A Synoptical Classification of the Bivalvia (Mollusca)

Cover illustration: *Exogyra costata* Say, 1820, left valve, University of North Carolina 8264; Upper Cretaceous, Peedee Formation, milepost 49, near Donohue Landing, Cape Fear River, North Carolina; maximum shell length (left to right) = 6.1 cm (new).
A SYNOPTICAL CLASSIFICATION OF THE BIVALVIA (MOLLUSCA)


PREFACE

Joseph G. Carter, Cristian R. Altaba, David C. Campbell, Peter J. Harries, and Peter Skelton

The following classification summarizes the suprageneric taxonomy of the Bivalvia for the upcoming revision of the Bivalvia volumes of the Treatise on Invertebrate Paleontology, Part N. The development of this classification began with Carter (1990a), Campbell, Hoekstra, and Carter (1995, 1998), Campbell (2000, 2003), and Carter, Campbell, and Campbell (2000, 2006), who, with assistance from the United States National Science Foundation, conducted large-scale morphological phylogenetic analyses of mostly Paleozoic bivalves, as well as molecular phylogenetic analyses of living bivalves. During the past several years, their initial phylogenetic framework has been revised and greatly expanded through collaboration with many students of bivalve biology and paleontology, many of whom are coauthors. During this process, all available sources of phylogenetic information, including molecular, anatomical, shell morphological, shell microstructural, bio- and paleobiogeographic as well as stratigraphic, have been integrated into the classification. The more recent sources of phylogenetic information include, but are not limited to, Carter (1990a), Malchus (1990), J. Schneider (1995, 1998a, 1998b, 2002), T. Waller (1998), Hautmann (1999, 2001a, 2001b), Giribet and Wheeler (2002), Giribet and Distel (2003), Dreyer, Steiner, and Harper (2003), Matsumoto (2003), Harper, Dreyer, and Steiner (2006), Kappner and Bieler (2006), Mikkelsen and others (2006), Neulinger and others (2006), Taylor and Glover (2006), Kříž (2007), B. Morton (2007), Taylor, Williams, and Glover (2007), Taylor and others (2007), Giribet (2008), and Kirkendale (2009). This work has also benefited from the nomenclator of bivalve families by Bouchet and Rocroi (2010) and its accompanying classification by Bieler, Carter, and Coan (2010).

This classification strives to indicate the most likely phylogenetic position for each taxon. Uncertainty is indicated by a question mark before the name of the taxon. Many of the higher taxa continue to undergo major taxonomic revision. This is especially true for the superfamilies Sphaerioida and Veneroida, and the orders Pectinida and Unionida. Because of this state of flux, some parts of the classification represent a compromise between opposing points of view. Placement of the Trigonoidoida is especially problematic. This Mesozoic superfamily has traditionally been placed in the order Unionida, as a possible derivative of the superfamily Unionoidea (see Cox, 1952; Sha, 1992, 1993; Gu, 1998; Guo, 1998; Bieler, Carter, & Coan, 2010). However, Chen Jin-hua (2009) summarized evidence that Trigonoidoida was derived instead from the superfamily Trigonoida. Arguments for these alternatives appear equally strong, so we presently list the Trigonoidoida, with question, under both the Trigonida and Unionida, with the contents of the superfamily indicated under the Trigonida.

Typified Versus Descriptive Names

The present classification gives preference to typified names over descriptive names above the family-group, following the recommendation by Stys and Kerzhner (1975) and Starobogatov (1991). Typified names are more useful than descriptive names, because their

1Author information provided in Appendix 4, p. 29 herein.
root indicates taxonomic affiliation and their suffix can be modified to reflect taxonomic rank. Descriptive names can be advantageous for indicating a key morphological feature, but this feature may not characterize all members of the group (e.g., the Palaeotaxodonta), and descriptive names indicate nothing about the phylogenetic placement of the taxon.

We agree with Dubois (2005) that adoption of a descriptive name should be guided by the spirit of priority and adherence to original definition. The term original definition is presently interpreted in a phylogenetic sense to mean the monophyletic clade defined by the original members of the taxon, their common ancestor, and all of its descendants. We have, therefore, not formally adopted the terms Palaeoheterodonta and Heterodonta, the original definitions of which have no useful phylogenetic equivalent in the present classification. These descriptive names, as well as the phylogenetically more useful Euheterodonta and Nepiomorphia, are, however, placed in the classification in bold-face type after their synonymous, or approximately synonymous, typified name. The descriptive names Autobranchia, Pterobranchia, Pteriomorphia, and Heteroconchia are presently formally adopted. Grobben's (1894) Autolamellibranchiata is herein replaced with the shorter, more euphonic Autobranchia, following C. M. Kolesnikov (1977), T. Waller (1978), Naumov (2006), and Bieler, Carter, and Coan (2010).

Authorship and Priority of Nomina above the Family-Group

The ICZN (1999) Code does not regulate taxon names above the family-group. Previous workers have used various guidelines to determine the composition, authorship, and priority of such names. Some have based these names on the oldest valid and available included family-group name in the group, or the first publication to define the group in a modern sense, or the oldest valid and available typified name above the family-group. We have adopted the latter guideline, with separate authorship and priority for names above and within the family-group. For example, the hyporder name Antipleuroidei Kříž, 2007, is presently adopted. Grobben's (1894) Autolamellibranchiata is herein replaced with the shorter, more euphonic Autobranchia, following C. M. Kolesnikov (1977), T. Waller (1978), Naumov (2006), and Bieler, Carter, and Coan (2010).

Typified names above the family-group, which are based on a junior generic synonym or homonym, are presently regarded as unavailable and are disregarded for purposes of priority. This is a departure from the ICZN (1999) Code rules for family-group names. For example, Anatina Lamarck, 1818, is a junior homonym of Anatina Schumacher, 1817. Consequently, the suborder Anatinae P. Fischer, 1887, based on Anatina Lamarck, 1818, is not available and has no bearing on the priority of any other typified name above the family-group. Also, the suborder Saxicavoidea Morretes, 1949, is unavailable because it is based on Saxicava Fleuriau de Bellevue, 1802, a junior synonym of Hiattella Bosc ex Daudin MS, 1801, and the suborder Saxicavoidea has no bearing on the priority of the presently adopted order Hiattellida. However, typified names above the family-group are not presently regarded as unavailable on the basis that their nominal family-group name is a junior synonym of another family-group name. For example, the suborder Leptonidina Dall, 1889, is available despite the fact that its nominal family-group name, Leptonidae J. Gray, 1847b, is now a junior synonym of Lasaeidae J. Gray, 1842.

