition to the median septum are observed, and these are found on each side of the spondylium. A true **spondylium simplex** elevated on a prominent median septum is observed in some Clarkellidae. Later forms (e.g., Camerellidae, Parastrophinidae) have a **spondylium duplex**. The presence or absence of a spondylium has taxonomic significance for distinction of families and subfamilies and the degree of its differentiation has generic value.

The **cardinal process** in known syntrophiids is rare. When present it is a simple, low ridge with variable height (e.g., *Glyptotrophia*, *Alimbella*). In some earlier forms (e.g., *Cambrotrophia*, *Palaeostrophia*, *Plectrotrophia*) the cardinal process is absent. Later genera (e.g., *Huenella*, *Huenellina*, *Tetra-lobula*, *Imbricatia*) have representatives lacking a cardinal process but provided with a rudimentary cardinal process or ridge. In the posterior part of the notothyrial cavity of *Diaphelasma* and *Syntrophinella* a horizontal plate for muscle attachment occurs. Some species of *Syntrophinella* have a well-developed orthoid cardinal process.

A **cruralium** is absent in the earlier syntrophiids and in later forms it is rare. Usually **brachiophores** are present, closely united to supporting plates. **Brachiophore plates** extend dorsomedially, attached to the valve floor or to the median ridge or septum. They may be very close, nearly united (e.g., Huenellidae) or separated widely (e.g., Clarkellidae). The last-mentioned feature, as also length and thickness of the brachiophore plates, is variable and seems to have some value for generic classifica-

tion. In some forms the brachiophore plates are poorly developed. They are slender in *Palaeostrophia* but low and stout in *Mesonomia*, *Glyptotrophia*, and *Diaphelasma*. In some species (e.g., *Plectotrophia*) convergent brachiophore plates unite with a low septum to form a short, simple cruralium. This structure is well developed in *Syntrophia rotundata* WALCOTT and some Clarkellidae with a high, thin median septum. Species in which the cruralium is obscured may be observed. In some Camerellidae and Parastrophinidae the cruralium is well developed and may be of simplex or duplex type, with the median septum low.

STRATIGRAPHICAL DISTRIBUTION AND PHYLOGENY

The Syntrophiidina include 12 families with 40 genera. The families are small, each represented by one or a few genera. The largest families are the Clarkellidae and Camerellidae, each with seven genera. The Syntrophiidina range from Middle Cambrian to Lower Devonian, but each separate family is somewhat restricted in time.

The oldest known syntrophiid, *Cambrotrophia cambria*, confined to the Middle Cambrian, is the only representative of the Eostrophiiidae. The specimens are poorly preserved. The interior, as far as known, is primitive, without spondylium and with rudimentary brachiophores. The shape and lateral profile of *C. cambria* resemble that of species of *Syntrophia* and suggest its relationship with syntrophioids.

The Huenellidae have a very short range, existing only through the Late Cambrian and Early Ordovician. They are divided into two subfamilies, chiefly on the basis of degree of development of the cardinal process. One of them, the Huenellinae, includes genera lacking a cardinal process and having a deep, usually sessile spondylium. The Mesonomiinae are characterized by a rudimentary cardinal process and recumbent brachiophore plates. The systematic position of *Mesonomia* is not yet clear. The presence of the brachial fold and pedicle sulcus in the umbonal part of the shell and its fascicostellate ornamentation may suggest some relationship with *Billingsella*;

the recumbent character of the brachiophore plates relates this form to *Finkelnburgia*. The shape of *Mesonomia*, the presence of a low brachial fold, and the flattened pedicle sulcus beginning near the middle are very syntrophioid and suggest affinities with Syntrophiidina. Probably this genus is intermediate between Billingsellidae and Syntrophiidae.

The family Tetralobulidae has some connection with the Huenellidae. ULRICH & COOPER (1938) suggest the possibility of evolving the former from the latter by separation of the brachiophore plates. The Tetralobulidae include four genera which are confined to the Lower Ordovician. *Tetralobula* externally and in some internal features, mainly in the pattern of the pallial markings, is very close to *Syntrophia* and even *Syntrophinella*. *Punctolira*, in the development of the distant brachiophore plates meeting on the floor of the valve, seems to be closely related to *Tetralobula*, rather than to *Porambonites*, which it resembles in ornamentation.

The Alimbellidae, lately described from the Lower Ordovician of USSR, are represented by two genera, *Alimbella* and *Medesia*. They show some external and internal similarity to *Huenellina*, *Xenelasma*, and *Plectotrophia*.

The Clarkellidae, one of the largest families, existed from Late Cambrian to Early Ordovician. Usually its members have a spondylium simplex, four or more discrete and divergent brachial septa, and an apical horizontal plate in the brachial valve for attachment of the diductors. The Clarkellidae include both smooth and ornamented forms. Externally they are very much like *Syntrophia*. Internally, especially in the pattern of pallial markings, they resemble *Billingsella*.

All representatives of the Syntrophopsidae are characterized by external or internal similarity. *Hesperotrophia* seems to be close to *Tetralobula*, differing in a few internal details.

The Porambonitidae are restricted to Lower, Middle, and Upper Ordovician. Their systematic position is questionable. Recently they were referred by COOPER (1956) to the Syntrophiidina but earlier were believed by SCHUCHERT & COOPER

(1932) to be aberrant orthoids. This family includes three genera. SPJELDNAES (1956) doubted the validity of two of them—*Isorhynchus* and especially *Noetlingia*. SPJELDNAES recognized only one genus, *Porambonites* PANDER (1830) with "illegal" type-species *P. reticulata* PANDER, selected by TEICHERT (1930). DALL (1877) selected *P. intermedia* PANDER (1830) as the type-species, which was accepted by HALL & CLARKE (1894). The genus *Isorhynchus* KING (1850), characterized by subglobular outline and diverging dental and brachiophore plates, is proposed by him as a subgenus, with *Terebratulites aequirostris* SCHLOTHEIM as type-species. *Noetlingia* HALL & CLARKE (1893) is accepted provisionally as a subgenus, with type-species *Spirifer tscheffkini* DE VERNEUIL (1840). This species in its internal structure is very similar to *P. reticulata*. SPJELDNAES suggested the existence of a gradual transition between *Noetlingia* and *Porambonites*; *P. reticulata* should be one of the intermediate species. *Poramborthis* HAVLÍČEK (1949) from the Tremadoc of central Bohemia differs in many features from genera of the Porambonitidae and Syntrophiidina. The specimens are biconvex, finely costellate, without sulcus and fold, internally with convergent dental plates but never united, brachiophore plates short, divergent. The external appearance and internal character of *Poramborthis* suggest more similarity to the Orthidina than to Syntrophiidina.

The Syntrophiidae are a small group, differentiated into two subfamilies, the Xenelasmae, without a spondylium and with subparallel dental plates, and the Syntrophiinae, with a spondylium simplex. *Xenelasma* has a brachial structure with narrow and short septalium, features that are further developed in *Syntrophia*.

The Brevicameridae are represented by a single genus, *Brevicamera*. Their interior, especially of the brachial valve, is very interesting. In appearance of the spondylium they resemble *Camerella*, but the median septum is short and does not extend anteriorly to the spondylium. Brachiophores are short but somewhat bulbous, opposite to the socket. A small process

is present, serving as an accessory articulating nub. The sessile septalium is unlike the brachial structure of any known genus.

The Camerellidae earlier were included in the Pentameracea by SCHUCHERT & COOPER (1932), with suggestion that they could have been derived from the Syntrophiidae. Their relation with the Syntrophiidina was indicated by their inclusion doubtfully in this suborder by ULRICH & COOPER (1936). The Camerellidae conditionally include *Branconia* SCHUCHERT & COOPER (1932), described by GAGEL (1890) from erratic boulders of the Estonian Ordovician. The specimens of *Branconia*, illustrated by GAGEL (pl. 4, fig. 12-a-d) were very poorly preserved, which makes their classification difficult. GAGEL suggested some similarity of *Branconia* to rhynchonellids. The shape of specimens, with fold and sulcus bearing semiplications and showing a septum in each valve, resemble features of *Gypidula* or even *Sieberella*.

The Parastrophiidae range from Upper Ordovician to Lower Devonian and terminate the stock of Syntrophiidina. This family includes both biconvex and plano-convex forms that usually are provided with a spondylium duplex, septalium, and cardinal process. They show similarity to the Pentameridae. According to ULRICH & COOPER (1938), *Anastrophia* may separate syntrophioids from pentameroids.

Suborder SYNTROPHIIDINA Ulrich & Cooper, 1936

[*nom. correct.* BIERNAT, herein (*pro* suborder Syntrophioida ULRICH & COOPER, 1936, p. 627)]

Variable in size, usually unequally biconvex; brachial fold and pedicle sulcus present; exterior smooth, costate or costellate; delthyrium open; spondylium simplex, in some cases duplex, or lacking; brachiophores invariably united by supporting plates of variable length; septalium present in some families; cardinal process absent or rudimentary; brachial muscles not enclosed by lamellae. *M.Cam.-L.Dev.*

Superfamily PORAMBONITACEA Davidson, 1853

[*nom. transl.* BIERNAT, herein (*ex* Porambonitidae DAVIDSON, 1853, p. 99)]

Characters of suborder. *M.Cam.-L.Dev.*

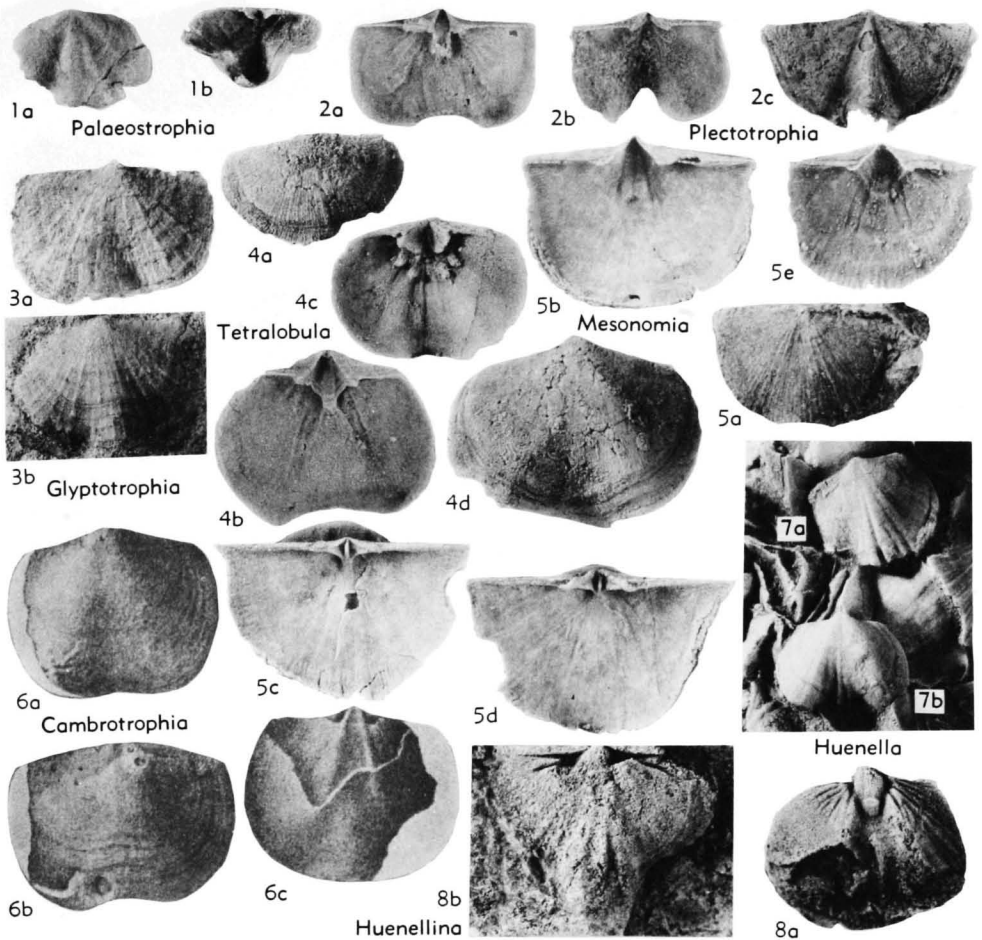


FIG. 398. Eostrophiidae (6); Huenellidae (Huenellinae) (1-2, 7-8); (Mesonomiinae) (3, 5); Tetralobulidae (4) (p. H527-H530).

Family EOSTROPHIIDAE
Ulrich & Cooper, 1936

[Eostrophiidae ULRICH & COOPER, 1936, p. 627]

Spondylium absent; brachiophore plates poorly developed. *M.Cam.*

Cambrotrophia ULRICH & COOPER, 1937, p. 78 [*pro Eostrophia* ULRICH & COOPER, 1936, p. 627 (*non* DALL, 1890)] [**Syntrophia cambria* WALCOTT, 1908, p. 800; OD]. Small, wider than long; bi-convex; smooth; weak fold and sulcus beginning on anterior half; spondylium absent; brachiophore plates rudimentary. *M.Cam.*, N.Am.-Austral.-USSR.—FIG. 398,6. **C. cambria* (WALCOTT), USA(Utah); 6a-c, ped.v., brach.v., ped.v. views, ca. X3 (848).

Family HUENELLIDAE
Schuchert & Cooper, 1931

[Huenellidae SCHUCHERT & COOPER, 1931, p. 247]

Medium size; exterior smooth, with concentric lines only or costellate to costate; pseudospondylium or sessile spondylium present; brachiophore plates usually weakly developed; cardinal process absent, rudimentary or simple, rodlike. *U.Cam.-L.Ord.*

Subfamily HUENELLINAE Schuchert & Cooper, 1931

[*nom. transl.* BIERNAT, herein (*ex* Huenellidae SCHUCHERT & COOPER, 1931, p. 247)] [=Palaeostrophiinae ULRICH & COOPER, 1936, p. 627]

Smooth, costellate or costate; with pseudo-

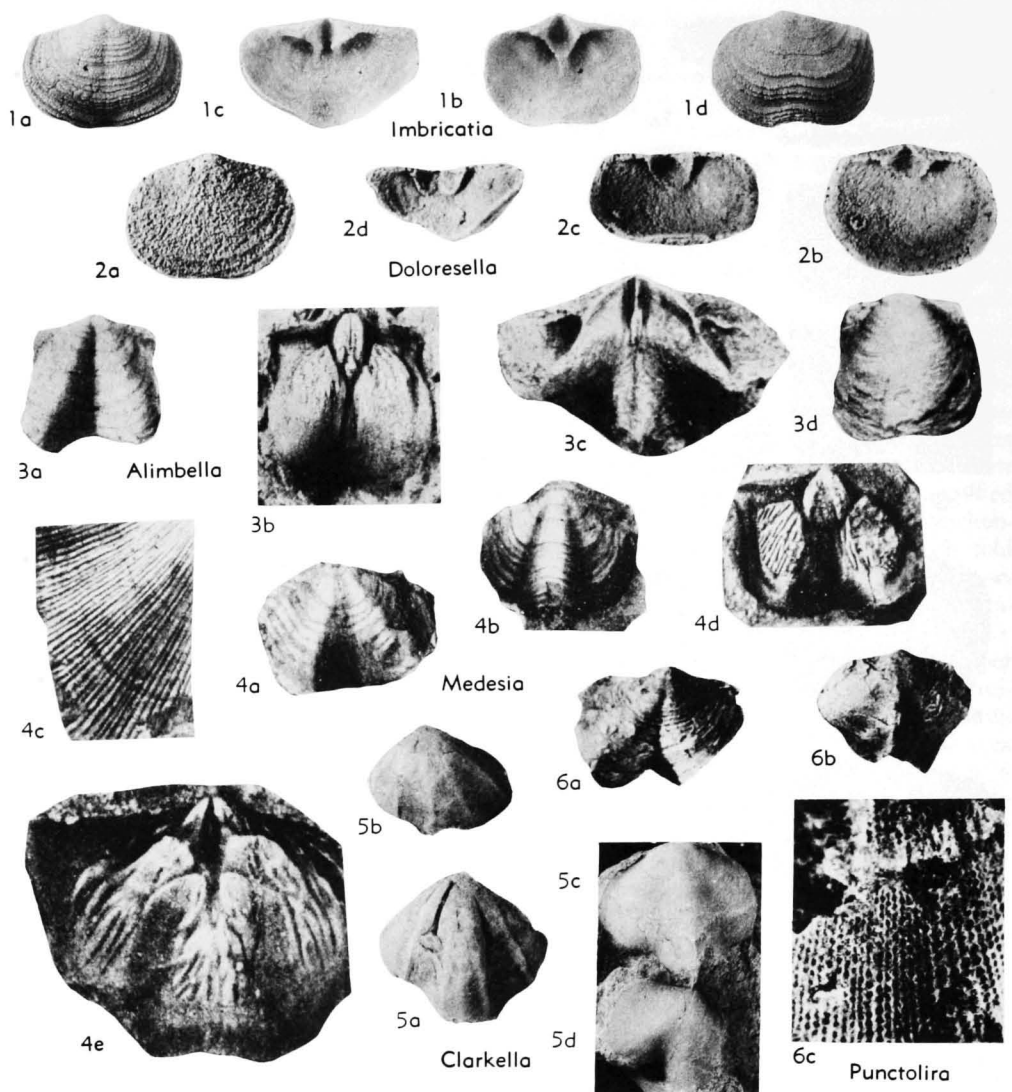


FIG. 399. Tetralobulidae (1-2, 6); Alimbellidae (3-4); Clarkellidae (5) (p. H530).

spondylium or sessile spondylium; brachio-
phore and supporting plates usually devel-
oped; cardinal process absent or scarcely
visible. *U.Cam.-L.Ord.*

Huenella WALCOTT, 1908, p. 109 [**Syntrophia
texana* WALCOTT, 1905, p. 294; OD]. Like *Plec-
totrophia* in outline but costate; fold marked by
few costae; pseudospondylium or sessile spon-
dylium present; cardinal process absent or scarcely
visible. *U.Cam.*, N.Am.(USA.)-USSR.(N.Zem.).
—FIG. 398,7. **H. texana* (WALCOTT), USA
(Wyo.); 7a,b, brach.v. ext., ped.v. ext., $\times 2$ (825).
Huenellina SCHUCHERT & COOPER, 1931, p. 247

[**Huenella triplicata* WALCOTT, 1924, p. 526;
OD]. Differs from *Huenella* in having lateral
septa at low angle to hinge; sulcus and fold strong,
with 2 or 3 distinct costae on their medial part.
U.Cam., USSR.(N.Zem.).—FIG. 398,8. **H.
triplicata* (WALCOTT), USA(Mo.); 8a,b, ped.v.
and brach.v. int. molds, $\times 2$ (729).

Palaeostrophia ULRICH & COOPER, 1936, p. 627
[**Syntrophia orthia* WALCOTT, 1905, p. 11; OD].
Like *Plectotrophia* but with subtriangular outline
and smooth surface, with concentric lines only;
short hinge; spondylium short, low, sessile; brach-
iophore plates delicate. *U.Cam.-L.Ord.*, China-N.
Am.-USSR.—FIG. 398,1. **P. orthia* (WALCOTT),

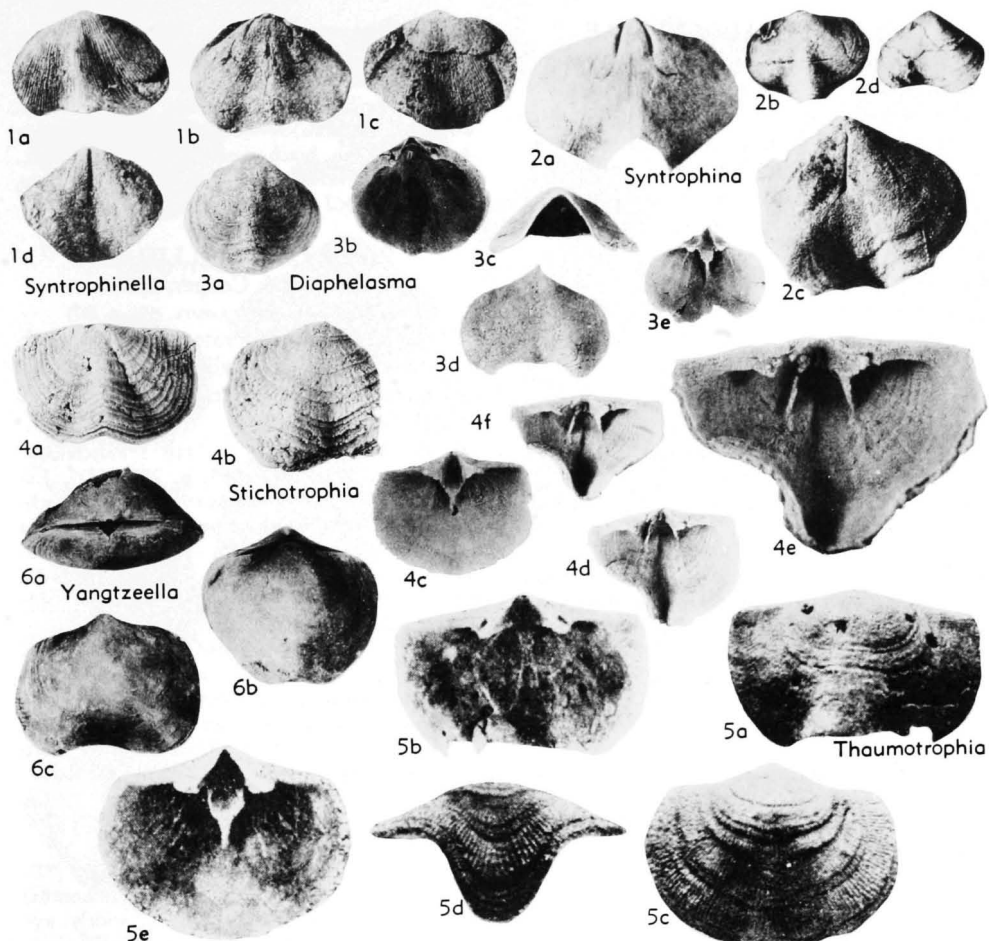


FIG. 400. Clarkellidae (p. H530-H531).

U.Cam.(*L.Chamit.*), China; 1a,b, brach.v. ext., int., $\times 2$ (825).

Plectotrophia ULRICH & COOPER, 1936, p. 627 [**P. bridgei*; OD]. Moderate size; costellate; sulcus extending into distinct tongue; hinge wide; sessile spondylium short, supported by low, short septum; brachiophore plates convergent, in some species united in V-shaped structure; cardinal process absent. *U.Cam.*, N.Am.(USA-Can.).—FIG. 398, 2. **P. bridgei*, Wilberns F., USA (Tex.); 2a, ped.v. int., 2b,c, brach.v. int., ext.; all $\times 2$ (825).

Subfamily MESONOMIINAE Ulrich & Cooper, 1936

[Mesomiinae ULRICH & COOPER, 1936, p. 627]

Shells with crowded, distinct costellae; pseudospondylium present; brachiophores short, with recumbent supporting plates; cardinal process rudimentary or rodlike. *U. Cam.-L.Ord.*

Mesonomia ULRICH & COOPER, 1936, p. 627 [**Eoorthis iophon* WALCOTT, 1924, p. 507; OD]. Subquadrate, wider than long; finely costellate; broad fold and sulcus; brachiophores with short supporting plates; rudimentary or rodlike cardinal process usually present. *U.Cam.-L.Ord.*, N.Am.(Can.-USA)-USSR.—FIG. 398, 5a. **M. iophon* (WALCOTT), L.Ord.(Mons F.), Can.; brach.v. ext., $\times 2$ (825).—FIG. 398, 5b-e. *M. magna* COOPER, U.Cam.(Ft. Sill F.), Okla.; 5b-e, ped.v. int. (holotype), brach.v. int., brach.v. int., ped.v. int, $\times 2$ (181).

Glyptotrophia ULRICH & COOPER, 1936, p. 627 [**G. imbricata*; OD]. Small, wider than long; hinge wide; internally like *Mesonomia* and *Huenella* but with external shape of *Syntrophina*; costellate, with very distinct concentric lamellae; cardinal process low and simple. *L.Ord.*, N.Am.-Eu.(USSR).—FIG. 398, 3. **G. imbricata*, L.Ord.(Mons F.), Can.; 3a,b, ped.v. ext., brach.v. ext., $\times 3$ (825).

Family TETRALOBULIDAE

Ulrich & Cooper, 1936

[Tetralobulidae ULRICH & COOPER, 1936, p. 627]

Shells moderate in size, with fine costellae, in some genera with distinct concentric lamellae; brachiophore plates strong; spondylium supported by stout septum anteriorly; accessory septa thickened on inner sides. *L.Ord.*

Tetralobula ULRICH & COOPER, 1936, p. 628 [**T. delicatula*; OD]. Finely costellate; spondylium low; 2 lateral septa; brachiophores blunt; muscular platform quadrilobate, elevated; cardinal process absent or rudimentary. *L.Ord.*, N.Am.(USA)-Eu.(USSR).—FIG. 398,4. **T. delicatula*, Chepultepec F., USA(Va.); 4a, brach.v. ext., $\times 2$; 4b-d, ped.v. int., brach.v. int., ped.v. ext., $\times 3$ (825).

Doloresella SANDO, 1957, p. 122 [**D. concentrica*; OD]. Syntrophoid in outline, moderate size; surface with delicate, radial costellae and concentric lamellae like *Imbricatia* and *Stichotrophia*; with pseudospondylium; brachiophores short, supporting plates convergent. *L.Ord.*(*Beekmantown.*), N.Am.—FIG. 399,2. **D. concentrica*, USA (Md.); 2a-c, ped.v. ext., int., int., $\times 2$; 2d, brach.v. int., $\times 2$ (706).

Imbricatia COOPER, 1952, p. 21 [**I. lamellata*; OD]. Like *Stichotrophia* in ornamentation; cardinal process absent; muscle scars well developed without strong callosities as in *Tetralobula*. *L.Ord.*, N.Am.(USA)-Eu.(USSR).—FIG. 399,1. **I. lamellata*, Cool Creek F., USA(Okla.); 1a,b, ped.v. ext., int., $\times 2$; 1c,d, brach.v. int., ext., $\times 2$ (181).

Punctolira ULRICH & COOPER, 1936, p. 628 [**P. punctolira*; OD]. Small, with syntrophoid outline; surface distinctly fenestrate; spondylium sessile posteriorly, supported anteriorly by low septum; brachiophore plates distant like those of *Tetralobula*. *L.Ord.*, N.Am.(USA).—FIG. 399, 6. **P. punctolira*, USA(Mo.); 6a, ped.v. ext., $\times 1.5$; 6b, brach.v. ext., $\times 2$; 6c, brach.v. ext. ornament, $\times 10$ (825).

Family ALIMBELLIDAE Andreeva, 1960

[Alimbellidae ANDREEVA, 1960, p. 293]

Shells moderate in size; smooth or finely costellate; sulcus and fold present or absent; pseudodeltidium rudimentary or lacking; cardinal process rodlike. *L.Ord.*

Alimbella ANDREEVA, 1960, p. 293 [**A. armata*; OD]. Smooth; like *Huenellina* and *Xenelasma* in outline and character of muscles. *L.Ord.*(*Tremadoc.*), USSR(Urals).—FIG. 399,3. **A. armata*; 3a,b, ped.v. ext., int. mold, $\times 1$; 3c, brach.v. int., $\times 3$; 3d, brach.v. ext., $\times 1$ (37).

Medesia ANDREEVA, 1960, p. 295 [**M. uralica*; OD]. Subquadrate or trapezoidal in outline; sulcus and fold present; finely costellate; internally like *Alimbella* and *Plectotrophia*. *L.Ord.*(*Tremadoc.*), USSR(Urals).—FIG. 399,4. **M. uralica*; 4a,b, ped.v. ext., brach.v. ext., $\times 1$; 4c, ped.v. ext. ornament, $\times 4$; 4d, ped.v. int. mold, $\times 1.5$; 4e, brach.v. int., $\times 3$ (37).

Family CLARKELLIDAE

Schuchert & Cooper, 1931

[Clarkellidae SCHUCHERT & COOPER, 1931, p. 247]

Shells small or moderate in size; smooth or costellate; with spondylium simplex; septa of brachial valve discrete, divergent. *U. Cam.-U.Ord.*

Clarkella WALCOTT, 1908, p. 110 [**Polytoechia? montanensis* WALCOTT, 1905, p. 295; OD]. Externally and internally like *Syntrophina* but brachial interior with 4 lateral septa. *L.Ord.*, E.Asia (Korea)-N. Am.-Eu. (USSR).—FIG. 399,5. *C. mcgerriglei* ULRICH & COOPER, Hastings Creek F., Can.; 5a,b, brach.v. ext. partly exfoliated, $\times 2$; 5c,d, brach.v. ext., ped.v. ext., $\times 2$ (825).

Calliglypha CLOUD, 1948, p. 468 [**C. miseri*; OD]. Wide-hinged, syntrophoid; internally like *Diaphelasma*, externally like *Glyptotrophia*; with radial and concentric ornament giving cancellate and nodose appearance; brachiophore plates short, distantly divergent; collar-like callosity for diductors. *L.Ord.*, N.Am.-Eu.(USSR).—FIG. 401,1. **C. miseri*, USA; 1a,b, ped.v. ext., int., $\times 2$; 1c,d, brach.v. ext., ped.v. int., $\times 3$ (168).

Diaphelasma ULRICH & COOPER, 1936, p. 629 [**D. pennsylvanicum*; OD]. Surface with concentric lamellae only; brachial plates weak, widely separated, with callosities as in *Syntrophina*. *L.Ord.*, N.Am.-Eu.(USSR).—FIG. 400,3. **D. pennsylvanicum*, Longview F., USA(Pa.); 3a-c, brach.v. ext., int. (holotype); 3d,e, ped.v. ext., int., all $\times 1.5$ (825).

Stichotrophia COOPER, 1948, p. 473 [**S. lamellata*; OD]. Surface concentrically lamellose; lamellae strong, covered by distant costellae; internally like *Diaphelasma* and *Syntrophina*. *L.Ord.*, N.Am.-Eu. (USSR).—FIG. 400,4. **S. lamellata*, Longview Ls., USA(Va.); 4a, brach.v. ext.; 4b,c, ped.v. ext., int.; all $\times 2$ (914a); 4d,f, brach.v. int., brach.v. int., $\times 2$; 4e, brach.v. int., $\times 4$ (913).

Syntrophina ULRICH in WELLER & ST. CLAIR, 1928, p. 74 [**Syntrophia campbelli* WALCOTT, 1912, p. 801; OD]. Externally and internally like *Clarkella* but with 2 long, slightly divergent septa in brachial valve. *L.Ord.*, E.Asia(China)-N.Am.-Eu. (USSR)-N.Afr.—FIG. 400,2. **S. campbelli* (WALCOTT), Chepultepec F., USA(Tenn.); 2a,c, brach.v. and ped.v. int. molds, $\times 3$; 2b,d, brach.v. ext., ped.v. ext., $\times 2$ (825).

Syntrophinella ULRICH & COOPER, 1934, p. 164 [**S. typica*; OD]. Like *Diaphelasma* but costel-

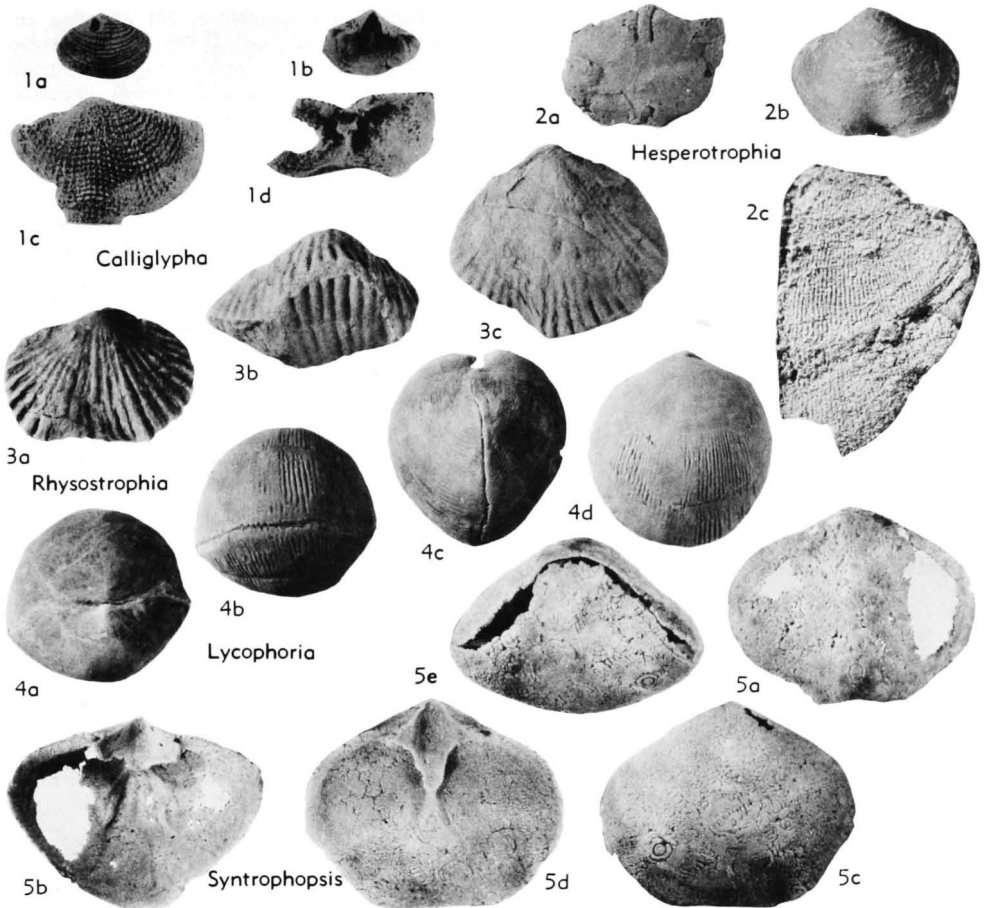


FIG. 401. Clarkellidae (1); Syntrophopsidae (2-3, 5); Lycophoriidae (4) (p. H530-H532).

late; spondylium low, sessile or simplex; small, lateral septa may be present; brachiophores short; supporting plates thin, strongly divergent. *L.Ord.*, E.Asia-N.Am.-Eu.(USSR).—FIG. 400,1. **S. typica*, Longview F., USA(Va.); 1a,b, brach.v. ext., int. mold; 1c,d, ped.v. ext., int. mold; all $\times 2$ (825).

Thaumotrophia WANG, 1955, p. 342 [**T. sinensis*; OD]. Ornament as in *Tetralobula*; internally resembling *Diaphelasma* but brachiophore plates stout, converging toward floor of valve. *L.Ord.*, E.Asia-Eu.(USSR).—FIG. 400,5. **T. sinensis*, Liangchiashan Ser., China(Liaoning Prov.); 5a,b, brach.v. ext., int.; 5c-e, ped.v. ext., ant., int.; all $\times 2.5$ (852).

Yangtzeella KOLAROVA, 1925, p. 219 [**Triplecia poloi* MARTELLI, 1901, p. 302; OD]. Smooth; fold weak; sulcus shallow; spondylium simplex supported by 2 or 4 lateral septa. *M.Ord.-U.Ord.*, E.Asia-?Eu.(USSR). — FIG. 400,6. **Y. poloi* (MARTELLI), Foppé & Neichiashan, China; 6a-c, post., brach.v., ped.v. views, $\times 1$ (729).

Family SYNTROPHOPSIDAE Ulrich & Cooper, 1936

[Syntrophopsidae ULRICH & COOPER, 1936, p. 630]

Smooth or radially costellate; spondylium posteriorly sessile, anteriorly supported by low septal ridge; brachiophores convergent, united with floor of valve. *L.Ord.*

Syntrophopsis ULRICH & COOPER, 1936, p. 630 [**S. magna*; OD]. Brachial interior as in *Syntrophina* but different in having short, converging brachiophore plates; spondylium short, sessile. *L.Ord.*, N. Am.-Eu. (USSR)-Tasm. — FIG. 401,5. **S. magna*, Black Rock F., USA(Ark.); 5a,b, brach.v. ext., int. (holotype); 5c,d, ped.v. ext., int. (holotype); 5e, ant. (holotype); all $\times 1.5$ (825).

Hesperotrophia ULRICH & COOPER, 1936, p. 630 [**H. obscura*; OD]. Exterior finely costellate; internally like *Syntrophopsis*; septum supporting anterior part of spondylium very low and short. *L.Ord.*, N.Am.-Eu.(USSR).—FIG. 401,2. **H. obscura*, Sarbach F., Can.(Alta.); 2a,b, brach.v.

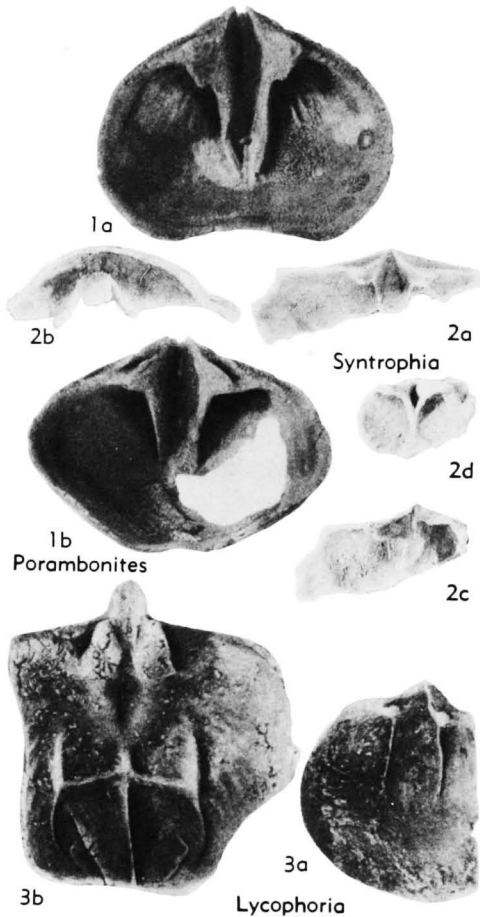


FIG. 402. Lycophoriidae (3); Porambonitidae (1); Syntrophidae (Syntrophinae) (2) (p. H532-H534).

int. mold, ped.v. ext., $\times 2$; 2c, brach.v. ext., $\times 6$ (825).

Rhysostrophia ULRICH & COOPER, 1936, p. 630 [**R. nevadensis*; OD]. Exterior with distinct, radial costellae or costae; internally like *Syntrophopsis*. *L.Ord.*, N.Am.-Eu.(USSR).—FIG. 401,3. **R. nevadensis*, U. Pogonip F., USA(Nev.); 3a-c, ped.v. ext. (holotype), ant., brach.v. ext., $\times 1.5$ (825).

Family LYCOPHORIIDAE Schuchert & Cooper, 1931

[Lycophoriidae SCHUCHERT & COOPER, 1931, p. 245]

Shell biconvex; dental plates well developed; cardinal process simple, rodlike, united with brachiophore plates. *L.Ord.-M.Ord.*

Lycophoria LAHUSEN, 1886, p. 221 [**Atrypa nucella* DALMAN, 1828, p. 130; OD]. Shell globular, costellate; teeth large, parallel to hinge; dental plates subparallel; cardinal process tripartite, formed by fusing brachiophore plates and cardinal process. *L.Ord.-M.Ord.*, Eu.(Baltoscandia).—FIG. 401,4; 402,3. **L. nucella* (DALMAN), *L.Ord.*(Chazy), Popovka; 401,4a-d, post., ant., lat., brach.v. views, $\times 1.5$ (729); 402,3a, ped.v. int., $\times 1.5$; 402,3b, brach.v. int., $\times 3$ (729).

Family PORAMBONITIDAE Davidson, 1853

[Porambonitidae DAVIDSON, 1853, p. 99]

Shells median to large, biconvex; radially ornamented with rows of pits in furrows; dental plates nearly parallel or divergent; brachiophore plates strong; dental and brachiophore plates in old individuals simulating spondylium and septalium. *L.Ord.-L.Sil.*

Porambonites PANDER, 1830, p. 95 [**P. intermedia*; SD HALL & CLARKE, 1895, p. 226]. Large, biconvex or convexoplane; teeth stout; dental plates coalesced, brachiophore plates fusing anteriorly with median septum. *L.Ord.-L.Sil.*, Australia-Eu. (Baltoscandia) - Asia (Himalayas) - N. Am. - Eu. (USSR).

[Although application of zoological rules relating to designation of the type-species of *Porambonites* seems to be straightforward and clear, authors have disagreed about it, variously citing *Terebratulites aequirostris* VON SCHLOTHEIM (1820), *Porambonites intermedia* [*recte intermedius*] PANDER (1830), and *P. reticulatus* PANDER (1830). The first-mentioned of these was explicitly chosen by DAVIDSON (1853, p. 99), since PANDER made no original designation of type among the 30 species assigned by him to the genus; however, DAVIDSON's subsequent designation, antedating others is invalid because *P. aequirostris* is not one of PANDER's original included group. The fact that KING (1850, p. 112) designated this species as the type of a new genus named *Isorhynchus* has no bearing on the type-species of *Porambonites*. Next, DALL (1877, p. 57) mentioned *P. intermedia* as PANDER's first-described species but did not explicitly "select" it as the type-species. HALL & CLARKE (1895, p. 226), however, definitely named *P. intermedia* as the type-species of *Porambonites*. TEICHERT (1930, p. 182), giving no consideration at all to *P. intermedia*, concluded that *P. reticulatus* is best qualified on the basis of known morphological characters to represent *Porambonites* and therefore named it as the type-species. SCHUCHERT & LEVENE (1929, p. 100) cited *P. intermedia* as type-species, but SCHUCHERT & COOPER (1932, p. 104) rejected this designation in favor of *P. reticulatus*, mainly on the ground of asserted unrecognizability of *P. intermedia*, especially in view of the loss of its type-specimens. Despite all this, unless changed by ICZN under its plenary powers, *P. intermedia* is the legally established type-species and if unrecognizable, the genus may be construed likewise to be unrecognizable or, alternatively, interpreted in agreement with a century or more of usage as having morphological characters displayed by *P. reticulatus* and other accepted species. This latter course does not conflict with the Zoological Code and here is adopted.]

P. (Porambonites). Subcircular in outline with sulcus beginning nearly at mid-length of pedicle valve; hinge line rather prominent. *L.Ord.* (*Skiddav.*), Glaukonit Kalk, Eu.(NW.USSR).—FIG. 403,8. *P. (P.) reticulatus*, *M.Ord.* (Chazy), Iswos on Walchow R.; 8a-c, brach.v., lat., ant. views, $\times 1$ (729).—FIG. 402,1. *P.*

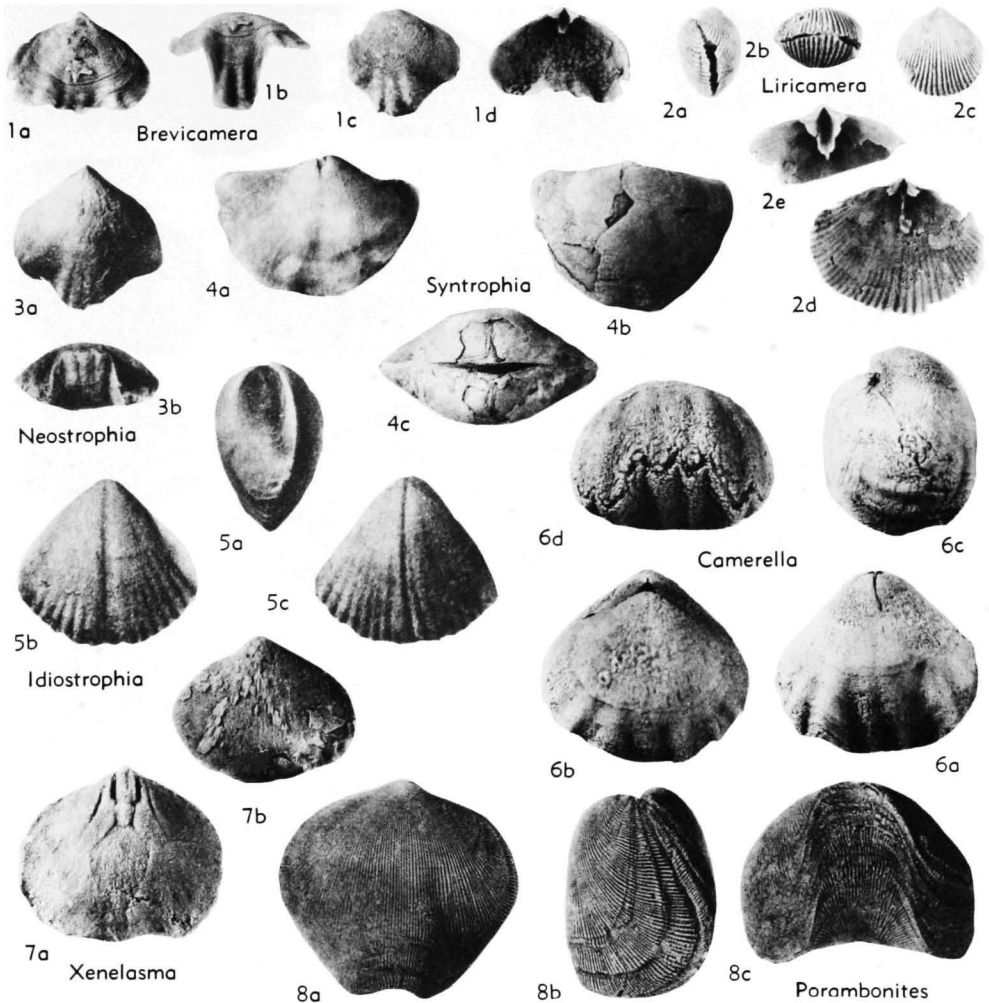


FIG. 403. Porambonitidae (8); Syntrophiidae (Syntrophiinae) (4), (Xenelasmae) (7); Brevicameridae (1); Camerellidae (Camerellinae) (2, 3, 5, 6) (p. H532-535).

(*P. schmidti* NOETLING, Mohawk., Est.; 1a,b, ped.v. int., brach.v. int., $\times 1$ (729).

P. (Equirostra) COOPER & MUIR-WOOD, 1951, p. 195 [pro *Isohynchus* KING, 1850, p. 112 (non SCHOENHERR, 1833)] [**Terebratulites aequirostris* VON SCHLOTHEIM, 1820; OD]. Subglobular in profile, subtriangular in outline, compressed in front; long, slightly diverging dental and brachio-phore plates. *U.Ord.*(*Caradoc.*), Echinospaerit Ls., Eu.

[KING's qualification of the type-species of *Isohynchus* designated by his reading "*Terebratulites aequirostris* Schlotheim, as represented by DE VERNEUIL in *Geologie de la Russie d'Europe*, v. 2, pl. 3, fig. 1, 1845" does not affect validity of accepting the species named by VON SCHLOTHEIM as type-species of *Isohynchus* (and hence of *Equirostra*), since Art. 70 of the Zoological Code (1961) stipulates that "it is to be assumed that an author correctly identifies the nominal species that he . . . designates as the type-species of a new or of an established genus."]

P. (Noetlingia) HALL & CLARKE, 1894, p. 229 [**Spirifer tscheffkini* DEVERNEUIL, 1845; OD (M)]. Hinge line wide and linear; internally similar to *P. (Porambonites)*. *L.Sil.*, Eu.(USSR).

Family SYNTROPHIIDAE Schuchert, 1896

[Syntrophiidae SCHUCHERT, 1896, p. 320]

Small to medium in size, with subparallel and discrete plates or spondylium simplex; septalium present. *L.Ord.*

Subfamily SYNTROPHIINAE Schuchert, 1896

[*nom. transl.* ULRICH & COOPER, 1936, p. 631 (ex Syntrophiidae SCHUCHERT, 1896, p. 320)]

Shells with spondylium simplex. *L.Ord.*

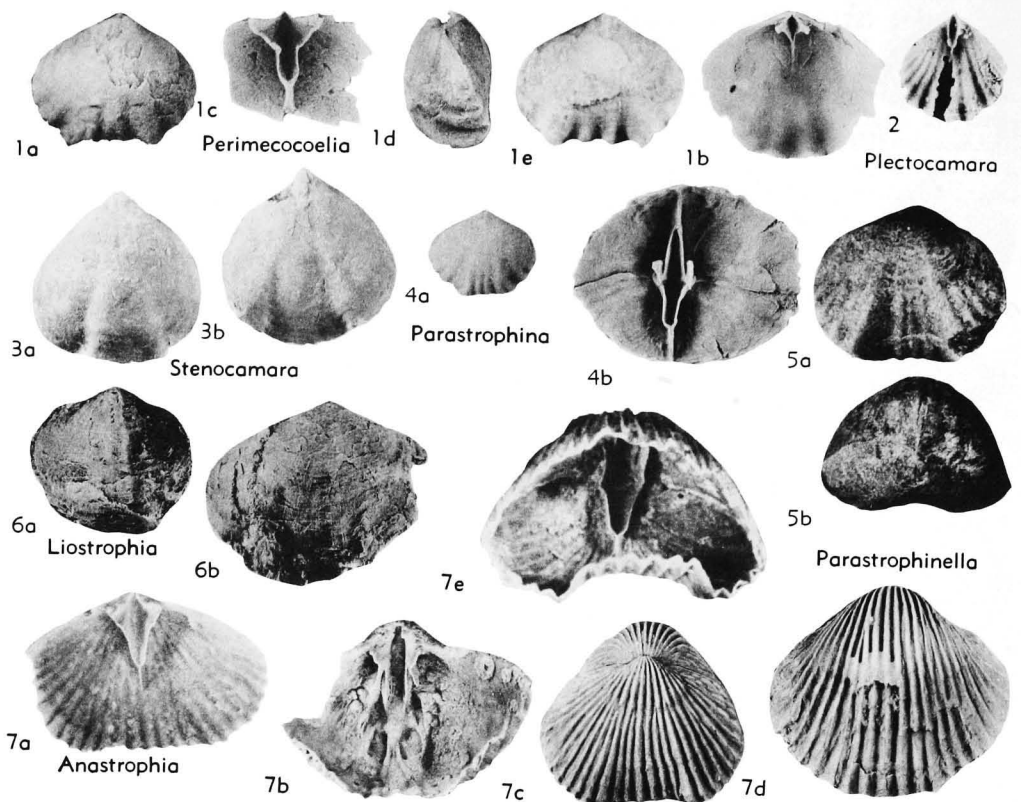


FIG. 404. Camerellidae (Camerellinae) (1-2), (Stenocamerinae) (3); Parastrophinidae (4-7) (p. H535-H536).

Syntrophia HALL & CLARKE, 1893, p. 270 [**Triplacia lateralis* WHITFIELD, 1886, p. 303; OD] [= *Syntrophia* HALL & CLARKE, 1894, p. 216 (syn. jr. hom.)]. Small to medium in size; exterior with concentric lines; long brachial septum supporting the beak short and shallow septalium. *L.Ord.*, N.Am.—FIG. 403,4. **S. lateralis* (WHITFIELD), Cassin F., USA (Vt.); 4a, ped.v. ext., $\times 1$; 4b, brach.v. ext., $\times 1.5$; 4c, post. view, $\times 2$ (825).—FIG. 402,2. *S. torynifera* ULRICH & COOPER, Smithville F. (2a-c), Black Rock F. (2d), USA (Ark.); 2a-c, post. ped.v. int. views, $\times 2$; 2d, brach.v. int., $\times 2$ (825).

Subfamily XENELASMATINAE

Ulrich & Cooper, 1936

[*nom. correct.* BIERNAT, herein (pro Xenelasmatinae ULRICH & COOPER, 1936, p. 631)]

With discrete, subparallel dental plates; septalium small, formed by brachiophore plates united with low septum. *L.Ord.*

Xenelasma ULRICH & COOPER, 1936, p. 631 [**X. syntrophioides*; OD]. Small, externally like *Syntrophia*; brachiophores short, supporting plates united with low septum to form septalium, as

in *Syntrophia*. *L.Ord.*, N.Am.—FIG. 403,7. **X. syntrophioides*, Longview F., USA (Va.); 7a, ped. v. int. mold, $\times 3$; 7b, ped.v. ext., $\times 4$ (825).

Family BREVICAMERIDAE Cooper, 1956

[Brevicameridae COOPER, 1956, p. 560]

Shell small, with paucicostate surface; short spondylium and sessile septalium. *Ord.*

Brevicamera COOPER, 1956, p. 560 [**B. camerata*; OD]. Both interareas reduced; semicostate; teeth small; spondylium short; brachiophore plates subparallel, with median callosity forming weak, sessile septalium. *Ord.*, N.Am.—FIG. 403,1. **B. camerata*, Pratt Ferry F., USA (Ala.); 1a-c, ped.v. ext., ant., int., $\times 2$; 1d, brach.v. ext., $\times 2$ (189).

Family CAMERELLIDAE Hall & Clarke, 1894

[Camerellidae HALL & CLARKE, 1894, p. 355]

Shell usually biconvex; spondylium duplex or simplex; septalium; interarea weakly developed or obsolete. *L.Ord.-Sil.*

Subfamily CAMERELLINAE

Hall & Clarke, 1894

[*nom. transl.* BIERNAT, herein (*ex* Camerellidae HALL & CLARKE, 1894, p. 355)]

Spondylium simplex with short septum, which may serve as support for it. *L.Ord.-Sil.*

Camerella BILLINGS, 1859, p. 301 [**C. volborthi*; SD HALL & CLARKE, 1894, p. 219] [= *Rhynchocamarara* SCHUCHERT & COOPER, 1931, p. 248 (type, *R. plicata*)]. Shell biconvex, anteriorly costate; teeth strong; brachiophore plates short, supported by elongate septal ridges forming a septalium. *M.Ord.-Sil.*, N. Am.-Eu.(USSR).—FIG. 403,6. **C. volborthi*, Rockland F., Can.(Que.); 6a-d, ped.v., brach.v., lat., ant. views, $\times 2$ (189).

Idiostrophia ULRICH & COOPER, 1936, p. 631 [**I. perfecta*; OD]. Medium in size, with compressed outline; anterior commissure rectimarginate; interarea obsolete; internally like *Camerella*. *Ord.*, N. Am.-Eu.(USSR).—FIG. 403,5. **I. perfecta*, Mystic Congl., Can.(Que.); 5a-c, lat., ped.v., brach.v. views, holotype, $\times 1.5$ (189).

Liricamera COOPER, 1956, p. 592 [**L. nevadensis*; OD]. Moderate size; nearly circular; anterior commissure rectimarginate; multicostellate; spondylium deep, supported by thin, high septum; cruralium small, supported by long septum. *L.Ord.*, N. Am.—FIG. 403,2. **L. nevadensis*, Pogonip F., USA(Nev.); 2a-c, lat., ant., brach.v. views (holotype), $\times 1$; 2d,e, brach.v. int., ped.v. int., $\times 2$ (189).

Neostrophia ULRICH & COOPER, 1936, p. 631 [**N. subcostata*; OD]. Subpentagonal in outline; anterior commissure uniplicate and semicostate; sulcus shallow; fold low; interior like *Camerella*. *Ord.*, N. Am.-Eu.(USSR).—FIG. 403,3. **N. subcostata*, Mystic Congl., Can.(Que.); 3a,b, brach.v., ant. views, $\times 2$ (825).

Perimecocoelia COOPER, 1956, p. 593 [**P. semicostata*; OD]. In outline and ornamentation like *Parastrophina*; in brachial interior differs from *Parastrophina* in lacking alate plates. *Ord.*, N. Am.—FIG. 404,1. **P. semicostata*, Pratt Ferry F., Effna F., USA(Ala.-Va.); 1a,b, brach.v. ext., int., $\times 2$; 1c, ped.v. int., $\times 2$; 1d, lat. view, $\times 2$; 1e, ped.v. ext., $\times 4$ (189).

Plectocamara COOPER, 1956, p. 596 [**P. costata*; OD]. Rhynchonellid in outline, spondylium narrow; brachiophore supports united with floor of valve to form narrow apical cavity; brachial median septum like small ridge or absent. *M.Ord.*, N. Am.—FIG. 404,2; 405,2. **P. costata*, Ward Cove F. (404,2), Lincolnshire F. (405,2), USA (Tenn.); 404,2, ped.v. int., $\times 3$ (189); 405,2a-f, ant., lat., ped.v., brach.v., post.v., brach.v. int. views, $\times 3$ (189).

Subfamily STENOCAMARINAE Cooper, 1956

[Stenocamarinae COOPER, 1956, p. 602]

Shell smooth without spondylium but with septalium. *L.Ord.*

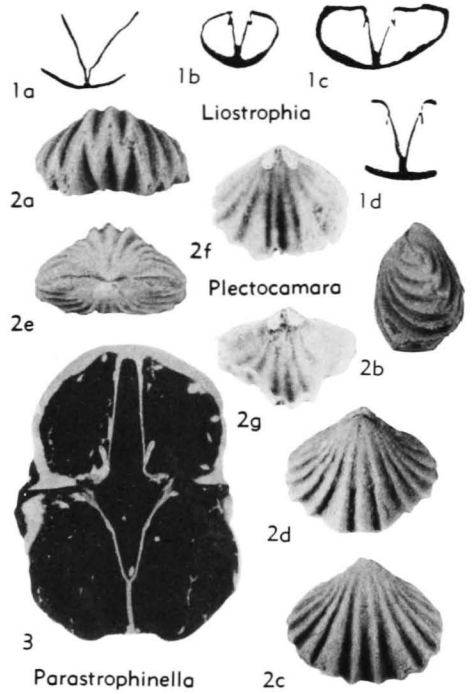


FIG. 405. Camerellidae (Camerellinae) (2); Parastrophinidae (1, 3) (p. H535-H536).

Stenocamara COOPER, 1956, p. 602 [**S. perplexa*; OD]. Shape like *Camerella*; anterior margin uniplicate; smooth; dental plates subparallel; septalium short, supported by long septum. *L.Ord.*, N. Am.—FIG. 404,3. **S. perplexa*, Ellett F., USA(Va.-Tenn.); 3a,b, brach.v. ext., ped.v. ext., $\times 2$ (189).

Family PARASTROPHINIDAE

Ulrich & Cooper, 1938

[Parastrophinidae ULRICH & COOPER, 1938, p. 194]

Shell unequally biconvex; surface partially to strongly costate; with spondylium duplex; septalium sessile or elevated with subparallel and or converging brachial plates and alate plates. *M.Ord.-L.Dev.*

Parastrophina SCHUCHERT & LEVENE, 1929, p. 94 [*pro Parastrophia* HALL & CLARKE, 1893, p. 221 (*non* FOLIN, 1875)] [**Atrypa hemiplicata* HALL, 1847, p. 144; OD]. Moderate size; costate in anterior half; brachial interior differing from *Camerella* in having alate plates. *M.Ord.*, N. Am.-Eu.(USSR). — FIG. 404,4a. **P. hemiplicata* (HALL), Martinsburg F., USA(W.Va.); brach.v. ext., $\times 1$ (189).—FIG. 404,4b. *P. rotundiformis* (WILLARD), Prosser F., USA(Iowa); int. (ped. below), $\times 2$ (189).

Anastrophia HALL, 1867, p. 163 [*pro Brachymerus* SHALER, 1865, p. 69 (*non* DEJEAN, 1834)] [**Pen-*

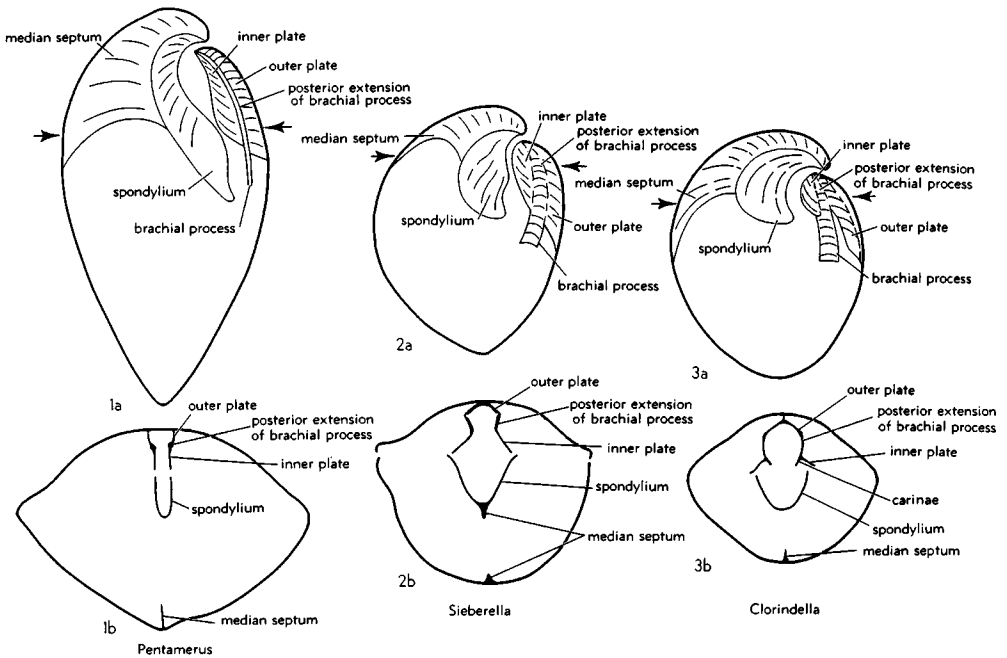


FIG. 406. Longitudinal sections (1a, 2a, 3a) (pedicle valve at left) and transverse sections (1b, 2b, 3b) (pedicle valve below) showing internal structure of three subfamilies of Pentameridae; heavy, unlettered arrows on longitudinal sections show position of transverse sections. 1. Pentamerinae, *Pentamerus* sp. cf. *P. oblongus* SOWERBY, Sil.(Reynales F.), Rochester, N.Y.—2. Gypidulinae, *Sieberella roemeri* HALL & CLARKE, Sil.(Henryhouse F.), Pontotoc Co., Okla.—3. Clorindinae, *Clorindella areyi* (HALL & CLARKE), Sil.(Irondequoit F.), Rochester, N.Y. [Explanation: *b*, brachial process; *bb*, posterior extension of brachial process; *c*, carinae; *i*, inner plate; *ms*, median septum; *o*, outer plate; *sp*, spondylium.]

tamerus verneuilli HALL, 1857, p. 104; OD]. Subtriangular in outline; costate; teeth stout; spondylium narrow, supported anteriorly by low, duplex septum; brachiophore plates parallel or nearly parallel, rarely united to form septalium; alate plates as in *Parastrophina*. Sil.-L.Dev., N.Am.-E. Eu.(USSR)-W.Eu.—FIG. 404,7. **A. verneuilli* (HALL), L.Dev. (Helderberg.), 7a,b, ped.v., brach.v. int. views, 7c,d, brach.v. ext., ped.v. ext.; 7e, int. (ped.v. below); all $\times 1.5$ (729).

Liostrophia COOPER & KINDLE, 1936, p. 355 [**L. glabra*; OD]. Like smooth *Parastrophina*; externally like *Syntrophia*; long septalium and alate processes just anterior to brachial supports, as in *Anastrophia*. U.Ord., N.Am.—FIG. 404,6; 405,1. **L. glabra*, Can.(Que.); 6a,b, brach.v. ext., $\times 1$ (194); 405,1a, sec. through beak of ped.v., showing spondylium duplex, $\times 3$; 405,1b-d, secs. of brach.v., 1.25, 2.25, 3 mm. from beak, $\times 3$ (194).

Parastrophinella SCHUCHERT & COOPER, 1931, p. 248 [**Pentamerus reversus* BILLINGS, 1857, p. 295; OD]. Biconvex, costate; spondylium with tendency to be sessile; septalium sessile, with subparallel brachial processes. U.Ord.-Sil., N.Am.-Eu.

(USSR).—FIG. 404,5. *P. ops* (BILLINGS), Sil. (Chicotte F.), Anticosti; 5a,b, ped.v., post. views, $\times 1$ (729).—FIG. 405,3. **P. reversa* (BILLINGS), Sil.(White Cliff), Anticosti; sec. showing spondylium and cardinalia, $\times 3$ (729).

PENTAMERIDINA

[Materials for this suborder prepared by THOMAS W. AMSDEN]

The Pentameridina are a suborder of middle Paleozoic brachiopods which comprise the superfamily Pentameracea, containing 43 genera and subgenera. They range from ?Middle Ordovician (Champlainian) to Upper Devonian (Senecan), but are most common in Lower Silurian to Lower Devonian strata. The Pentameridina tend to be larger than most middle Paleozoic brachiopods and include several species with very large shells. Some species of *Conchidium*, such as *C. alaskense* KIRK & AMSDEN and *C. vogulicum* (DE VERNEUIL), are among the largest known brachiopods.

MORPHOLOGY

EXTERNAL FEATURES

Most pentameroids are moderately to strongly biconvex with swollen pedicle umbo and beak of the pedicle valve arched over the brachial valve. This development reaches an extreme in such forms as *Gypidula* of the Gypidulinae and *Conchidium* of the Pentamerinae. A few genera exhibit reversed convexity of the valves, however, the most conspicuous being *Capelliniella*, in which convexity of the brachial umbo exceeds that of the pedicle, and *Brooksina*, in which the pedicle valve is much flattened or even concave.

The fold and sulcus are absent or obscure in most Pentameracea, with exception of the Gypidulinae and Clorindinae, where this structure is generally present. The development of interareas is variable within this group; they are well developed in the Stricklandiidae and Gypidulinae, but poorly developed or absent in the Virganiidae and Pentamerinae.

Ornamentation ranges from costellate to costate to smooth; in a few genera it is granulose (e.g., *Devonogypa*, *Gypidulella*), or pitted (e.g., *Wyella*). If ribbing is present, it is commonly in the form of costae or plications, rather than costellae. The Pentameridae, Virganiidae, and Stricklandiidae have both smooth and ribbed representatives, whereas the Parallelasmatidae include only paucicostate genera; the Enantiosphenidae contain only a single, noncostate genus.

INTERNAL FEATURES

The major structure inside of the pedicle valve is the **spondylium**, commonly called a **spondylium duplex**, which served as the seat of attachment for all muscles in this valve. In most pentameroids the spondylium is supported on a well-developed median septum (Fig. 406-409), but in some genera (e.g., *Harpidium*) the septum is abbreviated, or it may be completely lost (e.g., *Cymbidium*, *Holorhynchus*). The posterior end of the delthyrium may be closed by a deltidium which is generally concave downward (Fig. 410,2,3).

The brachial apparatus is tripartite, consisting of brachial processes which are braced at their posterior end by outer and inner plates (Fig. 406-410). The outer

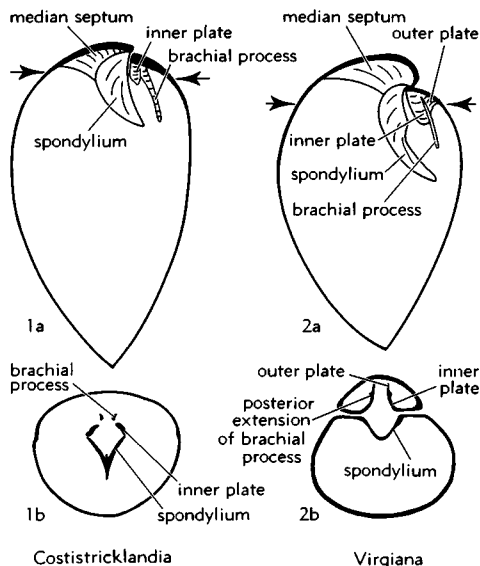


FIG. 407. Longitudinal sections (1a, 2a) and transverse sections (1b, 2b), oriented as in Figure 406, showing internal structure of Stricklandiidae and Virganiidae; heavy, unlettered arrows on longitudinal sections show position of transverse sections.—1. Stricklandiidae, *Stricklandia* (*Costistricklandia*) *gaspeensis* (BILLINGS), Sil. (LaVieille F.), Chaleur Bay, Quebec.—2. Virganiidae, *Virgiana barrandei* (BILLINGS), Sil. (Becksie River F.), Anticosti Island, Quebec. [Explanation: b, brachial process; i, inner plate; ms, median septum; o, outer plate; sp, spondylium.]

plates may be discrete or they may unite to form a **cruralium**. In most pentameraceans these plates are long, extending far enough forward to enclose the brachial muscle area, but in the Stricklandiidae and Virganiidae the brachial apparatus is much shortened and the muscle area lies outside of the plates. Near the posterior end of the shell the upper edges of the inner plates curve outward to meet lateral walls of the valve; the sockets are located here and thus the inner and outer plates serve to brace the articulating mechanism and lophophore supports. The brachial processes extend forward beyond the inner and outer plates as free rodlike or bladeliike structures which served to support at least a portion of the lophophore. In the Parallelasmatidae, Pentameridae, Stricklandiidae, and Virganiidae, these processes terminate blindly, but in the Enantiosphenidae they end in a loop (Fig. 409,8).

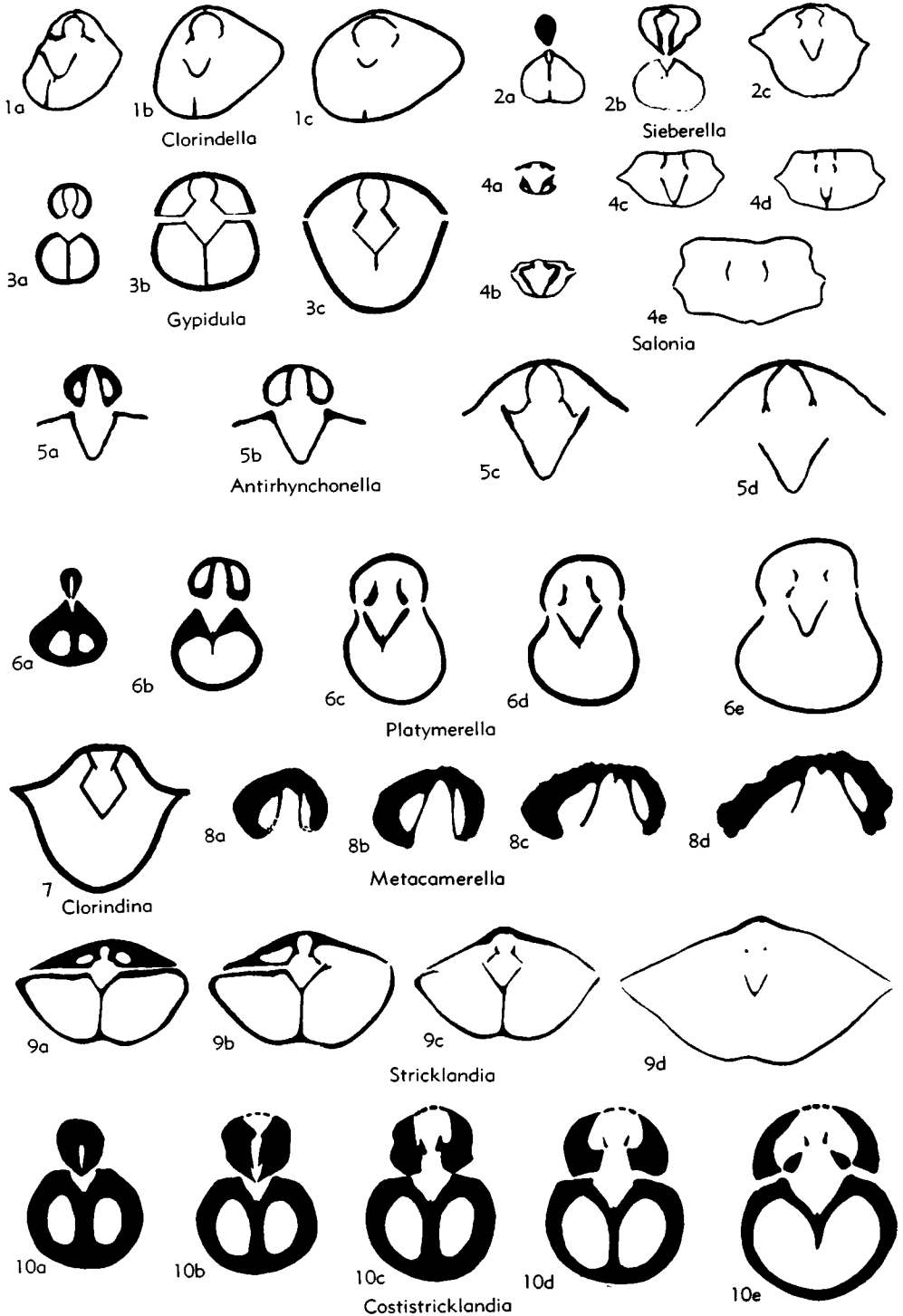


FIG. 408. Serial transverse sections (oriented as in Figure 406) of Parallelelasmatidae (4,8), Stricklandiidae (9,10), Virgianidae (6), and Pentameridae (1-3,5,7).

