CLASSIFICATION OF THE KONINCKINACEA

by

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ABSTRACT

The brachiopod superfamily Athyracea Williams 1956 (=Rostrospiracea Schuchert & LeVene 1929) has been renamed Koninckinacea Davidson 1851-55 nom. trans. Boucot & Staton. Athyracea became void with the priority replacement of the genus Athyris McCoy 1844 with a synonym, Cleiothyris Phillips 1841. According to Copenhagen nomenclatural priority rules, the superfamily name should be elevated from the oldest group of suprageneric rank within the superfamily; that being, in this instance, the family Koninckinidae Davidson 1851-55.

Correspondingly, the subfamily Athyrinae and family Athyridae have been renamed Cleiothyrinae and Cleiothyridae. Within the Cleiothyridae, a new subfamily, Tetractinellinae, has been erected. The subfamily Diplospirellinae has been elevated to family rank, and within that family a new subfamily, Kayserinae, has been erected for the single Devonian genus Kayseria. The subfamily Camarophorellinae has been reassigned to the family Meristellidae. From within the latter, the subfamily Hindellinae has been reassigned to the family Nucleospiridae.

Fifty-two genera have been assigned to the superfamily Koninckinacea and are described and classified within. A compilation of species assigned has been prepared for the lower paleozoic genera. Jugal preparations are diagrammatically figured for all genera for which this information is available.

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Family UNCITIDAE McCoy 1855
Subfamily Uncitinae McCoy 1855
(nom. transl. Waagen 1883)

Family CLEIOTHYRIDAE Boucot & Staton
Subfamily Cleiothyrinae Boucot & Staton
Subfamily Tetractinellinae Boucot & Staton
Subfamily Athyrisininae Grabau 1931

Family DIPLOSPIRELLIDAE Schuchert 1913
(Nom. transl. Boucot & Staton, herein;
ex. Diplospirellinae Schuchert 1913,
non. Diplospirinae Schuchert 1894)
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Subfamily Kayserinae Boucot & Staton

Family KONINCKINIDAE Davidson 1851-55
Subfamily Koninckininae Davidson 1851-55
(nom. transl. Davidson 1882-84)

*Previously placed in another family by Schuchert & LeVene 1929, and Muir-Wood 1955: with the CLEIOTHYRIDAE.
**Previously placed in another family by Schuchert & LeVene 1929, and Muir-Wood 1955: with the MERISTELLIDAE.
***Previously placed in another family by Schuchert & LeVene 1929, and Muir-Wood 1955: with the CLEIOTHYRIDAE.

SUPERFAMILY KONINCKINACEA

Actinoconchus	McCoy (1842) 1844
Amphiclina	Laube 1865
Amphiclinodonta	Bittner 1888
Amphitomella	Bittner 1890
Anathyris	Von Peetz 1901
Anisactinella	Bittner 1890
Anomactinella	Bittner 1890
Athyrisina	Hayasaka 1920
Buchanathyris	Talent 1956
Camarophorella	Hall & Clarke 1893
Camarospira	Hall & Clarke 1893
Charionella	Billings 1861
Clavigera	(Hector 1878) Thomson 1913
Cleiothyridina	Buckman 1906
Cleiothyris	Phillips 1841
Comelicania	Frech 1901
Composita	Brown 1849
Cryptothyrella	Cooper 1942
Dicamara	Hall & Clarke 1893
Dioristella	Bittner 1890
Diplospirella	Bittner 1890
Euractinella	Bittner 1890
Glassina	Hall & Clarke 1893
Greenfieldia	Grabau 1910

Hindella	Davidson 1882
Hyattidina	Schuchert 1913
Janiceps	Frech 1901
Kayseria	Davidson 1882
Koninckella	Munier-Chalmas 1880
Koninckina	Suess 1851-55
Koninckodonta	Bittner 1893
Meifodia	Williams 1951
Merista	Suess 1851
Meristella	Hall 1859
Meristina	Hall 1867
Meristospira	Grabau 1910
Misolia	Von Seidlitz 1913
Nucleospira	Hall 1857
Pentactinella	Bittner 1890
Pentagonia	Cozzens 1846
Pexidella	Bittner 1890
Pomatospirella	Bittner 1892
Pradoia	Comte 1938
Protathyris	Kozlowski 1929
Rowleyella	Weller 1911

Spirigerella	Waagen 1883
Stolzenburgiella	Bittner 1903
Tetractinella	Bittner 1890
Triathyris	Comte 1938
Uncinella	Waagen 1883
Uncites	Defrance 1825
Whitfieldella	Hall & Clarke 1893

DESCRIPTIONS

Superfamily KONINCKINACEA Davidson 1851-55

(Plate I-IV)

1851-51. Koninckinidae Davidson. Brit. Foss. Brach., vol. 1, pg. 92.
1882-84. Athyridae, Davidson. Gen. Sum. Brit. Foss. Brach., pg. 354.
1929. Rostrospiracea, Schuchert & LeVene. Cat. Foss. Brachiopoda, page 21.
1955. Rostrospiracea, Muir-Wood. Class. of Brachiopoda, page 92.
1956. Athyracea, Williams. Biological Reviews, vol. 31, page 284.
Herein. Koninckinacea.

Diagnosis: Impunctate shells of variable outline. Forms smooth, radially plicated, or marked by concentric lamellose expansions. Interarea on the pedicle valve generally lacking. Median septae in both valves either present or absent. Cardinal-plates generally present, with cardinal processes occasionally developed. Spiralium present, spiral cones laterally or ventrally directed. Jugum always present, varying from a simple band to complicated structures. Accessory lamellae may be entirely lacking, or variably developed, occasionally intercoiled with the spiral volutions to the ends of the spiral cones. Cruralia and spondylia may be present or lacking, as may be transverse plates or "shoe-lifter" processes.

Family **MERISTELLIDAE** Waagen 1883

(Plate I)

1859. Meristella, Hall.
1883. Meristellinae, Waagen. Salt-Range Fossils, I, page 449.
1895. Meristellidae, Hall & Clarke. Pal. N. Y., (8)2, page 358.
1913. Meristellidae, Schuchert. Zittel Text-Book Pal., page 415.
1929. Meristellidae (Hall & Clarke 1895), Schuchert & LeVene. Cat. Foss. Brachiopoda, page 21.
1955. Meristellidae (Hall & Clarke 1895), Muir-Wood. Class. of Brachiopoda, page 92.

Diagnosis: Smooth, biconvex forms, lacking concentric lamellar expansions. Spiral cones laterally directed. There is no development of a jugal saddle. Jugal bifurcations are always present; may be either short or extensively recurved to join the jugal process near their origin, but never extended laterally among the spiral cones.

Subfamily MERISTELLINAE Waagen 1883

(Plate I, figures 1-5)

1859. Meristella, Hall.
1883. Meristellinae Waagen. Salt-Range Fossils, I, page 449.
1894. Meristellinae, Schuchert. American Geologist, 13, page 107.

Diagnosis: Smooth, biconvex forms. Jugal bifurcations may be either short or recurved to join the jugal process near their origin. Spondylium or pedicle "shoe-lifter" process is lacking. Cruralium present; may be sessile, and may give rise to a cardinal process.

Genus PENTAGONIA Cozzens 1846

(Plate I, figure 1)

(=GONIOCOELIA Hall 1861)

1841. Atrypa unisulcata, Conrad. Fifth Ann. Rept. Geol. Surv. N. Y., pg. 56.
(=Pentagonia peersii Cozzens 1846. Annals of the N. Y. Lyceum of Natural Hist., Vol. IV, 1848, pg. 158. Advance copies 1846.)

1846. Pentagonia, Cozzens. Ann. N. Y. Lyc. Nat. Hist., Vol. IV, pg. 158.

1861 Goniocoelia, Hall. Fourteenth Rept. N. Y. State Cab. Nat. Hist., pg. 101.

Diagnosis. Shell outline pentagonal. Pedicle valve having very broad median sulcus with very abrupt lateral slopes, brachial valve with wide, rounded strong fold divided by a narrow, deep groove. Brachial median septum present.

Description. Exterior: Pentagonal in outline. Biconvex, brachial valve the deeper of the two. The pedicle valve has a very broad sulcus which is limited by divergent carinae, outside of which the cardinal or lateral slopes are very abrupt. On the brachial valve is a rounded median fold, which may be divided on its summit by a deep, narrow groove; in the umbolateral region are two short folds or flanges, beginning at the hinge-line, having a slightly sinuous curve and terminating before traversing much more than one-third the length of the valve. Occasionally there is a second of these ridges on each side.

Brachial Interior: The muscular impression of the valve is essentially as in Meristella. The cardinal-plate has a peculiar structure: it arises vertically from the

the bottom of the valve, presenting an erect, concave anterior face, which is traversed by a faint median ridge continuous with the median septum of the valve. The posterior portion of the upper surface of this plate bears a deep circular or crescentic concavity, most sharply defined on its anterior edge where it is bounded by the somewhat recurved vertical wall. On the lateral portions of the upper face of the anterior wall lie the elongate crural bases which are continued into short, straight crura, standing at an angle of about 45 degrees to the plane of the horizontal face of the plate. The spiral cones are as in Meristella, their curvature conforming to the peculiarly contracted interior cavity of the shell. The nature of the jugum is unknown.

Pedicle Interior: The muscular impressions of the valve are essentially as in Meristella.

PENTAGONIA

Species Assigned:

Pentagonia peersii Cozzens 1846.
Annals of the Lyceum of Natural History of N. Y., vol. 4, pg. 158, pl. 10, fig. 2 (a-b).

Atrypa unisulcata Conrad 1841.
Fifth annual report on the paleontology of the State of N. Y., Geol. Surv. N. Y., vol 5, No. 150, pg. 56.

Meristella (Pentagonia) unisulcata biplicata Hall 1862.
15th Rept. N. Y. State Cab. Nat. Hist., pg. 147.

Species Rejected:

Meristella (Pentagonia) unisulcata uniplicata Hall 1862.
This name applies only to the typical form of the species and may be rejected. Hall & Clarke, Pal. N. Y. (8)2: 81 bottom.

Distribution:

NORTH AMERICA

New York - Falls of the Ohio River, Upper Helderberg Limestone; (Middle Devonian):
Pentagonia peersii Cozzens 1846, original description.

New York - Schoharie, in Onondaga Limestone; (Middle Devonian):
Atrypa unisulcata Conrad 1841, original description.

New York - Canandaiqua Lake, Hamilton Group shales; (Middle Devonian):
Meristella (Pentagonia) unisulcata biplicata Hall 1862.

Genus MERISTELLA Hall 1859

(Plate I, figure 2)

1842. Atrypa laevis, Vanuxem. Geology of N. Y.; Rept. Third Dist., pg. 120.
(=Merista laevis Hall 1857. Tenth Rept. N. Y. State Cab. Nat. Hist., pg. 92.)
1859. Meristella, Hall. Twelfth Rept. N. Y. State Cab. Nat. Hist., pg. 78.

Diagnosis. Imperforate concave cardinal-plate supported by a median septum; cardinal process lacking. Recurved jugal bifurcations united at jugal stem. Short dental plates present, which may be obscured by secondary shell deposit.

Description. Exterior: Small to large shells, oval, ovoid or suborbicular, elongate or rarely transverse; valves unequally convex, often inflated, cardinal areas obscure. Surface smooth, or with fine concentric lines of growth, and with very fine, indistinct or obsolete, radiating striae. The umbo of the pedicle valve is strongly incurved at maturity, concealing most, if not all of the foramen; in early growth stages, however, the beak is more erect and exposes the deltidial plates in an elementary condition of development. The anterior margin of the shell is sinuate, and usually there is a sulcus on the pedicle valve, with a less conspicuous fold on the brachial valve; sometimes both valves bear a low sulcus, or the sulcus on the pedicle valve may be absent, while the fold on the brachial

valve is present, thus giving the shell a nasute anterior extension; again, fold and sulcus may be absent on both valves.

Brachial Interior: The beak is depressed and sometimes obscured by the incurvature of the umbo of the pedicle valve. The dental sockets are narrow and divergent. The strong cardinal-plate is subject to some unessential variation in form. Usually it is triangular, concave on the upper surface, and divided into two lobes by a median groove. The crura take their origin from just within the anterior margins of the lobes thus formed. In some species the cardinal-plate is more subquadrate in outline, the variation being produced by the development of post-lateral expansions. The plate is supported by a median septum, which extends for somewhat more than one-third the length of the valve. The thickened bases of the crura are short and straight, and the primary lamellae of the brachidium originate from them at an acute angle, descending into the cavity of the brachial valve, coming into closest apposition at the anterior extremity of the median septum. In the bottom of the brachial valve, the lamellae, in the course of their first volution, are united by a jugum which is produced by the extension of a slender process from the band on each side.

Beyond this junction the stem produced bifurcates, and each branch is produced in a curving band which arches forward on the pedicle side, and upon returning, is reunited to the sides of the jugum just above the junction of the branches arising from the primary lamellae. The structure of the jugum is thus similar to that of Merista, with the following exception: the circular arms of the loop curve first outward in the horizontal plane, then backward and abruptly downward to the inner edges of the primary lamellae; in their return the same curvature is reversed and they therefore meet the stem of the loop in the horizontal plane. In the mature individual, the spiral ribbon makes about fifteen volutions, the bases of the cones being sub-parallel to the longitudinal axis of the shell and their apices directed toward its lateral margins. In their general shape the cones conform to the character of the interior cavity, and in the less convex species they are appressed on the side of the flatter or brachial valve. The muscular area is elongate-ovate, and extends for the entire length of the median septum; the four adductor scars are sometimes distinctly seen, the posterior pair being broader and embracing the posterior extremities of the anterior scars.

Pedicle Interior: The delthyrium is wide, its

margins being thickened into dental ridges. The teeth are conspicuous, often much thickened and curved backward at their tips, interlocking with the opposite valve in such a manner as to make a very firm articulation. The teeth are supported by thickened or slender, short lamellae which rest upon the bottom of the valve, and are continued for a short distance about the posterior margin of the muscular impression. In old shells this portion of the valve becomes greatly thickened, the muscular impression correspondingly deepened and abruptly limited, and the identity of the dental lamellae is obscured by their becoming merged with or covered by secondary deposits of shell substance. No spondylium is present. The pedicle cavity is deep and frequently shows a strong, deep muscular scar. The impression of the diductor muscles is subquadrate-ovate or subtriangular in outline, very strongly impressed and usually clearly divisible into its two lateral components. The central adductor scar is faint, but linear when retained. The lateral scars are deeply striated longitudinally. The anterior margin of the muscular area is frequently obscure but is not infrequently a ridge from which radiate fine, anastomosing pallial sinuses. In the post-lateral regions the ovarian sinuses are sometimes retained.

Stratigraphic Range: Lower-Middle Devonian

Geographic Range: Europe, North America, South America, China

Genus CHARIONELLA Billings 1861

(Plate I, figure 2)

1843. Atrypa scitula, Hall. Geology of N. Y.; Rept. Fourth District, pg. 171.
1861. Charionella, Billings. Canadian Journal, Vol. 6, March, pg. 148.

Diagnosis. The anterior margin and a large portion along the middle of the imperforate cardinal-plate are ankylosed to the bottom of the valve, A myophragm is present in the brachial valve, or may be lacking.

Description. Exterior: Externally like Meristella. A pedicle foramen is present, bounded on the lower side by a deltidium of either one or two pieces, or by a portion of the shell.

Brachial Interior: A rudimentary medial ridge, a myophragm, may be present or entirely absent. The cardinal-plate is so greatly modified as to be apparently absent. Its general appearance is that of two ridges, strongly recurved at their edges, passing along the margins of the delthyrium, enclosing the dental sockets. These are supported by thin lamellae which converge toward the bottom of the valve. The anterior margin and central portion of the plate must be considered as absent, or as very concave and merged in or ankylosed to the substance of the valve. This is a wide departure from the structure of the cardinal-plate in the other spire-bearing brachiopoda. The crura, arising from the

extremities of the lateral ridges, are short and curved outward. The brachidium and jugum have the same structure as Meristella; the apices of the cones are laterally directed. The muscular scars are considerably more pronounced than in Meristella, occupying an elongate-oval space and being divisible into an anterior and posterior pair.

Pedicle Interior: Muscular scars essentially similar to those of Meristella.

CHARIONELLA

Species Assigned:

Charionella circe Billings 1861, Canadian Journal, vol. vi, new ser., figs. 100, 101.
(non Terebratula circe Barrande 1847)
Atrypa scitula Hall 1843, Geology of N. Y., Rept. Fourth Dist. pg. 171, fig. 1.

Distribution:

NORTH AMERICA

New York -- Williamsville, Erie County; (Devonian):
Atrypa scitula Hall 1843, original description.

Canada -- Corniferous Limestone, County of Haldimand; (Devonian):
Charionella circe Billings 1861, original description.

Genus MERISTINA Hall 1867

(Plate I, figure 3)

(=WHITFIELDIA Davidson 1882)

1863. Meristella maria, Hall. Trans. Albany Inst., Vol. IV, pg. 212.
1867. Meristina, Hall. Paleontology of N. Y., Vol. IV, pg. 299.
1882. Whitfieldia, Davidson. British Silurian Brachiopoda, Supplement, pg. 107.

Diagnosis. The loop is simple, the stem having a short bifurcation. Brachial median septum present. Dental lamellae well developed.

Description. Exterior: Externally like Meristella. Large shells, biconvex, the greatest depths of the valves being subequal. The pedicle beak is erect in youth, but so greatly incurved at maturity as to totally conceal the foramen and deltidium. Cardinal slopes are narrow but distinct, forming prominent shoulders which may be traced nearly to the middle of the lateral margins. A low, often indistinct median fold extends from the apex forward; at about the middle of the shell it is divided by a faint groove, becoming broader toward the margin and continued into a subnasute extension. The lateral slopes are scarcely depressed. The brachial valve also bears a low median fold, which manifests itself most conspicuously over the anterior portion of the shell. Surface of the valves smooth or with fine concentric growth striae. Shell substance fibrous, im-

punctate.

