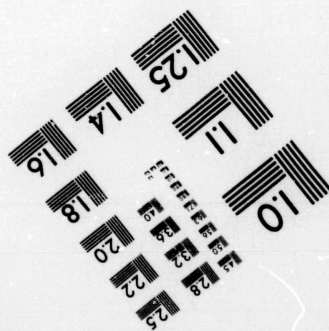
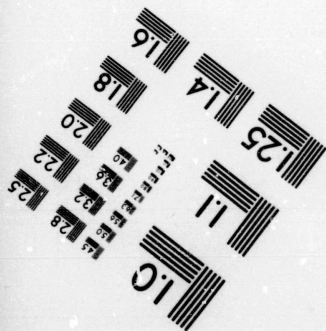
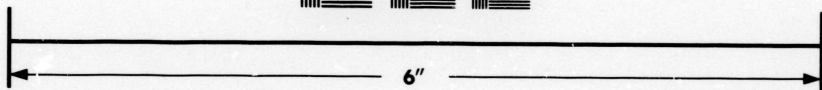
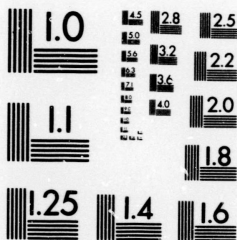


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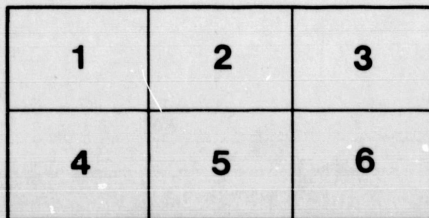
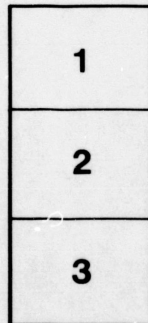
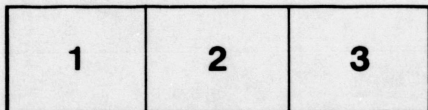
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X.—*Some Remarks on the Classification of the Trilobites, as influenced by Stratigraphical Relations: with Outline of a New Grouping of these Forms.* By
E. J. CHAPMAN, Ph.D., LL.D., Professor in the University of Toronto.

(Read May 8, 1889.)

(1.) It may be taken as an undoubted fact that palæontological classification has been very greatly influenced of late years by stratigraphical considerations. This is seen not only in the current subdivisions of the Trilobites, but in those also of the Ammonites and other extensive groups. These stratigraphical classifications have the advantage of being readily effected. They save trouble, by requiring little or no thought for their construction, and they are of course useful to the geologist as palæontological lists: but there their value ceases. Structural affinities become by this plan more or less unrecognized; and forms with but few characters in common, if occurring at the same geological horizon, are thus often forced into false relationship, rendering even moderately rigid definitions of families and other groups practically impossible.

(2.) It might be thought, in opposition to this view, that contemporary forms of a given order or family must be more nearly related to each other than to forms of the same order or family occurring at earlier or later periods. But this conception is certainly in the main erroneous. Forms of the same geological horizon should naturally offer fewer points of generic agreement than forms of different horizons. The latter may be connected by more or less direct evolution: whereas forms of the same horizon can only be related generically, if at all, through some remote ancestral type, from which, also, other distinct orders and classes may have sprung. In one case, there may be direct relationship: in the other, the connection can be little more than indirect.

(3.) An impression prevailed widely at one time, and perhaps still prevails, that the so-called "Primordial Trilobites" are distinguished from the Trilobites of higher horizons by a combination of characters peculiar to themselves, by which a marked "primordial aspect" is imparted to them. These characters, as commonly formulated, comprise:—A large, typically horned or spiny head-shield, with numerous body segments and a very small pygidium. This definition fails, of course, completely in the case of the eminently Cambrian family, the Agnostidae. But setting aside these still somewhat problematical forms, and looking only to the typical Trilobites, it is found to be equally inapplicable in many other cases. Whilst, for example, it holds good in Paradoxides, Olenus, Eurycare, and some few other Cambrian genera, we find the same combination of characters—the large and horned head-shield, the long thorax, the small pygidium—present also in Harpes, an essentially Upper Silurian and Devonian genus, unknown in Cambrian strata. The imaginary primordial aspect is sufficiently well marked in the Cambrian Olenus; but in the Silurian and Devonian *Arethusina* or *Aulacopleura* we see a combination of characters very similar to those of Olenus, among which may be specially cited the comparatively short glabella, spiny head-shield, open facial suture, small eyes connected