Priority is presently given to the higher ranking of two or more simultaneously published typified or descriptive names above the family-group. This is an extension of Article 24.1 of the ICZN (1999) Code for family-group names. For example, order Pectinacea J. Gray, 1854a, has priority over the simultaneously established (unspecified rank above family-group but below suborder) Anomiaina J. Gray, 1854a. Changes in the rank, spelling, and/or taxonomic composition of a descriptive name are not presently considered to be a valid basis for changing the author and date of the descriptive name.

Paraphyletic and polyphyletic taxa. Paraphyletic higher taxa are unavoidable in a classification that includes ancestors and descendants. This is illustrated by J. Schneider's (1995, 1998a, 1998b, 2002) revision of the superfamily Cardioidae. Schneider reduced superfamily Tridacnoidea to subfamily Tridacninae within Cardiidae to eliminate paraplyhy of Cardioidae with respect to Tridacnidae. However, this reduction in rank merely shifted paraphyly from Cardioidae to its subfamily Cerastodermatinae, the ancestral stock group for Tridacnidae. Building a taxonomy that includes living and extinct taxa presents a dilemma: choosing between explicitly recognizing paraphyletic taxa or multiplying supraspecific taxa beyond reasonable bounds (Cela-Conde & Altaba, 2002; Altaba, 2009). We favor an evolutionary classification that, being based upon cladistic analysis, does not dismiss evidence and reflects ancestor-descendant relationships. Paraphyletic taxa are indicated in the classification by an exclamation point (!) after the name.

Polyphyletic taxa are avoided in the classification, except in rare instances where the polyphyly is limited to descendants of the same genus, originating at about the same time. For example, the subfamily Lymnocardiinae is believed to contain more than one tribe derived, in the Miocene, from Cerastoderma of the subfamily Cerastodermatinae. In this case, Lymnocardiinae is also paraphyletic because it does not include Cerastoderma, the common ancestor of all its members.

Linnean Ranks and Suffixes for Names above the Family-Group

The present classification utilizes an increased number of Linnean ranks to adequately portray phylogenetic relationships. The number of Linnean ranks reflects a substantial increase in suprageneric taxa described over the past 50 years, and the fact that morphological and molecular phylogenetics have made possible a detailed phylogenetic framework for the Bivalvia. In order to minimize the number of Linnean ranks, we have not ranked the clade EuBivalvia and certain clades in more intensively studied groups, such as the Pectinoidea, Radiolitoidea, and Cardioidae. Those preferring a simpler classification can achieve this by disregarding some of the less familiar ranks, such as subcohort, infrasubcohort, mega-order, hyporder, minororder, epifamily, and series. Such condensation of the classification will hide some phylogenetic relationships, but it might be better suited for some summary and discussion purposes. The present
Linnean synopsis does not show ancestor-descendant relationships, but these are identified in the phylogenetic classification under preparation for the revised Bivalvia Treatise.

There is currently no consensus on suffixes for typified names above the family-group. The proposal by Rohdendorf (1977) for general zoology is compared in Table 1 with the classifications of the Bivalvia by Cox and others (1969, 1971), Starobogatov (1984, 1992), Waterhouse (2008), and that herein.

The suffix -ia is commonly used for bivalve subclasses and infraclasses, e.g., Protobranchia, Autobranchia, Pteriibranchia, and Heteroconchia (T. Waller, 1978; Amler, 1999). The suffix -ata was used by Blainville (1825, 1827) and by Grobben (1894) for orders (Lamellibranchiata and Autolamellibranchiata, respectively), and by Grobben (1892), Keen (1963), and Pojeta (1978) for subclasses (Protobranchiata, Anomalodesmata, and Lucinata, respectively).

Cohort and subcohort are generally inserted between class-group and ordinal-group names, although cohort has been used below the ordinal level for dinosaurs (e.g., Benton, 2005). The ranks subcohort, megaorder, hyporder, minorder, epifamily, and series have not been used before for the Bivalvia. Megaorder, hyporder, and minorder have been used for tetrapsods, although at varying ranks in the case of hyporder and minorder (cf. Novacek, 1986; Sereno, 1986, 1999; E. Gaffney & Meylan, 1988; van Valen, 1994; McKenna & Bell, 1997; Benton, 2005).

Waterhouse (2000, 2001, 2008) suggested using -idina for suborders rather than the -ina of some earlier authors, because -ina is reserved for subtribes by Article 29.2 of the ICZN (1999) Code. The subordinal suffix -oidina, advocated by Waller in T. Waller and Stanley (2005, p. 8), is presently rejected because -idina is more consistent with the -ida ordinal ending adopted by Scarlato and Starobogatov (1969, 1979a), Waterhouse (2008), and Bieler, Carter, and Coan (2010). The suffix -oid, as in nuculoid and pterioid, is retained for informal reference to orders, to avoid confusion with informal references to families, such as nuculids and pteriids.

The rank epifamily, with the suffix -oidae, has been used between superfamilies and family for reptiles (Bour & Dubois, 1984; de la Fuente, 2003; van der Meijden & others, 2005) and for insects (M. Engel, 2005). The term series has been used between superfamilies and family for Lepidoptera.

**New Taxa**

New taxon names are formally proposed in Appendices 1 and 2 (p. 19–27 herein). This excludes rank and/or spelling changes of previously established suprageneric taxa, which will be documented in the Introduction volume to the revised Bivalvia Treatise.

**CLASSIFICATION FORMAT**

The present classification of the Bivalvia differs from previous ones in its uniform priority basis for determining names above the family-group, more consistent use of typified rather than descriptive names above the family-group, and labelling of paraphyletic taxa. Details of the classification format are described below.

**Taxon Order**

The nominotypical family, subfamily, or tribe is listed first within each superfamily, family, or subfamily, respectively. This is followed by the remaining members of the group in alphabetical order. At higher taxonomic ranks, simpler clades are generally listed before more complex clades.

**Paraphyletic Taxa**

Paraphyletic taxa are indicated by an exclamation point after the name, e.g., Grade Euprotobranchia!.

**Extinct Taxa**

Extinct taxa are indicated by the symbol • before the name, e.g., •Family Actinodontidae.

**Taxonomically Isolated Plesions and Paraphyletic Taxa**

Some plesions and some paraphyletic taxa are taxonomically isolated in the sense that they lack membership in one or more expected, immediately higher Linnean ranks, e.g., the family Palaeocardiidae placed within the suborder Cardiida without an intervening hyporder, minorder, or superfamily. Such isolated plesions and paraphyletic taxa are presently labelled plesions and paraplesions, respectively, to emphasize their deviation from the normal Linnean hierarchy.

**Taxon Dates and References**

Where two references are given for a taxon, e.g., Glycymerididae Dall, 1908 (Leach in J. Gray, 1847a), the second one indicates the source of date priority. See Bouclet and Rocroi (2010) for documentation.