Brachial Interior: The cardinal-plate is deeply divided medially by a narrow groove, the two lateral lobes being elevated, and supporting the crural bases. The plate is thickened on the under side and supported by a median septum, which extends for one-half the length of the valve. The crura are short and straight, and the primary lamellae of the spiral ribbon originate from them at a sharp angle, diverge laterally as they turn downward, passing over a portion of the adjacent lateral volutions, approach each other toward the middle of their length, nearly meeting at the anterior edge of the median septum, thence again diverging to their anterior recurvature. The adjacent lateral coils do not follow precisely the curvature of the primary lamellae and the resultant cones at maturity have a gracefully undulated surface. The cones consist of more than ten volutions. The loop consists of two lateral branches, broad at their origin, inclined backward, and uniting to form a stem which bears a short bifurcation at its extremity. The bifurcations do not continue and recurve as in Meristella. The muscular area is elongate-ovate and more or less distinctly separated into anterior and posterior scars.

Pedicle Interior: Pedicle interior like Meristella. The teeth are conspicuous and are supported by thin plates,

which extend to the bottom of the valve and are produced forward to form the lateral boundaries of the muscular area. Between the posterior portion of these plates lies the deep scar of the pedicle muscle, which is separated from the elongate and radially striate diductor impression by a prominent callosity.

Stratigraphic Range: Silurian

Geographic Range: World-wide

Genus DIORISTELLA Bittner 1890

(Plate I, figure 4)

1862. Terebratula indistincta, Beyrich. Monats. Akad. Wiss. Berlin, pg. 34.
1890. Dioristella, Bittner. Abh. der K. K. Geol. Reichsanstalt, Vol. 14, pg. 299.

Diagnosis. Shell outline subtriangular. Jugal bifurcations return upon themselves as in Meristella, dental plates are lacking, and well-developed fold and sulcus are lacking.

Description. Exterior: Subtriangular to elongate-oval in outline, pedicle beak incurved, apically perforated by circular foramen. Very faint pedicle sulcus and brachial fold may be present, indistinct. Valves nearly equally biconvex, externally smooth or with fine, concentric growth-lines.

Brachial Interior: Spirals and jugum somewhat as in Meristella, with jugal bifurcations recurving to unite with jugal stem, after accompanying the primary lamellae only a very short distance.

Pedicle Interior: Dental lamellae lacking.

Stratigraphic Range: Triassic

Geographic Range: Austrian Alps

Genus GLASSINA Hall & Clarke 1893

Plate I, figure 5)

1839. Terebratula laeviuscula, Sowerby. Sil. Syst., pl. 13, fig. 14.
1893. Glassina, Hall & Clarke. Pal. N. Y., Vol. 8, pt. 2, pg. 98.

Diagnosis. Shell small, outline elongated pentagonal. Upright cleiothyrid stem absent, the jugal apparatus having the form of an inclined X. Brachial median septum present.

Description. Exterior: Small shells, outline somewhat elongated pentagonal; truncated and slightly indented anteriorly, broadest medially, tapering posteriorly. Valves nearly equally convex, with a slight median depression anteriorly in the pedicle valve. Beak strongly incurved, apically perforated by a minute oval foramen. Surface smooth, marked by a few concentric lines of growth.

Brachial Interior: Cardinal-plate supported by median septum present as in Meristina. The median septum extends a little more than one-third the length of the shell. The lateral jugal branches commence from the brachial side of the primary lamellae slightly above their center, are short, and converge after proceding in an upward and sloping direction between the spirals across to the pedicle side. They unite in a sharp point

beneath the hook-shaped attachments of the cardinal-plate. Immediately arising from this uniting point of the jugum there is a bifurcation; the two linear accessory lamellae curve in an upward and backward direction to the posterior border of the spiral cone. These accessory lamellae are short and make but a short curve within the primary lamellae. The jugum forms neither a saddle nor an upright stem, the whole apparatus having the form of an inclined X, with its upper tips curved outward. The spiral cones are laterally directed.

Pedicle Interior: Unknown.

GLASSINA

Species Assigned:

Terebratula laeviuscula Sowerby 1839, Murchison's Silurian System, pg. 631, pl. XIII, fig. 14.

Distribution:

EUROPE

Great Britain -- Wenlock Shale at Tynewidd, Llandovery; (Upper Silurian):
Terebratula laeviuscula Sowerby 1839, original description.

Genus MERISTOSPIRA Grabau 1910

1910. Meristospira michiganense, Grabau. Geol. Surv. Mich., Geol. Ser. 1, Pub. 2, pg. 159.
1910. Meristospira, Grabau. Geol. Surv. Mich., Geol. Series 1, Pub. 2, pg. 158.

Diagnosis. Brachial cardinal-plate strong, with erect cardinal process, perforated by a visceral foramen; it is independent of the median septum. Dental lamellae well-developed.

Description. Exterior: Similar to Meristella. Shells small, subcircular to transversely elongate, with an elevated, slightly incurved pedicle beak. A median sulcus is present in one or both valves. Surface is smooth except for concentric growth lines.

Brachial Interior: The cardinal-plate is strong and free from the bottom of the valve, being supported by the strong socket plates. It curves upwards and into the cavity of the pedicle valve as in Nucleospira, but not so strongly or abruptly. Just beneath the beak of the brachial valve the cardinal-plate is pierced by a visceral foramen as in Cleiothyris. A median septum is present, but is independent of the cardinal-plate. Nature of the brachidium and jugum unknown.

Pedicle Interior: Strong dental lamellae are present, restricted to the rostral region. A median septum

is lacking, although a myophragm may be present.

MERISTOSPIRA

Species Assigned:

Meristospira michiganense Grabau 1910, Mich. Geol. Surv. Geol. Ser. 1, pg. 159, pl. 20, figs. 5, 6, 7-11, pl. 21, figs. 4-6.

Distribution:

NORTH AMERICA

Michigan -- Amherstburg Dolomite, Upper Monroan; (Lower-Middle Devonian):
Meristospira michiganense Grabau 1910, original description.

Genus MEIFODIA Williams 1951

1851. Hemithyris subundata, McCoy. Ann. Mag. Nat. Hist. (2), 8, pg. 387.
1951. Meifodia, Williams. Quat. Jour. Geol. Soc., Vol. CVII, part 1, pg. 106.

Diagnosis. Brachial cardinal-plate strongly divided by prominent visceral foramen, supported by a pair of discrete septae which may be fused with the low median septum; cardinal process lacking.

Description. Exterior: Shells transversely oval in outline, unequally biconvex, the pedicle valve being the less convex. A brachial fold and corresponding pedicle sulcus similar to those of Meristella are present. Beaks small, strongly incurved. Exterior smooth.

Brachial Interior: Cardinal-plate divided by a narrow groove, supported by a pair of discrete septae which may be fused with the low median septum. Crural processes are closely set on either side of an occasionally well-defined septalium, and extend anteriorly parallel to each other for a short distance. Nature of the spiral cones and jugum is unknown. Dental sockets are well defined, widely divergent. The adductor scars are long, narrow, and variably impressed on either side of the median septum.

Pedicle Interior: Teeth strong, massive. Dental plates very short, usually concealed by secondary shell deposit, or obsolescent. Pedicle chamber well defined. Muscle area deeply impressed, triangular; it is narrow and restricted posteriorly, but splayed anteriorly. The adductor muscle scars are borne on a small, raised, solid transverse ridge of shell deposit with a steep posterior face and a gently sloping anterior face. The diductor scars are flabellate, extending anteriorly to or beyond the adductors. Myophragm present.

MEIFODIA

Species Assigned:

Meifodia ovalis Williams 1951, Quart. Jour. of Geol. Soc., vol. 57, 1, pg. 109, text-fig. 13, pl. 6, figs. 8-10.

Meifodia ovalis supercedens Williams 1951, Quart. Jour. of Geol. Soc., vol. 57, 1, pg. 110, text-fig. 14, pl. 6, figs. 11-13.

Hemithyris subundata McCoy 1851, Ann. Nat. Hist., 2nd Ser., vol. 8, pg. 394.

Meifodia subundata prima Williams 1951, Quart. Jour. of Geol. Soc., vol. 57, 1, pg. 107, text-fig. 11, pl. 6, figs. 1-3.

MEIFODIA

Distribution:

EUROPE

Great Britain -- Schists and limestone of Mathyrafal S. of Meifod, Montgomeryshire; schists of Pen y Craig, Llangynyw, Montgomeryshire; slate of Alt ffair ffynnon, Llanfyllin, North Wales; (Llandovery): Hemithyris subundata McCoy 1851, original description.

-- Scrach, Esgair goch, Esgair-fwyog; (Lower Llandovery): Meifodia subundata prima Williams 1951, original description.

-- Llwyn-yr-iar; (Middle Llandovery): Meifodia ovalis Williams 1951, original description.

-- Pentre-ty-gwyn, Llanerch-goch, Cefn-cerrig, Glyn-moch; (Upper Llandovery): Meifodia ovalis supercedens Williams 1951, original description.

COMPARISON OF THE CRITICAL PROPERTIES OF THE MERISTELLINAE

	SHELL EXTERIOR		CARDINALIA		JUGUM	DENTAL LAMELLAE
	Outline	Sulcus and Fold	Cardinal-plate	Brachial median septum		
PENTAGONIA	Pentagonal	Deeply Medially Grooved Strong brachial fold	Imperforate, deeply concave posteriorly, anteriorly bearing a faint median ridge, produced ventrally into an erect cardinal process.	Present	Unknown	Unknown
MERISTELLA	Meristellid*	Meristellid	Meristellid	Present	Meristellid	Meristellid
CHARIONELLA	Meristellid	Meristellid	Anterior margin and middle of plate ankylosed to bottom of brachial valve. Imprf.	Myophragm	Meristellid	Unknown
MERISTINA	Meristellid	Meristellid	Meristellid	Present	Jugum simple with stem giving rise to short bifurcations.	Well-developed

	SHELL EXTERIOR		CARDINALIA		JUGUM	DENTAL LAMELLAE
	Outline	Sulcus and Fold	Cardinal-plate	Brachial median septum		
DIORISTELLA	Sub-triangular to meristellid	Meristellid	Unknown	Unknown	Meristellid	Dental-plates lacking
GLASSINA	Elongated pentagonal, small.	Meristellid	Meristellid	Present	Jugal bifurcations short, originate at point of union of jugal processes, jugal stem lacking.	Unknown
MERISTOSPIRA	Meristellid	Meristellid	Cardinal-plate perforated by a visceral foramen, is independent of median septum, with erect cardinal process.	Present	Unknown	Well-developed

	SHELL EXTERIOR		CARDINALIA		JUGUM	DENTAL LAMELLAE
	Outline	Sulcus and Fold	Cardinal-plate	Brachial median septum		
MEIFODIA	Meristellid	Meristellid	Plate strongly divided by prominent visceral foramen, supported by a pair of discrete septae which may be fused with the median septum; cardinal process lacking.	Present, low.	Unknown	Meristellid

*

Meristellid -- This term is used throughout in a broad sense, i.e. it is not restricted to being identical with that characteristic as seen in the single genus Meristella (see generic description, page 11), but merely similar to that genus. Consequently, the limits of the term with respect to a particular character are defined herein by the variability of that character seen in the genera designated as being "Meristellid". For example, the combined shell outlines of Meristella, Charionella, Meristina, Meristospira, and Meifodia determine a "Meristellid" shell outline, whereas the combined dental-plate forms of only Meristella and Meifodia determine the "Meristellid" type of that property.

This definition will hold throughout this paper; that is, Cleiothyrid, Whitfieldellid, etc., are later defined in the same manner.

Subfamily MERISTINAE Schuchert & LeVene 1929

(Plate I, figure 6)

1851. Merista, Suess.
1929. Meristinae, Schuchert & LeVene. Cat. Foss. Brachiopoda, pg. 22.
1955. Meristinae, Muir-Wood. Class. of Brachiopoda, pg. 92.

Diagnosis: Smooth, biconvex forms. Jugal bifurcations recurved to join the jugal process near their origin. An unsupported "shoe-lifter" process is present in the pedicle valve.

Genus MERISTA Suess 1851

(Plate I, figure 6)

(=CAMARIUM Hall 1859)

1847. Terebratula herculea, Barrande. Brach. Sil. Schichten. Bohmen, pg. 382.
1851. Merista, Suess. Jahrb. Geol. Reichsanst. Wien, Vol. 2, pt. 4, pg. 150.
1859. Camarium, Hall. Pal. N. Y., Vol. 3, pg. 486.

Diagnosis. "Shoe-lifter" process developed in the pedicle valve.

Comparison. In the only other associated genus, Dicamara, there are "shoe-lifter" processes developed in both valves.

Description. Exterior: Shells circular, transverse or elongate in outline; biconvex. Anterior margin sinuate, producing a fold and sulcus on the marginal portion of the brachial and pedicle valves respectively. Surface smooth or with concentric growth-lines. Shell substance fibrous. The pedicle beak is perforated apically by a circular foramen, which, however, is usually concealed at maturity, by the incurvature of the beak; deltidial plates rarely retained.

Brachial Interior: A median septum is strongly developed which extends from the extremity of the umbo to about two-thirds of the length of the shell, dividing a simple ovate adductor impression. It supports at its origin the short cardinal-plate, which is deeply divided

by a narrow, gradually widening channel or groove. The principal stems forming the spirals are attached to the cardinal-plate; they proceed for a short distance into the interior of the shell with a very gentle inclination forward, and then are bent abruptly backwards at an acute angle, towards the bottom of the lateral portions of the beak. From thence they form a broad rounded curve facing the bottom of the brachial valve, and after converging to about half their length, again divide towards the front, and thus form the first spiral coil. At about half their length the primary lamellae widen and give off another lamella. These lamellae converge from both sides towards the middle of the interior of the shell between the spiral coils, and after the two extremities have come into contact, the stem thus formed proceeds in a straight direction for a short distance to near the cardinal-plate, and then bifurcates and curves round on each side. These curve downward to the primary lamellae of the coil and returning, meet the lateral branches below their point of union; the whole forming a scissors-shaped arrangement essentially like that of Meristella. The spiral cones are composed of ten or twelve convolutions, the number, however, varying in different specimens and at different stages of growth.

The extremities of the spirals are directed towards the middle of the lateral portions of the shell.

Pedicle Interior: The teeth are prominent and are supported by dental plates which extend for a short distance into the interior cavity or area considerably produced at their bases as thickened ridges. Between the dental plates, under the beak, is a roof-shaped plate fixed by its lateral diverging margins to the bottom of the valve and with its narrow end fitting under the extremity of the beak -- a "shoe-lifter" process. At its anterior margin it extends beyond the dental lamellae and rises in a low, broad curve. In rare instances this process, from its origin, bears a sharp median carina which makes the anterior margin highly angulate. The muscular area is limited to the space between the dental lamellae and to the surface of the "shoe-lifter," on which the adductor muscle has left a small, elongated, heart-shaped scar, under and along the outer sides of which are seen the much larger oval impressions of the cardinal muscles.

Stratigraphic Range: Silurian

Geographic Range: Europe, North America

Genus DICAMARA Hall & Clarke 1893

1837. Atrypa plebeia, Sowerby. Trans. Geol. Soc., ser. 2, Vol. 5, pl. 56, figs. 12, 13.
(=Terebratula scalprum Roemer 1844. Das Rheinische Uebergangsgebirge. Eine palaontologische-geogrostische Darstellung. Hanover.
1893. Dicamara, Hall & Clarke. Pal. N. Y., Vol. 8, pt. 2, pg. 73.

Diagnosis. "Shoe-lifter" processes developed in both pedicle and brachial valves.

Comparison. In the only other associated genus, Merista, there is a "shoe-lifter" process developed in only the pedicle valve.

Description. Exterior: Undescribed, presumably similar to Merista.

Brachial Interior: A "shoe-lifter" is quite as conspicuously developed in the brachial as in the pedicle valve, while the cavity beneath it is divided into two compartments by the median septum which extends beyond the anterior edge of the platform thus formed. The compound "shoe-lifter" is like the corresponding plate in the pedicle valve in having no connection with, or origin from the articulating apparatus. This plate is not a cruralium. Jugal structure unknown.

Pedicle Interior: The unsupported convex internal plate or "shoe-lifter" in the pedicle valve must be inter-

preted as an entirely different structure from the spondylium. It is not produced by convergent dental plates, but these, on the contrary, are divergent, the arched plate uniting its inner edges.

DICAMARA

Species Assigned:

Atrypa plebeia Sowerby (1837) 1840.
Transactions of the Geol. Soc. of London, 2nd series, vol. 5, pl. 3, no. 43, pg. 693, pl. 56, figs. 12, 13.

Terebratula prunulum Schnur 1851.
Programm der vereinigten hohern Burger-Provinzial-Gewerbeschule zu Trier, Die Brachiopoden aus dem Uebergangsgebirge der Eifel, pg. 7.

Terebratula scalprum Roemer 1844.
Das Rheinische Uebergangsgebirge. Ein Palaontologische Darstellung. Hanover, pg. 68, Tab. 5, fig. 1 (a-d).

Distribution:

EUROPE

France -- Calcareous marls of Golzinne near Namur; (Devonian):
Terebratula scalprum Roemer 1844, original description.

Great Britain -- Mount Wise, Plymouth; (Devonian):
Atrypa plebeia Sowerby 1840, original description.

-- Gerolstein Chalk, Eifel; (Middle Devonian):
Terebratula prunulum Schnur 1851, original description.

Subfamily CAMAROPHORELLINAE Schuchert & LeVene 1929

(Plate I, figure 7)

1893. Camarophorella, Hall & Clarke.
1929. Camarophorellinae, Schuchert & LeVene. Cat. Foss. Brachiopoda, pg. 22.
1955. Camarophorellinae, Muir-Wood. Class. of Brachiopoda, pg. 92.

Diagnosis: Smooth, biconvex forms. Jugal bifurcations recurved to join the jugal process near their origin. A spondylium is present in the pedicle valve, supported by a median septum.

Genus CAMAROPHORELLA Hall & Clarke 1893

(Plate I, figure 7)

1862. Pentamerus lenticularis, White & Whitfield. Jour. Bost. Soc. Nat. Hist., vol. 8, pg. 295.
1893. Camarophorella, Hall & Clarke. Pal. N. Y., vol. 8, pt. 2, pg. 215.

Diagnosis. A transverse platform, originating beneath the hinge plate, is penetrated by and attached to the brachial median septum, and curves toward the floor of the valve at its lateral margins where it is attached to it. Pedicle median septum is also present, supporting a broad spatuliform spondylium. Spiral cones with eight to ten volutions.

Comparison. In Camarospira this transverse platform is entirely lacking, and, in Rowleyella, if present, it is not attached laterally to the brachial valve. The spiral cones of Rowleyella consist of only four volutions.