by a ridge or band with the glabella, narrow body-axis with numerous or comparatively numerous segments, and small, short pygidium. Again in the Cambrian *Dikelocephalus*, and in *Ctenopyge* (Linnarsson), the pygidium is very large—thus presenting a marked departure from the so-called primordial type. Other examples might be cited to prove, (1) that these imaginary primordial characteristics are present in various post-primordial genera, and (2) that they are not always present in primordial or Cambrian types.

(4.) Nothing, perhaps, shows more forcibly the arbitrary, unnatural character of stratigraphical groupings, than the collocation in recent classifications of *Neseuretus*, Hicks, side by side with *Paradoxides* in the family of the *Olenidæ*. In all its leading characters, *Neseuretus* is simply a Cambrian *Calymene*, probably the ancestral source of the latter type; but in the classifications referred to, these genera are placed in different families and widely apart. To show these points in all their distinctness, viz., the close agreement of *Neseuretus* with *Calymene*, and its remote relations to *Paradoxides*, a comparative view of their more characteristic structures is given in the following table:—

	NESEURETUS.	CALYMENE.	PARADOXIDES.
<i>Glabella</i>	Contracted anteriorly, 3 lateral furrows.	Contracted anteriorly, 3 lateral furrows.	Expanded anteriorly. Transverse and lateral furrows.
<i>Thorax</i>	13 segments	13 segments	16 to 20 segments.
<i>Pygidium</i>	Comparatively wide, with furrowed sides, and 8 to 10 rings in its axis.	Of moderate width, with furrowed sides and 6 to 11 rings in its axis.	Very small and narrow, with rarely more than 2 or 3 rings in its axis, the sides forming merely a smooth border.

In these recent classifications, also, we find *Dikelocephalus* arranged under the *Olenidæ*, whilst *Arethusina* and *Harpides*, which agree very strikingly with *Olenus* in their more salient characters, are placed far apart from the latter under the *Proetidæ*, evidently upon purely stratigraphical grounds. The structural relations of these genera are briefly indicated in the annexed tabular view:—

	DIKELOCEPHALUS.	OLENUS.	ARETHUSINA.
<i>Glabella</i>	Comparatively large,	Comparatively small.	Quite small.
<i>Facial sutures</i>	Forming a point above the glabella	Open anteriorly.	Open anteriorly.
<i>Eyes</i>	Large. Unconnected with the glabella.	Comparatively small. Connected by a band with the glabella.	Comparatively small. Connected by a band with the glabella.
<i>Body-axis</i>	Comparatively broad.	Narrow.	Narrow.
<i>Pygidium</i>	Very large, with comparatively short axis.	Small, but with extended axis.	Small, but with extended axis.

(5.) As the Trilobites have no known Post-Palæozoic representatives, and are practically confined to strata representing the earlier and middle periods of the Palæozoic Age, broad distinctions, such as those which separate the Palæozoic Crinoids and Echinida from Mesozoic and higher forms of these orders, cannot obviously be looked for in any classification. Added to this disadvantage, there are other drawbacks which beset at present, and render difficult, the systematic grouping of the Trilobites. Briefly stated, these comprise, first of all, the very lax manner in which fragmentary examples have been referred to known types, or placed, as new genera, in families with which they have but few points of resemblance. Definitions, applicable enough in the first instance, become thus, after a time, of almost impossible application—the original definition being so extended as to include forms of very dissimilar structure. Mathematically rigid definitions in the grouping of organic forms cannot, of course, be strictly enforced without, at least, greatly multiplying our classification groups; but better an undue multiplication of orders and families, than this license of indefiniteness that now so habitually prevails. Another source of difficulty lies in the remarkable dissimilarity of aspect which exists in the case of many species commonly referred to one and the same genus, as seen in *Asaphus*, *Proetus*, *Cheirurus* and other forms. This has led to the creation of numerous sub-genera, by which, however, the difficulty is in no way lessened—family definitions still remaining vague and diffuse.