**Informal Descriptive Names**

Commonly used descriptive names that are not presently formally adopted but have exact phylogenetic equivalents in the present classification are placed in bold face type after their correlative typified name, e.g., Eupteriomorphia, Foliobranchia, Euheterodonta, Neoheterodontei, Nepiomorphia, Palaeotaxodontia. Commonly used descriptive names that are not presently formally adopted and have no exact phylogenetic equivalent in the present classification (as determined by their original composition) are placed in bold-face type and italics after their most compatible typified name, e.g., Palaeoheterodonta, Heterodontia. The taxonomically widely dispersed taxa formerly assigned to the Anomalodesmata are indicated by underlining.

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ABSTRACT OF CLASSIFICATION

To more clearly illustrate the major structure of the classification, the following abstract includes only the higher taxonomic ranks and their higher ranking paraplesions. A more detailed abstract, which includes all taxa at or above the rank of superfamily, plus all plesions and paraplesions, is provided in Appendix 3 (p. 27 herein). Symbols: • = extinct; ! = paraphyletic; underlining = former members of Anomalodesmata; ? = taxonomic placement uncertain.

Class Bivalvia Linnaeus, 1758 in 1758–1759
   •Grade Euproterobranchia! Nevesskaja, 2009
   •Order Fordillida! Pojeta, 1975
   •Order Tuarangiida MacKinnon, 1982
Clade Eubivalvia Carter, nov.
   Subclass Protobranchia Pelseneer, 1889 (=Palaeotaxodonta Korobkov, 1954)
      •Superorder Nuculiformii! Dall, 1889 (=Foliobranchia Ménégaux, 1889)
         Order Nuculida! Dall, 1889
         Order Solemyida Dall, 1889
      Superorder Nuculaniformii Carter, Campbell, & Campbell, 2000
         Order Nuculanida Carter, Campbell, & Campbell, 2000
      •Order Afghanodesmatida! Carter, nov.
   Subclass Autobranchia Grobben, 1894
   Infraclass Pteriomorphia Beurlen, 1944
      Cohort Mytilomorphi! Férussac, 1822 in 1821–1822
         Order Mytilida! Férussac, 1822 in 1821–1822
         •Order Colpomyida Carter, nov.
      Cohort Ostreomorphi Férussac, 1822 in 1821–1822
         Subcohort Arctioida J. Gray, 1854a
            •Order Cyrtodontida! Scarlato & Starobogatov in Nevesskaja & others, 1971
               •Suborder Cyrtodontidina! Scarlato & Starobogatov in Nevesskaja & others, 1971
               •Suborder Praecardiidina Newell, 1965 (=Nepiomorpha Kříž, 2007)
               •Hyporder Praecardioidei Newell, 1965
               •Hyporder Antipleuroidei Kříž, 2007
         Order Arcida J. Gray, 1854a
         (paraplesion) •Superfamily Leiopectinoidea! Krasilova, 1959
            Suborder Pectinidina J. Gray, 1854a
            Suborder Anomidiina J. Gray, 1854a
            Hyporder Anomiidea! J. Gray, 1854a
            •(paraplesion) Superfamily Pseudomonotoidea! Newell, 1938
               Minorder Anomiiotei J. Gray, 1854a
               Minorder Dimyoiotei Ridewood, 1903
            •Hyporder Aviculopectinoidei Starobogatov, 1992
            Hyporder Limoidei R. Moore in Moore, Lalicker, & Fischer, 1952
            •Hyporder Monotoidei Waterhouse, 2001
         Suborder Entoliidina Hautmann, nov.
   Infraclass Heteroconchia Hertwig, 1895
   Cohort Unionomorphi J. Gray, 1854a (=Palaeoheterodonta of authors)
      Subcohort Unioni J. Gray, 1854a
      (paraplesion) •Superfamily Lyrodesmatoida! P. Fischer, 1886
      Megaorder Unioniata J. Gray, 1854a
         Order Trigoniida! Dall, 1889
         Order Uniona J. Gray, 1854a
         Suborder Unioniida J. Gray, 1854a
         Suborder Hyridina Hoeh & others, 2009
         •Suborder Silesunionida! Skawina & Dzik, 2011
   Cohort Cardiomorphi Férussac, 1822 in 1821–1822 (=Heterodonta of authors)
      Subcohort Carditioida Dall, 1889
      •Order Actinodontida! Deschaseaux, 1952
      Order Carditida Dall, 1889
      Subcohort Cardiniida Férussac, 1822 in 1821–1822 (=Euheterodonta Giribet & Distel, 2003)
Infrasubcohort Lucinidia J. Gray, 1854a
(paraplesion) Superfamily Babinkoidea! Horný, 1960
Order Lucinida J. Gray, 1854a

Infrasubcohort Cardiidia Férussac, 1822 in 1821–1822
(paraplesion) Superfamily Grammysioidea! S. A. Miller, 1877
Megaorder Cardiata Férussac, 1822 in 1821–1822 (=Neoheterontei Taylor & others, 2007)
Superorder Pholadiformii J. Gray, 1854a
Order Pholadida J. Gray, 1854a

Superorder Cardiiformii Férussac, 1822 in 1821–1822
Order Cardiida Férussac, 1822 in 1821–1822
(paraplesion) •Superfamily Kalenteroidea! Marwick, 1953
Suborder Cardiida Férussac, 1822 in 1821–1822
(paraplesion) •Family Palaenocarditidae! Chavan, 1969b
Hyorder Cardioidei Férussac, 1822 in 1821–1822
Hyorder Veneroidei J. Gray, 1854a
Minorder Veneroitei J. Gray, 1854a
Minorder Dreissenoitei R. Moore in Moore, Lalicker, & Fischer, 1952
Suborder Gastrochaenidina Morretes, 1949
•Suborder Anthracosidida Silantiev & Carter, 2011
•Suborder Leptonidina Dall, 1889
Suborder Leptonidina Dall, 1889

Megaorder Poromya! Ridewood, 1903
Order Poromyida! Ridewood, 1903
Order Pandorida R. Stewart, 1930
Order Pholadomyida! Newell, 1965
Order Thraciida! Carter, nov.

Megaorder Solenata Dall, 1889
Order Solenida Dall, 1889
Order Hiatoellida Carter, nov.