Description. Exterior: Shells, small or of medium size, subcircular, subovate, transversely elliptical to elongate-elliptical, or ovate in outline, broadest near the middle. The valves are subequally to equally convex, a fold and sulcus present or absent but never strongly developed. Surface of the valves regularly arched and nearly smooth, marked only by fine concentric lines of growth and rarely by the very obscure radiating striae, never plicated. The pedicle valve with beak moderately incurved, perforated terminally by a rather large, subcircular foramen which encroaches upon the umbo. The delthyrium is closed by deltidial plates.

Brachial Interior: A high, strong, triangular median septum extends one half the length of the valve

and supports posteriorly a strong, deeply concave cardinal-plate. A platform takes its origin beneath the cardinal-plate and extends the length of the septum, being penetrated by and attached to it. On either side of this septum the platform is bent toward the valve and attached to its inner surface, forming a cavity between it and the inner surface of the valve, which is divided longitudinally by the median septum. To it were attached the adductor muscles. The crura are a continuation of the cardinal-plate and are inserted on its side near the anterior margin. They are long and slightly incurved. The primary lamellae converge dorsally, diverge anteriorly, converge ventrally, and diverge posteriorly as in Meristella. There are from 8-10 volutions of the spiral cones. The jugum is placed on the primary lamellae at about one-third their length from the crura and rests on the high median septum of the brachial valve. It consists of an inverted -U or -V shaped saddle between the primary lamellae, in shape not unlike the saddle of Cleiothyris but much smaller, on which the remainder of the jugum has been formed as a single plate by a process other than gradual growth of the arms of the structure. The lamellae of the jugum are placed at a sharp angle to each other, the outer portions lying just without and parallel to the primary lamellae. They recurve and are attached to the jugum near its base.

Pedicle Interior: In the pedicle valve a spondylium

is formed by the coalescence ventrally of the well developed dental lamellae, and supported throughout most or, usually, all of its length by a median septum which is slightly longer than the spondylium and about half as long as the valve. The edges of the spondylium are thickened and set into deep sockets in the brachial valve on either side of the hinge-plate. All muscles of the pedicle and all of the ventral attachments inserted on the spondylium.

Stratigraphic Range: Lower Carboniferous

Geographic Range: North America

Genus CAMAROSPIRA Hall & Clarke 1893

1867. Camarophoria eucharis, Hall. Palaeontology of N. Y., vol. iv, pg. 368.
1893. Camarospira, Hall & Clarke. Paleont. N. Y., vol. 8, pt. 2, pg. 82.

Diagnosis. Small spondylium supported by a low median septum in the pedicle valve. No transverse platform originating beneath the hinge-plate in the brachial valve; approximately 15 volutions in each spiral cone.

Comparison. Camarophorella is characterized by the presence of a brachial transverse platform attached laterally to the valve, while Rowleyella, which may not possess such a platform, is characterized by the presence of only 4 volutions of the spiral ribbon.

Description. Exterior: These shells are essentially meristelloid in external characters.

Brachial Interior: In the brachial valve the cardinal-plate is supported by a median septum slightly longer than that of the opposite valve; the narrow, cordate muscular impression, which it divides medially, is considerably thickened. The valve bears everted spirals similar to those of Meristella; the structure of the loop is unknown. Shells essentially meristelloid in internal characters.

Pedicle Interior: In the pedicle valve, the dental lamellae, instead of resting upon the bottom of the valve, are more strongly convergent than in Merista, Meristella, etc., uniting before they reach the internal surface of the valve, thus restricting the impression of the pedicle-muscle to a distinct chamber or spondylium, which is supported

by a low median septum. In the typical species this chamber has the same extent as the deep pedicle-cavity in Meristella, that is, about one-fourth the length of the valve, while the septum extends for a short distance beyond its anterior margin, dividing the scars of the adductor and diductor impressions. In this respect the internal structure of this valve is similar to that of the corresponding valve of Pentamerus.

CAMAROSPIRA

Species Assigned:

Camarophoria eucharis Hall 1867.
Geological Survey of New York, Paleontology: vol 4, pt. 1, pg. 368, pl. lvii, figs. 40-45.

Distribution:

NORTH AMERICA

New York -- Corniferous Limestone of (Province of Ontario); (Onondaga, Middle Devonian):
Camarophoria eucharis Hall 1867, original description.

Genus ROWLEYELLA Weller 1911

1900. Terebratula fabulites, Rowley, Am. Geol., vol. 25, pg. 265.
1911. Rowleyella, Weller. Jour. Geol., vol. 19, pg. 448.

Diagnosis. The spiral cones consist of about four volutions. A spondylium is supported by a strong median septum in the pedicle valve; a strong median septum is also present in the brachial valve.

Comparison. In Camarophorella the cones consist of 8-10 volutions, while in Camarospira there are approximately 15 volutions.

Description. Exterior: Shells small, subovate in outline, with subequally convex valves. Fold and sulcus are lacking; the surface of the shell marked only by inconspicuous concentric growth lines. Pedicle valve with the beak moderately incurved and apically perforated by a subcircular foramen which encroaches wholly upon the umbonal region, in contact with the delthyrium only at its apex, the delthyrium closed by deltidial plates.

Brachial Interior: In the brachial valve there is a strong median septum which reaches anteriorly for one-third or more of the length of the valve. Its connection with the cardinal-plate and brachidium has not been determined and if a platform beneath the cardinal-plate, such as occurs in Camarophorella, is present, its outer margins are entirely free, not joining the inner surface

of the valve to form the pair of finger-like cavities which are present in that genus. The attachment of the brachidium to the crura and the form of the jugum are unknown. The spiral cones are directed laterally and consist of about four volutions.

Pedicle Interior: In the pedicle valve a strong median septum is present which reaches about one-third the length of the valve, supporting a spondylium formed by the union of the dental plates.

Stratigraphic Range: Lower Carboniferous

Geographic Range: North America.

Family NUCLEOSPIRIDAE Davidson 1882-84

(Plate II, figures 1-6)

1859. Nucleospira, Hall
1882-84. Nucleospirinae, Davidson. Gen. Sum. Brit. Foss. Brach. vol. 5, page 354.
1883. Nucleospiridae (Davidson), Waagen. Salt-Range Fossils, I, page 486.
1929. Nucleospirinae (Davidson 1882), Schuchert & LeVene. Foss. Cat. Brachiopods, page 21.
1955. Nucleospiridae (Davidson 1884), Muir-Wood. Class of Brachiopoda, page 92.

Diagnosis: Smooth, biconvex forms. Spiral cones laterally directed. No development of a jugal saddle. Jugal bifurcations never present; jugum either V-shaped, or forming a simple single stem. Well-developed cardinal process may be present. Spondylia or "shoe-lifter" processes never developed.

Subfamily NUCLEOSPIRINAE Davidson 1882-84

(Plate II, figure 1)

1859. Nucleospira, Hall.
1882-84. Nucleospirinae, Davidson. Gen. Sum. Brit. Foss. Brach., vol. 5, pg. 354.
1929. Nucleospirinae, Schuchert & LeVene. Foss. Cat. Brachiopoda, pg. 21.

Diagnosis: Smooth, biconvex forms. Spiral cones laterally directed. Jugum Y-shaped, lacking a saddle; forming a simple straight stem which is continued beyond the opposite edge of the cones almost to the inner surface of the pedicle valve. Recurved cardinal process extends backward beyond the apex of the brachial valve into the pedicle valve. Dental lamellae lacking.

Genus NUCLEOSPIRA Hall 1859

(Plate II, figure 1)

1857. Spirifer ventricosa, Hall. 10th Rept. N. Y. State Cab., pg. 57.
1859. Nucleospira, Hall. 12th Rept. N. Y. State Cab. Nat. Hist., pg. 24.

Diagnosis. Recurved cardinal process extending backward beyond the apex of the brachial valve into the pedicle valve. Jugum with a long, straight, simple stem.

Description. Exterior: Shells usually small, depressed spheroidal, subcircular, or transversely elliptical in outline. Valves subequally-convex, often gibbous or ventricose. A median sulcus and fold on the pedicle and brachial valves, respectively, are low and ill-defined, usually obsolete except near the anterior margin. The epidermal layer of the shell is usually, if not always, covered with numerous, closely crowded, fine, short spinules. These, when removed, leave the surface with only regularly concentric growth-lines marked by papillae which are the bases of the spinules. There are no radial plications. Hinge-line very short, cardinal extremities rounded. Pedicle beak slightly extended beyond the brachial valve, and beneath it a triangular depression or area, which has sometimes a shallow semi-spoonshaped form; on each side of which, at the base, is a strong tooth. This small, low cardinal area is obscured by the strong incurvature of the small beak. Only in very young specimens is the deltidium exposed; it then consists of two plates attached to the

lateral margins of the delthyrium. In mature individuals these plates are coalesced and incurved, the median suture is lost and the foramen covered; the appearance of the deltidium is that of a triangular concave plate, limited by rather sharp dental ridges and covering the delthyrium for about half its length.

Brachial Interior: The cardinal plate arises with a verticle anterior face from the bottom of the shell, but just above the plane of the margins of the valve it is reflected in a curve so abrupt that its upper face becomes horizontal. The anterior face is concave and quadrate in outline; the posterior face is subtriangular, flat or concave, and is frequently bilobed at its extremity. In profile the plate has a hook-shaped appearance; its posterior extremity being elevated considerably above the beak of the valve, and when the valves are in articulation, extending quite to the bottom of the umbonal cavity of the pedicle valve. It is closely grasped at its base by the cardinal teeth of the pedicle valve. The crural bases are situated on the vertical face of the plate, just at the point of recurvature. The crura are slender, straight, long and rod-like, having a length equal to one-fourth that of the shell. They are attached at their tips to the inner surfaces of the primary lamellae. The primary lamellae of the spiral cones are greatly incurved and their apices close together; their umbonal blades are very broad. The loop originates at about one-fourth the length of the lamellae, is inclined

slightly backward, the lateral branches uniting directly in front of the apices of the lamellae, forming a simple straight stem, which is continued beyond the opposite edge of the cones and almost to the inner surface of the pedicle valve. The spiral ribbon makes from six to ten volutions; the cones have their attitude in the transverse diameter of the shell. The muscular area is very narrow, elongate, and ill-defined, the posterior adductor scars enveloping the extremities of the anterior adductors. They are divided into pairs by a median ridge of the same extent as that of the pedicle valve. It originates in the deep cavity beneath the cardinal process. Fine racemose vascular sinuses are sometimes retained over the pallial region of both valves.

Pedicle Interior: The teeth are prominent, approximate, recurved at their tips, supported by thickened bases but not by dental lamellae. Dental sockets very narrow. The muscular area is flabellate and not sharply defined at its margins, extending for nearly one-half the length of the shell; it is composed of two elongate-ovate adductor scars enclosed by broad and radially striated diductors. A median ridge begins in the umbonal region and extends to within a very short distance of the anterior edge of the valve.

Stratigraphic Range: Silurian - Lower Carboniferous

Geographic Range: World-wide

Subfamily HINDELLINAE Schuchert 1894

(Plate II, figures 2-6)

1882. Hindella, Davidson.
1894. Hindellinae, Schuchert. American Geologist, 13, pg. 106.
1913. Hindellinae, Schuchert. Zittel Text-Book Pal., page 415.
1929. Hindellinae, Schuchert & LeVene. Cat. Foss. Brachiopoda, page. 21.
1955. Hindellinae, Muir-Wood. Class. of Brachiopoda, page 92.

Diagnosis: Smooth, biconvex forms. Spiral cones laterally directed. Jugum simple, V-shaped, lacking a long stem; may be curved terminally or depressed. Cardinal process lacking. Dental lamellae well-developed.

Genus HINDELLA Davidson 1882

(Plate II, figure 2)

1862. Athyris umbonata, Billings. Palaeozoic Fossils, vol. i, pgs. 144-5.
1882. Hindella, Davidson. British Silurian Brachiopoda, Supplement, pg. 130.

Diagnosis. The jugum is very far forward and has a depressed form. Brachial beak prominent, pedicle beak greatly incurved. Pedicle muscle scars deep, narrow and elongate. Dental lamellae strong.

Description. Exterior: The outline is subcircular or elongate-ovate, longer than wide; the valves convex, the pedicle valve being gibbous in the umbonal region. There is a low sulcus on the pedicle valve which is apparent only over the pallial region; this is accompanied by a slight fold on the opposite valve. The hinge-line is very short but the cardinal slopes are frequently long and transverse, which, with the fullness of the beaks of both valves, produces a "shouldered" appearance. The apex of the pedicle valve is closely incurved, concealing both deltidium and foramen. Surface smooth, marked only by a few concentric lines of growth. Shell structure fibrous, impunctate.

Brachial Interior: The cardinal-plate is short and similar to that of Meristina and Whitfieldella, with two diverging crural bases divided by a median groove, or a subtriangular pit, and is supported by a median septum extending for about one-half the length of the valves. The two principal stems of the spiral cones are attached to the

crural bases, and after extending a little way into the interior of the shell between the spirals they are suddenly bent backwards towards the hinge. They then form a broad rounded curve, facing the bottom of the brachial valve; the curve being very gentle, so that the two primary lamellae on the brachial side seem almost like parallel lines. When the primary lamellae reach the front they give off a semicircular jugum having a projection or spike-like process at its top. This jugum, internal to the spirals, is directed upwards towards the beak, and is almost immediately behind the two primary lamellae on the brachial side of the spirals. The jugum's inclination to the primary lamellae is extremely oblique; the lateral processes or branches being directed backward in a low upward curve, uniting to form a short, straight, undivided stem. The posterior extremity of the entire process rarely extends back of the middle of the first lamella and does not rise to the center of the bases of the spirals. The spiral cones have their apices directed laterally and consist of six to ten volutions of the ribbon.

Pedicle Interior: The teeth are moderately prominent and are supported by strong dental plates, which not only extend to the bottom of the valve, but are continued forward for about one-third the length of the shell, and inclose a deep, narrow, elongate muscular area .

HINDELLA

Species Assigned:

Athyris prinstana Billings 1862 (advance sheets)
Geol. Surv. Canada, Pal. Foss. 1, 1865, pg. 145, fig. 122 (a-b).

Athyris umbonata Billings 1862 (advance sheets)
Geol. Surv. Canada, Pal. Foss. 1, 1865, pg. 144, fig. 121 (a-b).

Species Questionably Assigned:

Hindella ambigua Savage 1913.
Bull. Geol. Surv. Illinois, dated 1917, vol. 23, pg. 133,
pl. 6, figs. 17 and 18.

Distribution:

Species Assigned:

NORTH AMERICA

Anticosti -- Junction Cliff, in Division 1, Anticosti Group; (Ordovician):
Athyris umbonata Billings 1862, original description.

-- Prinstana Bay, in Division 1, Anticosti Group; (Upper Ordovician):
Athyris prinstana Billings 1862, original description.

Species Questionably Assigned:

NORTH AMERICA

Illinois -- Alexander County, Edgewood Formation; (Lower Silurian):
?*Hindella ambigua* Savage 1913, original description.

Missouri -- Edgewood, Pike County, Edgewood formation; (Lower Silurian):
?*Hindella ambigua*, original description.

Genus WHITFIELDELLA Hall & Clarke 1893

(Plate II, figure 3)

1843. Atrypa nitida, Hall. Geol. of N. Y., Rept. Fourth Dist., pgs. 71, 142.
1893. Whitfieldella, Hall & Clarke. Paleont. N. Y., vol. 8, pt. 2, pg. 58.

Diagnosis. Brachial median septum present. Pedicle beak not high or greatly incurved. Brachial muscle scars faint, longitudinally and transversely divided; pedicle scars similar to those of Meristella.

Description. Exterior: Shells small, ovate or elongate in outline; valves subequally convex. Umbo of the pedicle valve not high or greatly incurved, usually exposing the circular apical foramen, beneath which the deltidial plates are frequently retained. Cardinal slopes of both valves broad and not distinctly defined; anterior margin subtruncate and gently sinuate. Typically there is a faint sulcus on both valves near the anterior margin. Surface smooth or marked by concentric growth lines. Shell substance fibrous, impunctate.

Brachial Interior: Socket-plates thick, elevated. The cardinal-plate is concave, divided by a deep, central concavity which is supported by a median septum. On either side are the lobes bearing the bases of the crura. The brachidium consists of two laterally directed spiral cones with six to twelve volutions at maturity. The jugum is simple, the branches being nearly erect, and beyond their junction continued posteroventrally into a short, acute, generally slightly curved process, which makes a

large angle with the direction of the lateral branches. The muscular impressions, which are very faint, are divided, longitudinally, by the median septum, and, transversely, into anterior and posterior scars. From the antelateral margins of the muscular area in both valves, radiates a series of vascular sinuses, the principal trunks of which are very conspicuous; this feature, however, is rarely retained.

Pedicle Interior: The muscular impressions are similar to those of Meristella.

Stratigraphic Range: Silurian - Lower Devonian

Geographic Range: North America

Genus GREENFIELDIA Grabau 1910

1891. Meristella bella, Whitfield. Ann. N. Y. Acad. Sci., vol. v, pg. 510. (non Hall, 1857. 10th Rept. State Cab., pg. 92)
(=Hindella whitfieldi Grabau 1910. Geol. Surv. Mich., Geol. Series 1, pub. 2, pg. 148.)
1910. Greenfieldia, Grabau. Geol. Surv. Mich., Geol. Series 1, pub. 2, pg. 148.

Diagnosis. Brachial valve without median septum. Pedicle beak only slightly incurved; pedicle valve with slightly excavated, weakly impressed muscle scars. Dental lamellae prominent.

Description. Exterior: Valves strongly convex, the pedicle valve more so than the brachial. Surface marked only by concentric growth lines. The brachial beak is scarcely elevated above the hinge-line; greatest convexity in the middle third. A very faint mesial fold corresponding to the pedicle sulcus is occasionally indicated; more generally the surface is regularly convex, or even a faint mesial depression may occur. Anterior margin slightly sinuate. Pedicle valve with the beak slightly incurved and truncated by a circular foramen visible in some cases. Surface regularly convex from beak to anterior margin; greatest convexity about one-third the distance from the beak. A shallow mesial depression begins in the region of greatest convexity and becomes more pronounced anteriorly, at the same time becoming broader.

Brachial Interior: The cardinal-plate is medially divided. There is no median septum. Character of brachidium unknown.

Pedicle Interior: Muscle scars are slightly excavated and bounded by somewhat prominent dental lamellae.