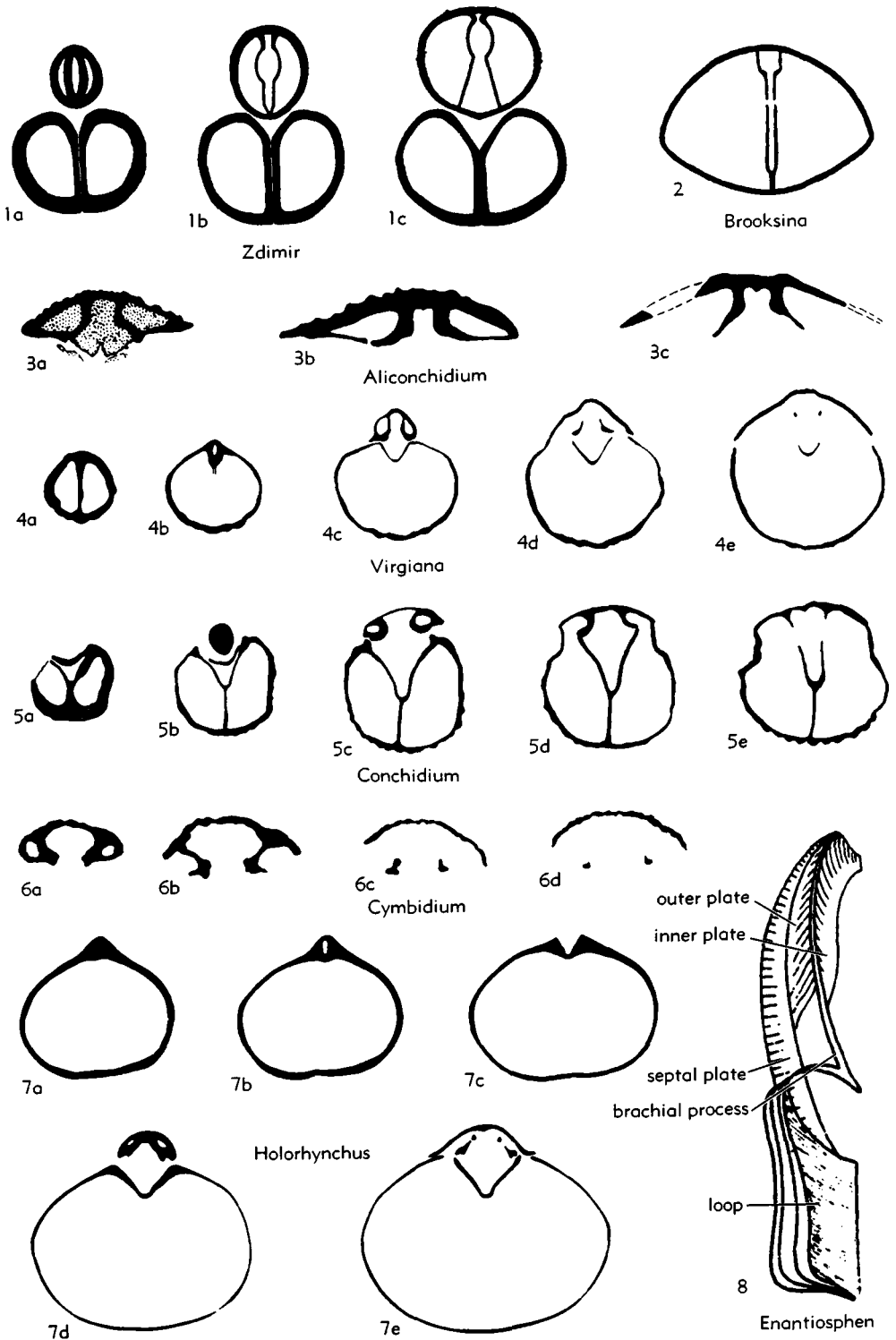


FIG. 409. Serial transverse sections (oriented as in Figure 406) of Virganiidae (4,7) and Pentameridae (1-3,5,6) and longitudinal drawing of Enantiosphenidae, *Enantiosphen* (8).

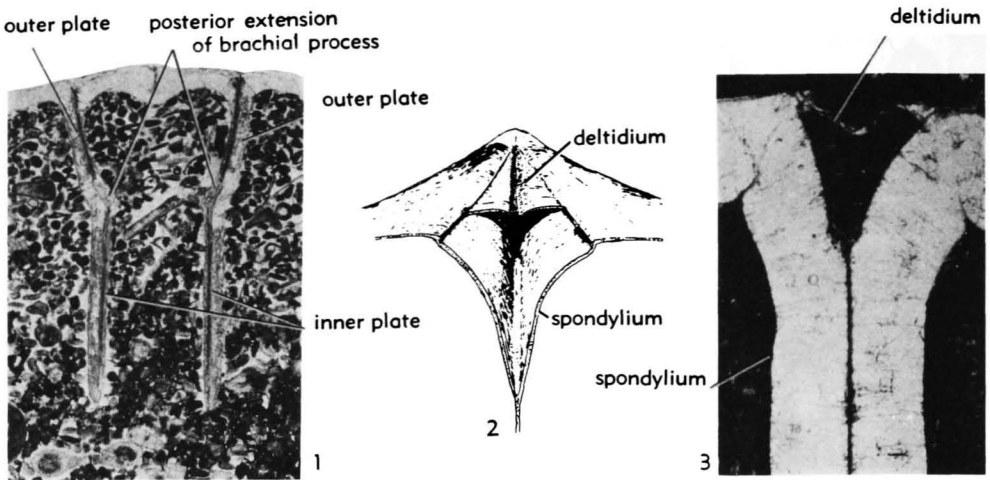


FIG. 410. Internal structures of *Pentamerus* sp. cf. *P. oblongus* SOWERBY, Sil.(Reynales F.), N.Y.—1. Photomicrograph of brachial apparatus ($\times 5$) showing outer plates, posterior extension of brachial processes, and inner plates.—2. Drawing of silicified specimens ($\times 3$) showing deltidium and part of spondylium.—3. Photomicrograph of part of spondylium showing deltidium and spondylium, $\times 10$.

CLASSIFICATION AND GEOLOGIC HISTORY

The Pentameridina first appeared in the ?Middle Ordovician (see remarks on Parallelasmatidae below) and they range into the Upper Devonian (Fig. 411). They are rare in the Ordovician, four genera being represented in the Middle Ordovician and one in the highest Upper Ordovician. The Pentameracea first became fairly numerous in the Early Silurian and were common to abundant in the shelly faunas of the Late Silurian. They are moderately common in the Early Devonian (7 genera) and Middle Devonian (9 genera), but became rare in the Late Devonian (3 genera).

Division of the Pentameracea into families and subfamilies is based largely upon interior structures of the brachial valve, supplemented by such shell features as presence or absence of interareas, relative convexity of the valves, and development of the fold and sulcus. Five families are recognized: Parallelasmatidae, Stricklandiidae, Virgianidae, Enantiosphenidae, and Pentameridae, the latter divided into three subfamilies (Pentamerinae, Gypidulinae, Clorindinae).

The oldest brachiopods now placed in the Pentameracea are the Parallelasmatidae which comprise a small group (4 genera) confined to the Middle Ordovician (Fig. 411). They have a pauciplicate shell of moderate convexity, a spondylium supported on a median septum, and well-developed plates supporting the brachial processes. Some question exists concerning inclusion of this family in the Pentameracea, and it has been suggested (872, p. 232) that they should be referred to the Porambonitacea. The Parallelasmatidae are separated from other representatives of the Pentameracea by almost the entire Upper Ordovician.

The Stricklandiidae comprise five genera and subgenera of Early and Middle Silurian brachiopods (Fig. 411). This family is characterized by an abbreviated brachial apparatus and well-developed interareas. The Virgianidae are similar to the Stricklandiidae in having short brachial plates, differing in their poorly developed interareas (Fig. 407). This family comprises three genera which range from Upper Ordovician (Ashgillian) through the Lower Silurian (Fig. 411). With exception of a single species of Pentamerinae (*Conchi-*

dium munsteri ST. JOSEPH, 1937), all Late Ordovician and early and middle Llando-verian Pentameracea are referred to the Stricklandiidae and Virgianidae, characterized by their abbreviated brachial apparatus. It is not until fairly late in Llando-verian time that the Pentameridae with well-developed brachial plates became common.

The Pentameridae (31 genera) is the largest family of the Pentameracea. They are characterized by well-developed brachial plates which extend forward far enough to enclose the muscle field. These plates are tripartite, consisting of inner plates, brachial processes, and outer plates (Fig. 406). Except for a single species from the Late Ordovician of Norway (*Conchidium munsteri* ST. JOSEPH, 1938), this family made first appearance in the late Llando-verian and ranged into the Late Devonian (Fig. 411). The youngest Pentameridae and youngest of the Pentameracea are found in the lower part of the Upper Devonian; they are species of *Gypidula* and *Pentamerella*.

The Enantiosphenidae is represented by a single genus (*Enantiosphen*), which is known only from the Middle Devonian of Great Britain and continental Europe (Fig. 411). *Enantiosphen* is the only pentameracean with a loop and is believed to be an offshoot of some stock of Pentameridae in which the distal ends of the brachial processes developed a connecting cross platform (Fig. 409,8).

**Suborder PENTAMERIDINA
Schuchert & Cooper, 1931**

[*nom. correct.* AMSDEN, herein (*pro* Pentameroidae SCHUCHERT & COOPER, 1931, p. 247)]

Shells variable in size but tending to be large; commonly strongly biconvex; exterior smooth, costellate, costate, rarely pitted or granulose. Pedicle interior with well-developed spondylium, usually supported on septum, but free in a few genera. Lophophore supports consisting of rodlike or bladlike brachial processes which are unmodified except in Enantiosphenidae, where they terminate in a loop; at posterior end brachial processes are supported on plates which usually extend forward sufficiently to enclose brachial muscle field but which may be shortened to exclude muscle field. ?*M.Ord.*, *U.Ord.*-*U.Dev.*

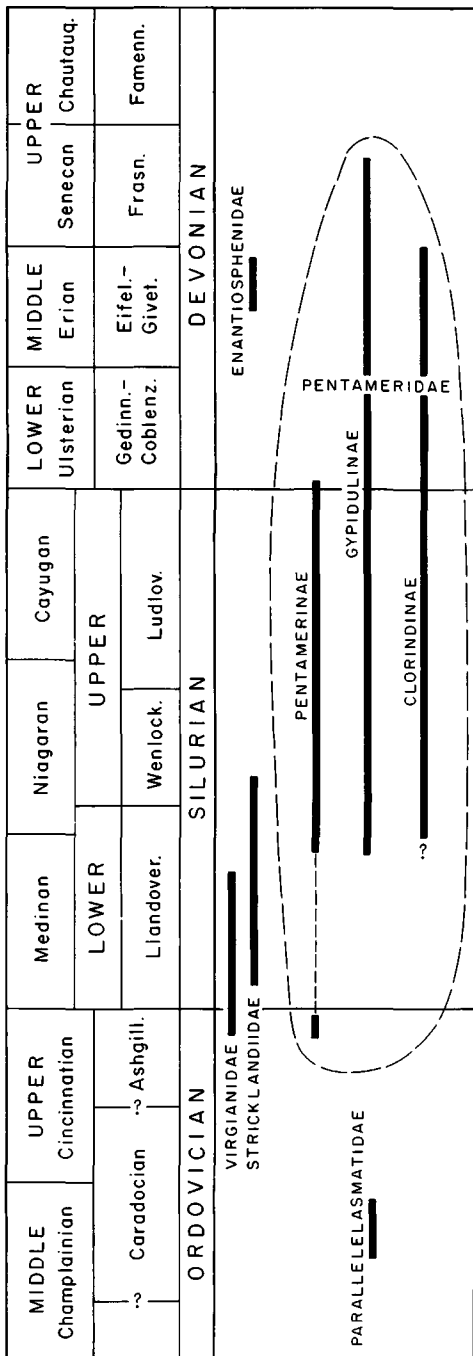


FIG. 411. Range of families and subfamilies of Pentameracea.

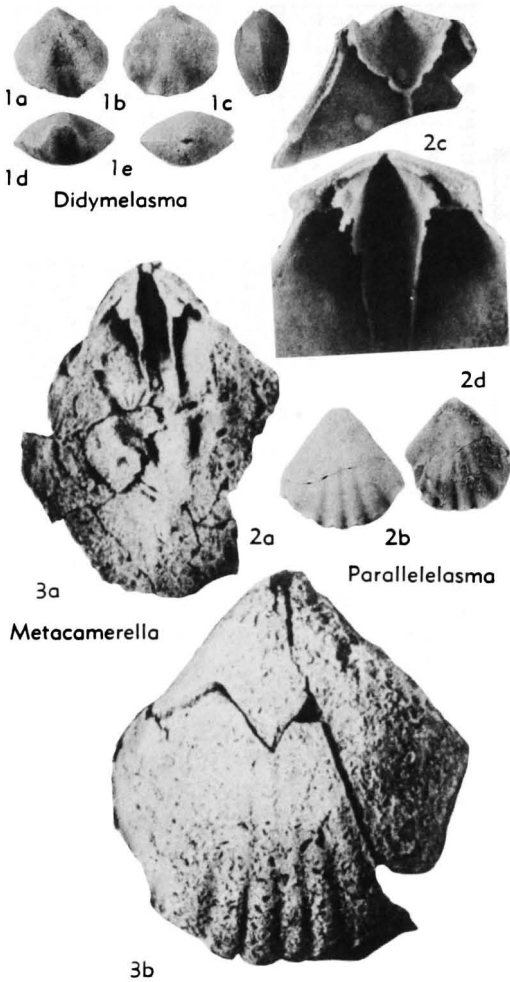


FIG. 412. Parallelelasmatidae (p. H542).

Superfamily PENTAMERACEA M'Coy, 1844

[*nom. transl.* SCHUCHERT, 1896, p. 320 (*ex* Pentameridae M'Coy, 1844, p. 103)]

Characters of suborder. ?*M.Ord.*, *U.Ord.*-*U.Dev.*

?Family PARALLELEASMATIDAE Cooper, 1956

[Parallelelasmatidae COOPER, 1956, p. 611]

Small to medium, subequally biconvex shells of moderate convexity. Surface generally smooth at posterior end, becoming paucicostate to pauciplicate anteriorly. Spondylium supported on median septum. Brachial plates well developed, discrete;

brachial processes relatively long, curved. [Taxonomic position doubtful, may belong in Porambonitacea (872).] *M.Ord.*

Parallelelasma COOPER, 1956, p. 611 [**P. pentagonum*; OD]. Subequally biconvex, paucicostate, with low brachial fold; brachial plates discrete, well developed. [May be synonym of *Metacamerella* (729, p. 231).] *M.Ord.*, SE.N.Am.—FIG. 412,2. **P. pentagonum*, Pratt Ferry F., USA (Ala.); 2*a,b*, brach.v. and ped.v. views, $\times 1$, $\times 2$; 2*c*, ped.v. int. showing spondylium and teeth, $\times 6$; 2*d*, brach.v. int. showing brachiophores, $\times 8$ (189).

Didymelasma COOPER, 1956, p. 615 [**D. longicrurum*; OD]. Small, weakly biconvex, pedicle sulcus and brachial fold; paucicostate; brachial plates relatively long, discrete. *M.Ord.* (*Wilderness*), N.Am.—FIG. 412,1. **D. longicrurum*, Lebanon F., USA (Tenn.); 1*a-e*, ped.v., brach.v., lat., ant., post. views, $\times 3$ (189).

Metacamerella REED, 1917, p. 934 (*emend.* WILLIAMS, 1962, p. 231) [**Stricklandinia? balclatchiensis* DAVIDSON, 1883, p. 166; OD]. Subequally biconvex, shells subpentagonal in outline; paucicostate, with low brachial fold; brachial plates discrete, well developed. *M.Ord.*, Eu.—FIG. 412,3; 408,8. **M. balclatchiensis* (DAVIDSON), Balclatchie beds, Scot.; 412,3*a,b*, brach.v. int., ext., $\times 2$ (872); 408,8*a-d*, brach.v. serial transv. secs., $\times 2$ (703).

[SCHUCHERT & LEVENE (1929, p. 83) correctly cited the name *Stricklandinia? balclatchiensis* as published by DAVIDSON (1883, p. 166), this spelling of the specific name being evidently intentional, as shown by DAVIDSON'S use of it for species of other genera (Davidson, 1883, p. 160, 176, 210) and by mention of Balclatchie as source locality in several places. WILLIAMS (1962, p. 109, 228, 232) inaccurately recorded the spelling *balclatchiensis* as the form published by DAVIDSON. Seemingly, *balclatchiensis* is not validly emendable to *balclatchiensis*, even though present usage in Scotland (Ayrshire) recognizes the locality Balclatchie Bridge (SW. of Girvan) and Balclatchie beds.]

Salonia COOPER & WHITCOMB, 1933, p. 500 [**S. magnaplicata*; OD]. Trilobate, pauciplicate, with pedicle sulcus and brachial fold; brachial plates discrete, processes relatively long, curved. *M.Ord.* (*Trenton.*), N.Am.—FIG. 408,4; 415,5. **S. magnaplicata*, Salona F., USA (Pa.); 408,4*a-e*, transv. secs. at 0.47, 0.61, 1.04, 1.33, 2.07 mm. from tip of ped.v. beak, all $\times 4$ (197); 415,5*a,b*, ped.v. and brach.v. views, $\times 2$ (197).

Family STRICKLANDIIDAE Schuchert & Cooper, 1931

[Stricklandiidae SCHUCHERT & COOPER, 1931, p. 248] [=Stricklandiniidae HALL & CLARKE, 1894, p. 355; Stricklandiidae AMSDEN, 1953, p. 146]

Smooth to costate, with well-developed interareas and generally elongate shells of moderate convexity. Pedicle spondylium relatively small, supported by short septum. Brachial apparatus much abbreviated; outer plates vestigial or absent, inner plates small; muscle area located in front of brachial plates. *L.Sil.-U.Sil.* (*Wenlock.*).

Stricklandia BILLINGS, 1859, p. 132 [**Atrypa lens* J. SOWERBY in MURCHISON, 1839, p. 637; SD OEHLERT, 1887, p. 1310] [= *Stricklandinia* BILLINGS, 1863, p. 370 (obj.)]. Large, smooth to weakly plicate, subcircular to elongate in outline, convexity moderate; spondylium supported on short septum; brachial apparatus relatively large, with small inner plates and in early species small outer plates which tend to be lost in later forms. *L.Sil.*(*Llandover.*), N.Am.(Appalachians-Ont.)-Eu.(Eng.-Norway). — FIG. 408,9; 414,8. **S. (S.) lens* (SOWERBY), Zone 6c, S. Norway; 408,9a-d, serial transv. secs., $\times 1$ (702); 414, 8a,b, lat. and brach.v. views, $\times 1$ (Amsden, n).

[In the mistaken belief that *Stricklandia* BILLINGS, 1859, constituted a junior homonym of *Stricklandia* BUCKMAN, 1845 (p. 94), applied to a fossil plant, BILLINGS (1863) published the name *Stricklandinia* as replacement for his genus of Silurian brachiopods. HALL & CLARKE (1894, p. 250) selected "*Stricklandinia gaspeensis*" BILLINGS, 1859 (= *Stricklandia gaspeensis*) as the type-species of *Stricklandinia* (and hence of *Stricklandia*), but in view of OEHLERT's earlier designation of *Atrypa lens* SOWERBY (one of the eligible six originally included species of *Stricklandia*) as type-species, the cited publication by HALL & CLARKE lacks force, being nomenclaturally null and void. Hence, AMSDEN's (1953, p. 143) choice of *S. gaspeensis* as the type-species of *Costistricklandia* is admissible and entirely legal.]

Costistricklandia AMSDEN, 1953, p. 143 [**Stricklandia gaspeensis* BILLINGS, 1859, p. 134; OD]. Large, costate, short pedicle beak; spondylium and supporting septum short; brachial apparatus relatively large for this family; outer plates vestigial; inner plates of moderate size, adductor scars elongate, deeply impressed. *L.Sil.*(*U.Llandover.*)-*U.Sil.*(*Wenlock.*), N.Am.(N.Y.-Ont.-Que.-Anticosti)-Eu.(Eng.)-USSR (Novaya Zemlya). — FIG. 407,1; 408,10; 414,4. **C. gaspeensis* (BILLINGS), L.Landover. or Wenlock. (LaVielle F.), Que.; 407, 1a,b, long., and transv. secs., $\times 1$ (Amsden, n); 408,10a-e, transv. secs. at 3.1, 3.6, 3.8, 4.5, 5.7 mm. from tip of ped.v. beak, all $\times 1$ (Amsden, n); 414,4, brach.v. view, $\times 1$ (Amsden, n).

Kulumbella NIKIFOROVA, 1960, p. 61 [**K. kulumbensis*; OD]. Shells large, plano-convex to bi-convex, with long hinge line; pedicle sulcus and brachial fold; surface marked with 2 sets of diagonal rugae intersecting to produce reticulate pattern; spondylium supported on short median septum; brachial processes short, supporting apparatus short. *L.Sil.*(*M.Llandover.*), USSR (Sib.)-?N.Am. — FIG. 413,2. **K. kulumbensis*, Sib.; 2a-c, brach.v., lat., and ped.v. views, $\times 1$ (600).

Microcardinalia BOUCOT & EHLERS, 1963, p. 51 [**Stricklandinia triplesiana* FOERSTE, 1890, p. 323; OD]. [In his original description FOERSTE (1885, p. 89) did not assign his new species *triplesiana* to any genus but later he referred it to *Stricklandinia* (= *Stricklandia*).] Small, subpentagonal in outline, smooth to sparsely costate; spondylium small, supporting septum short; brachial apparatus abbreviated, outer plates present in early species, absent in later ones; brachial adductor impres-

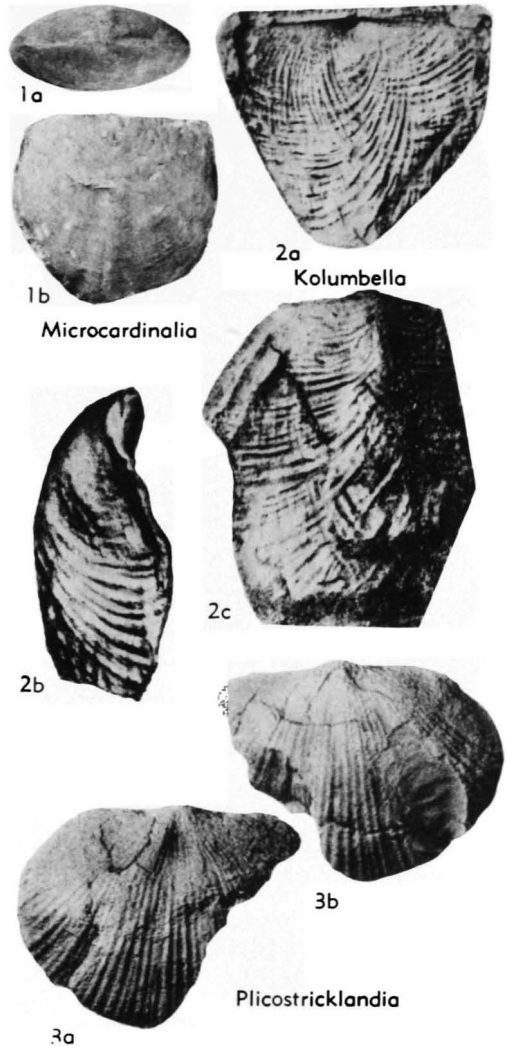


FIG. 413. Stricklandiidae (p. H543).

sions separate, elongate. *L.Sil.*(*Llandover.*), USA (Ky.-Ill.-Mich.-Ohio)-G.Brit.(Scot.). — FIG. 413, 1. **M. triplesiana* (FOERSTE), Brassfield F., Ohio; 1a,b, post. and ped.v. views, $\times 1$ (Amsden, n; 110).

Plicostricklandia BOUCOT & EHLERS, 1963, p. 55 [**Stricklandinia multilirata* WHITFIELD, 1878, p. 81; OD]. Similar to *Microcardinalia* but with costellate shell; outer plates vestigial. *L.Sil.*(*U.Llandover.*)-*U.Sil.*(*Wenlock.*), USA (Iowa-Wis.-Tex.)-Can.(Ont.)-?G.Brit. — FIG. 413,3. **P. multilirata* (WHITFIELD), Wenlock. (Hopkinton Dol.), Iowa; 3a,b, ped.v., brach.v. views, $\times 1$ (109).

Family VIRGIANIDAE Boucot & Amsden, 1963

[Virgianidae BOUCOT & AMSDEN, 1963, p. 296]

Smooth to costate, with interareas lacking or poorly developed. Spondylium moderate in size to small, supporting septum short or

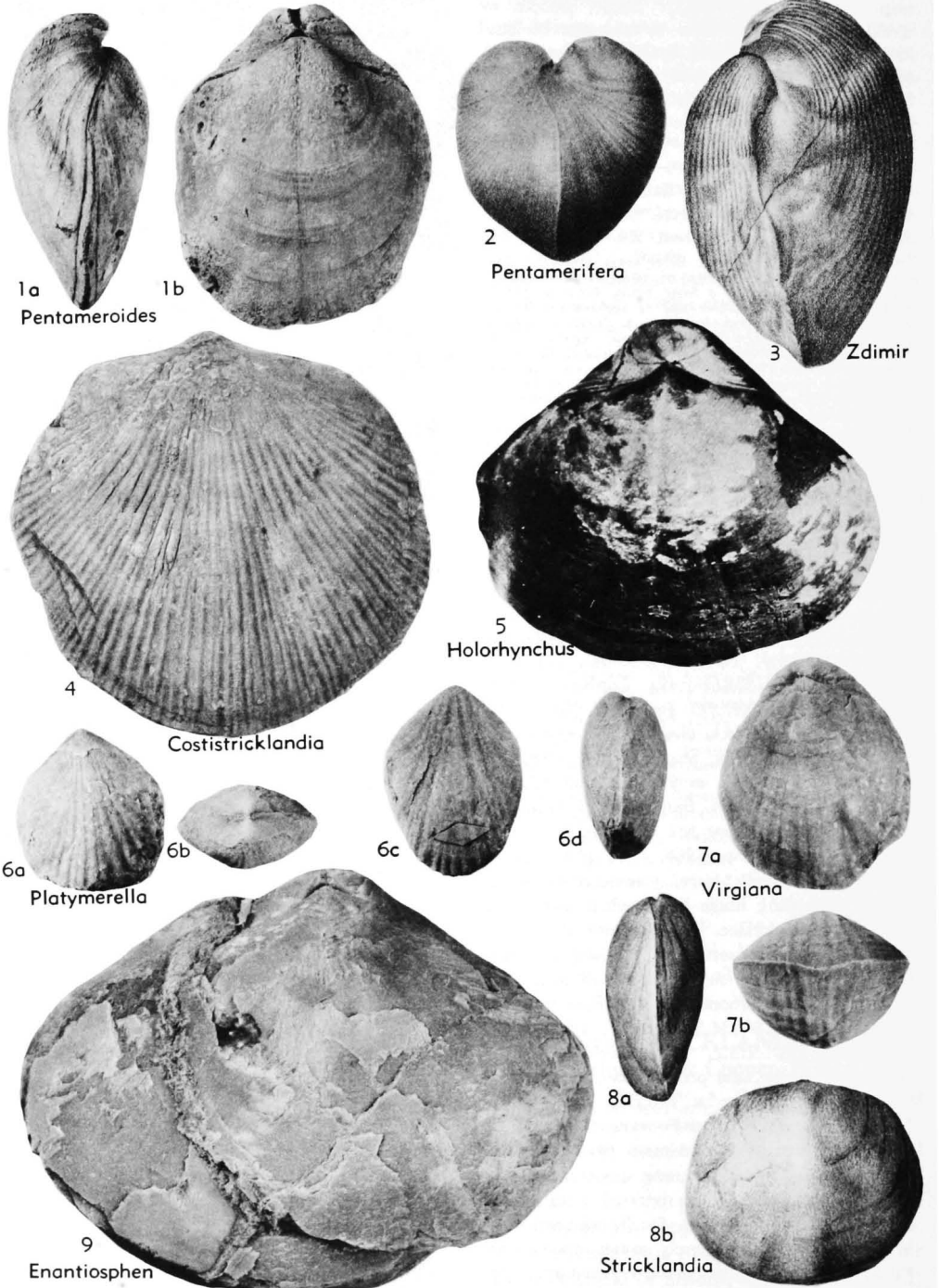


FIG. 414. Stricklandiidae (4, 8); Virgianidae (5-7); Pentameridae (Pentamerinae) (1, 3), (Gypidulinae) (2); Enantiosphenidae (9) (p. H543, H547-H548, H551-H552).

absent; spondylium and septum relatively thick-walled. Brachial apparatus much abbreviated; outer plates abbreviated or ab-

sent, inner plates small; muscle area located in front of brachial apparatus. *U.Ord.-L.Sil.* Virgiana TWENHOFEL, 1914, p. 27 [**Pentamerus*

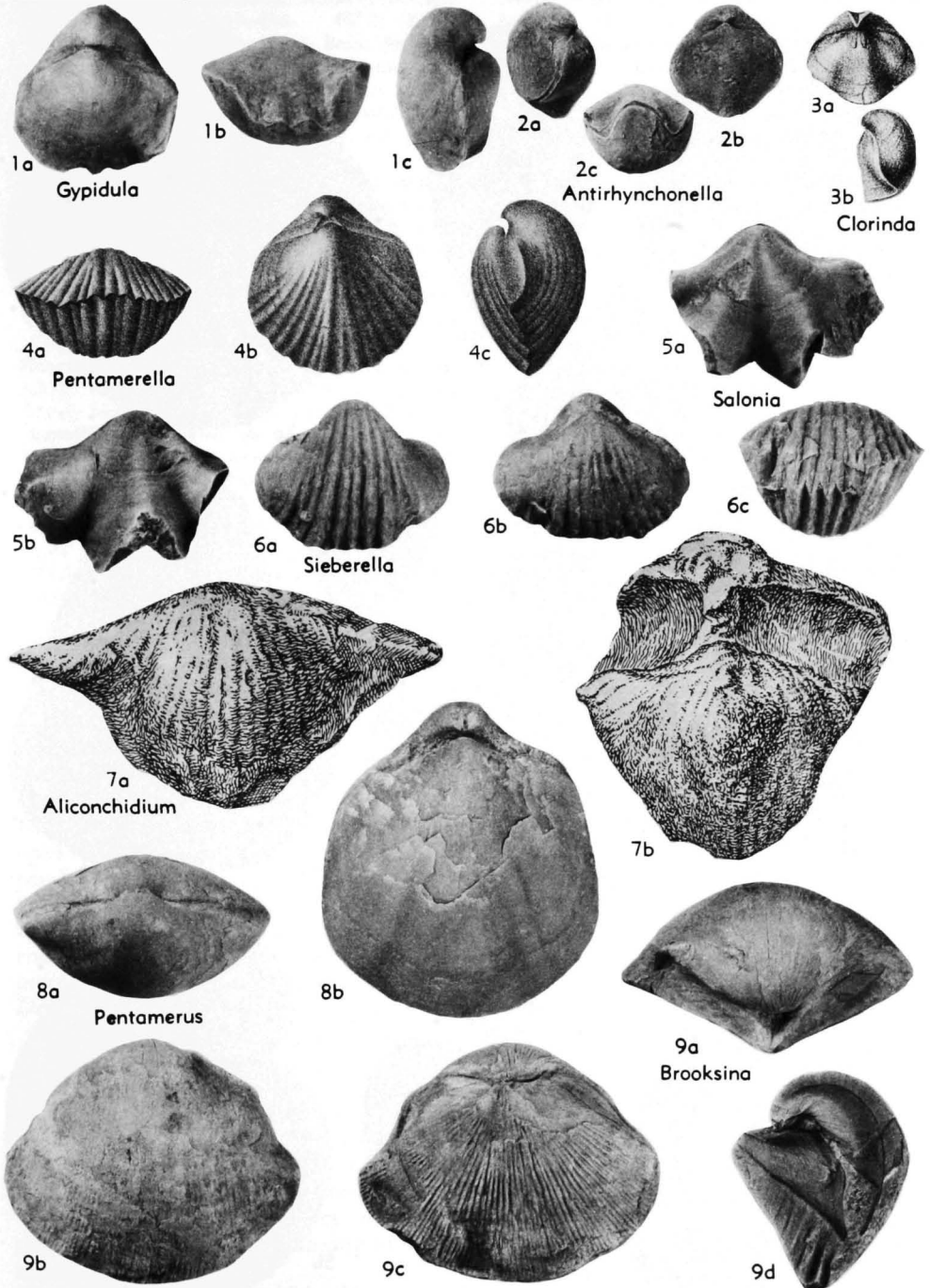


FIG. 415. Parallelelasmatae (5); Pentameridae (Pentamerinac) (7-9), (Gypidulinac) (1, 4, 6) (Clorindinae) (2, 3) (p. H542, H547-H548, H551).

barrandi BILLINGS, 1857, p. 296; OD]. Strongly biconvex, costate shells with prominent pedicle beak and umbo which arch over brachial valve;

pedicle valve commonly with low fold; spondylium of moderate size, supporting septum short; very short outer plates supporting long, rodlike

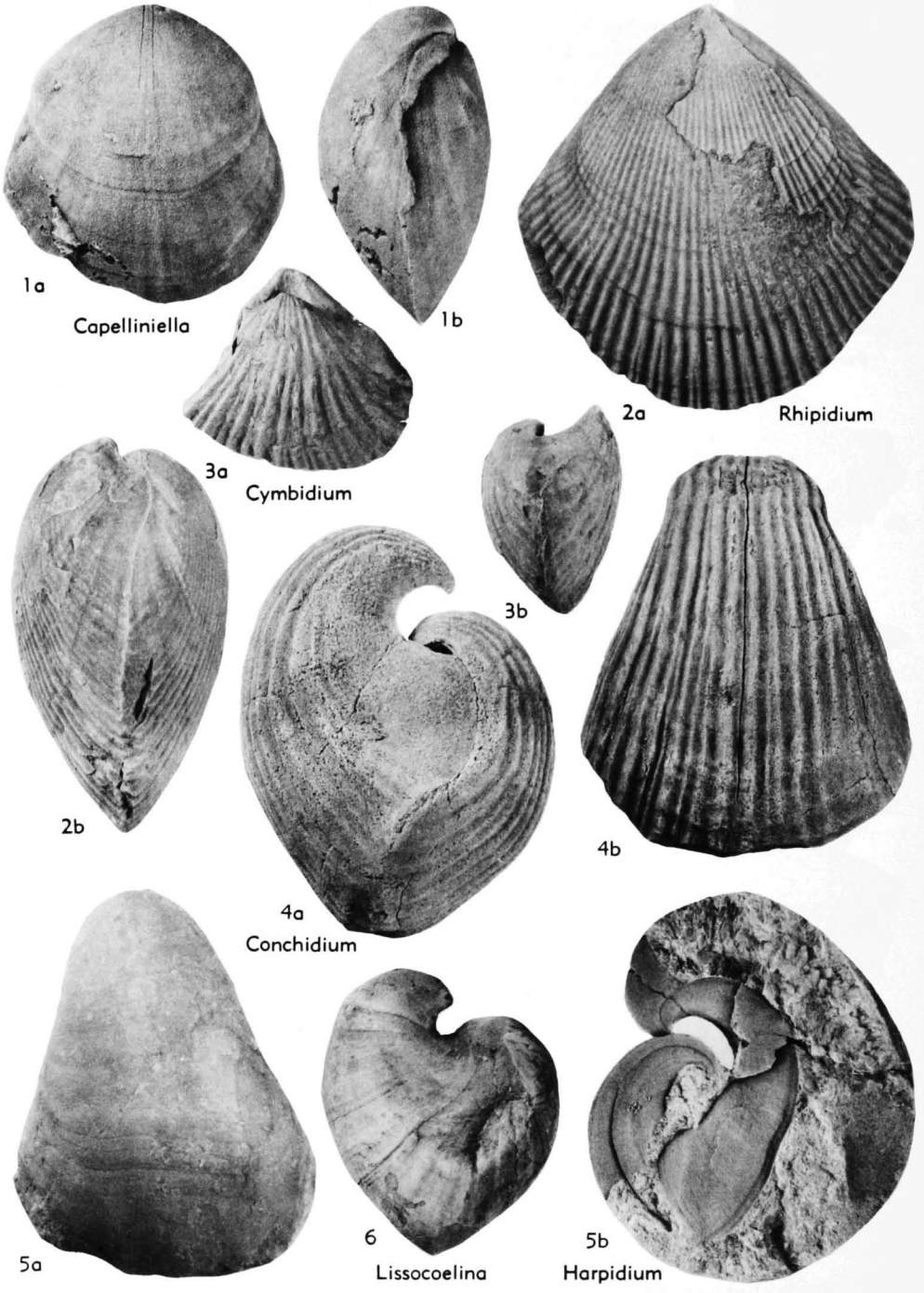


FIG. 416. Pentameridae (Pentamerinae) (p. H547-H548).

processes; small inner plates present. [The original spelling of *Pentamerus barrandi* is automatically correctable (Art. 32, c, Code, 1961) to *P. barrandei*.] *L.Sil.(M.Llandover.)*, N.Am.(USA-Can.-?Greenl.)-USSR(Sib.).—FIG. 407,2; 409,4; 414,7. **V. barrandei* (BILLINGS), Bessie River F., Que.(Anticosti); 407,2*a,b*, long. and transv. secs., $\times 1$ (Amsden, n); 409,4*a-e*, transv. secs. at 2,2, 4,4, 5,9, 7,7, 11,5 mm. from tip of ped.v. beak, all $\times 1$ (729); 414,7*a,b*, brach.v. and ant. views, $\times 1$ (Amsden, n).

Holorrhynchus KIAER, 1902, p. 68 [**H. giganteus*; OD]. Large, smooth, transversely elliptical in outline; spondylium free, no trace of supporting septum; outer plates absent or vestigial; small inner plates present. *U.Ord.(Ashgill.)*, Eu.(Norway-?Sweden).—FIG. 409,7; 414,5. **H. giganteus*, SE.Norway; 409,7*a-e*, serial transv. secs., $\times 1$ (702); 414,5, brach.v. view, $\times 0.8$ (702).

Platymereella FOERSTE, 1909, p. 70 [**P. manniensis*; OD]. Small, elongate elliptical in outline, moderately biconvex, multicostate; pedicle beak small. Spondylium supported on short septum; outer plates very short or absent, small inner plates present. *L.Sil.(M.Llandover.)*, USA(Tenn.-Ohio-Ill.).—FIG. 408,6; 414,6. **P. manniensis*, Tenn.; 408,6*a-e*, transv. secs. at 1.2, 1.9, 2.1, 2.6, 3.3 mm. from tip of ped.v. beak, all $\times 3$ (Amsden, n); 414,6*a-d*, brach.v., post., ped.v., lat. views, $\times 3$ (Amsden, n).

Family PENTAMERIDAE M'Coy, 1844

[Pentameridae M'Coy, 1844, p. 103]

Smooth, costate, costellate, granulose or pitted, with or without interareas, and generally having strongly biconvex shells. Pedicle spondylium well developed, commonly supported at least in part by septum. Brachial processes supported by well-developed plates which in some genera are parallel and discrete, and in others uniting to form cruralium; in both types brachial apparatus long, extending forward far enough to enclose muscle area; brachial processes rodlike or bladlike. *U.Ord.-U.Dev.*

Subfamily PENTAMERINAE M'Coy, 1844

[*nom. transl.* WAAGEN, 1883, p. 413 (*ex* Pentameridae M'COY, 1844, p. 103)]

Moderate to large size, with smooth, costate or costellate shells generally lacking well-developed interareas; fold and sulcus absent or weakly developed. Brachial processes long, rodlike; outer plates commonly discrete, but in few genera uniting to make cruralium. *U.Ord.-L.Dev.*

Pentamerus J. SOWERBY, 1813, p. 73 [**Pentamerus oblongus* J. DE C. SOWERBY, 1839; in MURCHISON,

1839, p. 641; by action of the ICZN]. [In 1954 the ICZN, Opinion 297, placed *Pentamerus* J. SOWERBY, 1813, on the Official List of Generic Names in Zoology; *Pentamerus oblongus* J. DE C. SOWERBY, 1839, was designated the type-species and added to the Official List of Specific Names in Zoology. The following names were placed on the Official Index of Rejected and Invalid Generic Names in Zoology: *Gypidia* DALMAN, 1828; *Trimurus* CALDWELL, 1934; *Miopentamerus* ALEXANDER (née CALDWELL), 1936; *Miopentamerus* WOODS, 1937. *Pentamerus laevis* J. SOWERBY, 1813, was placed on the Official Index of Rejected and Invalid Specific Names in Zoology.] Large, elongate, moderately biconvex, smooth surface; spondylium and supporting septum commonly extending forward less than half the length of pedicle valve; brachial plates discrete. *L.Sil.(U.Llandover.)-U.Sil.(Wenlock.)*, USA (N.Y.-Ohio-Ind.-Ky.-Ill.-Iowa-Wis.) - Can.(Ont. - Quebec-Anticosti)-Eng.-Sweden (God.)-Est.-Asia(China)-USSR (Urals, Turkestan).—FIG. 406,1; 415,8. P. sp. cf. **P. oblongus* (SOWERBY), *L.Sil.(U.Llandover.)* (Reynales F.), N.Y.; 406,1*a,b*, long. and transv. secs., $\times 1$ (Amsden, n); 415,8*a,b*, post. and brach. v. views, $\times 1$ (Amsden, n).

?**Aliconchidium** ST. JOSEPH, 1942, p. 247 [**A. yassi*; OD]. Large, biconvex, costate; hinge line long, cardinal extremities commonly alate; pedicle palintrope prominent; spondylium and supporting septum well developed; brachial plates discrete. [This genus differs from most other Pentamerinae in having a prominent palintrope]. ?*U.Sil.*, Australia.—FIG. 409,3; 415,7. **A. yassi*, Hume Ser., New S. Wales; 409,3*a-c*, serial transv. secs. of brach.v., $\times 1.5$ (703); 415, 7*a,b*, ped.v. and brach.v. views, $\times 1$ (703).

Brooksina KIRK, 1922, p. 2 [**B. alaskensis*; OD]. Multicostellate, of moderate size; brachial valve strongly convex, pedicle valve gently convex, flat or concave; spondylium and supporting septum long, extending almost entire length of valve; brachial plates discrete. *U.Sil.(Ludlov.)*, Alaska-USSR(Ural Mts.-Turkestan).—FIG. 402,2; 415, 9. **B. alaskensis*, SE.Alaska(Kosciusko Is.); 409,2, transv. sec., $\times 1$ (Amsden, n); 415, 9*a-c*, post., ped.v., brach.v. views, $\times 1$; 415,9*d*, long. sec., $\times 1$ (Amsden, n).

Callipentamerus (*see* p. H903).

Capelliniella STRAND, 1928, p. 38 [*pro* *Capellinia* HALL & CLARKE, 1894, p. 249 (*non* TRICHESE, 1874)] [**Capellinia mira* HALL & CLARKE, 1894, p. 249; OD]. Smooth shell differing from *Pentamerus* in having brachial valve deeper and more strongly convex than pedicle. *U.Sil.*, N.Am.-USSR (Turkestan).—FIG. 416,1. **C. mira* (HALL & CLARKE), Racine F., USA(Wis.); 1*a,b*, ped.v. and lat. views of int. mold (ped.v. at left), $\times 1$ (Amsden, n).

Conchidium OEHLERT, 1887, p. 1311 [**Anomia bilocularis* HISINGER, 1799, p. 285; OD]. Rostrate,

- strongly biconvex, costate; spondylium partially or completely supported on median septum, extending forward more than half length of pedicle valve; brachial plates discrete. *U.Ord.* (*Ashgill.*)-*L.Dev.* (*Skala.*), cosmop.—FIG. 409,5; 416,4. **C. bilocularis* (HISINGER), Sil., Sweden (Gotl.); 409,5a-e, transv. secs. at 4.2, 6.1, 8.1, 9.9, 12.1 mm. from tip of ped.v. beak, all $\times 1$ (729); 416, 4a-b, lat. and ped.v. views, $\times 1$ (Amsden, n; 729).
- [In 1954 the ICZN, Opinion 297, placed *Conchidium* OEHRLERT, 1887, on the Official List of Generic Names in Zoology, type-species *Anomia bilocularis* HISINGER, 1799, by original designation. The following names were placed on the Official List of Specific Names in Zoology: *bilocularis* HISINGER, 1799, as published in the combination *Anomia bilocularis*, and *knightsi* J. SOWERBY, 1813, as published in the combination *Pentamerus knightsi* [= *Conchidium knightsi*]. The following names were placed on the Official Index of Rejected and Invalid Generic Names in Zoology: *Conchidium* HISINGER, 1799; *Conchidium* BRONN, 1848; *Conchidium* WAHLENBERG, 1821.]
- Cymbidium** KIRK, 1926, p. 2 [**C. actum*; OD]. Multicostate; biconvex, brachial valve with greatest convexity; spondylium long, no median septum; brachial plates discrete, inner plates short. *U.Sil.* (*Ludlov.*), USA (Alaska-Nev.).—FIG. 409, 6; 416,3. **C. actum*, SE.Alaska (Kosciusko Is.); 409,6a-d, transv. secs. at 1.0, 3.0, 5.0, 6.0 mm. from tip of ped.v. beak, all $\times 1$ (729); 416,3a,b, brach.v. and lat. views, $\times 1$ (Amsden, n).
- Harpidium** KIRK, 1925, p. 1 [**H. insignis*; OD]. Smooth; biconvex; pedicle valve strongly convex, beaks of both valves arched, pedicle valve bent sharply over brachial; spondylium long, supporting septum short; brachial plates discrete. *U.Sil.*, Alaska-Greenl.-USSR (Ural Mts.).—FIG. 416,5. **H. insigne*, SE.Alaska (*Sa*, Heceta Is.; *Sb*, Kosciusko Is.); *Sa,b*, ped.v. view and long. sec., $\times 1$ (729).
- Jolvia** SAPELNIKOV, 1960, p. 56 [*]. *multiplexa*; OD]. Large, smooth to costate shells with well-developed spondylium and supporting septum; brachial apparatus with cardinal process. *U.Sil.* (*Wenlock.*), USSR (Ural Mts.).—FIG. 417,8. **J. multiplexa*, central Ural Mts., E. slope; brach.v. view, $\times 1$ (707).
- Lissocoelina** SCHUCHERT & COOPER, 1931, p. 248 [**Pentamerus pergibbosus* HALL & WHITFIELD, 1875, p. 139; OD]. Smooth, strongly biconvex; pedicle valve rostrate, arched over brachial; spondylium supported on long median septum; brachial plates discrete. *L.Sil.* (*U.Llandover.*)-*U.Sil.* (*Wenlock.*), N.Am.(USA).—FIG. 416,6. **L. pergibbosa* (HALL & WHITFIELD), U.Sil. (Louisville F.), USA (Ky.); lat. view, $\times 1$ (729).
- ?**Pentamerifera** KHODALEVICH, 1939, p. 22 [**Pentamerus taliensis* CHERNYSHEV, 1893, p. 183; OD]. Smooth, biconvex shells with long spondylium and supporting septum; brachial apparatus similar to *Pentameroides* (?). [Internal characters poorly known.] *U.Sil.*, USSR (Ural Mts.).—FIG. 414,2. **P. taliensis* (CHERNYSHEV), U.Sil., Urals E. slope; lat. view, $\times 1$ (157).
- Pentameroides** SCHUCHERT & COOPER, 1931, p. 248 [**Pentamerus oblongus subrectus* HALL & CLARKE, 1894, p. 238; OD (M)]. Smooth, biconvex, external shape like *Pentamerus*; spondylium and supporting septum well developed; brachial plates uniting to make cruralium supported on median septum. *L.Sil.* (*up. Llandover.*)-*U.Sil.* (*Wenlock.*), N. Am. (USA-Can.)-Eu. (Norway)-USSR (Ural Mts.).—FIG. 414,1. **P. subrectus* (HALL & CLARKE), U.Sil., USA (Iowa); *1a,b*, lat. and brach.v. views of int. mold, $\times 1$ (729).
- ?**Pleurodium** WANG, 1955, p. 344 [**Conchidium tenuiplicatus* GRABAU, 1925, p. 80; OD]. Large, transversely elliptical, subequally biconvex; pedicle palintrope prominent, curved, apsacline; no fold or sulcus; strong, angular costae which do not bifurcate. Spondylium long, supporting septum short; brachial interior unknown. [This genus differs from most other *Pentamerina* in having a well-marked palintrope.] *Sil.*, China (M. Yangtze Valley).—FIG. 417,5. **P. tenuiplicatum* (GRABAU); *5a,b*, ped.v. and ant. views, $\times 1$ (852).
- Rhipidium** SCHUCHERT & COOPER, 1931, p. 249 [**Pentamerus knappi* HALL & WHITFIELD, 1872, p. 184; OD]. Costate, moderately to strongly biconvex; pedicle beak and umbo shorter and less prominent than in *Conchidium*; spondylium and supporting septum generally extending forward half or less than half of valve length; brachial plates discrete. *U.Sil.* (*Wenlock.* or *Ludlov.*), N. Am. (USA)-Eu.—FIG. 416,2. **R. knappi* (HALL & WHITFIELD), Louisville F., USA (Ky.); *2a,b*, brach.v. and lat. views, $\times 1$ (729).

Subfamily GYPIDULINAE Schuchert & LeVene, 1929

[Gypidulinae SCHUCHERT & LEVENE, 1929, p. 15]

More or less galeatiform shells with interareas; fold and sulcus generally well developed, absent in few genera; exterior smooth, costate, pitted or granulose. Brachial apparatus commonly lyre-shaped in cross section, brachial processes bladeliike; outer plates discrete or coalesced into cruralium. *L.Sil.*-*U.Dev.*

Gypidula HALL, 1867, p. 163 [**Gypidula typicalis* AMSDEN, 1953, p. 140 (pro *Pentamerus occidentalis* HALL, 1858, p. 514, non HALL, 1852); OD HALL, 1867, p. 380]. Elongate oval to subcircular in outline, pedicle valve swollen, beak arched over brachial; costate to multicostate; pedicle fold and brachial sulcus; brachial plates discrete. *L.Sil.* (*Llandover.*)-*U.Dev.*, N.Am. (USA-Can.)-Eu.-Asia-USSR-Afr.—FIG. 408,3; 415,1. **G. typicalis* AMSDEN, U.Dev. (Cedar Valley F.), USA (Iowa); 408,3a-c, serial transv. secs., $\times 2$ (62); 415,1a-c, brach.v., ant., lat. views, $\times 1$ (729).

[HALL (1867, p. 380) designated *Pentamerus occidentalis* HALL, 1858, as the type-species of his new genus *Gypidula*. *Pentamerus occidentalis* HALL, 1858, is a homonym of *Pentamerus occidentalis* HALL, 1852, the latter being a species of *Conchidium*. AMSDEN, 1953, p. 140, replaced *Pentamerus occidentalis* HALL, 1858 (not *Pentamerus occidentalis* HALL, 1852) with *Gypidula typicalis*.]

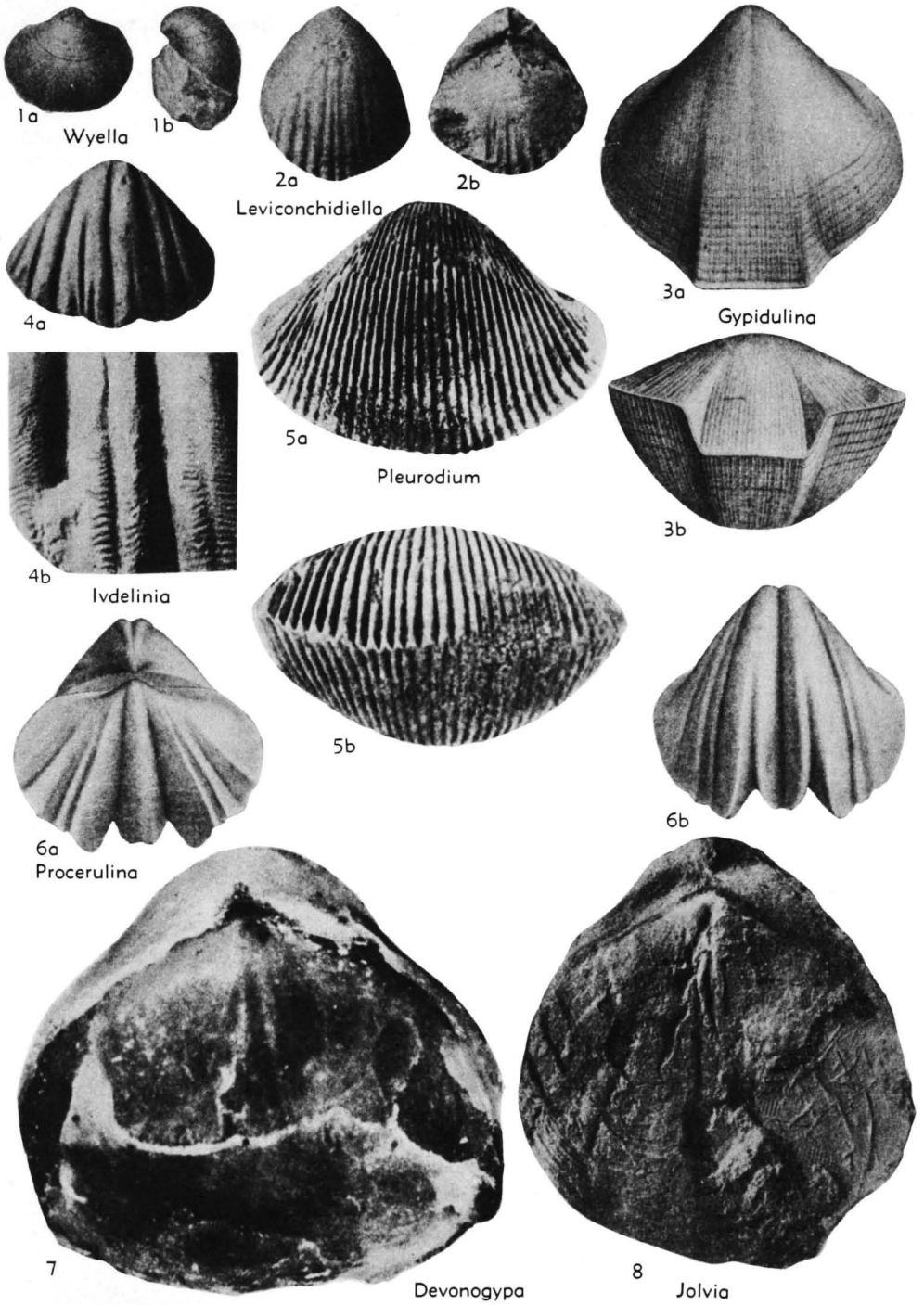


FIG. 417. Pentameridae (Pentamerinae) (5, 8), (Gypidulinae) (1-4, 6-7) (p. H548, H550-H551).

Barrandina BOOKER, 1926, p. 131 [**Pentamerus linguifera wilkinsoni* ETHERIDGE, 1892; OD]. Smooth, subgaleatiform shells with pedicle sulcus and brachial fold. Outer plates discrete (88). *U.Sil.*, New S. Wales.

?**Biseptum** KHODALEVICH & BREIVEL, 1959, p. 39 [**B. rectecostatum*; OD]. Shell large, costate, costae nonbifurcating; no fold nor sulcus. Outer plates uniting to make cruralium, supported on high septum. *M.Dev.*, USSR(Ural Mts.).—FIG. 418.4. **B. rectecostatum*, 4a,b, lat., transv. sec. post. part of ped.v., $\times 1$, $\times 3$ (468).

Devonogypa HAVLÍČEK, 1951, p. 3 [**D. spinulosa*; OD]. Large, subcircular to transversely elliptical, strongly biconvex; shallow brachial sulcus, low pedicle fold; surface smooth except for fine spines or granules arranged in irregular, horizontal to oblique rows. Pedicle and brachial interiors like *Gypidula*. *M.Dev.*(*Givet.*), Eu.(Czech.-Ger.).—

FIG. 417.7. **D. spinulosa*, Czech.; brach.v. view, $\times 1$ (40+).

Gypidulella KHODALEVICH & BREIVEL, 1959, p. 26 [**G. pennatula*; OD]. Hinge line straight, extended; pedicle fold and brachial sulcus; surface costate and tuberculate. Interior like *Sieberella*. *M.Dev.*, USSR (Ural Mts.).—FIG. 418.3. **G. pennatula*, 3a,b, ped.v., ant. views, $\times 1$; 3c, transv. sec., $\times 3$ (468).

Gypidulina RZHONSNITSKAYA, 1956, p. 49 [**Pentamerus optatus* BARRANDE, 1847, p. 37; OD] [= *Sieberina* ANDRONOV, 1961 (obj.)]. Smooth to pauciplicate shells with sharply defined pedicle fold and brachial sulcus. Brachial plates uniting to form cruralium. *L.Dev.*, USSR(Ural Mts.-Novaya-Zemlya-Kuznetsk Basin)-Eu.—FIG. 417.3. **G. optata* (BARRANDE), Czech.; 3a,b, ped.v. and ant. views, $\times 1$ (468).

Ivdelinia ANDRONOV, 1961, p. 45 [**Gypidula ivdel-*

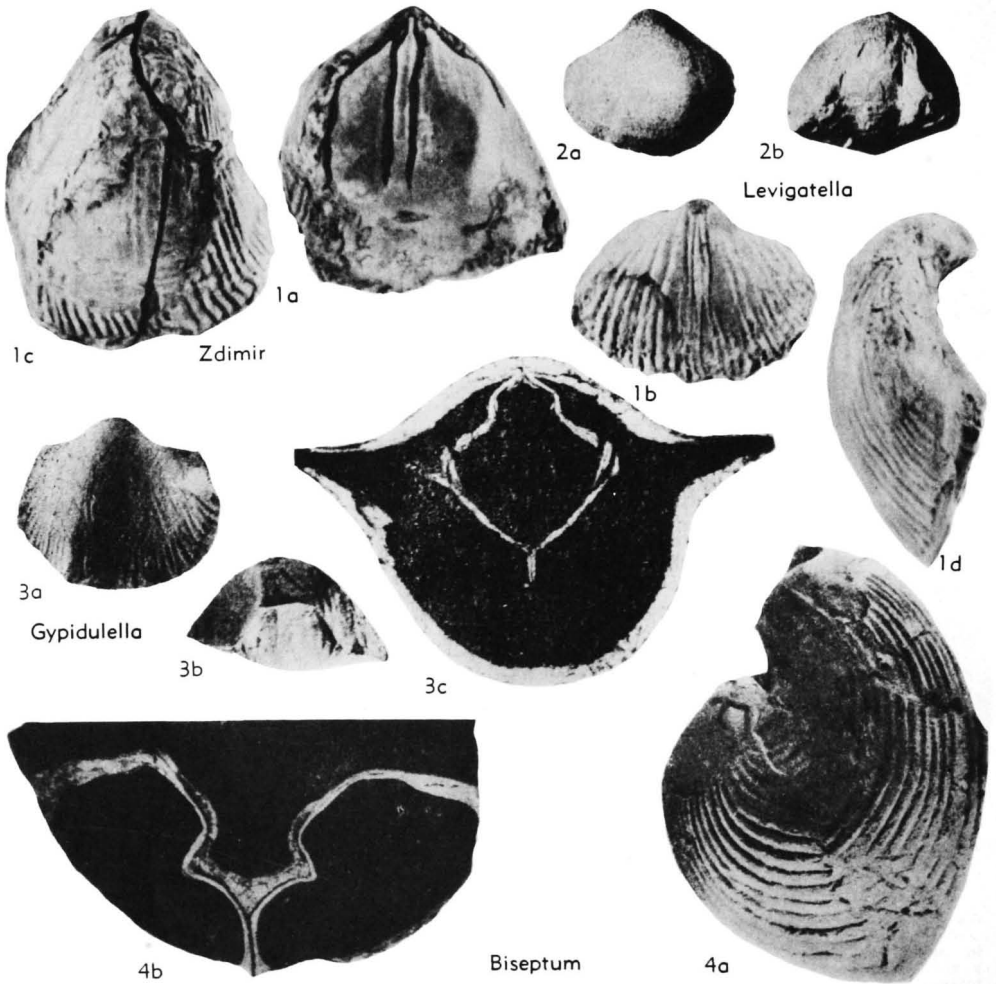


FIG. 418. Pentameridae (Gypidulinae) (p. H550-H551).

- ensis* KHODALEVICH, 1951, p. 22; OD]. Galeatiform, pedicle fold and brachial sulcus; costate and with fine concentric ridges crossing costae; costae split at anterior margin; brachial plates discrete or united into cruralium. *L.Dev.-M.Dev.*, USSR (Ural Mts.)-Eu.—FIG. 417.4. 1. *acutolobata* (SANDBERGER), *M.Dev.*, Kuznetsk Basin; 4a,b, ped. v. view and ornament, $\times 1$, $\times 5$ (692).
- Leviconchidiella** RZHONSNIISKAYA, 1960, p. 47 [**Sieberella? vagranica* KHODALEVICH, 1951, p. 39; OD]. Costate shells without distinct fold and sulcus. Brachial plates discrete. Like *Gypidula* but lacking fold and sulcus. *M.Dev.*, USSR.—FIG. 417.2. **L. vagranica* (KHODALEVICH), Kuzbas; 2a,b, ped.v. and brach.v. views, $\times 1$ (691).
- Levigatella** ANDRONOV, 1961, p. 38 [**Gypidula olga* KHODALEVICH, 1939, p. 15; OD]. Strongly biconvex, smooth, pedicle fold and brachial sulcus; brachial plates discrete as in *Gypidula*. *Sil.-U.Dev.*, USSR (Ural Mts.).—FIG. 418.2. **L. olga*, L.Dev. (Marginalis beds), Nadieja Reg.; 2a,b, ped.v., ant. view, $\times 4$ (466).
- Pentamerella** HALL, 1867, p. 163 [**Atrypa arata* CONRAD, 1841, p. 55; SD OEHLERT, 1887; p. 1312]. Costate to multicostate; pedicle sulcus and brachial fold; brachial plates united to form cruralium. *L.Dev.-U.Dev.*, N. Am. (USA-Can.)-Asia-USSR (Ural Mts.-Turkestan).—FIG. 415.4. **P. arata* (CONRAD), L.Dev. (Schoharie F.), USA (N.Y.); 4a-c, ant., brach.v., lat. views, $\times 1$ (729).
- ?**Procerulina** ANDRONOV, 1961, p. 76 [**Pentamerus acutolobatus procerulus* BARRANDE, 1879, p. 60; OD]. Like *Ivdelinia*, but paucicostate. [Possibly synonym of *Ivdelinia*.] *L.Dev.-U.Dev.*, Eu. (Czech.-Ger.)-USSR (Urals).—FIG. 417.6. **P. procerulus* (BARRANDE), L.Dev., Czech.; 6a,b, brach.v. and ped.v. views, $\times 1$ (38).
- Sieberella** OEHLERT in FISCHER, 1887, p. 1311 [**Pentamerus sieberi* VON BUCH in BARRANDE, 1847, p. 103; OD]. Costate, pedicle fold and brachial sulcus; brachial plates uniting to form cruralium. *U.Sil. (Wenlock.)-L.Dev.*, N. Am. (USA-Can. - Greenl.)-Eu. (Ger.)-N. Afr. (Morocco)-Asia (Turkestan)-USSR (Ural Mts. - Kuznetsk Basin).—FIG. 406.2. *S. roemeri* HALL & CLARKE, *Sil.* (Henryhouse F.), USA (Okla.); 2a,b, long. and transv. secs., $\times 2$ (Amsden, n).—FIG. 408.2; 415.6. **S. sieberi* (VON BUCH), L.Dev. (Konjeprus), Czech.; 408,2a-c, transv. secs. at 2.8, 4.0, 7.9 mm. from tip of ped.v. beak, all $\times 2$ (729); 415,6a-c, ped.v., brach.v., ant. views, $\times 1$ (Amsden, n).
- Wyella** KHODALEVICH, 1939, p. 21 [**Eichwaldia uralica* CHERNYSHEV, 1893, p. 179; OD]. Plicate to smooth shells with pitted exterior; pedicle fold and brachial sulcus; brachial plates discrete. *U. Sil. (Ludlov.)*, USSR (Ural Mts.).—FIG. 417.1. **W. uralica* (CHERNYSHEV), Ural Mts.; 1a,b, ped. v. and lat. views, $\times 1$ (466).
- Zdimir** BARRANDE, 1881, p. 171 [**Zdimir solus* BARRANDE, 1881 (= **Porambonites ?robustus* BARRANDE, 1879, p. 97); OD] [= *Conchidiella* KHODALEVICH, 1938, p. 32 (type, *Pentamerus pseudobaschkiricus* CHERNYSHEV, 1885, p. 55)]. Large shells with radial costellae which increase by bifurcation; fold and sulcus generally absent; brachial plates discrete. *M.Dev.*, Eu. (Czech.)-USSR.—FIG. 418.1. **Z. robustus*, Eifel. (Trebootov Ls.), Czech.; 1a-d, brach.v. (exfol.), brach.v., ped.v., lat. view ped.v., all $\times 1$ (115).—FIG. 409.1; 414,3. *Z. pseudobaschkiricus* (CHERNYSHEV), *M.Dev.*, Ural Mts.; 409,1a-c, serial transv. secs., $\times 1$ (466); 414,3, lat. view, slightly reduced (155, 466).

Subfamily CLORINDINAE Rzhonsnitskaya, 1956

[Clorindinae RZHONSNIISKAYA, 1956, p. 49]

Small to medium, biconvex, smooth to costate shells with more or less galeatiform profile. Brachial apparatus well developed, outer plates discrete or uniting to form cruralium; brachial processes bladeliike, ventral edge of processes extending inside of inner plates as small carinae. *Sil.-M.Dev.*

Clorinda BARRANDE, 1879, p. 109 [**C. armata*; OD]. Smooth, pedicle sulcus and brachial fold. Brachial plates discrete. *Sil.-M.Dev.*, N. Am. (Anticosti-Greenl.)-Eu.-Asia (Turkestan).—FIG. 415.3. **C. armata*, L.Dev. (E), Czech.; 3a,b, brach.v. and lat. views, $\times 1$ (53).

Antirhynchonella OEHLERT in FISCHER, 1887, p. 1311 [**Atrypa linguifera* J. DE C. SOWERBY in MURCHISON, 1839, p. 629; OD] [= *Barrandella* HALL & CLARKE, 1894, p. 241 (obj.)]. [In 1955, ICZN (Opinion 374) placed *Antirhynchonella* (type-species *Atrypa linguifera* J. DE C. SOWERBY, 1839) on The Official List of Generic Names; *Antirhynchonella* QUENSTEDT, 1871 (*nom. nud.*) and *Barrandella* HALL & CLARKE, 1894, were added to The Index of Rejected and Invalid Generic Names in Zoology]. Smooth, strongly biconvex; pedicle sulcus and brachial fold; brachial plates unite to form cruralium. *Sil.*, N. Am. (USA-Can.)-Eu. (Norway-G. Brit.)-Asia (Turkestan).—FIG. 408.5; 415.2. **A. linguifera* (SOWERBY), *U. Sil. (Wenlock.)*, Eng.; 408,5a-d, serial transv. secs., $\times 2$ (729); 415,2a-c, lat., brach.v., ant. views, $\times 1$ (729).

Clorindella AMSDEN, 1964, p. 236 [**Barrandella areyi* HALL & CLARKE, 1894, p. 368; OD]. Costate shells with pedicle-valve sulcus and brachial-valve fold; brachial plates uniting to form cruralium (34). *L.Sil.-U.Sil.*, N. Am.—FIG. 406.3; 408.1. **C. areyi* (HALL & CLARKE), *L.Sil.* (Clinton. = U. Llandover.), USA (N.Y.); 406,3a,b, long. and transv. secs., $\times 2$; 408, 1a-c, transv. secs. at 2.5, 3.1, 4.0 mm. from tip of ped.v. beak, all $\times 3$ (Amsden, n).

Clorindina KHODALEVICH, 1939, p. 11 [**C. uralica*; OD]. Costate, pedicle valve deeper than brachial; pedicle sulcus and brachial fold; brachial plates

discrete. *L.Dev.*, USSR.—FIG. 408,7. **C. uralica*, Urals; transv. sec., $\times 2$ (466).

Family ENANTIOSPHENIDAE Torley, 1934

[*Enantiosphenidae* TORLEY, 1934, p. 93]

Specialized forms with brachial processes terminating in loop; supporting plates consisting of inner plates, brachial processes, outer plates; outer plates unite to form median septum. *M.Dev.*

Enantiosphen WHIDBORNE, 1893, p. 97 [**Megan-*

teris? vicaryi DAVIDSON, 1882, p. 20; SD HOLZAPFEL, 1912, p. 123]. Smooth, biconvex, transversely elliptical; spondylium supported on high, median septum; brachial processes extending forward and expanding to form broad plates connected to one another by transverse, subhorizontal plate, this transverse plate supported in center by median septum. *M.Dev.*, Eu.(G.Brit.-Ger.).—FIG. 409,8; 414,9. **E. vicaryi* (DAVIDSON), Ger. (Bilveringen); 409,8, lat. view of brach. process and connecting septal plate, ant. extremity downward, $\times 2$ (from 504); 414,9, brach.v., $\times 1$ (815, 879).