DETAILED CLASSIFICATION

Class Bivalvia Linnaeus, 1758 in 1758–1759
•Grade Euprotobranchia! Neveskaja, 2009
  •Order Fordillida! Pojeta, 1975
    •Superfamily Fordilloidea! Pojeta, 1975
      •Family Fordillidae! Pojeta, 1975
      •Family Camyidae! Hinz-Schallreuter, 2000
  •Order Tuarangiida MacKinnon, 1982
    •Family Tuarangiidae! MacKinnon, 1982
      •Subfamily Tuarangiinae MacKinnon, 1982
    •Family Praenuculidae! McAlester, 1969
      •Subfamily Praenuculinae! McAlester, 1969
      •Subfamily Concavodontidae Sánchez, 1999
    •Superfamily Pristiglomoidea Sanders & Allen, 1973
      •Family Clinopisthidae! Pojeta, 1988
      •Family Ctenodontidae Wöhrmann, 1893
      •Family Ovatoconchidae! Carter, nov.
    •Superfamily Manzanelloidea Chronic, 1952
      •Family Manzanellidae Chronic, 1952

Clade Euclade Carter, nov.
Subclass Protobranchia Pelseneer, 1889 (=Palaeotaxodonta Korobkov, 1954)
Superorder Nuculiformii! Dall, 1889 (=Foliosibranchia Ménegaux, 1889)
Order Nuculida! Dall, 1889
Superfamily Nuculoidea! J. Gray, 1824
Family Nuculidae! J. Gray, 1824
Subfamily Nuculinae J. Gray, 1824
Subfamily Nuculominae Maxwell, 1988
•Subfamily Palaenuculinae! Carter, 2001
  •Family Praenuculidae McAlester, 1969
  •Subfamily Praenuculinae McAlester, 1969
  •Subfamily Concavodontidae Sánchez, 1999
Superfamily Pseudorotaloidae Sanders & Allen, 1973
Family Pseudorotaloidae Sanders & Allen, 1973
Order Solenymyida! Dall, 1889
Superfamily Solemyoidea! J. Gray, 1840b
Family Solemyidae! J. Gray, 1840b
Subfamily Solemyinae J. Gray, 1840b
Subfamily Janacekiinae! Ružička & Rehoř in Hajkr & others, 1978
  •Family Clinopisthidae! Pojeta, 1988
  •Family Ctenodontidae Wöhrmann, 1893
  •Family Ovatoconchidae! Carter, nov.
Superfamily Manzanelloidea Chronic, 1952
Family Manzanellidae Chronic, 1952
Superorder Nuculaniformii Carter, Campbell, & Campbell, 2000
Order Afghanodesmatida! Carter, nov.
  • Superfamily Tironuculoidea Babin in Babin & others, 1982
    • Family Tironuculidae Babin in Babin & others, 1982
    • Subfamily Tironuculinae! Babin in Babin & others, 1982
    • Subfamily Natasiinae Sánchez, 1997
    • Family Nuculacidae Pojeta & Stott, 2007
    • Family Similodontidae! Carter & Pojeta, nov.
  • Superfamily Afghanodesmatidoidea! Scarlato & Starobogatov, 1979a
    • Family Afghanodesmatidae Scarlato & Starobogatov, 1979a
    • Family Erinotripidae! Cope, 2000