(6.) In the classification shown, as regards its leading features, in the annexed synopsis, the Trilobites, considered as an order of Crustacea, are arranged under four sub-orders, or primary groups, founded on general structure and configuration, with subordinate sections based, as far as possible, on some striking or typical character. This latter, however, is to be taken in connection with the general characters of the sub-order to which the section may refer. The names attached to these sections refer necessarily to single characters, and they are thus to be regarded as names only, not as definitions. It is thought, however, that they may serve to bring rapidly before the mind's eye the more salient or special features of the types to which they refer. In the collocation of the families, an attempt is made to place them in as connected a sequence as possible, so that each family shall present relations to the family which follows it, whether placed in the same section or under contiguous sections; but in a linear system of arrangement, and especially where the objects to be classified are not very numerous, it is not possible to avoid occasional breaks in the continuity of the series.

In offering this new classification, I am not sanguine enough to expect that it will meet with general acceptance. In its subdivision of genera, and the recognition of these subdivisions in one or two cases as the types of new families, and in its disregard of stratigraphical considerations, it will necessarily ruffle existing prejudices. But it may tend to bring under more immediate notice the indefinite and hence unsatisfactory character of our commonly received subdivisions, and so lead eventually to a more successful grouping of these ancient forms.

ORDER **TRILOBITA.**

Sub-Order I.—PUSILLIFORMES.—Small, aberrant trilobites, with typically two thoracic segments, and head-shield and pygidium of nearly equal size.

Fam. 1. *Agnostidae*.—Typical genus, *Agnostus*, Cambrian, Lower Silurian.

Sub-Order II.—LATIFORMES:—More or less broad, often large, trilobites, with head-shield, thorax and pygidium of nearly equal dimensions. Body-segments typically 8 to 10 in number. Surface of shell commonly marked with wavy marginal lines.

§ 1. LEVATI.—Broad-formed or oval trilobites, with essentially smooth shell, and inconspicuous or feebly elevated glabella.

Fam. 2. *Illænidae*.—Pleuræ unfurrowed. Pygidium with smooth sides and smooth or feebly furrowed axis. Typ. gen.: *Illænus*, Up. Cam., Sil.; *Bumastus*, Sil.; *Nileus*, Lr. Sil.; *Stygina*, Lr. Sil.

Fam. 3. *Asaphidae*.—Pleuræ furrowed. Pygidium with smooth sides and smooth or feebly furrowed axis. Typ. Gen.: *Illænurus*, Cam.; *Niobe*, Lr. Sil.; *Asaphus*, Lr. Sil.; *Psilcephalus*, Cam.; *Barrandia*, Lr. Sil.; *Bathyrrellus*, Lr. Sil.; *Bathyrurus*, Cam., Lr. Sil.; *Megalaspis*, Lr. Sil.

NOTE.—The two families of this section, although widely separated in the classification of Barrande, are very closely allied, and are commonly united in more recent systems, principally from the fact that certain genera—*Illænurus*, *Niobe* and *Stygina*, more especially—appear to form an intermediate or transition group. But the typical representatives of each family are clearly characterised, and connecting points of this kind are abundantly traceable in the case of other families universally regarded as distinct. In the present classification, indeed, the collocation of the families is based, as far as this can be carried out, on the existence of these connecting or transitional forms.

As regards Family 3, I have separated from the *Asaphidae* proper the forms with horned head-shield and strongly furrowed pygidium, and have placed these in a distinct family under the generic name of *Basilicus*, already applied to them, as a sub-genus of *Asaphus*, by Salter. This is warranted by the very marked contrast presented by these strongly furrowed, lobate and conspicuously horned forms, to the smooth *Illænidae* and *Asaphidae*. The horned genus, *Megalaspis*, forms the connecting link.

§ 2. SULCATI.—Broad-formed or oval trilobites with horned head-angles, pointed pleuræ, and large, strongly-furrowed pygidium.

Fam. 4. *Basilicidae*.—Glabella with short side-furrows, or smooth. Typ. gen.: *Basilicus* (= *Asaphus* in part), Lr. Sil.; *Oxygia*, Lr. Sil.; *Homalotopeon*, Lr. Sil.

Fam. 5. *Dikelocephalidae*.—Glabella strongly developed, with transverse or side furrows. Number of body-segments unknown. Typ. gen.: *Dikelocephalus*, Cam.; *Dorypyge*, Cam.