RHYNCHONELLIDA

By D. V. AGER, RICHARD E. GRANT, D. J. McLAREN, and HERTA SCHMIDT

[Imperial College of Science and Technology, London; United States Geological Survey, Washington, D.C.; Geological Survey of Canada, Ottawa; and Senckenbergische Naturforschende Gesellschaft, Frankfurt]

Order RHYNCHONELLIDA Kuhn, 1949

[*nom. correct.* MOORE in MOORE, LALICKER, & FISCHER, 1952, p. 221 (pro order Rhynchonellacea KUHN, 1949, p. 104)]
[Diagnosis prepared by D. V. AGER]

Articulate brachiopods, usually with rostrate shell, functional pedicle developed, delthyrium partially closed by deltidial plates. Mantle canals much branched, with one pair of main trunks in each mantle. Median septum commonly supporting septalium or hinge plates in brachial valve; dental plates usually present; spondylia normally absent. Recent representatives mostly with 2 pairs of metanephridia, lophophore spirolophous, with ventrodorsally directed cones supported by crura. Shell substance normally impunctate, rarely with inner fibrous layer punctate (583). *M.Ord.-Rec.*

Superfamily RHYNCHONELLACEA Gray, 1848

[*nom. transl.* SCHUCHERT, 1896, p. 323 (ex Rhynchonellidae GRAY, 1848, p. 438)] [Materials for this superfamily prepared by D. V. AGER, D. J. McLAREN, and HERTA SCHMIDT as indicated by families]

Shell impunctate, commonly lacking spondylia. *M.Ord.-Rec.*

PALEOZOIC RHYNCHONELLACEA

By HERTA SCHMIDT and
D. J. McLAREN

Separation of Paleozoic from Mesozoic and Tertiary rhynchonellaceans is an arbitrary and artificial arrangement which for

the present may be justified by the fact that the two groups have been studied from different points of view and seldom by the same workers. An additional factor is the scarcity of Lower and Middle Triassic rhynchonelloids. Paleozoic rhynchonellaceans currently are being subjected to a proliferation of genera, and there is no reason to suppose that this has ended. Recognition of the importance of detailed study of internal structures by means of a variety of techniques has resulted in the realization of the great complexity and abundance of forms in the superfamily, and this has not yet been fully exploited taxonomically.

Our present state of knowledge makes classification extremely difficult. Of 134 Paleozoic rhynchonellaceans here recognized (excluding homonyms and synonyms), 87 are definitely placed in 19 families or subfamilies and 47 are classed questionably in these groups or segregated as "Family Uncertain." Some of the family-group taxa are significant assemblages of related genera, whereas others merely represent a convenient, and presumably temporary, pigeonholing of morphologically similar forms. Difficulties in classification may arise from the methods used to examine interiors. Thus, while the study of internal structure by means of serial grinding techniques gives accurate information on interiors, it may nevertheless be difficult to interpret in terms of a shell interior examined in a different manner. Silicified specimens, internal molds, and prepared in-

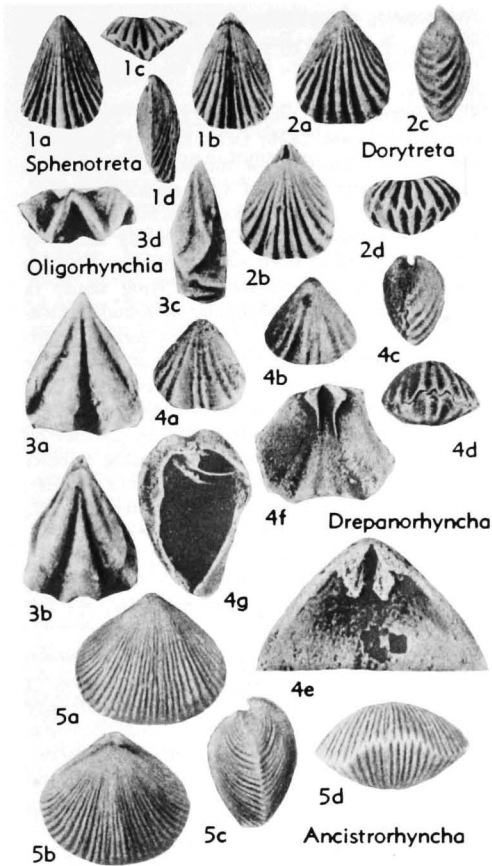


FIG. 419. Ancistrorhynchidae (4-5); Oligorhynchidae (1-3) (p. H553-H554).

teriors differ in appearance and are not always easy to interpret in mutually intelligible terms.

There is still little agreement on the morphological features of most value in defining genera and higher taxa. Different features are stressed by different workers and synonyms will certainly be discovered when some existing genera are more fully known. Nevertheless, ultimate recognition of accurately defined genera holds promise of rigorous stratigraphic refinement. Features of external morphology used in grouping genera into families include: degree and type of ornament, shape of shell, beak and beak ridges, interarea, shape of fold and sulcus, form of commissure, and presence of marginal spines. Muscle impressions appear significant features in the interior of

the pedicle valve and, in the brachial valve, all details of the cardinalia, shape and degree of development of hinge plates, septalium, median septum, and cardinal process are important characters.

In contrast to Mesozoic and Tertiary Rhynchonellacea, the form of the crura as yet has had little influence on classification of Paleozoic genera. In many genera the crura are unknown, although serial grinding often allows accurate observation of extremely delicate features. As far as now known, it seems that morphology of the crura is not as valuable in classification in Paleozoic rhynchonellaceans as in later forms.

Family ANCISTRORHYNCHIDAE Cooper, 1956

[*nom. transl.* H. SCHMIDT, herein (*ex* Ancistrorhynchinae COOPER, 1956, p. 618)] [Materials for this family prepared by HERTA SCHMIDT]

Small interarea in pedicle valve or both valves, ventral sulcus and dorsal fold present, delthyrium open, rounded costae extending from apex to anterior margin; commissure finely denticulate to undulate. Dental plates well developed; hinge plate divided; septa, cardinal process, and septalium wanting. *M.Ord.*

Ancistrorhyncha ULRICH & COOPER, 1942, p. 624 [**A. costata*; OD]. Small; sulcus and fold weakly developed, tongue short; pedicle valve with vestigial interarea and foramen. Costae numerous, fine. Crura long, slender, ending in hooklike expansions that point anterolaterally; socket walls strongly curved medially. *M.Ord.*, N.Am.—FIG. 419,5; 420,1. **A. costata*, USA (Okla.); 419,5a-d, ped.v., brach.v., lat., ant. views, $\times 2$ (189); 420, 1a-e, ser. secs., $\times 5$ (Schmidt, n).

Drepanorhyncha COOPER, 1956, p. 627 [**Porambonites ottawaensis* BILLINGS, 1862; OD]. Small to medium-sized; sulcus and fold well developed;

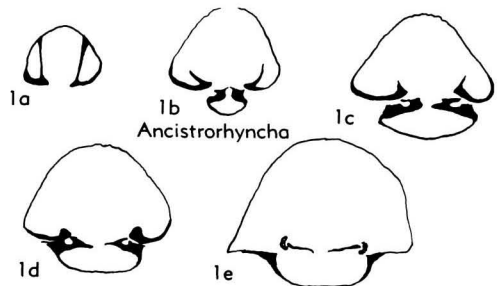


FIG. 420. Ancistrorhynchidae (p. H553).

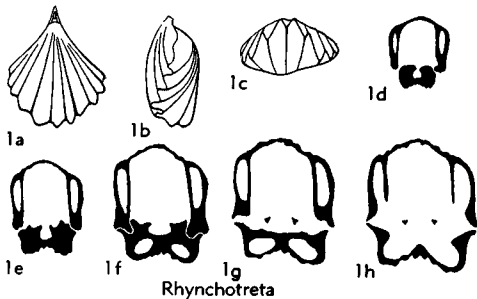


FIG. 421. Oligorhynchiidae (p. H554).

both valves with narrow interareas; costae not very numerous, medium fine. Pedicle valve with large teeth and elongate dental plates spaced closely together, making deep, narrow delthyrial cavity. Hinge plates concave; crural bases enlarged to concave plates; crura slender, very long. *M.Ord.*, N.Am.-Eu.—FIG. 419,4. **D. ottawaensis* (BILLINGS), Can.(Ont.); 4a-d, ped.v.v., brach.v., lat., ant. views, $\times 1$; 4e, brach.v. int., $\times 3$; 4f,g, ped.v. int., long. sec. showing crura, $\times 2$ (189).

Family OLIGORHYNCHIIDAE Cooper, 1956

[Oligorhynchiidae COOPER, 1956, p. 658] [Materials for this family prepared by HERTA SCHMIDT]

Small, triangular shells longer than wide, with erect beak; folding inverted at least in posterior part of shell (fold in pedicle and sulcus in brachial valve). Strongly plicated; teeth and dental plates well developed; hinge plate divided, supported by inner ridge or by plates including notothyrial cavity, or by both; median septum lacking, but inner dorsal swelling or ridge present, corresponding to outer sulcus; cardinal process wanting. *M.Ord.*, ?*Sil.*

Oligorhynchia COOPER, 1935, p. 48 [**O. subplana*; OD]. Pedicle valve with strong median furrow between costae but without sulcus; posterior part of brachial valve with sulcus reverting anteriorly to become fold; few (3 or 4) strong, rounded angular costae. Dental plates strong, divergent. Hinge plate divided, attached to inner swelling produced by outer sulcus of valve, further supported by delicate converging plates; crura long, slender, nearly straight and extending almost directly anteriorly or obliquely toward pedicle valve. *M.Ord.*, N.Am.-Eu.—FIG. 419,3. **O. subplana*, USA(Tenn.); 3a-d, ped.v., brach.v., lat., ant. views, $\times 4$ (189).

Dorytreta COOPER, 1956, p. 666 [**D. bella*; OD]. Externally resembling *Sphenotreta*, but with sulcus of brachial valve reverting to fold anteriorly; foramen with thickened margin. Dental plates short. Crura shorter and stouter than those of

Sphenotreta, abruptly bent toward pedicle valve. *M.Ord.*, N.Am.—FIG. 419,2. **D. bella*, USA (Okla.); 2a-d, ped.v., brach.v., lat., ant. views of holotype, $\times 4$ (189).

?*Rhynchotreta* HALL, 1879, p. 166 [**Terebratula cuneata* DALMAN, 1828; OD]. Acutely triangular, with apical foramen; low median fold in pedicle valve beginning nearly at apex anteriorly becoming reversed to shallow sulcus; brachial valve with narrow depression at umbo, developing anteriorly into fold; sides of both valves in posterior parts abruptly bent, commissure thus lying nearly in plane; costae strong, subangular or rounded. Dental plates nearly parallel (in cross section); umbonal cavities rather narrow; teeth strong. Hinge plate divided, halves resting on thickened shell wall in posterior part of valve; hinge plates separated anteriorly from shell wall by cavities on either side of median ridge corresponding to outer sulcus; crural bases prominent; crura slender, nearly straight, extending almost anteriorly. *Sil.*, Eu.(Scand.-G.Brit.-Czech.)-N.Am.—FIG. 421,1. **R. cuneata* (DALMAN), Gotl.; 1a-c, brach.v., lat., ant. views, $\times 1$; 1d-h, ser. secs. at 0.5, 0.8, 1.4, 1.55, and 1.7 mm. from post. extremity, $\times 4$ (all from 702).

Sphenotreta COOPER, 1956, p. 663 [**S. cuneata*; OD]. Triangular to oval, with strong folding in pedicle valve and deep sulcation in brachial valve extending from posterior to anterior margin; costae numerous, rounded-angular. Dental plates short. Hinge plates small, triangular; crura long and slender, directed obliquely to anterior margin and slightly toward pedicle valve. *M.Ord.*, N.Am.—FIG. 419,1. **S. cuneata*, USA(Tenn.); 1a-d, ped.v., brach.v., ant., lat. views, $\times 4$ (189).

Family RHYNCHOTREMATIDAE Schuchert, 1913

[*nom. correct.* SCHUCHERT & LEVENE, 1929, p. 18, *et transl.* COOPER, 1956, p. 628 (ex Rhynchotrematinae SCHUCHERT, 1913, p. 396)] [Materials for this family prepared by HERTA SCHMIDT]

Sulcus and fold well developed; costae strong, angular to rounded angular, beginning at apex, in most genera simple, crossed by concentric lamellae or striae; commissure denticulate. Hinge plates concave, separated by notothyrial cavity containing septiform cardinal process. *M.Ord.*-*M.Dev.*

Subfamily RHYNCHOTREMATINAE Schuchert, 1913

[*nom. correct.* SCHUCHERT & LEVENE, 1929, p. 18 (pro Rhynchotrematinae SCHUCHERT, 1913, p. 396)] [=Lepidocyliidae COOPER, 1956, p. 657]

Dental plates and umbonal cavities in most genera distinct; notothyrial cavity formed by welding of hinge plates with median septum or ridge or callosity. [The relations of nominal genera assigned to this

subfamily are not yet sufficiently cleared up; some of them may prove to be synonymous.] *M.Ord.-L.Dev.*

Rhynchotrema HALL, 1860, p. 68 [**Atrypa increbescens* HALL, 1847, p. 146; OD]. Small, rostrate, rounded triangular to transversely elliptical in outline; delthyrium narrow, only partially closed by narrow, elongate deltidial plates. Dental plates short; umbonal cavities small; teeth with large fossettes; muscle field triangular, adjustor scar large; dorsal median septum extending to middle of valve; notothyrial cavity small; cardinal process slender to thick. *M.Ord.-U.Ord.*, N.Am.-?Eu. —FIG. 422,3. **R. increbescens* (HALL), *M.Ord.* (Trenton.), USA; 3a, ped.v., $\times 1$; 3b,c, brach.v. and post. views, $\times 2$ (189).

Ferganella NIKIFOROVA, 1937, p. 39 [**F. turkestanica*; OD]. Medium-sized to large, rounded to subpentagonal in outline; ventral beak suberect; deltidial plates obsolete. Teeth stout; dental plates and umbonal cavities present; notothyrial cavity large, oval, supported by thick median septum; cardinal process thin. *Sil.-L.Dev.*, Asia (Fergana)-Eu. (G. Brit.-Baltic). —FIG. 422,4. **F. turkestanica*, Downton., Fergana; 4a-d, ped.v., brach.v., lat., ant. views, $\times 1$; 4e, sec. in articulation zone, $\times 3$ (599).

Hypsipytycha WANG, 1949, p. 17 [**H. hybrida*; OD]. Small, elongate rounded in outline, sulcus and fold strongly pronounced; ventral beak suberect; foramen large; deltidial plates well developed, moderately convex, uniting in mid-line; surface lamellae pronounced. Teeth strong; dental plates high, bounding narrow umbonal cavities; muscle field subcordate, with prominent adjustor scar; median ridge of brachial valve short. *U.Ord.*, N.Am. —FIG. 422,6. **H. hybrida*, USA (Iowa); 6a-d, ped.v., brach.v., lat., ant. views, $\times 2$; 6e, ped.v. int., $\times 2$; 6f, brach.v. int. (beak portion), $\times 4$ (851).

Lepidocyclus WANG, 1949, p. 12 [**L. laddi*; OD]. Medium-sized to large, old specimens globose; both beaks usually curved; delthyrium wide; deltidial plates large, conjunct along median line; surface lamellae strong. Teeth very stout, supported by strong shell thickening that encloses tubular delthyrial cavity; ventral muscle field large, flabelliform, deeply impressed; adjustor scar small; hinge plates strong; crura long, ending in hooklike expansions; dorsal median septum extending approximately to middle of shell. *U.Ord.*, N.Am. —FIG. 422,7. **L. laddi*, Maquoketa Sh., USA (Iowa); 7a-d, ped.v., brach.v., lat., ant. views, $\times 1$; 7e,f, ped.v. int., brach.v. int., $\times 1$ (851). —FIG. 423,3. *L. capax* (CONRAD), Cincinnati, USA (Ohio); 3a-c, transv. secs. 14.2, 13.0, 12.8 mm. from ant. margin, $\times 3$; 3d, transv. sec. 13.2 mm. from ant. margin, $\times 4.5$ (Schmidt, n).

?**Pleurocornu** HAVLÍČEK, 1961, p. 46 [**Rhyn-*

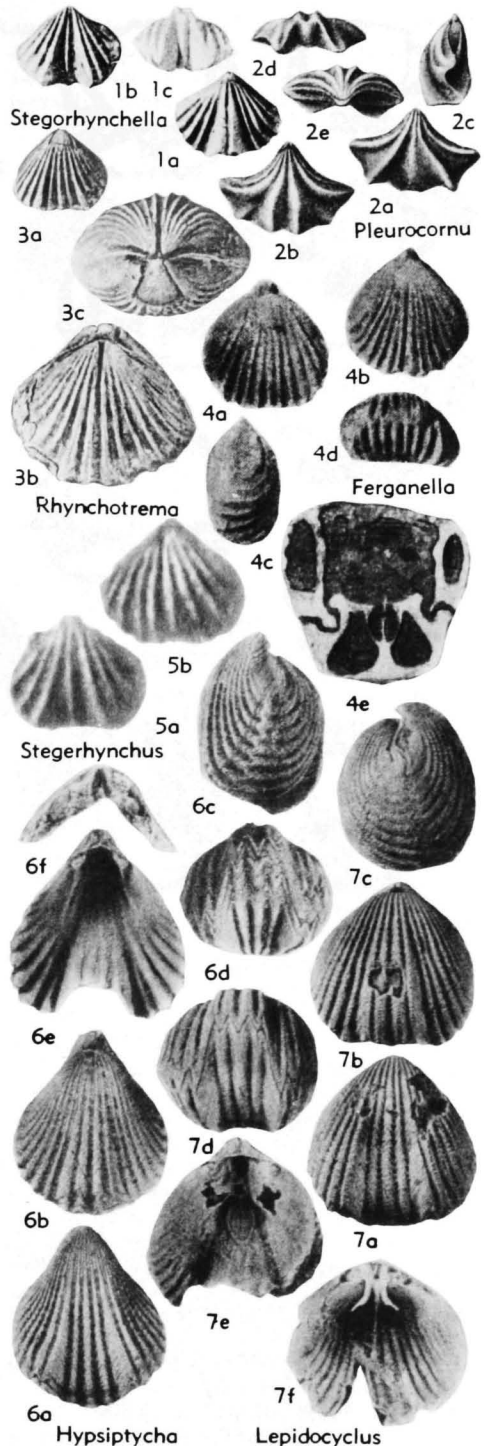


FIG. 422. Rhynchotrematidae (Rhynchotrematinae) (p. H555-H556).

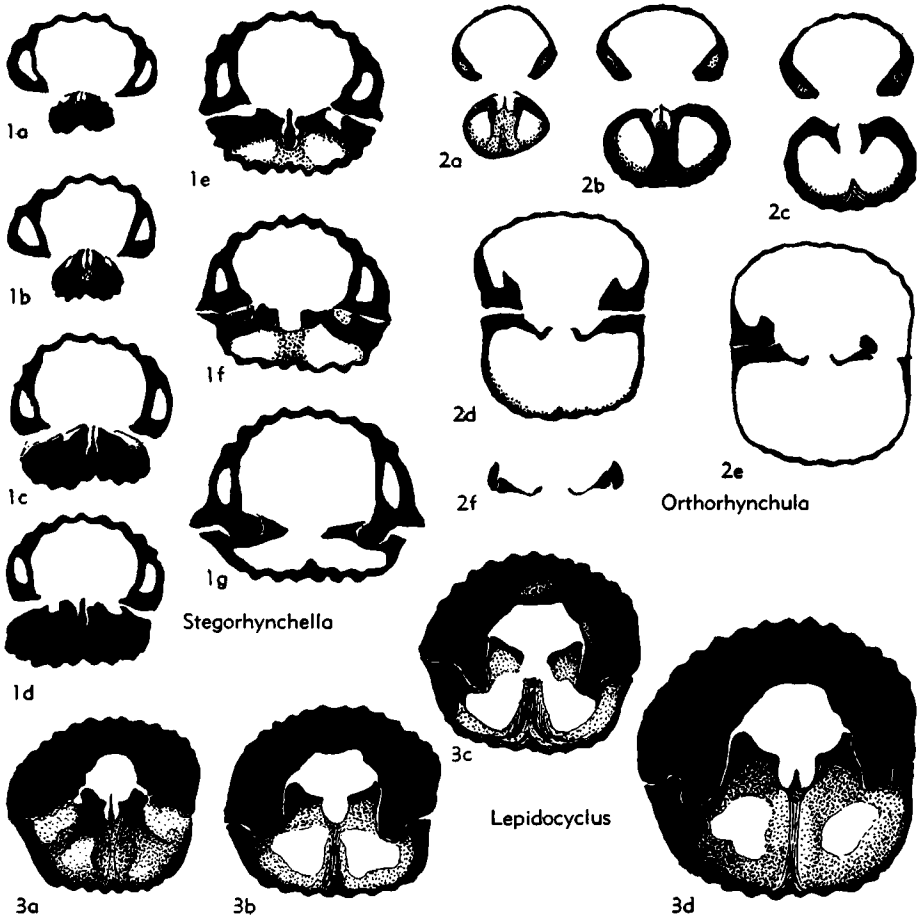


FIG. 423. Rhynchotrematidae (Rhynchotrematinae) (1, 3), Orthorhynchulinae (2) (p. H555-H557).

chonella amissa BARRANDE, 1879; OD]. Medium-sized, rounded trigonal in outline, with narrow, protracted beak; ventral sulcus deep, defined by high costae; dorsal fold scarcely indicated; costae not numerous, strong, becoming very high anteriorly; commissure strongly denticulate. Teeth situated on thickened wall of valve; hinge plate entire, with small median cavity only in its uppermost part; cardinal process thin, septiform; median septum stout. *Sil.*, Eu.(Boh.).—FIG. 422,2; 424,1. **P. amissum* (BARRANDE), Wenlock, Boh. (Lodenice); 422,2a-e, ped.v., brach.v., lat., ant., post. views, $\times 1$ (53); 424,1a-e, ser. secs., $\times 3$ (411a).

Stegerhynchus FOERSTE, 1909, p. 98 [**Rhynchonella* (*St.*) *whitii-praecursor* (= *S. praecursor*); OD]. Small, transversely elliptical in outline. Dental plates and umbonal cavities present. Interior of brachial valve with median longitudinal elevation posteriorly broadening and strengthened by shell thickening, leaving only narrow notothyrial

cavity; cardinal process very narrow. *M.Sil.*, N.Am.—FIG. 422,5. **S. praecursor* (FOERSTE), Clinton, USA (Tenn.); 5a,b, ped.v. and brach.v. views, $\times 2$ (305).

Stegerhynchella RZHONSNITSKAYA, 1959, p. 27 [**Stegerhynchus decuplicatus angaciensis* CHERNYSHEV, 1937, p. 29; OD]. Probably synonymous with *Stegerhynchus*. *U.Sil.*, Asia (Mongol.).—FIG. 422,1; 423,1. **S. decuplicatus angaciensis* (CHERNYSHEV), Tuva; 422,1a-c, ped.v., brach.v., ant. views, $\times 1$ (910); 423,1a-g, transv. secs., 7.45, 7.4, 7.3, 7.2, 7.0, 6.9, 6.8 mm. from ant. margin, $\times 6$ (Schmidt, n).

Subfamily ORTHORHYNCHULINAE Cooper, 1956

[*nom. transl.* SCHMIDT, herein (*ex Orthorhynchulidae* COOPER, 1956, p. 669)]

Dental plates reduced, scarcely visible because of thickened shell wall. Pair of crural plates starting from inner edges of hinge

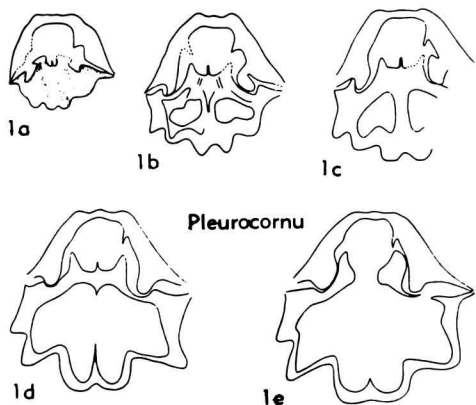


FIG. 424. Rhynchotrematidae (Rhynchotrematinae) (p. H556).

plates and extending dorsally, may be obscured by callosity; dorsal septum present or reduced. *M.Ord.-M.Dev.*

Orthorhynchula HALL & CLARKE, 1893, p. 181 [**Orthis? linneyi* JAMES, 1881; OD]. Medium-sized, broadly elliptical in outline, with short, straight hinge line and interareas in both valves; delthyrium without deltidial plates; costae strong. Teeth blunt; dental plates visible in young specimens, umbonal cavities filled by adventitious testaceous matter in older shells; ventral muscle field short, subquadrate. Hinge plates strongly concave; crura very long; crural plates in older specimens united by callosity imbedding dorsal septum. *M.Ord.*, N.Am.—FIG. 423,2; 425, 3. **O. linneyi* (JAMES), USA (Ky.); 423,2a-f, transv. secs. 13.2, 13.0, 12.8, 12.5, 12.3, 12.0 mm. from ant. margin, $\times 3.75$ (Schmidt, n); 425,3a,b, lat., post. views, $\times 1$; 3c, brach.v. int. (tilted), $\times 2$ (189).

Callipleura COOPER, 1942 [**Rhynchospira nobilis* HALL, 1860, p. 83; OD] [= *Cyclorhina* HALL & CLARKE, 1893, p. 206 (non PETERS, 1871)]. Medium-sized to large, broadly elliptical to pentagonal in outline; hinge line straight, short, laterally with winglike expansions; interareas in both valves; ventral beak truncated by large, round foramen; delthyrium very broad, only partially covered by small deltidial plates; costae crossed by fine concentric striae, crests of costae formed by row of knots, each knot corresponding to several striae. Teeth broad, attached to wall of valve and supported by thick converging dental plates forming pedicle cavity; crural plates resting on shell wall; cardinal process very delicate, conjoint with median ridge, both commonly imbedded in shell substance; crura ending in spoon-shaped processes. *M.Dev.* (Hamilton.), N.Am.—FIG. 425,4. **C. nobilis* (HALL), USA (N.Y.); 4a, brach.v. view, $\times 1$; 4b, ped.v. int., $\times 1$ (914).

Latonotoechia HAVLÍČEK, 1960, p. 244 [**Terebratula latona* BARRANDE, 1847; OD]. Medium-sized to large, sulcus and fold commonly asymmetrical; foramen hypothrydid, anteriorly bound-

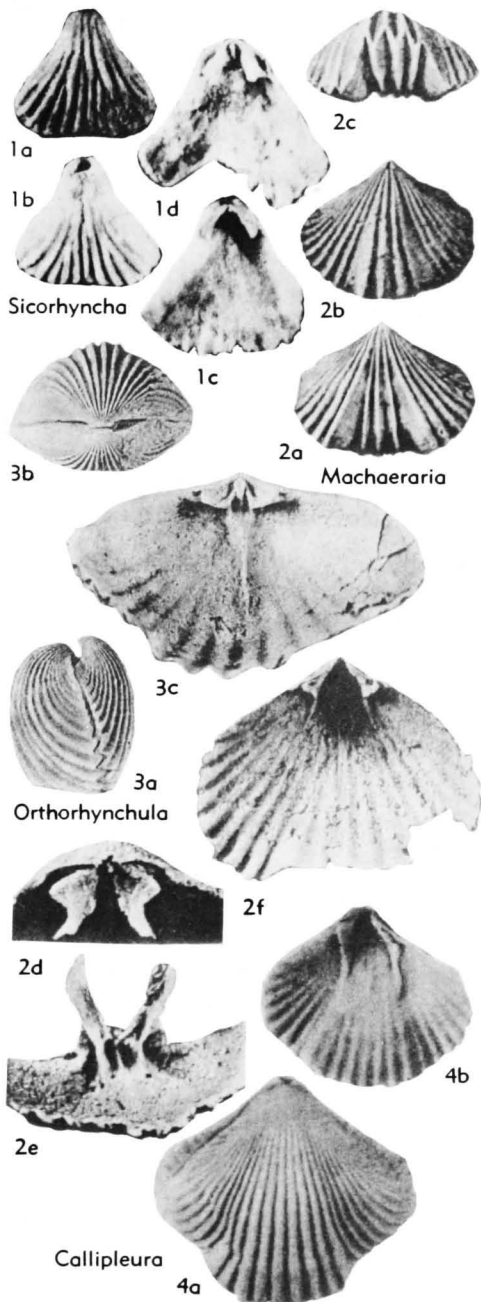
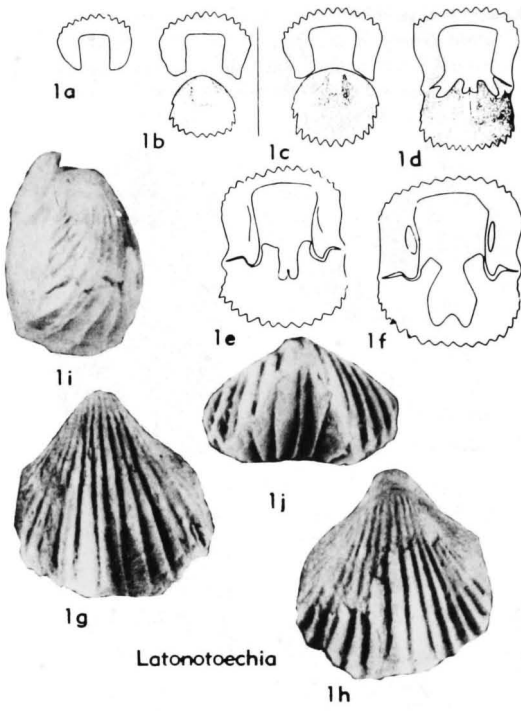


FIG. 425. Rhynchotrematidae (Orthorhynchulinae) (p. H557-H558).



Latonotoechia

FIG. 426. Rhynchotrematidae (Orthorhynchulinae) (p. H558).

ed by conjunct deltidial plates; dental plates scarcely discernible because of thickened shell wall. Hinge plates resting on callosity which fills out posterior part of valve, leaving free notothyrial cavity; crural plates not discernible. *L.Dev.*, Eu. (Boh.).—FIG. 426,1. **L. latona* (BARRANDE), Koněprusy; 1a-f, ser. secs. at 17.7, 17.0, 16.3, 16.0, 15.3, and 14.8 mm. from ant. margin, $\times 2$; 1g-j, ped.v., brach.v., lat., ant. views, $\times 1$ (411a).

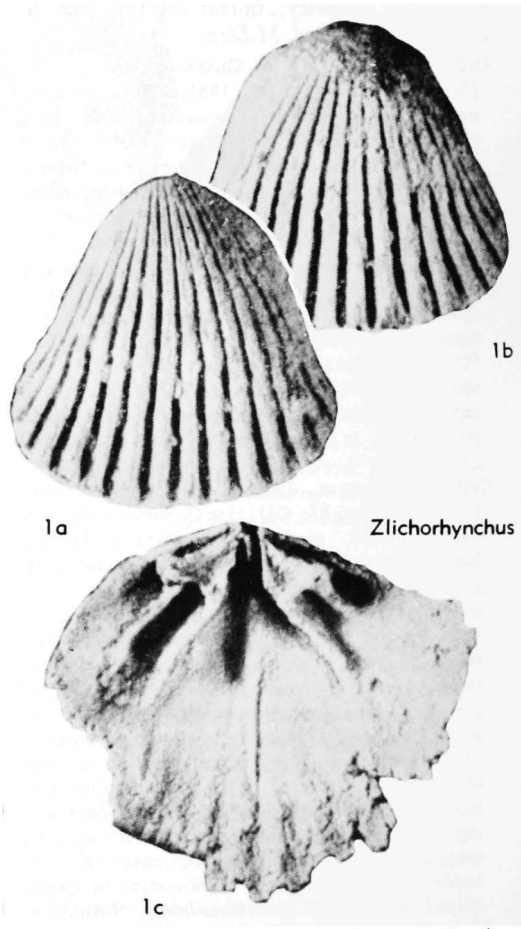
Machaeraria COOPER, 1955, p. 55 [**Rhynchonella formosa* HALL, 1857, p. 76; OD]. Medium-sized; delthyrium partially closed by disjunct deltidial plates; foramen small. Teeth slender, with small fossettes; dental plates short, thin, bounding narrow umbonal cavities; diductor scars elongate-flabellate; adductor scars small, elongate-oval. Socket ridges terminating in small teeth which articulate with fossettes of pedicle valve; crura curved, crescentic in section, with free ends bluntly pointed; crural plates meeting floor of valve to form narrow notothyrial cavity; cardinal process consisting of long, thin shaft and narrow crinkled myophore. *L.Dev.*(*Helderberg.*), N.Am. —FIG. 425,2. **M. formosa* (HALL), USA (N.Y.); 2a-c, ped.v., brach.v., ant. views, $\times 1$; 2d, brach.v. int. (post. portion), $\times 4$; 2e, brach.v. int. (tilted), $\times 4$; 2f, ped.v. int., $\times 3$ (185).

Orthorhynchuloides WILLIAMS, 1962, p. 240

[**Hemithyris nasuta* M'COY, 1852, p. 203; OD]. Like *Orthorhynchula* but with costae dying out anteriorly and without massive callosity medianly between convergent crural plates. *M.Ord.*, Eu. (Scot.). [WILLIAMS.]

Sicorhyncha HAVLÍČEK, 1961, p. 28 [**Stegerhynchus trinacrius* HAVLÍČEK, 1956, p. 571; OD]. Small to medium-sized, trigonal to pentagonal in outline; ventral sulcus normally developed; dorsal fold may be absent; foramen pernesothyridd to epithyridd, scarcely touching top of delthyrium; deltidial plates conjunct in their upper parts; costae high, angular, some of them bifurcating. Interior resembling that of *Latonotoechia*. *L.Dev.*, Eu. (Boh.-Fr.).—FIG. 425,1. **S. trinacria trinacria* (HAVLÍČEK), Boh. (Hlubocepy); 1a,b, ped.v., brach.v. views, $\times 2.5$; 1c,d, ped.v. int., brach.v. int., $\times 2.5$, $\times 2.8$ (411a).

Zlichorhynchus HAVLÍČEK, 1963, p. 403 [**Z. hiatus*; OD]. Medium-sized; greatest width toward front; no fold or sulcus; anterior commissure uni-



Zlichorhynchus

FIG. 427. Rhynchotrematidae (Orthorhynchulinae) (p. H558-H559).

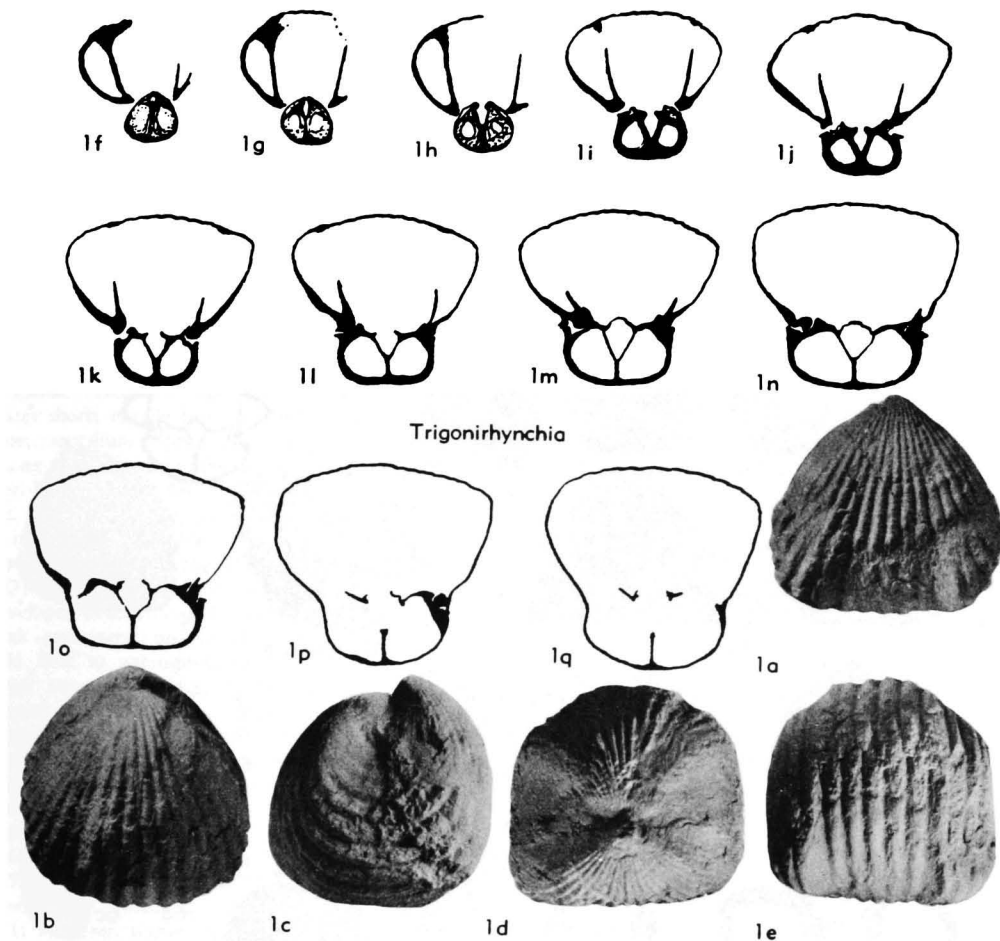


FIG. 428. Trigonirhynchiidae (p. H559).

plicate in adults; delthyrium large; deltidial plates minute; strong, rounded costae over whole shell. Dental plates thin and short; hinge plates triangular, concave, divided; small lamellar cardinal process; inner edges of hinge plates supported by crural plates that diverge anteriorly. *L.Dev.*, Eu. (Czech.).—FIG. 427, 1. **Z. hiatus*; 1a, b, ped.v., brach.v. views, $\times 4$; 1c, brach.v., int., $\times 4$ (413a). [McLAREN.]

Family TRIGONIRHYNCHIIDAE McLaren, n. fam.

[Materials for this family prepared by D. J. McLAREN except as indicated otherwise]

Small to medium-sized; costae strong, simple, angular or subangular, extending from beak, rarely bifurcate; uniplicate, commissure serrate; fold and sulcus commonly developed. Dental plates present; median septum supporting well-formed septalium

that may be open or wholly or partly covered by plate uniting outer hinge plates; no cardinal process. *M.Ord.-L.Carb.*(Miss.).

Trigonirhynchia COOPER, 1942, p. 228 [**Uncinulina fallaciosa* BAYLE, 1878; OD] [= *Uncinulina* BAYLE, 1878 (non TERQUEM, 1862)]. [non *Trigonirhynchia* DAGIS, 1961, p. 94]. Medium-sized to large; rounded-triangular in outline; pedicle valve much less vaulted than brachial valve; front and flanks usually steeply sloping or truncated; sulcus and fold moderately deep but well defined; costae strong, generally simple, angulated, beginning in beaks; commissure denticulate. Dental plates convergent dorsally; brachial valve with large septalium covered in its anterior part by convex or flat plate. *L.Dev.-M.Dev.*, Eu.—FIG. 428, 1. **T. fallaciosa* (BAYLE), *L.Dev.*, Fr. (Néhou); 1a-e, ped.v., brach.v., lat., post., ant. views, $\times 1.2$; 1f-q, ser. transv. secs., $\times 2.8$ (931d). [SCHMIDT.]

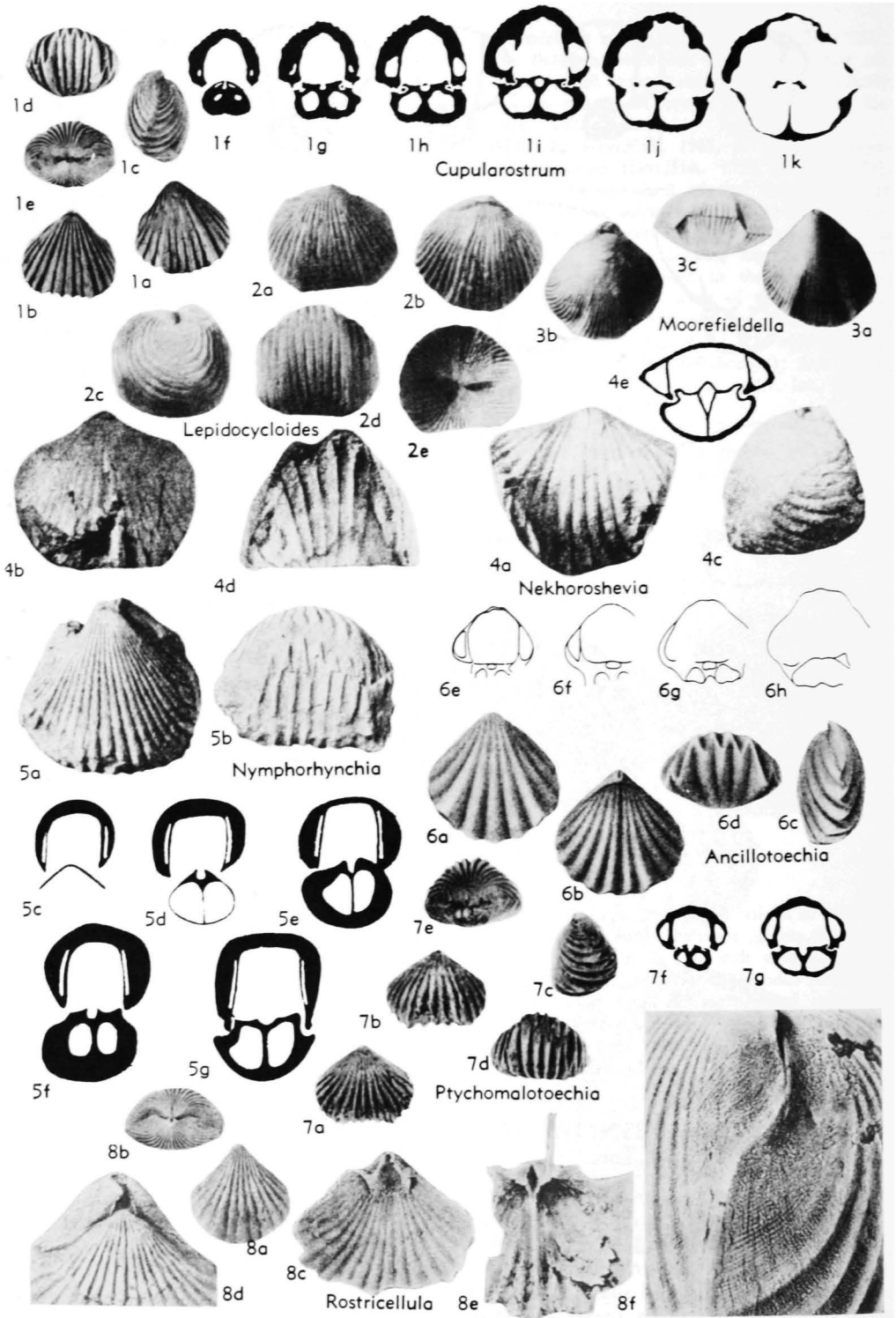


FIG. 429. Trigonirhynchiidae (p. H561-H562).

Ancillotoechia HAVLÍČEK, 1959, p. 78 [**Rhynchonella ancillans* BARRANDE, 1879; OD]. Similar to *Cupularostrum* but narrower, with smaller apical angle; fold high anteriorly. Septalium broad, entirely covered, supported by median ridge or strong septum, posteriorly broader than septalial cavity. *M.Sil.-U.Sil.*, Eu.—FIG. 429,6. **A. ancillans* (BARRANDE), U.Sil., Boh.; 6a-d, ped.v., brach.v., lat., ant. views, $\times 2$ (53); 6e-h, ser. transv. secs. 7.55, 7.50, 7.45, 7.40 mm. from ant. margin, $\times 5$ (411a).

Bathyrhyncha FUCHS, 1923, p. 854 [**B. sinuosa*; OD]. Medium-sized to large, inflated; pedicle beak incurved; sulcus extending from beak, trough-shaped; costae rounded, with narrow interspaces. Interior imperfectly known; dental plates short; muscle field deeply impressed, elongate; septalium apparently uncovered, septum strong, may extend to mid-length. *L.Dev.(Gedin.)*, Ger.-Belg.—FIG. 430,3. **B. sinuosa*; 3a, ped.v. int. mold, $\times 1$ (212b); 3b-d, lat., post., ant. views of int. molds, $\times 2$ (907a).

Cupularostrum SARTENAER, 1961 [**C. recticostatum*; OD]. Small to medium-sized; fold and sulcus developed anteriorly only, sulcus shallow; pedicle beak prominent; pedicle valve inflated; crest of fold falls to anterior margins; shell thick. Interior structures strong; dental plates short; U-shaped septalium, open posteriorly, covered with strong, arched, plate anteriorly, with median longitudinal ridge on ventral surface; cover persisting forward of articulation; septum stout, persists up to half shell length. [This genus includes many species formerly assigned to *Camaro-toechia*.] *M.Dev.*, N.Am.(N.Y.-Yukon).—FIG. 429,1. **C. recticostatum*, M.Dev., USA (N.Y.); 1a-e, ped.v., brach.v., lat., ant., post. views, $\times 1$; 1f-k, ser. transv. secs. at 1.3, 1.7, 2.0, 2.2, 2.4, 2.7 mm. from apex, $\times 3$ (930c).

Hemiplethorhynchus VON PEETZ, 1898, p. 178 [**H. fallax*; OD] [= *Greenockia* BROWN, 1952, p. 91]. Medium-sized, subpentagonal in outline, uniplicate; pedicle valve flattened, with sulcus developed from mid-length; beak small, incurved; brachial valve convex; fold well marked; costate, with abundant subangular costae. Dental plates small; hinge plates united anteriorly, divided posteriorly, forming triangular opening into septalium at apex. *L.Carb.*, USSR(Altay)-Can.(Alta.).—FIG. 430,1a-d. **H. fallax*, Tournais., Altay; 1a-c, ped.v., lat., ant. views, $\times 1$; 1d, brach.v. int., $\times 1$ (711a).—FIG. 430,1e-g. *H. snaringensis* (BROWN), L.Miss.(Banff), Can.(Alta.) [Type-species of *Greenockia*]; 1e, ped.v., young spec., $\times 1$; 1f, brach.v., $\times 1$; 1g, post. view, int. mold, $\times 1$ (907b).

?**Lepidocyclus** NIKIFOROVA, 1961, p. 212 [**L. baikiticus*; OD]. Similar to *Lepidocyclus* but without deltidial plates. Internally with weak dental plates, strongly impressed muscle impressions and deep pedicle cavity; stout divided hinge

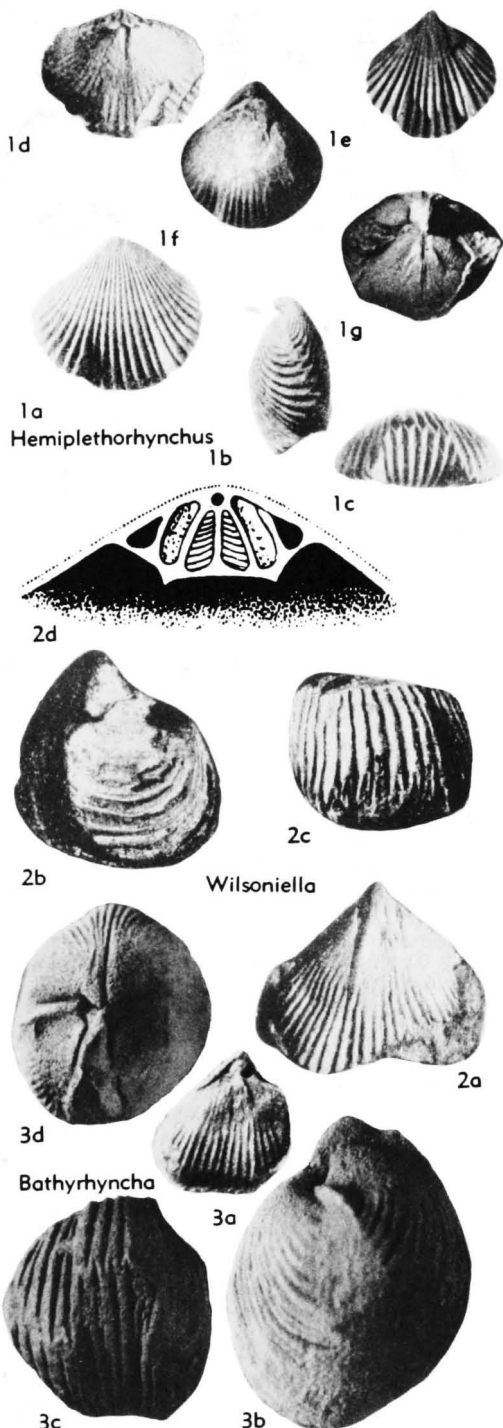


FIG. 430. Trigonirhynchiidae (p. H561-H562).

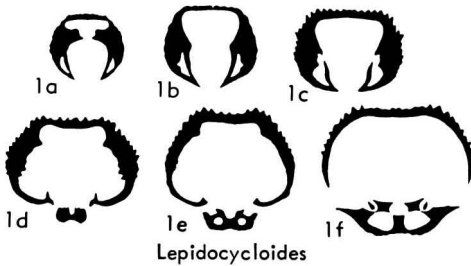


FIG. 431. Trigonirhynchiidae (p. H561-H562).

plates; open septalium; without cardinal process. *U.Ord.*, USSR (Sib.).—FIG. 429,2; 431,1. **L. baikiticus*; 429,2a-e, ped.v., brach.v., lat., ant., post. views, $\times 1$; 431,1a-f, ser. transv. secs. 14.1, 13.8, 13.5, 12.8, 12.1, 11.6 mm. from ant. margin, $\times 1.5$ (602).

Moorefieldella GIRTY, 1911, p. 62 [**Rhynchonella Eurekensis* WALCOTT, 1884, p. 223; OD]. Small to medium-sized, ovate to subpentagonal, equi-valve, uniplicate; low fold and sulcus developed anteriorly only; beak prominent, subrect; interarea wide; costellate, with even, rounded costellae; commissure smooth. Dental plates present; divided hinge plate; high septum. *U. Miss. (Meramec.)*, USA (Ark.-Okla.-Nev.).—FIG. 429,3. **M. eurekensis* (WALCOTT); 3a-c, ped.v., brach.v., ant. views, $\times 1$ (346a).

?**Nekhoroshevia** BUBLICHENKO, 1956 [**N. altaica*; OD]. High, cuboidal; septalium deep, entirely covered with convex plate and supported by high, slender median septum. *U. Dev. (Frasn.)*, USSR (Rudny Altay).—FIG. 429,4. **N. altaica*; 4a-d, ped.v., brach.v., lat., ant. views, $\times 1$; 4e, transv. sec. near apex, $\times 2$ (690).

Nymphorhynchia RZHONSNIISKAYA, 1956, p. 53 [**N. bischoffoides*; OD]. Subtrigonal to subpentagonal; strongly marked, concave interareas; delthyrium open; fold and sulcus broad, poorly developed; costae strong, asymmetrical, flattened near front, with longitudinal grooves; no marginal spines; fine, closely set transverse notches on costae over entire shell. Dental plates close to lateral margins of shell; hinge plate massive; septalium open. *M. Dev. (Eifel.)*, Eu. (Boh.)-USSR (Kuznetsk).—FIG. 429,5. **N. bischoffoides*, Kuznetsk; 5a,b, brach.v., ant. views, $\times 1.5$ (690); 5c-g, ser. transv. secs., $\times 3$ (689a).

Ptychomalotochia SARTENAER, 1961, p. 7 [**Rhynchonella Omaliusi* GOSSELET, 1877; OD]. Similar to *Cupularostrum*, but with deeper, wider sulcus. Crural bases stronger; hinge plates more developed anteriorly; septalium uncovered. *U. Dev. (Famenn.)*, Eu.-N.Am.-Asia.—FIG. 429,7. **P. omaliusi* (GOSSELET), W.Eu.; 7a-e, ped.v., brach.v., lat., ant., post. views, $\times 1$; 7f,g, ser. transv. secs. at 0.85, 1.15 mm. from apex, $\times 3$ (930c).

?**Rostricellula** ULRICH & COOPER, 1942, p. 625 [**R. rostrata*; OD]. Subtriangular to subpentagonal, deltidial plates rudimentary; interarea narrow. Strong dental plates; teeth small, curved; septalium short; septum strong, extending to middle of valve or beyond; crura long, slender. *M. Ord.-U. Ord.*, ?*Sil.*, N.Am.-Eu.-Asia.—FIG. 429,8. **R. rostrata*, M. Ord., N.Am.; 8a,b, ped.v., post. views, $\times 1$; 8c, ped.v. int., tilted, $\times 2$; 8d,e, ped.v. beak, brach.v. int., $\times 4$; 8f, lat. view showing fine ornament, $\times 6$ (188).

Sinotectirostrum SARTENAER, 1961a, p. 3 [**S. medicinale*; OD]. Similar to *Cupularostrum* but larger; fold and sulcus develop earlier; pedicle valve less inflated. Dental plates more persistent; septalium deep and narrow, covered anteriorly but weakly; covering commonly not preserved. *U. Dev. (Famenn.)*, W.Can.—FIG. 432,1. **S. medicinale*; 1a,b, lat., post. views, $\times 1$; 1c-f, ser. transv. secs. at 2.0, 2.25, 3.0, 4.0 mm. from apex, $\times 3$ (709a).

Wilsoniella KHALFIN, 1939, p. 83 [**W. prima*; OD] [= *Ussovia* KHALFIN, 1955, p. 239 (obj.)] [non *Wilsonella* NIKIFOROVA, 1937]. Large, subcuboidal, with inflated brachial valve; fold and sulcus developed only anteriorly; coarse, rounded costae with narrow interspaces. Dental plates rudimentary, teeth large; septalium opening into small foramen posteriorly; anteriorly, hinge plates united by double, ventrally ridged, triangular plate. ?*U. Dev.*, USSR (Altay).—FIG. 430,2. **W. prima*; 2a-c, ped.v., lat., ant. views, $\times 1$; 2d, brach.v. int., enlarged (690).

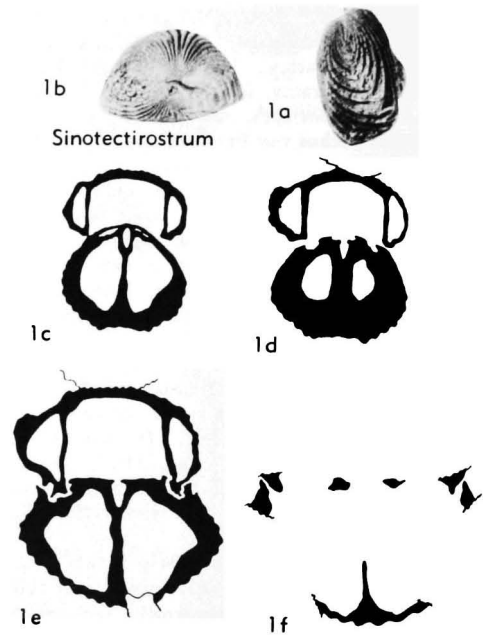


FIG. 432. Trigonirhynchiidae (p. H562).

Family UNCINULIDAE Rzhonsnitskaya,
1956

[Uncinulidae RZHONSNITSKAYA, 1956, p. 125] [Materials for this family prepared by HERTA SCHMIDT except as indicated otherwise]

Shells occurring in two different shapes representing different growth stages: (1) high forms (most common), cubic to globose, with front and sides truncated by rectangular bending of valves, commissure commonly situated on truncated parts; (2) flat forms (rare), with valves meeting at acute angle. Sulcus and fold present or absent, tongue nearly always present; ventral beak curved to erect; foramen minute or wanting; costae in most species numerous, rounded or flattened, separated by linear furrows, each furrow of high forms projecting beyond margin of valve as slender spine which extends under costa of opposite valve (Fig. 433), but rarely spines are wanting; costae in truncated parts of shell much flattened and longitudinally grooved, crossed by undulating or zigzag-shaped transverse lines. Dental plates well developed, may be welded to wall of valve or umbonal cavities may be filled out by callus in older specimens; dorsal septum present; septalium in more primitive forms well developed and free, in more progressive forms partially or completely filled out or obsolescent. *Sil.-U.Dev.*, ?*Perm.*

Subfamily UNCINULINAE Rzhonsnitskaya,
1956

[*nom. transl.* SCHMIDT, herein (*ex* Uncinulidae RZHONSNITSKAYA, 1956, p. 125)]

Cardinal process strongly developed, broad and low or narrower and projecting, with its basal part filling out posterior portion or whole cavity of septalium; myophore consisting of numerous vertical ridges; hinge plates conjunct also anteriorly from cardinal process. *L.Dev.-U.Dev.*, ?*Perm.*

Uncinulus BAYLE, 1878, pl. 13, fig. 15 expl. [**Hemithiris subwilsoni* D'ORBIGNY, 1850, p. 92; SD OEHLERT, 1884, p. 423]. Roundish to pentagonal in outline; both valves convex; sulcus and fold moderately or weakly developed, in few species wanting; tongue usually well marked, but rarely absent; commissure even, appearing denticulate only if worn. Ventral muscle field divided by delicate septum or ridge; prominent oval diductors enclosing small round adductors; dorsal median septum rather high; septalium reduced, completely filled out; cardinal process broad, low, covering large part of hinge plate. *L.Dev.-U.Dev.*,

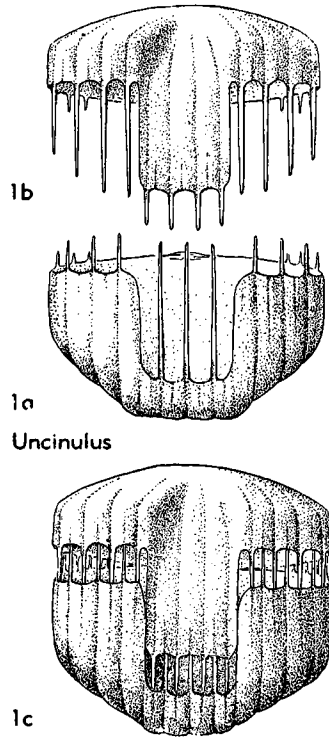


FIG. 433. Uncinulid marginal spines (schematic); 1a-c, brach.v., ped.v., both valves connected, slightly opened (931a) (p. H563).

cosmop.—FIG. 434,6; 435,3. **U. subwilsoni* (D'ORBIGNY), *L.Dev.*, Fr.; 434,6a-e, ped.v., brach.v., lat., ant. views, ped.v. int. mold, $\times 1$; 6f, brach.v. int., enl. (927); 435,3a-l, ser. secs., 13.1, 13.0, 12.8, 12.6, 12.3, 11.8, 11.7, 11.6, 11.5, 11.2, 10.2, 8.5 mm. from ant. margin, $\times 3$ (Schmidt, n). ?*Fitzroyella* VEEVERS, 1959, p. 104 [**F. primula*; OD]. Small, subpentagonal in outline, rather flat, valves almost equally convex; hinge line short, in larger specimens nearly straight; beak suberect, with apical foramen; anterior and anterolateral parts of valves bent over perpendicularly; sulcus and fold developed, tongue short; rounded angular costae beginning at apex, increasing by intercalation and branching; commissure strongly denticulate. Dental plates strong but short, converging dorsally; brachial valve with short median ridge and rudimentary septalium; cardinal process not ascertained. *M.Dev.-U.Dev.*, Eu.-Australia.—FIG. 434,2. **F. primula*, U.Dev.(Frasn.), W.Australia (Fitzroy Basin); 2a-d, ped.v., brach.v., ant., lat. views, $\times 3$; 2e-k, ser. secs. 0.65, 0.80, 0.90, 0.95, 1.05, 1.15 mm. from apex, $\times 7$ (211). **Glossinulus** SCHMIDT, 1942, p. 394 [**Rhynchonella adolphi mimica* BARRANDE, 1879, p. 178=*Glossinulus mimicus* (BARRANDE, 1879, p. 178); OD].

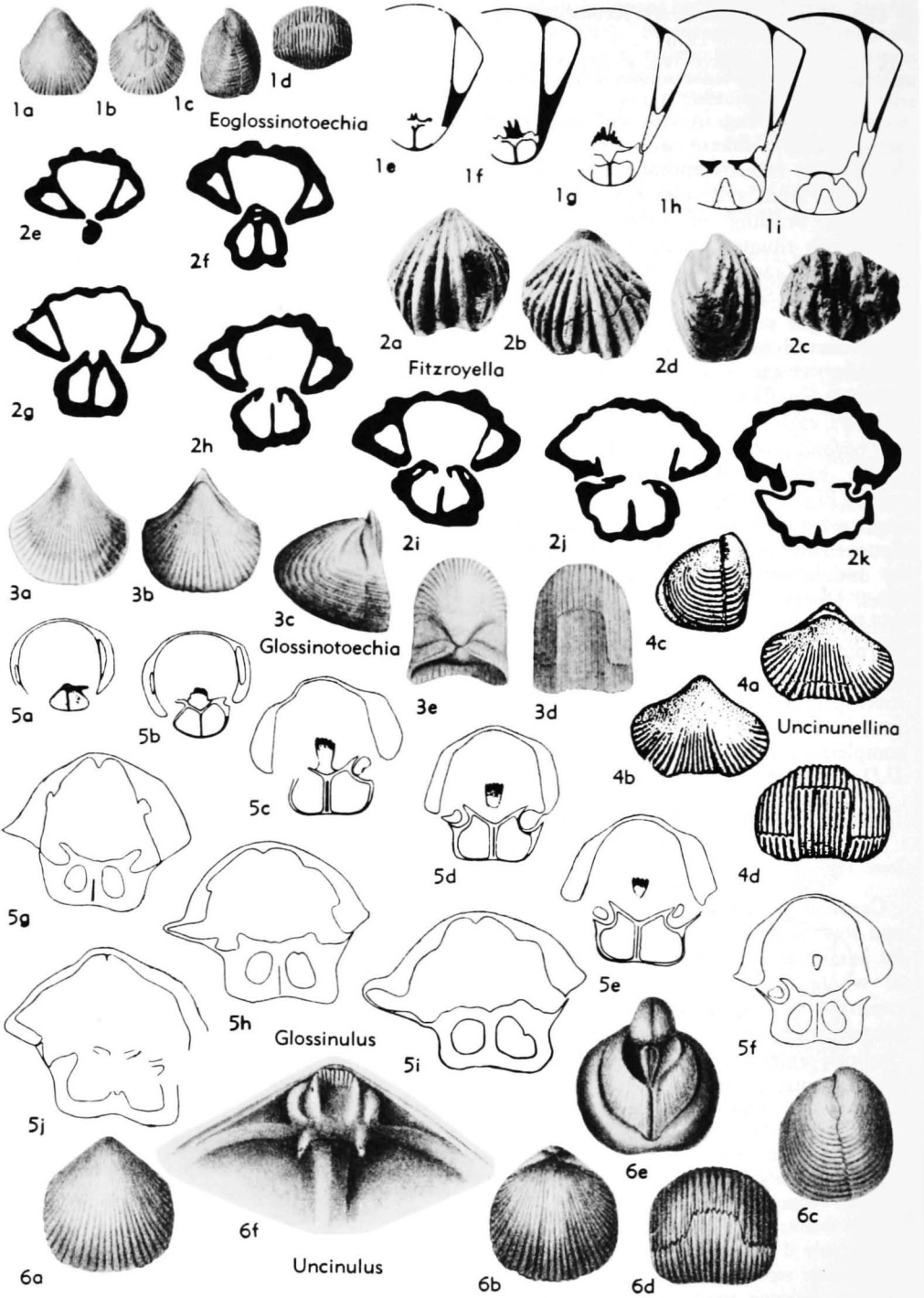


FIG. 434. Uncinulidae (Uncinulinac) (p. H563, H565-H566).

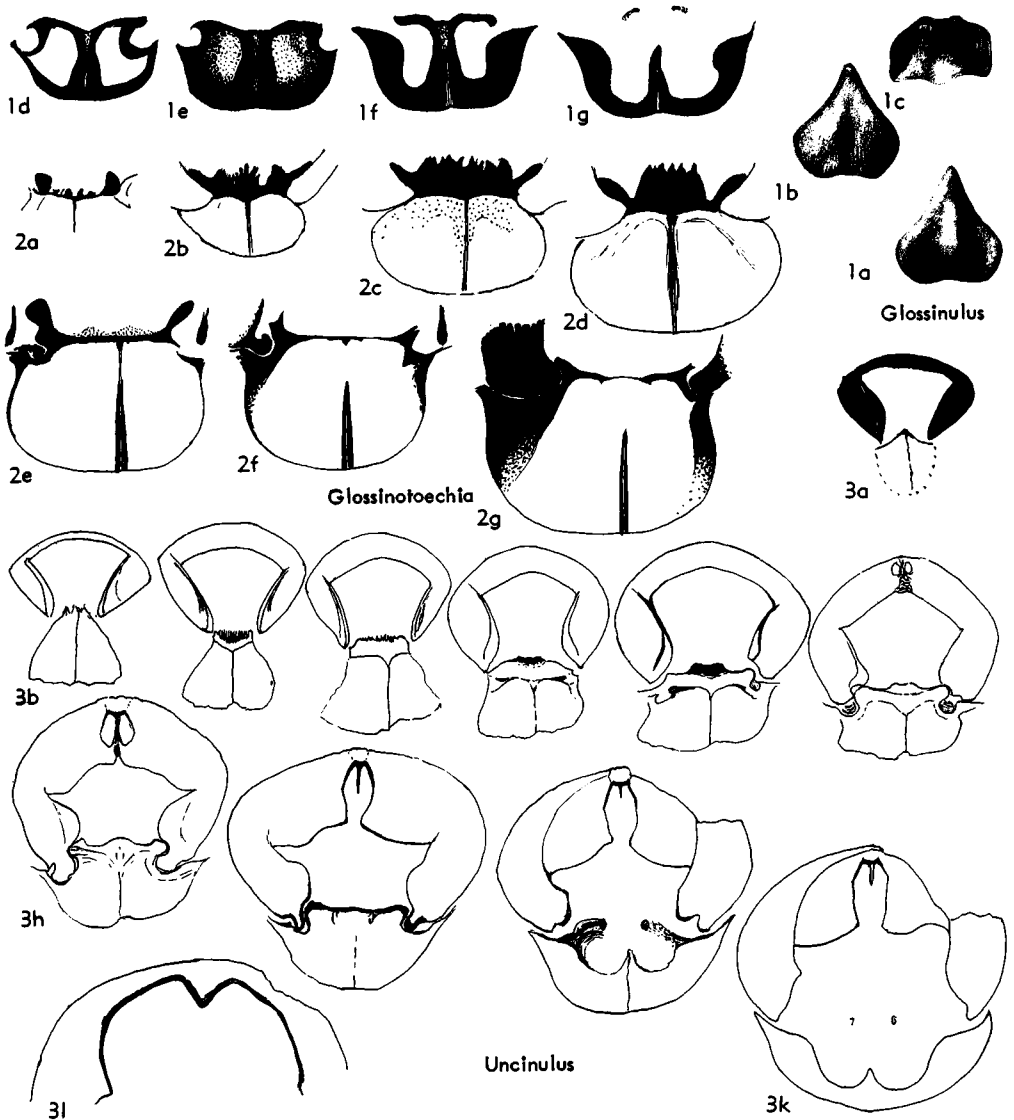


FIG. 435. Uncinulidae (Uncinulinae) (p. H563, H565).

Triangular to acute-oval in outline; pedicle valve flat to concave; beak nearly erect; tongue rectangular; zigzag lines on truncated parts of valves strongly pronounced. Umbonal cavities small; septalium reduced, completely filled; inner socket ridges prominent; cardinal process strongly developed. *L.Dev.-M.Dev.*

G. (Glossinulus). Cardinal process very long, tongue-shaped. *L.Dev.-M.Dev.*, Eu.—FIG. 434, 5; 435, 1. ***G. (G.) mimicus** (BARRANDE), *L.Dev.* (U.Ems.), Ger. (Eifel.); 435, 1a-c, ped. v., brach. v., ant. view, $\times 1$; 435, 1d-g, ser. sec. of brach. v. ant. from cardinal process, 9.1, 8.9, 8.7, 8.1 mm.

from ant. margin, $\times 7$ (Schmidt, n); 434, 5a-j, ser. showing cardinal process, 6.4 mm. from ant. margin, $\times 4$ (411a).

G. (Glossinotoechia) HAVLÍČEK, 1959, p. 81 [**Terebratula henrici* BARRANDE, 1847, p. 440; OD]. Cardinal process broader and shorter than in *Glossinulus*. *L.Dev.-M.Dev.*, Eu.-Afr.—FIG. 434, 3; 435, 2. ***G. (G.) henrici** (BARRANDE), Boh. (Koněprusy); 434, 3a-e, ped. v., brach. v., lat. v., ant. view, $\times 1$ (53); 435, 2a-g, ser. sec. of brach. v., 13.3, 13.0, 12.5, 12.0, 11.5, 11.3, 11.1 mm. from ant. margin, $\times 6$ (Schmidt, n).

Eoglossinotoechia HAVLÍČEK, 1959, p. 81 [*E

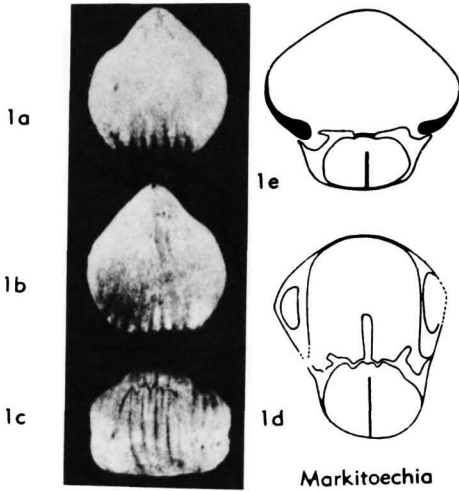


FIG. 436. Uncinulidae (Uncinulinae) p. H566).

cacuminata; OD]. Resembling *Glossinotoechia*, but with pedicle valve more convex. Septalium small, its posterior part filled out by moderately large cardinal process; anterior part of septalial cavity free. *Sil.-L.Dev.*, Boh.—FIG. 434,1. **E. cacuminata* HAVLIČEK, *Sil.*, Dvorce; 1a-d, ped.v., brach.v., lat., ant., views, $\times 1$ (53); 1e-i, ser. secs. 9.8, 9.6, 9.5, 9.35, 9.3 mm. from ant. margin, $\times 6$ (411a).

Markitoechia HAVLIČEK, 1959, p. 81 [**Uncinulus* (*Uncinulus*) *marki* HAVLIČEK, 1956, p. 568; OD]. Exterior like *Uncinulus*, but with long, tongue-shaped cardinal process like that of *G.* (*Glossinulus*). *M.Dev.*, Eu.(Boh.)—FIG. 436,1. **M. marki* (HAVLIČEK), Hlubočepy; 1a,b, ped.v., brach.v., 1c, ant. view, $\times 2.4$; 1d,e, secs. with cardinal process and anterior from cardinal process, $\times 7$ (411a).