GREENFIELDIA

Species Assigned:

Hindella? (Greenfieldia) rostralis Grabau 1910, Mich. Geol. Surv., Geol. Ser. 1, pg. 150, pl. 21, figs. 1, 2, 7.

Nucleospira rotunda Whitfield 1882, Am. N. Y. Acad. Sci., II, pg. 194, figs. 11-14.

Hindella? (Greenfieldia) whitfieldi Grabau 1910, Mich. Geol. Surv., Geol. Ser. 1, pg. 149, pl. 19, fig. 4, pl. 21, figs. 11, 17-19, pl. 30, figs. 8-10.
(=Meristella bella Whitfield 1891, Ann. N. Y. Acad. Sci., vol. V, pg. 510, pl. V, figs. 8-10; non Hall 1857).

Distribution:

NORTH AMERICA

Ohio -- Greenfield Dolomite division of the Monroe Formation; (Upper Silurian):
Hindella? (Greenfieldia) rostralis Grabau 1910, original description.
Nucleospira rotunda Whitfield 1882, original description.
Hindella? (Greenfieldia) whitfieldi Grabau 1910, original description.

Genus HYATTIDINA Schuchert 1913

(Plate II, figure 4)

(=HYATTELLA Hall & Clarke 1893)

1842. Atrypa congesta, Conrad. Jour. Acad. Nat. Sci. Phila., vol. 8, pg. 265.
1893. Hyattella, Hall & Clarke. (non Lendenfeld 1889 Sponges). Paleont. N. Y., vol. 8, pt. 2, pg. 61.
1913. Hyattidina, Schuchert. In Zittel, Text. of Paleont., pg. 415.

Diagnosis. Pedicle valve with strong median sulcus and two faint lateral sulci. Brachial median septum lacking. Cardinal-plate triangular, divided by a deep, narrow cleft. Pedicle beak acute, concealing most of the deltidium.

Description. Exterior: The outline is compactly subpentahedral; valves subequally convex. The umbo of the pedicle valve acute, concealing most of the deltidium. The pedicle valve bears a strong median sulcus and two faint lateral sulci, the brachial valve having corresponding folds. Surface and ante-lateral margins are strikingly sinuate. Fine, sharp, closely crowded concentric growth lines cover the exterior.

Brachial Interior: The cardinal-plate is triangular and divided medially by a deep cleft. The lateral portions are broad and elevated, supporting short, straight crura. The loop is like that of Whitfieldella.

The spiral ribbon has six or fewer volutions and is very loosely coiled. There is no median septum.

Pedicle Interior: The pedicle cavity is deep and strongly striate, bounded by strong dental lamellae. The diductor scars are distinctly defined, enclosing a linear adductor.

HYATTIDINA

Species Assigned:

Hyattidina charletona Twenhofel 1914.
Bull. Victoria Memorial Museum 3, pg. 34, pl. 1, figs. 6,7.

Atrypa congesta Conrad 1842.
Jour. Acad. Nat. Sci., Phila, 8: pg. 265, pl. 16, fig. 18.

Athyris junia Billings 1866.
Cat. Sil. Foss. Anticosti, pg. 46.

Rhynchonella? portlockiana Davidson 1869,
Mon. Brit. Foss. Brach., vol 3, pg. 189, pl. 24, figs. 23-25.

Species Questionably Assigned

Hyattella? lamellosa Weller 1903.
Geol. Surv. N. J., Rep. Pal. 3, pg. 258, pl. 23, figs. 15-18.

Distribution:

NORTH AMERICA

Anticosti -- 6 miles east of Otter River, near Jupiter River and the Jumpers, in Divisions 2,3, & 4; (Middle Silurian):
Athyris junia (Billings 1866, original description.

-- Charleton (3), Charleton point; (Ordovician):
Hyattidina charletona Twenhofel 1914, original description.

New York -- Medina, in Clinton Group; (Lower Silurian):
Atrypa congesta Conrad 1842, original description.

EUROPE

Ireland -- Limestone of the Chair of Kildare; (Middle-Upper Ordovician):
Rhynchonella portlockiana Davidson 1869, original description.

Species Questionably Assigned:

NORTH AMERICA --

New Jersey--Rondout Formation; (Upper Silurian):
Hyattella? lamellosa Weller 1903, original description.

Genus CRYPTOTHYRELLA Cooper 1942

(Plate II, figure 5)

1906. Whitfieldella quadrangularis, Foerste. Kentucky Geol. Surv. Bull. 7, pg. 327.
1942. Cryptothyrella, Cooper. Wash. Acad. Sci. Jour., vol. 32, no. 8, pg. 233.

Diagnosis. Pedicle valve with large, deep triangular muscle field. Long, divergent dental lamellae. A long median septum in the brachial valve supports a concave cardinal-plate. Beaks small strongly incurved; the brachial beak fitting into a concave deltidium under the pedicle beak.

Description. Exterior: Large, elongate, lenticular in lateral profile, elliptical to subcircular in cross-section. Anterior commissure rectimarginate to uniplicate. Beak small, strongly incurved; foramen minute, apical. Brachial beak fitting into a concave plate under the pedicle beak. Surface smooth, shell substance impunctate.

Brachial Interior: Similar to that of Whitfieldella, with long median septum supporting a divided cardinal-plate. Brachidium with compressed spiral cones and inverted-Y shaped jugum, the tail of the Y directed posteroventrally.

Pedicle Interior: Long divergent dental lamellae on each side of an elongate triangular muscle field.

CRYPTOTHYRELLA

Species Assigned:

Atrypa cylindrica Hall 1852, Pal. N. Y. 2, pg. 76, pl. 24, fig. 2(a-h).

Whitfieldella quadrangularis Foerste 1906, Kentucky Geol. Surv. Bull. 7, pg. 327, pl. 1, fig. 4(a-c).

Distribution:

NORTH AMERICA

New York -- Upper limestone of the group at Lockport, Niagara County; (Upper Silurian): Atrypa cylindrica Hall 1852, original description.

Ohio -- Thirty-eight feet above the base of the Clinton; (Silurian): Whitfieldella quadrangularis Foerste 1906, original description.

Genus BUCHANATHYRIS Talent 1956

(Plate II, figure 6)

1956. Buchanathyris westoni, Talent. Proc. Roy. Soc. Victoria, New Ser. vol. 68, pg. 37.
1956. Buchanathyris, Talent. Proc. Roy. Soc. Victoria, New Series vol. 68, pg. 36.

Diagnosis. Short, flat cardinal-plate perforated immediately inside the beak by a large foramen. Pedicle muscular impressions are poorly defined. Dental lamellae short and stout. Median septae are lacking in both valves. Beaks are small, strongly incurved.

Description. Exterior: Shell subrounded in outline, subequally biconvex. Beak small, strongly incurved, bearing a circular foramen. Pedicle valve occasionally with a shallow median sulcus. Surface ornamentation of concentric growth lines or projecting growth lamellae.

Brachial Interior: Beak with a short, flat cardinal-plate, perforated by a foramen immediately inside the beak, and giving rise anteriorly to crural processes abruptly recurved and giving rise to a pair of laterally directed spiral cones of about twelve volutions. Jugum consisting of two limbs rising ventrally, uniting, and being produced into a somewhat posteroventrally directed process. Median septum lacking.

Pedicle Interior: Hinge-teeth supported by short,

stout dental lamellae and inserted into deep dental sockets. Median septum lacking.

BUCHANATHYRIS

Species Assigned:

Buchanathyris waratahensis Talent 1956, Proc. Roy. Soc. Vict., vol. 68, pg. 39, pl. III, figs. 5-8.

Buchanathyris westoni Talent 1956, Proc. Roy. Soc. Vict., vol. 68, pg. 36, text. fig. 9.

Distribution:

AUSTRALIA

Victoria -- Buchan Caves Limestone, Jackson's Crossing Limestone, Tabberabbera and Waratah Formations; (Middle Devonian):
Buchanathyris waratahensis Talent 1956, original description.
Buchanathyris westoni Talent 1956, original description.

COMPARISON OF THE CRITICAL PROPERTIES OF THE HINDELLINAE

CARDINALIA

	Exterior	Cardinal-plate	Median Septae	Jugum	Dental Lamellae
Hindella Davidson 1882	Low pedicle sulcus apparent only over pallial region. Pedicle beak strongly incurved, brachial beak prominent. Deltidium concealed.	Concave, imperforate cardinal-plate	Brachial septum present, pedicle septum unknown.	Whitfieldellid but very far forward and with depressed form.	Strong dental lamellae.
Whitfieldella Hall & Clarke 1893	Both valves faintly sulcate anteriorly. Pedicle beak not high or greatly incurved.	Concave, imperforate cardinal-plate.	Brachial septum present, pedicle septum unknown.	Whitfieldellid	Unknown
Greenfieldia Grabau 1910	Pedicle valve with shallow median sulcus; pedicle beak slightly incurved. Brachial beak scarcely elevated above hinge-line.	Medially divided cardinal-plate.	Brachial septum lacking, pedicle unknown.	Unknown	Prominent dental lamellae.

COMPARISON OF THE CRITICAL PROPERTIES OF THE HINDELLINAE

	CARDINALIA				
	Exterior	Cardinal-plate	Median Septae	Jugum	Dental Lamellae
Hyattidina Schuchert 1913	Shell small compactly subpentagonal; pedicle valve with strong median sulcus and two faint lateral sulci. Acutely incurved pedicle beak conceals most of deltidium.	Triangular cardinal-plate divided by deep narrow groove.	Brachial septum lacking, pedicle unknown.	Whitfieldellid	Strong dental lamellae.
Cryptothyrella Cooper 1942	Smooth surface, beaks small, strongly incurved; brachial beak fitting into the concave deltidium.	Divided cardinal-plate.	Brachial septum present, pedicle septum lacking.	Whitfieldellid	Long, divergent dental lamellae; large, deep, triangular pedicle muscle field.
Buchanathyris Talent 1956	Pedicle valve occasionally with a shallow median sulcus. Beaks small, strongly incurved.	Flat, foraminate cardinal-plate	Median septae lacking in both valves	Whitfieldellid	Short, stout dental lamellae.

Family UNCITIDAE McCoy 1855

Subfamily UNCITINAE McCoy 1855

(Plate II, figure 7)

1825. Uncites, Defrance.
1855. Uncitidae, McCoy. British Palaeozoic Fossils, page 380.
1883. Uncitinae, Waagen. Salt-Range Fossils, I, page 494.
1894. Uncitinae, Schuchert. American Geologist, 13, page 105.
1913. Uncitidae (Waagen); Schuchert. Zittel Text-Book Pal., page 413.
1929. Uncitidae (Waagen), Schuchert & LeVene. Cat. Foss. Brachiopoda, page 22.
1955. Uncitidae (Schuchert & LeVene), Muir-Wood. Class. of Brachiopoda, page 92.

Diagnosis: Finely plicated, biconvex forms. Spiral cones laterally directed. Jugal saddle lacking; jugum forming a simple unbifurcated band, lacking stem or pointed projection. Cardinal process present or absent. Dental lamellae present or absent.

Genus UNCITES Defrance 1825

(Plate II, figure 7)

1822. Terebratulites gryphus, Schlotheim. Petrefactenkunde, pl. 19, fig. 1.
1825. Uncites, Defrance. In Blainville, Manuel de Malacologie et de Conchyliologie, pg. 630.

Diagnosis. Possesses a large, erect cardinal process and marginal cardinal pouches. Dental plates present, as is a median septum in the pedicle valve.

Comparison. In the only other associated genus, Uncinella, cardinal process and cardinal pouches are lacking.

Description. Exterior: Shells large, elongate-oval, rostrate, or subtriangular in outline, valves nearly equally convex, covered with numerous, bifurcating, radiating plications or rarely smooth. Shell substance fibrous, impunctate. The pedicle valve has a long, hollow, tapering beak which is always arched or incurved and frequently is distorted. There is no cardinal area and the hinge-line is greatly curved. There is no foramen in mature individuals though a small, oval apical foramen may be retained in young forms. The deltidium is large and concave and consists of a single piece; all trace of the original components being lost. It extends to near the cardinal edge, where it partially conceals the broad, full, closely incurved beak of the

brachial valve.

Brachial Interior: The cardinal process is large, erect and slightly bilobed on its posterior margin; it rests upon a short plate bearing two ridges which are continued into the bases of the crura. On either side of these ridges and just within the margins of the valve, is a strong, oval, concave, pouch-like plate. The crura are very long, passing into the primary lamellae without interruption. The spirals are relatively small, situated anteriorly, and consist of seven or eight volutions. These are connected by a simple erect loop, which is situated medially, and terminates at the junction of the lateral branches in a short, horizontal process.

Pedicle Interior: The teeth are supported by dental plates and between them lies a broad median ridge which narrows as it approaches the hinge.

UNCITES

Species Assigned:

Terebratulithes gryphus Schlotheim 1822.
Nachtrage Zur Petrefactenkunda. Gotha, in der Beckerschen Buchhandlung, pg. 67, pl. XIX, fig. 1 (a-c)
(=Uncites gryphoides Defrance 1825).

Distribution:

EUROPE

-- Muschel-und Schneckenverstein der Ubergangs-formation und des dazu gerigen Kalksteins; (Devonian):
Terebratulithes gryphus Schlotheim 1822, original description.

Genus UNCINELLA Waagen 1883

1883. Uncinella indica, Waagen. Palaeontologia Indica, Ser. 13, Salt-Range Fossils, vol. 1, pg. 494.
1883. Uncinella, Waagen. Palaeontologia Indica, Ser. 13, Salt-Range Fossils, vol. 1, pg. 494.

Diagnosis. Neither cardinal process nor marginal cardinal pouches are present. Dental plates and pedicle median septum are also lacking.

Comparison. In the only other associated genus, Uncites, a prominent erect cardinal process and marginal cardinal pouches are developed.

Description. Exterior: In external shape the genus resembles Retzia. No sulcus or fold is developed; the valves are finely plicated; the hinge-line is curved; the beak thick and strongly incurved, mostly appresed to the cardinal part of the brachial valve. A small distinct deltidium is present, pierced behind the apex by a large oval foramen. The apex of the brachial valve is very strongly incurved, and partly concealed under the apical part of the pedicle valve. The deltidium does not continue to the hinge-line, but is cut out for the reception of the brachial apex.

Brachial Interior: Cardinal plate and process between the dental sockets are lacking; the apex of the valve bears a flat triangular space, apparently for muscle attachment. At the valve apex two sharp ridges take their

origin, limiting the dental sockets on either side. These latter are elongated, deep, triangular grooves. The crura take their origin immediately at the apex as thin, shelly plates sloping strongly toward the midline, very nearly reaching the bottom of the valve. As far as the dental sockets extend, these crural plates are fastened to them. Lower down they become free, and then form rather broad, shelly blades, which always retain their sloping position towards the valve midline. They are sunk deeply into the interior of the valve, extending not very far from its bottom. The spiral cones have the same general disposition as in Retzia or Uncites, but neither the loop nor the mode of junction of the primary lamellae with the crura is known. It is probable that the primary lamellae form simply the continuation of the crura as in Uncites.

Pedicle Interior: Two long, ridge-like hinge-teeth extend along the curved hinge-line on both sides of the deltidium. They are not supported by dental plates, nor is there a trace of other partitions.

Stratigraphic Range: Permian.

Geographic Range: India.

Family CLEIOTHYRIDAE Boucot & Staton herein

(Plate III)

(=ATHYRIDAE Davidson 1882-84)

1841. Cleiothyris, Phillips.
1844. Athyris, McCoy.
1882-84. Subfamily Athyridae, Davidson. Gen. Sum. To Brit. Foss. Brach., page 35.
1883. Athyrinae, Waagen, Salt Range Fossils, I, page 449.
1894. Athyridae (Phillips 1841), Schuchert. American Geologist 13, page 105.
1913. Athyridae (Phillip 1841), Schuchert. Zittel Text-Book Pal., page 417.
1929. Athyridae (Phillips 1841), Schuchert & LeVene. Cat. Foss. Brachiopoda, page 22.
1955. Athyridae (Davidson 1884), Muir-Wood. Class. of Brachiopoda, page 92.
Herein. Cleiothyridae.

Diagnosis. Plicated or smooth, biconvex or plano-convex forms, often with concentric lamellar expansions. Spiral cones laterally directed. Jugum complex, typically with a well developed saddle. Jugal bifurcations always terminate between the first and second spiral volutions. Cardinal process present or lacking.

Subfamily CLEIOTHYRINAE Boucot & Staton herein

(Plate III, figures 1-5, 8)

(=ATHYRINAE Davidson 1882-84)

1841. Cleiothyris, Phillips
1844. Athyris, McCoy.
1882-84. Subfamily Athyridae, Davidson. Gen. Sum. Brit. Foss. Brach., page 354.
1883. Athyrinae, Waagen. Salt Range Fossils, I, page 450.
1894. Athyrinae, Schuchert. American Geologist, 13, page 106.
1913. Athyrinae, Schuchert. Zittel Text-Book Pal., page 417.
1929. Athyrinae, Schuchert & LeVene. Cat. Foss. Brachiopoda, page 22.
1955. Athyrinae, Muir-Wood. Class. of Brachiopoda, page 92.
Herein. Cleiothyrinae.

Diagnosis: Plicated or smooth, biconvex or plano-convex forms, often with concentric lamellar expansions. Spiral cones laterally directed. Jugal saddle well-developed or lacking. Jugal bifurcations always terminate between the first and second spiral volutions. Well-developed cardinal process may be present.

Genus CLEIOTHYRIS Phillips 1841

(Plate III, figure 1)

(=ATHYRIS McCoy 1844)
(=CLIOTHYRIS Agassiz 1846)
(=SPIRIGERA D'Orbigny 1847)
(=SPIRITHYRIS Quenstedt 1868)
(=EUTHYRIS Quenstedt 1869)
(=CLEIDOTHYRIS Paetel 1875)

1834. Terebratual concentrica, von Buch. Ueber Terebrateln, pg. 103.
1841. Cleiothyris, Phillips. Pal. Foss. Cornwall and Devon, pg. 55.
1844. Athyris, McCoy. A synopsis Carbon. Foss. Ireland, pgs. 128,146.
1846. Cliothyris, Agassiz. Nomen. Zool. Index Universalis, pg. 90.
1847. Spirigera, D'Orbigny. Comptes Rendus, vol. xxv, pg. 268.
1868. Spirithyris, Quenstedt. Petref. Deutsch. Bd. ii, Brachiopoden, fasc. 1, pg. 30.
1869. Euthyris, Quenstedt. Petref. Deutsch. Bd. ii, Brachiopoden fasc. 3, pg. 442.
1875. Cleidothyris, Paetel. Fam. Gatt. Moll., pg. 45.