Order Nuculanida Carter, Campbell, & Campbell, 2000
Superfamily Malletioidea! H. Adams & A. Adams, 1858 (d’Orbigny, 1846)
  Family Malletiidae! H. Adams & A. Adams, 1858 (d’Orbigny, 1846)
    • Family Cucullellidae! P. Fischer, 1886
      • Subfamily Cucullellinae P. Fischer, 1886
      • Subfamily Palaconeillinae! Babin, 1966
    • Family Pseudocystrodonidinae Maullieux, 1939
    • Family Strabidae Prantl & Růžička, 1954
      Family Tindariidae Verrill & Bush, 1897
        Subfamily Tindarinae! Verrill & Bush, 1897
        Subfamily Neilonellinae Schileyko, 1989
Superfamily Nuculanoida H. Adams & A. Adams, 1861 (J. Gray, 1854a)
  Family Nuculanidae! H. Adams & A. Adams, 1858 (J. Gray, 1854a)
    • Family Isoracidae Keen, 1996b
Family Phaseolidae Scarlato & Starobogatov in Nevesskaja & others, 1971
  Subfamily Phaseolinae Scarlato & Starobogatov in Nevesskaja & others, 1971
  Subfamily Siliculinae! J. A. Allen & Sanders, 1973
    • Family Polidevciidae! Kumpera, Prantl, & Růžička, 1960
    • Family Sareptidae Stoliczka, 1870 in 1870–1871
      Subfamily Sareptinae! Stoliczka, 1870 in 1870–1871
      Subfamily Yoldiellinae J. A. Allen & Hannah, 1986
    • Family Yoldiidae Dall, 1908
      Family Zealedidae Scarlato & Starobogatov, 1979a
        Subfamily Zealedinae Scarlato & Starobogatov, 1979a
        Subfamily Parayoldiellinae Filatova & Schileyko, 1984
Subclass Autobranchia Grobben, 1894
Infraclass Pteriomorphia Beurlen, 1944
Cohort Mytilomorph! Férussac, 1822 in 1821–1822
  Order Mytilida! Férussac, 1822 in 1821–1822
    • Superfamily Modiolopsoidea! P. Fischer, 1886
      • Family Modiolopsidea! P. Fischer, 1886
      • Family Goniodontinidae Sánchez, 2006
Superfamily Mytiloidea Rafinesque, 1815
  Family Mytilidae! Rafinesque, 1815
    Subfamily Mytilinae Rafinesque, 1815
      Tribe Mytilini! Rafinesque, 1815
      Tribe Adulini Scarlato & Starobogatov, 1979b
      Tribe Aulacomyini Carter, nov.
    Subfamily Arcuatulinae Scarlato & Starobogatov, 1979b
    Subfamily Bathymodiolinae Kenk & Wilson, 1985
    Subfamily Lithopagininae H. Adams & A. Adams, 1857 (J. Gray, 1854a)
      Tribe Lithopaginini H. Adams & A. Adams, 1857 (J. Gray, 1854a)
      Tribe Botulini Scarlato & Starobogatov, 1979b
    Subfamily Modiolinae! G. Termier & H. Termier, 1950
      Subfamily Xenomytilinae Squires & Saul, 2006
  Family Crenellidae J. Gray, 1840b
    Subfamily Crenellinae J. Gray, 1840b
      Tribe Crenelli! J. Gray, 1840b
      Tribe Dacrydiini Ockelmann, 1983
    Subfamily Musculinae Iredale, 1939
  Family Septiferidae Scarlato & Starobogatov, 1979b
    Subfamily Septiferinae! Scarlato & Starobogatov, 1979b
    Subfamily Limnoperninae Scarlato & Starobogatov, 1979b
  • Order Colpomyida Carter, nov.
    • Superfamily Colpomyoidea Pojeta & Gilbert-Tomlinson, 1977
      • Family Colpomyidae! Pojeta & Gilbert-Tomlinson, 1977
      • Family Evyanidae Carter, Campbell, & Campbell, 2000
Cohort Ostreomorphi Férussac, 1822 in 1821–1822
(plesion) •Family Matheriidae Scarlato & Starobogatov, 1979a
(plesion) •Family Ichyroodontidae Scarlato & Starobogatov, 1979a
Subcohort Arcioni J. Gray, 1854a
•Order Cyrtodontida Scarlato & Starobogatov in Nevesskaja & others, 1971
  •Suborder Cyrtodontidina Scarlato & Starobogatov in Nevesskaja & others, 1971
    •Superfamily Cyrtodontontoidea Cope, 1996
    •Family Cyrtodontidae Ulrich in Ulrich & Scofield, 1894
  •Superfamily Falcotodontontoidea Cope, 1996
  •Family Falcotodontidae Cope, 1996
  •Superfamily Pittcherioidea Scarlato & Starobogatov, 1979a
  •Family Pittcheriidae Scarlato & Starobogatov, 1979a
•Suborder Praecardiidina Newell, 1965 (=Nepiomorpha Kříž, 2007)
  •Hyporder Praecardioidae Newell, 1965
  •Superfamily Praecardioidae R. Hoernes, 1884
    •Family Praecardiidae R. Hoernes, 1884
    •Family Buchiolidae Grimm, 1998
  •Superfamily Cardioloidae R. Hoernes, 1884
    •Family Cardioliidae R. Hoernes, 1884
    •Family Slavidae Kříž, 1982
•Hyporder Antipleuroidei Kříž, 2007
•Superfamily Dualinoidea Conrath, 1887
  •Family Dualinidae Conrath, 1887
    •Subfamily Dualininiae Conrath, 1887
    •Subfamily Loxopteriinae Nagel-Myers, Amler, & Becker, 2009
  •Family Praelucinidae Conrath, 1887
•Family Praelucinidae Starobogatov, 1977
•Family Stolidotidae Starobogatov, 1977
•Family Spanilidae Kříž, 2007
Order Arcida J. Gray, 1854a
•Superfamily Glyptarcoidea Cope, 1996
•Family Glyptarcidae Cope, 1996
•?Family Pucamyidae Sánchez in Sánchez & Benedetto, 2007
Superfamily Arcoidea Lamarck, 1809
Family Arcidae Lamarck, 1809
  Subfamily Arcinae Lamarck, 1809
  Subfamily Anadarinae Reinhardt, 1935
  Subfamily Noetiinae R. Stewart, 1930
  Tribe Noettini R. Stewart, 1930
  Tribe Striarciini MacNeil, 1937
  Tribe Trinaciini MacNeil, 1937
•Family Catamarcaiidae Cope, 2000
Family Cucullaeidae R. Stewart, 1930
•Family Frejidae Ratter & Cope, 1998
Family Glycymerididae Dall, 1908 (Leach in J. Gray, 1847a)
  Subfamily Glycymeridinae Dall, 1908 (Leach in J. Gray, 1847a)
  •Subfamily Arcullaeinae Newell, 1969a
•Family Parallelodontidae Dall, 1898
  Subfamily Parallelodontinae Dall, 1898
  •Subfamily Grammatodontinae L. Stephenson, 1941
  •Tribe Grammatodontini L. Stephenson, 1941
  •Tribe Cellullini Scarlato & Starobogatov, 1979b
  •Tribe Nemodontini L. Stephenson ex MacNeil MS, 1941
Superfamily Limopsioidea Dall, 1895a
Family Limopsidae Dall, 1895a
Superfamily Philobryoidea Félix Bernard, 1897
Family Philobryidae Félix Bernard, 1897
Subcohort Ostreioni Férussac, 1822 in 1821–1822
•Megaorder Myalinata H. Paul, 1939
•Order Myalinida H. Paul, 1939
  •Superfamily Alatoconchoidea H. Termier, Termier, & Lapparent, 1974
  •Family Alatoconchidae H. Termier, Termier, & Lapparent, 1974
  •Family Salakconchidae Yancey & Ozaki, 1986
  •Superfamily Ambonychoidea S. A. Miller, 1877
  •Family Ambonychiidae S. A. Miller, 1877
  •Family Lunulacardiidae P. Fischer, 1887
• Subfamily Lunulacardiinae P. Fischer, 1887
• Subfamily Pterochaeniinae Fang & Ding, 1993
• Family Monopteriidae Newell, 1969b
• Family Mysidiellidae Cox, 1964
• Family Myalinidae Frech, 1891
• Family Ramonalinidae Yancey, Wilsom, & Mione, 2009
• Superfamily Inoceramoidea C. Giebel, 1852
  • Family Inoceramidae C. Giebel, 1852
  • Subfamily Inoceraminae C. Giebel, 1852
  • Subfamily Coloniceraminae Pochialaynen, 1985
  • Subfamily Sachalinoceraminae Zonova, 1984
• Family Atomodesmatidae Waterhouse, 1976
• Subfamily Atomodesmatinae Waterhouse, 1976
• Subfamily Malimanininae Waterhouse, 2001
• Subfamily Permoceraminae Waterhouse, 2008
• Family Kolymiidae V. Kuznetsov, 1973
• Family Retroceramidae Koschelkina, 1980
• Superfamily Prokopieskioidea H. Vokes, 1967
• Family Prokopieskiidae H. Vokes, 1967
  • Subfamily Prokopieskiinæ H. Vokes, 1967
  • Subfamily Abiellinae Starobogatov, 1970
  • Subfamily Concinellinae Silantiev, nov.
  • Subfamily Kinerkaellinae Scarlato & Starobogatov, 1979a
• Family Anadontellidae Silantiev, nov.
• Family Naiaditidae Scarlato & Starobogatov, 1979a