Plethorhyncha HALL & CLARKE, 1893, p. 191 [**Rhynchonella speciosa* HALL, 1856, p. 81; SD SCHUCHERT & LEVENE, 1929, p. 99]. Large, longitudinally ovoid in outline; high forms higher than wide, with front and sides much flattened; sulcus and fold poorly developed or wanting; both beaks curved; cardinal margin of pedicle valve with considerable auriculate projections fitting into indentures of brachial valve margin; costae on truncated parts of shell with distinct longitudinal grooves and transverse zigzag lines; marginal spines present. Dorsal median septum well developed, in adult forms thickened; hinge plates in young specimens separated by small septalium, in old forms much thickened and coalesced, enclosing septalium. *L.Dev.*, N.Am.—FIG. 437,1; 438,1. **P. speciosa* (HALL), Oriskany, USA (Md.); 437,1a-d, lat., ant., post. views, brach.v. int. (young shell), $\times 1$ (396); 438,1, post. view (int. mold), $\times 1.5$ (931c).

?**Uncinunellina** GRABAU, 1932, p. 72 [**Uncinulus theobaldi* WAAGEN, 1884, p. 425; OD]. Broad, resembling *Uncinulus*. Interior insufficiently known. *Perm.*, Asia-Eu.(USSR).—FIG. 434,4. **U. theobaldi* (WAAGEN), India; 4a-d, ped.v., brach.v., lat., ant. views, $\times 1$ (845).

Subfamily HEBETOECIINAЕ Havlíček, 1960

[*nom. transl.* SCHMIDT, herein (ex Hebetoechiidae HAVLIČEK, 1960, p. 243)]

Primitive uncinulids, with high and flat forms developed as growth dimorphism; septalium pronounced, its cavity free or partially filled out by callus covering walls of septalium and, in some genera, projecting beyond hinge plates, forming incipient cardinal process. *Sil.-M.Dev.*

Hebetoechia HAVLIČEK, 1959, p. 79 [**Terebratula hebe* BARRANDE, 1847, p. 442; OD]. Sides and front of shell flattened, with longitudinally grooved costae; marginal spines present. Septalium filled out in its posterior part, with fill project-

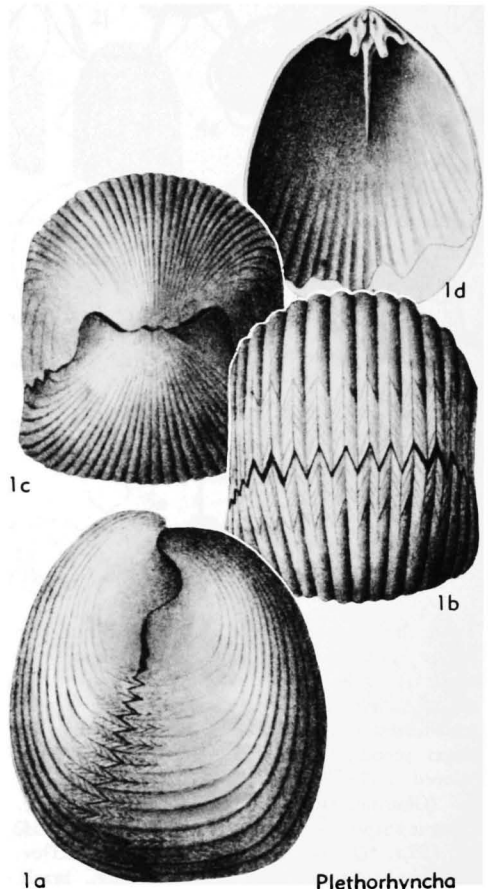


FIG. 437. Uncinulidae (Uncinulinae) (p. H566).

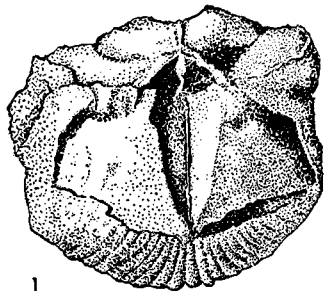
ing above hinge plate as bilobate process; anterior part of septalium free. *U.Sil.* (Ludlow)-*L.Dev.*, Eu. (Boh.).—FIG. 439, 1. **H. hebe* (BARRANDE), *Sil.*, Boh. (Dlouhá Hora); 1*a-d*, ped.v., brach.v., lat., ant. views, $\times 1$ (53); 1*e-h*, ser. secs. 9.9, 9.7, 9.5, 9.4 mm. from ant. margin, $\times 3$ (411a).

?*Cassidirostrum* McLAREN, 1961, p. 2 [**C. pedderi*; OD]. Medium-sized, gibbous, rounded to subpentagonal in outline; pedicle valve moderately vaulted, brachial valve inflated; beak erect to strongly incurved, defined by ridges; sulcus and fold inconspicuous; tongue moderately large, with rounded anterior margin; costae beginning at apex, angular, commonly simple; commissure denticulate. Dental plates convergent dorsally; umbonal cavities narrow; hinge plates not persisting throughout zone of articulation; septalium stretching farther forward than hinge plates, supported by strong median septum; septalial cavity filled out by callus extending over crural bases, forming bipartite process. *M.Dev.* (*L.Givet.*), Can. (NW.Terr.).—FIG. 439, 2; 440, 1. **C. pedderi*, Can. (Anderson River); 439, 2*a-e*, ped.v., brach.v., lat., ant., post. views, $\times 1$; 440, 1*a-d*, ser. secs. 2.8, 3.0, 3.3, 3.6 mm. from apex, $\times 2$ (548a).

Estonirhynchia SCHMIDT, 1954, p. 236 [**Sphaerirhynchia* (*E.*) *estonica*; OD]. Almost perfectly globose; longitudinal furrows on costae and marginal spines wanting. Dental plates well developed, diverging dorsally, extending into zone of articulation; brachial interior like that of *Sphaerirhynchia*. *Sil.*, Eu. (Balt.)-?N.Am.—FIG. 441, 1. **E. estonica* (SCHMIDT), Est. (Oesel); 1*a-e*, ped.v., brach.v., ant., lat., post. views, $\times 2$; 1*f*, g, ser. in articulation zone of different specimens, $\times 4$ (731b).

Lanceomyonia HAVLIČEK, 1960, p. 243 [**Terebratula tarda* BARRANDE, 1847, p. 441; OD]. Resembling *Sphaerirhynchia* in shape; costae restricted to anterior halves of valves, broad, low, longitudinally grooved; marginal spines present. Ventral muscle field rather narrow, defined by ridge; dental plates distinct; septalium not covered; cardinal process wanting. *U.Sil.*, Eu. (Boh.).—FIG. 439, 3. **L. tarda* (BARRANDE), Boh. (Dvorce); 3*a,b*, brach.v., ant. view, $\times 1$ (53); 3*c-e*, ser. secs., 20.7, 20.0, 19.8 mm. from ant. margin, $\times 2$ (411a).

?*Obturamentella* AMSDEN, 1958, p. 99 [**Wilsonia wadei* DUNBAR, 1919, p. 52; OD]. Small with roundish to pentagonal outline; length, width, and breadth nearly equal; both valves gently convex and sharply deflected along margins; sulcus and fold shallow, narrow, restricted to anterior portion of shell; costae low and broad, rounded, beginning near apex; interspaces between costae narrow. Ventral muscle field deeply impressed; diductor scars elongate, enclosing small but deep adductor scars; muscle field



1
Plethorhyncha

FIG. 438. Uncinulidae (Uncinulinae) (p. H566).

divided in its whole length by low median septum; dental plates rudimentary; teeth scarcely defined from shell wall. Dorsal median septum low; septalium filled with shell material forming cardinal process of variable shape, either concave or flush with edges of septalium or projecting beyond hinge plate. *L.Dev.*, N.Am. (Tenn.-Okla.-Mo.).—FIG. 439, 7. **O. wadei* (DUNBAR); 7*a-c*, ped.v., brach.v., lat. view, $\times 2$; 7*d,e*, ped.v. int., $\times 3$, $\times 2$; 7*f,g*, different secs., $\times 18$ (33).

?*Pectorhyncha* McLEARN, 1918, p. 137 [**Atrypa obtusiplicata* HALL, 1852, p. 279; OD]. Small to medium-sized, gibbous to spheroidal; sulcus and fold weakly developed; costae beginning near apex, rounded, separated by narrow interspaces and crossed by concentric striae; median groove on anterior part of costae and marginal spines wanting. Dental plates at least partly cemented to shell wall; teeth longitudinally grooved, resting on shell wall; septalium not covered; dorsal median septum long, thickened posteriorly. *Sil.*, N.Am. (N.Y.).—FIG. 439, 4. **P. obtusiplicata* (HALL), Niagaran, Lockport; 4*a-c*, ped.v., brach.v., brach.v. int. views, $\times 1.5$ (379).

Sphaerirhynchia COOPER & MUIR-WOOD, 1951, p. 195 [*pro Wilsonella* NIKIFOROVA, 1937, p. 35 (non CARTER, 1885)] [**Terebratula wilsoni* SOWERBY, 1818, p. 38]. Globose-cubic, front and sides flattened; costae with longitudinal grooves in flattened parts of shell; marginal spines present. Dental plates reduced, restricted to apical parts of valve; hinge plates separated; septalium not covered; cardinal process wanting. *Sil.*, Eu.-?N.Am.—FIG. 439, 5; 442, 3. **S. wilsoni* (SOWERBY), Wenlock., Eng. (Dudley); 439, 5*a-d*, brach.v., lat., ant. views, ped.v., int., $\times 1$ (229); 442, 3, transv. sec. in articulation zone, $\times 5$ (Schmidt, n).

Tadschikia NIKIFOROVA, 1937, p. 35 [**Wilsonella* (*T.*) *wilsoniaformis*; OD]. Resembling *Sphaerirhynchia* in shape; costae on front and sides longitudinally grooved. Dental plates strong, subparallel; pedicle collar present in some shells; hinge plates united; septalial cavity reduced, filled out in its upper part by callus extending also over hinge plate and forming low process. *U.Sil.*, Asia

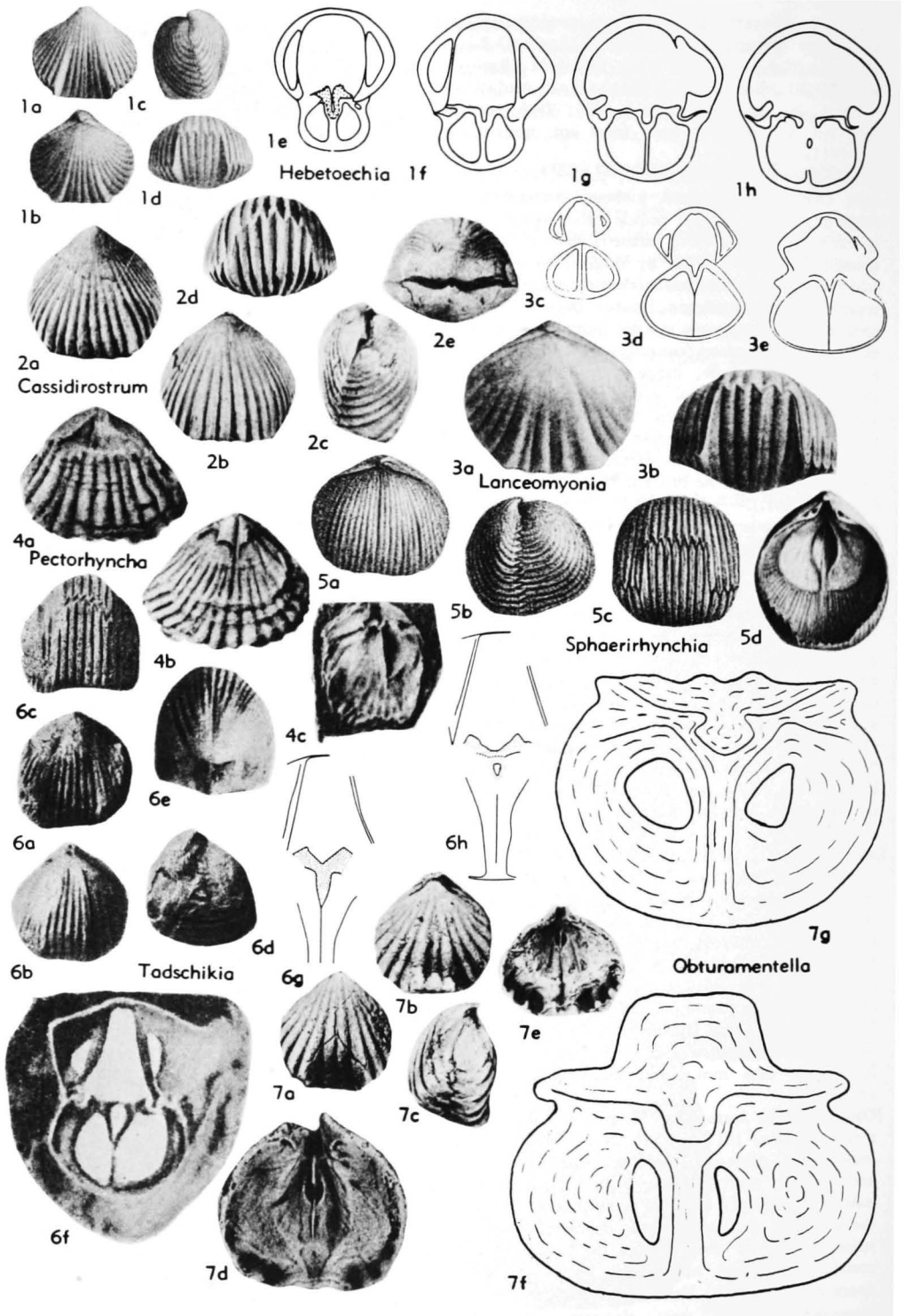


FIG. 439. Uncinulidae (Hebetochiinae) (p. H566-H567, H569).

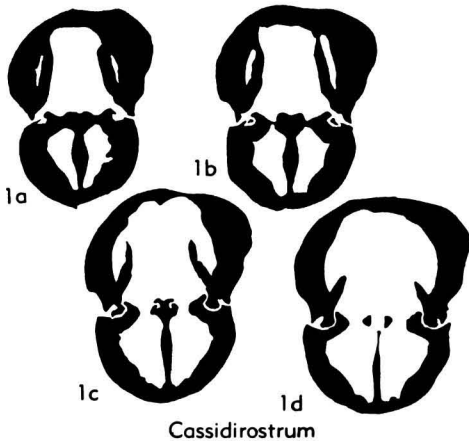


FIG. 440. Uncinulidae (Hebetocheiinae) (p. H567).

(Turkestan).—FIG. 439.6. **T. wilsoniaformis* (NIKIFOROVA); 6a-e, ped.v., brach.v., ant., lat., post. views, $\times 1$; 6f, sec. within articulation zone, $\times 2$ (all from 599); 6g, h, sections through septalium, $\times 2$ (411a).

Subfamily HYPOTHYRIDININAE Rzhonsnitskaya, 1956

[Hypothyridininae RZHONSNITSKAYA, 1956, p. 125]

Dorsal septum and septalium rudimentary or wanting; cardinal process and myophore resembling that of *Uncinulus*. *Sil.-U.Dev.*

Hypothyridina BUCKMAN, 1906, p. 323 [*pro Hypothyris* PHILLIPS, 1841, p. 55 (=KING, 1846, p. 28) (*non* HÜBNER, 1821)] [*Atrypa cuboides* SOWERBY, 1840, pl. 56, fig. 24; OD KING]. Medium-sized to large, high, cuboidal; sulcus and fold generally well defined, but low; tongue broad; costae numerous, low, rounded; commissure situated on angles of truncated front and sides or very near to angles. Dental plates distinct; dorsal median septum and septalium scarcely discernible; interior edges of hinge plates curved dorsally; hinge plates united by cardinal process. *M.Dev.-U.Dev.*, cosmop.—FIG. 443.2. **H. cuboides* (SOWERBY), probably *U.Dev.*, Eng. (Plymouth); 2a, b, ant. view, brach.v., $\times 1$ (932). —FIG. 442.1. *H. sp. cf. H. impleta* (SOWERBY), *U.Dev.*, Ger. (Langenaubach); 1a, b, transv. secs. of different young specimens, $\times 7$ (Schmidt, n). —FIG. 442.2. *H. procuboides* (KAYSER), *M.Dev.*, Ger. (Eifel); 2a-d, transv. ser. secs. 16.9, 16.7, 16.5, 16.4 mm. from ant. edge, $\times 5$ (Schmidt, n).

Decoropugnax HAVLÍČEK, 1960, p. 244 [*Terebratulata berenice* BARRANDE, 1847, p. 77; OD]. Small to medium-sized, rather flat, rounded trigonal to pentagonal in outline; sulcus and fold broad and shallow, tongue low, rectangular; costae numerous, fine, restricted to anterior halves of valves. Dental plates short, divergent; septalium

and cardinal process not observed. *U.Sil.*, Eu. (Boh.-Ural)-Asia (Fergana).—FIG. 443.1. **D. berenice* (BARRANDE), Boh. (Dlouhá Hora); 1a-d, ped.v., brach.v., lat., ant. views, $\times 1$ (53); 1e, f, ser. secs., $\times 6$ (411a).

Lorangerella CRICKMAY, 1963, p. 10 [*L. phaulomorpha*; OD]. Small-sized, subglobose; beak incurved, interarea not developed; fold and sulcus developed anteriorly; tongue vertical to recurved, broad, rounded; smooth posteriorly; rounded to subangular costae develop anteriorly, with narrow interspaces, grooved internally at margin. Dental plates slender, very short; hinge plates plane, inclined inwards; cardinal process supported, close to apex, by stout median ridge; crura cylindrical, hooked. *U.Dev.* (*L. Frasn.*), Can. (Alta.).—FIG. 444.1. **L. phaulomorpha*; 1a-d, ped.v., brach.v., ant., post. views, $\times 2.3$ (915b); 1e-l, ser. transv. secs. at 0.2, 0.6, 0.8, 0.9, 1.0, 1.2, 1.6, 1.9 mm. from apex, $\times 5$ (McLaren, n). [MCLAREN.]

Subfamily HADRRORHYNCHIINAE McLaren, n. subfam.

[Materials for this subfamily prepared by D. J. McLAREN]

Coarsely costate. Septalium very small, filled anteriorly; hinge plates wide, plane; no cardinal process; crura with small outside, lateral projections. *M.Dev.* (*Givet.*).

Hadrorhynchia McLAREN, 1961, p. 3 [*Pugnoides sandersoni* WARREN, 1944, p. 115; OD]. Medium-sized to large, subpentagonal to transversely elliptical; coarsely costate anteriorly, with rounded costae, umbones smooth, costae and interspaces grooved on interior of shell near commissure.

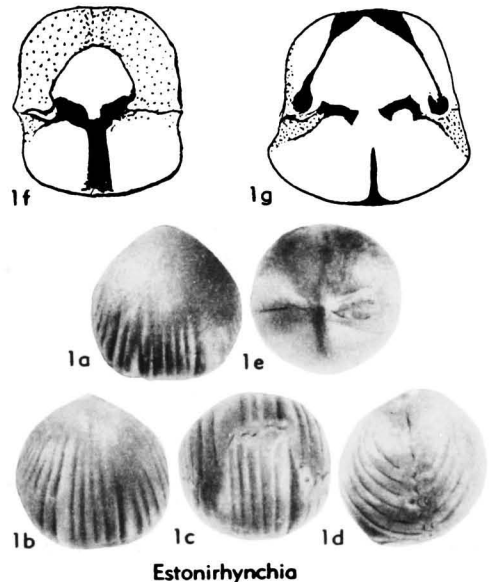


FIG. 441. Uncinulidae (Hebetocheiinae) (p. H567).

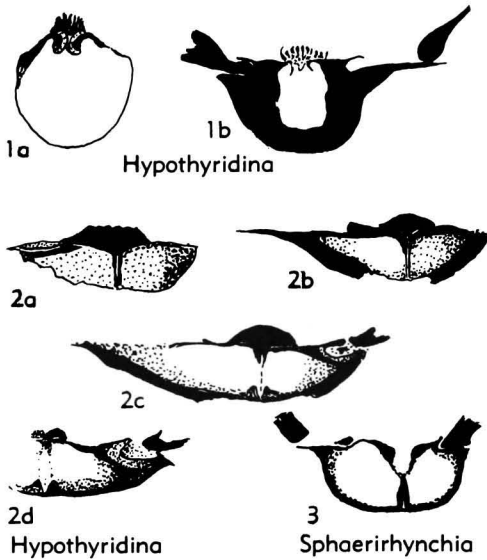


FIG. 442. Uncinulidae (Hebetocheiinae) (3), (Hypothyridininae) (1-2) (p. H567, H569).

Dental plates widely spaced; hinge plates plane, divided by small septalium posteriorly, united anteriorly by 2 broad longitudinal ridges divided by median groove; septum long and slender. *M. Dev.*, W.Can.(Mackenzie Distr.-B.C.)-USA(Nev.)-USSR (Nov. Zemlya-NE.Sib.).—FIG. 445, 1. **H. sandersoni* (WARREN), Givet., W.Can.(Mackenzie Distr.); 1a-c, brach.v., lat., ant. views, $\times 1$; 1d, lat. view, detail, $\times 3$; 1e-i, ser. transv. secs. at 1.8, 2.05, 2.2, 2.65, 3.9 mm. from apex, $\times 3$ (548a).

Family EATONIIDAE, Schmidt, n.fam.

[Materials for this family prepared by HERTA SCHMIDT]

Pedicle valve slightly convex, flanks tending to bend angularly toward opposite valve, beak slightly incurved, tongue marked; brachial valve moderately convex; costae beginning at apex, generally crossed by fine concentric striae. Dental plates cemented to shell wall (at least in old specimens); ventral muscle field well defined, in some genera deeply impressed and divided by small septum; hinge plates united by prominent cardinal process and welded with dorsal septum or ridge; cardinal process bilobate in most genera (at least in young shells) but may appear quadrilobate by dividing of each lobe, or may have trilobate form or may consist of simple process possibly developed by coalescing of bilobate form. *Sil.-L.Dev.*

Eatonia HALL, 1857, p. 90 [**Atrypa medialis* VANUXEM, 1852, p. 120; SD HALL & CLARKE, 1893, p. 205] [non *Eatonia* SMITH, 1875; nec CAMBRIDGE, 1898; nec MEUNIER, 1905] [= *Pareatonia* McLEARN, 1918, p. 137 (obj.)]. Small to large, rounded in outline; deltidial plates large; ventral beak with ridges; lateral marginal parts of pedicle valve abruptly bending dorsally and partly covered by brachial valve; costae broad, most of them simple, but in addition fine costellae or radial striae and fine concentric striae may be present; commissure undulate to denticulate. Teeth small; ventral muscle field pentagonal, deeply impressed and bounded by prominent ridge; posterior parts of adductors enclosed in chambers on either side of small septum which continues posteriorly and anteriorly as low ridge dividing whole muscle field; cardinal process consisting of stout stem and 2 strong lobes with their elongate ends (myophores) excavated, stretching far into pedicle valve; crura stout at their bases, rounded in cross section, narrow and flattened distally, with tips expanded into transverse plates. *L.Dev.*, N.Am.—FIG. 446, 1; 447, 3a-c. **E. medialis* (VANUXEM), L.Helderberg, USA(Md.) (446, 1), USA(N.Y.) (447, 3a-c); 446, 1, ped.v. int., $\times 1.3$ (Schmidt, n); 447, 3a-c, ped.v., brach.v., lat. views, $\times 1$ (396).—FIG. 447, 3d. *E. sinuata* HALL, L.Helderberg., USA(N.Y.); cardinal process and crural bases from below, $\times 2$ (396).

Clarkeia KOZŁOWSKI, 1923, p. 26 [**Terebratulata antisensis* D'ORBIGNY, 1847, p. 36; OD]. Medium-sized, rounded in outline, moderately convex; sulcus and fold distinct; ventral beak slightly incurved, with apical foramen; delthyrium wide, completely filled out by dorsal beak; costae strong, beginning at apex, those of fold bifurcating. Teeth thick; dental plates cemented to shell wall with

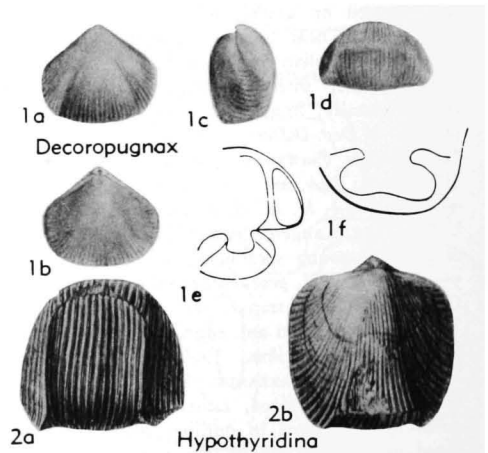


FIG. 443. Uncinulidae (Hypothyridininae) (p. H569).

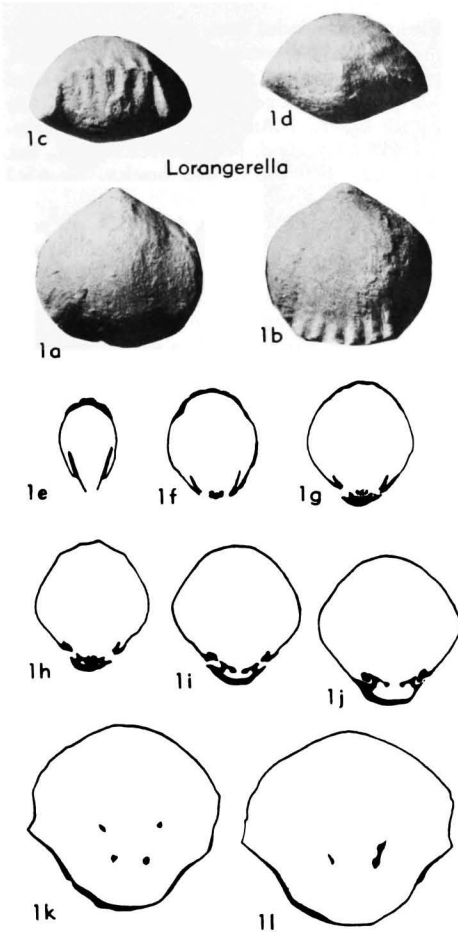


FIG. 444. Uncinulidae (Hypothyridininae) (p. H569).

anterior margins free; ventral muscle field flabelliform, deeply impressed, bounded by ridge starting from dental plates; adductor scars very small, surrounded by large diductor scars; cardinal margin of brachial valve much thickened in older specimens; muscular impressions marked, bounded by ridges; cardinal process prominent, bilobate in young shells, each lobe being divided into 2 secondary lobes, but in older shells becoming trilobate by coalescence of median secondary lobes; dorsal septum thick, extending approximately 0.7 of length of valve; crura very strong at bases. *Sil.*, S.Am.(Bol.-Arg.).—FIG. 447, 5. **C. anti-siensis* (D'ORBIGNY), Bol.; 5a,b, ped.v., brach.v. views, $\times 1$; 5c-e, interiors of brach. valves of different ages, $\times 2$; 5f, ped.v. int., $\times 2$ (922).

Costellirostra COOPER, 1942, p. 231 [**Atrypa peculiaris* CONRAD, 1841, p. 56; OD]. Rounded to triangular in outline; posterolateral parts of pedicle valve abruptly bent dorsally and covered by

brachial valve, as in *Eatonia*; costellae numerous, bifurcating; coarser costae may be indicated in marginal region; commissure denticulate, denticles being coarser and less numerous than costellae; lateral commissure in type-species shifted near edge of shell into plane of pedicle valve; frontal commissure shifted dorsally so that it crosses fold. Interior resembling that of *Eatonia*, but lobes of cardinal process more divergent anteriorly and myophores more compressed laterally. *L.Dev.*, N. Am.—FIG. 447, 2. **C. peculiaris* (CONRAD), USA(N.Y.); 2a,b, brach.v., ant. views, $\times 1$; 2c, ped.v. int. mold, $\times 1$ (396); 2d, brach.v. int. showing cardinal process, crura, and muscular impressions, $\times 1$ (384).

?**Eatonioides** McLEARN, 1918, p. 45 [**E. lamellornatus*; OD]. Exterior resembling *Eatonia*, but with concentric lamellae; radiating striae absent. Dorsal septum present; septalium not filled out; cardinal process wanting. *Sil.*, N.Am.—FIG. 447, 1. **E. lamellornatus*, Arisaig, N.Scotia; 1a-d, ped.v., brach.v., lat., ant. views, $\times 1$ (550).

Eucharitina SCHMIDT, 1955, p. 121 [**Terebratulina eucharis* BARRANDE, 1847, p. 424; OD]. Medium-sized to large, oval in outline; pedicle valve flat to concave, with large tongue strongly curved

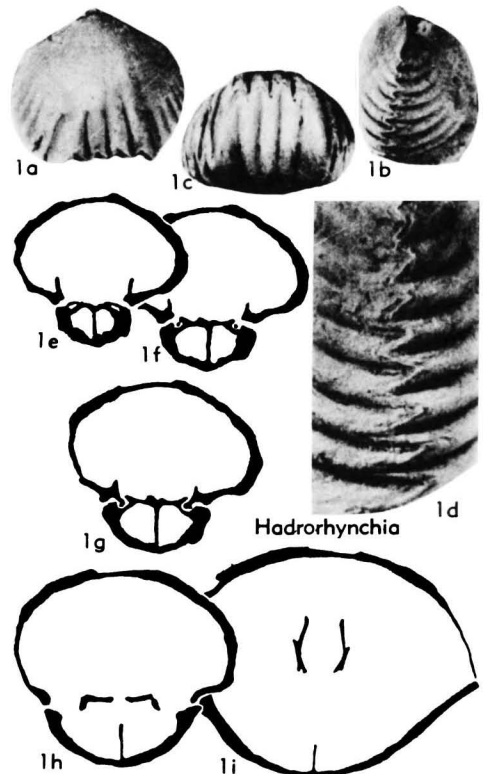


FIG. 445. Uncinulidae (Hadrorthynchiinae) (p. H569-H570).

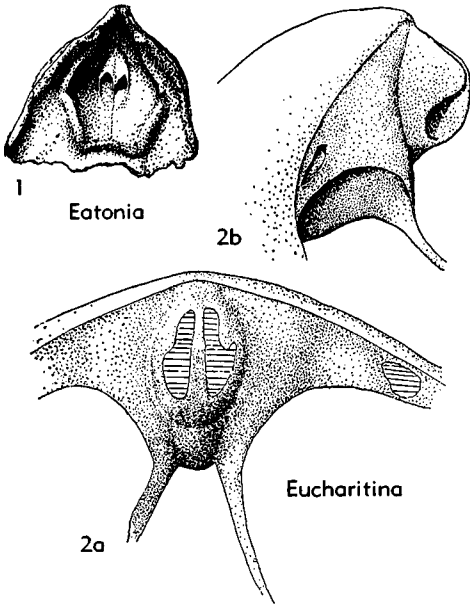


FIG. 446. Eatoniidae (p. H570-H572).

dorsally; brachial valve convex but without prominent fold; flanks of pedicle valve and front of brachial valve abruptly bent toward opposite valve; costae flattened, with longitudinal grooves on truncated parts of shell; commissure denticulate, denticles prolonged and acuminate to marginal spines that taper uniformly from base to point, extending under costae of opposite valve. Ventral muscle field longitudinal oval, bounded by marked rim and divided by small septum; cardinal process large, its basal part filling out small septalium and uniting hinge plates; 2 lobes of cardinal process deeply excavated, process thus appearing quadripartite or, by coalescence of median parts, tripartite; crura long, slender. *L. Dev.*, Eu.-?Afr.—FIG. 446,2; 447,6. **E. eucharis* (BARRANDE), Boh. (Koněprusy); 446,2a,b, brach.v., cardinalia from vent. side and lat. view, $\times 4.7$ (931c); 447,6a-d, ped.v., brach.v., lat., ant. views, $\times 1$ (53); 447,6e-i, serial secs. at 29.1, 29.0, 28.9, 28.7, 28.6 mm. from ant. margin, $\times ?$ (411a).

Pegmarhynchia COOPER, 1955, p. 58 [**P. zimmi*; OD]. Small, rounded triangular to subpentagonal in outline; pedicle valve nearly plane in profile, with narrow, short sulcus near anterior margin, forming small tongue; deltidial plates small or lacking; foramen triangular; brachial valve gently convex, with small marginal fold; costae simple, rounded; commissure densely denticulate. Dental plates wanting; teeth ponderous, corrugated; muscle field very large, subtriangular, without prominent bounding ridge; hinge plates united to form broad, thick plate that commonly is elevated

medially into rounded boss, deep pit under beak; sockets transversely corrugated; crura short, broad, crescentic in section, with concave face directed inward; median ridge nearly obsolete to slightly elevated. *L.Dev.*, N.Am.—FIG. 447,4. **P. zimmi*, USA (N.Y.); 4a-d, ped.v., brach.v., post., ant. views, $\times 2$; 4e,f, ped.v. int., brach.v. int., $\times 2$ (185).

Tanerhynchia ALLAN, 1947, p. 442 [**Eatonia parki* ALLAN, 1935, p. 22; OD]. Medium-sized, transversely oval in outline; coarsely multicostate; commissure denticulate. Teeth strong, supported by plates not reaching floor of valve; muscle field restricted to posterior half of valve, impressed and bounded by low carinae; adductor scars divided by faint median ridge; dorsal median septum short; sockets large, corrugated; crura short and bluntly pointed; cardinal process with erect shaft and flat rugose myophore. *L.Dev.*, N.Z.—FIG. 447,7. **T. parki* (ALLAN); 7a,b, ped.v. int., brach.v. int., $\times 1.5$ (27).

Family PUGNACIDAE Rzhonsnitskaya, 1956

[*nom. correct. et transl.* SCHMIDT, herein (*ex* Pugnaxinae RZHONSNITSKAYA, 1956, p. 125)] [Materials for this family prepared by HERTA SCHMIDT]

Small to large; sulcus, fold, and tongue generally well developed; beak commonly with ridges; costae not numerous, generally simple, coarse, angular or rounded-angular, in most genera restricted to anterior parts of valves, in some species wanting; commissure more or less denticulate, depending on strength or absence of costae; fine radial striae observed in many genera. Dental plates rarely wanting; hinge plates separated in their whole height; cardinal process absent; crural plates or ridges stretching dorsally from crural bases, connected with floor of valve at least in their upper parts, or uniting with median septum or ridge, forming very shallow septalium not reaching articulation zone; crural plates, generally narrowing in articulation zone, may be continued on crura, crural shape developing calcarifer type; median septum not strong, in some genera reduced to low ridge or absent. *L.Dev.-L.Carb.*

Pugnax HALL & CLARKE, 1893, p. 202 [**Terebratula acuminata* SOWERBY, 1822, p. 23; SD ICZN Opinion 420, 1956]. Small to large, commonly tetrahedral; sulcus and fold beginning in posterior halves of valves, broad but not strictly defined; brachial valve in some species elevated nearly to keel shape; pedicle valve rather flat or concave in posterior part; tongue narrowing anteriorly, with rounded or ogival anterior margin; costae strong

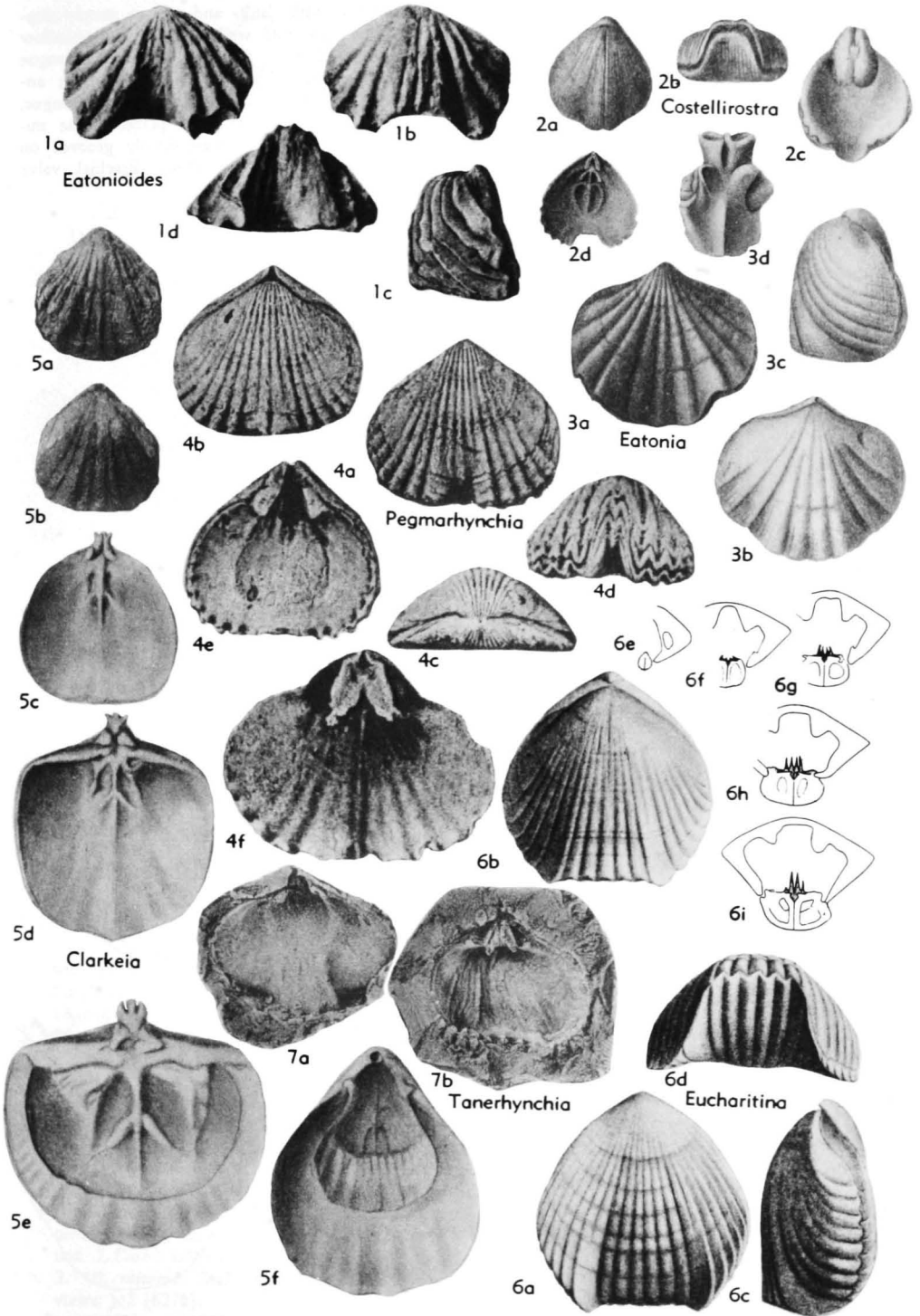


FIG. 447. Eatoniidae (p. H570-H572).

to weak or wanting; crural plates generally not uniting or forming septalium. *M.Dev.-Carb.*—
 FIG. 448, I. **P. acuminatus* (SOWERBY), Eng. (Derbyshire) (1a,b), Eire (Dublin) (1c-q); 1a,b, post., ant. views, $\times 1$ (after 581); 1c-q, ser. secs., $\times 2.8$ (931d).

Corvinopugnax HAVLIČEK, 1961, p. 36 [**Rhynchonella corvina* BARRANDE, 1847, p. 426; OD].

Subcuboidal with flanks and tongue steeply sloping; sulcus and fold well defined; sulcus shallow with flattened floor; fold not prominent; tongue broad, its anterior margin almost straight; anterior part of fold abruptly bent toward tongue, anterior commissure lying in plane; costae numerous, flattened and longitudinally grooved on steeply sloping parts of shell. Brachial valve

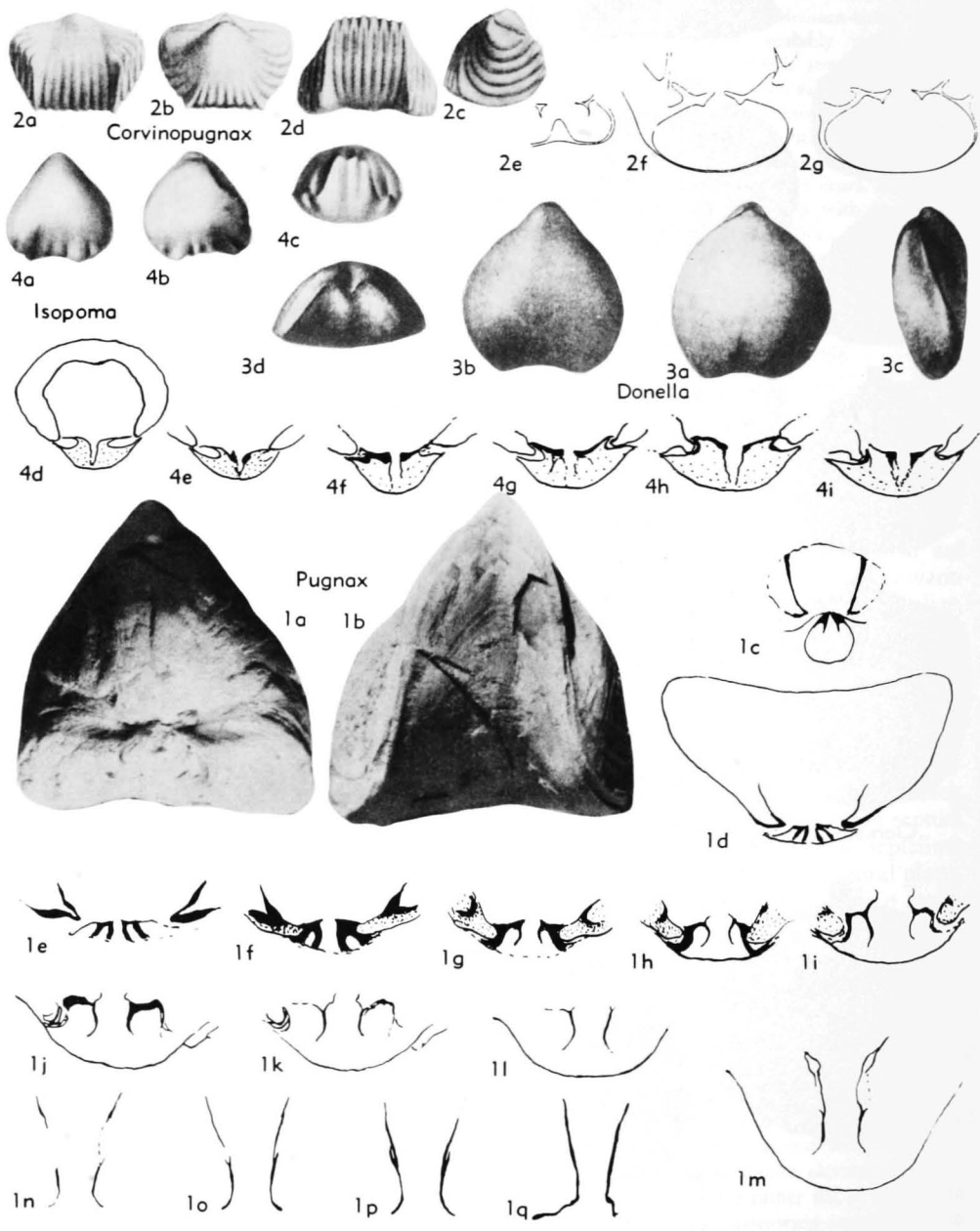


FIG. 448. Pugnacidae (p. H572, H574-H575).

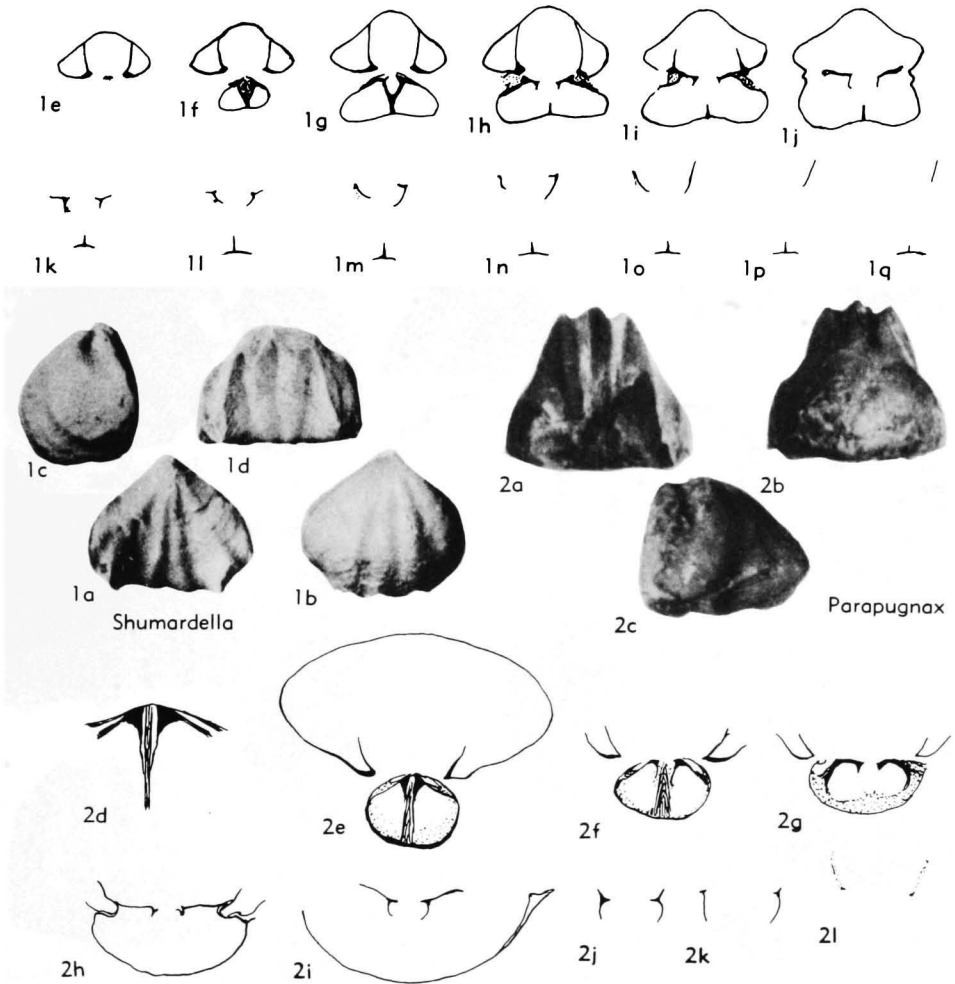


Fig. 449. Pugnacidae (p. H575-H576).

with short dorsal median ridge. *L.Dev.-M.Dev.*, Eu.(Boh.-Ger.).—FIG. 448,2. **C. corvinus* (BARRANDE), *M.Dev.*, Boh.(Koněprusy); 2a-d, ped.v., brach.v., lat., ant. views, $\times 1$ (53); 2e-g, ser. secs., $\times 3$ (411a).

Donella ROTAY, 1931, p. 21 [**D. minima*; OD]. Small, resembling *Pugnax* in shape, with sulcus and fold not distinctly defined; surface usually smooth, rarely with 1 or 2 costae restricted to marginal parts of sulcus and fold and causing denticulation in commissure. Interior not sufficiently known; dental plates wanting; dorsal septum extending forward beyond zone of articulation. *L.Carb.*, USSR(Donetz Basin).—FIG. 448, 3. **D. minima*; 3a-d, brach.v., ped.v., lat., ant. views, $\times 2$ (627a).

Isopoma TORLEY, 1934, p. 81 [**Terebratula brachyptycta* SCHNUR, 1853, p. 178; OD]. Small to

medium-sized, rounded to pentagonal in outline; both valves nearly equally convex; ventral beak blunt; sulcus and fold weakly developed; tongue short; costae short and coarse; radial striae not observed. Interior of pedicle valve with low median ridge in posterior part; dental plates not discernible; crural plates delicate, not uniting. *M.Dev.*, Eu.—FIG. 448,4. **I. brachyptyctum* (SCHNUR), Couvin., Ger.(Eifel); 4a-c, ped.v., brach.v., ant. views, $\times 1.5$ (718b); 4d-i, ser. secs., $\times 5$ (931d).

Parapugnax SCHMIDT, 1964 [**P. brecciae* (= *Pugnax pugnax brecciae* SCHMIDT, 1941, p. 278); OD]. Pedicle valve flat or slightly convex, but not concave; sulcus and fold distinctly defined; anterior margin of tongue nearly straight or but faintly rounded. Median ridge or moderately high septum present in dorsal interior; crural plates

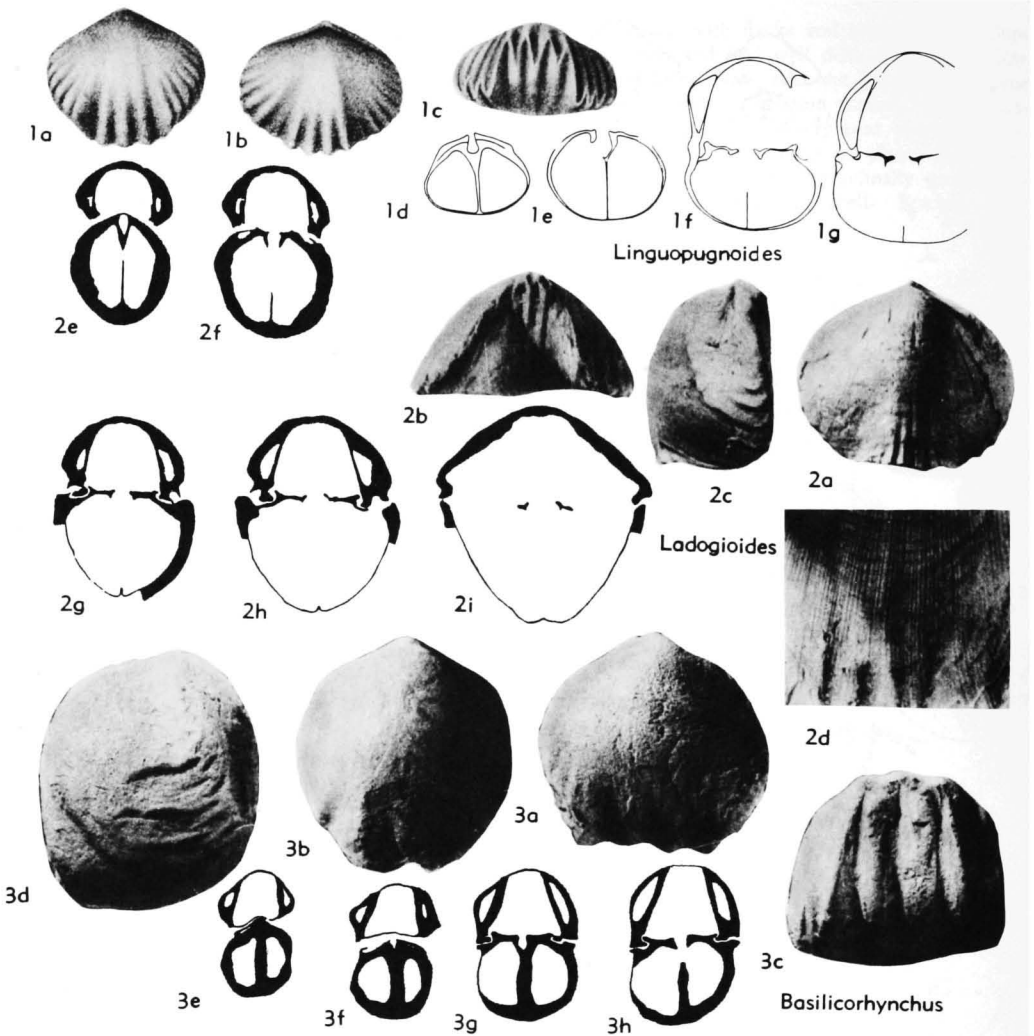


FIG. 450. Family Uncertain (?aff. Pugnacidae) (p. H576-H577).

approaching or uniting with median septum or ridge, forming flat septalium. *M.Dev.-U.Dev.*, Eu. —FIG. 449,2. **P. brecciae* (SCHMIDT), Ger.(Dill distr.); 2a-c, ped.v., brach.v., lat., $\times 1$ (718c); 2d, sec. near and parallel to surface, $\times 5$; 2e-l, ser. secs., $\times 3.5$ (931d).

Shumardella WELLER, 1910, p. 512 [**Rhynchonella missouriensis* SHUMARD, 1855, p. 204; OD]. Medium-sized to large, triangular in outline; beak little incurved; sulcus and fold well marked, few rounded costae beginning in posterior halves of valves. Dental plates present; umbonal chambers rather large; dorsal median septum low, reaching about half length of valve; crural plates uniting to form very shallow septalium. *L.Carb.(Miss.)*, N.Am.(Pa.-Iowa-Mo.).—FIG. 449,1. **S. missouriensis* (SHUMARD), USA (Mo.); 1a-d, ped.v.,

brach.v., lat., ant. views, $\times 1$ (178); 1e-q, ser. transv. secs., $\times 4$ (931d).

**Family UNCERTAIN
(?aff. PUGNACIDAE)**

The following genera, though possibly related to Pugnacidae, are not included in this family on account of some differences.

Basilicorhynchus CRICKMAY, 1952, p. 1 [**Leiorhynchus basilicum* CRICKMAY, 1952, p. 600; OD]. Medium-sized, subglobular, tumid; sulcus and fold very short; flanks and tongue steeply sloping; costae confined to anterior region; fine radial striae present, smooth posteriorly; commissure denticulate. Dental plates strong, diverging dorsally; septum rather strong and high; septalium shallow,

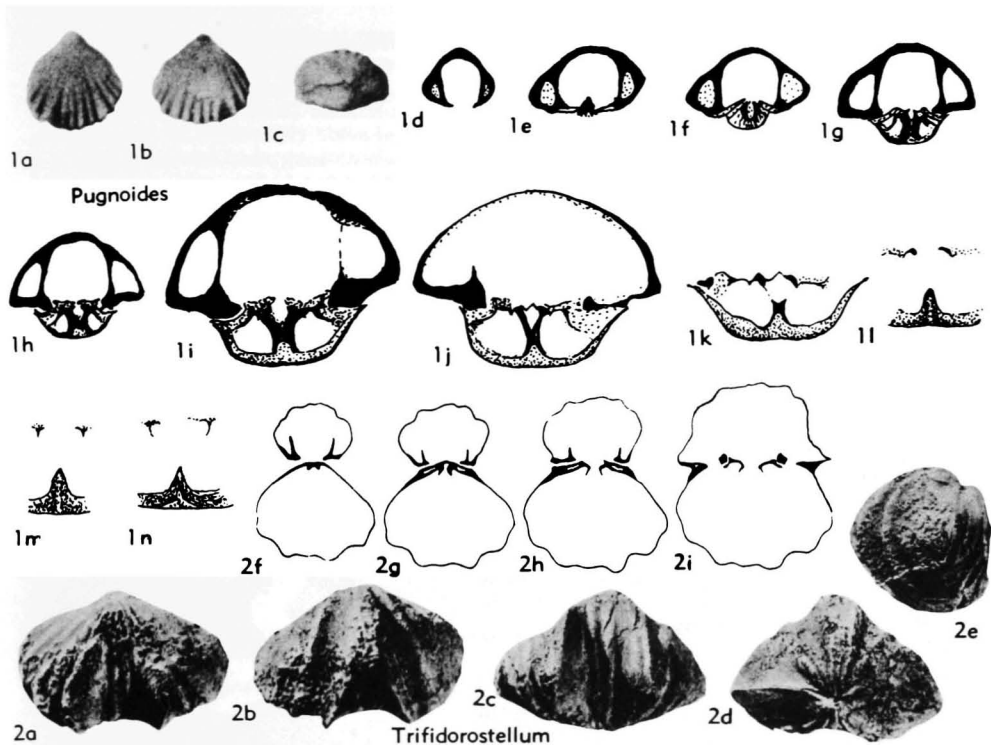


FIG. 451. Family Uncertain (?aff. Pugnacidae) (p. H577-H578).

persisting into articulation zone, uncovered. *U. Dev. (Famenn.)*, N. Am. (Can.)-W. Eu.-?Armenia.

—FIG. 450.3. **B. basilicum* (CRICKMAY), Can. (N.W. Terr.) (3a-d), Belg. (3e-h); 3a-d, ped. v., brach. v., ant., lat. views, $\times 1.5$ (203); 3e-h, ser. secs., 0.5, 0.6, 0.9, 1.1 mm. from apex; $\times 2$ (930b). [SCHMIDT.]

Ladogioides McLAREN, 1961 [**L. pax*; OD] [= *Athabascia* CRICKMAY, 1963, p. 10]. Exteriously resembling *Pugnax*; medium-sized to large, with inflated brachial valve and shallow pedicle valve; sulcus rather deep but not sharply defined; fold gradually turning into general curvature of shell; tongue high, with rounded or ogival anterior margin; costae strong, angular, restricted to anterior parts of shell, or may be wanting; costellae or striae covering whole shell; commissure denticulate. Dental plates diverging dorsally; umbonal cavities narrow; septalium very shallow, not persisting to articulation zone; dorsal median septum very short. *U. Dev. (Frasn.)*, N. Am.-?Pol.—FIG. 450.2. **L. pax*, Can.; 2a-c, brach., ant., lat. views, $\times 1$; 2d, surface detail, $\times 3$; 2e-i, ser. secs. at 1.0, 1.4, 1.7, 2.1, 2.6 mm. from apex, $\times 3$ (548a). [SCHMIDT, McLAREN.]

Linguopugnoides HAVLIČEK, 1960 [**Rhynchonella (nympha) carens* BARRANDE, 1879 (= *Linguopugnoides carens* BARRANDE, 1879); OD]. Small to medium-sized, with broad fold and sulcus and

high tongue; deltidial plates wanting; costae strong, angular, dental plates developed, diverging dorsally; dorsal median septum moderately high. *Sil.-L. Dev.*, Eu. (Boh.-USSR)-M. Asia.—FIG. 450.1. **L. carens* (BARRANDE), *Sil.*, Boh.; 1a-c, ped. v., brach. v., ant. view, $\times 1$ (53); 1d-g, ser. secs., distance from front: 12.35, 12.15, 11.8, 11.6 mm.; $\times 2$ (411a). [SCHMIDT.]

Pugnoides WELLER, 1910, p. 512 [**Rhynchonella ottumwa* WHITE, 1862; OD]. Small to medium-sized; strong costae beginning anteriorly from umbo but in posterior halves of valves; commissure strongly denticulate. Dental plates well developed; delthyrial cavity and umbonal cavities large; crural plates nearly approaching each other or uniting, forming septalium which reaches articulation zone; opening of septalium covered in its anterior part by angular plate. ?*Dev.*, *L. Carb.*, ?*Perm.*, N. Am.-Eu.-?Asia.—FIG. 451.1. **P. ottumwa* (WHITE), Miss., USA (Iowa); 1a-c, ped. v., brach. v., post. view; $\times 1$ (178); 1d-n, ser. secs., $\times 4$ (1d-h), $\times 6.5$ (1i-n) (931d). [SCHMIDT.]

Trifidorostellum SARTENAER, 1961, p. 5 [**Leiorhynchus dunbarensis* HAYNES, 1916, p. 38; OD]. [= *Pseudoleiorhynchus* ROZMAN, 1962, p. 122 (type, *Leiorhynchus uralicus* NALIVKIN, 1947, p. 90)]. Small to large, broad-ovate in outline,

brachial valve rather inflated; ventral sulcus well defined, deep, rounded, beginning at short distance from beak, persisting on tongue; fold prominent, defined on either side by marked furrows; few strong rounded costae present, generally simple, median costae beginning at or not far from beak, lateral ones more distant from beak; commissure undulated to denticulated. Dental plates

slender, short; hinge plates separated; short crural plates present, not united; septum and septalium wanting. *U.Dev.(Famenn.)*, N.Am.; *L.Carb.*, Asia(Urals-Kazakh.-Kuznetsk basin).—FIG. 451, 2. **T. dunbarens* (HAYNES), USA(Mont.); 2*a-e*, ped.v., brach.v., ant., post., lat. views, $\times 1$; 2*f-i*, ser. secs., 0.8, 1.0, 1.1, 1.3 mm. from apex, $\times 2.9$ (709*a*). [SCHMIDT.]

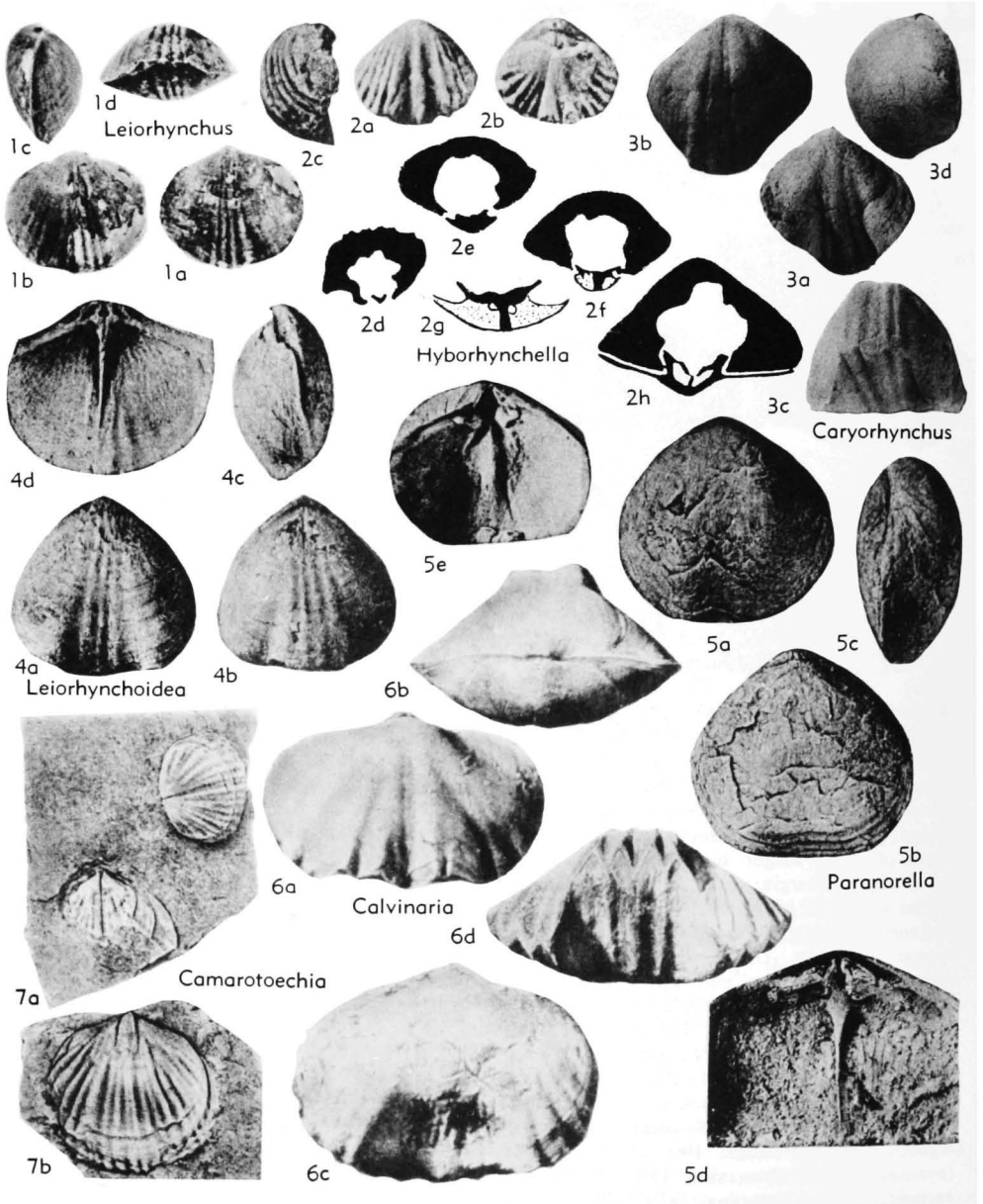


FIG. 452. Camarotoechiidae (Camarotoechiinae) (p. H580-H582).

Family CAMAROTOECHIIDAE

Schuchert & LeVene, 1929

[Camarotoechiidae SCHUCHERT & LEVENE, 1929, p. 18] [Materials for this family prepared by HERTA SCHMIDT except as indicated otherwise]

Medium-sized to large, round or elliptical in outline, sides and front never truncated;

costae generally rounded. Brachial valve with high median septum or ridge; hinge plate entire, or divided only in its most anterior portion, or divided by small shallow open septalium; cardinal process in most genera wanting. ?*L.Sil.*, *U.Sil.-Perm.*

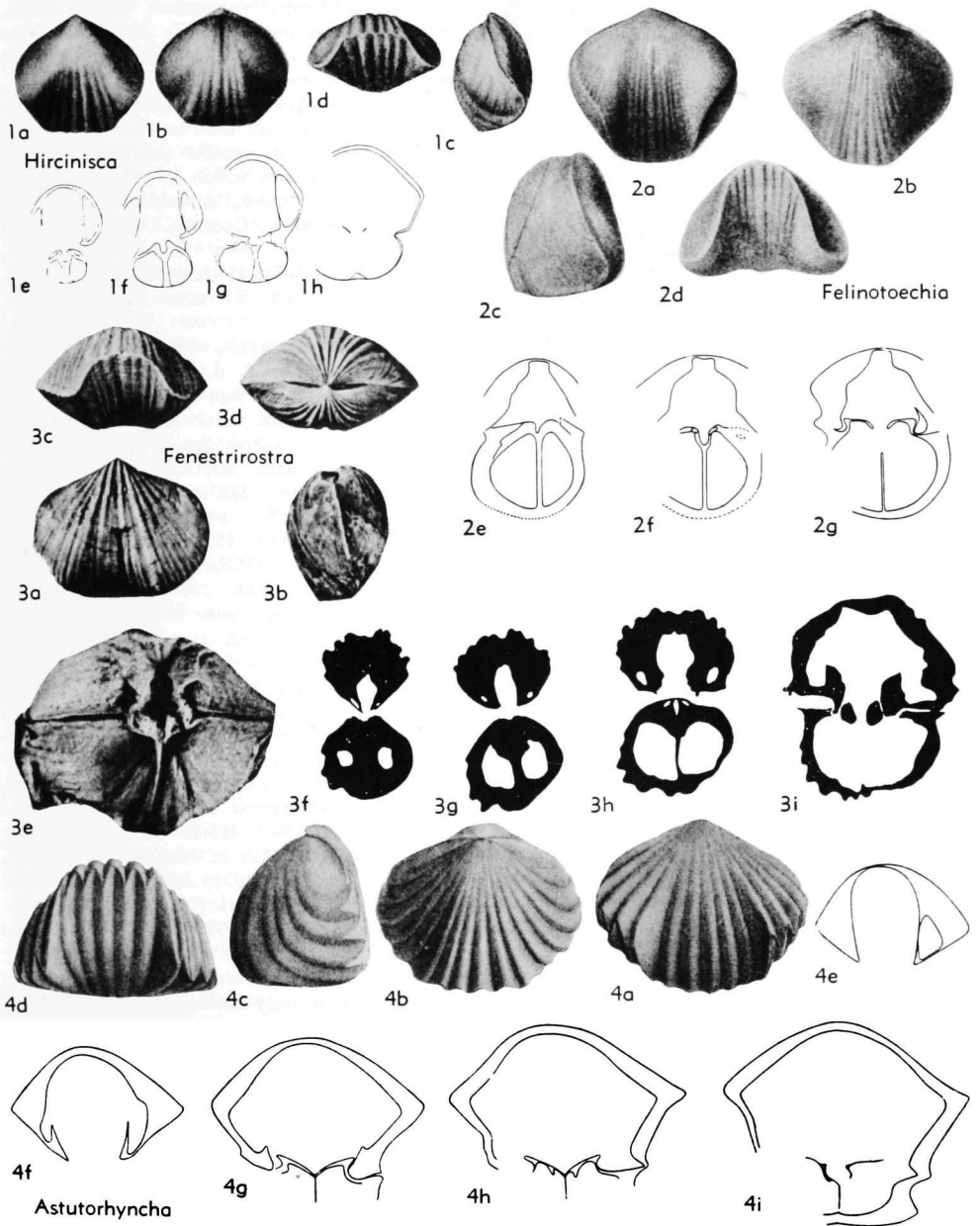


FIG. 453. Camarotoechiidae (Camarotoechiinae) (p. H580-H581).

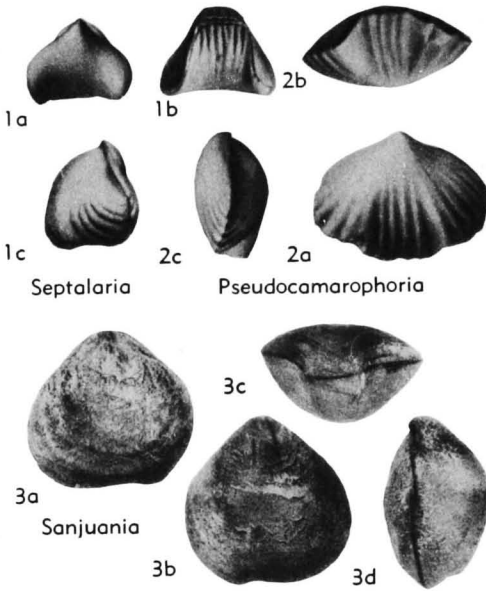


FIG. 454. Camarotoechiidae (Camarotoechiinae) (3), (Septalariinae) (1-2) (p. H582-H584).

Subfamily CAMAROTOECHIINAE
Schuchert & LeVene, 1929

[Camarotoechiinae SCHUCHERT & LEVENE, 1929, p. 18] [=Leiorhynchinae STAINBROOK, 1945, p. 43; Nudirostrinae ROGER, 1952, p. 88] [Materials for this subfamily prepared by HERTA SCHMIDT and D. J. MCLAREN]

Costae with tendency to obliterate, especially on flanks. Crural bases slightly projecting ventrally, enclosing small median groove or shallow septalium; cardinal process absent. ?*L.Sil.*, *U.Sil.-Perm.*

Camarotoechia HALL & CLARKE, 1893, p. 189 [*Atrypa congregata* CONRAD, 1841, p. 55; OD]. Moderately high to flat, slightly inflated only in umbonal region; ventral sulcus and dorsal fold well defined, beginning at short distance from apex; costae low, unequal, starting near apex, those on sulcus and fold bifurcating, crossed by strong concentric striae; commissure undulated. Dental plates short, strong; dorsal muscular field long, narrow; dorsal septum long. *M.Dev.*, N.Am.—FIG. 452.7. **C. congregata* (CONRAD), USA (N.Y.); 7a, two brach.v. int. molds, $\times 1.5$; 7b, ped.v. int. mold, $\times 1$ (930b).

?**Astutorhyncha** HAVLÍČEK, 1961, p. 105 [*Rhynchonella Proserpina* BARRANDE, 1847, p. 420; OD]. Medium-sized to large, transverse, inflated; brachial valve high; fold and sulcus prominent; costae strong, rounded, simple; commissure serrate; umbones smooth. Dental plates short, divergent; septum high, slender; septalium if developed, shallow; crural bases project ventrally. [This genus probably is better placed in "Family Un-

certain."] *U.Sil.-L.Dev.*, Eu.(Czech.)-C.Asia.—FIG. 453.4. **A. proserpina* (BARRANDE), *M.Dev.* (Eifel.), Boh.; 4a-d, ped.v., brach.v., lat., ant. views, $\times 1$ (53); 4e-i, ser. secs. 19.4, 19.3, 18.8, 18.7, 18.5 mm. from ant. margin, $\times 2.5$ (411a). [MCLAREN.]