Diagnosis. Shape variable; pedicle sulcus with brachial fold may be present; broad lamellar expansions at each growth-line. Cardinal-plate foraminate, flat or concave, subquadrate or subtriangular in outline, with lateral margins thickened and elevated. Median septae lacking; a myophragm present in each valve. Jugum with broad saddle which posteriorly narrows and bifurcates into dorsally terminating accessory lamellae.

Description. Exterior: Shell outline variable, transversely elliptical, subcircular, elongate-subovate, subquadrate or subpentagonal; shells subequally biconvex, subglobose or depressed. In the brachial valve the beak is not prominent; a median fold corresponds in strength to the sulcus of the pedicle valve. In the pedicle valve the beak is short, inconspicuous, and incurved, usually concealing the small

round foramen and deltidium of two plates; frequently, however, the former is exposed, lying contiguous to the brachial umbo. Cardinal slopes typically not well-defined. The convexity of the valve is greatest in the umbonal region, the surface sloping evenly to the sides, and becoming depressed medially into a sulcus, which is most conspicuous anteriorly. Sulcus and fold may be lacking in younger forms. The surface of the valves is variously ornamented; typically, there is a broad lamellar expansion at each concentric growth-line; occasionally this expansion is striated longitudinally, or it may be divided into flat spines, which merge into the lamella at their bases; again, the spines may be long and tubular, but connected by the lamellar expansions. The surface frequently appears to be smooth, or convered only with concentric growth-striae. Faint, indistinct radiating striae may be present. Shell substance fibrous, impunctate.

Brachial Interior: The dental sockets are broad and deep. The cardinal-plate varies considerably in form; typically, it is subtriangular in outline, and supported by stout crural plates. The median portion is flat or concave, but rarely may be thickened and convex; the lateral margins are thickened and elevated, bordering the dental

sockets. At the apex of the plate, just within the brachial beak, is a circular visceral foramen, which is continued beneath the plate into the cavity of the valve, sometimes by a cylindrical tube, which, after originating beneath the plate, extends longitudinally and freely in a slight upward curve for one-third of the valve length. The anterior margin of the plate is straight or slightly concave, occasionally trilobate, and the crura are attached at the extremities of the lateral ridges. Sometimes the outline of the cardinal-plate is rendered subquadrate by the development of two post-lateral expansions. Four pedicle muscle impression pits are found on the cardinal-plate.

The brachidium consists of spiral cones lying base-to-base, with their apices directed laterally. The form of these cones varies with that of the internal cavity, but as a rule they are much compressed vertically, the posterior curvature being short and convex, while the anterior curve is long and sometimes depressed. The crura originate from the cardinal-plate at a large angle, and are long and convergent; the primary lamellae, arising from their extremities, make an angular curve at their origin, thence, typically, curving deeply upward and backward, to form the first volution. The cones are connected

by a jugum, which takes its origin on the first half of the primary lamellae; two lateral lamellae converge, uniting at about half the distance across the base of the cones, forming a broad saddle with a convex upper surface; the anterior extremity of this saddle may be simple or divided; its posterior portion is narrowed, inclined downward or toward the beak of the brachial valve for a short distance, thence it rises abruptly toward the umbo of the pedicle valve, and bifurcates near the extremities of the crura, each branch following the curvature of the primary lamellae and continuing for only a part of the distance between the ends of the crura and the origin of the loop. The accessory lamellae vary somewhat in form, are narrower than the primary lamellae, and lie between the first and second volutions of the spiral ribbon.

The muscular area consists of a long, narrow, ovate scar, which is divided into a subquadrate posterior pair, and a subcordate anterior pair of adductor impressions. These are separated longitudinally by a very faint myophragm. On casts of the interior, the filling of the visceral foramen of the cardinal-plate frequently shows a cross-striation like that of the pedicle cavity of the opposite valve, and also indicates that the myophragm is continued throughout the extent of this passage.

Pedicle Interior: The teeth are prominent, recurved at the tips, and supported by stout dental lamellae, which are not produced anteriorly about the muscle area. Between them lies a deep, transversely striated pedicle cavity; in front of this an ovate muscular scar extends about one-half the length of the valve and is divided into flabellate diductors which are frequently very indistinct, and narrow, cordate adductors. The pallial region is covered with ovarian pittings and branching sinuses.

Stratigraphic Range: Devonian - Permian

Geographic Range: World-wide

Genus ACTINOCONCHUS McCoy (1842) 1844

(Plate III, figure 2)

1836. Spirifera planosulcata, Phillips. Geol. Yorkshire, pt. 2, pg. 220.
1842. Actinoconchus paradoxus, McCoy. In Griffith, Notice Respecting the Fossils of the Mountain Limestone of Ireland, pg. 13.
1844. Actinoconchus, McCoy. A Synopsis of the Characters of the Carboniferous Limestone Fossils of Ireland, pg. 149.

Diagnosis. Extravagant development of concentric lamellar expansions which are striated radially by distant sulci. Medium septum present in the pedicle valve.

Description. Exterior: Shell globose; the margin of both valves greatly extended, forming a flat, circular, striated disc. Characterized by the extravagant development of the concentric lamellar expansions, which are very wide, and striated radially by distant sulci about half a line apart. These expansions appear to be fine, tubular spines connected by, or imbedded in a tenuous calcareous plate.

Brachial Interior: The jugum is essentially the same as that of Cleiothyridina, though it is placed further forward. The saddle is neither divided nor pectinated, while the spiral ribbon bears marginal spinules.

Pedicle Interior: A median septum traverses the

pedicle cavity half the length of the valve. Dental plates are strong, and are continued forward, slightly diverging, for more than half the length of the septum.

Stratigraphic Range: Carboniferous

Geographic Range: Europe

Genus COMPOSITA Brown 1849

(Plate III, figure 3)

(=SEMINULA Hall & Clarke 1893)

1823. Spirifer ambiguus, Sowerby. Min. Conch., vol. 4,pg. 105.
1849. Composita, Brown. Illustr. Foss. Conch. Gt. Brit. & Ireland, pg. 131.
1893. Seminula, Hall & Clarke (non McCoy 1844). Pal. N. Y., vol. 8, pt. 2, pg. 93.

Diagnosis. Surface with no lamellar expansions; shell smooth, marked by strong pedicle sulcus and brachial fold, and concentric growth-lines. Cardinal-plate strongly developed, concave, foraminate; posteriorly developed into a process projecting into the pedicle umbonal cavity; anteriorly, erect and trilobate. Brachial median septum present, independent of cardinal-plate.

Description. Exterior: Shell small, subovate to subpentahedral in outline, often elongate or ficiform; valves biconvex, the pedicle valve with a strong anterior sulcus and the brachial valve with a corresponding fold. Both sulcus and fold may be divided by a sharp, narrow groove extending from the umbones to the anterior margin; frequently, there is a single, obscure lateral fold on each side of both valves. The pedicle beak is incurved and the deltidial area is usually concealed; the foramen, however, is exposed as a circular or ovate aperture which encroaches on the umbonal region of the valve. The hinge-line is very short. Surface of the valves smooth; that is, with sharp concentric

striae only, which are never produced into lamellae.

Brachial Interior: The cardinal-plate is highly developed; its upper face is subquadrate in outline, concave on the surface, the concavity deepening toward the visceral foramen which lies just beneath the beak; not infrequently the foramen is closed by testaceous secretions. The posterior flanges of the plate pass beyond the hinge-line and into the umbonal cavity of the opposite valve. The anterior face of the plate is erect and the anterior edge somewhat trilobed, the lateral lobes bearing the crural bases. The crura are straight, and their attachment to the primary lamellae is similar to that of Cleiothyridina. The primary lamellae, on the umbonal curve, are broad, the loop usually situated posteriorly. The saddle of the loop is often bilobed on its anterior margin, and frequently both it and the outer margins of the accessory lamellae are fimbriated. The posterior narrowing and bifurcation of the saddle is similar to that of Cleiothyris.

The muscular impressions of this valve are very narrow, and subdivided into two pairs of elongate scars. The members of the posterior pair are divided by a median septum or ridge, which begins beneath, though it does not support, the cardinal-plate. Branching vascular sinuses are

sometimes retained over the pallial region.

Pedicle Interior: The diductor muscular impressions are very faintly defined; the adductor and pedicle impressions are as in the typical forms of Cleiothyris, as are the dental lamellae. Branching vascular sinuses are sometimes retained over the pallial region.

Stratigraphic Range: Carboniferous - Permian

Geographic Range: North America, Europe, Australia

Genus CLAVIGERA (Hector 1878) Thomson 1913

(=HECTORIA Trechmann 1918)

1878. Clavigera, Hector. Trans. N. Zealand Institute, vol. 11, pg. 538.
1913. Clavigera bisulcata, Thomson. N. Zealand Geol. Surv., Pal. Bull. 1, pg. 49.
1918. Hectoria, Trechmann (non Castelnau 1873 Pisces). Quart. Jour. Geol. Soc., vol. lxxiii, pg. 216.

Diagnosis. Equally biconvex, with long, straight hinge-line as in Spirifer. Lamellar concentric growth lines lack expansions; shells strongly bisulcate.

Description. Exterior: Possesses a lamellar shell structure as in Cleiothyris, but lamellar expansions are lacking. Pedicle beak incurved, foraminate. There is a distinct area and fissure under the pedicle beak, and a long, straight hinge-line, in which respect it resembles Spirifer. Valves almost equally convex, and both are strongly sulcate medially.

Brachial Interior: "Strong, stud-shaped cardinal boss, which in the cast gives rise to a singular hood-like process.....," Hector. Cardinal-plate apparently subovate, concave, divided by a narrow groove. The apices of the spiral cones are central and directed to the middle of the lateral margins.

Pedicle Interior: Unknown.

Stratigraphic Range: Triassic

Geographic Range: New Zealand

Genus SPIRIGERELLA Waagen 1883

(Plate III, figure 4)

1883. Spirigerella derbyi, Waagen. Salt-Range Brachiopoda, pg. 450.
(=Athyris subtilita Derby (non Hall). Bull. Cornell Univ., vol. 1, no. 2, pg. 7, pl. 1, fig. 7).

1883. Spirigerella, Waagen. Salt Range Fossils, Productus Limestone Fossils, Brachiopoda Palaeont. Indica, Series 13, pt. 1, pg. 450.

Diagnosis. Surface lacking lamellar expansions; smooth, or with sharp, concentric growth-lines; subplano-convex, with a broad, flat pedicle sulcus and considerably elevated brachial valve. Strong, high, foraminate cardinal-plate, similar to that of Composita. Posteriorly situated jugum similar to that of Actinoconchus, but bearing a median septum on the saddle summit.

Description. Exterior: Shell outline elongate, or transverse; subplano-convex, with the pedicle valve depressed by a broad, flat sulcus, and the brachial valve considerably elevated. The cardinal slopes are strongly developed. The surface is smooth, or with sharp, concentric growth-lines, which are not produced into lamellae or spines. The strongly incurved and pointed pedicle beak is appressed to the brachial beak, so that the very small apical pedicle foramen is entirely concealed. This foramen leads to a long narrow canal. Below the foramen and between the hinge-teeth extends a deeply-excavated triangular space,

which serves for the reception of the brachial beak. This space is occupied by a concave deltidium which limits the foramen at its lower side, and under which passes the canal forming the continuation of the foramen. The deltidium is grown together with the substance of the shell, except at its lower end, where the canal opens within the valve, and the deltidium is free for a short distance. The substance of the pedicle valve is generally extremely thick and heavy in the cardinal region.

Brachial Interior: The cardinal-plate is very large, and extends over a large portion of the apex of the brachial valve. It takes its origin on the bottom of the brachial valve in two thick shelly pieces, further up in which the dental sockets are excavated. The anterior face of the plate is erect, and the upper face is concave and subquadrate in outline. Between the supporting pieces, below the concave plate, a conical groove is enclosed, with its apex directed towards the apex of the valve. This groove tapers very quickly and terminates in a round foramen, forming the entrance to a very narrow canal, which pierces the substance of the whole cardinal-plate, and terminates directly at the apex of the brachial valve forming a visceral foramen. This foramen is entirely

concealed if the cardinal-plate is complete, and opens in a deep fissure which separates the projecting cardinal-process from the apex of the brachial valve. From the dental sockets a cardinal-process passes vertically upwards, about parallel to the longitudinal axis of the shell, and forms an approximately rectangular shelly piece which projects far above the apex of the valve. On the ventral side, this shelly piece is longitudinally divided into two parts by a low, prominent, furrowed ridge, and is sometimes provided at its upper end with two large, round, deeply-excavated grooves. On the dorsal side, only a median longitudinal furrow is present.

The crura originate between the dental sockets at the base of the cardinal-process. The points of insertion are sometimes connected by a sharp transverse ridge, sometimes not. The crura are straight and comparatively long. They are joined by the primary lamellae of the spiral cones at an acute angle. The lamellae then curve around in a sickle-shaped arc and descend to the point where the jugum takes its origin, posteriorly, on their upper third. Two short lamellae curve towards the midline, where they unite in a broad, roof-shapped saddle. From the upper apical part of this saddle a shelly lamella

starts in a direction towards the ventral valve. It is apparently variably developed in different species, being typically broadly lamellar, in the form of a septum. The saddle is entire on its anterior margin, and the median septum on its summit extends from this anterior edge to the stem bifurcations, which are similar to those seen in Actinoconchus, and of a normal size. The spiral cones are large, and fill the greater part of the interior of both valves. They are laterally directed.

Pedicle Interior: Unknown

Stratigraphic Range: Permian

Geographic Range: South America, India

Genus AMPHITOMELLA Bittner 1890

(Plate III, figure 5)

1843. Terebratula hemisphaeroidica, Klipstein. Ostl. Alp., pg. 222.
1890. Amphitomella, Bittner. Abh. K. K. Geol. Reichsanst., vol. 14, pgs. 298, 303.

Diagnosis. Surface smooth; cardinal-plate strong, divided. Brachial and pedicle septae join together to form a single large median partition. The jugum is simple, posteriorly situated; it lacks a saddle, and the bifurcations extend nearly the entire length of the primary lamellae.

Description. Exterior: Smooth shells. Brachial beak drawn up high into the pedicle beak.

Brachial Interior: A very strong double cardinal-plate is present. A median septum extends the entire length of the shell and divides the cavity into two chambers. This joins with the median septum of the opposite valve to form a large single median partition. Jugum situated posteriorly; saddle scarcely developed. The accessory lamellae extend for nearly the entire length of the first volution of the primary lamellae; terminating, as in Cleiothyris, nevertheless, between the first and second volutions. Spiral cones simple.

Pedicle Interior: Median septum uniquely developed, as mentioned above.

Stratigraphic Range: Triassic

Geographic Range: Austrian Alps

Genus POMATOSPIRELLA Bittner 1892

1892. Spirigera (Pomatospirella) thecidium, Bittner. Abh. K. K. Geol. Reichsanst., vol. 17, pg. 26.
1892. Pomatospirella, Bittner. Abh. K. K. Geol. Reichsanst., vol. 17, pg. 26.

Diagnosis. Shell plano-convex, with a straight hinge-line. Surface smooth; pedicle valve sulcate, brachial valve with anterior fold.

Description. Exterior: Shells small, having the contour of Dayia or Cyclospira. Valves plano-convex; the brachial valve flat and the pedicle valve highly convex. The hinge-line is long, taking up two-thirds of the shell width, and almost straight. The pedicle beak is incurved, formaninate; cardinal area absent. The pedicle valve has a median sulcus extending from the beak, which becomes moderately deep and remains fairly narrow. The brachial valve shows an indistinct anterior fold. Shells smooth, with very weak concentric growth-lines; fibrous. The fibers converge with bilateral symmetry towards the midline.

Brachial Interior: Unknown.

Pedicle Interior: Unknown.

Stratigraphic Range: Triassic

Geographic Range: Austrian Alps

Genus ANATHYRIS Von Peetz 1901

1841. Spirifera phalaena, Phillips. Pal. Foss. Cornwall, pg. 71.
1901. Anathyris, Von Peetz. Trav. Sect. Geol. St. Petersb., vol. 4, pgs. 134, 378.

Diagnosis. Shell externally bisulcate. The foraminate, concave cardinal-plate is supported by a pair of stout septae which are anteriorly free from the valve bottom. Median septae are lacking in both valves; a short, low myophragm is present in the brachial valve only.

Description. Exterior: Forms having a straight hinge-line and a distinct "hidden" pedicle "linking" area under the beak of the brachial valve. The other characters are typically Cleiothyrid, although the brachial valve is sulcate. The pedicle beak is foraminate; the deltidium composed of two conjunct plates.

Brachial Interior: Median septum lacking, although a weak, short myophragm is developed. The foraminate, concave cardinal-plate is supported by a pair of long, stout, crural septae which are anteriorly free from the valve bottom. The spiral cones are laterally directed, and typical of the subfamily. The nature of the jugum is unknown.

Pedicle Interior: The teeth are stout, and supported

by short and thin, but nevertheless well developed, dental lamellae. A median septum is lacking.

ANATHYRIS

Species Assigned:

Anathyris alejensis Comte 1938
Annales de Paleontologie, Tome 27, pg. 43, pl. 4, figs. 11, 11a-b, 12, 12a.

Terebratula Ezquerra Verneuil & d'Archiac 1845
Bull. Soc. Geol. France (2)2, pg. 467, pl. 14, fig. 5(a-d).

Anathyris Helmersenii Buch 1840.
Archiv. fur Mineralogie, Geognosie, Bergbau und Huttenkunde for 1841, pg. 59.

Spirifera phalaena Phillips 1841.
Palaeozoic Fossils of Cornwall, Devon, and West Somerset, pg. 71, pl. 28, fig. 123.

Anathyris trapezoidalis Von Peetz 1901.
Trav. Sect. Geol. St. Petersb., vol. 4, pg. 141.

Distribution:

EUROPE

Great Britain -- In South Devon, at Hope, near Torquay; (Eifelian):
Spirifera phalaena Phillips 1841, original description.

Northern Spain -- Upper Santa Lucia Limestones; (Devonian):
Anathyris alejensis Comte 1938, original description.