NOTE.—*Dikelocephalus*, as a Cambrian type, is commonly placed with *Paradoxides* and other Cambrian forms under the family of the *Olenidae*. But from these it is distinctly separated by its large pygidium. This latter character, together with its horned head-shield and the meeting of its facial sutures in a spade-like point above the glabella, connects it far more closely with the horned and furrowed *Asaphidae* or *Basilicidae*, in many of which, as well as in many species of the *Asaphidae* proper, the course of the sutural outline is the same. The greater number of body-segments may

prove to be a divergent character, but the actual number of these is at present uncertain, and in the closely related *Dorypyge* the thorax is entirely unknown.

§ 3. PALMATI.—Broad-formed trilobites, with large, short-axed, radiately-furrowed pygidium.

Fam. 6. *Lichasidae*.—Pleuræ furrowed. Pygidium with short, broad axis and deeply indented margin. Typ. gen.: *Lichas*, Sil.

Fam. 7. *Bronteidae*.—Pleuræ with slightly raised surface-band. Pygidium with very short axis and entire margin. Typ. gen.: *Bronteus*, Lr. Sil., Dev.

§ 4. COLUMNATI.—Trilobites of more or less oval form, with large pygidium, the axis of which is typically long, prominent and many-segmented.

Fam. 8. *Phaetonida*.—Glabella short, conical. Body-axis comparatively narrow. Pygidium in some cases with digitated outline. Typ. gen.: *Phaeton*, Sil., Dev.; *Dechenella*, Dev.; *Brachymetopus*, Carb.

Fam. 9. *Proetidae*.—Glabella large, smooth or furrowed. Body-axis comparatively broad. Axis of pygidium typically with 10 or more pseudo-segments. Typ. gen.: *Proetus*, Sil., Dev.; *Phillipsia*, Dev., Carb.; *Griiffithides*, Carb.

NOTE.—The family of the Proetidae, as commonly recognized, includes under the genera Proetus and Phillipsia forms of marked dissimilarity of aspect, so far, at least, as regards the glabella and to some extent the relative width of the body-axis. Whilst in Proetus proper the glabella is very large, reaching quite, or very nearly, to the anterior margin of the headshield, in the forms referred to the sub-genus Phaeton (= *Proetus striatus*, Barr.) it is remarkably short and small. The digitated margin of the pygidium, sometimes referred to as a sub-generic distinction, is a character of quite subordinate value. In Dechenella and in Brachymetopus, commonly placed under Phillipsia, there is a similar departure, as regards the glabella, from the typical generic form¹. I have, therefore, separated these types with short glabella from the genera with which they are commonly associated, and have placed them in a distinct family.

Sub-Order III.—CONIFRONTES.—Trilobites of more or less elongated form, tapering downwards.

Body-axis of 13 or more segments, not distinctly separated from the pseudo-segments of the axis of the pygidium. The latter, typically, of moderate size, or small. Glabella: coniform, contracted (or not expanded) anteriorly.

§ 1. LONGICONT.—Glabella comparatively large, extending to, or nearly to, the anterior margin of the head-shield. Facial sutures terminating at the genal angles.

Fam. 10. *Homalonotida*.—Longitudinal furrows feebly indicated. Glabella: flat, typically unfurrowed. Typ. Gen.: *Homalonotus*, Sil., Dev.; *Burmeisteria* (= *H. armatus* and other spinose forms), Dev.

Fam. 11. *Calymenida*.—Thorax, pygidium and glabella, strongly lobed. The glabella tapering anteriorly. Typ. gen.: *Calymene*, Sil.; *Neseuretus*, Cam.

Fam. 12. *Triarthridae*.—Glabella of nearly uniform width, with side furrows. Body segments 14 to 15 in number. Typ. gen.: *Triarthrus*, Lr. Sil.

NOTE.—Homalonotus, commonly placed under the Calymenidae, is here separated on account of

¹ No doubt a series of intermediate varieties might be found in which the distinction becomes gradually lessened or obscured; but connecting series of this kind may be traced more or less everywhere, and if rigidly followed out would render generic distinctions practically impossible.

its very distinct aspect. In some of its forms it looks almost like a transition type between the Calymenidae and the Asaphidae. Triarthrus, which much resembles Calymene in its facial suture, pleuræ and pygidium, forms the connecting link between this section and the Conocephalidae.