Calvinaria STAINBROOK, 1945, p. 43 [*Rhynchonella ambigua* CALVIN, 1878, p. 727; OD]. Large, transversely elliptical in outline; ventral sulcus, dorsal fold, and tongue strongly developed; costae rounded to subangular, beginning anteriorly from umbo; commissure undulated to denticulated. Dental plates commonly divergent dorsally; umbonal cavities may be filled out by callus; hinge plate divided in its anterior part and detached from median septum within or posterior to zone of articulation. *U.Dev.*, cosmop.—FIG. 452.6; 455.1. **C. ambigua* (CALVIN), USA (Iowa); 452, 6a,b, brach.v., post. view; 452,6c, ped.v.; 452,6d, ant. view, $\times 1$ (768); 455,1a-g, ser. secs., $\times 2$, 2.6, 2.7, 2.95, 3.3, 3.5, 3.8 mm. from apex, $\times 2$ (930a).

Caryorhynchus CRICKMAY, 1952 [*Leiorhynchus carya* CRICKMAY, 1952, p. 599; OD]. Very near to *Leiorhynchus*, perhaps synonymous; ventral sulcus deep; brachial valve inflated; costae confined to fold and sulcus. Interior with abundant callus; dental plates not distinguishable from thickened shell wall. *M.Dev.-U.Dev.*, N.Am.—FIG. 452.3; 455.3. **C. carya* (CRICKMAY), *U.Dev.* (Frasn.), Can.(Alta.); 452,3a-d, ped.v., brach.v., ant., lat. views, $\times 1$; 455,3a-d, ser. secs., $\times 5$ (203).

?**Felinotoechia** HAVLÍČEK, 1961, p. 73 [*Atrypa astuta* BARRANDE var. *felina* BARRANDE, 1879, pl. 18; OD]. Medium-sized, transverse, inflated, with high brachial valve; well-developed fold and sulcus with very high, broad tongue; low, rounded costae confined to anterior part of fold and sulcus, less commonly on flanks. Pedicle valve thick-walled, without dental plates; muscle impressions strongly impressed; median septum high, slender, supporting deep narrow septalium. *U.Sil.-L.Dev.*, Eu.(Czech.).—FIG. 453.2. **F. felina* (BARRANDE), *U.Sil.* (Budňany); 2a-d, ped.v., brach.v., lat., ant. views, $\times 1$ (53); 2e-g, ser. secs. at 0.1 mm. intervals, $\times 2$ (411a). [MCLAREN.]

?**Fenestrirostra** COOPER, 1955, p. 56 [*Rhynchonella glacialis* BILLINGS, 1862, p. 143; OD]. Medium-sized to large, transverse, subequally biconvex; pedicle beak strongly incurved, foramen minut; thick deltidial plates; surface costellate; costellae rounded, uneven, increase by bifurcation and intercalation, and tending to be obliterated forward; entire surface finely capillate. Shell thick; dental plates short, stout; narrow, deep septalium, supported by stout median septum; hinge plates formed of thick socket ridges that pass into crural bases. [This genus probably is better placed in "Family Uncertain."] *L.Sil.*, Can.(Que.).—FIG. 453.3. **F. glacialis* (BILLINGS), Becksie, Anticosti; 3a-d, ped.v., lat., ant., post. views, $\times 1$; 3e,

rubber replica post. int., $\times 2$; 3*f-i*, ser. secs. 3.0, 3.6, 3.7, 4.2 mm. from apex, $\times 2$ (185). [McLAREN.]

?*Hircinisca* HAVLIČEK, 1960, p. 241 [**Atrypa hircina* BARRANDE var. de *Sapho* BARRANDE, 1879, pl. 90; OD]. Medium-sized, quadrate or transverse; smooth or weakly costate anteriorly on fold and sulcus, flanks always smooth. Long, thin dental plates, slightly divergent anteriorly; stout septum, open septalium. [This genus probably is better placed in "Family Uncertain."] *M.Sil.-U.Sil.*, Eu. (Czech.).—FIG. 453, 1*a-d*. **H. hircina* (BARRANDE), *U.Sil.*(Wenlock.), Boh.; 1*a-d*, ped.v., brach.v., lat., ant. views, $\times 1$ (53).—FIG. 453, 1*e-h*. *H. hebes* HAVLIČEK, *U.Sil.*(Budňany), Boh.; 1*e-h*, ser. secs. 9.0, 8.8, 8.5, 8.3 mm. from ant. margin, $\times 2$ (411*a*). [McLAREN.]

?*Hyborhynchella* COOPER, 1955, p. 59 [**H. bransoni*; OD]. Small, thick, rounded in outline; pedicle valve strongly swollen; brachial valve nearly plane to concave in profile; ventral sulcus and dorsal fold restricted to anterior halves of valves; tongue narrow; beaks curved, with short, obscure ridges; costae rounded, broadest on fold and sulcus; commissure strongly undulate to denticulate. Dental plates not discernible because of thickening of shell; teeth not defined from shell wall; hinge plate entire, slightly concave, with small median groove, supported by low septum which strongly thickens posteriorly; inner socket ridges prominent. *U.Dev.*, N.Am.—FIG. 452, 2. **H. bransoni*, USA(N.Mex.); 2*a,b*, ped.v., brach.v., $\times 2$; 2*c*, lat. view, $\times 2$; 2*d-h*, ser. secs., 0.5, 0.65, 0.8, 1.0, 1.15 mm. from apex, $\times 3$, except 2*g*, $\times 6$ (185).

Leiorhynchoidea CLOUD, 1944, p. 57 [**L. schucherti*; OD]. Round to broad elliptical, commonly rather flat, ventral sulcus and dorsal fold shallow, tongue short; costae weak to obsolescent. Ventral muscle field long-ovate, narrow adductors divided by low median ridge, laterally and anteriorly bounded by broader diductors. Dorsal muscle field narrow; hinge plate resting on thickened shell wall, its lateral parts concave, defined laterally by projecting socket plates, medially by prominent crural bases; median depression between crural bases with small ridge; sockets crenulated; dorsal median ridge strongly thickening before uniting with hinge plate. [GIRTY'S (1911) *Leiorhynchus carboniferum* from the Moorefield Shale of Arkansas is judged to belong to *Leiorhynchoidea*.] ?*U.Miss.*, *U.Perm.*, N.Am.—FIG. 452, 4. **L. schucherti*, Mex.(Coahuila); 4*a-c*, ped.v., brach.v., lat. view, $\times 1$; 4*d*, brach. int., young specimen, $\times 2$ (912).

Leiorhynchus HALL, 1860, p. 75 [**Orthis quadracostata* VANUXEM, 1842, p. 168; SD OEHLERT, 1887, p. 1308] [= *Liiorhynchus* OEHLERT, 1887 (obj.) (non RUDOLPHI, 1801); *Nudirostra* COOPER & MUIR-WOOD, 1951 (obj.)]. Rather near to *Camarotoechia*; globose, sulcus and fold weakly developed, beginning in or at short distance be-

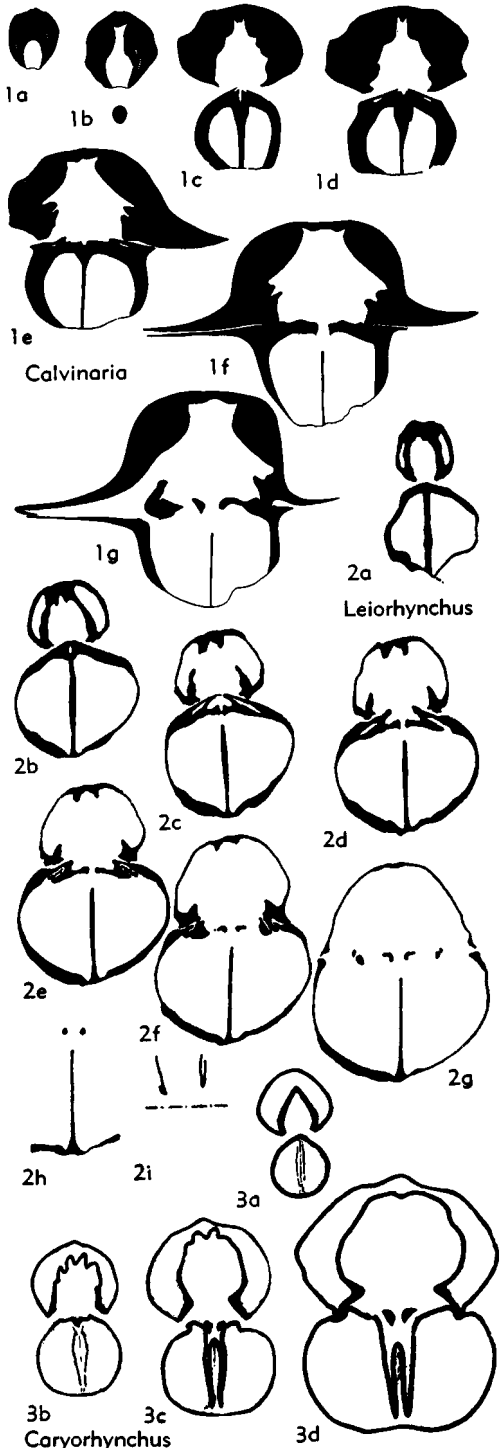


FIG. 455. Camarotoechiidae (Camarotoechiinae) (p. H580-H582).

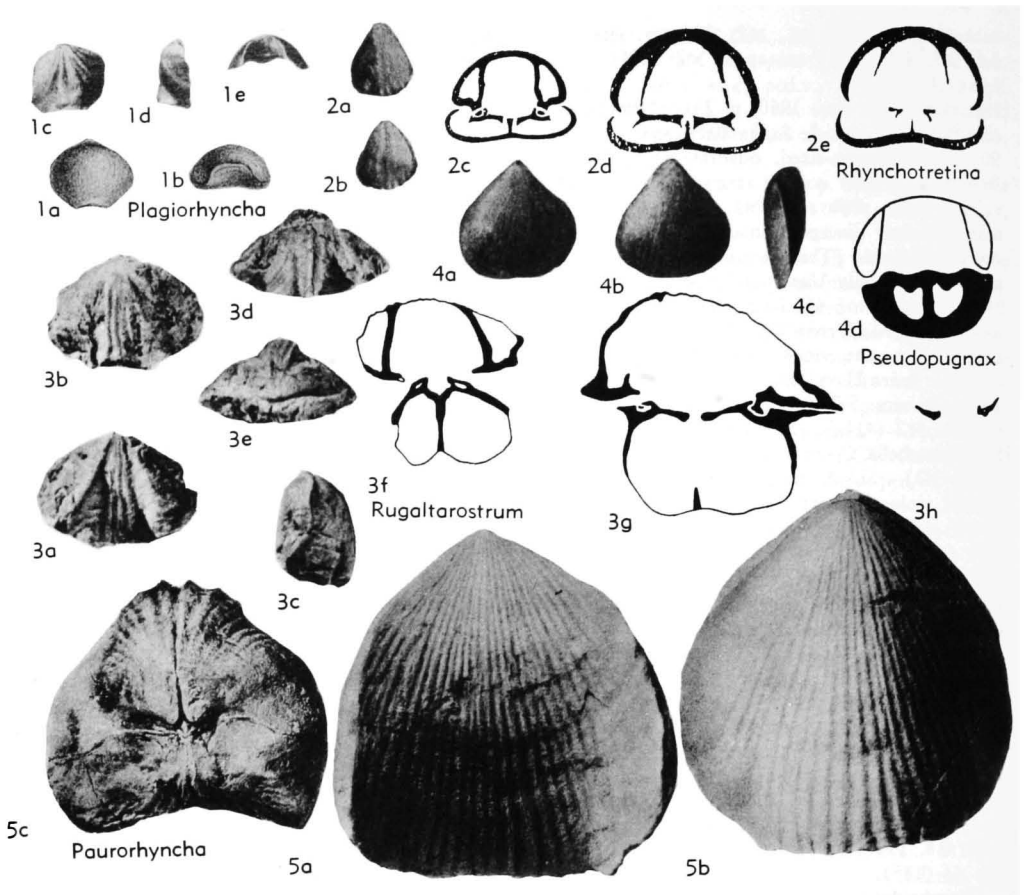


FIG. 456. Camarotoechiidae (Camarotoechiinae) (1-3, 5), (Septalariinae) (4) (p. H582-H584).

hind mid-length of valves; beak curved; ventral interarea limited by ridges; costae on flanks weak or obsolescent, on sulcus and fold stronger, low, rounded, of variable width, in type-species beginning near beaks, some of them bifurcating; commissure undulated. Dental plates well developed, nearly approaching each other ventrally, in some shells united to form spondylium duplex; dorsal septum high and long, detached from hinge plate in beginning of or posteriorly to zone of articulation; crura with trough-shaped ends. *M.Dev.-U.Dev.*, cosmop.—FIG. 452,1; 455,2. **L. quadricostatus* (VANUXEM), *U.Dev.*, USA (N.Y.); 452, 1a-d, ped.v., brach.v., lat., ant. views, $\times 1$; 455, 2a-i, ser. secs., 0.45, 0.8, 0.9, 0.95, 1.0, 1.1, 1.5, 1.8, 3.05 mm. from apex, $\times 3.2$ (930b).

Paranorella CLOUD, 1944, p. 59 [**P. imperialis*; OD]. Biconvex, with pedicle valve the deeper, subcircular in outline; broad shallow ventral and dorsal sulcus restricted to anterior parts of valves; tongue very short, trapezoidal, or scarcely marked; costae wanting. Ventral muscle field broad, bounded by low ridge. Hinge plate re-

sembling that of *Leiorhynchoidea*. *U.Perm.*, N.Am. —FIG. 452,5. **P. imperialis*, Mex.(Coahuila); 5a-c, ped.v., brach.v., lat. view, $\times 1$; 5d, brach.v. int., $\times 2$; 5e, ped.v. int., $\times 1$ (912).

Sanjuania AMOS, 1958, p. 841 [**S. dorsisulcata*; OD]. Very near to *Paranorella*, perhaps synonymous. *L.Carb.*, Arg.—FIG. 454,3. **S. dorsisulcata* AMOS; 3a-d, ped.v., brach.v., ant., lat. views, $\times 1$ (905b).

?**Paurorhyncha** COOPER, 1942, p. 231 [**Rhynchonella Endlichi* MEEK, 1875, p. 46; OD]. Large, subtriangular; sulcus deep and very wide, extending from beak; brachial valve high; finely costate to costellate with rounded costellae, which may branch, extending from umbones, weak or absent on flanks. Small dental plates and teeth; foramen minute, deltidial plates vestigial; long median septum supporting V-shaped, open septalium. [This genus probably is better placed in "Family Uncertain."] *U.Dev.*(*Famenn.*), W.USA-?USSR [reported occurrence in *M.Dev.* of Kazakhstan probably incorrect].—FIG. 456,5a,b. **P. endlichi* (MEEK), Ouray, Colo.; 5a,b, ped.v., brach.

v. views, $\times 1$ (469).—FIG. 456, 5c. *P. cooperi* STAINBROOK, Percha, N.Mex., post. view int. mold, $\times 1$ (769). [MCLAREN.]

?*Plagioryncha* McLEARN, 1918, p. 138 [**Rhynchonella Glassii* DAVIDSON, 1883, p. 155 (= *Atrypa depressa* J. DE C. SOWERBY, 1839, p. 629); OD]. Small to medium-sized; subequally biconvex; outline subcircular; lateral margins of brachial valve vertical; fold and sulcus developed anteriorly; tongue subrectangular or rounded; weakly costate or costellate or smooth; costae may be confined to fold and sulcus; may be finely capillate. Dental plates not developed; teeth small; muscle impressions strongly impressed; hinge plates divided; septum low; septalium open. *L.Sil.-U.Sil.* (*Wenlock*), Eu.-Can. (N.S.).—FIG. 456, 1. **P. glassii* (DAVIDSON), Wenlock, Eng., L.Sil., Can. (N.S.); 1a, b, brach.v., ant. views, $\times 1$ (229); 1c-e, brach.v., lat., ant. views, $\times 1$ (550). [MCLAREN.]

?*Rhynchotretina* KHALFIN, 1939, p. 175 [**R. aequivalvis*; OD]. Small, subtriangular, with acute apical angle and rounded anterior; almost equi-valve, inflated, no fold and sulcus, rectimarginate; pedicle beak short, straight; costate anteriorly, smooth posteriorly. Interior imperfectly known; strong dental plates; no septalium; median septum protruding between divided hinge plates. [This genus probably is better placed in "Family Uncertain."] *L.Dev.*, USSR (Altay).—FIG. 456, 2. **R. aequivalvis*; 2a, b, ped.v., brach.v., views, $\times 1$ (690); 2c-e, ser. secs., $\times 10$ (464). [MCLAREN.]

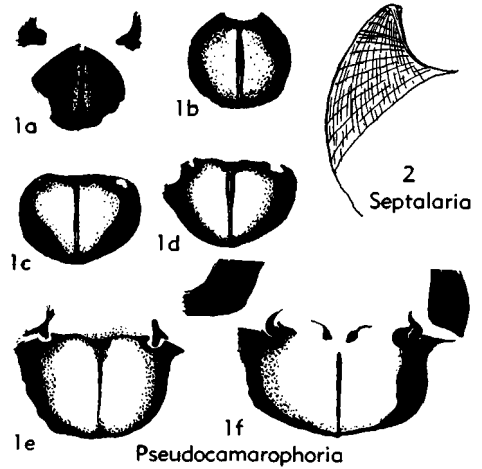


FIG. 458. Camarotoechiidae (Septalariinae) (p. H583-H584).

Rugaltarostrom SARTENAER, 1961, p. 6 [**Leiorhynchus madisonense* HAYNES, 1916, p. 39; OD]. Small to large, transverse; sulcus developed from near beak, wide; maximum height of shell at or near anterior margin; few, rounded, bifurcating costae on fold and sulcus, flanks smooth; may be finely capillate. Dental plates slender; dorsal septum supports wide cup-shaped septalium; hinge plates plane, inclined inward. *U.Dev.* (*Famenn.*), N.Am. (Mont.-Idaho-Alta.-N.W.T.).—FIG. 456, 3. **R. madisonense* (HAYNES), USA (Mont.); 3a-e, ped.v., brach.v., lat., ant., post. views, $\times 1$; 3f-h, ser. secs. at 0.65, 0.95, 1.45 mm. from apex, $\times 9$ (709a). [MCLAREN.]

Subfamily SEPTALARIINAE Havlíček, 1960

[*nom. transl.* SCHMIDT, herein (ex Septalariidae HAVLÍČEK, 1960, p. 241)] [=?*Pseudopugnaxinae* LIXHAREV in RZHON-SNITSKAYA, 1958, p. 114]

Hinge plate without median groove, its halves united by small plate slightly depressed between crural bases; latter developed as narrow ridges projecting dorsally. *L.Dev.-M.Dev.*, ?*U.Perm.*

Septalaria LEIDHOLD, 1928, p. 41 [**Terebratula ascendens* STEININGER, 1853, p. 61; SD TORLEY, 1934, p. 74 (= *T. subtetragona* SCHNUR, 1851, p. 3)]. Medium-sized, commonly with sulcus and fold; prominent tongue always present, strongly bent dorsally in adult specimens; ventral beak but slightly incurved; costae beginning at or near apex, broader than furrows between them, low, rounded; marginal spines present in type-species. Dental plates short, bounding narrow umbonal cavities; upper part of hinge plate with small protruding rounded cardinal process which may be provided with parallel ridges; dorsal septum very high, triangular, with acute angle directed ventrally. *M.Dev.*, Eu.-Australia.—FIG. 454, 1; 457,

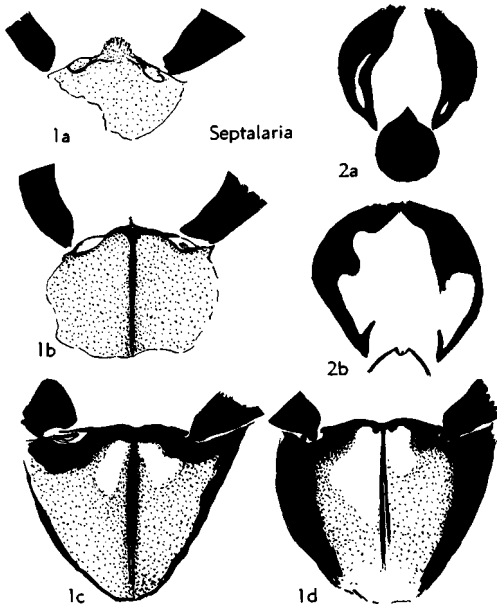


FIG. 457. Camarotoechiidae (Septalariinae) (p. H583-H584).

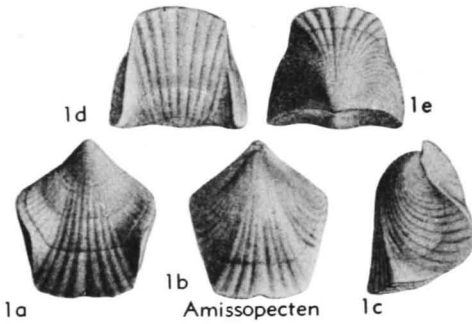


FIG. 459. Camarotoechiidae (Septalariinae) (p. H584).

1,2; 458,2. **S. subtetragona* (SCHNUR), Nohn., Ger.(Eifel); 454,1a-c, ped.v., ant., lat. views, $\times 1$ (718b); 457,1,2, transv. secs. of 2 specimens at (1a-d) 15.2, 15.0, 14.9, 14.8 mm. and (2a,b) 11.2, 11.1 mm. from ant. margin, $\times 5$ (Schmidt, n); 458,2, lat. view of dorsal septum, $\times 3.3$ (Schmidt, n).

Amissopecten HAVLÍČEK, 1960, p. 243 [**Terebratula velox* BARRANDE, 1847, p. 430; OD]. Resembling *Septalaria*. Dental plates wanting or obsolescent; cardinal process absent. *M.Dev.*, Eu.(Boh.).—FIG. 459,1; 460,1. **A. velox* (BARRANDE), Koněprusy Ls.; 459,1a-e, ped.v., brach.v., lat., ant., post. views, $\times 1$ (53); 460,1a-d, ser. secs., 16.3, 16.1, 15.9, 15.7 mm. from ant. margin, $\times 5$ (411a).

Pseudocamerophoria WEDEKIND, 1925, p. 197 [**Terebratula microrhyncha* C. F. ROEMER, 1844, p. 65; OD]. Medium-sized to large, round to transverse elliptical; sulcus and fold strong, tongue large; beaks incurved; costae beginning near apex, irregular in strength, rounded, interspaces about as large as costae; commissure undulated. Umbonal cavities commonly filled out by callus; brachial interior resembling that of *Septalaria*, but without cardinal process. *L.Dev.-M.Dev.*, Eu.—FIG. 454,2; 458,1. **P. microrhyncha* (C. F. ROE-

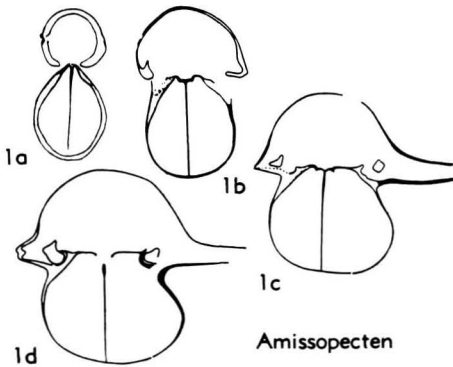


FIG. 460. Camarotoechiidae (Septalariinae) (p. H584).

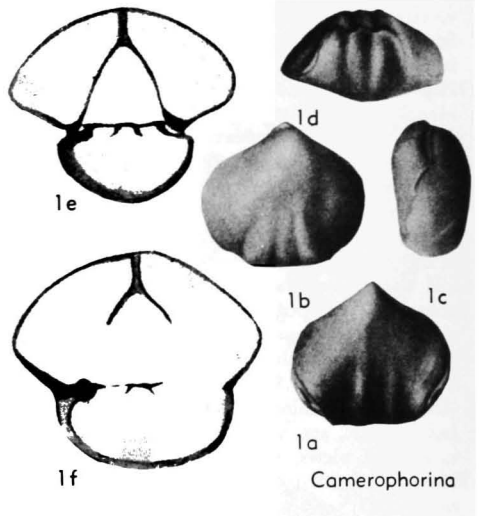


FIG. 461. Camerophorinidae (p. H584).

MER), M.Dev.(Couvin.), Ger.(Eifel); 454,2a-c, ped.v., ant., lat. views, $\times 1$ (718b); 458,1a-f, transv. secs. at 15.3, 15.0, 14.8, 14.6, 14.4, 14.0 mm. from ant. margin, $\times 4$ (Schmidt, n).

?*Pseudopugnax* LIKHAREV, 1956, p. 56 [**P. planissimus*]. Small to medium-sized, triangular in outline, flat, with broad, shallow sulcus in anterior part of pedicle valve, without marked fold in brachial valve; sculpture wanting; commissure even. Dental plates slightly diverging dorsally; dorsal septum well developed; hinge plates connected by median plate extending anteriorly farther than lateral parts of hinge plate, detached from dorsal septum anteriorly from articulation. *U.Perm.*, N.Caucasus.—FIG. 456,4. **P. planissimus*; 4a-c, ped.v., brach.v., lat. views, $\times 1.5$; 4d, ser. sec., $\times 3$ (517).

Family CAMEROPHORINIDAE Rzhonsnitskaya, 1958

[Camerophorinidae RZHONSNITSKAYA, 1958, p. 115] [=Camerophorinidae RZHONSNITSKAYA, 1956, p. 126 (nom. vet.)]
[Materials for this family prepared by D. J. McLAREN]

Smooth posteriorly, weakly ribbed anteriorly; spondylium supported by low septum in pedicle valve; hinge plate entire, no septum or septalium in brachial valve. *M.Dev.*

Camerophorina SCHMIDT, 1941, p. 43 [**Terebratula pachyderma* QUENSTEDT, 1871, p. 200; OD]. Medium-sized, broad; commissure uniplicate; fold and sulcus developed anteriorly; most of shell smooth, few weak, rounded costae at front margin. Outer hinge plates joined by slightly convex single plate. *M.Dev.*, Ger.-Czech.—FIG. 461,1. **C. pachyderma* (QUENSTEDT), Eifel.; 1a-d, ped.v., brach.v., lat., ant. views, $\times 1$; 1e,f, ser. secs., $\times 2.5$ (718b).

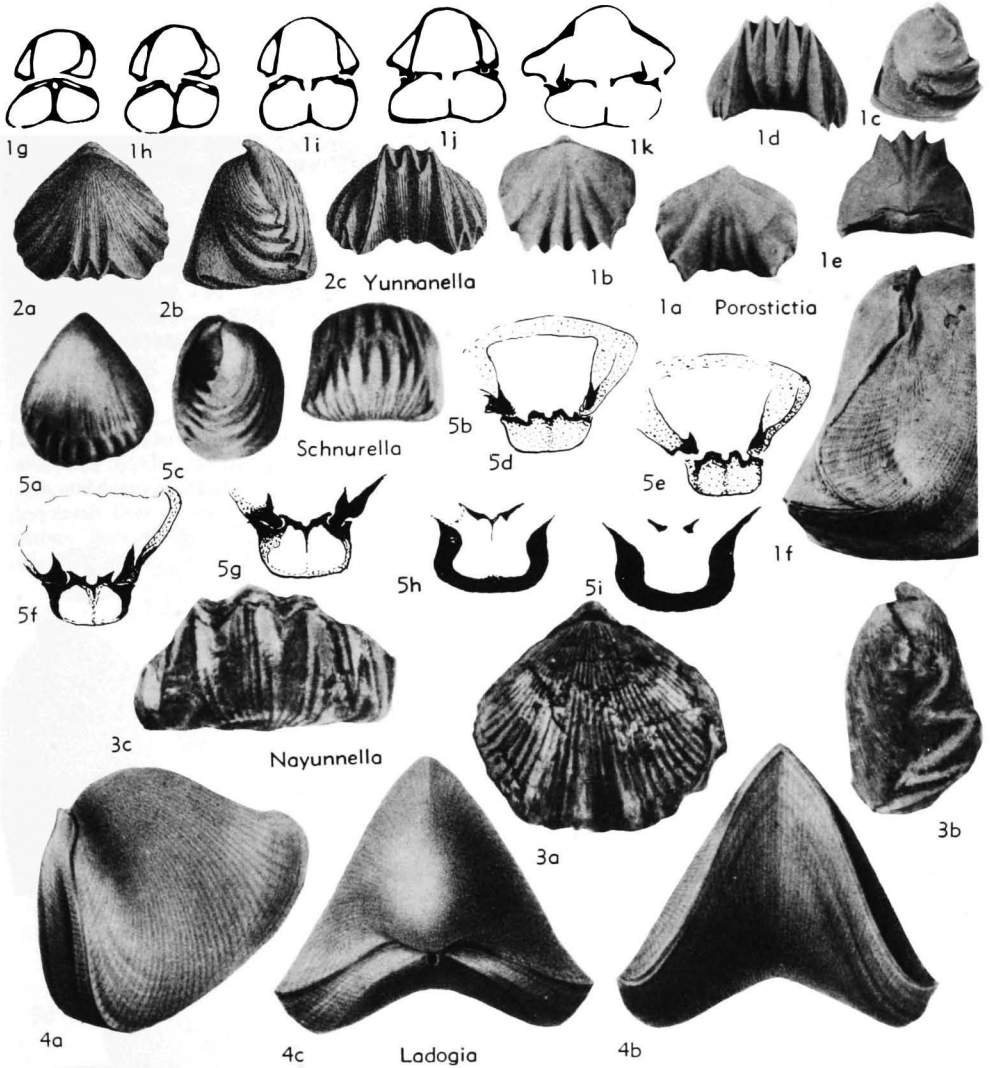


FIG. 462. Yunnanellidae (p. H585-H588).

Family YUNNANELLIDAE
Rzhonsnitskaya, 1959

[*nom. transl.* McLAREN, herein (ex Yunnanellinae RZHONSNITSKAYA, 1959, p. 28)] [=Yunnanellidae RZHONSNITSKAYA, 1956, p. 125; Junnanellidae RZHONSNITSKAYA, 1958, p. 112] [Materials for this family prepared by D. J. McLAREN except as indicated otherwise]

Smooth or paucicostate, with subangular to angular costae on anterior part of shell or, axially, from beak; entire shell costellate or capillate; uniplicate, commissure coarsely serrate. Dental plates present; strong median septum supporting deep open septalium. ?*M.Dev.*, *U.Dev.*, ?*L. Miss.*

Yunnanella GRABAU, 1923, p. 195 [*Rhynchonella Hanburii* DAVIDSON, 1853, p. 356; OD] [=*Yunnanellina* GRABAU, 1931 (obj.); *Junnanella*, *Junnanellina* RZHONSNITSKAYA, 1958, p. 113 (*nom. van.*)]. Small to medium; brachial fold high; anterior part of shell paucicostate on fold and flanks; whole shell finely capillate. Interior poorly known; wide septalium; strong septum. *U.Dev.* (*Famenn.*), China-USSR.—FIG. 462,2; 463,1. **Y. hanburii* (DAVIDSON), China(Yunnan); 462, 2a-c, brach.v., lat., ant. views, ×1 (230a); 463,1, sec. near apex, enlarged (361a).
 ?*Eoparaphorhynchus* SARTENAER, 1961a, p. 2 [*E. maclareni*; OD]. Closely resembles *Paraphorhynchus*

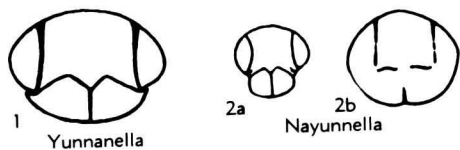


FIG. 463. Yunnanellidae (p. H585-H586).

chus; costellae reduced or absent. Septum strong; septalium deep, narrow. *U.Dev.(Famenn.)*, N.Am. (Can.:Alta., N.W.T.-USA:Nev.)-Eu.-Asia.—FIG. 464,1. **E. maclareni*, Can.(N.W.T.); 1a-e, ped.v., brach.v., post., ant., lat. views, $\times 1$; 1f-j, ser. sec. at 1.65, 2.2, 3.6, 5.2, 5.8 mm. from apex, $\times 3.25$ (709a).

?*Ladogia* NALIVKIN, 1941, p. 165 [**Terebratula Meyendorffii* DE VERNEUIL, 1845, p. 74; OD]. Medium-sized to large; brachial valve high, acuminate; pedicle valve flattened, with high, pointed tongue; prominent beak ridges; lateral commissure raised; noncostate; strong, flattened, bifurcating costellae. Dental plates bent inwards; hinge plates concave; septalium broad, U-shaped; septum

strong, persists forward of articulation. [This genus may be placed better in "Family Uncertain."] *M.Dev.(Givet.)-U.Dev.(Frasn.)*, E.Eu.—FIG. 462, 4; 465,1. **L. meyendorffii* (VERNEUIL), *U.Dev.(Frasn.)*; 462,4a-c, lat., ant., post. views, $\times 1$ (841); 465,1a-e, ser. secs. at 1.8, 1.9, 2.6, 3.1, 4.1 mm. from apex, $\times 2$ (548b). [MCLAREN.]

Nayunnella SARTENAER, 1961, p. 2 [*pro Yunnanella* GRABAU, 1931 (non GRABAU, 1923)] [**Yunnanella synplicata* GRABAU, 1931, p. 141; OD]. Similar to *Yunnanella*; shell flatter and more coarsely costellate; costellae develop into smooth costae anteriorly by fusion or widening. *U.Dev.(Famenn.)*, China.-USSR.—FIG. 462,3; 463,2. **N. synplicata* (GRABAU), China(Yunnan); 462, 3a-c, brach.v., lat., ant. views, $\times 2$ (358); 463, 2a,b, ser. sec., enlarged (361a).

?*Paraphorhynchus* WELLER, 1905, p. 260 [**P. elongatum*; SD SCHUCHERT & LEVENE, 1929, p. 93] [= *Paryphorhynchus* WELLER, 1914, p. 187 (nom. van.)]. Medium-sized or large, triangular to elongate triangular; fold and sulcus well developed; beak ridges prominent, rounded; shell entirely capillate. Dental plates approximate ventrally;

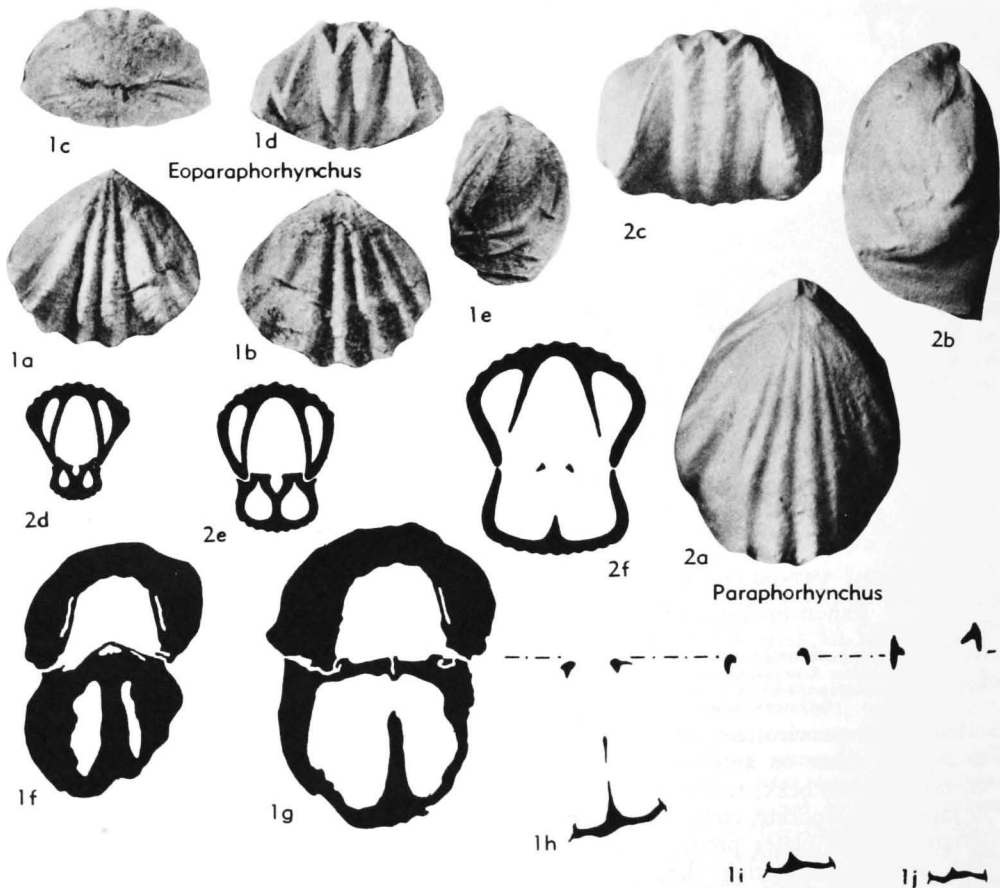


FIG. 464. Yunnanellidae (p. H585-H587).

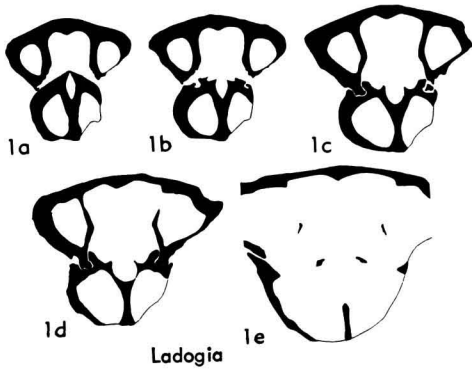


FIG. 465. Yunnanelliceras (p. H586).

hinge plates plane. *L. Miss. (Kinderhook.)*, N. Am. —FIG. 464, 2. **P. elongatum*; 2a-c, brach. v., lat., ant. views, $\times 1$; 2d-f, ser. sec. $\times 2.5$ (858).

Porostictia COOPER, 1955, p. 62 [**Paraphorhynchus perchaensis* STAINBROOK, 1947, p. 316; OD]. Brachial valve deep; strongly uniplicate; posterior part of shell without costae; entire shell covered by fine capillae separated by rows of fine pits. *U. Dev. (Famenn.)*, USA (N. Mex.-Ariz.). —FIG. 462, 1. **P. perchaensis* (STAINBROOK); 1a-e, ped. v., brach. v., lat., ant., post. views, $\times 1$; 1f, lat. view, $\times 2$; 1g-k, ser. sec. at 1.5, 2.2, 2.6, 2.8, 3.0 mm. from apex, $\times 2$ (185).

Schnurella SCHMIDT, 1964 [**Terebratulula schnuri* DE VERNEUIL, 1840, p. 261; OD]. Triangular to longitudinal-oval in outline; rather high in adult specimens; pedicle valve flat, brachial valve strongly convex; flanks and front truncated in adult shells; sulcus wanting or very shallow and taking up whole width of valve; fold not discernible in convexity of brachial valve; tongue nearly as broad as valve; costellae terminating at beginning of coarse costae; costae flattened on truncated parts of shell. *M. Dev.*, ?*U. Dev.*, Eu. (Ger.). —

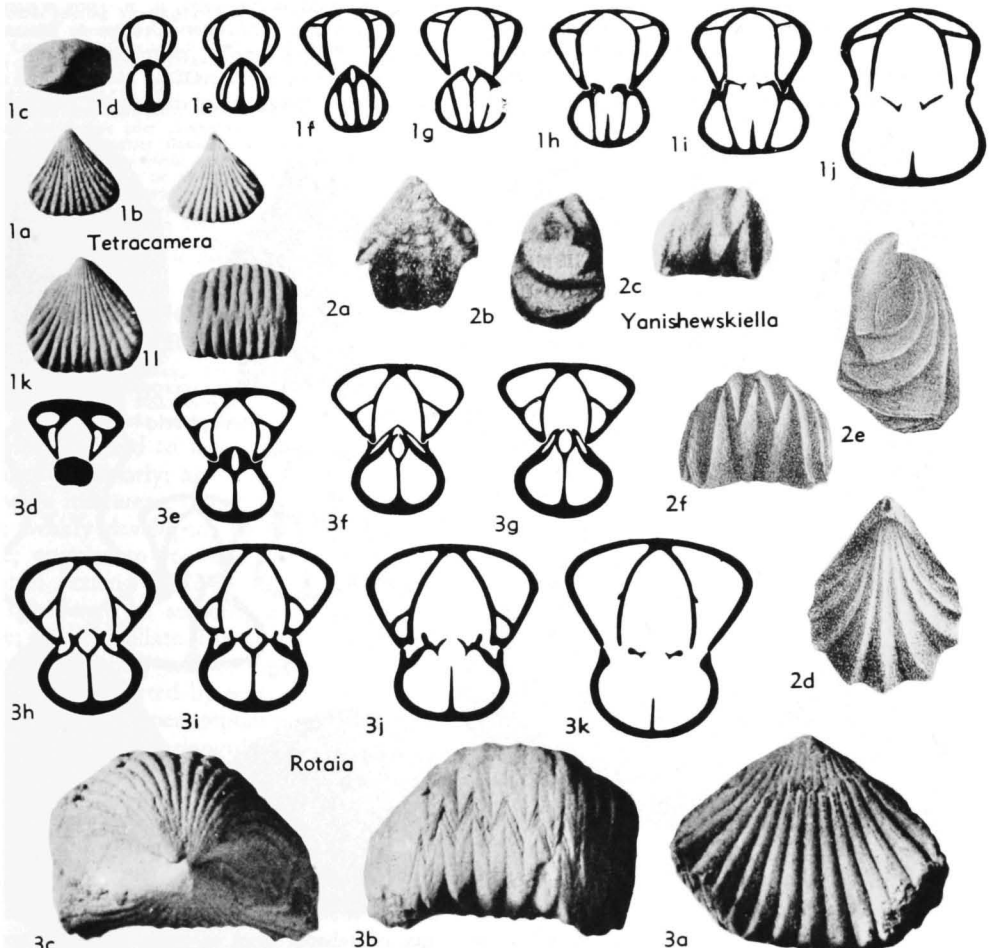
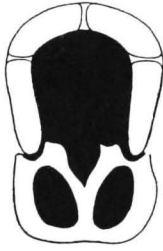


FIG. 466. Tetracameridae (p. H588-H589).



Yanishewskiella

FIG. 467. Tetracameridae (p. H589).

FIG. 462,5. **Schnurella schnuri*, Givet., Ger. (Eifel); 5a-c, ped.v., ant., lat. views, X1 (718b); 5d-i, ser. secs., X2 (931d). [SCHMIDT.]

Family TETRACAMERIDAE
Likharev in Rzhonsnitskaya, 1956

[nom. transl. RZHONSNITSKAYA, 1958, p. 115 (ex Tetracamerinae LIKHAREV in RZHONSNITSKAYA, 1956, p. 126) [Materials for this family prepared by D. J. McLAREN]]

Subtriangular to wedge-shaped; lateral and anterior margins truncate; commissure plane or uniplicate, serrate; wholly costate

with simple, subangular to rounded costae. Spondylium sessile, or supported on low septum in pedicle valve, with two lateral buttressing plates. Brachial valve with narrow outer hinge plates; septalium open or partially covered with inner hinge plates; strong median septum. *L. Carb. (Miss.)*.

Tetracamera WELLER, 1910, p. 503 [**Rhynchonella subcuneata* HALL, 1858, p. 11; OD]. Small or medium-sized; acute apical angle; commissure plane or weakly uniplicate; costae subangular; capillae may develop. Septalium open; lateral lamellae support hinge below dental sockets and rest on floor of brachial valve on either side of median septum. *Miss., N.Am.-?USSR.*—FIG. 466,1a-j. **T. subcuneata* (HALL), U.Miss., USA (Ind.); 1a-c, ped.v., brach.v., post. views, X1; 1d-j, ser. secs., X2.5(858).—FIG. 466,1k,l. *T. arctirostrata* (SWALLOW), U.Miss., USA (Mo.); 1k,l, ped.v., ant. views, X1 (858).

Rotaia RZHONSNITSKAYA, 1959, p. 30 [*pro Welleria* ROTAY, 1941, p. 107 (*non* ULRICH & BASSLER, 1923)] [**Rhynchonella subtrigona* MEEK & WORTHEN, 1860, p. 451; OD]. Medium-sized or large; obtuse apical angle; commissure uniplicate,

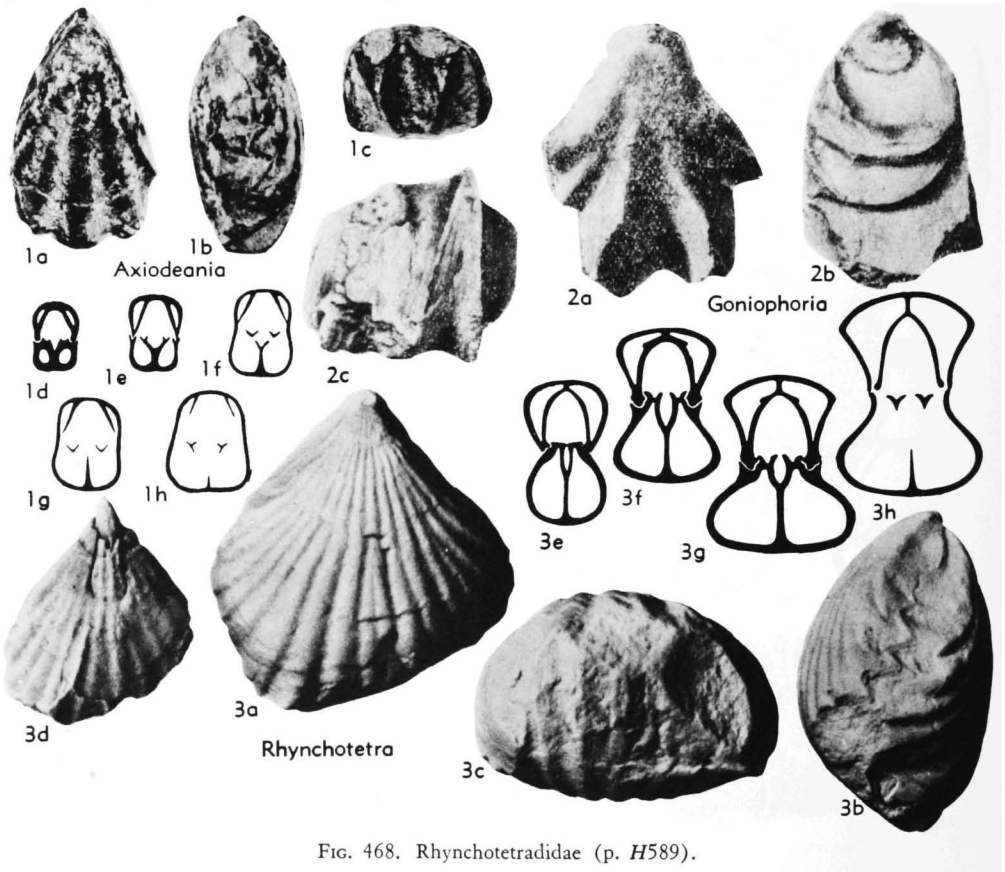


FIG. 468. Rhynchotetradidae (p. H589).

deeply serrate, downwardly deflected; costae rounded; low fold and shallow sulcus develop anteriorly. Septalium partly covered by discrete inner hinge plates. *L.Carb.*(*Miss.*), N.Am.-Australia (New S. Wales)-?USSR.—FIG. 466,3. **R. subtrigona* (MEEK & WORTHEN), *L.Miss.*, USA (Ill.); 3a-c, ped.v., ant., post. views, $\times 1$; 3d-k, ser. secs., $\times 1.25$ (858).

Yanishewskiella LIKHAREV, 1957, p. 139 [**Goniophoria angulata* YANISHEVSKIY, 1910, p. 83 (= ?*Anomia angulata* LINNÉ, 1767); OD]. Costae few, angular to subangular. Spondylium supported by septum and 2 lateral buttressing plates parallel to plane dividing valves. *L.Carb.*, USSR (S.Urals-Fergana)-?Eu.(Eng.).—FIG. 466,2a-c; 467,1. **Y. angulata* (YANISHEVSKIY), Fergana; 466, 2a-c, ped.v., lat., ant. views, $\times 1$; 467,1, transv. sec. near beak, $\times 5$ (517a).—FIG. 466,2d-f. **Y. angulata* (YANISHEVSKIY)?, Eng.; 2d-f, brach.v., lat., ant. views of LINNÉ's *Anomia angulata*, $\times 1$ (229).

[Doubts relating to recognition of this nominal genus arise from (1) uncertainty that specimens from Fergana used by LIKHAREV in drawing up his diagnosis of *Yanishewskiella* are conspecific with *Goniophoria angulata* YANISHEVSKIY from the southern Urals, including the holotype of this species, and (2) possibility that neither the Fergana nor Urals specimens are conspecific with LINNÉ's *Anomia angulata* from the British Isles. LIKHAREV's explicit original designation of the species *Goniophoria angulata* as the type-species of *Yanishewskiella* serves (under provisions of the Zoological Code) to tie this genus to the species named, defined by its holotype and associated specimens from the Urals region, regardless of the identity of shells studied by LIKHAREV in 1957 and his statement "if this Fergana species happens to differ from the holotype [of *Goniophoria angulata*] it should acquire a new species name."]

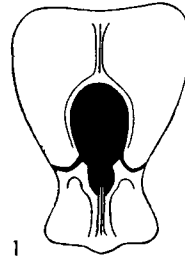
Family RHYNCHOTETRADIDAE

Likharev in Rzhonsnitskaya, 1956

[*nom. correct.* McLAREN, herein (ex Rhynchotetradidae LIKHAREV in RZHONSNITSKAYA, 1956, p. 126)] [= Rhynchotetradidae LIKHAREV in RZHONSNITSKAYA, 1959, p. 30] [Materials for this family prepared by D. J. McLAREN]

Medium-sized to large, subovate, wedge-shaped posteriorly; apical angle acute; large concave interareas; uniplicate; fold and sulcus weakly developed; paucicostate to costate; angular to rounded costae that may branch, extend from beak; posterolateral margins may be smooth; commissure serrate; finely capillate. Dental plates converge ventrally or may join to form spondylium, sessile or supported by septum; hinge plate divided; deep, open septalium; strong septum; crural bases triangular. [May be closely related to Tetracameridae.] *L.Carb.-L. Perm.*

Rhynchotetra WELLER, 1910, p. 506 [**Rhynchonella caput testudinis* WHITE, 1862, p. 23; OD]. Large; costae rounded to subangular, few bifurcate. Dental plates converging ventrally to join floor of pedicle valve, or form spondylium supported by septum. [Type-species imperfectly



Goniophoria

FIG. 469. Rhynchotetradidae (p. H589).

known; WELLER (1914, p. 205-7) would include forms with or without spondylium in this genus]. *Miss.*, N.Am.-?USSR.—FIG. 468,3a-d. **R. caput-testudinis* (WHITE); Kinderhook., USA (Iowa); 3a-c, brach.v., lat., ant. views, $\times 1$; 3d, int. cast ped.v., $\times 1$ (858).—FIG. 468,3e-h. *R. missouriensis* WELLER, Kinderhook., USA (Mo.); 3e-h, ser. secs., $\times 2.5$ (858).

Axiodeancia CLARK, 1917, p. 374 [**A. platypleura*; OD]. Narrowly triangular with rounded anterior; sides vertical; few strong, subangular costae extending from beak axially; posterolaterally smooth; commissure coarsely serrate; capillate. Strong, ventrally approximating dental plates. *L. Miss.*, USA (Mont.).—FIG. 468,1. **A. platypleura*; 1a-c, brach.v., lat., ant. views, $\times 1.3$; 1d-h, ser. secs., $\times 1.3$ (161a).

Goniophoria YANISHEVSKIY, 1910, p. 80 [**G. monstrosa*; SD SCHUCHERT & LEVENE, 1929, p. 63]. High, laterally compressed near beak; few high, angular, commonly asymmetrical costae; strongly serrate commissure. Spondylium supported by strong median septum; septum in brachial valve protruding into cavity of septalium. [LIKHAREV (1957) suggested that species possessing a spondylium assigned to *Rhynchotetra* may belong here (e.g., *R. missouriensis* WELLER).] *L.Carb.-L. Perm.*, USSR (Urals-Fergana)-Eu.-?N.Am.—FIG. 468,2. **G. monstrosa*, *L.Carb.*, USSR (S.Urals); 2a-c, brach.v., lat., ant. views, $\times 1$ (517a).—FIG. 469,1. *G. carinata* YANISHEVSKIY, *L.Carb.*, USSR (S.Urals), sec. near apex, $\times 2$ (517a).

Family WELLERELLIDAE

Likharev in Rzhonsnitskaya, 1956

[*Wellerellidae* LIKHAREV in RZHONSNITSKAYA, 1956, p. 125] [Materials for Paleozoic representatives of this family prepared by HERTA SCHMIDT (Mesozoic subfamilies by D. V. AGER)]

Sulcus and fold moderately developed; costae commonly strong, angular to subangular; commissure denticulate. No septalium or cardinal process; hinge plate entire; dorsal septum and dental plates variously developed. *L.Carb.-U.Cret.*

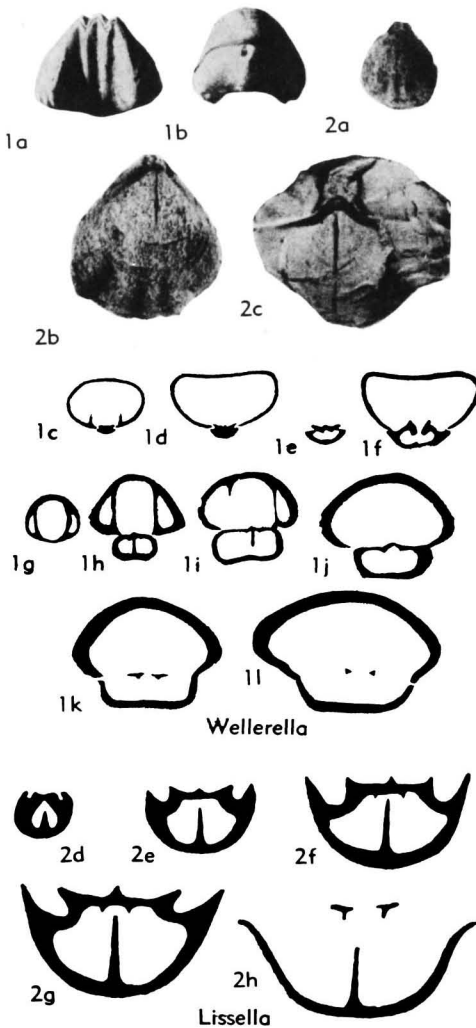


FIG. 470. Wellerellidae (Wellerellinae) (p. H590).

Subfamily WELLERELLINAE Likharev in Rzhonsnitskaya, 1956

[*nom. transl.* LIKHAREV in RZHONSNITSKAYA, 1958, p. 114] [Materials for this subfamily prepared by HERTA SCHMIDT]

Small to medium-sized; beak acute, little incurved. Dental plates commonly short or wanting; hinge plates united by flat or convex to keel-shaped plate; dorsal septum in most genera low or absent. *L. Carb.-U. Perm.*

Wellerella Group

Umbo smooth, costae beginning at moderate distance from apex. *U. Carb.-Perm.*

Wellerella DUNBAR & CONDR, 1932, p. 286 [**W. tetrahedra*; OD]. Small, circular to subpentagonal in outline; fold and sulcus well developed; deltidial

plates leaving free oval foramen in front of beak; few simple subangular costae beginning away from apex. Dental plates short; hinge plates united by flat or keel-shaped plate; dorsal septum very short or wanting. *U. Carb.-Perm.*, N. Am.-S. Am.-Asia-Eu. (Ural region).—FIG. 470, 1a-f. **W. tetrahedra*, M. Penn. (Marmaton), USA (Mo.); 1a, b, ant., post. views, ca. $\times 2$; 1c-f, ser. secs., ?mag. (270).—FIG. 470, 1g-l. *W. osagensis* (SWALLOW), U. Penn. (Shawnee Gr., Plattsmouth Ls.), USA (Neb.); ser. secs., ?mag. (270).

Lissella CAMPBELL, 1961, p. 452 [**L. booralensis*, p. 453; OD]. Small, oval, with sulcus and fold in anterior halves of valves; few rounded to subangular costae developed anteriorly. Dental plates very delicate; hinge plate robust with prominent median ridge; crural bases protruding dorsally; dorsal septum rather high and long, but not connected with hinge plate. *U. Carb.*, Australia.—FIG. 470, 2. **L. booralensis*, Booral F., New S. Wales (Gloucester trough); 2a, b, ped. v., $\times 1$, brach. v., $\times 2$; 2c, posterodorsal view, $\times 2$; 2d-h, transv. secs. (from several int. molds), $\times 3$ (143).

Pseudowellerella Group

Costae beginning at apex. *Perm. Carb.-U. Perm.*

Pseudowellerella LIKHAREV, 1956, p. 58 [**P. nikitchi*; OD]. Small, rounded, triangular in outline; sulcus and fold weakly developed; costae numerous, bifurcating. Dental plates wanting; hinge

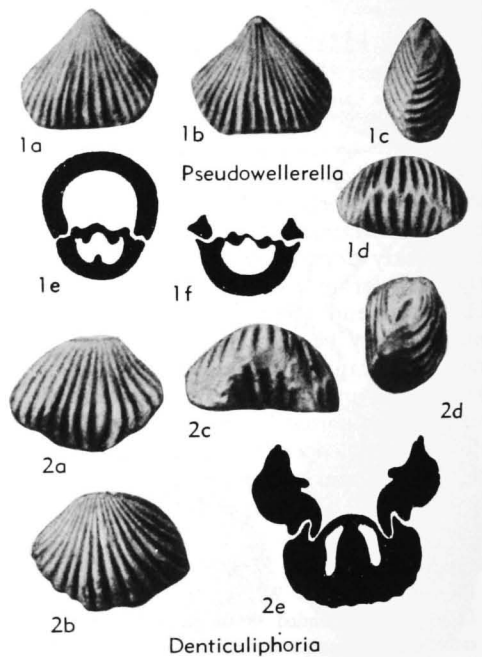


FIG. 471. Wellerellidae (Wellerellinae) (p. H590-H591).

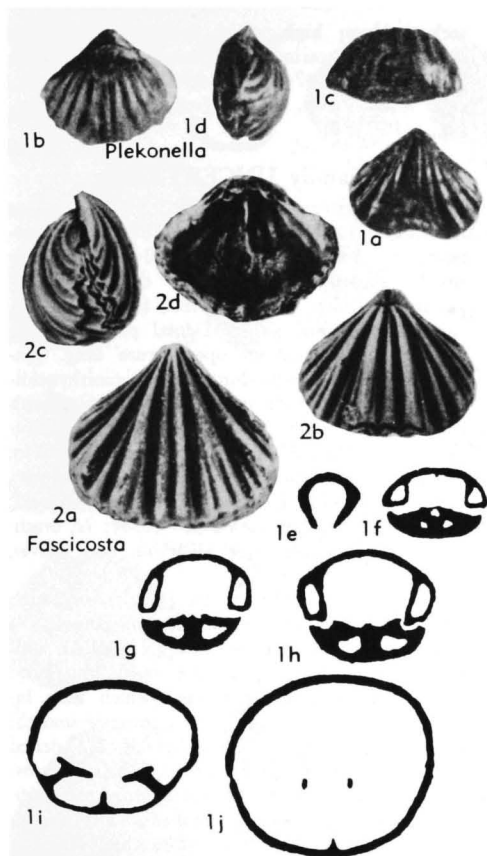


FIG. 472. Wellerellidae (Wellerellinae) (p. H591).

plates united by convex plate; dorsal median ridge short, low. *U.Perm.*, USSR (N.Caucasus).—FIG. 471,1. **P. nikitchi*; 1a-d, ped.v., brach.v., lat., ant. views, $\times 1$; 1e,j, transv. secs, $\times 4$ (517)

Denticuliphoria LIKHAREV, 1956, p 57 [**D. rara*; OD]. Resembling *Pseudowellerella* in shape, but with stronger and less numerous simple costae. Dental plates wanting; teeth very strong and long; accessory ventral denticles fitting into accessory sockets of brachial valve; hinge plates united by convex plate extending farther anteriorly than lateral parts of hinge plate; dorsal septum or ridge thick and short, becoming separated from hinge plate within zone of articulation. *U. Perm.*, USSR (N.Caucasus).—FIG. 471,2. **D. rara*; 2a-d, ped.v., brach.v., ant., lat. views, $\times 1.5$; 2e, ser. sec., $\times 5$ (517).

Fascicosta STEHLI, 1955, p. 71 [**Rhynchonella? longaeva* GIRTY, 1909, p. 322; OD]. Small, sub-pentagonal to rounded triangular in outline; sulcus and fold beginning near mid-length; tongue low; beak prominent, with subapical foramen and large conjunct deltidial plates; costae strong, increasing by bifurcation and implantation, crossed

by fine concentric lines; commissure denticulate to undulate. Dental plates small; teeth and sockets crenulate; hinge plate supported by low broad ridge, rarely by low septum. *Perm.*(*Word.-Capitan.*), N.Am.(Tex.).—FIG. 472,2. **F. longaeva* (GIRTY), Cherry Canyon F., W.Tex.(Guadalupe Mts.; 2a-c, ped.v., brach.v., lat. views, $\times 2$; 2d, brach.v. int., $\times 2$ (774).

Plekonella CAMPBELL, 1953, p. 17 [**P. acuta*; OD]. Medium-sized, transversely oval; sulcus and fold developed in anterior parts of valves; costae simple. Dental plates well developed; hinge plate concave, divided only anteriorly from zone of articulation, with ridge directed ventrally; dorsal septum or ridge thick but short. *Permocarb.*, Australia (Queensl.).—FIG. 472,1. **P. acuta*, Inglesia Beds; 1a-d, ped.v., brach.v., ant., lat. views, $\times 1$; 1e-j, transv. secs. (several specimens), ?mag. (139).

Allorhynchus Group

Genera having some external and internal features of Wellerellinae but lacking connecting plate between hinge-plates. [Loosely annexed to subfamily.] *L.Carb.-U.Perm.*

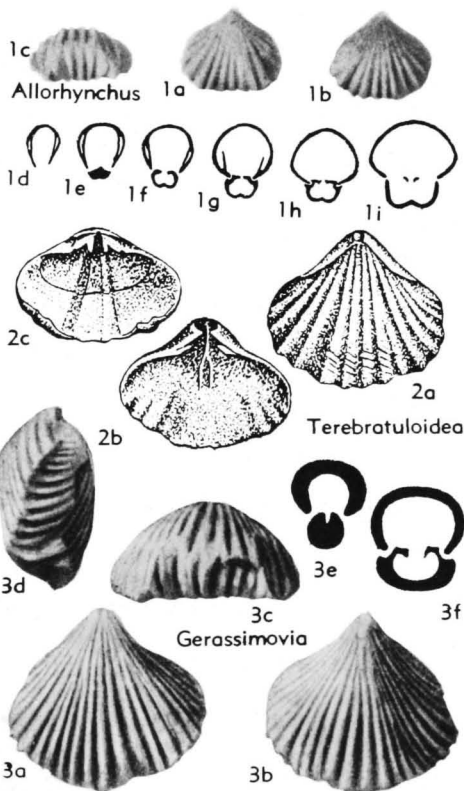


FIG. 473. Wellerellidae (Wellerellinae) (p. H592).

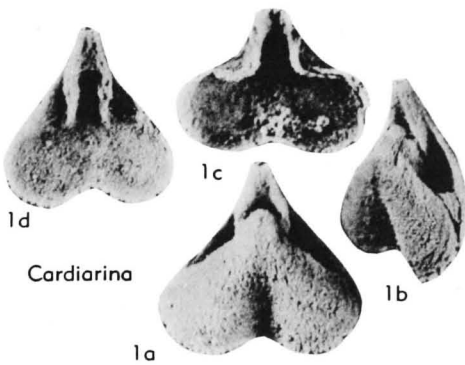


FIG. 474. Cardiarinidae (p. H592).

Allorhynchus WELLER, 1910, p. 509 [**Rhynchonella heteropsis* WINCHELL, 1865, p. 121; OD]. Small, transversely elliptical; ventral beak prominent; sulcus and fold distinct in anterior halves of valves; costae numerous, simple, angular, beginning at apex. Dental plates short, in type-species closely approached to shell wall; dorsal septum absent but low ridge may be present. *L. Carb.*, ?*Perm.*, N.Am.—FIG. 473,1. **A. heteropsis* (WINCHELL). *L. Miss.*(Kinderhook.), USA (Iowa); 1a-c, ped.v., brach.v., ant. views, $\times 1$ (178); 1d-i, ser. secs., $\times 2.5$ (856a).

Gerassimovia LIKHAREV, 1956, p. 59 [**G. gefoensis*; OD]. Exteriorly resembling *Pseudowellera*. *U. Perm.*, USSR (N.Caucasus).—FIG. 473,3. **G. gefoensis*; 3a-d, ped.v., brach.v., ant., lat. views, $\times 1$; 3e,f, ser. secs., $\times 4$ (517).

Terebratuloidea WAAGEN, 1883, p. 410 [**T. davidsoni*]. Transversely elliptical; sulcus and fold well marked; ventral beak truncated by large foramen; costae simple, strong, beginning on beak, crossed by transverse lines. Dental plates and dorsal septum wanting. *Permocarb.*, Asia (India-China)-Eu. (USSR-Alps-Sicily).—FIG. 473,2. **T. davidsoni*; 2a-c, brach.v., ped.v. int., brach.v. int., $\times 1$ (396, after Waagen).

?Family CARDIARINIDAE Cooper, 1956

[Cardiarinidae COOPER, 1956, p. 527] [Materials for this family prepared by D. J. McLAREN]

Foramen apical, beak elongate, strong inner beak ridges, no crura, with elaborate parathyridium. *Penn.*

Cardiarina COOPER, 1956, p. 527 [**C. cordata*; OD]. Minute, heart-shaped; rectimarginate to sulcate; smooth. Pedicle valve with symphytium(?), excavated lateral margins; long dental plates that loop anteriorly round excavated area; teeth small, narrow, attached to inner side of dental plates. Brachial valve with narrow sockets, thin outer

socket ridges; high, stout, inner socket ridges; strong median carina, no septum. *Penn.*, USA (N. Mex.).—FIG. 474,1. **C. cordata*; 1a,b, brach., side tilted views, $\times 15$; 1c,d, brach.v., ped.v. int., $\times 15$ (188).

Family UNCERTAIN

Diabolirhynchia (see p. H904).

Dorsisinus SANDERS, 1958, p. 53 [**Centronella louisianensis* WELLER, 1914, p. 241; OD]. Very small, smooth-shelled; sulcate; delthyrium triangular, deltidial plates incipient; fold on pedicle, sulcus on brachial valve. Dental plates present; septum long, septalium open, crura long. [Interior suggests relationship with Trigonirhynchidae, but external form may call for grouping with other smooth sulcate forms (e.g., *Paranorella*, *Sanjuanina*.)] *L. Miss.*, USA (Miss. Valley)-Mex.—FIG. 475,1. **D. louisianensis* (WELLER), Kinderhook, USA (Ill.) (1a,b); *L. Miss.*, Mex. (Sonora) (1c,d); 1a,b, ped.v., brach.v. views, $\times 4$ (858); 1c, brach.v. int., $\times 3$; 1d, oblique view int. both valves, $\times 4$ (705a). [McLAREN.]

Katunia KULKOV, 1963, p. 54 [**K. subtrigonata*; OD]. Small to medium-sized, subtriangular to subpentagonal in outline; strongly inflated; uniplicate; fold and sulcus developed anteriorly; rounded to subangular costae (which may bifurcate) developed toward front; posterior smooth; commissure serrate. Thick-shelled; no dental plates; teeth supported by inturned shell margins; inner margins of massive divided hinge plate support rounded crura; no cardinal process or median septum; low ridge on floor of brachial valve. *L. Dev.*, USSR (Gorno-Altay) - ?Eu. (Karnic Alps).—FIG. 476,4. **K. subtrigonata*, Gorno-Altay; 4a-d, ped.v., brach.v., lat., ant. views, $\times 1$; 4e-i, ser. secs., $\times 3$ (493a). [McLAREN.]

Ladogifornix SCHMIDT, 1964 [**Terebratula fornicata* SCHNUR, 1853, p. 175; OD]. Medium-sized, sub-tetrahedral; pedicle valve flat to concave; brachial valve strongly convex; sulcus broad, deep, rounded; tongue high with curved margin; fold high, not distinctly defined; costae numerous, fine, more prominent near front, some of them branching; commissure finely denticulate. Pedicle valve without median ridge; dental plates nearly parallel in cross section; umbonal cavities large;

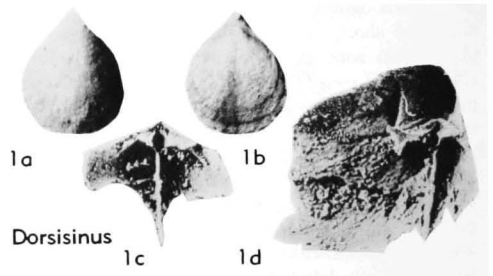


FIG. 475. Family Uncertain (p. H592).

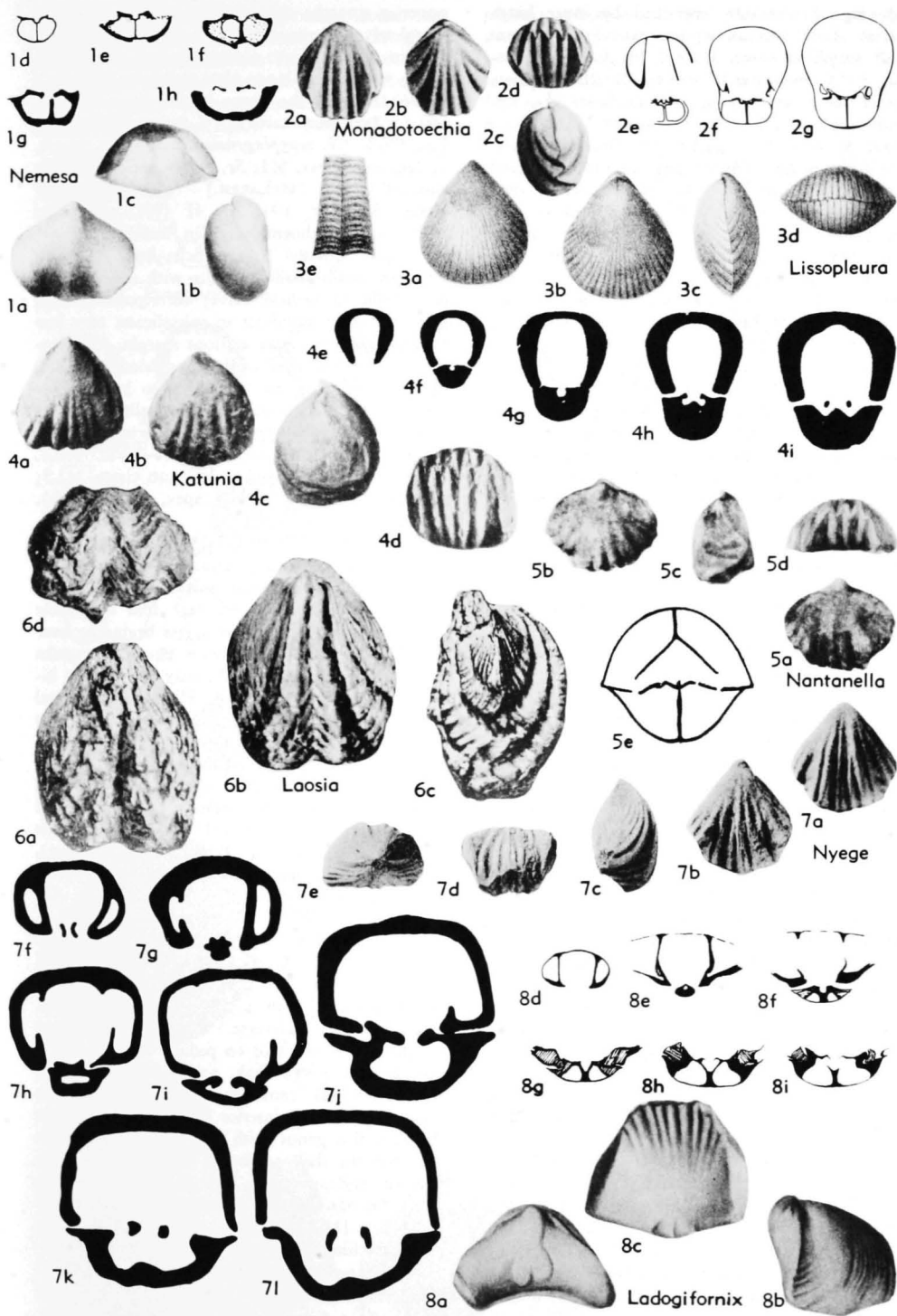


FIG. 476. Family Uncertain (p. H592, H594).

opening of septalium restrained by inner hinge plates; dorsal median septum extending to about half length of valve. *M.Dev.*, Eu.(Ger.).—FIG. 476.8. **L. fornicatus* (SCHNUR), Ger.(Eifel); *8a-c*, ped.v., lat., ant. views, $\times 1$ (718b); *8d-i*, ser. transv. secs., $\times 2.5$ (931d). [SCHMIDT.]