-- Pordetras de la Pena, between Ferrones and Boniellas (Asturies), and at Nehou (Manche); (Devonian):
Terebratula Ezquerra Verneuil & d'Archiac, original description.

Russia -- Gebirgsformationen (Devonian):
Terebratula Helmersenii Buch 1840, original description.

Genus COMELICANIA Frech 1901

1878. Athyris megalotis, Stache. Jahrb. Geol. Reichsanst., vol. 28, pl. 6, fig. 1.
1901. Comelicania, Frech. Lethaea Geogn., Leth. Pal., vol. 2, pt. 3, pg. 551.

Diagnosis. Large, biconvex shells; decidedly alate, as in Spirifer. Angulated sulci in both valves.

Description. Exterior: Large, smooth, decidely alate Cleiothyrids with angulated sulci in both valves. The brachial beak is flat and low; pressed to the deltidial region of the pedicle valve; area completely lacking. These forms closely resemble Anathyris, but have little development of the anterior ribs and have sharply pointed wing-ends. The sulcus is poorly developed and limited laterally.

Brachial Interior: Unknown.

Pedicle Interior: Unknown.

Stratigraphic Range: Upper Permian

Geographic Range: Austrian Alps

Genus JANICEPS Frech 1901

1878. Athyris peracuta, Stache. Jahrb. Geol. Reichsanst., vol. 28, pl. 6, fig. 4.
1901. Janiceps, Frech. Leth. Geogn., Leth. Pal., vol. 2, pt. 3, pg. 551.

Diagnosis. Small, sharply triangular Cleiothyrids with angulated sulci in both valves.

Description. Exterior: Small, sharply triangular Cleiothyrids with angulated sulci in both valves.

Brachial Interior: Unknown

Pedicle Interior: Unknown

Stratigraphic Range: Upper Permian

Geographic Range: Austrian Alps

Genus CLEIOTHYRIDINA Buckman 1906

(Plate III, figure 2)

(=CLEIOTHYRIS King 1850)
(=CLIOTHYRIS Hall & Clarke 1893)

1858. Athyris royssii, Davidson. Monograph Brit. Carb. Brach., pg. 84.
1850. Cleiothyris, King (non Phillips 1841). A Monogr. of the Permian Fossils of England, Pal. Soc.,pg. 137.
1893, Cliothyris, Hall & Clarke. Pal. N. Y., vol. 8, pt. 2, pg. 90.
1906. Cleiothyridina, Buckman. Ann. Mag. Nat. Hist., ser. 7, vol. 18, pg. 324.

Diagnosis. Surface bearing broad, thin, lamellar expansions in concentric rows, which are divided into long, flat spinules. Pedicle sulcus and brachial fold may be well-developed or obsolete. Cardinal-plate narrow and acutely triangular.

Description. Exterior: Shells small to large, varying in outline from transversely elliptical to subcircular or longitudinally ovate lenticular, subequally biconvex. Pedicle median sulcus and brachial fold may be either well developed or obsolete. Pedicle beak small, usually incurved so as to conceal the circular foramen and delthyrium in mature shells. The surface ornamentation consists of concentric rows of broad, thin, lamellar expansions which are divided nearly to their bases, into long, flat spinules.

Brachial Interior: The cardinal-plate is narrow and rather acutely triangular. The primary lamellae are attached to the crura not only at their apices but for a short distance along their inner faces, not making the nooses peculiar to Cleiothyris proper; they are broad and blade-like, narrowing beyond the insertion of the jugum. The jugum is situated posteriorly; the accessory lamellae are narrow near their origin, broaden and then taper again, having the shape of a sickle. The spiral ribbon is pectinated on all its outer edges.

Pedicle Interior: The dental lamellae and muscle scars are similar to those of Cleiothyris.

Stratigraphic Range: Carboniferous and Permian

Geographic Range: World-wide

Genus PROTATHYRIS Kozlowski 1929

(Plate III, figure 6)

1929. Protathyris praecursor, Kozlowski. Palaeont. Polonica, T. I, pg. 224.
1929. Protathyris, Kozlowski. Palaeontologia Polonica, T. I, pgs. 30, 223.

Diagnosis. Externally and internally resembling Cleiothyris; distinguished by a simple jugum which possesses no saddle, and whose bifurcations terminate at the postero-dorsal curvature of the primary lamellae.

Description. Exterior: Closely resembles Cleiothyris.

Brachial Interior: The structure of the cardinalia, the mode of union between the crura and the primary lamellae, and the nature of the muscular impressions are all very similar to those of Cleiothyris. The jugum, however, lacks the characteristic saddle, so that the converging jugal branches immediately give rise to a narrow, median stem, which bifurcates as usual. The accessory lamellae, however, extend, paralleling the umbonal coils of the primary spiral lamellae, and then, rather than extend dorsally, stop more or less at the place where the primary lamellae curve anteriorly.

Pedicle Interior: Similar to that of Cleiothyris.

PROTATHYRIS

Species Assigned:

Terebratula didyma Dalman 1828, K. Svenska Vet.-Akad. Handl., for 1827, pg. 62, tab. 6, fig. 7.

Protathyris infantile Kozlowski 1929, Pal. Palonica, T.-I, pg. 230, pl. XI, fig. 47.

Protathyris praecursor Kozlowski 1929, Pal. Palonica, T.-I, pg. 224, text fig. 83-85; pl. XII, fig. 41-46.

Distribution:

EUROPE

Podolia -- Borszczow and Czortkow Formations; (Lower Gedinnian):
Protathyris praecursor Kozlowski 1929, original description.

-- Dzwinogrod Formation (between Dzwinogrod and Wolkowce); (Silurian-Devonian):
Protathyris infantile Kozlowski 1929, original description.

Gotland -- (Silurian):
Terebratula didyma Dalman 1828, original description.

Genus PRADOIA Comte 1938

1845. Terebratula toreno, Verneuil & d'Archiac. Bull. Soc. Geol. France (2), 2, pg. 460.
1938. Pradoia, Comte. Annales de Paleontologie, t. 27, pg. 43.

Diagnosis. Externally similar to Anathyris, but lacking the regular, concentric lamellose striae. The surface is covered with delicate papillae, and marked by poorly developed radial ribs which are most prominent on the folds which limit the angulated sulci. Valves bisulcate, bearing either one or three sulci on each valve.

Description. Exterior: Externally similar to Anathyris. Outline distinctly subpentagonal. Pedicle beak thin, incurved; perforated by a large circular foramen. Deltidium and area lacking. Forms may have a shallow median sulcus on each valve, bordered by two lateral folds which diverge from the beak and become progressively obliterated; or the medial sulci may be more pronounced, with the more prominent folds separated from the hinge-line by sulci, making each valve trisulcate. The shells are correspondingly sulcate or elevated on each valve. The median sulci and folds are marked from beak to anterior margin by a variable number of fine radiating ribs, which occasionally bifurcate. The surface is rugose, with numerous low, round, compact papillae. Concentric lamellose striae are lacking, although irregular concentric growth

lines are occasionally observed near the beaks.

Brachial Interior: Unknown

Pedicle Interior: Unknown

PRADOIA

Species Assigned:

Terebratula Collettii Verneuil 1850, Bull. Soc. Geol. France (2), 7, pg. 173, pl. 3, fig. 9 (a-b).

Terebratula Toreno Verneuil&Archiac 1845, Bull. Soc. Geol. France (2), 2, pg. 469, pl. 14, fig. 8 (a-d).

Distribution:

EUROPE

Spain -- Sabero (Leon); (Upper Emsian):
Terebratula Collettii Verneuil 1850, original description.

-- Ferrones (Asturies); (Upper Emsian):
Terebratula Collettii Verneuil 1850, original description.
Terebratula Toreno Verneuil&Archiac 1845, original description.

Genus TRIATHYRIS Comte 1938

1850. Terebratula mucronata, Verneuil. Bull. Soc. Geol. France (2), 7, pg. 171.
1938. Triathyris, Comte. Annales de Paleontologie, t. 27, pg. 45.

Diagnosis. Each valve bears a median ridge which is prolonged anteriorly into a pronounced pointed projection.

Description. Exterior: Forms somewhat similar to Cleiothyris and Pradoia, but uniquely marked by a median ridge on each valve. These ridges are projected beyond the anterior margin forming a sharply pointed, conical process. They have in common with Pradoia the absence of area, and papillar rugosity of the test, but they are never marked by radial ribs. The pedicle beak is thin, rather long, and pierced by a small foramen; deltidium present. Shells biconvex, thickened in the umbonal region; outline subrounded to subquadrangular.

Brachial Interior: Unknown.

Pedicle Interior: Unknown.

TRIATHYRIS

Species Assigned:

Terebratula mucronata Verneuil 1850, Bull. Soc. Geol. France (2), 7, pg. 171, pl. 3, fig. 6 (a-c).

Species Rejected:

Terebratula bordiu Verneuil 1850, apparently a punctate terebratuloid.

Terebratula Schultzii Verneuil 1850, apparently a punctate terebratuloid.

Distribution:

EUROPE

Spain -- Sabero (Leon); (Upper Emsian):
Terebratula mucronata Verneuil 1850, original description.

COMPARISON OF THE CRITICAL PROPERTIES OF THE SUBFAMILY CLEIOTHYRINAE

	EXTERIOR		CARDINALIA		
	Outline	Surface	Cardinal Plate	Median Septae	Jugum
CLEIOTHYRIS Phillips 1841	*Cleiothryid. Biconvex	Cleiothyrid	Cleiothyrid	Median septae lacking; a myophragm present in each valve	Cleiothyrid
ACTINOCONCHUS McCoy (1842) 1844	Cleiothyrid Biconvex	Extravagant development of concentric lamellar expansions, which are striated radially by distant sulci	Unknown	Pedicle median septum present; brachial unknown	Cleiothyrid
COMPOSITA Brown 1849	Cleiothyrid Biconvex	Surface with no lamellar expansions; shell smooth marked by pedicle sulcus and brachial fold, concentric lines of growth	Strongly developed, concave foraminate, cardinal-plate, posteriorly developed into a process projecting to the pedicle umbonal cavity, and anteriorly erect, trilobate	Brachial median septum present independent of cardinal-plate; pedicle unknown	Cleiothyrid

	Outline	Surface	Cardinal Plate	Median Septae	Jugum
CLAVIGERA (Hector 1878) Thomson 1913	Long, straight hinge-line as in Spirifer biconvex	Lamellar concentric growth lines lacking expansions, strongly bisulcate	Unknown	Unknown	Unknown
SPIRIGERELLA Waagen 1883	Cleiothyrid Subplano-convex	Surface lacking lamellar expansions; smooth, or with sharp, concentric growth-lines; broad flat pedicle sulcus and considerably elevated brachial valve	Strong, high, foraminate cardinal-plate similar to that of Composita	Unknown	Posteriorly situated jugum similar to that of Actinoconchus but bearing a median septum on the saddle summit
AMPHITOMELLA Bittner 1890		Surface smooth. Pedicle valve sulcate, brachial valve with anterior fold	Strong divided cardinal plate	Brachial and pedicle median septae join together to form a single large median partition	Posteriorly situated simple jugum lacking saddle, with bifurcations extending nearly the entire length of the primary lamellae.

	Outline	Surface	Cardinal Plate	Median Septae	Jugum
POMATOSPIRELLA Bittner 1892	Cleiothyrid. Hinge-line straight, plano-convex	Surface smooth. Pedicle valve sulcate, brachial valve with anterior fold	Unknown	Unknown	Unknown
ANATHYRIS Von Peetz 1901	Cleiothyrid Biconvex	Cleiothyrid, Bisulcate	Foraminate concave cardinal-plate supported by a pair of stout septae which are anteriorly free from valve bottom	Septae lacking in both valves. Low myophragm in brach. valve only.	Unknown
COMELICANIA Frech 1901	Large, biconvex, decidedly alate as in Spirifer	Angulated sinuses in both valves	Unknown	Unknown	Unknown
JANICEPS Frech 1901	Small, sharply triangular; biconvex	Angulated sinuses in both valves	Unknown	Unknown	Unknown

	Outline	Surface	Cardinal-Plate	Median Septae	Jugum
CLEIOTHYRIDINA Buckman 1906	Cleiothyrid Biconvex	Surface bearing broad thin, lamellar expansions in concentric rows, which are divided into long, flat spinules. Pedicle sulcus and brachial fold obsolete or well-developed	Cardinal-plate narrow and acutely triangular	Unknown	Cleiothyrid
PROTATHYRIS Kozlowski 1929	Cleiothyrid Biconvex	Cleiothyrid	Cleiothyrid	Unknown	Simple jugum with no saddle bifurcations terminate at the postero-dorsal curvature of the primary lamellae

	Outline	Surface	Cardinal-plate	Median Septae	Jugum
PRADOIA Comte 1938	Cleiothyrid Biconvex	Regular concentric lamelose striae lacking. surface covered with delicate papillae, marked by poorly developed radial ribs, bisulcate	Unknown	Unknown	Unknown
TRIATHYRIS Comte 1938	Cleiothyrid Biconvex	Each valve bears a median ridge which is prolonged anteriorly into a pronounced pointed projection	Unknown	Unknown	Unknown

Subfamily TETRACTINELLINAE Boucot & Staton herein

(Plate III, figures 6 and 7)

1890. Tetractinella, Bittner.
Herein. Tetractinellinae.

Diagnosis: Strongly plicated, biconvex forms. Concentric lamellar expansions never present. Spiral cones laterally directed. Jugal saddle, if present, is poorly developed. Accessory lamellae always terminate between the first and second spiral volutions. Cardinal process lacking.

Genus TETRACTINELLA Bittner 1890

(Plate III, figure 7)

1820. Terebratulites trigonellus, Schlotheim. Petref., pg. 271 (pars); 1834, in Von Buch, Terebrateln, pg. 83.
1890. Tetractinella, Bittner. Abh. K. K. Geol. Reichsanst., vol. 14, pgs. 300, 303.

Diagnosis. Retzioid rather than cleiothyrid in outline, with four corresponding ribs on each valve. Spiral cones with eleven close volutions. Jugum very large, having an upright cleiothyrid stem with typical bifurcations, but lacking a well developed saddle.

Description. Exterior: Forms with sloping shoulders, retzioid rather than cleiothyrid in outline, and bearing on the surface four sharp plications, which, at the margin, are opposite, not alternate.

Brachial Interior: Simple spiral cones, laterally directed, composed of eleven close volutions. Jugal branches erect, uniting in a very large, elongate, narrow, stem-like saddle which is nearly vertical. Short accessory lamellae bifurcate from the posterior extremity of the jugum.

Pedicle Interior: Dental plates present.

Stratigraphic Range: Triassic

Geographic Range: Austrian Alps

Genus PENTACTINELLA Bittner 1890

1841. Terebratula quinquecostata, Munster. Geogn. Petref. Sudostl. Tirols, 4, pg. 59.

1890. Pentactinella, Bittner. Abh. K. K. Geol. Reichsanst., vol. 14, pgs. 300, 302-3.

Diagnosis. Retzioid rather than cleiothyrid in outline, with five corresponding ribs on each valve. Interior unknown.

Description. Exterior: Very similar to Tetractinella. Forms with sloping shoulders, retzioid rather than cleiothyrid in outline, and bearing on the surface five sharp plications, which, at the margin, are opposite, not alternate.

Brachial Interior: Unknown

Pedicle Interior: Unknown

Stratigraphic Range: Triassic.

Geographic Range: Austrian Alps.

Genus ANOMACTINELLA Bittner 1890

1841. Terebratula flexuosa, Munster. Geogn. Petref. Sudostl. Tirols, 4, pg. 59.

1890. Anomactinella, Bittner. Abh. K. K. Geol. Reichsanst., vol. 14, pgs. 300, 302-3.

Diagnosis. Retzioid rather than cleiothyrid in outline, with many corresponding ribs on each valve. Spiral cones with seven to eight volutions.

Description. Exterior: Forms with sloping shoulders, retzioid rather than cleiothyrid in outline, and bearing on the surface many plications sharply developed toward the margin, where they are opposite, not alternate.

Brachial Interior: Simple spiral cones having seven to eight coils. Jugum typically cleiothyrid, with accessory lamellae not extended, but limited to the beginning of the first primary volution.

Pedicle Interior: Unknown

Stratigraphic Range: Triassic.

Geographic Range: Austrian Alps.

Genus STOLZENBURGIELLA Bittner 1903

1903. Spirigera bukowskii, Bittner. Jahrb. Geol. Reichsanst., vol. 52, pg. 508.
1903. Stolzenburgiella, Bittner. Jahrb. Geol. Reichsanst., vol. 52, pg. 508.

Diagnosis. Forms marked by many corresponding ribs. Pedicle valve sulcate, with corresponding median brachial fold bearing four ribs. Shells appear externally similar to the Rhynchonella. Brachial median septum lacking.

Description. Exterior: Externally very similar to Rhynchonella having many low, thin, sharp ribs. These correspond on each valve and number 25-27 in large specimens. The shell outline, especially in the ratio of length to width, is variable. The pedicle valve is marked by a low median sulcus, produced anteriorly in a tongue-like projection. The brachial valve bears a corresponding fold. Only on young specimens is the anterior commissure straight; that of adults being strongly curved by the sulcus and fold. The brachial fold bears four ribs. The pedicle beak is low, little developed, and perforated by a foramen. The shell is fibrous, and the valves vary little in thickness.

Brachial Interior: A median septum is lacking. The primary lamellae are very thin, and the spiral cones have only a few coils. It is known that extended accesory

lamellae are lacking, but the nature of the jugum is unknown.

Pedicle Interior: Unknown

Stratigraphic Range: Triassic

Geographic Range: Austrian Alps

Genus MISOLIA Von Seidlitz 1913

(Plate III, figure 8)

1913. Misolia misolica, Von Seidlitz. Palaeontographica, Suppl. 4, Abt. 2, 1913-1914, pg. 179.
1913. Misolia, Von Seidlitz. Palaeontogr., Suppl. 4, Abt. 2, 1913-14, pg. 172.

Diagnosis. Marked by many alternating ribs. Jugum forming an anteriorly directed spike-like process, with the bifurcations arising posteriorly from the converging jugal branches before they unite; the stem and accessory lamellae forming a "V".