Megaorder Ostreata Férussac, 1822 in 1821–1822
  (plesion) • Family Myodakryotidae Tunnicliff, 1987
Superorder Ostreiformii Férussac, 1822 in 1821–1822 (= Eupteriomorpha Boss, 1982)
Order Ostreata Férussac, 1822 in 1821–1822
Suborder Ostreida Férussac, 1822 in 1821–1822
Superfamily Ostroidea Rafinesque, 1815
• Family Ostreiidae Rafinesque, 1815
  • Subfamily Ostreinae Rafinesque, 1815
    • Tribe Ostreini Rafinesque, 1815
    • Tribe Pustulostreini Harry, 1985
    • Tribe Undulostreini Harry, 1985
  • Subfamily Lophinae Vialov, 1936
    • Tribe Lophani Vialov, 1936
    • Tribe Myrakeenini Harry, 1985
• Family Arctostreidae Vialov, 1983
  • Subfamily Arctostreinae Vialov, 1983
  • Subfamily Palaeolophinae Malchus, 1990
• Family Eligmitidae T. Gill, 1871
• Family Flemingostreidae Stenzel, 1971
  • Subfamily Flemingostreinae Stenzel, 1971
    • Tribe Flemingostreini Stenzel, 1971
    • Tribe Ambigostreini Malchus, 1990
    • Tribe Curvostreini Malchus, 1990
  • Subfamily Crassostreinae Scarlato & Starobogatov, 1979a
    • Tribe Crassostreini Scarlato & Starobogatov, 1979a
    • Tribe Striostreini Harry, 1985
    • Tribe Turkostreini Malchus, 1990
  • Subfamily Liostreinae Vialov, 1983
• Family Gryphaicidae Vialov, 1936
  • Subfamily Gryphaicinae Vialov, 1936
  • Subfamily Exogyrinae Vialov, 1936
    • Tribe Exogyrinini Vialov, 1936
    • Tribe Amphidonteini Vialov, 1983
  • Subfamily Gryphaostreinae Stenzel, 1971
  • Subfamily Pycnodonteinae Stenzel, 1959
  • Tribe Pycnodonteini Stenzel, 1959
  • Tribe Hyotissini Scarlato & Starobogatov, 1979b
  • Tribe Neopycnodonteini Harry, 1985
Suborder Malleidina Jan, Gray, 1854a
  (paraplesion) • Family Pterineidae F. Meek, 1864b
Superfamily Pinnioidea Leach, 1819
• Family Pinnidae Leach, 1819
• Superfamily Posidonioidea Neumayr, 1891
  • Family Posidoniiidae Neumayr, 1891
  • Family Aulacomyellidae Ichikawa, 1958
    • Subfamily Aulacomyellinae Ichikawa, 1958
    • Subfamily Bositrinae Waterhouse, 2008
  • Family Daonellidae Neumayr, 1891
  • Family Halobiidae Kirtl, 1912

Superfamily Pterioidea J. Gray, 1847b (Goldfuss, 1820)
  Family Pteriidae J. Gray, 1847b (Goldfuss, 1820)
    • Subfamily Pteriinae J. Gray, 1847b (Goldfuss, 1820)
    • Subfamily Dattinae M. Healey, 1908
  • Family Bakevelliidae W. King, 1850
  • Family Cassianellidae Ichikawa, 1958
  • Family Kochiidae Frech, 1891

Family Malleidae Lamarck, 1818
  • Subfamily Malleinae Lamarck, 1818
  • Subfamily Isognomoninae Woodring, 1925 (J. Fleming, 1828)
  • Subfamily Pulvinitinae L. Stephenson, 1941
  • Family Pergamidiidae Cox, 1964
    • Subfamily Pergamidiinae Cox, 1964
    • Subfamily Oretiinae Waterhouse, 2008
  • Family Vlastidae Neumayr, 1891
  • Subfamily Vlastinae Neumayr, 1891
    • Subfamily Praeostreinae Kittl, 1912

• Superfamily Rhombopterioidea Korobkov in Eberzin, 1960
  • Family Rhombopteriidae Korobkov in Eberzin, 1960
  • Family Umburridae P. A. Johnston, 1991

Order Pectinida J. Gray, 1854a
(paraplesion)
  • Superfamily Leiopectinoidea Krasilova, 1959
  • Family Leiopectinidae Krasilova, 1959

Suborder Pectinidina J. Gray, 1854a
Superfamily Pectinoidea Rafinesque, 1815
   • Epifamily Pectinoideae Rafinesque, 1815
     • Family Pectinidae Rafinesque, 1815
       • Subfamily Pectininae Rafinesque, 1815
         • Tribe Pectinini Rafinesque, 1815
         • Tribe Aequipectinini Nordsieck, 1969
         • Tribe Amusiini Ridewood, 1903
         • Tribe Austrochlamydini Jonkers, 2003
         • Tribe Decatopectinini T. Waller, 1986
       • Subfamily Camptonectinae Habe, 1977
       • Subfamily Palliolinae Korobkov in Eberzin, 1960
         • Tribe Palliolini Korobkov in Eberzin, 1960
       • Tribe Adamussini Habe, 1977
         • Tribe Eburneopectinini T. Waller, 2006
         • Tribe Mesopeplini T. Waller, 2006
         • Tribe Pseudentoliini T. Waller, 2006
         • Tribe Serripectinini T. Waller, 2006
       • Subfamily Pedinae Bronn, 1862
         • Tribe Pedini Bronn, 1862
         • Tribe Chlamydini Teppner, 1922
         • Tribe Crassadomini T. Waller, 1993
       • Tribe Fortipectinini K. Masuda, 1963
         • Subtribe Fortipectinina K. Masuda, 1963
         • Subtribe Patinopectinina Habe, 1977
       • Tribe Mimachlamydini T. Waller, 1993
  • Subfamily Pseudopectininae Kasum-Zade, 2003
  • Subfamily Weylinae Kasum-Zade, 2003

• Family Pleuronectitidae Hautmann, nov.

Suborder Anomiidina J. Gray, 1854a
Hyporder Anomioidei J. Gray, 1854a
• (plesion) Family Saharopteriidae G. Termier & H. Termier in Pareyn, Termier, & Termier, 1972
• (paraplesion) Superfamily Pseudomonotoidea! Newell, 1938
  • Family Pseudomonotidae! Newell, 1938

Minorder Anomioidae J. Gray, 1854a
Superfamily Anomioidea Rafinesque, 1815
Family Anomiidae! Rafinesque, 1815
  • Subfamily Anomiinae! Rafinesque, 1815
  • Subfamily Heteranomiinae Scarrato & Starobogatov, 1979a
    • Family Permanomiidae Carter, 1990a
    • Family Placunidae Rafinesque, 1815

Minorder Dimyoidei Ridewood, 1903
Superfamily Dimyoidea P. Fischer, 1886
Family Dimyidae P. Fischer, 1886
Superfamily Plicatuloidea J. Gray, 1854b
Family Plicatulidae! J. Gray, 1854b
  • Family Chondrodontidae Freneix, 1960
  • Superfamily Prospondyloidea! Pchelintseva, 1960
    • Family Prospondylidae! Pchelintseva, 1960
    • Subfamily Prospondylinae! Pchelintseva, 1960
    • Subfamily Pegenaivalvulinae Waterhouse, 2008