Laosia MANSUY, 1913, p. 83 [**L. Dussaulti*; OD]. Small, elongate subpentagonal in outline; apical angle acute; brachial valve more inflated than pedicle valve; pedicle beak erect; shell covered by few, coarse, angular, simple costae; median costa low on brachial valve, opposite deep, angular sulcus on pedicle valve; commissure coarsely serrate; strong concentric growth lines. Interior unknown. *Perm.*, Indo-China.—FIG. 476.6. **L. dussaulti*; *6a-d*, ped.v., brach.v., lat., ant. views, $\times 3$ (532b). [McLAREN.]

Leiorhynchoides DOVGAL, 1953, p. 139 [**L. gratianovae*; OD]. Medium-sized, subpentagonal in outline; brachial valve more convex than pedicle; fold and sulcus present, margin uniplicate; rounded costae toward front of valves. Interior imperfectly known; impressed elongate diductor impressions and no dental plates in pedicle valve; median septum in brachial valve, no septalium, hinge plates reduced. *M.Dev.*, USSR(Altay). [McLAREN.]

Lissopleura WHITFIELD, 1896, p. 232 [**Rhynchonella aequivalvis* HALL, 1857, p. 66; OD]. Small, compressed, broadly ovate in outline; equivalve; beak small, erect to incurved; commissure plane to weakly uniplicate; without fold or sulcus; costate from beak; low rounded costae with narrow linear interspaces; fine concentric ornament. Dental plates present, and bilobed muscle impression in pedicle valve; strong median septum; hinge plate unknown. [This genus may be a compressed youthful form of rhynchonelloid.] *L.Dev.*(Helderberg.), USA(N.Y.).—FIG. 476.3. **L. aequivalvis* (HALL); *3a-d*, ped.v., brach.v., lat., ant. views, $\times 1$; *3e*, portion of costae showing concentric ornament, enlarged (384). [McLAREN.]

Monadotochia HAVLIČEK, 1960, p. 243 [**Terebratulina Monas* BARRANDE, 1847, p. 444; OD]. Small, elongate, inflated; lateral margins almost vertical; uniplicate; shallow sulcus, low fold anteriorly only; few subangular costae developed toward front; smooth posteriorly; commissure serrate. Dental plates short, thin; hinge plate entire, concave, grooved posteriorly; supported by median septum. *L.Dev.*, Czech.-E.Eu.—FIG. 476.2a-d. **M. monas* (BARRANDE), Boh.; *2a-d*, ped.v., brach.v., lat., ant. views, $\times 2$ (53).—FIG. 476.2e-g. *M. monadina* HAVLIČEK, Boh.; *2e-g*, ser. transv. secs. 5.2, 5.15, 5.05 mm. from ant. margin, $\times 4$ (411a). [McLAREN.]

Nantanela GRABAU, 1936, p. 70 [**N. mapingensis*; OD]. Small, transverse; uniplicate, with strong fold and sulcus in anterior part of shell; tongue broad, vertical; beak erect; interarea small; paucicostate anteriorly, costae subrounded to angular;

posterior smooth; commissure serrate. Interior incompletely known; spondylium supported by septum in pedicle valve; septum present in brachial valve; structure of hinge plate unknown. [GRABAU (1936) assigned the genus to the Camerophoriacea (=Stenoscismatacea.)] *L.Perm.*, China.—FIG. 476.5. **N. mapingensis*; *5a-d*, ped.v., brach.v., lat., ant. views, $\times 1$; *5e*, transv. sec. near apex, enlarged (362a). [McLAREN.]

Nemesa SCHMIDT, 1941, p. 41 [**N. nemesana*; OD]. Small, subpentagonal in outline; brachial valve more inflated than pedicle; beak incurved, interarea small; shallow sulcus with short tongue near front in pedicle valve; corresponding fold low or absent; uniplicate to sulciphate; very few rounded shallow costae at front margin, commonly only 1 in sulcus, 2 on fold; remainder of shell smooth. Dental plates very close to lateral margins of shell, commonly lost in callus; divided hinge plates; open septalium supported by slender septum. *M.Dev.*(Eifel.), Ger.—FIG. 476.1. **N. nemesana*; *1a-c*, ped.v., lat., ant. views, $\times 1.5$; *1d-h*, ser. transv. secs. near apex, $\times 2.5$ (718b). [McLAREN.]

Nyege VEEVERS, 1959, p. 113 [**N. scopimus*; OD]. Small to medium-sized, subpentagonal in outline; equivalve; intraplicate to sulcate; pedicle beak suberect; without interarea; high fold in pedicle and broad sulcus in brachial valves beginning near umbones; rounded costae with equal interspaces extending nearly from beak, may increase by bifurcation and intercalation. High, short dental plates; divided hinge plates, bifid cardinal process at apex; no septum; crura apparently straight. [VEEVERS (1959) included the genus in the Atrypoidea but failed to find spiralia. Externally it closely resembles species from the Famennian of the southern Urals assigned to *Plectorhynchella* by ROZMAN (1962) (e.g., *P. markovskii* ROZMAN), but she reported the presence of a septum supporting the hinge plate.] *U.Dev.*(Famenn.), W. Australia.—FIG. 476.7. **N. scopimus*; *7a-e*, ped.v., brach.v., lat., ant., post. views, $\times 1.5$; *7f-l*, ser. transv. secs. 0.5, 0.7, 0.9, 0.95, 1.05, 1.15, 1.35 mm. from apex, $\times 9$ (838). [McLAREN.]

Payuella GRABAU, 1934, p. 150 [**P. obscura*; OD]. Medium-sized, transverse, flattened; sulcus on brachial valve; low fold on pedicle valve; ?sulcate; pedicle beak erect; weak, rounded costae extend nearly from beak; commissure serrate. Dental plates present, otherwise interior unknown. [GRABAU classified this genus with the Dielasmataidae, but described the shell as fibrous and made no mention of endopunctae.] *L.Perm.*, China.—FIG. 477.5. **P. obscura*; *5a-c*, brach.v., lat., post. views, $\times 2$ (362). [McLAREN.]

Phoenicoetochia HAVLIČEK, 1960, p. 242 [**Terebratulina Phoenix* BARRANDE, 1847, p. 431; OD]. Small, high in anterior region; sulcus and fold beginning at distance from beak; sulcus shallow, tongue low; fold very low, in some shells not dis-

tinguishable from curvature of valve; costae not numerous, strong, rounded, restricted to marginal parts of valves; commissure strongly denticulate. Dental plates slender, thin; hinge plates divided, narrow; median septum supporting wide septalium. *L.Dev.*, Eu.(Boh.).—FIG. 477,3. *P.

phoenix (BARRANDE), Boh.(Kroněprusy); 3*a-d*, ped.v., brach.v., lat., ant. views, $\times 1$ (53); 3*e-h*, ser. transv. secs., $\times 7.5$ (SCHMIDT, n). [SCHMIDT.] *Plectorhynchella* COOPER & MUIR-WOOD, 1951, p. 195 [*pro Monticola* NALIVKIN, 1930, p. 86 (*non* BOIE, 1822)] [*Athyris collinensis* FRECH, 1902,

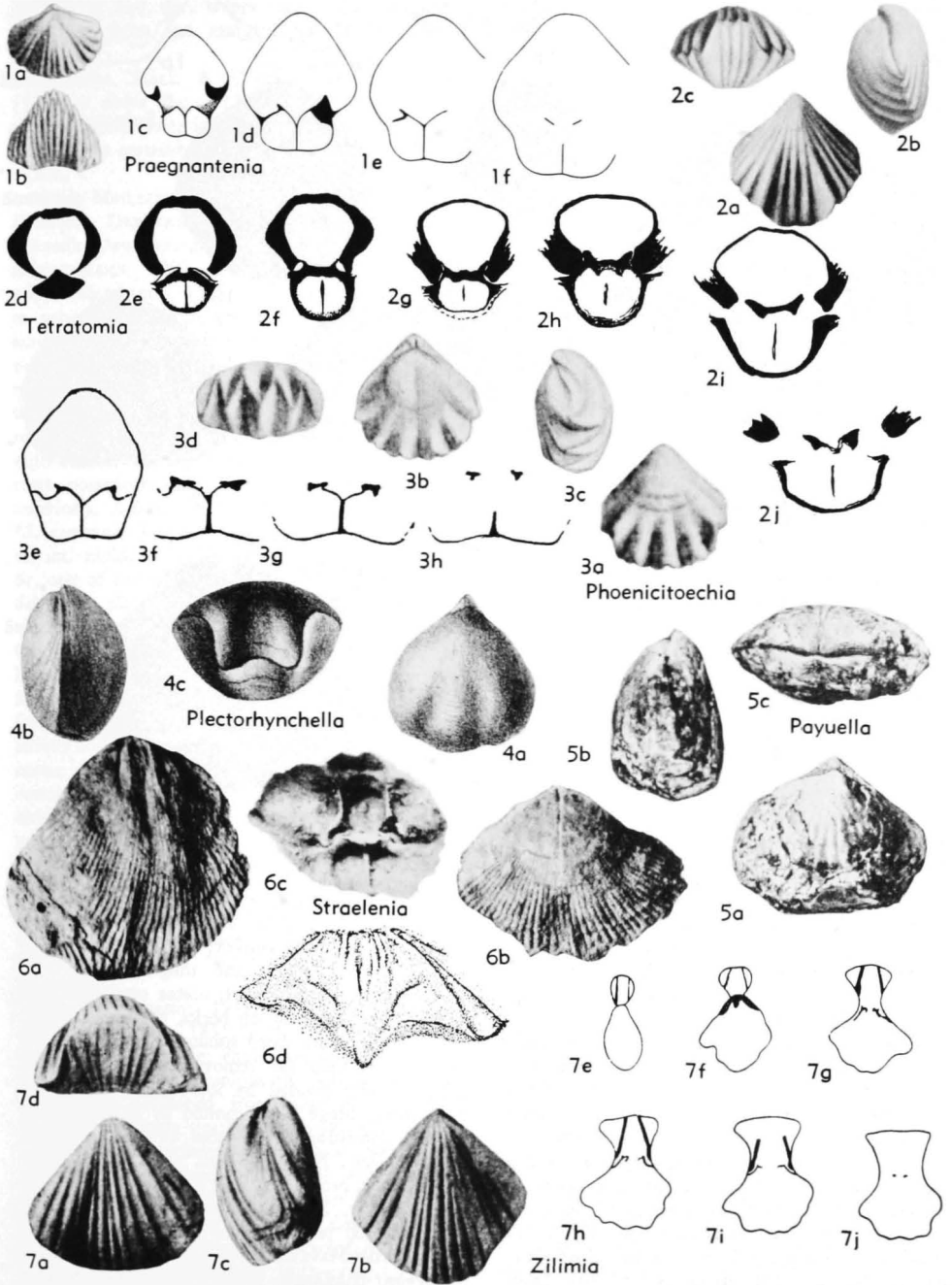


FIG. 477. Family Uncertain (p. H594-H597).

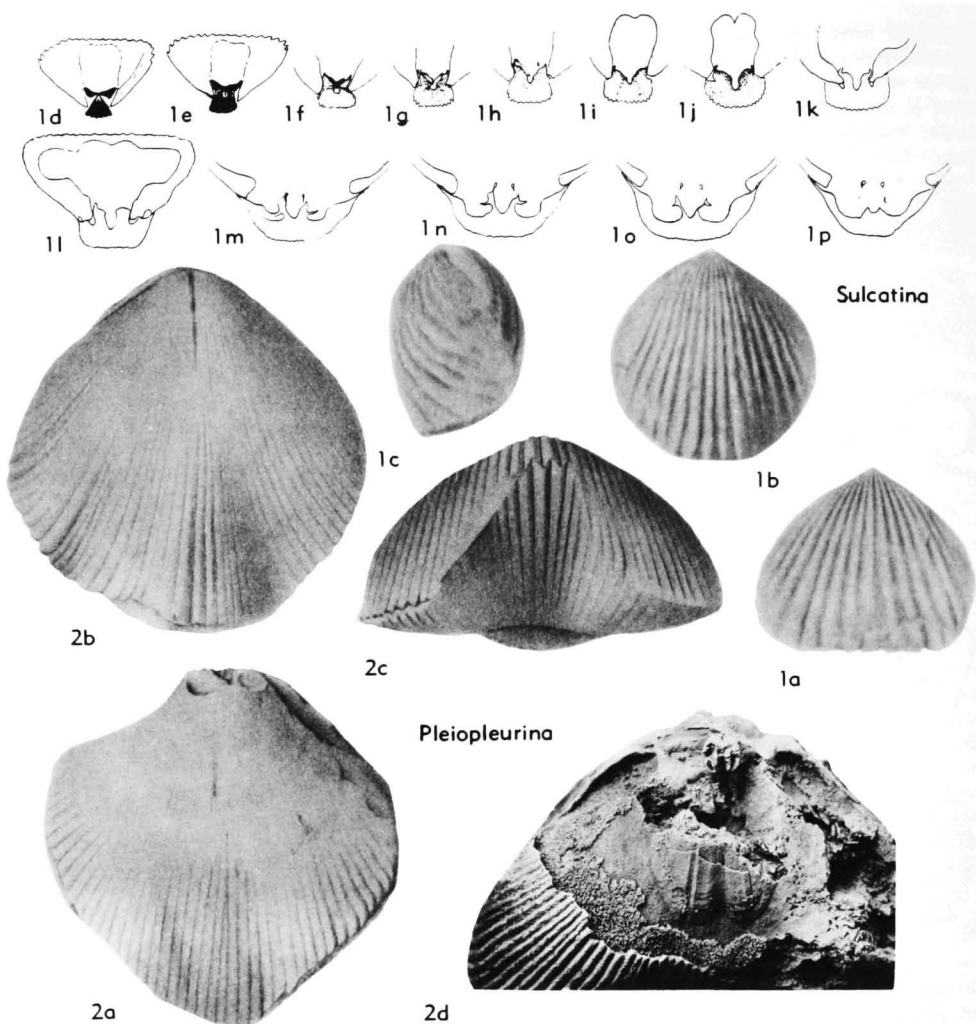


FIG. 477A. Family Uncertain (p. H596-H597).

p. 99; OD]. Small, subpentagonal, inflated; intraplicate to sulcate; pedicle beak nearly straight to erect; pedicle valve fold and brachial valve sulcus confined to anterior part of shell; smooth posteriorly; may develop low, irregular, bifurcating costae anteriorly; strong concentric micro-ornament. Interior poorly known; dental plates present; dorsal median septum, and possibly divided hinge plates. [HAVLIČEK (1961, p. 203) stated that Bohemian species assigned to this genus may belong to the Atrypoida and not the Rhynchonelloidea. The affinities of the type-species are not clear, nor is it certain that all species assigned to the genus are, in fact, congeneric.] ?*L.Dev.*, *U.Dev.*, ?*L.Carb.*, Eu., USSR.—FIG. 477,4. **P. collinensis* (FRECH), *U.Dev.*, Karnic Alps; 4a-c, brach.v., lat., and ant. views, $\times 2$ (311b). [McLAREN.]

Pleiolepurina SCHMIDT, 1964 [**Atrypa pleiolepurina* CONRAD, 1841, p. 55; OD]. Large, not high; pedicle valve faintly convex; brachial valve moderately convex; sulcus and tongue broad; fold prominent in anterior part; costae numerous, relatively fine, beginning on beaks, rounded-angular; commissure denticulate, situated on edges. Ventral muscle field far removed posteriorly, oval, longitudinally divided by low ridge; dorsal septum short; hinge plates united by stout cardinal process consisting of 2 tubes or funnels; crura thick. *L.Dev.*, N.Am.—FIG. 477A,2. **P. pleiolepurina*; 2a-c, ped.v., brach.v., ant. view, $\times 1$ (384); 2d, Oriskany, N.York, posterior part of brach.v. with cardinal process, $\times 1.5$ (931d). [SCHMIDT.] **Pracnangentia** HAVLIČEK, 1961, p. 99 [**Terebratula praegnans* BARRANDE, 1847, p. 428; OD]. Similar to *Phoenicitoechia*; more inflated, with high fold

and tongue; anterior commissure depressed below crest of brachial valve; numerous angular costae increasing by bifurcation, developed anteriorly only; umbones smooth; commissure strongly serrate. *L.Dev.*, Eu. (Czech.).—FIG. 477, I. **P. praegnans* (BARRANDE); *1a, b*, brach.v., ant. views, $\times 1$ (53); *1c-f*, ser. transv. secs. 7.2, 7.0, 6.85, 6.75 mm. from ant. margin, $\times 4$ (411a). [McLAREN.]

Protorhyncha HALL & CLARKE, 1893, p. 180 [**Atrypa dubia* HALL, 1847, p. 21; OD]. Types of type-species lost; interior unknown. [Unrecognizable, not certainly a rhynchonellacean.] *M.Ord.*, N.Am.

Straelenia MAILLIEUX, 1935, p. 10 [**Rhynchonella Dunensis* DREVERMANN, 1902, p. 108=*Rhynchonella Dannenbergi* KAYSER mut. nov. minor DREVERMANN, 1902, p. 107; OD] [= *Dinapophysia* MAILLIEUX, 1935, p. 5]. Large, transverse to subquadrate, with greatest width about mid-length; inequivalve; fold and sulcus weakly developed; commissure shallowly uniplicate; numerous, rounded, simple costae, which may extend from umbones. Dental plates present; strong median septum supporting undivided hinge plate with surface bearing longitudinal ridges and furrows posteriorly and rounded median elevation anteriorly. *L.Dev.*, W.Eu.-?N.Afr.—FIG. 477, 6. **S. dunensis* (DREVERMANN), Belg.-Ger.; *6a*, ped. v., int. mold, $\times 1$; *6b*, brach.v., int. mold, $\times 1$; *6c*, cast of cardinalia of both valves, $\times 2$ (529a); *6d*, hinge plate, $\times 6$ (931c). [McLAREN.]

Sulcatina SCHMIDT, 1964 [**Trigonirhynchia sulcata* COOPER, 1942, p. 234; OD]. Medium-sized to large; rounded trigonal in outline; pedicle valve flat, brachial valve strongly convex; sulcus and fold beginning at distance from apex, broad, not strictly defined; anterior margin of tongue curved; costae simple, strong, angular, beginning at apex; commissure denticulate, situated on edge. Interior of apical parts filled by callus; dental plates very deep; hinge plates separated by deep cavity; walls of cavity extending to valve wall; 2-winged process above and partly on hinge plates. *Sil.*, N.Am.-?Eu.—FIG. 477A, I. **S. sulcata*; *1a-c*, ped.v., brach.v., lat. view, $\times 1$ (178); *1d-p*, Indiana (Waldron), ser. secs., $\times 2$ (931d). [SCHMIDT.]

Tetratomia SCHMIDT, 1941, p. 13 [**Terebratula tetratoma* SCHNUR, 1851, p. 4; OD]. Small, subpentagonal in outline; equivalve, moderately convex; beak incurved; uniplicate, with strong fold and sulcus developed from near beak; tongue trapezoidal; costate nearly from beak, with simple, angular costae; commissure weakly serrate. Dental plates commonly fused with shell walls; hinge-plate entire; no septalium; median septum not joined to hinge plate, becoming detached from floor of valve and extending forward of articulation as unsupported plate, *M.Dev.* (*Eifel.*), Ger.—FIG. 477, 2. **T. tetratoma* (SCHNUR); *2a-c*,

ped.v., lat., ant. views, $\times 2$ (718b); *2d-j*, ser. transv. secs., $\times 4$ (719a). [McLAREN.]

Zilimia NALIVKIN, 1947, p. 93 [**Rhynchonella polonica* GÜRICH, 1896, p. 291; OD] [= *Zilimia* NALIVKIN, 1937, p. 107 (*nom. nud.*)]. Large, subtriangular to subpentagonal in outline; brachial valve strongly inflated, pedicle valve flattened to concave; beak long, straight; uniplicate, sulcus very broad, shallow, tongue high and rounded; fold high, developed only anteriorly; costae numerous, rounded, and increase by bifurcation over whole shell; commissure smooth. Dental plates strong; hinge plates divided; no septalium, cardinal process, or median septum. *U.Dev.* (*Famenn.*), Pol.-USSR (Urals).—FIG. 477, 7a-d. **Z. polonica* (GÜRICH), Ural; *7a-d*, ped.v., brach.v., lat., ant. views, $\times 1$ (690).—FIG. 477, 7e-j. *Z. mugodjarica* ROZMAN, Ural; *7e-j*, ser. transv. secs. 1.5, 2.5, 5.0, 7.0, 7.5, 8.0 mm. from apex, $\times 1$ (683a). [McLAREN.]

MESOZOIC AND CENOZOIC RHYNCHONELLACEA

By D. V. AGER

Mesozoic and Cenozoic rhynchonellaceans are segregated in the *Treatise*, partly because of separate authorship and partly because of the great taxonomic break between the Paleozoic and later forms. The separation is reflected not only in the classification, but also in the characters used in diagnosis and even in the morphological terminology. The separation is largely artificial, since the author has no doubt that most or all of the Mesozoic lineages can be traced back into the Paleozoic, but it cannot be resolved at present because the groups have been studied in different ways and the same information is not available about both. This arises particularly from the dependence placed by Mesozoic workers on serial section studies.

To a certain degree the same reservations apply to the apparent break in the rhynchonellacean lineages at the end of the Mesozoic, but at that time there does seem to have been a considerable reduction and restriction of the stocks, both geographically and ecologically.

Numerically, described rhynchonellacean genera from Mesozoic rocks are nearly five times greater than those reported from Cenozoic deposits, including Recent. The combined assemblage of Triassic, Jurassic, and Cretaceous rhynchonelloids contains 105 genera (not counting 17 nominal genera

classed as synonyms), whereas the total number of known Cenozoic genera amounts only to 20 (likewise omitting nominal genera considered to be synonyms, 8 in number). A single genus (*Aetheia*) is included in the count of both Mesozoic and Cenozoic forms, which indicates a surprising degree of classificatory separateness.

The large number of genera erected for Mesozoic brachiopods, particularly those proposed for Jurassic rhynchonelloids and terebratuloids by S. S. BUCKMAN (1918) in a single publication, has been much criticized by specialists in other fields. The preponderance of named Jurassic forms over those from Triassic and Cretaceous strata actually does not reflect relative complexity of the groups occurring in the three systems. Certainly, the rhynchonelloids were quite as varied in late Triassic times as in the Jurassic, and those of the former period still constitute the greatest gap in our knowledge of the Brachiopoda.

The validity of the named genera is a very subjective matter, though almost any grouping of related forms among the thousands of species which have been called "*Rhynchonella*" is likely to be useful. Unfortunately, different criteria have been used by different authors, e.g., BUCKMAN (1918) placed great emphasis on muscle scars and internal plates, WISNIEWSKA (1932) assigned major significance to forms of the crura, and LEIDHOLD (1920) considered microscopic structure of the shell to have greatest weight. Almost every morphological character, considered apart from others, can be shown to be unsatisfactory as a basis for classification in one or more groups, and few genera have yet been fully described both internally and externally. Although further investigations will undoubtedly show that many of the nominal genera are most usefully regarded as synonyms, there seems to be little value in suppressing them now, since later studies of internal and microscopic structures may call for their resurrection. Also, it is probable that several new generic names will be needed, especially for designation of Triassic forms.

The arrangement of genera in subfamilies proposed here should be regarded as an attempt to bring together members of related but independently evolving stocks.

MORPHOLOGICAL FEATURES

CRURA

Eight different forms of crura have so far been distinguished among the Mesozoic and Cenozoic rhynchonelloids, and three more are added here (Fig. 478). These are not, however, of equal importance and distinctiveness. Undoubtedly the basic and most separate types are the three originally defined by ROTHPLETZ (1886), and named by him "radulifer," "falcifer," and "septifer."

Radulifer. The radulifer type of crura are unspecialized hook- or rodlike structures which project from the hinge plates toward the pedicle valve. This is the simplest form of crura and may well be the basic type. What may be regarded as the typical radulifer crus is shown in Fig. 478,1, but commonly the crura are much straighter than this and have various terminal processes. These processes, which are often overlooked by students of the group, were mentioned in ROTHPLETZ's original description, and in fact are implied by the name of the form. The essential character of radulifer crura, as seen in transverse sections, is that they arise on the ventral side of the hinge plates and project (albeit only slightly) into the pedicle valve. They are accompanied by a more or less well-developed dorsal median septum.

Falcifer. The falcifer type was originally defined by ROTHPLETZ as sickle-shaped, as the name indicates, but the most essential character of this type is that they arise on the dorsal side of the hinge plates and project into the brachial valve as broad blade-like processes (Fig. 478,2). They are characteristically accompanied by a very reduced dorsal median septum or none at all.

Septifer. The septifer type refers to crura which have the form of septa that descend directly from the dorsal side of the hinge plates to the floor of the brachial valve (Fig. 478,3). In his original description, ROTHPLETZ implied that septifer crura might arise from the falcifer type simply by the crura coming into contact with the brachial valve. The converse is more likely to be true, since, in the main, the septifer types precede the falcifer types in time. What is more, some genera such as *Sulcirostra* as revised by AGER (1959) and *Crurirhynchia*

DAGIS (1961) appear to show combinations of the radulifer and septifer types.

Arcuifer. WISNIEWSKA (1932) redefined the ROTHPLETZ types with the aid of serially

ground Polish material and added a fourth type named arcuifer. She recognized this only in the little-known genus *Monticlairella* (Fig. 478,4), however. The crura are hammer-shaped in cross section, with arcuate "heads" which are concave toward each other. Several members of the subfamily Norellinae are now known to have crura which approach this form, but it may also grade into the radulifer type, and is not really well enough known to be properly evaluated now.

Calcarifer. MUIR-WOOD (1934) added a fifth type, termed calcarifer, which she recognized particularly in the genera *Kallirhynchia* and *Rhynchonelloidella*. It was said to be characterized by a dorsally directed process at the distal end of each crus (Fig. 479,1,2), but when a reconstruction was made from the only complete set of transverse sections available (Fig. 478,5), it proved to be close to the falcifer shape. On general morphological grounds also,

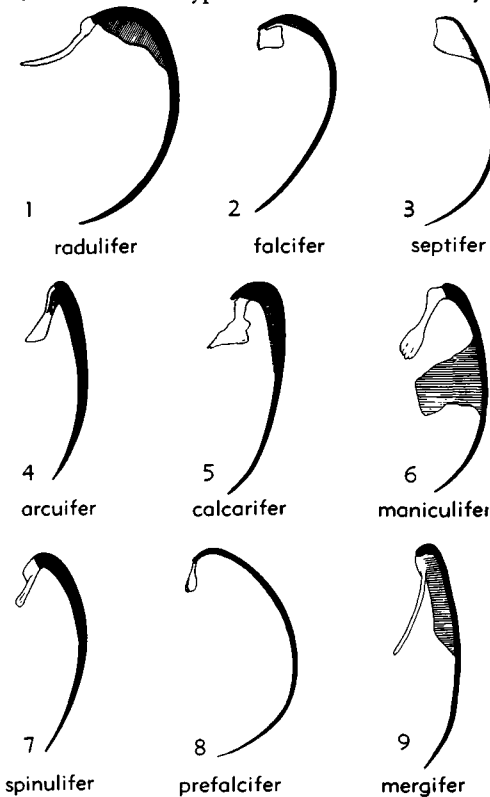


FIG. 478. Types of crura in Mesozoic and Cenozoic Rhynchonellida, illustrated by longitudinal sections of brachial valves through left crus with median septum (shaded), if present, not in same plane (1,6,7 drawn from previous illustrations, others reconstructed from serial transverse sections) (Ager, n).—1. *Gibbirhynchia amalthei* (QUENSTEDT), L.Jur., Ger.; ca. $\times 5$.—2. *Lacunosella visulica* (OPPEL), U.Jur., Fr.; ca. $\times 1.75$.—3. *Septocrurella deflexoides* (UHLIG), M.Jur., Rumania; ca. $\times 3.5$.—4. *Monticlairella czenstochowiensis* (ROEMER), U.Jur., Pol.; ca. $\times 5$.—5. *Kallirhynchia platiloba* (MUIR-WOOD), M.Jur., Eng.; ca. $\times 3.75$.—6. *Mannia nysti* (DAVIDSON), Mio., Belg.; ca. $\times 12$.—7. *Grammetaria bartschi* (DALL), Rec., Philip.; ca. $\times 4$.—8. *Cirpa kiragliae* (AGER), L. Jur., Turkey; ca. $\times 3.5$.—9. *Peregrinella whitneyi* (GABB), L.Cret., USA; ca. $\times 3.5$. [Two other types of crura (canalifer, cilifer) are not suitable for representation in longitudinal sections, since their essential characters are only recognizable in transverse section, the canalifer type being concavoconvex and the cilifer type flattened in the plane of the commissure. Similarly the arcuifer type (Fig. 1,4) can be clearly distinguished only in transverse sections, which show the lateral origin of the crura and their inwardly facing concave faces.]

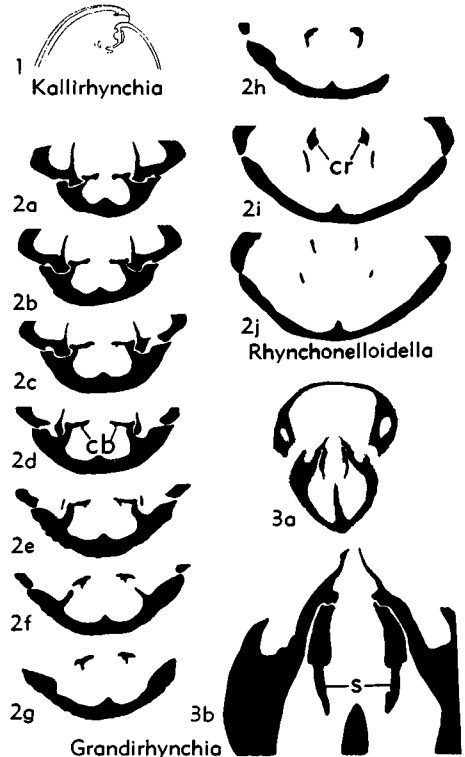


FIG. 479. Calcarifer type crura in Rhynchonellidae (Tetrarhynchiinae) (Ager, n).—1, *Kallirhynchia*; 2, *Rhynchonelloidella*; 3, *Grandirhynchia*.

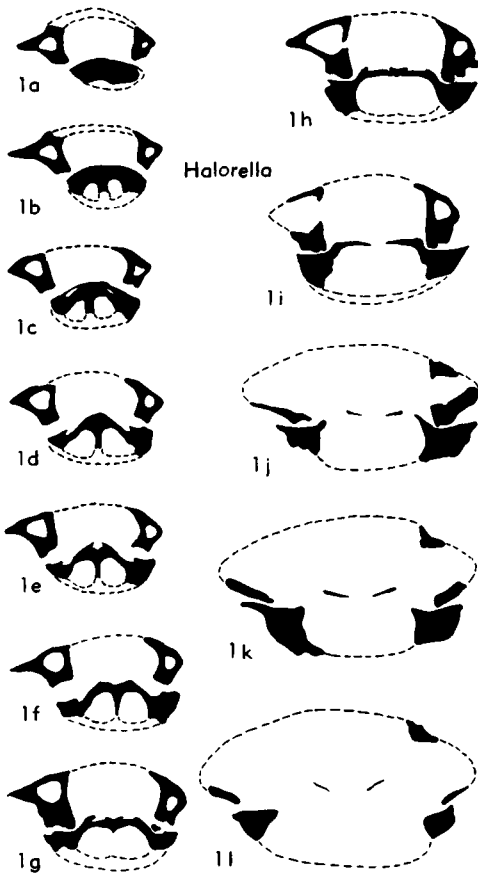


FIG. 480. Serial transverse sections of *Halorella amphitoma* (BRONN), Trias., Austria, showing cilifer type of crura (figures indicate distance from pedicle-valve beak in mm.), ca. $\times 2.5$ (810).

the genera with calcarifer-type crura appear to belong to the dominantly falcifer subfamily (i.e., Lacunosellinae).

Maniculifer. COOPER (1959) described two further types designated as maniculifer and spinulifer, in his work on Cenozoic rhynchonelloids, but these are certainly derived from the radulifer form or merely variants of it. The maniculifer type has curious handlike processes at the end of straight, ventrally directed crura (Fig. 478, 6). As has already been stated, various terminal processes are commonly developed on radulifer crura, though these commonly are lost in the process of fossilization and preparation for study. COOPER described the maniculifer type in the Cenozoic Crypto-

poridae, but it and other variants of the radulifer type certainly occur far back in the Mesozoic and possibly earlier.

Spinulifer. The spinulifer type also appears to be no more than a variant of the radulifer type, in this case with the crura laterally compressed (Fig. 478,7). Such bladeliike supports are found from very early in rhynchonelloid history and do not appear to have any evolutionary significance.

Prefalcifer. One additional type has been named by the present author (AGER, 1962). It is termed prefalcifer. In this type the crura are straight (i.e., in the plane of the commissure) and are slightly compressed (Fig. 478,8). It is regarded as a variant of the falcifer type, but is worthy of distinction because it precedes the falcifer in time and particularly characterizes an important early Mesozoic group (Cirpinae). As with true falcifer forms, the dorsal median septum is characteristically reduced.

Three further types are named herein, all variants of the radulifer type, but they characterize particular families and subfamilies and are easily recognized in serial transverse sections.

Mergifer. The mergifer type is characterized by long crura, radulifer in form, but very close together and parallel, and arising directly from the swollen edge of a high dorsal median septum (Fig. 478,9). It is well seen in the Peregrinellinae and in several Paleozoic genera, for example, as illustrated recently by HAVLÍČEK (1961) in *Plagiorhyncha* from the Silurian of Czechoslovakia. In cross section, the crura and high septum have the form of a two-pronged pitchfork (Latin, *merga*).

Canalifer. In the canalifer type the ventrally directed radulifer crura are folded longitudinally in the form of a dorsally facing channel or gutter (Latin, *canalis*). In other words, the crura are V- or U-shaped in cross section. In some shells (e.g., *Curtirhynchia*) a further lateral flange occurs, giving the crura Z-shaped cross sections. This type is especially characteristic of the Cyclothyrinae and is one of the best criteria for recognizing that group.

Cilifer. The cilifer type also has crura of radulifer form, but flattened in the plane of the commissure between the valves, and they form direct prolongations of the

horizontal hinge plates (Fig. 480), with or without a lateral flange. They are chisel-like in appearance (Latin, *cilio*), and characterize the Triassic Halorellinae, which may be a very ancient stock. DAGIS (1963) has now shown that these continue ventrally by turning suddenly through a right angle and forming parallel, slightly crescentic blades.

SHELL STRUCTURE

A character which is potentially of great value in the study of Mesozoic and Cenozoic rhynchonelloids is the form of the "shell-mosaic" or *Schuppenpanzerstruktur*. This is a scaly pattern produced by the grouping together of the calcite fibers which form the shell. It is only seen on the inner surface, in exceptionally well-preserved specimens, and usually takes the form of elongated polygons or ellipses. It has long been known in living species, but LEIDHOLD (1920) figured it in Upper Jurassic forms from Germany and the present author (AGER, 1957) figured it in the type-species of *Rhynchonella* from the Upper Jurassic (Volgian) of the Moscow region. The variability observed in the few species so far studied suggests that it may be an extremely useful classificatory tool; much further work is needed on such microscopic shell structures, especially since they have proved so successful in other groups.

DENTICULA

Structures named denticula appear only to have been described in Mesozoic forms. They are small toothlike projections developed in the pedicle valve externally of the main teeth and fitting into accessory sockets in the brachial valve. Presumably they reinforced the articulation. In one small family (Austrihrynchiidae) they occur instead in the brachial valve.

SEPTALIUM

The septalium is a structure characteristic of many Mesozoic rhynchonelloids, and there is every reason to believe that it is identical with the similar structure in Paleozoic rhynchonelloids (which is usually called a *cruralium*) and with the "small chamber" described by COOPER (1959) in Cenozoic forms.

LEIDHOLD (1928) introduced the term and described it as a chamber formed by splitting of the dorsal median septum ventrally. This is, in fact, the impression given by the majority of specimens, especially when the shell has been recrystallized and the

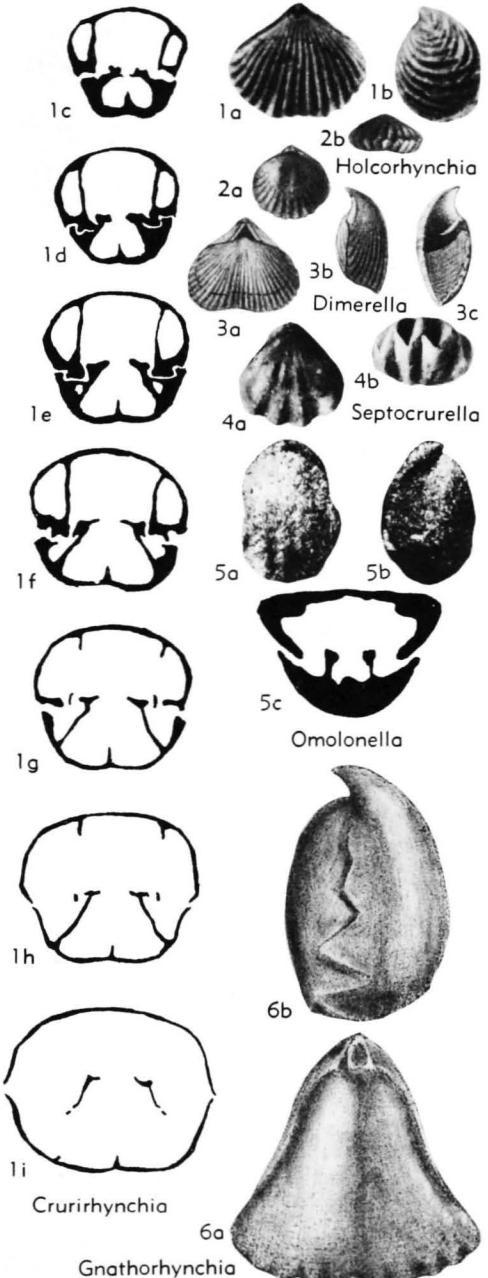


FIG. 481. Dimerellidae (Dimerellinae) (3), Rhynchonellinae (1-2, 4-6) (p. H602-H603).

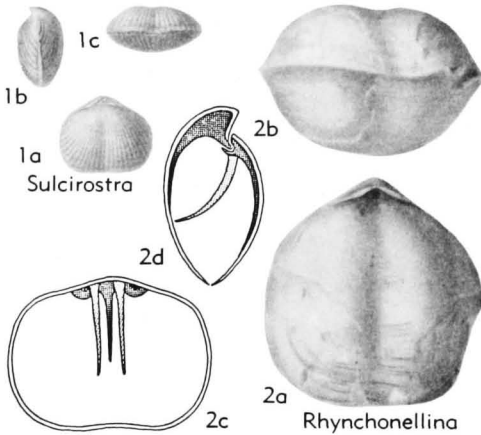


FIG. 482. Dimerellidae (Rhynchonellinae) (p. H602-H603).

finer sutures obliterated. However, when the material is sufficiently well preserved, it can be seen that the septalium is, in fact, formed by two plates (septalial plates) which descend from the inner edges of the hinge plates to meet the median septum (Fig. 479,3b). This was shown by WISNIEWSKA (1932, p. 6), MUIR-WOOD (1936, p. 50), COOPER (1959, p. 10) and the present author (AGER, 1956, p. 22), all dealing with different forms, and it is reasonable to suppose that this is the normal state of affairs.

Great stress has been placed by some workers on the presence or absence of the septalium as a criterion in classification, but the present author has often found it so little developed as to be misleading, and it is often overlooked (or overemphasized) because of the precise orientation of the transverse sections in a particular case.

Family DIMERELLIDAE Buckman, 1918

[Dimerellidae BUCKMAN, 1918, p. 72]

Usually sulcate and very small (though the Halorellinae and Peregrinellinae are exceptionally large), deltidial plates commonly reduced, crura very long; dorsal septum may be prominent (3, 136). ?Dev., Trias.-L.Cret.

Subfamily DIMERELLINAE Buckman, 1918

[nom. transl. AGER, 1959, p. 330 (ex Dimerellidae BUCKMAN, 1918)]

Dorsal median septum very strong. Trias. *Dimerella* ZITTEL, 1870, p. 220 [**D. gümbeli*; OD]. Shell depressed, slightly sulcate, with wide, straight

hinge line, capillate; beak high, erect; wide, open delthyrium. Crura long, radulifer; dorsal median septum very high, rising anteriorly. Trias., Eu. —FIG. 481,3. **D. gümbeli*, Ger.; 3a,b, brach. v., lat. views, $\times 2$; 3c, long. sec., $\times 2$ (900).

Subfamily RHYNCHONELLINAE Ager, 1959
[Rhynchonellinae AGER, 1959, p. 330]

Shell with little or no dorsal median septum and extremely long septifer crura. U. Trias.-U. Jur.

Rhynchonellina GEMMELLARO, 1876?, p. 29 [**R. suessi*; OD] [= *Terebratulopsis* DE GREGORIO, 1930 (obj.)]. Medium-sized, biconvex, rectimarginate to sulcate, smooth; beak strong, with wide delthyrium and rudimentary deltidial plates. Crura very long, touching ventral valve. U. Trias.-L. Jur., S. Eu. —FIG. 482,2. **R. suessi*, Sicily; 2a,b, brach. v., ant. views, $\times 0.7$ (329); 2c,d, brach. v. int., half of shell in lat. view showing long crura and median septum of brach. v. (reconstr.), enlarged (3).

Capillirostra COOPER & MUIR-WOOD, 1951, p. 195 [pro *Rhynchonellopsis* BÖSE, 1894, p. 57 (non VINCENT, 1893)] [**Rhynchonellina?* *finkelsteini* BÖSE, 1894, p. 77; OD]. Like *Sulcistrostra* but small, depressed, with grooves delimiting dorsal muscle scars and shorter crura. [Probably a juvenile form and only doubtfully included here.] U. Jur. (Oxford.), Eu.

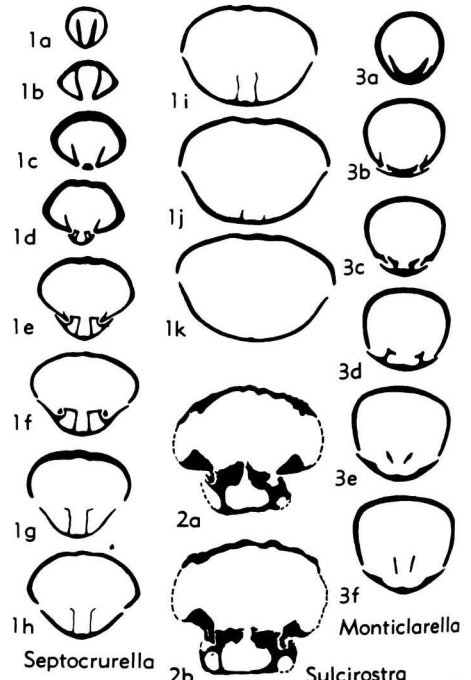


FIG. 483. Dimerellidae (Rhynchonellinae) (1-2), Norellinae (3) (p. H603-H604).

Carapezzia TOMLIN, 1930, p. 24 [pro *Geyeria* CARAPEZZA & SCHOPEN, 1899, p. 248 (non BUCHECKER, 1876)] [**Rhynchonellina* (*Geyeria*) *globosa* CARAPEZZA & SCHOPEN, 1899, p. 248; OD]. Like *Rhynchonellina* but very massive, incurved beak and fine capillae on well-preserved specimens; crura long. *L.Jur.*, Eu. (Sicily).

Caucasella MOISSEEV, 1934, p. 187 [**Rhynchonella* *trigonella* ROTHPLETZ, 1886, p. 154; OD]. Triangular, flattened anteriorly, with many sharp costae, no perceptible fold; beak small, incurved, well-developed planareas. Crura septifer. *U.Jur.*, Eu. (Alps-S.USSR).—FIG. 487,2. **C. trigonella* (ROTHPLETZ), Switz.; 2a,b, brach.v., ant. views, $\times 1$ (679).

Crurirhynchia DAGIS, 1961, p. 96 [**C. kiparisovae*; OD]. Medium-sized, transversely oval; multicostate throughout; beak low. Ridgelike median septum; crura arising from oblique septa, more or less fused with socket bases. *U.Trias.* (Nor-?Rhaet.), USSR (Caucasus)-?C.Eu.—FIG. 481,1. **C. kiparisovae*, USSR (Caucasus); 1a,b, brach.v., lat. views, $\times 1$; 1c-i, ser. transv. sec., $\times 2.5$ (211).

Gnathorhynchia BUCKMAN, 1918, p. 29 [**Rhynchonella* *liostraca* BUCKMAN, 1886, p. 217; OD]. Like *Holcorhynchia* but triangular in outline. Dorsal septum strong; crura septifer. [Doubtfully separable from *Holcorhynchia*.] *Jur.* (Bajoc.-Callov.), Eu.-USA (Calif.).—FIG. 481,6. **G. liostraca* (BUCKMAN), Eng.; 6a,b, brach.v., lat. views, $\times 4$ (229).

Holcorhynchia BUCKMAN, 1918, p. 28 [**Rhynchonella* *standishensis* BUCKMAN, 1901, p. 245; OD]. Small, subcircular, depressed, posteriorly sulcate, with many fine costae anteriorly after long smooth stage; beak small, hypothyriddid. *U.Trias.* - *L.Jur.* (Pliensbach. - Toarc.), Eu. - Asia (Anatolia-Japan).—FIG. 481,2. **H. standishensis* (BUCKMAN), Eng.; 2a,b, brach.v., ant. views, $\times 1$ (138).

Omolonella MOISSEEV, 1936, p. 39 [**O. omolonensis*; OD]. Medium-sized, smooth, with few faint costae anteriorly; shell wall very thick. Ventral median ridge; short dorsal septum and septalium; crura arising on strong septa. *U.Trias.*, Sib.-Eu. (Alps)-N.Am. (Alaska).—FIG. 481,5. **O. omolonensis*, Sib.; 5a,b, brach.v., lat. views, $\times 1$ (567); 5c, transv. sec., $\times 2$ (567).

Septocurrella WISNIEWSKA, 1932, p. 63 [**Rhynchonella* *sanctae Clarae* ROEMER, 1870, p. 247; OD]. Small, sulcate, with few rounded costae. Beak small, upright. Crura short, septifer, supported by crural plates; dorsal septum a low ridge. *Jur.* (Callov.-Oxford.-?Tithon.), Eu.—FIG. 481,4; 483,1. **S. sanctaeclarae* (ROEMER), Pol.; 481,4a,b, brach.v., ant. views, $\times 1$; 483,1a-k, transv. sec. of beak region (ped.v. above), $\times 2$ (893).

Sulcistrotra COOPER & MUIR-WOOD, 1951, p. 195 [pro *Rhynchonellopsis* DEGRIGORIO, 1930, p. 5 (non VINCENT, 1893; nec BÖSE, 1894)] [**Rhy-*

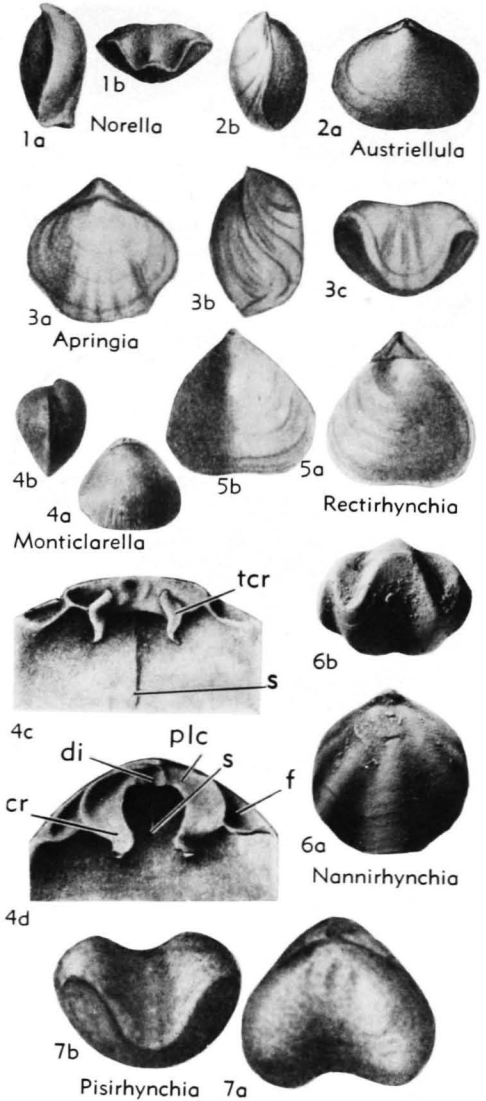


FIG. 484. Dimerellidae (Norellinae) (p. H604).

chonellina *seguenzae* GEMMELLARO, 1876?, p. 34; OD]. Like *Rhynchonellina* but costate. No septalium; very short median septum and lateral septa supporting massive hinge plates. *U.Trias.* - *L.Jur.*, S.Eu.-?Asia (Anatolia).—FIG. 482,1; 483,2. **S. seguenzae* (GEMMELLARO), Sicily; 482,1a-c, brach.v., lat., ant. views, $\times 1$ (329); 483,2a,b, transv. sec. of beak region (ped.v. above), $\times 2$ (3).

Subfamily NORELLINAE Ager, 1959

[Norellinae AGER, 1959, p. 330]

Small, mostly smooth shells with small

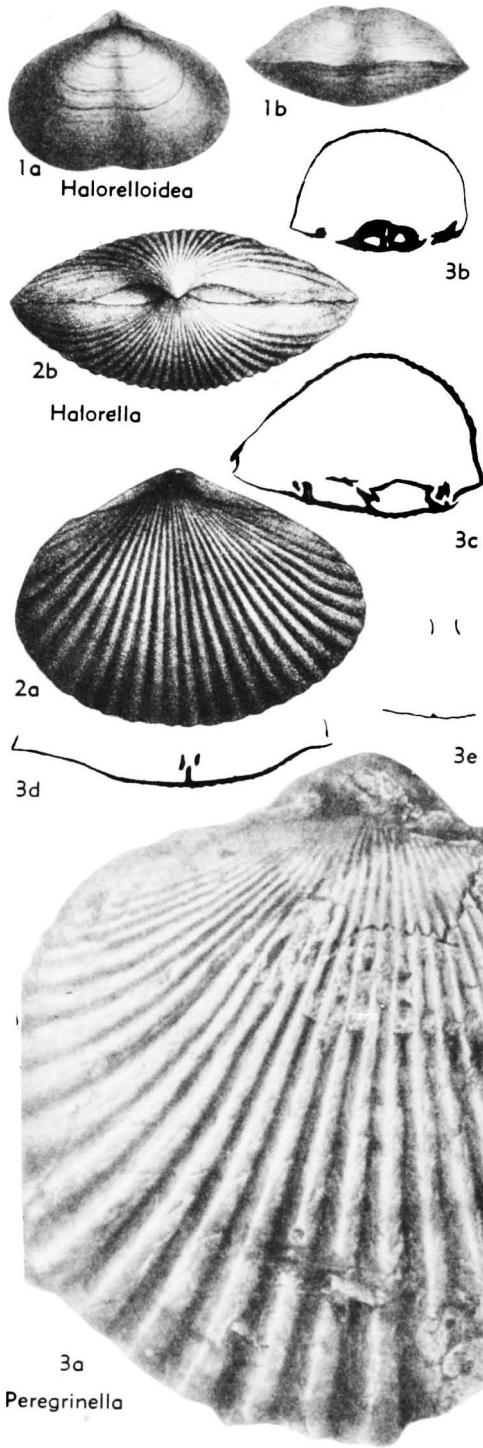


FIG. 485. Dimerellidae (Hallorellinae) (1-2), (Peregrinellinae) (3) (p. H605).

delthyria. Crura arcuifer (where known). *M.Trias.-U.Jur., ?L.Cret.*

Norella BITTNER, 1890, p. 315 [**Rhynchonella refractifrons* BITTNER, 1890, p. 39 (ICZN, 1961, Op. 633)]. Smooth, subcircular, some shells with slight plication, sulcate; beak small, incurved. Dental plates long; no dorsal median septum; crura arcuifer. *M.Trias.-U.Trias., Eu.(Alps)*.—FIG. 484,1. **N. refractifrons* (BITTNER), Austria; 1a,b, lat., ant. views, $\times 1$ (76).

Apringia DE GREGORIO, 1886, p. 22 [**A. giuppa*; OD]. Like *Pisirhynchia* but larger, with wider sulcation, which may be asymmetrical, and less obvious costae. *L.Jur.(Toarc.)*, Eu.—FIG. 484,3. **A. giuppa*, Sicily; 3a-c, brach.v., lat., ant. views, $\times 1$ (918).

Austriellula STRAND, 1928, p. 37 [*pro Austriella* BITTNER, 1890, p. 314 (non TENISON-WOODS, 1881)] [**Rhynchonella dilatata* SUESS, 1855, p. 29; OD] [= *Jacobella* PATTE, 1926, p. 125 (non JEANNET, 1908); *Austriellina* SCHUCHERT & LEVENE, 1929, p. 119 (obj.)]. Smooth, triangular, rectimarginate or slightly sulcate; some species uniplicate. *M.Trias.-U.Trias., Eu.(Alps)-SE.Asia*.—FIG. 484,2. **A. dilatata* (SUESS), Austria; 2a,b, brach.v., lat. views, $\times 1$ (792).

Monticlarella WISNIEWSKA, 1932, p. 55 [**Rhynchonella czenstochowiensis* ROEMER, 1870, p. 247; OD]. Small, posteriorly sulcate, capillate anteriorly after smooth stage. Dorsal septum faint; crura arcuifer. *U.Jur.(Oxford.-Kimmeridg.)*, ?*L.Cret.*, Eu.—FIG. 483,3; 484,4. **M. czenstochowiensis* (ROEMER), Pol.; 483,3a-f, transv. secs. of beak region (ped.v. above), $\times 2$ (893); 484,4a,b, brach. v., lat. views, $\times 1$; 484,4c,d, brach.v. int., ped.v. int., $\times 6$ (893).

Nannirhynchia BUCKMAN, 1918, p. 67 [**N. subpygmaea*; OD]. Minute, globose; sulcate, with median uniplication; fold well marked, finely capillate, with few rounded costae anteriorly, very fine spines; beak massive, incurved, foramen small. No median septum; crura arcuifer. *L.Jur.(Toarc.)-M.Jur.(Bajoc.)*, Eu.—FIG. 484,6. *N. pygmaea* (MORRIS), Eng.; 6a,b, brach.v., ant. views, $\times 10$ (Ager, n).

Pisirhynchia BUCKMAN, 1918, p. 28 [**Rhynchonella pisoides* ZITTEL, 1869, p. 129; OD]. Small, globose, sulcate, ventral fold low, with few rounded costae after long smooth stage; no umbonal callosities. *L.Jur.*, S.Eu.—FIG. 484,7. **P. pisoides* (ZITTEL), Italy; 7a,b, brach.v., ant. views, $\times 3$ (938).

Rectirhynchia BUCKMAN, 1918, p. 74 [**Rhynchonella lopensis* MOORE, 1855, p. 114; OD]. Minute, smooth, depressed; sulcate, with strong ventral fold; straight hinge line. Beak large, hypothyridid. *M.Jur.(Bajoc.)*, Eu.—FIG. 484,5. **R. lopensis* (MOORE), Eng.; 5a,b, brach.v., ped.v. views, $\times 4$ (229).

Subfamily HALORELLINAE Ager, n. subfam.

Large, with wide, straight hinge line, rectimarginate or nearly so, commonly with opposite sulci, may be asymmetrical; high hypothridid beak. Dental plates widely spaced, septum very small or absent; crura direct prolongations of hinge plates, flattened in plane of commissure (cilifer type). [This and the next subfamily extend back at least to the Devonian. Its members may have lived only in a restricted geosynclinal environment, which would explain their infrequent appearance in the known stratigraphical record. The subfamilies may be the ancestral stock from which most, if not all, of the other Mesozoic rhynchonellids evolved.] ?*Dev.*, *Trias.*

Halorella BITTNER, 1884, p. 107 [*Rhynchonella amphitoma* BRONN, 1832, p. 162; SD HALL & CLARKE, 1894, p. 832] [= *Barzellinia* DE GREGORIO, 1930, p. 8 (type, *B. primogenita*; OD)]. Medium-sized to large, subcircular to laterally oval, with many sharp costae; rectimarginate to slightly uniplicate, commonly developing opposite sulci in each valve, sulci may be asymmetrical; beak sharp, suberect; aperture elongate. Crura may be unusually long; median septum short. [Devonian fossils from Morocco and Nevada referred to *Halorella* are doubtful representatives of the genus in the view of HERTA SCHMIDT.] ?*Dev.*, Morocco - USA (Nev.); *Trias.*, Eu. (Alps)-S. Asia-USA (Ore.).—FIG. 480, 1; 485, 2. **H. amphitoma* (BRONN), Austria; 480, 1a-l, serial transv. secs., $\times 1$ (Ager, n); 485, 2a, b, brach.v., post. views, $\times 1$ (76).

Halorelloidea AGER, 1960, p. 159 [*Halorella rectifrons* BITTNER, 1884, p. 107; OD]. Like *Halorella* but usually smaller and smooth, or with only few irregularly developed costae; 2 sharp opposite sulci well developed or with sharp dorsal fold; commonly asymmetrical; no median septum. *U. Trias.*, Eu. (Alps-S. Asia).—FIG. 485, 1. **H. rectifrons* (BITTNER), Austria; 1a, b, brach.v., ant. views, $\times 1$ (76).

Subfamily PEREGRINELLINAE Ager, n. subfam.

Large, coarsely costate dimerellids, pentameroid-like in appearance. Dental plates much reduced or absent; crura radulifer in form, but set very close together throughout their length and arising directly from swollen ventral edge of dorsal median septum (mergifer type). [Though at present including only one Cretaceous genus, there are undescribed forms both in the Cretaceous and the Jurassic, which indicate a connection with the Rhynchonellinae

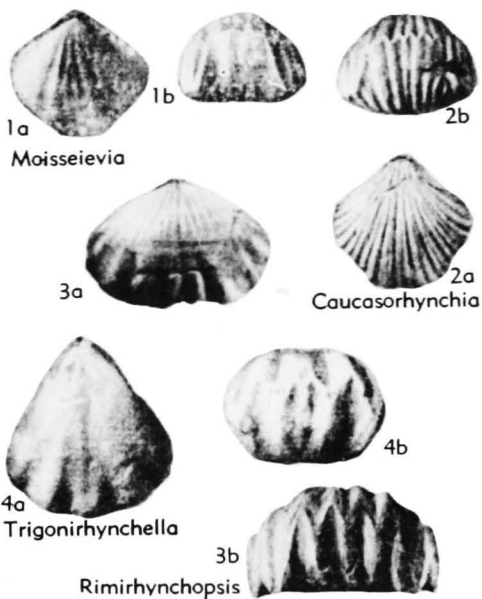


FIG. 486. Wellerellidae (Cirpinae) (p. H606-H608).

and with certain Paleozoic genera such as *Plagiorhyncha* of the Silurian.] ?*Dev.*, *M. Jur.-L. Cret.*

Peregrinella OEHLERT, 1887, p. 1305 [*T. peregrina* VON BUCH, 1835, p. 73 (non SCHLOTHEIM, 1813, = *Terebratula multicarinata* LAMARCK, 1819, p. 253); OD]. Large, circular, biconvex, rectimarginate, with many strong costae; beak massive, incurved. Hinge plates wide, flat; dental plates oblique, short, teeth small; crura long, close together; septum long. *L. Cret.* (*Valangin.-Hauteriv.*), Eu. (Alps-Carpathians)-Calif.—FIG. 485, 3. **P. multicarinata* (LAMARCK), Fr.; 3a, brach.v. view, $\times 1$ (907); 3b-e, serial transv. secs., $\times 1$ (934).

Family WELLERELLIDAE Likharev in Rzhonsnitskaya, 1956

[Wellerellidae LIKHAREV in RZHONSNITSKAYA, 1956, p. 125]

Uniplicate, no septalium or cardinal process, entire hinge plates; dorsal septum and dental plates variously developed (694). *L. Carb.-U. Cret.*

Subfamily WELLERELLINAE Likharev in Rzhonsnitskaya, 1958

[See p. H590, prepared by HERTA SCHMIDT]

Subfamily CIRPINAE Ager, n. subfam.

Multicostate, hinge plates fused; dorsal median septum usually very much reduced; beak generally small and incurved, with

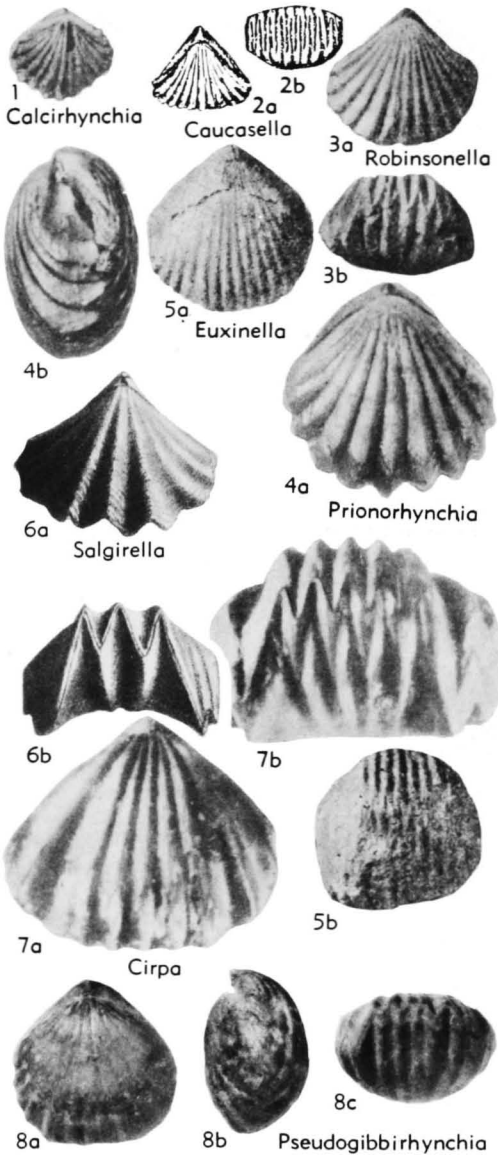


FIG. 487. Dimerellidae (Rhynchonellinae) (2); Wellerellidae (Cirpinae) (1, 3-8) (p. H603, H606-H607).

well-developed planareas. Deltidial plates thick and distinctive; crura priefalcifer (where known). *Trias.-U. Jur.*

Cirpa DEGRIGORIO, 1930, p. 40 [**Rhynchonella* (*C.*) *primitiva* (probably=*R. briseis* GEMMELLARO, 1874, p. 77), OD]. Outline subtriangular, rectangular and flattened anteriorly; with low fold, uniplication, and few strong, sharp costae; beak small, marked planareas; deltidial plates double.

Hinge plates flat, fused; median septum very short; crura priefalcifer. *L. Jur.* (*Pliensbach.*), Eu-Anatolia.—FIG. 487, 7. *C. langi* AGER, Eng.; 7a, b, brach.v., ant. views, $\times 2$ (1).—FIG. 488, 2. *C. briseis* (GEMMELLARO), Sicily; 2a-k, transv. secs. at 0.6-2.6 mm. from tip of beak (ped.v. above), $\times 3.25$ (1).

Calcirhynchia BUCKMAN, 1918, p. 30 [**C. calcaria*; OD]. Small; with wide uniplication, low fold and many sharp costae, no posterior smooth stage; beak small, incurved. Crura priefalcifer. *L. Jur.* (*Hettang.*), Eu.—FIG. 487, 1. **C. calcaria*, Eng.; brach.v. view, $\times 1$ (138).

Caucasorhynchia DAGIS, 1963, p. 63 [**C. kuenensis*;

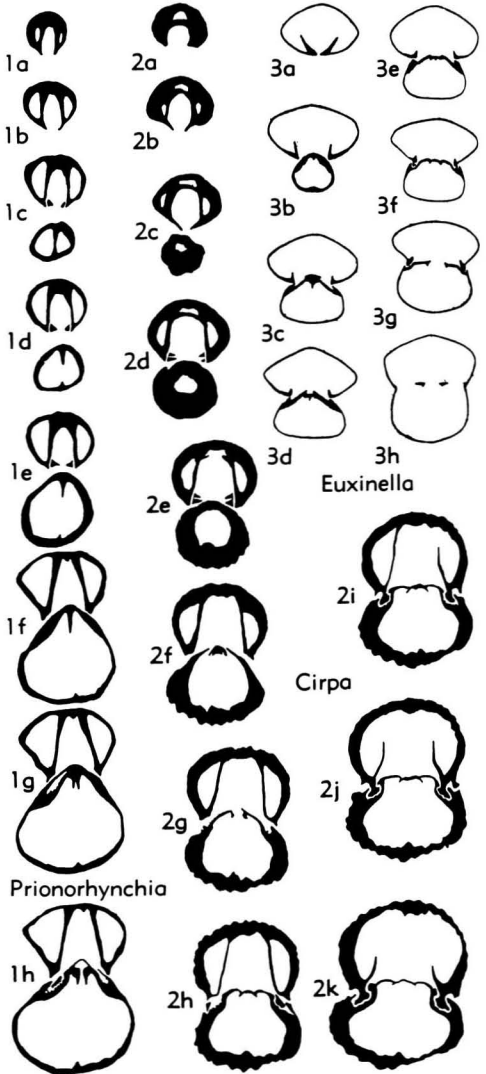


FIG. 488. Wellerellidae (Cirpinae) (p. H606-H607).

OD]. Medium-sized, subcircular to pentagonal in outline, biconvex, low uniplication and fold; many blunt costae throughout growth, branching anteriorly. Ridgelike median septum; hinge plates flat, almost fused; prefalcifer crura, lateral umbonal cavities very narrow. *U.Trias.(Nor.-Rhaet.)*, USSR (Caucasus).—FIG. 486,2. **C. kuenensis*; 2a,b, brach.v., ant. views, $\times 1$ (212a).

Euxinella MOISSEEV, 1936, p. 41 [**E. iatirgvantaensis*; OD]. Globose, flattened anteriorly, with strong uniplication, no distinct fold, multicostate; beak massive. Septalium absent; dorsal median septum hardly visible; crura ?prefalcifer. *Trias.*, Asia (Sib.)-N.Am. (W.Can.).—FIG. 487,5; 488,3. **E. iatirgvantaensis*; 487,5a,b, brach.v., ant. views, $\times 1$ (567); 488,3a-h, transv. secs. of beak region (ped.v. above), enlarged (567).

Hagabirhynchia JEFFERIES, 1961, p. 5 [**H. arabica*; OD]. Small, sulcate to uniplicate, strong costae. Beak massive with weak ventral septum. Hinge plates separate but no true septalium; low persistent dorsal median septum; crura prefalcifer. *U.Trias.(Nor.)*, Arabia.—FIG. 489,1. **H. arabica*, Oman; 1a,b, brach.v., ant. views, $\times 2.5$; 1c-i, transv. secs. beak region (ped.v. above), $\times 5$ (437).

Moisseievia DAGIS, 1963, p. 46 [**M. moisseievi*; OD]. Subpentagonal to transversely elliptical, very small beak, strongly uniplicate; costae mainly confined to fold, lateral areas smooth. Well-developed pedicle collar and double deltidial plates; fused hinge plates, no dorsal median septum, prefalcifer crura. *U.Trias.(Nor.-Rhaet.)*, USSR (Caucasus).—FIG. 486,1. **M. moisseievi*; 1a,b, brach.v., ant. views, $\times 1$ (212a).

Prionorhynchia BUCKMAN, 1918, p. 62 [**Terebratulina serrata* SOWERBY, 1825, p. 168; OD]. Medium-sized to large, without interarea but planareas well developed; rectimarginate or uniplicate; costae strong, sharp; beak very small, incurved; deltidial plates narrow, thick. Dorsal septum very short; crura prefalcifer. *L.Jur.*, Eu.-Anatolia-Indo-China-?Timor.—FIG. 487,4; 488,1. **P. serrata* (SOWERBY), Eng.; 487,4a,b, brach.v., lat. views, $\times 1$; 488,1a-h, transv. secs. at 0.4-2.0 mm. from tip of beak (ped.v. above), $\times 2.5$ (1).

Pseudogibbirhynchia AGER, 1962, p. 108 [**Rhynchonella Moorei* DAVIDSON, 1852, p. 82; OD]. Small, globose, brachial valve flattened posteriorly; low uniplication, multicostate. Very short median septum, strengthened deltidial plates, prefalcifer crura. *L.Jur.*, Eu.—FIG. 487,8. **P. moorei* (DAVIDSON), Eng.; 8a-c, brach.v., lat., ant. views, $\times 2$ (1).