§ 2. CURTICONI.—Glabella typically short, smooth or lightly furrowed. Body-rings 12 to 17 in number, typically over 13. Pygidium small or comparatively small, with typically 2 or 3 (more rarely 6 to 8) rings in its axis.

Fam. 13. *Conocephalidae*.—Eyes present. Typ. gen.: *Ellipsocephalus* (?), Cam.; *Cyphaspis*, Sil., Dev.; *Angelina*, Cam.; *Conocephalites*, Cam., Lr. Sil.; *Agraulos* (= *Arionellus*), Cam.; *Liostracus*, Cam.; *Ptychoparia*, Cam.; *Solenopleura*, Cam.; *Sao*, Cam.

Fam. 14. *Conocoryphidae*.—Eyeless forms of *Conocephalidae*. Typ. gen.; *Conocoryphe*, Cam.; *Ctenocephalus*, Cam.

NOTE.—The genus *Ellipsocephalus*, as regards the character of its glabella, is a somewhat aberrant type; but in its general structure and aspect it is closely related to the *Conocephalidae* and cannot very well be placed in any other family. The separation of the eyeless forms, typified by *Conocoryphe*, is a convenient, if not strictly necessary, subdivision. *Cyphaspis* connects the *Conocephalidae* with *Arethusina*.

§ 3. VITTATI.—Eyes connected by a narrow band with the glabella. The latter short and small. Body-segments numerous, with narrow axis. Pygidium, typically, very small.

Fam. 15. *Olenidae*.—Body-segments 12 to 15 or 16 in number. Head-shield straight or flattened along its anterior margin, and prolonged posteriorly into spines or horns. Typ. gen.: *Olenus*, Cam.; *Eurycare*, Cam.

Fam. 16. *Arethusinidae*.—Body-segments 22 in adult forms. Head-shield semicircular, terminating in points or spines. Typ. gen.: *Arethusina* (= *Aulacopleura*), Sil., Dev.; *Harpides*, Cam., Lr. Sil.

Fam. 17.—*Harpesidae*.—Head-shield very large and horned, with broad, finely punctured border. Typ. gen.: *Harpes*, Up. Sil., Dev.; *Harpina*, Lr. Sil.

NOTE.—The section in which these families are placed is named after one of their more striking characters, the band or fillet which connects the eyes with the sides of the glabella; but they have also other points of agreement, as seen more especially in their numerous body-segments, their narrow axis and small pygidium. Through *Harpides*, the *Harpesidae* proper are connected both with *Arethusina* and with *Olenus*.

Sub-Order IV.—FRONTONES.—Trilobites with large or strongly pronounced glabella, widening as a rule anteriorly. Pygidium very small or of moderate size, the many-ringed body-axis extending quite or nearly to its extremity.

§ 1. ANNULATI.—Many-ringed, comparatively elongated forms, with pygidium obscurely separated from the thorax. Body-segments typically 11 in number. Facial sutures terminating at the sides of the head-shield.

Fam. 18. *Phacopsidae*.—Pleuræ furrowed. Eyes coarsely faceted. Pygidium rounded or spinose. Typ. gen.: *Phacops*, Up. Sil., Dev.; *Dalmanites*, Sil.; *Odontocephalus*, Dev.

Fam. 19. *Encrinuridae*.—Pleuræ with raised band. Pygidium long, narrow, with many-ringed axis. Typ. gen.: *Encrinurus*, Sil.; *Cybele*, Lr. Sil.; *Cromus*, Up. Sil.; *Amphion*, Lr. Sil.

Fam. 20. *Cheiruridae*.—Pleurae with raised band. Eyes finely faceted. Pygidium horned, spinose or digitated. Typ. gen.: *Cheirus*, Up. Cam., Dev.; *Deiophon*, Up. Sil.; *Spharexochus*, Sil.; *Staurcephalus*, Sil.; *Placoparia*, Lr. Sil.

NOTE.—The families of this section are more or less closely connected by the peculiar course of the facial sutures, alike in all, and by their typically eleven body-segments. The Ecerinuridae and Cheiruridae, are connected by their "bourreletted" pleurae; and this same condition—as well as their spinose character generally—connects the Cheiruridae with the Acidaspidae of the next section.

§ 2. ARMATI.—Essentially broad-headed, spinose forms, with pointed or spiny pleurae, and small to very small (commonly spine-bearing or digitated) pygidium. Body-segments 9 to 20.