Description. Exterior: Oval, elongate, or pentagonal in outline; length exceeds width. Valves biconvex, strongly plicated by many alternating radial ribs; may exhibit either a brachial fold and pedicle sulcus, or a pedicle fold and brachial sulcus. Anterior commissure sinuate, hinge-line straight. Area weak and poorly visible, hidden by a strongly incurved pedicle beak, which is perforated by a large foramen. A divided deltidium is present. Shells fibrous, impunctate; adults marked by concentric growth-lines.

Brachial Interior: Well developed median septum present. Jugum forms an anteriorly directed spike-like

process. The jugal bifurcations, instead of arising from this process, arise posteriorly from the converging jugal branches before they unite. Consequently, the stem and accessory lamellae form a "V".

Pedicle Interior: Well developed median septum is formed by straw-shaped dental lamellae that diverge from the beak, and then converge in the midline. Muscle scars are weak, shallow.

Stratigraphic Range: Triassic

Geographic Range: Indonesia

COMPARISON OF THE CRITICAL PROPERTIES OF THE TETRACTINELLINAE

	EXTERIOR	SPIRAL CONES	JUGUM
TETRACTINELLA Bittner 1890	Four corresponding ribs on each valve.	Eleven close volutions	Very large; having an upright cleiothyrid stem with typical bifurcations, but lacking a well-developed saddle.
PENTACTINELLA Bittner 1890	Five corresponding ribs on each valve.	Unknown	Unknown
ANOMACTINELLA Bittner 1890	Marked by many corresponding ribs sharply developed towards the margin.	Seven to eight volutions	Unknown
STOLZENBURGIELLA Bittner 1903	Rhynchonellid in appearance, marked by many corresponding ribs. Median brachial fold bears four ribs.	Spiral cones composed of only a few volutions.	Unknown

COMPARISON OF THE CRITICAL PROPERTIES OF THE TETRACTINELLINAE

	EXTERIOR	SPIRAL CONES	JUGUM
MISOLIA Von Seidlitz 1913	Marked by many, alternating ribs.		Jugum forming an anteriorly directed spike-like process with the bifurcations arising posteriorly from converging jugal branches before they unite; the stem and accessory lamellae forming a "V".

Subfamily ATHYRISININAE Grabau 1931

1920. Athyrisina, Hayasaka.
1931. Athyrisininae, Grabau. Dev. Brach. of China, I, pg. 509.
1955. Athyrisininae (Grabau 1936), Muir-Wood. Class. of Brachiopoda, pg. 92.

Diagnosis: Strongly plicated, biconvex forms, with irregular lamellar concentric growth lines. Spiral cones laterally directed.

Genus ATHYRISINA Hayasaka 1920

1920. Athyrisina squamosa, Hayasaka. Geograph. Research in China 1911-16, Tokyo Geog. Soc. Rept., 1920, pg. 179.
1920. Athyrisina, Hayasaka. Geograph. Research in China 1911-16, Tokyo Geog. Soc. Rept., 1920, pg.179.

Diagnosis. An impunctate form, morphologically resembling genera of the Rhynchospiridae; marked by many coarse radial ribs. Hinge-line is straight and very short. Pedicle beak foraminate; area lacking. Strong pedicle sulcus and brachial fold present.

Description. Exterior: Shells biconvex, pedicle valve somewhat exceeding the brachial in gibbosity. The outline is Cleiothyrid, being transversely elliptical to obtusely rhombic; width exceeds length. Hinge-line straight and very short. Pedicle valve has its greatest convexity in the umbonal region. Pedicle beak incurved, obtusely pointed, slightly over-hanging the hinge-line; it is truncated by a circular foramen. A distinct, deep and narrow sulcus begins in the umbonal region, gradually widening anteriorly, ending in a tongue-like projection of the anterior margin. The brachial valve bears a corresponding fold. The brachial beak is very low and strongly incurved, so that it is hidden beneath that of the opposite valve. Cardinal area is indistinguishable or but slightly developed. The surface of both valves is ornamented with coarse radial ribs that seldom increase on the lateral portions. In the sulcus or on the fold the ribs are some-

what less distinct and less prominent; intercalation and bifurcation take place here. Many irregular, concentric growth-lines are present, of a somewhat scaly or lamellar nature. Shell substance impunctate.

Brachial Interior: Spiral cones are laterally directed; jugum unknown.

Pedicle Interior: Unknown.

ATHYRISINA

Species Assigned:

Athyrisina kochi Grabau 1931, Pal. Sinica, Series B, vol. III, fasc. 3, pg. 521, pl. 53, fig. 1.

Athyrisina minor Hayasaka 1920, Geograph. Research in China 1911-16, Tokyo Geog. Soc. Rept., pl. 23, figs. 8-12.
(=Athyrisina biplicata Grabau 1931).

Athyrisina minuta Hayasaka ,
(described in Grabau 1931, pgs. 519-21).

Retzia plicata Mansuy 1912, Etude Geologique du Yunnan Oriental Part II, pg. 43, pl. VI, figs. II (a-g).
(=Athyrisina triplicata Grabau 1931).

Athyrisina quadriplicata Grabau 1931, Pal. Sinica, Series B, vol. III, fasc. 3, pg. 523, pl. 52, fig. 11.

Athyrisina squamosa Hayasaka 1920, Geograph. Research in China 1911-16, Tokyo Geog. Soc. Rept., pg. 180, pl. 23, figs. 5, 6, 16, 17.

Athyrisina squamosa rhomboidalis Hayasaka 1920, Geograph. Res. in China 1911-16, Tokyo Geog. Soc. Rept., pg. 182, pl. 23, figs. 7 & 18.

Athyrisina uniplicata Grabau 1931, Pal. Sinica, Series B, vol. III, fasc. 3, pg. 516, pl. 52, figs. 1-4.

ATHYRISINA

Distribution:

CHINA -- Pen-chao-tse, Chao-hau-hsien, Pao-ning-fu, province Sze-chuan; (Middle Devonian):
Athyrisina squamosa Hayasaka 1920, original description.
Athyrisina squamosa rhomboidalis Hayasaka 1922, original description.

-- Ning-chiang, Han-chung-fu, province Shen-hsi; (Middle Devonian):
Athyrisina squamosa rhomboidalis Hayasaka 1922, original description.

-- Between Shang-shui-tang and Mien-tien, Nang-ning-hsien, Nan-ning-fu, province Kwang-hsi; (Middle Devonian):
Athyrisina minor Hayasaka 1922, original description.

-- Huan-wei, province Yunnan; (Middle Devonian):
Athyrisina uniplicata Grabau 1931, original description.

-- Between Yi-leng and Lou-nan, in East Yunnan; (Middle Devonian):
Retzia plicata Mansuy 1912, original description.

-- Lo-kang-tung, Lou-nan-hsien, province Yunnan; (Middle Devonian):
Athyrisina kochi Grabau 1931, original description.

-- Wangchia beds of South Kansu; (Middle Devonian):
Athyrisina quadriplicata Grabau 1931, original description.

Family DIPLOSPIRELLIDAE Schuchert 1913

(Plate IV, figures 1-4)

1890. Diplospirella, Bittner.
1894. Diplospirinae, Schuchert. American Geologist, 13, page 106.
1913. Diplospirellinae, Schuchert. Zittel Text-Book Pal, page 418.
1929. Diplospirellinae (Munier-Chalmas 1880), Schuchert & LeVene. Cat. Foss. Brachiopoda, pg. 22.
1955. Diplospirinae (Schuchert 1894), Muir-Wood. Class. of Brachiopoda, page 92.
Herein. Diplospirellidae (Schuchert 1913).

Diagnosis: Smooth or plicated, biconvex forms. Concentric lamellar expansions lacking. Spiral cones laterally directed. Jugums simple or complex, with or without saddle, occasionally with an additional jugal process which articulates with the pedicle valve. Accessory lamellae continue intercoiled with the spiral volutions to the ends of the spiral cones.

Subfamily DIPLOSPIRELLINAE Schuchert 1913

(Plate IV, figures 1-3)

(=DIPLOSPIRINAE Schuchert 1894)

1890. Diplospirella, Bittner.
1894. Diplospirinae, Schuchert. American Geologist, 13, page 106.
1913. Diplospirellinae, Schuchert. Zittel Text-Book Pal., page 418.
1929. Diplospirellinae (Munier-Chalmas 1880), Schuchert & LeVene, Cat. Foss. Brachiopoda, pg. 22.
1955. Diplospirinae (Schuchert 1894), Muir-Wood. Class. of Brachiopoda, pg. 92.
Herein. Diplospirellinae.

Diagnosis: Smooth or plicated, biconvex forms. Concentric lamellar expansions lacking. Spiral cones laterally directed. Jugums simple or complex, but never possessing a saddle or additional articulating process. Accessory lamellae continue intercoiled with the spiral volutions to the ends of the spiral cones.

Genus DIPLOSPIRELLA Bittner 1890

(Plate IV, figure 1)

1841. Terebratula wissmanni, Munster. Geogn. Petref. Sudostl. Tirols, 4, pg. 64.
1890. Diplospirella, Bittner. Abh. Geol. Reichsanst., Wien, vol. 14, pgs. 297, 303.

Diagnosis. Smooth shells with approximately 10 volutions in the spiral cones. The jugum is a narrow, postero-ventrally directed stem, formed by the union of curved lamellae arising from the primary lamellae, which bifurcates to give rise to the accessory lamellae.

Comparison. Of the associated genera, Anisactinella and Euractinella are strongly plicated, while Pexidella, which is smooth, possesses only four to five loosely coiled volutions of the spiral cones, and the jugum is formed as a crural connecting piece very similar to that of Koninckina, directly giving rise to the accessory lamellae.

Description. Exterior: Smooth, subcircular forms. Valves are biconvex, thickened.

Brachial Interior: Jugum is well developed, situated posteriorly; saddle narrow, having the form of an oblique stem, from the posterior extremity of which are given off the accessory lamellae. These are broad, serrate on the outer margin, and extend with the primary coils to their end; 10 spiral volutions in large forms.

Pedicle Interior: Unknown.

Stratigraphic Range: Triassic.

Geographic Range: Austrian Alps.

Genus PEXIDELLA Bittner 1890

(Plate IV, figure 2)

1855. Sprifer strohmayeri, Suess. Brach. Hallstatt. Schichten, pg. 27.
1890. Pexidella, Bittner. Abh. Geol. Reichsanst., Wien, vol. 14, pg. 300.

Diagnosis. Smooth forms with four to five volutions in the spiral cones. The jugum is formed as a crural connecting piece as in Koninckina, that directly gives rise to the accessory lamellae.

Comparison. Of the associated genera, Anisactinella and Euractinella are strongly plicated, while Diplospirella, which is smooth, possesses approximately 10 spiral volutions, and the jugum is a narrow, postero-ventrally directed stem, formed by the union of curved lamellae arising from the primary lamellae.

Description. Exterior: A group of exceedingly variable smooth forms with biconvex valves greatly thickened in the umbonal regions. A pedicle sulcus and brachial fold may be weakly developed, high and narrow, shallow and broad, or entirely lacking. Growth lines present, and rarely, faint radial ribs at the anterior margin.

Brachial Interior: Spiral cones are directed laterally. Jugum similar to that of Koninckina. Accessory lamellae narrow, extending for nearly the entire length of the spiral cones, whose loose coils number four to five.

Pedicle Interior: Unknown.

Stratigraphic Range: Triassic.

Geographic Range: Austrian Alps.

Genus ANISACTINELLA Bittner 1890

(Plate IV, figure 3)

1841. Terebratula quadriplecta, Munster. Geogn. Petref. Sudostl. Tirols, 4, pg. 58.
1890. Anisactinella, Bittner. Abh. Geol. Reichsanst., Wien, vol. 14, pg. 302.

Diagnosis. Forms with alternating plications. The jugum is probably similar to that of Diplospirella or Dioristella; the accessory lamellae, which are extended to the end of the spiral cones, give rise to processes in the umbonal region which return to join the jugum as in Dioristella.

Comparison. Of the associated genera, Diplospirella and Pexidella are smooth, while Euractinella, whose jugum is unknown, possesses plications which correspond in each valve.

Description. Exterior: Shells with the ribs on the valves alternating in position. Deltidium is elevated, well developed; area sharply limited.

Brachial Interior: One of the most aberrant of Alpine Triassic forms, because the accessary lamellae, which extend with the primary coils to the end of the spiral cones, also give rise to a connective process in the umbonal region which returns to join the jugum, as in Dioristella-a meristellid characteristic. Cardinal-plate well developed.

Pedicle Interior: Unknown.

Stratigraphic Range: Triassic.

Geographic Range: Austrian Alps.

Genus EURACTINELLA Bittner 1890

1841. Terebratula contraplecta, Munster. Geogn. Petref. Sudostl. Tirols, 4, pg. 59.
1890. Euractinella, Bittner. Abh. Geol. Reichsanst., Wien. vol. 14, pg. 302.

Diagnosis. Forms with corresponding plications, jugum unknown.

Comparison. Of the associated genera, Diplospirella and Pexidella are smooth, while Anisactinella has alternating plications and a highly unique jugal apparatus (see generic description on page following).

Description. Exterior: Forms with a small, strongly limited area and broad ribs separated by deep, narrow furrows, that correspond with those of the opposite valve.

Brachial Interior: Double spired.

Pedicle Interior: Unknown.

Stratigraphic Range: Triassic.

Geographic Range: Austrian Alps.

Subfamily KAYSERINAE Boucot & Staton herein

(Plate IV, figure 4)

1882 . Kayseria, Davidson.
Herein. Kayserinae.

Diagnosis: Strongly plicated biconvex forms lacking concentric lamellar expansions. Spiral cones laterally directed. Jugums complex, with a saddle, from which arises an additional jugal process which articulates with the pedicle valve. Accessory lamellae continue intercoiled with the spiral volutions to the ends of the spiral cones.

Genus KAYSERIA Davidson 1882

(Plate IV, figure 4)

1841. Orthis lens, Phillips. Pal. Foss. Cornwall, pg. 65.
1882. Kayseria, Davidson. Brit. Foss. Brach., vol. 5, pt. 1, pg. 21.

Diagnosis. Jugum with an upright ventral process continued completely across the umbonal cavity, articulating with the median ridge of the pedicle valve.

Discription. Exterior: Small shells with depressed convex or lenticular valves, radially plicated exterior, and a median plicated sulcus on both valves. impunctate.

Brachial Interior: A high, triangular median septum arises from beneath the divided cardinal-plate and reaches its greatest elevation at a point behind the center of the valve, whence it descends rather abruptly, traversing altogether about two-thirds the length of the valve. The spiral cones form sharp angles with the crura, and are directed laterally. Each spiral consists of about fourteen coils; that is, of seven principal coils, arising from the hook-shaped crura, and seven accessory coils, arising from the bifurcation at the end of the jugum. The primary lamellae, after leaving the cardinal-plate, proceed for a short distance downwards; then they suddenly bend back-

wards, forming a broad rounded curve facing the bottom of the brachial valve. At about one-third of their length they give off two short lamellae, which go straight across between the spirals, and converging, unite at a little more than half way between the brachial and pedicle side of the spirals. These lamellae bend slightly outwards before coming to their point of union, thus forming, when united, a circular opening, through the center of which the brachial septum passes. The angular apex of this septum is in close apposition to that part of the jugum where the two curved lamellae unite, and, indeed, the septum and the jugum seem to be united here. The two curved lamellae which form the commencement of the jugum are thin at their origin, but they increase in thickness until they unite, and then from the point of their union the jugum is prolonged by a single, short, stout, rounded (saddle) process in a straight or slightly upward direction across the remaining distance to the spiral edge. The accessory lamellae originate from a posterior elevation or process arising from the jugum at this point, just in front of the crural angles. The jugum is also continued, from near the point of union of the curved lamellae, into an upright simple stem which is continued completely across the umbonal cavity and comes into contact with the opposite valve,

resting upon the pedicle median ridge, or with its extremity inserted into a groove upon that ridge. The accessory lamellae thread their way from between the first and second primary volutions, between the primary coils to the end of the spiral cone. This greatly extended accessory lamella in each spiral is more narrow and delicate than is the primary ribbon, which is thickened on its inner margin.

Pedicle Interior: A low, thickened median septum is present, but otherwise the valve is devoid of pronounced peculiarities.

KAYSERIA

Species Assigned:

Orthis lens Phillips 1841.
Palaeozoic Fossils of Cornwall, Devon. and West Somerset, pg. 65, pl. 26, fig. 110 (a-b).

Distribution:

EUROPE

Great Britain -- In South Devon, at Hope near Torquay; (Eifelian):
Orthis lens Phillips 1841, original description.

Family KONINCKINIDAE Davidson 1851-55

Subfamily KONINCKININAE Davidson 1851-55

(Plate IV, figures 5 and 6)

1851-55. Koninckina, Suess.
1851-55. Koninckinidae, Davidson. Brit. Foss. Brach., vol. 1, page 92.
1882-84. Subfamily Koninckinidae, Davidson, Gen. Sum.Brit. Foss. Brach., vol. 5, page 355.
1883. Koninckininae, Waagen. Salt-Range Fossils, I, page 449.
1894. Koninckininae, Schuchert. American Geologist, 13, page 107.
1913. Koninckininae, Schuchert. Zittel Text-Book Pal., page 419.
1929. Koninckinidae (Davidson 1853), Schuchert & LeVene. Cat. Foss. Brachiopoda, page 22.
1955. Koninckinidae (Davidson 1853), Muir-Wood. Class. of Brachiopoda, page 92.
1955. Koninckininae (Waagen 1883), Muir-Wood. Class.of Brachiopoda, page 92.

Diagnosis: Smooth, concavo-convex forms lacking concentric lamellar expansions. Spiral cones ventrally directed. Jugums are simple crural connecting pieces. Accessory lamellae continue intercoiled with the spiral cones to their ends.

Genus KONINCKINA Suess 1853

(Plate IV, figure 5)

1841. Productus leonhardi, Wissmann. In Munster, Geogn. Petref. Sudost. Tirols, 4, pg. 18.
1853. Koninckina, Suess. In Davidson, Brit. Foss. Brach., vol. 1, pg. 92.

Diagnosis. Deltidium lacking, shell alate at broad hinge-line. Spiral cones with three to four loose coils.

Description. Exterior: Shell outline suborbicular, variable. Valves concavoconvex; pedicle valve convex, with slight sulcus, brachial valve concave. The greatest thickness of the brachial valve is in the midline, of the pedicle valve at the lateral margins. The anterior margin is broad and straight, but very broad, straight hinge-line gives the shell an alate appearance. The pedicle beak is strong, full, incurved and imperforate, with auricular expansions. Cardinal area and deltidial plates are obsolete at maturity. Valves smooth.