Rimirhynchopsis DAGIS, 1963, p. 71 [**R. triadicus*; OD]. Medium-sized, laterally ovate, small beak, strong deltidial plates; strongly uniplicate, low fold; many fine capillae posteriorly, strong costae anteriorly. Shell thick, umbonal cavities small; low massive median septum and septalium, massive teeth and denticula, flat hinge plates, prefalci-

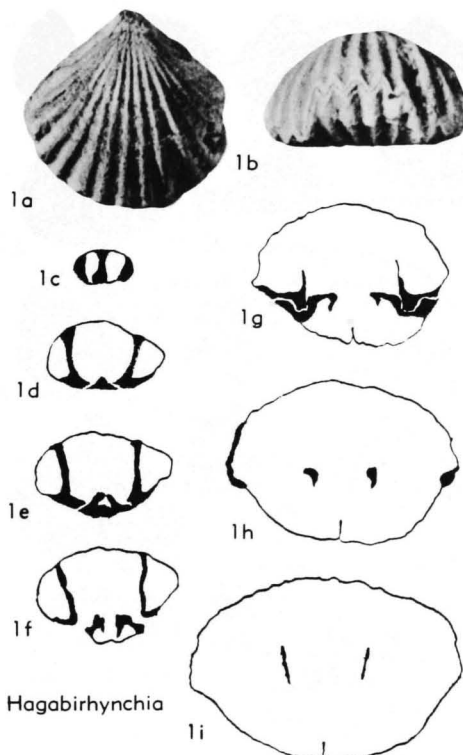


FIG. 489. Wellerellidae (Cirpinae) (p. H607).

fer crura. *U.Trias.(Nor.-Rhaet.)*, USSR (Caucasus).—FIG. 486,3. **R. triadicus*; 3a,b, brach.v., ant. views, $\times 1$ (212a).

Robinsonella MOISSEEV, 1936, p. 45 [**R. mastakanensis*; OD]. Triangular, depressed, with strong uniplication and many sharp costae, no smooth stage; beak small, incurved. Septalium absent; median ridge in ventral valve; dorsal septum massive. *Trias.*, Sib.—FIG. 487,3. **R. mastakanensis*; 3a,b, brach.v., ant. views, $\times 1$ (567).

Salgirella MOISSEEV, 1936, p. 48 [**Rhynchonella albertii* OPPEL, 1861, p. 546; OD]. Medium-sized, uniplicate, with acute apical angle and very strong, sharp costae, no anterior flattening; beak small, incurved; deltidial plates double; median septum short. [Possibly a synonym of *Cirpa*, but it cannot be confirmed that the Siberian form, on which the genus was founded, is the same as OPPEL's.] *L.Jur.*, Eu.-Sib.—FIG. 487,6. *S. albertii* (OPPEL), Ger.; 6a,b, brach.v., ant. views, Ger.; $\times 1$ (928).

Squamirhynchia BUCKMAN, 1918, p. 63 [**Terebratulina triplicata squamiplex* QUENSTEDT, 1871, p. 72; OD]. Depressed, brachial valve nearly flat, with low uniplication and fold, strong branching costae, and no smooth stage; beak strong, upright, with large foramen. Low persistent septum, shal-

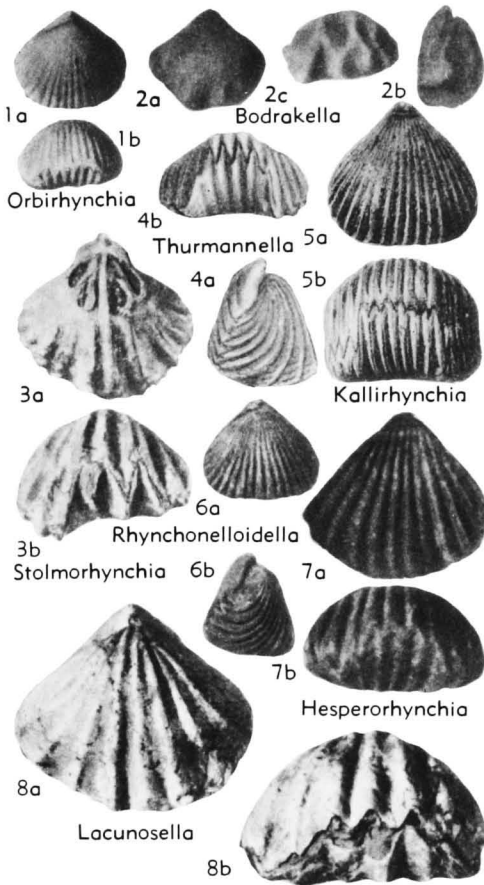


FIG. 490. Wellerellidae (Lacunosellinae) (p. H608-H609).

low septalium; crura prefalci-fer, concave dorsally, at distal ends, double deltidial plates. *L.Jur.* (*Sinemur.-L.Pliensbach.*), Eu.—FIG. 500,6. **S. squamiplex* (QUENSTEDT), Ger.; brach.v. view, $\times 1$ (651).

Trigonirhynchella DAGIS, 1963, p. 41 [*nom. subst. pro Trigonirhynchia* DAGIS, 1961, p. 94 (non COOPER, 1942)] [**Trigonirhynchia trigona* DAGIS, 1961, p. 95; OD]. Triangular, small acute beak, no interarea; smooth posteriorly, with few sharp costae anteriorly. Divergent dental plates, no pedicle collar, ridgelike median septum, prefalci-fer crura. *U.Trias.(Nor.)*, USSR(Caucasus)-?Eu. (Alps).—FIG. 486,4. **T. trigona*; 4a,b, brach. v., ant. views, $\times 1$ (212a).

Subfamily LACUNOSELLINAE Smirnova, 1963

[Lacunosellinae SMIRNOVA, 1963, p. 15]

Usually small, multicostate, commonly asymmetrical, characterized mainly by absence or very slight development of dorsal

median septum and septalium, and presence of falci-fer or calcarifer crura. *L.Jur.-U.Cret.*

Lacunosella WISNIEWSKA, 1932, p. 30 [**Rhynchonella arolica* OPPEL, 1866, p. 294; OD]. Medium-sized, subtriangular, with few strong costae commonly branching, in some shells asymmetrical, crura falci-fer. No dorsal septum or septalium; teeth strong. *U.Jur.(Oxford.-Tithon.)*, ?*L. Cret.*, Eu.—FIG. 490,8. **L. arolica* (OPPEL), Pol.; 8a,b, brach.v., ant. views, $\times 1$ (893). [Whether this is the same species as first inadequately figured by HEER (1864) is doubtful.]

Bodrakella MOISSEEV, 1936, p. 47 [**Rhynchonella bodrakensis* MOISSEEV, 1934, p. 182; OD]. Small, uniplicate. Dorsal median septum reduced to ridge. *L.Jur.*, Sib.—FIG. 490,2. **B. bodrakensis* (MOISSEEV); 2a-c, brach.v., lat. ant. views, $\times 1$ (566). [May belong to the Cirpinae.]

Hesperorhynchia WARREN, 1937, p. 2 [**H. superba*; OD]. Medium-sized, subtriangular, with moderate uniplication and low fold; costae strong and few, no smooth stage; beak small, incurved. No dorsal septum, dental plates short. *U.Cret.*, Can.—FIG. 490,7. **H. superba*, Sask.; 7a,b, brach.v., ant. views, $\times 1$ (936).

Kallirhynchia BUCKMAN, 1918, p. 31 [**Rhynchonella concinna* var. *yaxleyensis* DAVIDSON, 1878, p. 206; OD]. Medium-sized, almost convexiplanate; well-developed uniplication, flat fold; multicostate after short posterior smooth stage; beak hypothyridd, suberect. Dorsal septum short, low; crura long, calcarifer to ?falci-fer. *Jur. (Bathon.-?Callov.)*, Eu.-India-?Japan-USA (Calif.).—FIG. 479,1; 490,5. **K. yaxleyensis* (DAVIDSON), Eng.; 479,1, part of long. sec. through beak region, brach.v. on right, enlarged (576); 490, 5a,b, brach.v., ant. views, $\times 1$ (576).

Orbirhynchia PETTITT, 1954, p. 29 [**O. orbigny*; OD]. Biconvex, with low arcuate uniplication and very slight dorsal fold, which may be asym-

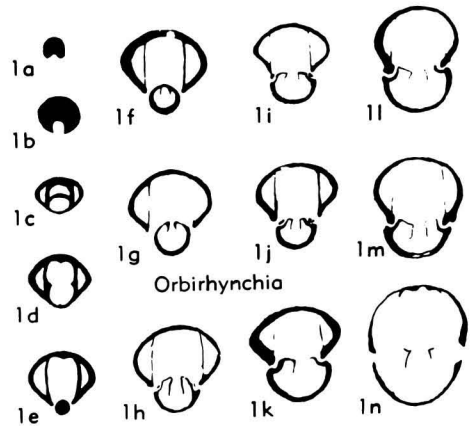


FIG. 491. Wellerellidae (Lacunosellinae) (p. H608-H609).

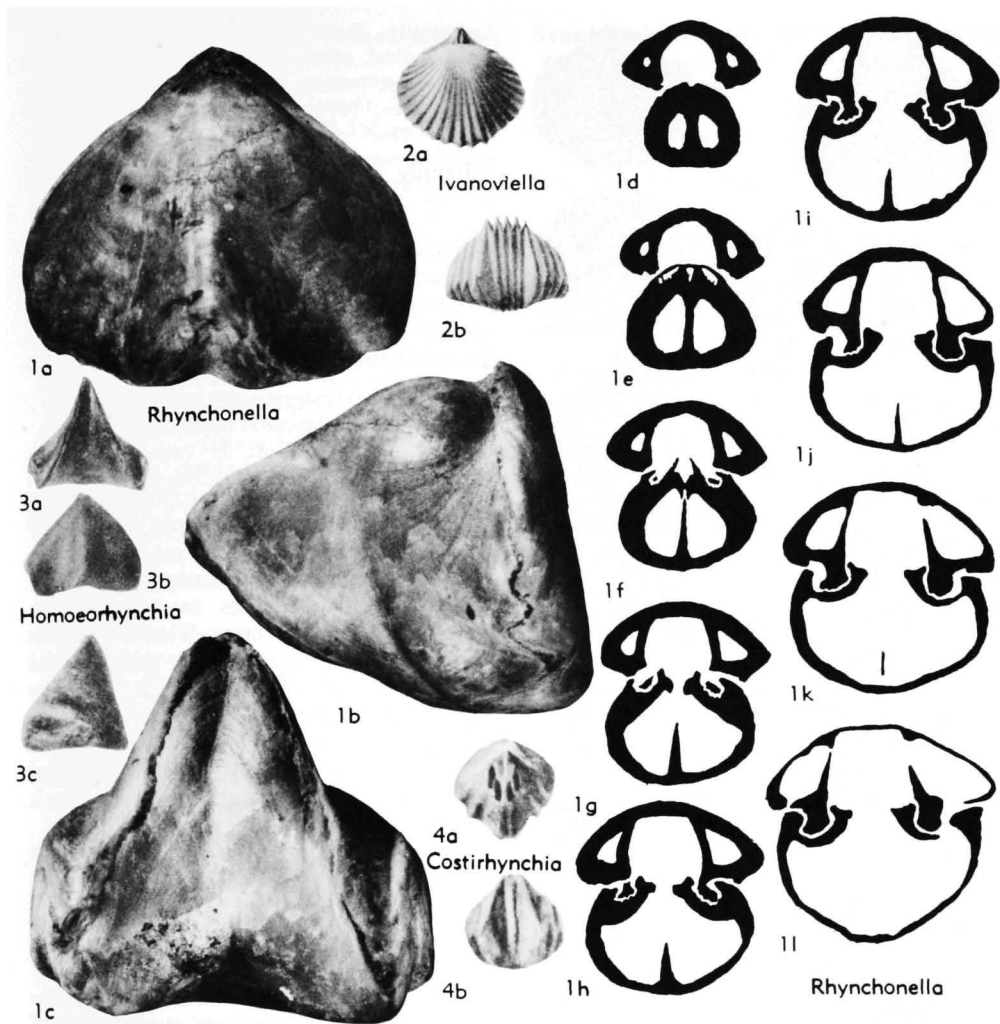


FIG. 492. Rhynchonellidae (Rhynchonellinae) (p. H610-H611).

metrical; with many rounded costae, smooth posteriorly; beak small, crura falcifer. Dorsal median septum and septalium absent. *Cret. (Alb.-Senon.)*, NW.Eu.—FIG. 490,1; 491,1. **O. orbignyi*, Eng.; 490,1a,b, brach.v., ant. views, $\times 1$; 491,1a-n, transv. secs. of beak region (ped.v. above), $\times 3$ (639).

Rhynchonelloidella MUIR-WOOD, 1936, p. 49 [**Rhynchonella varians* var. *smithi* DAVIDSON, 1878, p. 213; OD]. Medium-sized, uniplication strong, dorsal fold low, with many sharp costae; beak small, massive, incurved. Dental plates long; dorsal septum short; crura calcarifer. *M.Jur.-U. Jur.*, NW.Eu.—FIG. 479,2; 490,6. **R. smithi* (DAVIDSON), Eng.; 479,2a-j, transv. secs. of beak region (ped.v. above), 2d, showing crural base

(cb) and 2i showing crura (cr), $\times 2$ (579); 490, 6a,b, brach.v., lat. views, $\times 1$ (579).

Stolmorhynchia BUCKMAN, 1918, p. 46 [**S. stolidota*; OD]. Very variable in size and shape, uniplicate, may be asymmetrical; few sharp costae developed anteriorly; beak small, suberect. Dorsal septum feeble or absent; muscle scars impressed; crura falcifer. [Genus probably requires subdivision and needs confirmation of occurrence.] *L. Jur.*, ?*L.Cret.*, Eu.-N.Afr.-India.—FIG. 490,3. **S. stolidota*, Eng.; 3a,b, brach.v. (mold) and ant views, $\times 1$ (138).

Thurmannella LEIDHOLD, 1920, p. 357 [**Terebratula Thurmanni* VOLTZ, 1833, p. 172; OD]. Medium-sized, almost convexiplanate; with strong uniplication and slight fold, many costae, smooth

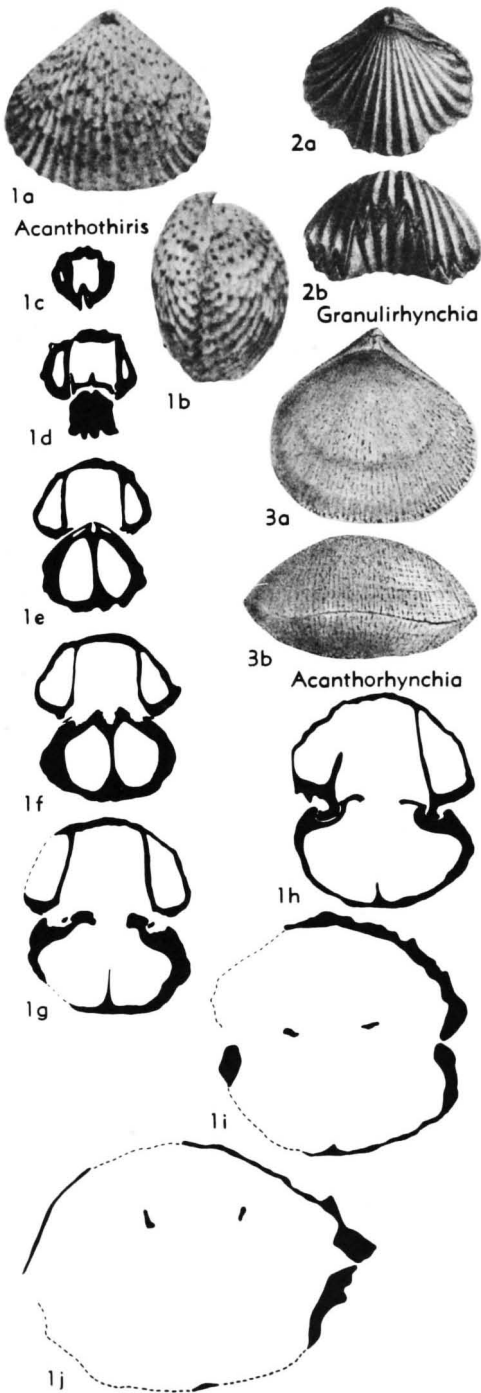


FIG. 493. Rhynchonellidae (Acanthothyridinae) (p. H611).

posteriorly. Crura falcifer, strongly curved ventrally, distal points directed toward each other and almost meeting. *U. Jur. (Oxford.)*, Eu.—FIG. 490, 4. **T. thurmanni* (VOLTZ), Eng.; 4a, b, lat., ant. views, $\times 1$ (229).

Family RHYNCHONELLIDAE Gray, 1848

[Rhynchonellidae GRAY, 1848, p. 438]

Shell without prominent median septum in brachial valve and none in pedicle valve; crura comparatively short, cardinal process absent; anterior margin of valves rectimarginate or uniplicate (3, 810). *Trias.-U. Cret.*

Subfamily RHYNCHONELLINAE Gray, 1848

[*nom. transl.* GILL, 1871, p. 25 (ex Rhynchonellidae GRAY, 1848, p. 438)]

Shell form cynocephalous, with strong, sharp dorsal folds and uniplications; long smooth stages posteriorly, only few costae anteriorly; crura radulifer. *Trias.-U. Jur.*

It has often been suggested that cynocephalous rhynchonellids are polyphyletic, homeomorphic end forms. This is difficult to prove or disprove, but the group seems to constitute a continuous stock, with no significant differences between its members. It ranges from the Triassic to the type-genus of the family at the end of the Jurassic and does not depart far from the main stock (4).

Rhynchonella FISCHER, 1809, p. 35 [**R. loxiae*; OD] [= *Eurhynchonella* LEIDHOLD, 1920, p. 352 (obj.)]. Small to medium in size, triangular; dorsal fold high, ventral sulcus somewhat flattened; few sharp costae anteriorly; beak small, incurved. Dental plates strong, septalium shallow, dorsal septum short; crura radulifer. [The so-called capillae of this genus are probably just a matter of the preservation of the fibrous shell at the type locality of the type-species.] *U. Jur. (Vulg./Portland.)*, Eu.—FIG. 492, 1. **R. loxiae*, USSR (near Moscow); 1a-c, brach.v., lat., ant. views, $\times 4$; 1d-l, transv. secs. at 1.5-2.5 mm. from tip of beak, ped.v. above, $\times 4.6$ (2).

Costirhynchia BUCKMAN, 1918, p. 39 [**C. costigera*; OD]. Small, globose, with high fold and few costae; small beak with slitlike foramen. Median septum long. *M. Jur. (Bajoc.)*, Eu.—FIG. 492, 4. **C. costigera*, Eng.; 4a, b, brach.v. (mold) and ant. views, $\times 1$ (136).

Homoeorhynchia BUCKMAN, 1918, p. 36 [**Terebratula acuta* J. SOWERBY, 1816, p. 115 (non J. DE C. SOWERBY, 1825); OD]. Small to medium in size, with high, sharp dorsal fold and few sharp costae anteriorly; beak small, incurved. Dorsal septum short; crura fairly long, radulifer; dorsal muscle-scars anterior. ?*Trias.*, Eu. (Alps); *L. Jur.-M. Jur.*, Eu.-W.N.Am.—FIG. 492, 3. **H. acuta*

(J. SOWERBY), Fr.; 3a-c, ant., brach.v., lat. views, $\times 1$ (1).

Ivanoviella MAKRIDIN, 1955, p. 83 [**Rhynchonella alemanica* ROLLIER, 1917, p. 151] [= *Ivanoviella* MAKRIDIN, 1955, p. 83 (*nom. van.*)]. Like *Homocorhynchia*, but with more costae which develop earlier. Massive spoon-shaped crura. *U. Jur.* (*Callov.-Oxford.*), Eu.-Asia.—FIG. 492,2. **I. alemanica* (ROLLIER), Fr.; 2a,b, brach.v., ant. views, $\times 1$ (377).

Subfamily ACANTHOTHYRIDINAE Schuchert, 1913

[*nom. correct.* AGER, herein (*pro Acanthothyridinae* SCHUCHERT, 1913, p. 400) (name based on junior synonym of *Acanthothiris*, here retained in accordance with Zool. Code, 1961, Art. 40)]

Mesozoic rhynchonellids having only spinosity (may be incipient) in common. [A very doubtful grouping.] *M. Jur.-U. Jur.*

Acanthothiris D'ORBIGNY, 1850, p. 323 [**Anomia spinosa* LINNÉ, 1788, p. 3346; SD BUCKMAN & WALKER, 1889, p. 50] [= *Acanthothiris* PAETEL, 1875, p. 1 (*nom. van.*)]. Globose, uniplicate, with low dorsal fold; many bifurcating costae, not smooth posteriorly, spinose throughout; beak small, incurved. Dorsal septum ridgelike; crura radulifer. *M. Jur.* (*Bajoc.-Bathon.*), Eu.-Asia.—FIG. 493,1. **A. spinosa* (LINNÉ), Eng.; 1a,b, brach. v., lat. views, $\times 1$ (136); 1c-j, serial transv. secs., $\times 4$ (Ager, n).

Acanthorhynchia BUCKMAN, 1918, p. 69 [**Acanthothyris panacanthina* BUCKMAN & WALKER, 1889, p. 53; OD]. Medium-sized, biconvex or very slightly uniplicate, without fold; capillate, spinose; beak sharp, suberect. Dorsal septum short, feeble; crura falcifer. *Jur.* (*Bajoc.-Portland.*), Eu.-N.Afr.-India.—FIG. 493,3. **A. panacanthina* (BUCKMAN & WALKER), Eng.; 3a,b, brach.v., ant. views, $\times 1$ (229).

Granulirhynchia BUCKMAN, 1918, p. 64 [**Rhynchonella granulata* UPTON, 1905, p. 83; OD]. Wide, depressed, with low, wide fold and many sharp costae covered with fine granules; beak fairly strong, suberect, foramen rimmed. Dorsal septum strong; dorsal muscle-scars broad. *M. Jur.* (*Bajoc.*), Eu.—FIG. 493,2. **G. granulata* (UPTON), Eng.; 2a,b, brach.v., ant. views, $\times 1$ (935).

Subfamily TETRARHYNCHIINAE Ager, n. subfam.

Multicostate, some with short smooth stage posteriorly, uniplicate, with moderate dorsal fold; beak small, usually incurved; delthyrium usually small, foramen not rimmed. Crura radulifer, usually in form of simple hooks. [These are "ordinary-looking" rhynchonellids, as generally understood, and as such constitute the bulk and probably the main stock of the Mesozoic forms.] *U. Trias.-L. Cret.*

Tetrarhynchia BUCKMAN, 1918, p. 41 [**Terebratula tetraëdra* SOWERBY, 1812, p. 191 = *Tetrarhynchia tetraëdra* (SOWERBY) (*nom. correct.*, AGER, 1956, p. 7); OD]. Medium-sized, laterally expanded, subtriangular, with many fairly sharp costae, short smooth stage posteriorly; beak small, incurved. Median septum short, septalium deep;

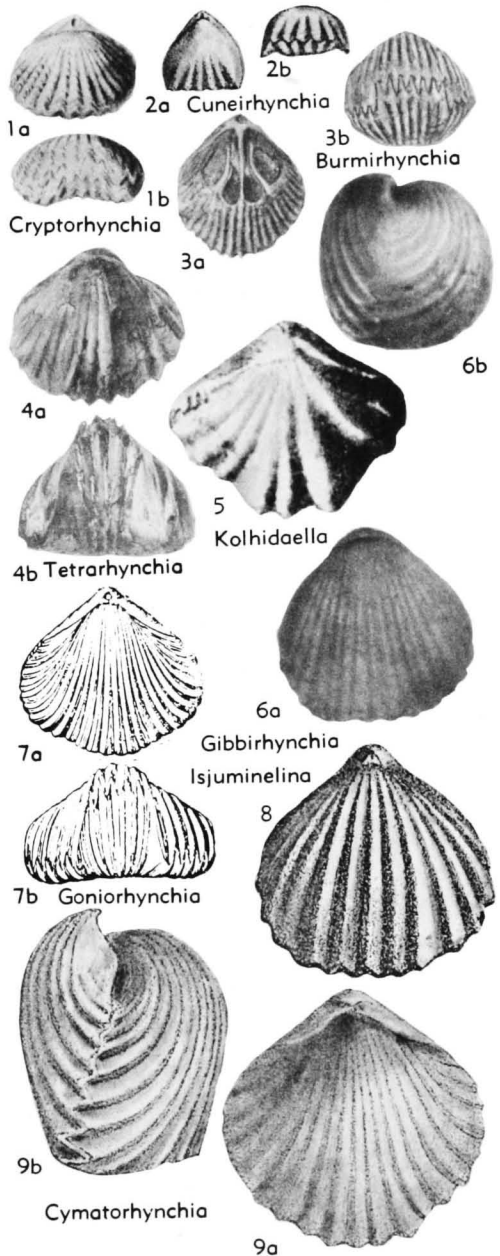


FIG. 494. Rhynchonellidae (Tetrarhynchiinae) (p. H611-H614).

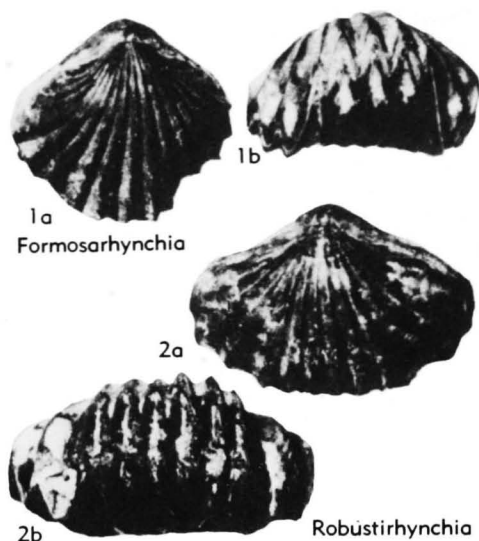


FIG. 495. Rhynchonellidae (Tetrarhynchiinae) (p. H612, H614).

crura radulifer. *Jur.*(*Sinemur.-Bajoc.*), Eu.-N.Am. (NW.Can.).—FIG. 494,4; 496,1. **T. tetrahedra* (SOWERBY), Eng.; 494,4a,b, brach.v., ant. views, $\times 1$; 496,1a-k, transv. secs. of beak region (ped.v. above), $\times 1.75$ (1).

Burmhirhynchia BUCKMAN, 1918, p. 49 [**B. gutta*; OD]. Medium-sized, globose; with slight uniplication, indistinct fold, and many rounded costae; beak massive, hypothryidid. Dental plates divergent; median septum strong. *M.Jur.*(*Bathon.-Callov.*), Eu.-Somaliland - M.East - India - Burma-China - ?Japan - ?Australia. — FIG. 494,3. **B. gutta*, Burma; 3a,b, brach.v. mold and ant. views, $\times 1$ (138).

Cryptorhynchia BUCKMAN, 1918, p. 66 [**Rhynchonella pulcherrima* KITCHIN, 1900, p. 52; OD]. Small, uniplicate, dorsal fold moderate; ornament reticulate; beak sharp, suberect. Teeth and sockets projecting well into brachial valve, having appearance of lateral septa; no septalium; crura radulifer, bladellike, converging ventrally. *M.Jur.*(*Bathon.*), Eu.-India-N.Z. — FIG. 494,1. **C. pulcherrima* (KITCHIN), Cutch; 1a,b, brach.v., ant. views, $\times 1$ (478).

Cuneirhynchia BUCKMAN, 1918, p. 35 [**Rhynchonella dalmasi* DUMORTIER, 1869, p. 331; OD]. Small, depressed, uniplicate, convexi-planate or convexi-concave; pronounced smooth stage with few blunt costae anteriorly; beak small, upright. Hinge plates massive, dorsal septum long and low. ?*Trias.*, Eu.(Alps); *L.Jur.*(*Sinemur.-Pliensbach.*), Eu.-Anatolia.—FIG. 494,2. **C. dalmasi* (DUMORTIER), Fr.; 2a,b, brach.v., ant. views, $\times 1$ (916).

Cymatorhynchia BUCKMAN, 1918, p. 53 [**Rhyn-*

chonella cymatophorina BUCKMAN, 1910, p. 105 (= *R. cymatophora* BUCKMAN, 1895, non ROTH-PLETZ, 1886); OD]. Medium-sized to large, with strong dorsal fold and uniplication; many sharp costae, no smooth stage; beak small, hypothryidid. Dorsal septum strong; no septalium; crura radulifer. *M.Jur.*(*Bajoc.*), Eu.—FIG. 494,9. **C. cymatophorina* (BUCKMAN), Eng.; 9a,b, brach.v., lat. views, $\times 1$ (229).

Formosarhynchia SEIFERT, 1963, p. 177 [**F. formosa*; OD]. Like *Cymatorhynchia* but dorsal valve less inflated posteriorly and definite septalium present. *M.Jur.*(*Bajoc.*), Eu.—FIG. 495,1. **F. formosa*, Ger.; 1a,b, brach.v., ant. views, $\times 1$ (735a).

Gibbirhynchia BUCKMAN, 1918, p. 43 [**G. gibbosa*; OD]. Small, globose, with strong uniplication, multicostate; beak small, incurved, with 2 deep, narrow muscle impressions. Crura short, radulifer. *L.Jur.*(*Sinemur.-Toarc.*), Eu.-Anatolia-Iran. — FIG. 494,6. **G. gibbosa*, Eng.; 6a,b, brach.v., lat. views, $\times 2$ (905a).

Goniorhynchia BUCKMAN, 1918, p. 52 [**G. goniaeae*; OD]. Medium-sized, wide; with strong uniplication and dorsal fold; many strong, sharp costae; not smooth posteriorly; beak small, suberect. Dorsal septum weak; crura radulifer; with much internal secondary thickening. *M.Jur.*(*Bathon.*), Eu. — FIG. 494,7. **G. goniaeae*, Eng., 7a,b, brach.v., ant. views, $\times 1$ (909).

Grandirhynchia BUCKMAN, 1918, p. 40 [**G. grandis*; OD]. Large, laterally expanded, uniplicate; with few strong blunt costae and pronounced smooth stage posteriorly; beak large, suberect, sharp beak ridges. Very deep septalium, long median septum; crura long, radulifer. *L.Jur.*(*Pliensbach.*), G. Brit. - Greenl. — FIG. 479,3; 497,11. **G. grandis*, Scot.; 479,3a, transv. sec. 4.5 mm. from

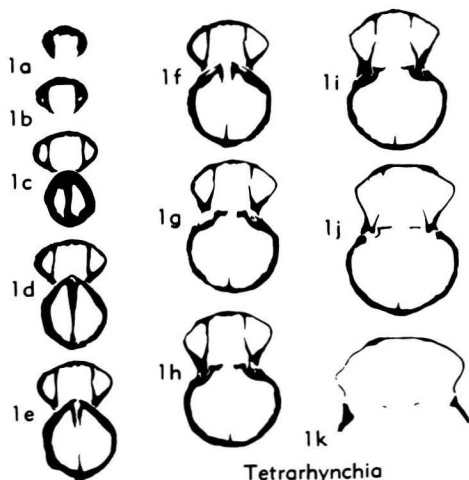


FIG. 496. Rhynchonellidae (Tetrarhynchiinae) (p. H611-H612).

tip of beak (ped.v. above), $\times 2$; 479,3b, part of brach.v. in same sec. showing septalial plates (s), $\times 7$; 497,11a,b, lat., ant. views, $\times 1$ (1).

Isjuminella MAKRIDIN, 1960, p. 254 [**Rhynchonella pseudodecorata* ROLLIER, 1917, p. 139; OD] [= *Isjuminella* MAKRIDIN, 1955, p. 85

(*nom. nud.*) (type, "*Rhynchonella decorata* von BUCH" does not exist)]. Large, globose, uniplicate, thick-shelled. Dorsal septum supporting septalium; crura short. [Insufficiently known; probably a synonym of one of the other genera listed herein.] *U.Jur.*(*Oxford.*), Eu.-S.USSR.—

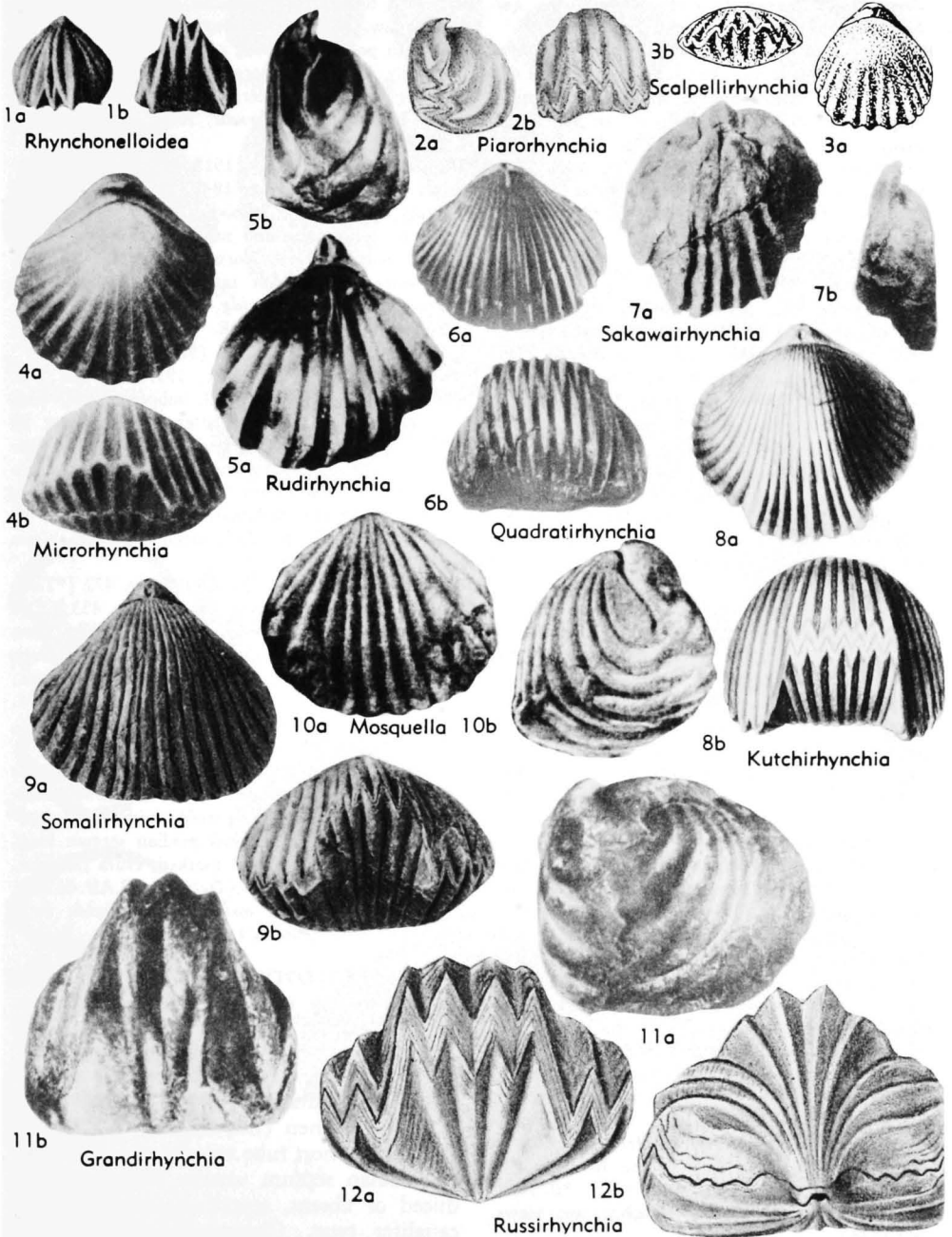


FIG. 497. Rhynchonellidae (Tetrarhynchiinae) (p. H612, H614).

- FIG. 494.8. **I. pseudodecorata* (ROLLIER), Ger.; brach.v. view, $\times 2$ (626).
- Kolhidaella** MOISSEEV, 1939, p. 189 [**K. kolhidaensis*; OD] [= *Gagriella* MOISSEEV, 1939, p. 183 (type, *G. abhasiaensis*)]. Large, pentagonal, strongly folded and uniplicate, strong costae. [Insufficiently known; may be close to *Lacunosella*.] *L. Cret.*, USSR (Caucasus).—FIG. 494.5. **K. kolhidaensis*; oblique brach.v. view, $\times 1$ (627).
- Kutchirhynchia** BUCKMAN, 1918, p. 54 [**Rhynchonella concinna* var. *kutchensis* KITCHIN, 1900, p. 48; OD]. Medium-sized, globose, with strong uniplication and dorsal fold; no smooth stage, many costae; beak short, suberect. Dental plates very long, dorsal septum strong but short. [Possibly a synonym of *Cymatorhynchia*.] *M. Jur.* (Bathon.), Eu.-India.—FIG. 497.8. **K. kutchensis* (KITCHIN), Cutch; *8a,b*, brach.v., ant. views, $\times 1$ (478).
- Microrhynchia** MUIR-WOOD, 1952, p. 124 [**M. barnackensis*; OD]. Small, globose, with fine costae anteriorly; uniplicate (may be asymmetrical), fold ill-defined; beak slightly incurved. Well-developed dorsal septum, no septalium; crura calcifer. *M. Jur.*, Eu.—FIG. 497.4. **M. barnackensis*, Eng.; *4a,b*, brach.v., ant. views, $\times 4.5$ (582).
- Mosquilla** MAKRIDIN, 1955, p. 6 [**Terebratula oxoptychia* FISCHER, 1843, p. 118; OD]. Like *Russirhynchia*, but with more costae, septum joined to hinge plates by callous thickening, crura thin and blade-like. *U. Jur.* (Volg.), USSR.—FIG. 497.10. **M. oxoptychia* (FISCHER); *10a,b*, ped.v., lat. views, $\times 1$ (694).
- Piarorhynchia** BUCKMAN, 1918, p. 34 [**Rhynchonella lineata* var. *radstockiensis* DAVIDSON, 1878, p. 210; OD] [= *Tropiorhynchia* BUCKMAN, 1918]. Medium-sized, globose to depressed, equivalved, uniplicate, dorsal fold low; pronounced smooth stage posteriorly, rounded costae anteriorly; beak small, incurved. Dorsal septum massive; crura radulifer; with thick horizontal hinge plates. *U. Trias.*, Eu. (Alps)-W. Can.; *L. Jur.*, Eu.-N. Afr.—FIG. 497.2. **P. radstockiensis* (DAVIDSON), Eng.; *2a,b*, lat., ant. views, $\times 1$ (229).
- Quadrirhynchia** BUCKMAN, 1918, p. 42 [**Q. quadrata*; OD]. Medium-sized to large; strong, wide uniplication, with many, very sharp costae; beak small, incurved. Pedicle collar present; median septum very short; crura radulifer. *L. Jur.* (*U. Pliensbach.*), W. Eu.—FIG. 497.6. **Q. quadrata*, Eng.; *6a,b*, brach.v., ant. views, $\times 1$ (1).
- Rhynchonelloidea** BUCKMAN, 1918, p. 38 [**Rhynchonella ruthenensis* REYNÈS, 1868, p. 101; OD]. Medium-sized, with strong dorsal fold and uniplication; few fairly sharp costae after smooth stage; beak small but clear and erect. Dorsal septum strong, short; crura radulifer, distally concave. [Perhaps attributable to the *Rhynchonellinae*.] *L. Jur.-M. Jur.*, Eu.—FIG. 497.1. **R. ruthenensis* (REYNÈS), Fr.; *1a,b*, brach.v., ant. views, $\times 1$ (136).
- Robustirhynchia** SEIFERT, 1963, p. 174 [**Terebratula Ehningensis* QUENSTEDT, 1857, p. 497; OD]. Like *Goniorhynchia* but very wide, with wide uniplication and thinner shell. *U. Jur.* (*Callov.*), Eu.—FIG. 495.2. **R. ehningensis* (QUENSTEDT), Ger.; *2a,b*, brach.v., ant. views, $\times 1$ (735a).
- Rudirhynchia** BUCKMAN, 1918, p. 44 [**R. rudis*; OD]. Small, subtriangular, uniplicate, dorsal fold low, with few strong, fairly sharp costae, smooth posteriorly; beak strong, sharp, projecting, slightly incurved. Dorsal septum and septalium strong; crura radulifer. *L. Jur.* (*Pliensbach.*), Eu.—FIG. 497.5. **R. rudis*, Eng.; *5a,b*, brach.v., lat. views, $\times 2$ (1).
- Russirhynchia** BUCKMAN, 1918, p. 52 [**Rhynchonella fischeri* ROUILLIER, 1847, p. 394; OD]. Medium-sized to large, globose, with strong uniplication, dorsal fold, and many very strong costae; beak short, suberect. Dorsal septum strong; crura radulifer; with much internal secondary thickening. *U. Jur.* (*Kimmeridg.-Volg.*), Eu. (USSR-W. Eu.).—FIG. 497.12. **R. fischeri* (ROUILLIER); *12a,b*, ant., post. views, $\times 1$ (929).
- Sakawairhynchia** TOKUYAMA, 1957, p. 126 [**S. tokomboensis*; OD]. Small, subpentagonal, with strong uniplication and flattened fold, about 10 to 15 subangular costae; beak sharp, upright. Septalium shallow, with median projection; crura radulifer. *U. Trias.* (*Carn.*), Asia (Japan-Himalayas)-Eu. (Alps)-N. Am. (W. Can.). — FIG. 497.7. **S. tokomboensis*, Japan; *7a,b*, brach.v. and lat. views of int. mold, $\times 1$ (812).
- Scalpellirhynchia** MUIR-WOOD, 1936, p. 477 [**Terebratula scalpellum* QUENSTEDT, 1851, p. 453; OD]. Small, biconvex, flattened anteriorly, uniplication low, with costae anteriorly; beak short, erect. Dorsal septum long, supporting wide septalium; crura radulifer. *L. Jur.*, Eu.—FIG. 497.3. **S. scalpellum* (QUENSTEDT), Ger.; *3a,b*, brach.v., ant. views, $\times 2$ (579).
- Somalirhynchia** WEIR, 1925, p. 79 [**S. africana*; OD]. Large, uniplicate, dorsal fold low, multicostate; beak strong, incurved, with small foramen, hypothyridid. Dorsal median septum long, strong; muscle scars well marked; crura radulifer, enlarged distally. *U. Jur.* (*Oxford.*), E. Afr.-M. East.—FIG. 497.9. **S. africana*, Somaliland; *9a,b*, brach.v., ant. views, $\times 1$ (577).

Subfamily CYCLOTHYRIDINAE Makridin, 1955

[*nom. correct.* AGER, herein (*pro Cyclothyrisinae* MAKRIDIN, 1955, p. 82)] [Cyclothyridae proposed by PHILLIPS, 1841, p. 55, for *Epithyris* and *Hypothyris* is not an available family group name under Article 11e of the International Code]

Multicostate, rarely with posterior smooth area; beak massive, with hypothyridid, rimmed foramen (i.e., deltidial plates produced into short tube around pedicle). Dorsal median septum usually very much reduced or absent, septalium lacking; crura canalifer type. Characteristically strongly costate, some shells with fine capillae pos-

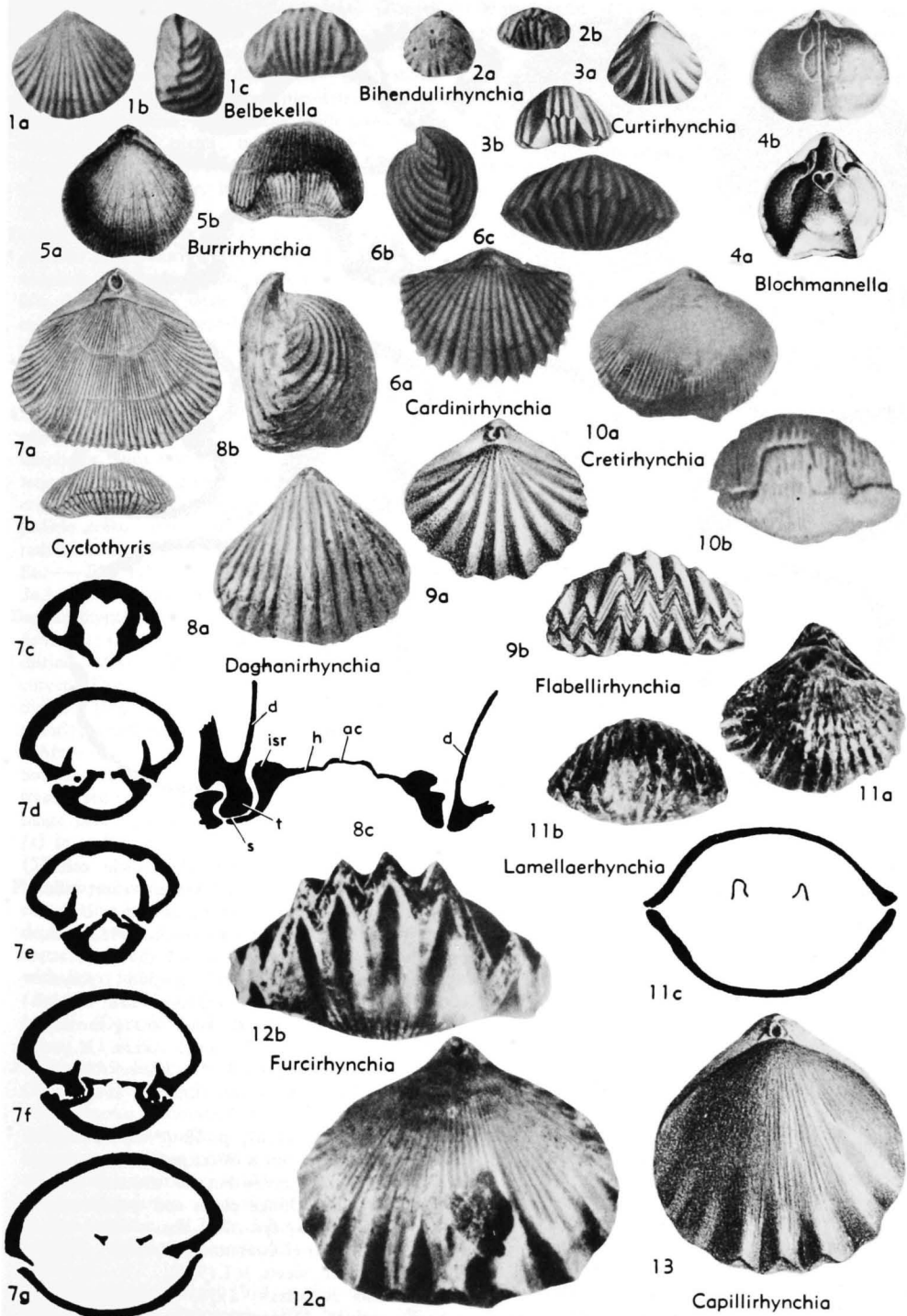


FIG. 498. Rhynchonellidae (Cyclothyridinae) (p. H616-H617).

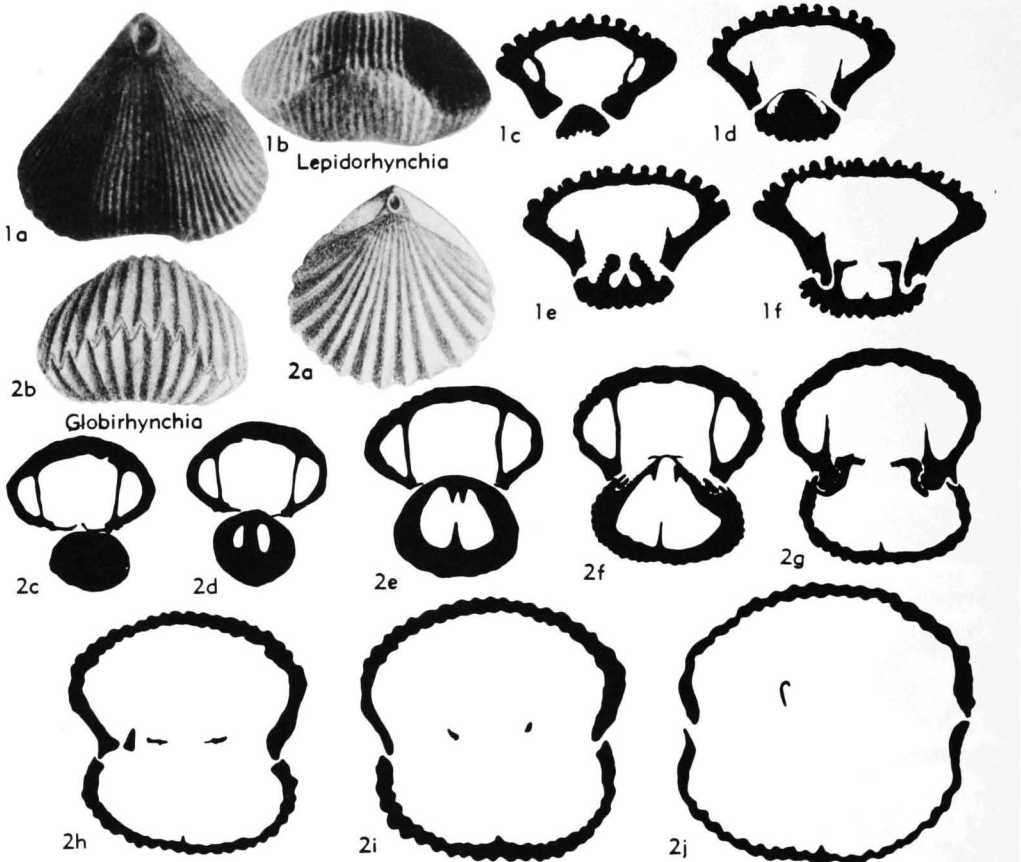


FIG. 499. Rhynchonellidae (Cyclothyridinae) (p. H617).

teriorly passing into costae anteriorly; may be asymmetrical. *L.Jur.-U.Cret.*

Cyclothyris M'COY, 1844, p. 103 [**Terebratula latissima* J. DE C. SOWERBY, 1829, index (= **T. lata* J. DE C. SOWERBY, 1825, p. 165) (non J. SOWERBY, 1815), p. 227; OD]. Large, wide, depressed, with low arcuate uniplication, commonly asymmetrical with many fine costae, may be capillate posteriorly; beak erect. Dorsal septum very short or absent. *Cret. (Apt.-Cenoman.)*, Eu.-N.Am.—FIG. 498, 7. **C. latissima* (J. DE C. SOWERBY), Eng.; 7a, b, brach.v., ant. views, $\times 1$, $\times 0.7$ (229); 7c-g, serial transv. secs., $\times 2$ (629).

Belbekella MOISSEEV, 1939 [**B. airgulensis*; OD]. Globose, subtriangular, uniplicate, without distinct fold, multicostate, lacking smooth stage; beak massive, erect. Strong teeth and denticula; septum may be absent. *Cret.*, USSR (Crimea-Caucasus-C.Asia)?-W.Eu.—FIG. 498, 1. **B. airgulensis*; 1a-c, brach.v., lat., ant. views, $\times 1$ (925).

Bihendulirhynchia MUIR-WOOD, 1935, p. 104 [**B. afra*; OD]. Small, smooth and sulcate posteriorly, uniplicate anteriorly, with low fold and about 10

costae; beak erect, hypothyriddid. Pedicle collar supported by septum; dorsal septum short and low; no septalium; crura short, radulifer. *U.Jur. (L. Kimmeridg.)*, Somaliland.—FIG. 498, 2. **B. afra*; 2a, b, brach.v., ant. views, $\times 1$ (577).

Blochmannella LEIDHOLD, 1920, p. 356 [**Rhynchonella Friereni* BRANCO, 1879, p. 128; OD]. Like *Septaliphoria* but with long, strong median septum and well-marked muscle scars. *M.Jur. (Bajoc.)*, Eu.—FIG. 498, 4. **B. friereni* (BRANCO), Ger.; 4a, b, ped.v. int., brach.v. int., $\times 2$ (503).

Burrirhynchia OWEN, 1962, p. 58 [**Rhynchonella leightonensis* LAMPLUGH & WALKER, 1903, p. 261; OD]. Like *Cretirhynchia* but for disjunct deltidial plates, thinner hinge plates and weaker median septum. *L.Cret. (Apt.-Alb.)*, Eu.—FIG. 498, 5. **B. leightonensis* (LAMPLUGH & WALKER), Eng.; 5a, b, brach.v., ant. views, $\times 1$ (923).

Capillirhynchia BUCKMAN, 1918, p. 58 [**Rhynchonella wrightii* DAVIDSON, 1852, p. 69; OD]. Large, globose, uniplicate, with low fold; capillae all over shell, strong sharp costae anteriorly; beak strong, suberect. *Jur. (Bajoc.-Callou.)*, Eu.-N.Am.

- (Calif.).—FIG. 498,13. **C. wrighti* (DAVIDSON), Eng.; brach.v. view, $\times 1$ (229).
- Cardinirhynchia** BUCKMAN, 1918, p. 74 [**Terebratula acuticosta* ZIETEN, 1830, p. 58; OD]. Wide, hinge line nearly straight; multicostate; with incipient uniplication; broad beak with large foramen; deltidial plates narrow. *M.Jur.(Bajoc.-?Bathon.)*, Eu.—FIG. 498,6. **C. acuticosta* (ZIETEN), Ger.; 6a-c, brach.v., lat., ant. views, $\times 1$ (937).
- Cretirhynchia** PETTITT, 1950, p. 1 [**Terebratula plicatilis* J. SOWERBY, 1816, p. 37; OD]. Biconvex, uniplicate, dorsal fold low; smooth or with many low, round costae; beak short. Large teeth; low median septum, no septalium. [Probably requires division.] *U.Cret.*, NW.Eu.—FIG. 498,10. **C. plicatilis* (SOWERBY), Eng.; 10a,b, brach.v., ant. views, $\times 1$ (639).
- Curtirhynchia** BUCKMAN, 1918, p. 36 [**Rhynchonella oolitica* DAVIDSON, 1852, p. 81; OD]. Small, uniplicate, with low dorsal fold; blunt costae anteriorly, smooth posteriorly; beak sharp, suberect, hypothyriddid. Dorsal septum, no septalium, pedicle collar supported by short septum; crura radulifer, distally concave. *M.Jur.(Bajoc.)*, NW.Eu.—FIG. 498,3. **C. oolitica* (DAVIDSON), Eng.; 3a,b, brach.v., ant. views, $\times 1$ (229).
- Daghanirhynchia** MUIR-WOOD, 1935, p. 82 [**D. daghaniensis*; OD]. Medium in size, uniplicate, with distinct dorsal fold, costae few; beak acute, incurved. Dental plates strong, dorsal septum weak; divided hinge plates united by thin lamella anteriorly; crura nearly horizontal. *U.Jur.(Callov.)*, E.Afr.—FIG. 498,8. **D. daghaniensis*, Br. Somaliland; 8a,b, brach.v., lat. views, $\times 1$; 8c, transv. sec. showing accessory plate (*ac*) uniting hinge plates (*h*), inner socket ridge (*isr*), tooth (*t*) in socket (*s*), and dental plates (*d*), enlarged (577).
- Flabellirhynchia** BUCKMAN, 1918, p. 65 [**Rhynchonella lycettii* DAVIDSON, 1852, p. 65; OD]. Wide, depressed, with low fold and many strong, sharp costae; anterior margin thickened; beak strong, with large foramen. Dorsal septum feeble. *M.Jur.(Bajoc.)*, Eu.-N.Am.(Calif.).—FIG. 498,9. **F. lycettii* (DAVIDSON), Eng.; 9a,b, brach.v., ant. views, $\times 1$ (229).
- Furcirhynchia** BUCKMAN, 1918, p. 59 [**F. furcata*; OD] [= *Lineirhynchia* BUCKMAN, 1918 (type, *Lineirhynchia cotteswoldiae* (UPTON), 1899, p. 129)]. Small to medium-sized, depressed to cynocephalous; capillate posteriorly, with few strong, sharp costae anteriorly; beak strong, upright, with large oval foramen. Dorsal median septum long; crura radulifer. *U.Trias.-L.Jur.*, Eu.-W.Canada.—FIG. 498,12. **F. furcata*, Eng.; 12a,b, brach.v., ant. views, $\times 2$ (1).
- Globirhynchia** BUCKMAN, 1918, p. 48 [**Rhynchonella suboboleta* DAVIDSON, 1852, p. 91; OD]. Small to medium-sized, globose; with arcuate uniplication and low dorsal fold; many sharp costae, no smooth stage; beak massive, suberect, hypothyriddid. Dorsal septum long and low; no septalium; dorsal muscle scars linear; crura radulifer, hooked dorsally. *M.Jur.(Bajoc.)*, NW.Eu.-USA (Calif.).—FIG. 499,2. **G. suboboleta* (DAVIDSON), Eng.; 2a,b, brach.v., ant. views, $\times 1$ (229); 2c-j, serial transv. secs., $\times 4$ (Ager, n).
- Lamellaerhynchia** BURRI, 1953, p. 274 [**Terebratula rostriformis* ROEMER, 1836, p. 40 (= *T. multiformis* ROEMER, 1839, *partim*); OD]. Medium-sized, multicostate; uniplicate, rectimarginate, or asymmetrical; beak strong, projecting, suberect. Dorsal septum ridgelike; crura distally concave. [Possibly a synonym of *Belbekella*.] *L.Cret.(U. Valangin.-Barrem.)*, W.Eu.-N.Am.(Tex.).—FIG. 498,11. **L. rostriformis* (ROEMER), Ger.; 11a,b, brach.v., ant. views, $\times 1$; 11c, transv. sec. of beak region, $\times 2.4$ (138).
- Lepidorhynchia** BURRI, 1956, p. 689 [**L. dichotoma*; OD]. Medium-sized, biconvex, with many fine branching costae; rectimarginate or slightly uniplicate, sulcus in both valves; beak high, with large foramen. Dental plates poorly developed; median septum a low ridge. *L.Cret.(U. Hauteriv.)*, ?*U.Cret.(Cenoman.)*, Eu.—FIG. 499,1. **L. dichotoma*, Switz.; 1a,b, brach.v., ant. views, $\times 2$; 1c-f, transv. secs. of beak region, $\times 4$ (138).
- Malwirhynchia** CHIPLONKER, 1938, p. 306 [**M. transversalis*; OD]. Small, low uniplication and ill-defined fold; many fine costae, bifurcating anteriorly. Beak short, suberect, with large foramen. Weak dorsal septum, crura ?calcarifer. ?*L. Cret.(Alb.)*, *U. Cret.(Cenoman.)*, India.—FIG. 500,1. **M. transversalis*, India; brach.v. view, $\times 1$ (911).
- Maxillirhynchia** BUCKMAN, 1918, p. 55 [**M. implicata*; OD]. Small; low rectangular fold and uniplication after short early sulcate stage. Capillate throughout, strong costae anteriorly. Beak sharp, incurved, hypothyriddid. [Doubtfully included here.] *L.Jur.(Pliensbach.-Toarc.)*, Eu.—FIG. 500,9. **M. implicata*, Eng.; 9a-c, brach.v., lat., ant. views, $\times 3$ (Ager, n).
- Parvirhynchia** BUCKMAN, 1918 [**Rhynchonella parvula* EUDES-DESLONGCHAMPS, 1862; p. 29; OD]. Small, depressed, with low fold and uniplication; few blunt costae, capillate throughout; beak strong, erect. Dorsal septum low; crura ?calcarifer. *Jur.(Bajoc.-Oxford.)*, Eu.-Japan.—FIG. 500,4. **P. parvula* (EUDES-DESLONGCHAMPS), Eng.; 4a,b, brach.v., lat. views, $\times 2$ (229).
- Plicarostium** BURRI, 1953, p. 281 [**P. hauteriviense*; OD]. Medium-sized, with many sharp costae; cynocephalous, nearly convexiplanate; beak projecting. Thick dental plates almost fused with shell wall; median septum a low ridge, arising late; crura distally concave. *L.Cret.(Hauteriv.)*, Eu.—FIG. 500,2. **P. hauteriviense*, Switz.; 2a,b, brach.v., lat. views, $\times 1$ (138).
- Praecyclothyris** MAKRIDIS, 1955, p. 84 [**Rhynchonella moeschi donetiziana* MAKRIDIS, 1952; OD]. Like *Septaliphoria* but with a flared rim inside the foramen. *U.Jur.(Callov.-Kimmeridg.)*, USSR-

?W.Eu.—FIG. 500,8. **P. moeschi donetziana* (MAKRIDIN); 8a,b, brach.v., ant. views, $\times 1$ (694).
Ptilorhynchia CRICKMAY, 1933, p. 877 [**P. plumasensis*; OD]. Medium-sized, triangular, subglobose; uniplication strong, with blunt costae anteriorly after long smooth stage; beak small, upright, hypothyriddid. Dental plates divergent. U.Jur.(?Kimmeridg.), USA (Calif.).—FIG. 500,3. **P. plumasensis*; 3a,b, brach.v., ant. view, $\times 1$ (915a).

Ptyctorhynchia BUCKMAN, 1918, p. 47 [**Rhynchonella pentaptycta* BUCKMAN, 1910, p. 103; OD]. Small, globose, with low wide uniplication and fold; few very strong costae anteriorly; beak small, suberect; foramen hypothyriddid, slightly rimmed. M.Jur.(Bajoc.), Eu.—FIG. 500,5. **P. pentaptycta* (BUCKMAN), Eng.; 5a,b, brach.v., lat. views, $\times 1$ (229).

Rhactorhynchia BUCKMAN, 1918, p. 50 [**R. rhacta*;

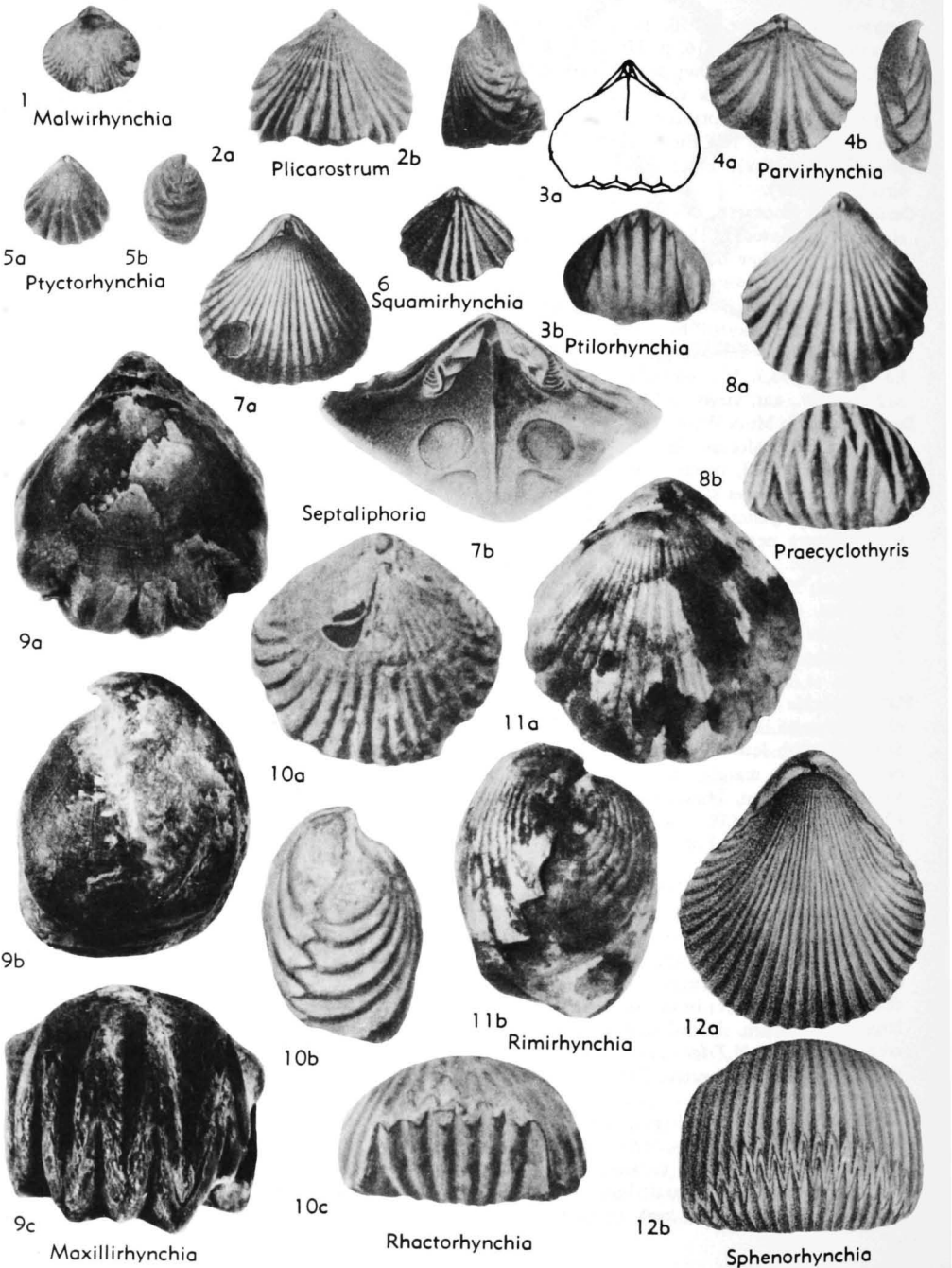


FIG. 500. Wellerellidae (Cirpinae) (6); Rhynchonellidae (Cyclothyridinae) (1-5, 7-12) (p. H607-H608, H617-H619), university of Kansas Paleontological Institute

OD]. Medium-sized to large, globose, with feeble, commonly asymmetrical dorsal fold and many strong, sharp costae; beak strong, slightly incurved, hypothyriddid. Dorsal septum strong; crura radulifer; muscle scars expanded. [An important, long-ranging genus that may need subdivision.] ?*L. Jur.*, SE. Asia; *M. Jur.* (*Bajoc.*), ?*U. Jur.* (*Kimmeridg.*), Eu.-N. Afr.-?E. Afr.-India-N. Am.—FIG. 500,10. **R. rhacta*, Eng.; 10a-c, brach.v., lat., ant. views, $\times 1$ (138).

Rimirhynchia BUCKMAN, 1918, p. 60 [**R. rimosiformis* BUCKMAN, 1918, p. 60 = **Rhynchonella anglica* ROLLIER, 1917, p. 92; OD]. Like *Furcirhynchia* (to which it is closely related) but very globose, with massive incurved beak. *L. Jur.* (*Sinemur.-L. Pliensbach.*), W. Eu.-W. Canada.—FIG. 500,11. **R. anglica* (ROLLIER), Eng.; 11a,b, brach.v., lat. views, $\times 2$ (1).

Septaliphoria LEIDHOLD, 1921, p. 354 [**Rhynchonella arduennensis* OPPEL, 1857, p. 608 (= *R. inconstans* D'ORBIGNY, 1850, p. 24, non SOWERBY, 1821); OD]. Medium-sized to large, uniplicate, commonly asymmetrical, costate; strong, high beak with large hypothyriddid foramen. Septalium supported by short median septum; crura strong, concave dorsally. *U. Jur.* (*Oxford.*)-? *L. Cret.* (*Valangin.*), Eu.-?E. Afr.—FIG. 500,7. **S. arduennensis* (OPPEL), Ger.; 7a, brach.v. view, $\times 1$; 7b, ped.v. int., $\times 2$ (503).

Sphenorhynchia BUCKMAN, 1918, p. 30 [**Terebratulaplicatella* J. DE C. SOWERBY, 1825, p. 167; OD]. Medium-sized to large, globose, wedge-shaped; with arcuate uniplication, dorsal fold raised in some shells, with many sharp costae; beak small, massive, suberect. Dorsal septum strong. [Doubtfully included here.] *Jur.* (*Bajoc.-Callov.*), Eu.-?Asia (Afghan.)—FIG. 500,12. **S. plicatella* (J. DE C. SOWERBY), Eng.; 12a,b, brach.v., ant. views, $\times 1$ (229).

Stiirhynchia BUCKMAN, 1918, p. 68 [**Rhynchonella dorsetensis* DAVIDSON, 1884, p. 177; OD]. Small to medium-sized, depressed, uniplicate, with many fine dichotomizing capillae, no costae; beak small, sharp. Dental plates short; dorsal septum feeble. *M. Jur.* (*Bajoc.*), ?*U. Jur.* (*Kimmeridg.*), Eu.—FIG. 501,1. **S. dorsetensis* (DAVIDSON), Eng.; brach.v. view, $\times 2$ (229).

Suiaella MOISSEEV, 1956, p. 20 [**S. weberi*; OD]. Like *Belbekella* but smaller, with brachial valve less convex than pedicle, and crura less curved. *L. Cret.* (*Barrem.*), USSR (Crimea-Caucasus)—FIG. 501,3. **S. weberi*; 3a-c, brach.v., lat., ant. views, $\times 1.5$ (925).

Sulcirhynchia BURRI, 1953, p. 271 [**Rhynchonella valangiensis* DELORIOU, 1864, p. 442; OD]. Medium-sized, with many sharp costae, slight sulcus in median fold; beak projecting. Median septum soon reduced to low ridge; crura radulifer, slightly concave distally. *L. Cret.* (*U. Valangin.-?L. Apt.*), Eu.—FIG. 501,2. **S. valangiensis* (DELORIOU), Switz.; 2a,b, brach.v., lat. views, $\times 1$; 2c, diagram. ant. view (brach.v. above), $\times 1$ (138).

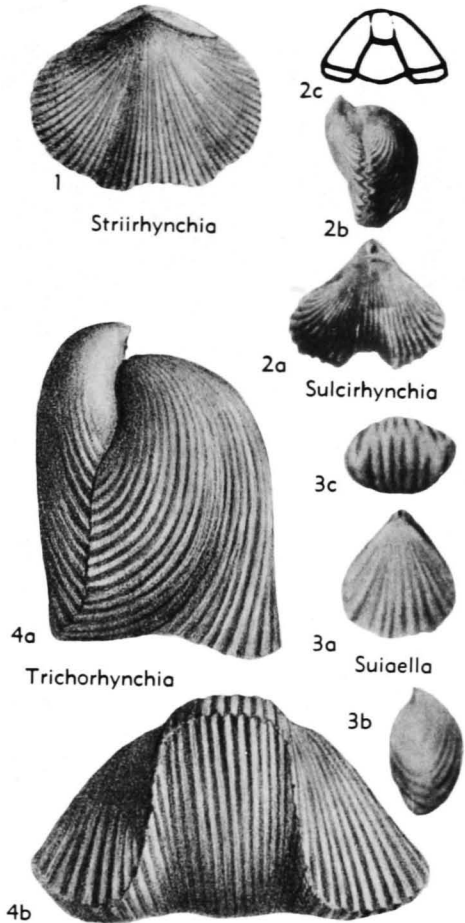


FIG. 501. Rhynchonellidae (Cyclothyridinae) (p. H619).

Trichorhynchia BUCKMAN, 1918, p. 58 [**Rhynchonella deslongchampsii* DAVIDSON, 1852, p. 253; OD]. Large, with wide uniplication, strong flattened dorsal fold, many fine costae; beak massive. [Possibly belongs to Tetrarhynchiinae.] *Jur.* (*Pliensbach.-Bajoc.*), NW. Eu.—FIG. 501,4. **T. deslongchampsii* (DAVIDSON), Fr.; 4a,b, lat., ant. views, $\times 1$ (229).