• Hyporder Aviculopectinoidei! Starobogatov, 1992
  • Superfamily Aviculopectinoidea! E. Meek & Hayden, 1865
    • Family Aviculopectinidae! E. Meek & Hayden, 1865
      • Subfamily Aviculopectininae! E. Meek & Hayden, 1865
    • Subfamily Echiniferpectininae Waterhouse, 2008
    • Subfamily Hayasakapectininae! Boyd & Newell, 2000
    • Subfamily Spypidpectininae Waterhouse, 2008
  • Family Deltopectinidae Dickins, 1957
    • Subfamily Deltopectininae! Dickins, 1957
    • Subfamily Cyrtorostrinae Newell & Boyd, 1995
    • Subfamily Squamuliferpectininae Waterhouse, 2008
  • Family Limatulinae! Waterhouse, 2001
  • Superfamily Chaenocardioidea S. A. Miller, 1889
    • Family Chaenocardia! S. A. Miller, 1889
    • Family Streblochondriidae Newell, 1938
      • Subfamily Streblochondriinae Newell, 1938
      • Subfamily Guizhoupectininae M. Astafieva, 1994
      • Subfamily Orbiculopectininae Waterhouse, 2001
        • Tribe Orbiculopectini Waterhouse, 2001
        • Tribe Eocamptonectini Waterhouse, 2001
      • Subfamily Saturnopectininae D. Campbell, nov.
      • Subfamily Streblopteriinae Waterhouse, 2008
    • Family Limipteriidae Astafieva, 1995
    • Family Antijaniriidae Hautmann, nov.
    • Family Hunanpectinidae! Yin Hong-fu, 1985
      • Subfamily Hunanpectininae Yin Hong-fu, 1985
        • Tribe Hunanpectini Yin Hong-fu, 1985
        • Tribe Furcatini Waterhouse, 2001
      • Subfamily Asoellinae! Begg & Campbell, 1986
    • Family Limipectinidae Newell & Boyd, 1990
      • Subfamily Limipterini Newell & Boyd, 1990
      • Subfamily Acanthopectininae Newell & Boyd, 1995
      • Tribe Acanthopectini Newell & Boyd, 1995
      • Tribe Costatoplicatinini Waterhouse, 2008
      • Tribe Lamnipectini Waterhouse, 2008
    • Family Ornithopectinidae Hautmann, nov.
  • Superfamily Pterinopectinoidea! Newell, 1938
    • Family Pterinopectinidae! Newell, 1938
      • Subfamily Pterinopectininae! Newell, 1938
      • Subfamily Pterinopectinellinae Waterhouse, 2008
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•Subfamily Tesseriinae Waterhouse, 2008
•Family Claraiidae Gavrilova, 1996
•Subfamily Clarainae! Gavrilova, 1996
•Subfamily Chuluariinae Waterhouse, 2008
•Family Natalissimidae! Waterhouse, 2008
•Subfamily Natalissiminae! Waterhouse, 2008
•Subfamily Pseudaviculopectininae! Waterhouse, 2008

Hyporder Limoidei R. Moore in Moore, Lalicker, & Fischer, 1952
Superfamily Limoidea Rafinesque, 1815
Family Limidae! Rafinesque, 1815
Subfamily Liminae Rafinesque, 1815
•Subfamily Ctenostreoninae Kasum-Zade, 2003
Subfamily Limatulinae! Kasum-Zade, 2003
Tribe Limatulini! Kasum-Zade, 2003
•Tribe Calcicuniculariini Waterhouse, 2008
•Subfamily Plagiostominae Kasum-Zade, 2003
Family Isolimeidae Kasum-Zade, 2003

•Hyporder Monotoidei Waterhouse, 2001
•Superfamily Buchioidae! Cox, 1953 (P. Fischer, 1886)
•Family Buchiidae Cox, 1953 (P. Fischer, 1886)
•Family Dolponellidae Waterhouse, 2001
•Family Monotidae! P. Fischer, 1886
•Subfamily Monotinae P. Fischer, 1886
•Subfamily Otapiriinae! Waterhouse, 1982
•Superfamily Eurydesmatoidae! Reed, 1932
•Family Eurydesmatidae! Reed, 1932
•Family Manticiulidae Waterhouse, 2008
•Superfamily Oxytomoidea Ichikawa, 1958
•Family Oxytomidae Ichikawa, 1958
•Subfamily Oxytomininae Ichikawa, 1958
•Subfamily Maccouyllinae Waterhouse, 2008

Suborder Entoliidina! Hautmann, nov.
Superfamily Entolioidae Teppner, 1922
Family Entoliidae Teppner, 1922
•Subfamily Entoliinae Teppner, 1922
•Subfamily Palaeontoliinae! Romanow, 1985
Subfamily Syncyclonematinae T. Waller, 1978
•Family Entoliodisidae Kasum-Zade, 2003
•Subfamily Entoloiidesinae! Kasum-Zade, 2003
•Subfamily Calvaentoliinae Kasum-Zade, 2003
•Family Pernopectinidae! Newell, 1938
Family Propeamussiidae Abbott, 1954
•Superfamily Euchondrioidae! Newell, 1938
•Family Euchondriidae! Newell, 1938