Brachial Interior: A median septum is present, extending from the cardinal-plate to the anterior margin. The spiral volutions are double, the principal pair arising from simple crural processes, with the extremities of

which they make a sharp angle. The jugum is formed by the anterior extension and union of the crural processes. The accessory spirals continue intercoiled with the primary coils, and take their origin from the upper surface of the jugum. They are thinner and less broad than the primary coils. The spiral cones are depressed and have their apices directed toward the lateral slopes of the pedicle valve. There are three to four loose coils.

Pedicle Interior: Medium septum present.

Stratigraphic Range: Triassic

Geographic Range: Austrian Alps.

Genus KONINCKELLA Munier-Chalmas 1880

1847. Leptaena liasina, Bouchard. Ann. Mag. Nat. Hist., vol. 18, figs. 2a-d.
1880. Koninckella, Munier-Chalmas. Bull. Soc. Geol. France, Ser. 3, vol. 8, pg. 280.

Diagnosis. Dental plates well-developed. Shell alate at broad hinge-line, with anterior and lateral margins thin and sharp. Spiral cones with three to four volutions, primary coils bearing long, marginal spinules.

Description. Exterior: Very similar to Koninckina. Shell concavo-convex. Hinge-line straight, narrower than that of Koninckina. Cardinal area, cardinal-plate, and deltidial plates well developed. Pedicle beak with large foramen. Anterior and lateral margins of shell thin, as in Koninckina. Valves smooth.

Brachial Interior: Sprial cones duplicate, with three to four volutions as in Koninckina. The primary coils bear long, marginal spinules. Jugum unknown.

Pedicle Interior: Unknown.

Stratigraphic Range: Triassic-Jurassic

Geographic Range: Austrian Alps.

Genus KONINCKODONTA Bittner 1893

(Plate IV, figure 5)

1893. Koninckodonta fuggeri, Bittner. Jahrb. Geol. Reichsanst. Wien, vol. 43, pg. 137.

1893. Koninckodonta, Bittner.

Diagnosis. Shell alate at broad hinge-line; lateral and anterior margins of shell thickened, with submarginal internal rows of interlocking thickened tubercules. Spiral cones loosely coiled, having not quite four volutions. Deltidium well-developed.

Description. Exterior: Similar to Koninckina and Koninckella. Shell outline suborbicular, narrower than long, although the broad hinge-line gives an alate appearance. Concavo-convex; pedicle valve convexity almost hemispherical, brachial valve deeply concave. Shells very large, with faintly developed radial ribs which are more sharply marked on the wings. The wings are blunt, not pointed. Cardinal area and deltidium are well-developed. The anterior and lateral shell margins are thickened as in Amphiclina. Shell fibrous.

Brachial Interior: On the interior of the valve is a submarginal row of thickened tubercules which interlock with similar callosities on the opposite valve,

presumably for articulation. These are more poorly developed, and less regular, than those seen in Amphiclinodonta. The spiral cones are duplicate, echinate, and depressed, with not quite four loosely coiled volutions.

Pedicle Interior: Interlocking submarginal tubercules present.

Stratigraphic Range: Triassic

Geographic Range: Austrian Alps

Genus AMPHICLINA Laube 1865

(Plate IV, figure 6)

1841. Producta dubia, Munster. Geogn. Petref. Sudostl. Tirols, 4, pg. 68.
1865. Amphiclina, Laube. Denks. Akad. Wiss. Wien, Math.-Naturw. Classe, vol. 25, pt. 2, pg. 28.

Diagnosis. Greatest shell width at lateral margins, with very narrow hinge-line. Thickening of anterior and lateral shell margins is present, but submarginal rows of interlocking tubercules are lacking. The deltidium is well developed, and the sharply projecting brachial beak moves into its lower cut-out. The spiral cones are composed of four or five more or less compact volutions.

Description. Exterior: Shell subtriangular in outline, concavo-convex; brachial valve concave, pedicle valve convex. Hinge-line straight, very narrow. Area very small, with elevated, well-developed triangular deltidium possessing a lower "cut-out" into which the sharply projecting brachial beak moves. The pedicle beak is straight or slightly incurved and apically perforated by a foramen. Thickening of the anterior and lateral margins is pronounced, particularly in the brachial valve. The shell is expanded at its lateral margins, in contrast with the alate appearance of Koninckina. Valves smooth, fibrous.

Brachial Interior: Cardinal-plate well developed. A low median septum is present towards the anterior margin.

Spiral cones duplicate, as in Koninckina, although with four to five volutions which are more compact and less evolute.

Pedicle Valve: Unknown.

Stratigraphic Range: Triassic-Jurassic

Geographic Range: Austrian Alps

Genus AMPHICLINODONTA Bittner 1888

(Plate IV, figure 6)

1888. Amphiclinodonta liasina, Bittner. Jahrb. Geol. Reichsanst. Wien, vol. 37, pg. 288.
1888. Amphiclinodonta, Bittner.

Diagnosis. Greatest shell width at lateral margins, hinge-line very narrow. Anterior and lateral shell margins thickened, with submarginal articulating tubercule rows present. Deltidium and spiral cones as in Amphiclina.

Description. Exterior: Very similar to Amphiclina. Outline subtriangular; width slightly exceeds length; hinge-line narrow and shell broad at lateral margins. Valves concavo-convex; concave brachial and rather convex pedicle valve. The beaks are pointed, with area small and narrow. Shells coursely fibered; smooth, marked by a few, indistinct, growth lines, or by faint radial ribs at the anterior margin.

Brachial Interior: Denticulate callous ridges and tubercules lie within the margins, and are seen as sharp, dark spots. Structure of the brachial apparatus is similar to that of Amphiclina. The primary coils bear marginal spinules as in Koninckella.

Pedicle Interior: Submarginal denticulate ridges and tubercules present for interlocking articulation with those of the opposite valve.

Stratigraphic Range: Triassic

Geographic Range: Austrian Alps

COMPARISON OF THE CRITICAL PROPERTIES OF THE KONINCKININAE

	Hinge-line	Thickening of anterior and lateral margins of the shell (seen in section)	Submarginal Rows of thickened tubercules which interlock for articulation	Deltidium	Sprial cones
Koninckina	alate at broad hinge-line	None	None	Absent at maturity	3-4 loose coils
Koninckella	similar to Koninckina	None	None	Well-developed plates	primary coils bear long marginal spinules; 3-4 coils
Koninckodonta	Similar to Koninckina	Present	Present but more poorly developed than in Amphiclinodonta	Well-developed	Not quite 4 coils, Loosely coiled
Amphiclina	Greatest width at lateral margins, very narrow hinge-line	Present	None	Sharply projecting brachial beak moves into lower cut-out in deltidium Well-developed plates	4-5 coils, more compact than in Koninckina
Amphclinodonta	Similar to Amphiclina	Present	Present	Similar to Amphiclina	Similar to Amphiclina

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Meristellidae

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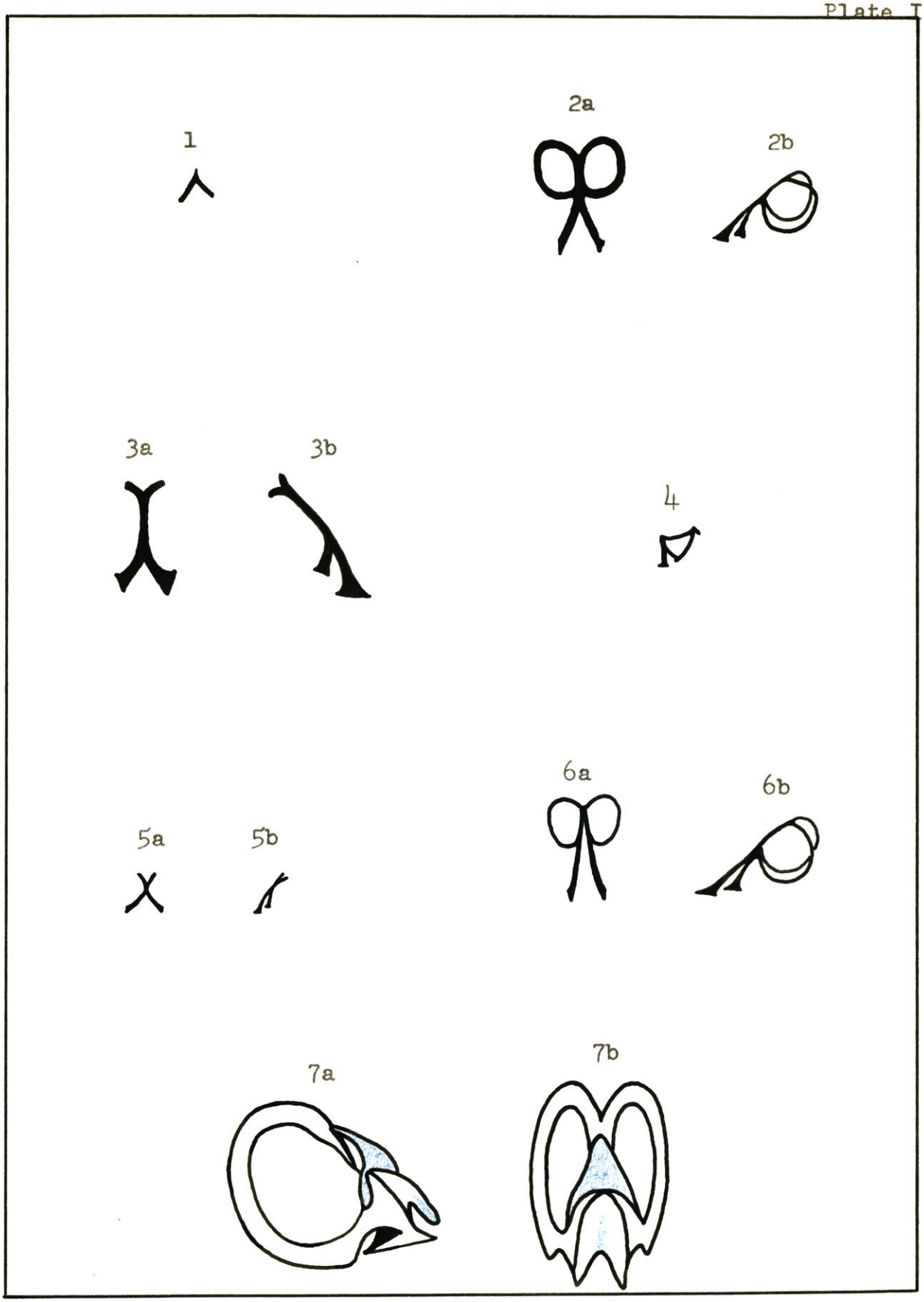
Plate I



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Nucleospiridae and Uncitidae

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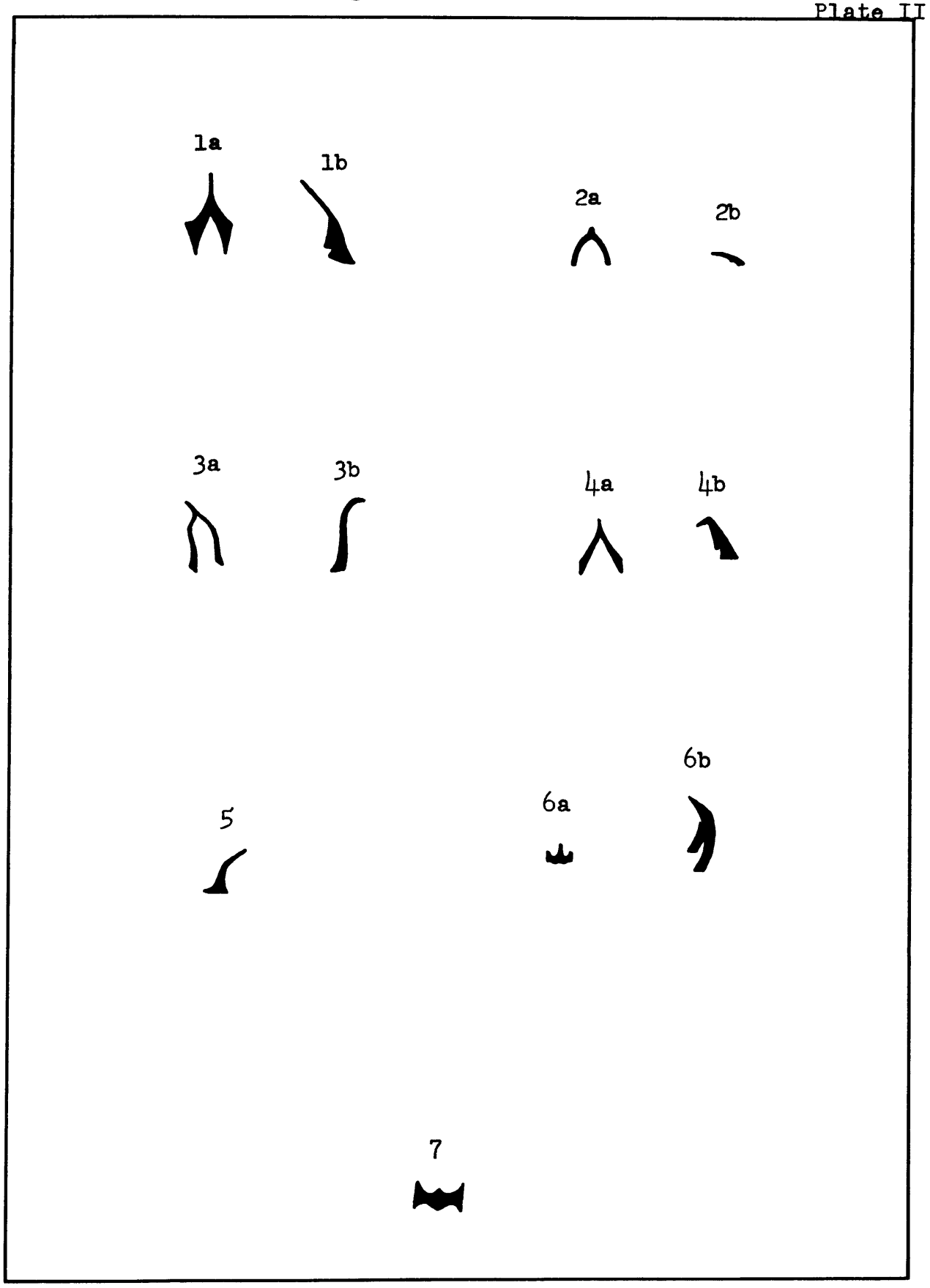

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Cleiothyridae

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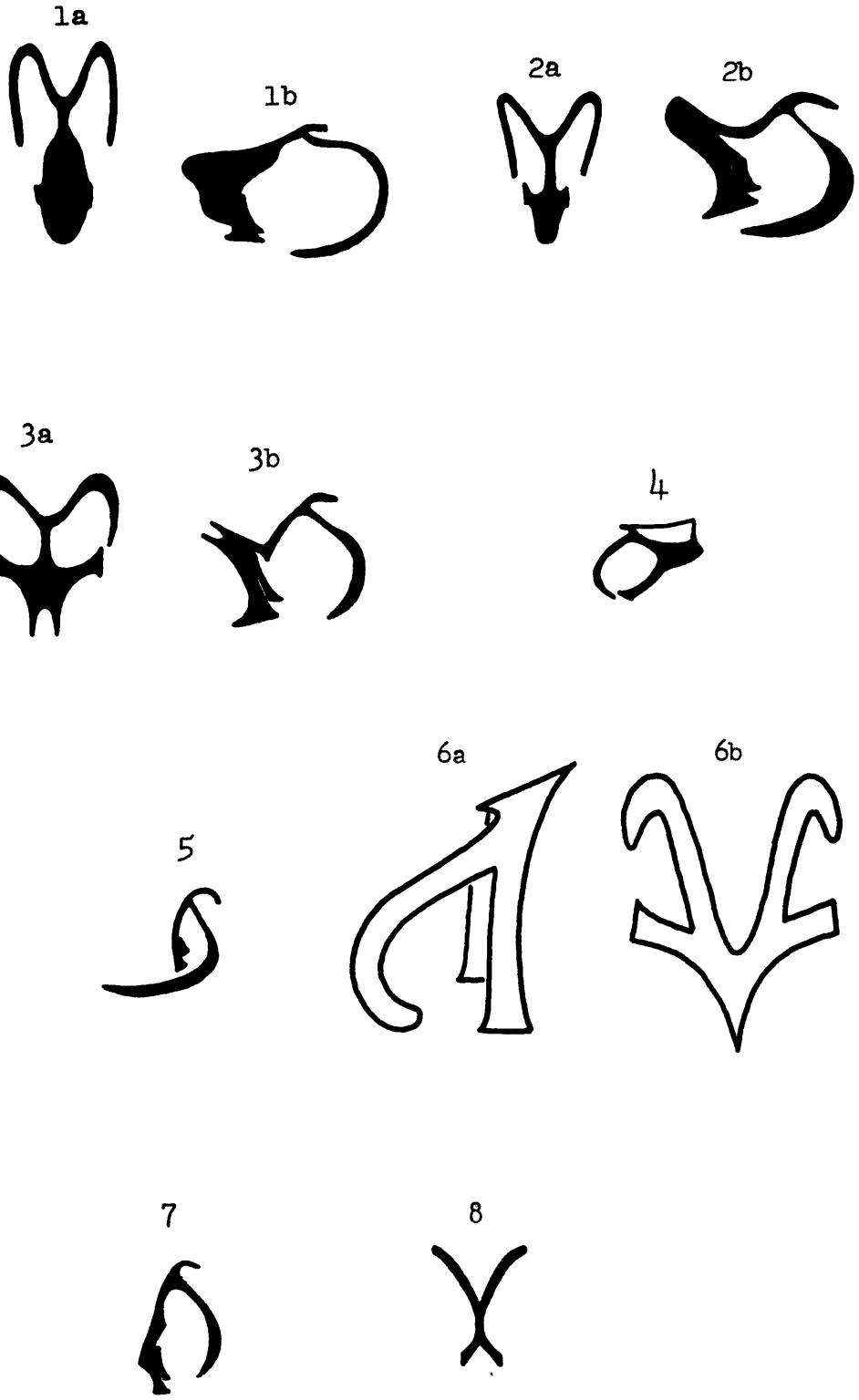
Plate III



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KONINCKINACEA

Diplospirellidae and Koninckinidae

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