Family SEPTIRHYNCHIIDAE Muir-Wood & Cooper, 1951

[Septirhynchiidae MUIR-WOOD & COOPER, 1951, p. 5]

Unusually large, pentameroid in appearance, with cardinal process in dorsal valve and median septum in ventral valve (577, 926). *U. Jur.*

Septirhynchia MUIR-WOOD, 1935, p. 106 [**Rhynchonella azaisi* COTTREAU, 1924, p. 581; OD]. Thick-shelled, with many strong, subangular costae, fold low. Long ventral median septum

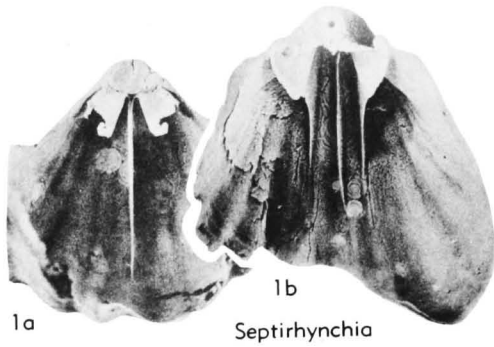


FIG. 502. Septirhynchiidae (p. H619-H620):

and strong dental plates; dorsal median septum low; small knoblike cardinal process; long radulifer crura. *Jur. (Callov.-Kimmeridg.)*, E.Afr.-W. Asia (Sinai).—FIG. 502, 1. *S. pulchra* MUIR-WOOD & COOPER, Abyssinia; 1a, b, brach.v. int., ped.v. int., $\times 1.3$ (926).

Family AUSTRIRHYNCHIIDAE Ager, 1959

[Austrirhynchiidae AGER, 1959, p. 325]

Shell extremely expanded laterally, with cardinal process and dorsal denticula (3). [Perhaps should be classed as subfamily of Dimerellidae.] *Trias*.

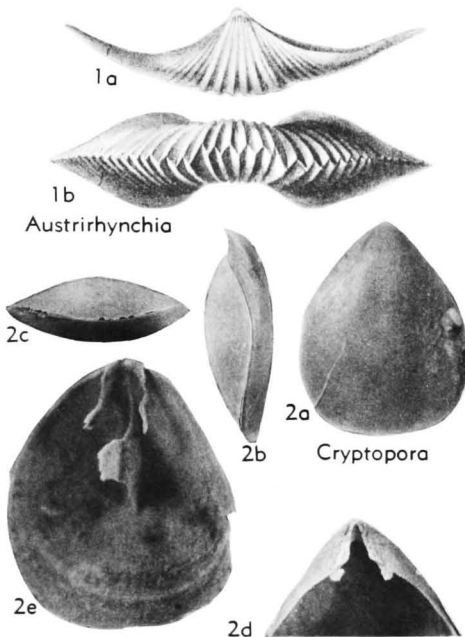


FIG. 503. Austrirhynchiidae (1); Cryptoporidae (2) (p. H620, H622).

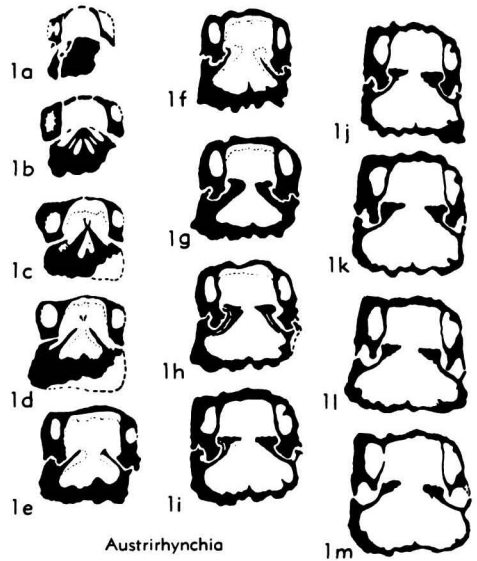


FIG. 504. Austrirhynchiidae (p. H620).

Austrirhynchia AGER, 1959, p. 325 [*Terebratula cornigera* SCHAFHÄUTL, 1851, p. 407; OD]. Small, triangular, anterolateral angles considerably extended; with short, wide uniplication, multicostate, well-developed planareas; beak incurved, with large hypothryridid foramen. Dorsal septum very short, with bilobed cardinal process, dorsal denticula present; crura radulifer. *U.Trias. (Carn.-Rhaet.)*, Eu. (Alps).—FIG. 503, 1; 504, 1. **A. cornigera* (SCHAFHÄUTL), Austria; 503, 1a, b, brach. v., ant. views, $\times 1$ (933); 504, 1a-m, transv. secs. of beak region, 0.3-1.2 mm. from tip of beak (ped.v. above), $\times 3.7$ (3).

Family CRYPTOPORIDAE Muir-Wood, 1955

[Cryptoporidae MUIR-WOOD, 1955, p. 76]

Large deltoid foramen slightly restricted by elongate, triangular, elevated deltoidal plates; crura long, maniculifer, continuous with socket ridges; median septum elevated; cardinal process a lobate thickening between socket ridges; single pair of nephridia (193, 583). *Eoc.-Rec.*

Cryptopora JEFFREYS, 1869, p. 136 [*Atretia gnomon* JEFFREYS, 1876, p. 251; OD (M)] [= *Atretia* JEFFREYS, 1870, p. 421 (type, *A. gnomon* JEFFREYS, 1876, p. 251); *Mannia* DAVIDSON, 1874, p. 156 (type, *M. nysti*; OD, M); *Neatretia* FISCHER & OEHLERT, 1891, p. 122 (obj.)]. Subtrigonal, rectimarginate to broadly sulcate, smooth. Beak moderately long, nearly straight; deltoidal plates rudimentary, disjunct. Thickened plate elevated above floor in apex of pedicle valve.

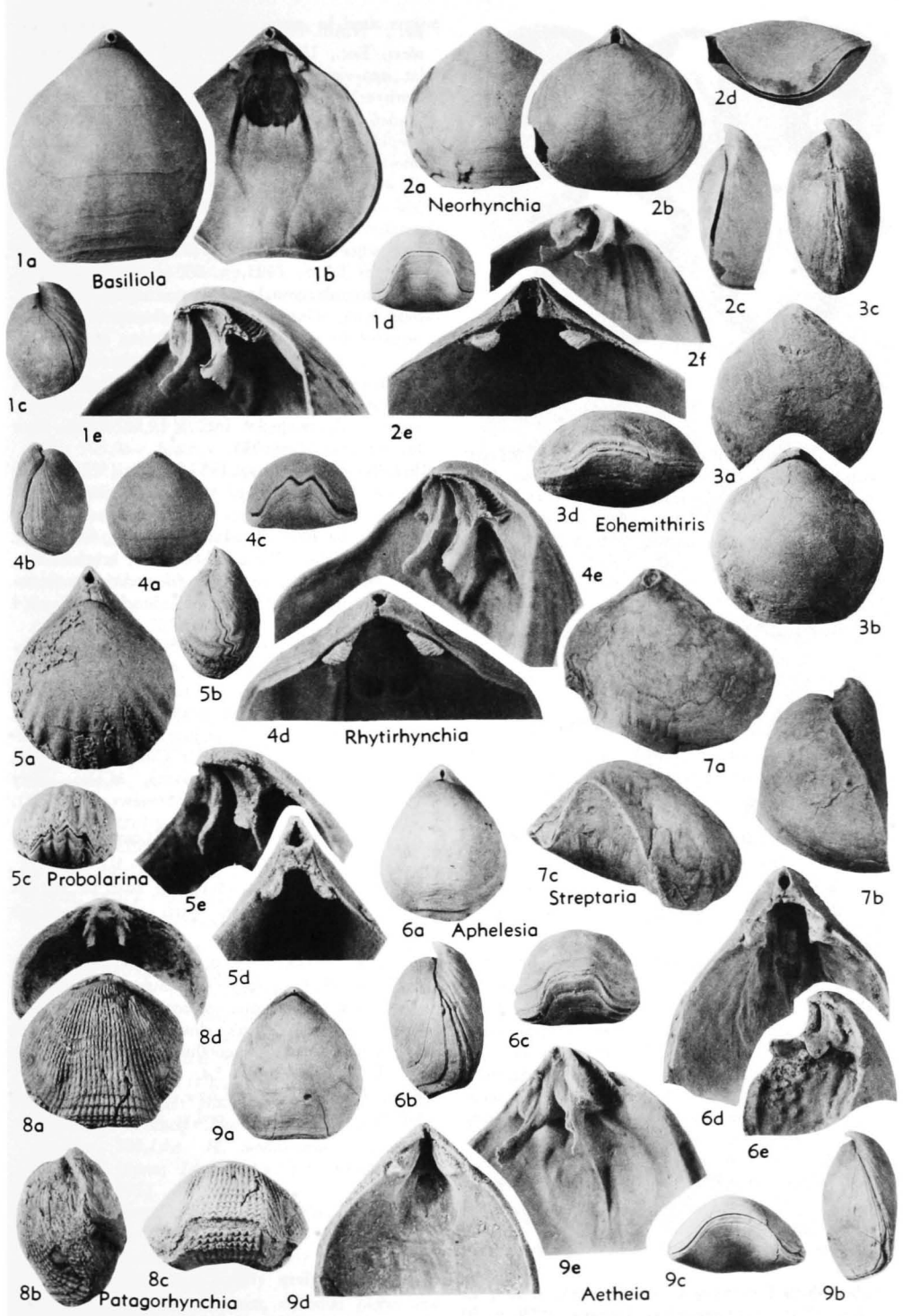


FIG. 505. Basiliolidae (Basiliolinae) (1-5, 7), (Aphelesiinae) (6), (Aetheiinae) (8-9) (p. H622-H623).

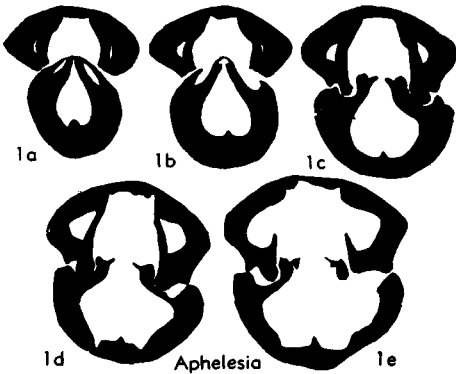


FIG. 506. Basiliolidae (Aphelesiinae) (p. H622-H623).

Small bilobed cardinal process; median septum rising anteriorly in brachial valve. *Eoc.-Rec.*, Eu.-N. Am. - Atl. - Afr.-Australia.—FIG. 503.2. **C. gnomon* (JEFFREYS), *Rec.*, off E.USA (Mass.); 2a-c, ped.v., lat., ant. views, $\times 6$; 2d, post. ped.v. int., $\times 8$; 2e, brach.v. int., slightly oblique, $\times 8$ (193).

Family BASILIOLIDAE Cooper, 1959

[Basiliolidae COOPER, 1959, p. 25]

Smooth or semicostate; conjunct deltidial plates and small auriculate foramen; well-developed pedicle collar; broad falcifer crura supported by outer hinge plates or socket ridges; median septum in brachial valve reduced to ridge or absent (193). *Cret.-Rec.*

Subfamily BASILIOLINAE Cooper, 1959

[Basiliolinae COOPER, 1959, p. 25]

Brachial valve with crura attached to broad outer hinge plates, no median septum (193). *Eoc.-Rec.*

Basiliola DALL, 1908, p. 442 [**Hemithyris beecheri* DALL, 1895, p. 717; OD] [= *Basiola* THOMSON, 1915, p. 390 (*nom. null.*); *Neohemithyris* YABE & HATAI, 1934, p. 587 (type, *Rhynchonella lucida* GOULD, 1861, p. 323; OD)]. Subpentagonal uniplicate, smooth. Inconspicuous fold in strongly convex brachial valve. Beak small, foramen submesothyridd. Uniplication in pedicle valve fitting into re-entrant in brachial valve. Strong complex pedicle collar; long crescentic falcifer crura. *Plio.-Rec.*, Japan-Indon.-Pac.—FIG. 505.1. **B. beecheri* (DALL), *Rec.*, off Hawaii; 1a,b, brach.v. view, ped.v. int., $\times 2$; 1c,d, lat., ant. views, $\times 1$; 1e, oblique view brach.v. int. showing crura, $\times 4$ (193).

Eoemithyris HERTLEIN & GRANT, 1944, p. 55 [**E. alexi*; OD] [= *Eoemithyris* COOPER, 1959, p. 30 (*nom. van.*)]. Like *Basiliola* but more nearly equi-valve and without elaborate pedicle collar. *Eoc.-*

Rec., N.Am.-Fiji-Australia.—FIG. 505.3. **E. alexi*, *Eoc.*, USA (Calif.); 3a-d, ped.v., brach.v., lat., ant. views, $\times 2$ (193).

Neorhynchia THOMSON, 1915, p. 388 [**Hemithyris strebeli* DALL, 1908, p. 441; OD]. Pentagonal, deeply sulcate, smooth. Beak short, hypothyridid. Short crura. *Rec.*, Pac.—FIG. 505.2. **N. strebeli* (DALL); 2a-d, ped.v., brach.v., lat., ant. views, $\times 2$; 2e, ped.v. int., $\times 4$; 2f, oblique view brach.v. int., $\times 4$ (193).

Probolarina COOPER, 1959, p. 37 [**Rhynchonella holmesii* DALL, 1903, p. 1536; OD]. Subpentagonal to subtrigonal, uniplicate, costate anteriorly. Beak long, pointed, nearly straight; foramen hypothyridid to submesothyridd. Strong pedicle collar and dental plates. Crura scimitar-like. *Eoc.*, N.Am.—FIG. 505.5. **P. holmesii* (DALL), USA (N.Car.); 5a, brach.v. view, $\times 3$; 5b,c, lat., ant. views, $\times 2$; 5d, ped.v. int., $\times 4$; 5e, oblique view brach.v. int., $\times 6$ (193).

Rhytirhynchia COOPER, 1957, p. 8 [**Hemithyris sladeni* DALL, 1910, p. 440; OD]. Like *Basiliola* but costate anteriorly; dental plates much reduced. *Plio.-Rec.*, Pac.-Ind.O.—FIG. 505.4. **R. sladeni* (DALL), *Rec.*, Ind.O.; 4a-c, brach.v., lat., ant. views (lectotype), $\times 1$; 4d, ped.v. int. (lectotype), $\times 3$; 4e, oblique view brach.v. int., $\times 4$ (193).

Streptaria COOPER, 1959, p. 38 [**Terebratula debuchii* MICHELOTTI, 1938, p. 4; OD]. Pentagonal, sharply uniplicate, asymmetrical; may be faintly costate anteriorly. Beak short, foramen rimmed, dental plates reduced; pedicle collar poorly developed. *Eoc.-Mio.*, Eu.-N.Afr.-Cuba.—FIG. 505.7. **S. debuchii* (MICHELOTTI), *M.Mio.*, Italy (Sicily); 7a-c, brach.v., lat., ant. views, $\times 2$ (193).

Subfamily APHELESIINAE Cooper, 1959

[Aphelesiinae COOPER, 1959, p. 41]

Crura attached directly to side of socket ridge; brachial valve with thick median ridge (193). *Eoc.-Plio.*

Aphelesia COOPER, 1959, p. 41 [**Anomia bipartita* BROCCHI, 1814, p. 469; OD]. Subtrigonal to subpentagonal, uniplicate, smooth, with incipient costae anteriorly; beak elongated, hypothyridid, foramen rimmed; no septalium. *Eoc.-Plio.*, *Medit.*—FIG. 505.6; 506.1. **A. bipartita* (BROCCHI), *Plio.*, Italy (Sicily); 505.6a-c, brach.v., lat., ant. views, $\times 1$; 505.6d,e, ped.v. int., brach.v. int.,



Aetheia

FIG. 507. Basiliolidae (Aetheiinae) (p. H623).

×2 (193); 506, 1a-e, transv. secs. of beak region (ped.v. above), ×1.8 (193).

Subfamily AETHEIINAE Cooper, 1959

[Aetheiinae COOPER, 1959, p. 42]

With minute foramen, concave deltidial plates, dental plates reduced to obsolete, inner hinge plates thick (193). *Cret.-Mio.*

Aetheia THOMSON, 1915, p. 389 [**Waldheimia*(?) *sinuata* HUTTON, 1873, p. 36 (= *?Terebratula gualteri* MORRIS, 1850, p. 329); OD] [= *Thomsonica* COSSMANN, 1920, p. 137 (obj.)]. Elongate-oval to triangular, uniplicate, smooth; beak small, erect, submesothyridid. Hinge teeth thick, attached to valve wall; deltidial plates conjunct; no dental plates; median septum short, stout; inner hinge plates filling intercrural space; cardinal process small, crura very long. *U.Cret.-Mio.*, N.Z. —FIG. 505,9; 507,1. **A. gualteri* (MORRIS), *Mio.*; 505,9a-c, brach.v., lat., ant. views, ×1; 505,9d, ped.v. int., ×2; 505,9e, oblique view brach.v. int., ×4 (193); 507,1, brach.v. view, ×1 (810).

Patagorhynchia ALLAN, 1938, p. 199 [**Rhynchonella patagonica* VON IHERING, 1903, p. 334; OD]. Subcircular to subpentagonal, uniplicate; finely costate with strong growth lines anteriorly; beak small, nearly straight, submesothyridid. *Eoc.*, S. Am. —FIG. 505,8. **P. patagonica* (VON IHERING), Arg.; 8a-c, brach.v., lat., ant. views, ×1; 8d, brach.v. int., ×1 (193).

Family HEMITHYRIDIDAE

Rzhonsnitskaya, 1956

[*nom. transl. et correct.* AGER, herein (ex Hemithyridae RZHONSNITSKAYA, 1956, p. 126; based on jr. obj. syn. of *Hemithyris* D'ORBIGNY, 1847)]

With strong, slender, curved radulifer crura attached to small outer hinge plates by their posterodorsal face or to thick socket ridges; crura radulifer, distally pointed and horizontally flattened (193). *Eoc.-Rec.*

Hemithyris D'ORBIGNY, 1847, p. 342 [**Anomia psittacea* GMELIN, 1790, p. 3348; SD D'ORBIGNY, 1847, p. 342] [= *Hemithyris* BRONN, 1848, p. 246 (obj.)]. Trigonal, uniplicate, finely costate with intermediate striae. Beak long, suberect, hypothyridid; ventral median ridge posteriorly, low dorsal median ridge. *Mio.-Rec.*, N.Hemis. —FIG. 508,1a-c. **H. psittacea* (GMELIN), Rec., off Alaska; 1a-c, brach.v., lat., ant. views, ×1 (193). —FIG. 508,1d,e. *H. woodwardi* (DAVIDSON), Rec., off Japan; 1d,e, ped.v. int., brach.v. int., ×3, ×4 (193).

Notosaria COOPER, 1959, p. 48 [**Tenibratula nigricans* SOWERBY, 1846, p. 91; OD]. Subpentagonal, uniplicate, dorsal fold low; finely costate, growth lines anteriorly; beak nearly straight to suberect; large hypothyridid foramen, deltidial plates disjunct; low dorsal median ridge. *Mio.-Rec.*, Eu.-N.Z.-S.Ind.O.(Kerguelen Is.). —FIG. 508,2. **N.*

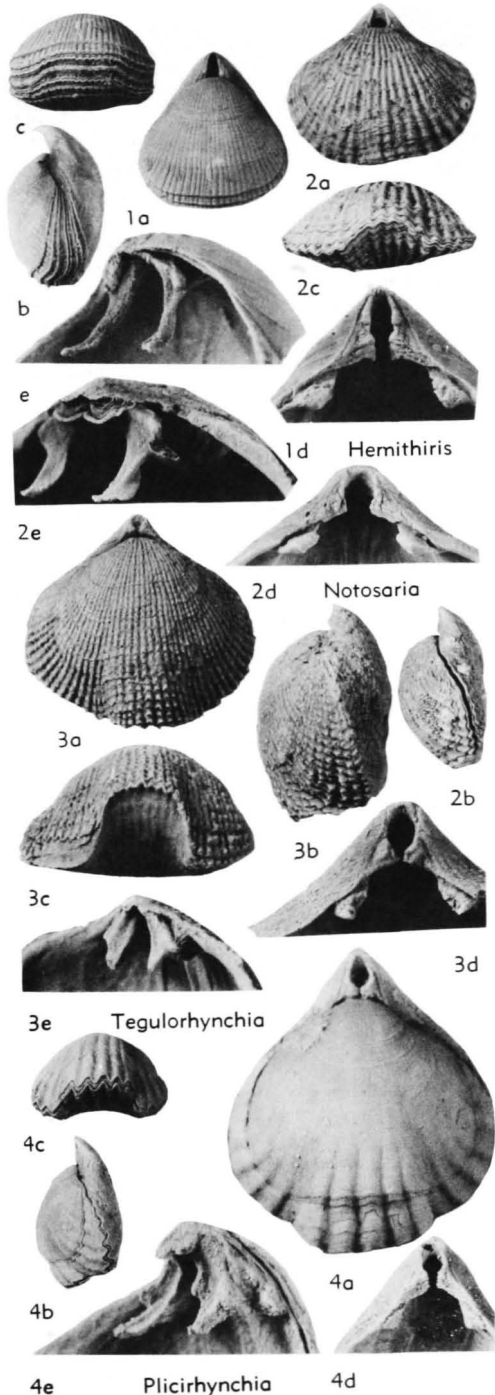


FIG. 508. Hemithyrididae (p. H623-H624).

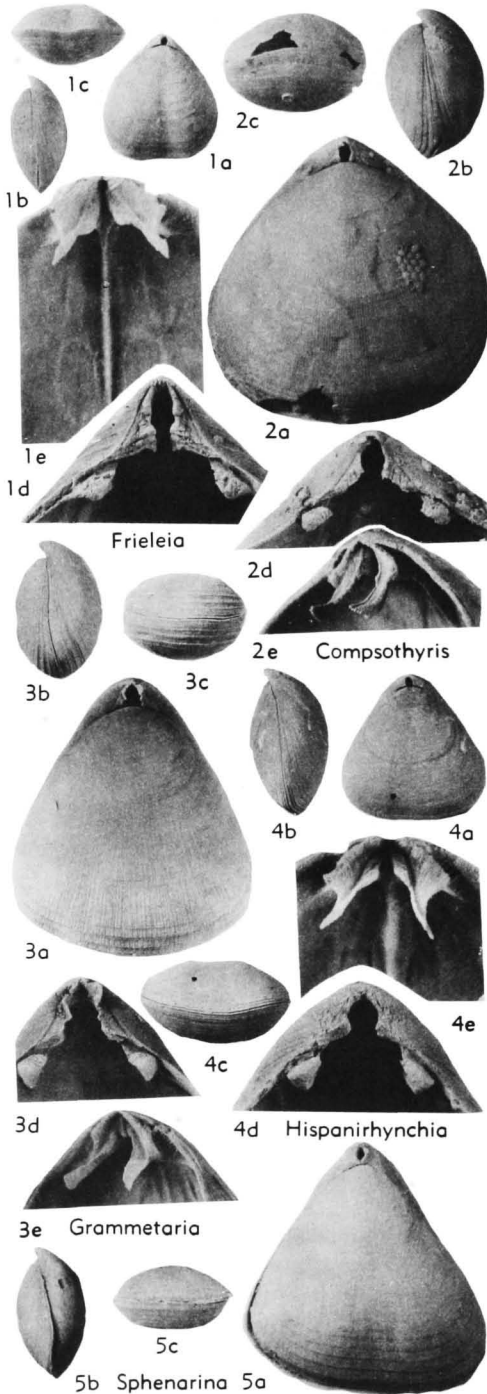


FIG. 509. Frieleidae (p. H624-H625).

nigricans (SOWERBY), Rec., N.Z.; 2a-c, brach.v., lat., ant. views, $\times 1$; 2d,e, ped.v. int., brach.v. int., $\times 2$, $\times 4$ (193).

Plicirhynchia ALLAN, 1947, p. 493 [**Rhynchonella plicigera* VON IHERING, 1897, p. 270; OD]. Sub-trigonal to subpentagonal, uniplicate; striate posteriorly, costate anteriorly; beak long, acute; large hypothyriddid foramen; deltidial plates thick and conjunct; thick bilobed cardinal process; small dorsal median ridge. *Eoc.*, S.Am.(Arg.)-?Antarctic. —FIG. 508,4. **P. plicigera* (VON IHERING), Arg.; 4a, brach.v. view, $\times 2$; 4b,c, lat., ant. views, $\times 1$; 4d,e, ped.v. int., brach.v. int., $\times 2$, $\times 4$ (193).

Tegulorhynchia CHAPMAN & CRESPIN, 1923, p. 175 [**Rhynchonella squamosa* HUTTON, 1873, p. 37; OD]. Trigonal to subpentagonal, uniplicate, dorsal fold low; costate and lamellose, some shells with hollow spines; beak long, upright; foramen large, hypothyriddid; deltidial plates usually conjunct; crura short; dorsal median septum short, low. *Oligo-Rec.*, Australia-Pac.O. —FIG. 508, 3a-c. **T. squamosa* (HUTTON), Mio., N.Z.; 3a-c, brach.v., lat., ant. views, $\times 1$ (193). —FIG. 508, 3d-e. *T. doederleni* (DAVIDSON), Mio. or Plio., Okinawa; 3d,e, ped.v. int., brach.v. int., $\times 4$ (193).

Family FRIELEIIDAE Cooper, 1959

[Frieleidae COOPER, 1959, p. 53] [=Hispanirhynchiidae COOPER, 1959, p. 59]

Usually capillate to costellate, triangular; dental plates strong, spinulifer crura short and straight, septalium small. (Cooper, 1959, emended.) [Includes the family Hispanirhynchiidae (193) since its specified characters correspond entirely with those of this family.] ?*Eoc.*, ?*Mio.*, ?*Plio-Rec.*

Frieleia DALL, 1895, p. 713 [**F. halli*, p. 714; OD]. Elongate, oval to subtrigonal; shell thin, rectimarginate to ligate, smooth to faintly costate; beak short, nearly straight to suberect, hypothyriddid, deltidial plates thick, disjunct, with long divergent crura, long slender dorsal median septum supporting short septalium; inner hinge plates strongly developed. ?*Mio.*, *Rec.*, W.U.S.A.-N. Pac. —FIG. 509,1. **F. halli*, Rec., N.Pac.; 1a-e, brach.v., lat., ant. views, $\times 1$; 1d,e, ped.v. int., brach.v. int., $\times 4$, $\times 6$ (193).

Compsothyris JACKSON, 1918, p. 188 [**Rhynchonella racovitzae* JOUBIN, 1901, p. 5; OD]. Trigonal, broad gentle uniplication, dorsal fold inconspicuous, with fine radial striae; hypothyriddid; ridgelike dorsal septum supporting small septalium. *Rec.*, Antarctic. —FIG. 509,2. **C. racovitzae* (JOUBIN); 2a, brach.v. view, $\times 2$; 2b,c, lat., ant. views, $\times 1$; 2d,e, ped.v. int., brach.v. int., $\times 4$ (193).

Grammetaria COOPER, 1959, p. 58 [**Hemithyris bartschi* DALL, 1920, p. 289; OD]. Elongate trigonal, rectimarginate, capillate; beak small, suberect; hypothyriddid; deltidial plates auriculate,

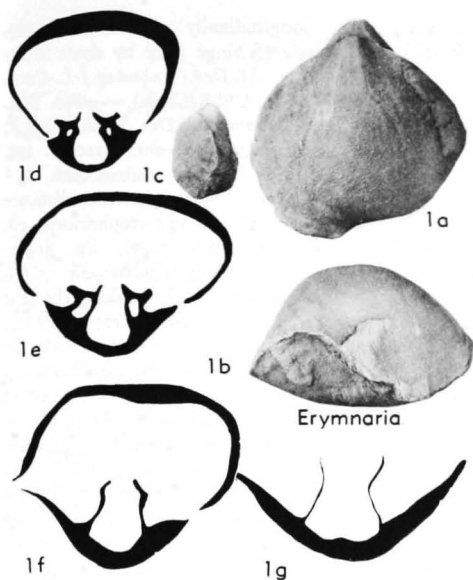


FIG. 510. Erymnariidae (p. H625).

conjunct; crura short; dorsal median ridge stout, supporting wide septalium. *Rec.*, Pac.—FIG. 509,3. **G. bartschi* (DALL), Phillip.; 3a, brach.v. view, $\times 2$; 3b,c, lat., ant. views, $\times 1$; 3d,e, ped.v. int., brach.v. int., $\times 4$ (193).

Hispanirhynchia THOMSON, 1927, p. 159 [*Rhynchonella cornea* FISCHER, 1887, p. 171; OD]. Elongate trigonal, rectimarginate to ligate to slightly uniplicate; fine capillae and with growth lines, beak short, suberect, with large hypothryridid foramen, deltidial plates disjunct; crura bladeliike, dorsal median ridge low, thick. ?*Eoc.*, Cuba; *Rec.*, N.Atl.-E.Pac.—FIG. 509,4. **H. cornea* (FISCHER), *Rec.*, off Morocco; 4a-c, brach.v., lat., ant. views, $\times 1$; 4d,e, ped.v. int., brach.v. int., $\times 4$, $\times 6$ (193).

Sphenarina COOPER, 1959, p. 62 [*Rhynchonella sicula* SEGUENZA, 1870, p. 461; OD]. Like *Hispanirhynchia* but lacking dorsal median ridge, deltidial plates conjunct, auriculate. *Plio.*, *Medit.*—FIG. 509,5. **S. sicula* (SEGUENZA), Sicily; 5a, brach.v. view, $\times 2$; 5b,c, lat., ant. views, $\times 1$ (193).

Family ERYMNARIIDAE Cooper, 1959

[Erymnariidae COOPER, 1959, p. 64]

Shell with septifer crura (193). *Eoc.*

Erymnaria COOPER, 1959, p. 64 [*Terebratula polymorpha* MASSALONGO, 1850, p. 18; OD]. Trigonal to subpentagonal; uniplicate, some shells asymmetrical; smooth or irregularly costate anteriorly; beak short, foramen hypothryridid, deltidial plates conjunct. *Eoc.*, *Medit.*-Cuba.—FIG. 510,1. **E. polymorpha* (MASSALONGO), Italy; 1a,b, brach.v., ant. views, $\times 2$; 1c, lat. view, $\times 1$; 1d-g, transv. secs. of beak region (ped.v. above), $\times 4$ (193).

Superfamily STENOSCISMATACEA Oehlert, 1887 (1883)

[*nom. correct.* MUIR-WOOD, 1955, p. 69 (*pro* Stenosismatacea SHROCK & TWENHOFFEL, 1953, p. 317; *nom. transl. et correct. ex* Stenosismatinae OEHLERT, 1887, p. 1304)] [=Camerophoriacea WAAGEN, 1883 (*nom. transl.* GRABAU, 1936, p. 70, *ex* Camerophoriinae WAAGEN, 1883, p. 435)] [Materials for this superfamily prepared by RICHARD E. GRANT]

Camarophorium in brachial valve; also typically with spondylium in pedicle valve. *M.Dev.-U.Perm.*

Three morphological terms that pertain especially to stenoscismatacean shells need to be noted and explained. These are **camarophorium**, an elongate large trough-shaped structure located on a high median septum duplex in the brachial valve; **intercamarophorial plate**, a short, low median septum on the posterior mid-line of the camarophorium extending to the underside of the hinge plate but independent of the septum supporting the camarophorium; and **stolidium**, a thin marginal extension of one or both valves which forms a narrow to broad frill protruding at a distinct angle to the main contour of the shell.

Family ATRIBONIIDAE Grant, 1965

[Atriboniidae GRANT, 1965, p. 1]

Stolidium lacking, costae weak, fine or absent, spondylium typically sessile in apex, intercamarophorial plate present or absent. *M.Dev.-U.Perm.*

Subfamily ATRIBONIINAE Grant, 1965

[Atriboniinae GRANT, 1965, p. 29]

Intercamarophorial plate strong, extending anteriorly beyond undivided hinge plate. *M.Dev.-L.Perm.*

Atribonium GRANT, 1965, p. 37 [*A. simatum*; OD]. Small (average length of adults, 8-10 mm.); outline and profile subtrigonal; anterior surface flattened; commissure uniplicate; valve edges overlapping slightly along posterior slopes; costae low, rounded, beginning about mid-length on adults. Pedicle valve geniculate near anterior margin; beak nearly straight to suberect; delthyrium constricted by opposite beak and by pair of small conjunct or nearly conjunct deltidial plates; foramen slit-shaped; sulcus broad, shallow; interior with spondylium sessile near apex in most species, then elevated on low median septum duplex, extending from beak about 0.3 length of valve. Brachial valve more strongly convex than pedicle valve, anterior margin geniculate, fold commonly flat, standing above flanks only near anterior margin; interior with undivided hinge plate bearing low cardinal boss at apex; camarophorium short,

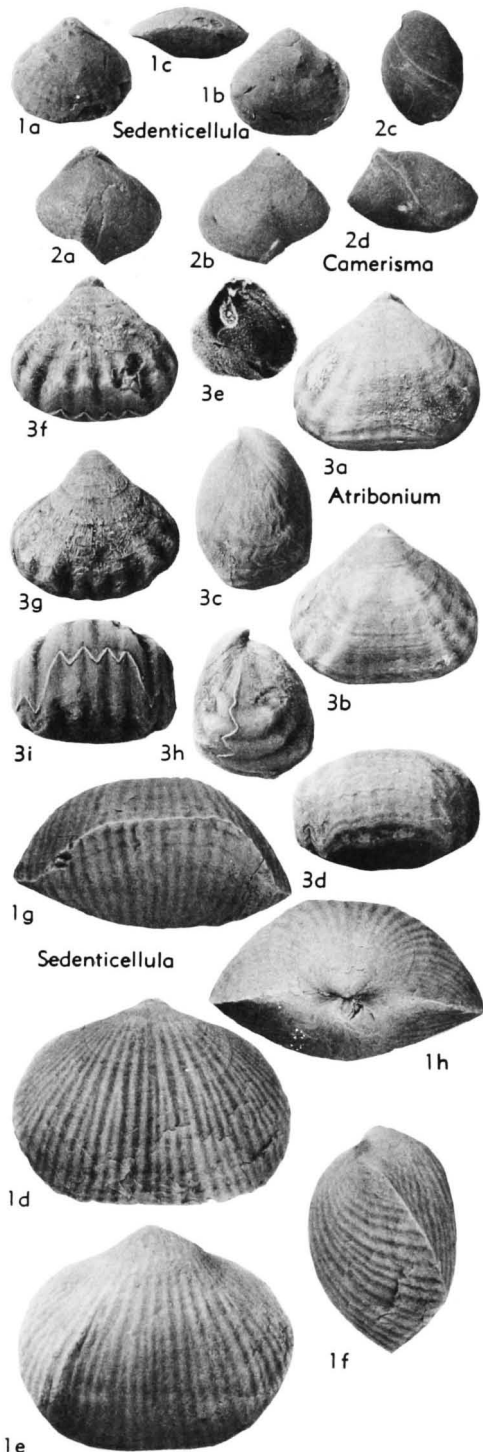


FIG. 511. Atriboniidae (Atriboniinae) (p. H625-H627).

relatively flat longitudinally and transversely, braced to underside of hinge plate by short intercamarophoral plate. *M. Dev.* (Onondag.)-*L. Carb.* (*L. Miss.*), USA-S.Can.-USSR (Urals).—FIG. 511, 3a-e; 512, 2k-s. **A. simatum*, *M. Dev.*, USA (Mich.); 511, 3a-e, brach.v., ped.v., lat., ant., brach.v. int. views, $\times 2$ (365); 512, 2k-s, ser. transv. secs., $\times 4$ (orig. length, 11.5 mm., figures indicate distance from ped.v. beak in mm.; c, camarophorium; cp, cardinal process; hp, hinge plate; icp, intercamarophoral plate; sp, spondylium); 2k (0.6), c small swelling on septum, icp clearly duplex; 2l (0.7), c wider; 2m (0.8), cp higher; 2n (1.0), cp at max. height; 2o (1.2), hp detached; 2p (1.5), icp thin, crural bases visible; 2q (1.6), icp absent; 2r (1.9), crura present; 2s (2.5), crura absent (365).—FIG. 511, 3f-i; 512, 2a-j. *A. cooperorum* GRANT, *M. Dev.*, USA (Mich.); 511, 3f-i, brach. v., ped.v., lat., ant. views, $\times 2$ (365); 512, 2a-j, ser. transv. secs., $\times 4$ (orig. length, 9.1 mm.; figures and abbrev. as above); 2a (0.3), sp sessile; 2b (0.5), c and cp visible, sp sessile; 2c (0.8), sp elevated; 2d (1.1), hp detached, icp separated; 2e (1.4), dental plates detached; 2f (1.8), hp small, icp absent; 2g (2.1), hp absent; 2h (2.5), c wide; 2i (2.9), c wider; 2j (4.2), septal remnant of sp, c high and narrow, reaching 4.5 mm. from beak (365).

Camerisma GRANT, 1965, p. 63 [**C. prava*; OD] [= *Laevicamera* GRABAU, 1936 (*nom. nud.*)] [see *Ptilocamara*]. Length up to 20 mm.; outline oval or subpentagonal; strongly biconvex; shell walls thick; commissure strongly uniplicate; costae absent or weak, confined to anterior region; posterolateral valve edges strongly overlapping. Pedicle valve with beak thick, blunt, tightly curved against dorsal umbo, entirely closing delthyrium and foramen; sulcus shallow, with narrow median trough or slight flattening; interior with spondylium elevated on low median septum duplex. Brachial valve more strongly convex than pedicle valve; fold highly arched, crest bluntly or sharply ridged, symmetrical or skewed to one side; interior with large fimbriate cardinal boss at apex of hinge plate; strong camarophorium curving ventrally on high median septum duplex, braced to underside of hinge plate by thick duplex intercamarophoral plate. *Miss.*, USA (Alaska); *L. Perm.* (*Artinsk.*), Yugosl.-USSR.—FIG. 511, 2; 512, 3. **C. prava*, *Miss.*, Alaska; 511, 2a-d, brach.v., ped.v., lat., ant. views, $\times 1$ (365); 512, 3a-d, ser. transv. secs., $\times 2.7$ (orig. length, 15 mm., figures indicate distance from ped.v. beak in mm.; c, camarophorium; cp, cardinal process; hp, hinge plate; icp, intercamarophoral plate; sp, spondylium); 3a (2.0), cp low; 3b (2.6); 3c (2.7), c, icp, sp septa all duplex, with wedged insertion of septa into shell; 3d (3.0), hp thin, crura visible, c slightly thickened at base of septum (365).

Sedenticellula COOPER, 1942, p. 231 [**Camarophoria hamburgensis* WELLER, 1910, p. 500; OD].

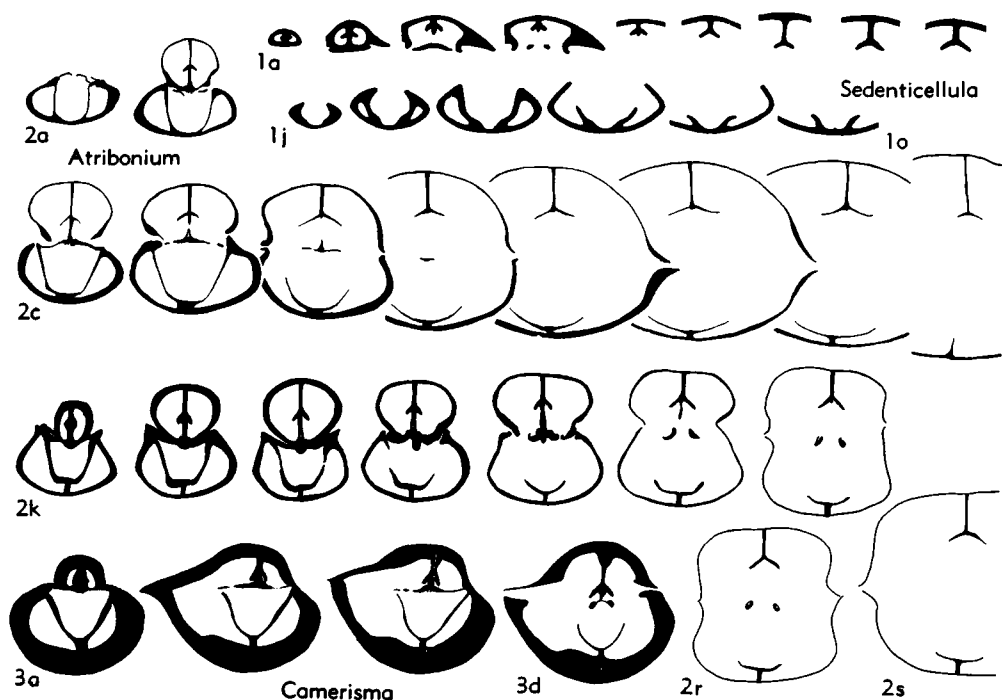


FIG. 512. Atriboniidae (Atriboniinae) (p. H625-H627).

Medium-sized (length of adult, approx. 12 mm.) flatly to rather strongly biconvex; outline elongate or transverse; commissure weakly unipliicate; costae low, narrow, beginning at beaks or in posterior third of shell, simple, bifurcating or intercalating; valve edges not overlapping. Pedicle valve with short beak, nearly straight to suberect; delthyrium small, constricted by dorsal beak; deltidial plates not observed; foramen small, open; sulcus shallow, broad; interior with spondylium sessile in posterior, elevated farther forward on low median septum. Brachial valve more convex than pedicle valve; fold low, crest flattened; interior with shallow camarophorium; intercamarophoral plate low, thick. *L.Miss.*, USA (Ill.-Tex.).—FIG. 511, 1a-c; 512, j. **S. hamburgensis* (WELLER), Ill.; 511, 1a-c, brach.v., ped.v., ant. views, $\times 2$ (365); 512, 1a-o, ser. transv. secs., 1a-i, brach.v.; 1j-o, ped.v. showing sessile spondylium; all $\times 2.5$ (858).—FIG. 511, 1d-h. *S. sacra* GRANT, Tex.; 1d-h, brach.v., ped.v., lat., ant., post. views, $\times 2$ (365).

Subfamily PSILOCAMARINAE Grant, 1965

[Psilocamarinae GRANT, 1965, p. 29]

Intercamarophoral plate absent or rudimentary, hinge plate divided or short. *U. Carb.-U.Perm.*

Psilocamara COOPER, 1956, p. 523 [**P. renfroarum*; OD] [= *Levicamera* GRABAU, 1934 (nom. nud.)]

[see *Camerisma*]. Small (average length of adults, 5-7 mm.), smooth to weakly costate; outline subpentagonal; commissure strongly unipliicate; posterolateral valve edges with little or no overlap. Pedicle valve with short beak, straight to slightly incurved; sulcus shallow, some shells with weak median groove; delythrium small, constricted by dorsal beak and pair of small disjunct deltidial plates; foramen slit-shaped; interior with deep spondylium on low median septum duplex. Brachial valve with high fold sloping smoothly to flanks, crest bluntly ridged; interior with short undivided hinge plate; camarophorium gently curved ventrally; intercamarophoral plate absent. *M.Penn.-L.Perm.*, USA (Tex.); ?*L.Perm.*, China (Nantan-Yunnan).—FIG. 513, 1; 514, 1. **P. renfroarum*, M.Penn., Tex.; 513, 1a-e, brach.v., ped.v., lat., ant., post. views, $\times 2$ (188); 514, 1a-g, ser. transv. secs. (figures indicate distance from ped.v. beak in mm.), 1a (?); 1b (0.3); 1c (0.65); 1d (0.77); 1e (1.0); 1f (1.2); 1g, (1.0); 1a, 1b-f, 1g, different specimens, intercamarophoral plate absent in 1a, 1d, 1g; 1a, $\times 3$; 1b-f, $\times 2.7$; 1g, $\times 3.3$ (188, 365).

Camarophorina LIKHAREV, 1934, p. 211 [**Camarophorina antisella* BROILI, 1916, p. 58; OD]. Small (length, approx. 8 mm.) flatly to rather strongly biconvex; commissure strongly sulcate; costae absent or very weak; valve edges not overlapping. Pedicle valve inflated in umbonal region, profile

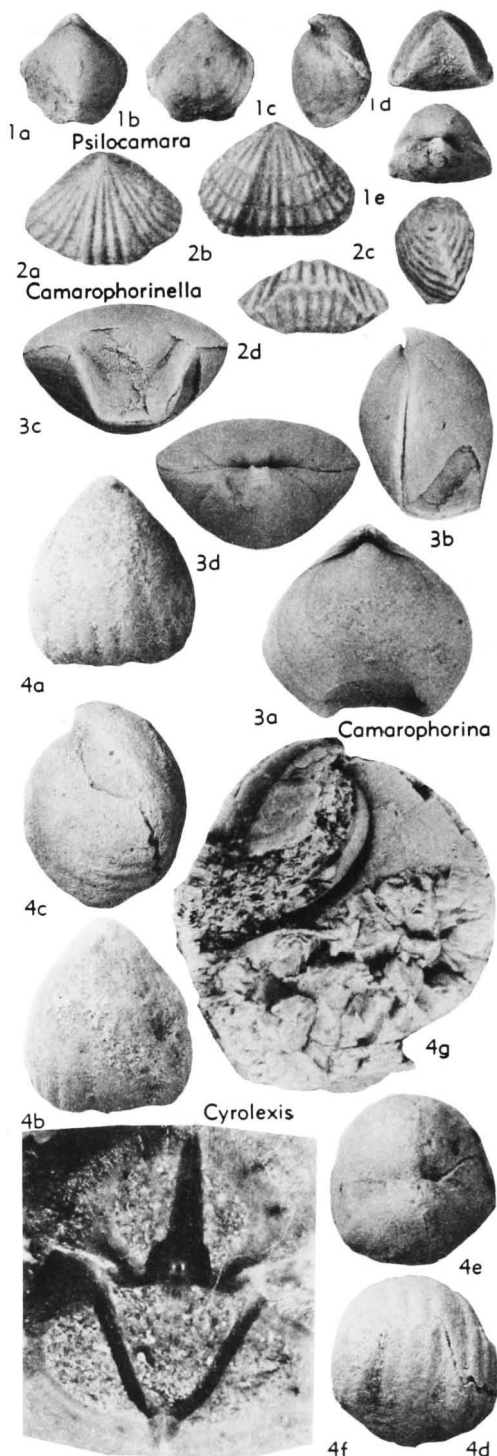


FIG. 513. Atriboniidae (Psilocamarinae) (p. H627-H629).

flat along crest of fold; beak short, sharp, suberect; delthyrium small, nearly filled by dorsal beak; deltidial plates unknown; fold standing above flanks about 0.7 of distance in front of beak; interior with spondylium elevated on high median septum duplex. Brachial valve with sulcus distinctly depressed only near anterior margin; interior with short undivided hinge plate bearing cardinal boss near apex; camarophorium thick near apex, edges meeting hinge plate, curving ventrally on high septum duplex; intercamarophorial plate absent. *L.Carb.*, Eng.; *U.Perm.*, Timor.

—FIG. 513,3; 514,3. **C. antisella* (BROILI), *U. Perm.*, Timor; 513,3a-d, brach.v., lat., ant., post. views, $\times 2$ (365); 514,3a-g, ser. transv. secs., $\times 3.3$ (orig. length, 11 mm., figures indicate distance from ped.v. beak in mm.; c, camarophorium; cp, cardinal process; hp, hinge plate; icp, intercamarophorial plate; sp, spondylium); 3a (0.8), c not shown but visible through clear shell, sp elevated; 3b (1.2), c thick, without icp, cp and hp visible; 3c (1.6), icp absent; 3d (1.8), sp, septum and plates very thin; 3e (2.6), sp absent, c with duplex septum; 3f (3.0), c trough deep; 3g (3.4), c trough high, pushed onto septum, c ending 3.9 mm. from beak (365).

Camarophorinella LIKHAREV, 1936, p. 63 [**C. caucasica*; OD]. Transversely subpentagonal, holocostate, with costae simple, bifurcating or intercalating; commissure uniplicate; valve edges not overlapping. Pedicle valve with shallow sulcus distinct from flanks; beak short; delthyrium, deltidial plates and foramen unknown; interior with deep spondylium; median septum low and thick near apex, thinner and higher toward anterior margin. Brachial valve slightly more convex than pedicle valve; fold low, flat-crested; interior with hinge plate divided as far back as low cardinal boss at apex of valve; camarophorium high, curving ventrally, sides attached to underside of hinge plate; intercamarophorial plate absent. *U.Perm.*, USSR (N.Caucasus).—FIG. 513,2; 514,2. **C. caucasica*; 513,2a-d, brach.v., ped.v., lat., ant. views, $\times 1$ (518); 514,2a-e, ser. transv. secs., $\times 2$ (c, camarophorium; cp, cardinal process; hp, hinge plate; sp, spondylium); 2a, cp visible; 2b, hp divided, joined to c edges; 2c, 2d, c and sp detached from shell proximally, hp reduced; 2e, c and sp thin (518).

Cyrolexis GRANT, 1965, p. 88 [**C. haquei*; OD]. Globular (length, 12-14 mm.); commissure uniplicate; costae low, rounded, beginning about mid-length; valve edges abutting at anterior margin, overlapping broadly on posterior slopes. Pedicle valve with inflated umbonal region; beak short, incurved against dorsal umbo, closing delthyrium; sulcus shallow, beginning far forward; interior with spondylium sessile in posterior part, anteriorly elevated on low median septum duplex. Brachial valve with fold low, crest flat, elevated only in anterior third of shell; interior with undivided

hinge plate; camarophorium curved strongly ventrally, posterior edges touching hinge plate; intercamarophorial plate absent or rudimentary. *L. Perm.* - *U. Perm.*, USSR (Urals-E. Sib.)-Pak. (Salt Range).—FIG. 513,4; 514,4. **C. haquei*, *L. Perm.*, Pak.; 513,4a-e, brach.v., ped.v., lat., ant., post. views, $\times 2$; 513,4f, transv. sec. 0.5 mm. from ped.v. beak, $\times 6$; 513,4g, profile along mid-line, $\times 4$; 514,4a-j, ser. transv. secs., $\times 2.7$ (orig. length, 12.9 mm., figures indicate distance from ped.v. beak in mm.; *c*, camarophorium; *cp*, cardinal process; *hp*, hinge plate; *icp*, intercamarophorial plate); 4a (0.9), *icp* absent; 4b (1.1), *c* edges meeting *hp* with thick filling between, *cp* high; 4c (1.3), *icp* marked by small dot of shell; 4d (1.6), *c* separating from crura; 4e (1.8), *c* separate from crura; 4f (1.9), crura thinner, divergent; 4g (2.2), crura near edges of *sp*, separated widely; 4h (2.4), wide overlap of valves, crura absent; 4i (2.8), *sp* nearly absent; 4j (3.5), *c* septum separated from valve floor, wide overlap of valve edges, *c* disappearing at 4.5 mm. (all 365).

Family STENOSCISMATIDAE Oehlert, 1887 (1883)

[*nom. transl. et correct.* MUIR-WOOD, 1955, p. 91 (ex *Stenoschismatinae* OEHLERT, 1887, p. 1304)] [=Camerophoriidae WAAGEN, 1883 (*nom. transl.* GRABAU, 1936, p. 70) (ex *Camerophoriinae* WAAGEN, 1883, p. 435)]

Outline rhynchonelliform or uncinuliform, stolidium incipient, well developed, or degenerate, camarophorium and spondylium large, intercamarophorial plate present; early representatives small and weakly costate, late forms typically large, strongly or completely costate. *M.Dev.-U.Perm.*

Subfamily STENOSCISMATINAE Oehlert, 1887 (1883)

[*nom. correct.* MUIR-WOOD, 1955, p. 91 (*pro* *Stenoschismatinae* OEHLERT, 1887, p. 1304)] [=Camerophoriinae WAAGEN, 1883, p. 435]

Rhynchonelliform, with incipient or well-developed stolidium, costae beginning in front of beaks. *M.Dev.-U.Perm.*

Stenosisma CONRAD, 1839, p. 59 [*non Stenosisma* HALL, 1847, 1867; *nec Stenosisma* HALL & CLARKE, 1894; *Stenochisma* GRABAU & SHIMER, 1907] [**Terebratula schlotheimi* VON BUCH, 1835; OD] [=Camerophoria KING, 1844 (*nom. nud.*); *Camerophoria* KING, Aug., 1846, p. 89 (*obj.*); *Camerophoria* HERRMANNSEN, Dec., 1846, p. 161 (*nom. van.*); *Stenosisma* OEHLERT, 1887, p. 1309 (*nom. van.*)]. Small to large (length to 35 mm.) subtrigonal or pentagonal; strongly uniplacate; costae on fold, flanks or both, beginning near beaks or far in front of them, rounded or sharp; broad stolidium around anterior margins of adults; posterolateral edges of pedicle valve flattened, strongly overlapped by edges of brachial valve.

Pedicle valve beak long for genus, nearly straight to tightly incurved; deltidial plates conjunct or disjunct; foramen oval, open or completely closed; sulcus distinctly depressed; interior with large

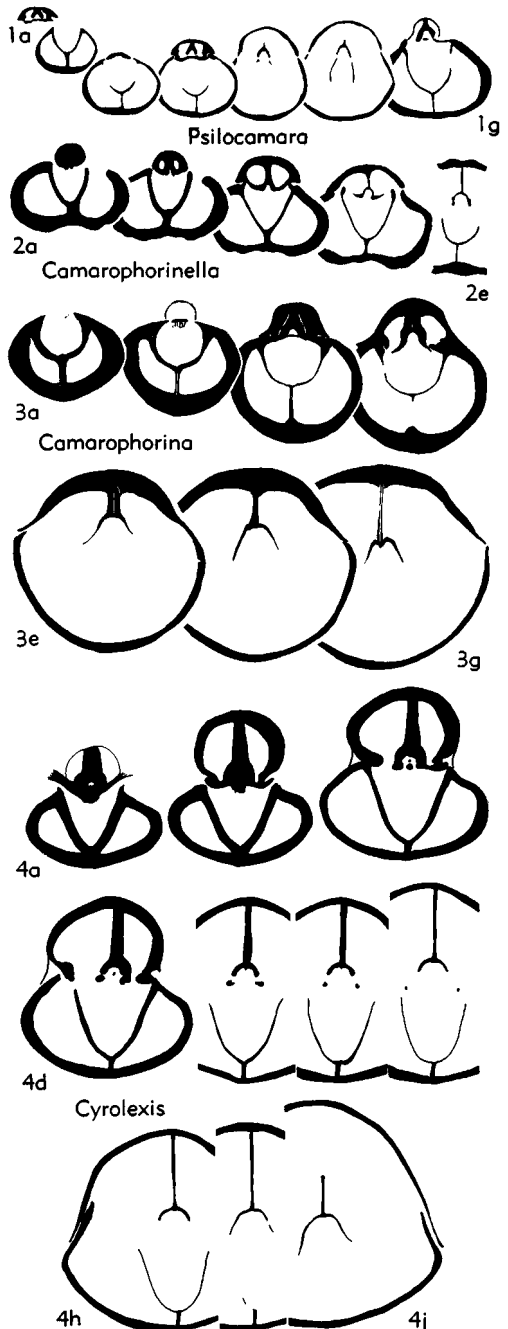


FIG. 514. Atriboniidae (Psilocamarinae) (p. H627-H629).

spondylium elevated on low median septum duplex; weak muscle marks in spondylium; adductors narrow, median; diductors large, surrounding adductors; adjustors undifferentiated in apical part of spondylium; gonocoel troughs deep, transverse, one on each side beginning at anterior

edge of median septum; mantle canals beginning as mesial pair near origin of gonocoels, bifurcating toward margins, extending onto stolidium. Brachial valve with high, distinct fold; interior with broad undivided hinge plate; large, low cardinal boss at apex, finely fimbriate for diductor muscle

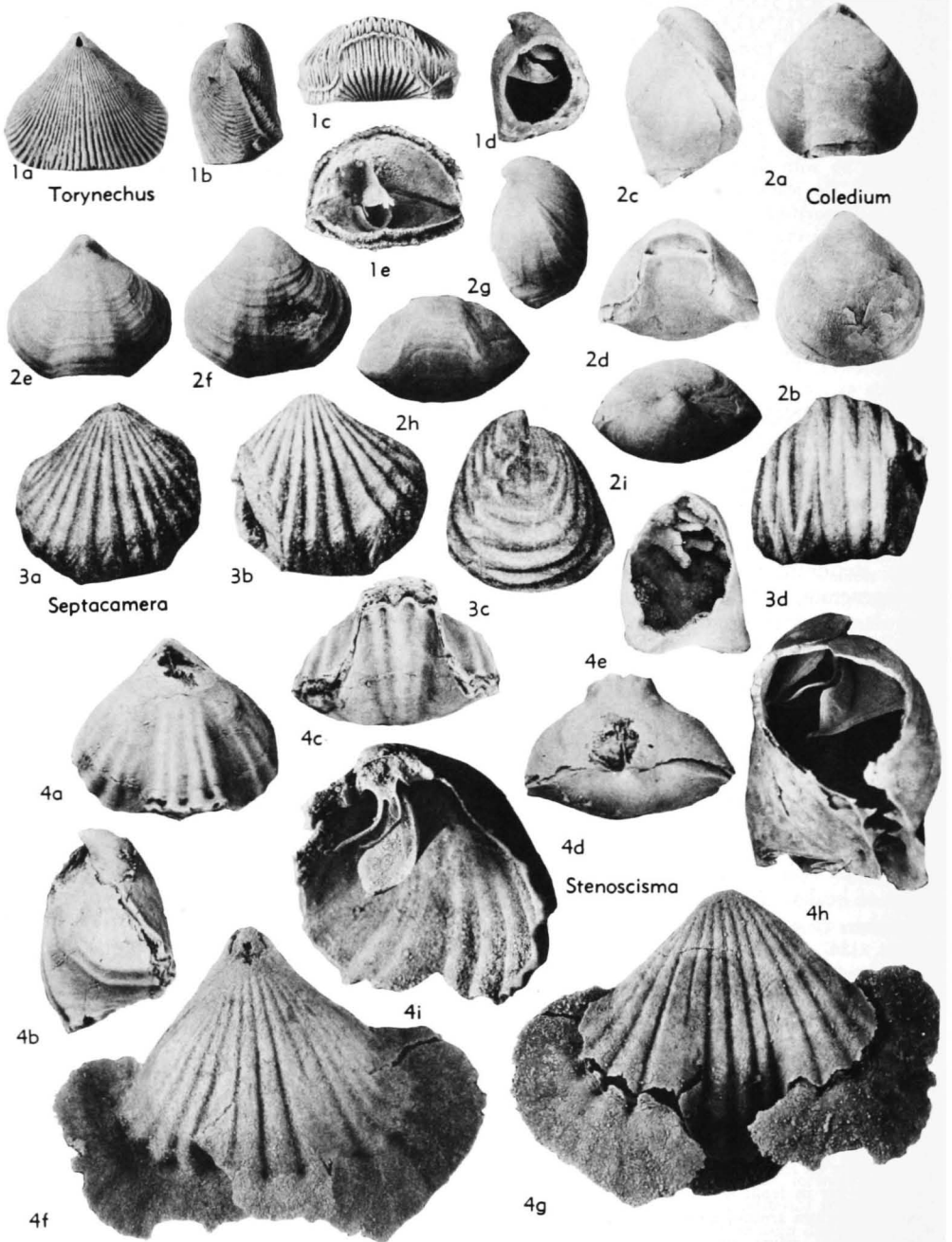


FIG. 515. Stenosismatidae (Stenosismatinae) (2, 4), (Torynechinae) (1, 3) (p. H629-H632).

attachment; crura extending from hinge plate, bowed distally and ventrally; camarophorium long, deep, ventrally curved on high median septum duplex, intercamarophoral plate strong; muscle marks weak on concave surface of camarophorium; anterior adductors small, paired along mid-line; posterior adductors larger, lateral and posterior; mantle canals as in opposite valve. *L. Carb.*, Eu.; *U. Perm.*, cosmop.—FIG. 515,4a-e; 516,1. **S. schlotheimi* (VON BUCH), *U. Perm.*, Ger.; 515,4a-e, brach.v., lat., ant., post., lat. int. views, $\times 2$ (365); 516,1a-i, ser. transv. secs., $\times 2.5$ (858).—FIG. 515,4f-i. *S. venustum* (GIRTY), *L. Perm.*, USA (Tex.); 4f-h, brach.v., ped.v., lat. int. showing relationships of camarophorium, spondylium, and crura, $\times 1.5$; 4i, brach.v., int., $\times 2$ (all 365).

Coledium GRANT, 1965, p. 95 [**C. erugatum*; OD]. Small, rarely large (average length about 10 mm.); commissure uniplicate; costae few, rounded, weak or absent, beginning far forward; valve edges overlapping at posterior margin; stolidium narrow and sporadic or absent. Pedicle valve with beak slightly attenuate, suberect to incurved; deltidial plates small and disjunct or absent; foramen small, rarely closed by incurvature of beak; sulcus shallow, beginning far forward; interior with spondylium on low median septum duplex, rarely sessile in posterior region. Brachial valve with fold not sharply raised above flanks; interior with hinge plate and camarophorium as in *Stenosisma*; intercamarophoral plate short. *M. Dev.-Penn.*, USA; *Perm.*, Timor.—FIG. 515,2a-d; 516,2. **C. erugatum*, *U. Miss.*, Okla.; 515,2a-d, brach.v., ped.v., lat., ant. views, $\times 2$; 516,2a-k, ser. transv. secs., $\times 4$ (orig. length, 11.4 mm.), figures indicate distance from ped.v. beak in mm.; c, camarophorium; cp, cardinal process; hp, hinge plate; icp, intercamarophoral plate; sp, spondylium); 2a (1.2), cp hardly discernible; 2b (1.5), cp and hp present; 2c (2.1), cp large, fimbriate; 2d (2.6), no cp; 2e (2.9); 2f (3.0), hp reduced, sp low, narrow; 2g (3.4), icp low, sp absent, septum low; 2h (4.0), icp nearly absent; 2i (4.2); 2j (4.7), c high, wide, flexed, septum thin; 2k (5.5), c high, strongly flexed transversely, septum detached from valve floor (all 365).—FIG. 515, 2e-i. *C. evexum* GRANT, *L. Miss.*, Tex.; 2e-i, brach.v., ped.v., lat., ant., post. views, $\times 2$ (365).

Subfamily TORYNECHINAE Grant, 1965

[*Torynechinae* GRANT, 1965, p. 31]

Uncinuliform, with stolidium greatly reduced (less commonly absent), costae beginning at beaks. ?*U. Carb.*, *L. Perm.*

Torynechus COOPER & GRANT, 1962, p. 1128 [**T. caelatus*; OD]. Rounded subtriangular in outline and profile, anterior surface flattened; length of adult about 18 mm.; commissure uniplicate; costae fine, sharp, numerous, beginning at beaks, intercalating and bifurcating; posterolateral valve edges over-

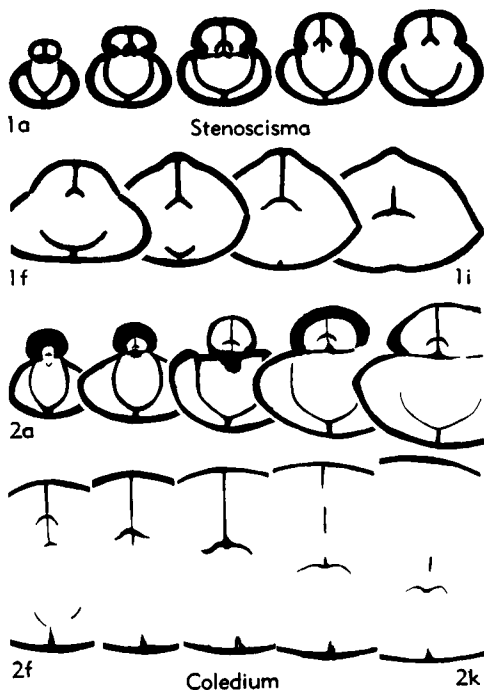


FIG. 516. Stenosismatidae (Stenosismatinae) (p. H629-H631).

lapping slightly; anterior margins protruding slightly, indicating incipient or decadent stolidium. Pedicle valve sharply geniculate near anterior margin; beak elongate, attenuate, suberect to erect; deltidial plates small; foramen small, oval; sulcus depressed below flanks only near front margin; interior with spondylium on low median septum duplex; muscle marks weak in spondylium; transverse gonocoeal troughs shallow; pattern of mantle canals as in *Stenosisma*. Brachial valve sharply geniculate in anterior region; fold low, broad, flat-crested; interior as in *Stenosisma*; intercamarophoral plate short, thick, may be buried in callus; muscle marks and mantle canals as in *Stenosisma*. *L. Perm.* (Leonard.); USA (Tex.).—FIG. 515,1. **T. caelatus*; 1a-e, brach.v., lat., ant., lat. int., int. profile views, $\times 1$ (365).

[The spondylium-bearing rhynchonellid brachiopods found in Leonard beds of the Glass Mountains, western Texas, which now are assigned to the genus *Torynechus*, were first described and figured by R. E. KING (1931, p. 112, pl. 35, fig. 6-7), who introduced for them the new genus *Uncinuloides* and designated as its type-species a form named *Rhynchonella Guadalupeae* SHUMARD (1858, p. 295). Although the type of SHUMARD's species has been lost, other specimens collected in the Guadalupe Mountains from the Capitan Limestone, the source of *R. guadalupae*, possess *Wellerella*-like dental plates instead of a spondylium in the pedicle valve. Clearly, they are not the same as shells which KING named *Uncinuloides guadalupensis* (SHUMARD), one of which was selected by COOPER & GRANT as the holotype of *Torynechus caelatus*. The specific name *guadalupensis* is not the same as *guadalupae*, and thus argument might be advanced that the type-species of *Torynechus* actually is *Uncinuloides guadalupensis* KING (non *guada-*

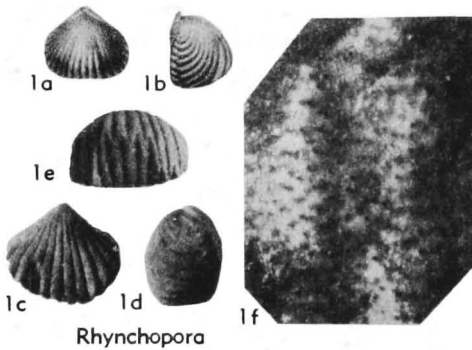


FIG. 517. Rhynchoporidae (p. H632).

lupae SHUMARD) (= *Torynechus caelatus* COOPER & GRANT); this can be countered effectively by pointing out that KING's usage of *U. guadalupensis* makes evident that *guadalupensis* is a subsequent spelling with status of an "unjustified emendation" which ranks as a junior objective synonym of *guadalupae* (1961 Code, Art. 33,a,ii). *Uncinuloides* then is tied to a misidentified type-species (Art. 70) calling for adjudication by ICZN; instead, COOPER & GRANT have decided to settle the issue themselves by adopting the disposition given in Art. 70,a,iii, which is to accept the species named by the designator, regardless of the misidentification. Challenge is unlikely and accordingly *Torynechus*, with type-species *T. caelatus*, is here recognized as valid and *Ucinuloides* is left for needed further research.]

Septacamera STEPANOV, 1937, p. 146 [**Camarophoria kutorgae* CHERNYSHEV, 1902, p. 90] [= *Septacamera* LIKHAREV, 1960, p. 249 (*nom. null.*)]. Large (length about 25 mm.), profile rounded subtrigonal, with flattened anterior surface; commissure strongly uniplicate; costae strong, simple, beginning at beaks; valve edges apparently not overlapping. Pedicle valve geniculate near anterior margin; beak short, suberect; foramen open; sulcus shallow, distinct from flanks; interior with posterior part of spondylium sessile, elevated farther forward on relatively high median septum,

possibly also braced by pair of short lateral buttress plates. Brachial valve with distinct fold standing above flanks only near anterior edge; interior with large camarophorium on high septum, strongly curved ventrally; presence of intercamarophorial plate uncertain. ?*U. Carb.*, *L. Perm.* (*Sakmar.*), USSR (Urals - Timan); *L. Perm.* (*Word equiv.*), USA (Ore.) - Can. (Arctic). — FIG. 515, 3. **S. kutorgae* (CHERNYSHEV), *L. Perm.*, Urals; 3a-d, brach. v., ped. v., lat., ant. views, $\times 1$ (518).

Superfamily RHYNCHOPORACEA Muir-Wood, 1955

[Rhynchoporacea MUIR-WOOD, 1955, p. 91 (erroneously attributed to MOORE, 1952, who classed Rhynchoporacea as suborder)] [Materials for this superfamily prepared by D. J. McLAREN]

Shell punctate, lacking spondylium or camarophorium. *Miss.-Perm.*

Family RHYNCHOPORIDAE Muir-Wood, 1955

[Rhynchoporidae MUIR-WOOD, 1955, p. 91]

Characters of superfamily. *Miss.-Perm.*

Rhynchopora KING, 1865, p. 124 [**Terebratula Geinitziana* DE VERNEUIL, 1845, p. 83; OD] [= *Rhynchoporina* OEHLERT, 1887, p. 1305 (obj.)]. Subtriangular to subpentagonal; costate; uniplicate; fold on brachial and sulcus on pedicle valve; tongue high; shell flattened anteriorly. Dental plates present; hinge plate entire, supported posteriorly by septum and septalium; crura directed anteriorly. *L. Carb.-Perm.*, Eu.-Asia-N. Am.-S. Am. — FIG. 517, 1a, b. **R. geinitziana* (DE VERNEUIL), *U. Perm.*, USSR (Russ. platform); 1a, b, brach. v., lat. views, $\times 1$ (841). — FIG. 517, 1c-f. *R. triznae* SOKOLSKAYA, *L. Carb.* (Tournais), USSR (Kuznetsk basin); 1c-e, ped. v., lat., ant. views, $\times 1$; 1f, shell microstructure, $\times 25$ (711a).

SPIRIFERIDA

By A. J. BOUCOT,¹ J. G. JOHNSON,¹ CHARLES W. PITRAT,² and R. D. STATON³

¹California Institute of Technology, ²University of Massachusetts, and ³Museum of Comparative Zoology at Harvard College]

Order SPIRIFERIDA Waagen, 1883

[*nom. correct.* MOORE in MOORE, LALICKER, & FISCHER, 1952, p. 221 (*pro* order Spiriferacea KUHN, 1949, p. 104, *nom. transl. ex* suborder Spiriferacea WAAGEN, 1883, p. 447)] [*emend.* BOUCOT, JOHNSON, & PITRAT, herein] [Diagnosis prepared by A. J. BOUCOT, J. G. JOHNSON, & R. D. STATON]

Articulate brachiopods with spiral brachidium (except Leptocoeliidae); jugum present or absent. Shell punctate or impunctate, lacking pseudopunctae; mostly biconvex, rarely plano-convex, with relatively large body cavity; cicatrix of attachment uncom-

mon; delthyrium open or closed, circular foramen present or absent. *M. Ord.-Jur.*

Suborder ATRYPIDINA Moore, 1952

[*nom. correct.* BOUCOT, JOHNSON, & STATON, herein (*pro* suborder Atrypacea MOORE, 1952, p. 221)] [= suborder Atrypoida MUIR-WOOD, 1955, p. 91] [Materials for this suborder prepared by A. J. BOUCOT, J. G. JOHNSON, and R. D. STATON]

Impunctate, mostly biconvex spire-bearing brachiopods, commonly with narrow cardinal margin. Interarea low, obsolescent, or lacking. Pedicle-valve beak may be trun-