Fam. 21. *Acidaspidae*.—Head, pleurae and pygidium, all spine-bearing. Body-segments 9 to 10. Pleurae with "bourrelet." Typ. gen.: *Acidaspes*, Sil., Dev.

Fam. 22. *Paradoxidae*.—Head-shield very large and broad, with horned angles and large, anteriorly expanded glabella. Body-segments 12 to 20; pleurae, furrowed, terminating in spines; pygidium very small. Typ. gen.: *Paradoxides*, Cam.; *Hydrocephalus*, Cam.: *Telephus* (?) Lr. Sil.

§ 3. GLOBOSI.—Glabella large and prominent, oval or globular, and unfurrowed. Thorax short, with 5 to 6 segments.

Fam. 23. *Trinucleidae*.—Head-shield very large, terminating in horns, and surrounded by a broad, perforated border. Eyes commonly absent. Typ. gen.: *Trinucleus*, Lr. Sil.; *Dionide*, Lr. Sil.; *Microdiscus* (?), Cam.

Fam. 24. *Ampyxidae*.—Head-shield without perforated border. Glabella extended anteriorly into a strong spine. Eyes absent. Typ. gen.: *Ampyx*, Sil.; *Endymionia* (?), Up. Cam.

Fam. 25. *Æglinidae*.—Glabella very large and globular, extended anteriorly, in some species, into a stout spine. Eyes abnormally developed. Typ. gen.: *Æglina*, Lr. Sil.

NOTE.—This latter family forms a connecting link between the Globosi and the Oculosi. It should, perhaps, be placed under the last-named section; but it would appear to be very closely allied to the Ampyxidae (notwithstanding the absence of eyes in that family) by its 5-6 body-segments, its triangular pygidium, and its enormously developed glabella, which in some of its forms (e.g., *Æ. armata*, Barr.), extends forward into a distinct point or spine, much as in Ampyx. Whilst Barrande makes *Æglina* the type of a distinct family, Zittel places it under the Asaphidae.

§ 4. OCULOSI.—Eyes enormously developed. Head-shield with horned angles. Pygidium very small, with 2-3 rings in its axis.

Fam. 26. *Bohemillidae*.—Body-segments 5 in number. Typ. gen.: *Bohemilla*, Lr. Sil.

Fam. 27. *Remopleuridae*.—Body-segments 11 to 13 in number. Typ. gen.: *Remopleurides*, Lr. Sil., *Caphyra*, Lr. Sil.

SUMMARY.

Retrospective view of the Sub-Orders, Sections and Families of the preceding classification.

ORDER **TRILOBITA**.

Sub-Order I.—PUSILLIFORMES.

Fam. 1, Agnostidæ.

Sub-Order II.—LATIFORMES.

§ 1. LEVATI.

Fam. 2, Illænidæ.

Fam. 3, Asaphidæ.

§ 2. SULCATI.

Fam. 4, Basilicidæ.

Fam. 5, Dikelocephalidæ.

§ 3. PALMATI.

Fam. 6, Lichasidæ.

Fam. 7, Bronteidæ.

§ 4. COLUMNATI.

Fam. 8, Phaetonidæ.

Fam. 9, Proetidæ.

Sub-Order III.—CONIFRONTES.

§ 1. LONGICONI.

Fam. 10, Homalonotidæ.

Fam. 11, Calymenidæ.

Fam. 12, Triarthridæ.

§ 2. CURTICONI.

Fam. 13, Conocephalidæ.

Fam. 14, Conocoryphidæ.

§ 3. VITTATI.

Fam. 15, Olenidæ.

Fam. 16, Arethusinidæ.

Fam. 17, Harpesidæ.

Sub-Order IV.—FRONTONES.

§ 1. ANNULATI.

Fam. 18, Phacopsidæ.

Fam. 19, Encrinuridæ.

Fam. 20, Cheiruridæ.

§ 2. ARMATI.

Fam. 21, Acidaspidæ.

Fam. 22, Paradoxidæ.

§ 3. GLOBOSI.

Fam. 23, Trinucleidæ.

Fam. 24, Ampyxidæ.

Fam. 25, Æglinidæ.

§ 4. OCULOSI.

Fam. 26, Bohemillidæ.

Fam. 27, Remopleuridæ.