Infraclasse Heteroconchia Hertwig, 1895
Cohort Unionomorpha J. Gray, 1854a (=Palaeoheterodonta of authors)
(paraplesion) •Family Thoraliidae N. Morris, 1980
Subcohort Unioni J. Gray, 1854a
(paraplesion) •Superfamily Lyrodesmatoidae! P. Fischer, 1886
•Family Lyrodesmatidae! P. Fischer, 1886
•Family Pseudarcidae Scarlato & Starobogatov, 1979a
Megaorder Unioni J. Gray, 1854a
Order Trigonida! Dall, 1889
Superfamily Trigonioidae! Lamarck, 1819
Family Trigoniidae! Lamarck, 1819
Subfamily Trigoniinae Lamarck, 1819
•Subfamily Minetrigoniinae T. Kobayashi, 1954
•Subfamily Nototrigoniinae Skwarko, 1963
•Subfamily Pleurotrigoniinae van Hoepen, 1929
•Subfamily Nequenitrigoniinae H. Leanza, 1993
•Subfamily Psilotrigoniinae C. Fleming, 1987
•Family Eoschizodidae Newell & Boyd, 1975
•Family Groeberellidae Pérez, Reyes, & Damborenea, 1995
•Family Myophoriidae! Bronn, 1849 in 1848–1849
•Family Prosogyrotrigoniidae T. Kobayashi, 1954
•Subfamily Prosogyotrigoniinae T. Kobayashi, 1954
•Subfamily Praegoniinae C. Fleming, 1962
• Family Scaphellinidae Newell & Ciriacks, 1962
• Family Schizodidae Newell & Boyd, 1975
  • Subfamily Schizodinae Newell & Boyd, 1975
  • Subfamily Eoastartinae Newell & Boyd, 1975
  • Subfamily Sinodorinae Pojeta & Zhang, 1984
• Superfamily Myophorelloidea T. Kobayashi, 1954
  • Epifamily Myophorelloidae T. Kobayashi, 1954
  • Family Myophorellidae T. Kobayashi, 1954
    • Subfamily Myophorellinae T. Kobayashi, 1954
    • Tribe Myophorellini T. Kobayashi, 1954
    • Tribe Steinmanellini M. Cooper, 1991
    • Subfamily Vaugoniinae T. Kobayashi, 1954
    • Tribe Vaugonini T. Kobayashi, 1954
    • Tribe Quadratotrigoniini Saveliev, 1958
• Family Buchotrigoniidae H. Leanza, 1993
  • Subfamily Buchotrigoniinae H. Leanza, 1993
  • Subfamily Syrotrigoniinae Perez & Reyes, 1997
• Family Laevitrigoniidae Saveliev, 1958
  • Subfamily Laevitrigoniinae Saveliev, 1958
  • Subfamily Frenguelliellinae Nakano, 1960
• Epifamily Megatrigonioidae van Hoepen, 1929
  • Series Megatrigoniitae van Hoepen, 1929
• Family Megatrigoniidae van Hoepen, 1929
  • Subfamily Megatrigoniinae van Hoepen, 1929
    • Tribe Megatrigoniini van Hoepen, 1929
    • Tribe Apiotrigoniini Tashiro, 1979
    • Subtribe Apiotrigoniini Tashiro, 1979
    • Subtribe Heterotrigoniini M. Cooper, 1991
  • Subfamily Pterotrigoniinae van Hoepen, 1929
    • Tribe Pterotrigoniini van Hoepen, 1929
    • Tribe Scabrotrigoniini M. Cooper, 1989
• Family Iotrigoniidae Saveliev, 1958
  • Series Rutitrigoniitae van Hoepen, 1929
• Superfamily Rutrigonioidoidea Cox, 1952 (or in Unionidae)
• Family Rutrigoniidae Cox, 1952
  • Subfamily Rutrigonioidinae Cox, 1952
  • Subfamily Peregrinoconchinae Gu Zhi-wei & others in Ma & others, 1976
• Family Nakamurasaiididae Guo, 1981
• Family Nippononaiidae Chen Jin-hua, 1987
  • Subfamily Nippononaiinae Chen Jin-hua, 1987
  • Subfamily Sinonaiinae Chen Jin-hua, 1987
• Family Plicatounionidae Chen Jin-hua, 1987
• Family Pseudohyriidae T. Kobayashi, 1954
  • Subfamily Qiyangiinae Chen Jin-hua, 1983
• Family Rectidentinae Modell, 1942
Order Unionida J. Gray, 1854a
Suborder Unioniida J. Gray, 1854a
Superfamily Unionioidea Rafinesque, 1820
  • Family Unioniidae Rafinesque, 1820
    • Subfamily Unioninae Rafinesque, 1820
      • Tribe Unionini Rafinesque, 1820
      • Tribe Anodontini Rafinesque, 1820
    • Subfamily Ambleminae Rafinesque, 1820
      • Tribe Amblemini Rafinesque, 1820
      • Tribe Lampslini Ihering, 1901
      • Tribe Pleurobemini Hannibal, 1912
      • Tribe Quadrulini Ihering, 1901
    • Subfamily Gonideinae Ortmann, 1916
    • Subfamily Modellnaiinae Brandt, 1974
    • Subfamily Parreysiinae Henderson, 1935
    • Subfamily Qiyangiinae Chen Jin-hua, 1983
  • Subfamily Rectidentinae Modell, 1942
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- Family Margaritiferidae Henderson, 1929
  • Family Sancticarolitidae Simone & Mezzalira, 1997
- Superfamily Mullerioidea Deshayes, 1832a
  Family Mulleriidae Deshayes, 1832a
    • Subfamily Mulleriinae Deshayes, 1832a
    • Subfamily Leilinae Morretes, 1949
    • Subfamily Monocoeidae Modell, 1942
    • Subfamily Myctopodinae J. Gray, 1840b
  Family Etheriidae Deshayes, 1832a
  Family Iridinidae Swainson, 1840
  Subfamily Iridininae Swainson, 1840
  Subfamily Aspathariinae Modell, 1942
  • Subfamily Monocondylaeinae Modell, 1942
  • Subfamily Mycetopodinae J. Gray, 1840b
- Family Etheriidae Deshayes, 1832a
- Superfamily T rigonioidoidea Cox, 1952 (or in T rigoniida, which see)
- Suborder Hyriidina Hoeh & others, 2009
  Superfamily Hyrioida Swainson, 1840
  Family Hyriidae Swainson, 1840
    • Subfamily Hyriinae Swainson, 1840
    • Tribe Hyriini Swainson, 1840
    • Tribe Castaliini Morretes, 1949
    • Tribe Cucumerunionini Iredale, 1934
    • Tribe Diplodontini Ihering, 1901
    • Tribe Hyridellini McMichael & Hiscock, 1958 (Iredale, 1934)
  Subfamily Velesunioninae Iredale, 1934
  • Suborder Silesunionidina! Skawina & Dzik, 2011
  • Superfamily Silesunionoidea! Skawina & Dzik, 2011
  • Family Silesunionidae! Skawina & Dzik, 2011
  • Family Unionellidae! Skawina & Dzik, 2011
  • Cohort Cardiomorphi Férussac, 1822 in 1821–1822 (Heterodonta of authors)
    (plesion) • Family Lipanellidae Sánchez, 2005
  Subcohort Carditioni Dall, 1889
    • Order Actinodontida! Deschaseaux, 1952
      • Superfamily Anodontopsoida! S. A. Miller, 1889
        • Family Anodontopsidae S. A. Miller, 1889
        • Family Actinodontidae! Davies, 1933
        • Family Baidostroscidae Fang & Cope, 2008
        • Family Cycloconchidae! Ulrich in Ulrich & Scofield, 1894
          • Subfamily Cycloconchinae! Ulrich in Ulrich & Scofield, 1894
          • Subfamily Taselasmodinae Fang & Cope, 2008
        • Family Intihuarellidae! Sánchez in Sánchez & Vaccari, 2003
        • Family Redonididae! Babin, 1966
      • Superfamily Nyassoida! S. A. Miller, 1877
        • Family Nyassidae! S. A. Miller, 1877
      • Superfamily Palaeomuteloidea Lahusen, 1897
        • Family Palaeomutelidae Lahusen, 1897
        • Subfamily Aenigmoconchidae Betekhtina in Betekhtina & Soukhov, 1968
      • Superfamily Astartidae! d’Orbigny, 1844 in 1844–1848 (J. Gray, 1840b)
        • Subfamily Astartinae! d’Orbigny, 1844 in 1844–1848 (J. Gray, 1840b)
        • Subfamily Astartellinae! Boyd & Newell, 1968
        • Subfamily Eriphylinae Chavan, 1952b
        • Subfamily Opinae! Chavan, 1952b
        • Subfamily Pinzonellinae Beurlen, 1954
        • Subfamily Terrainae Scarlato & Starobogatov, 1979a
  Order Cardiida Dall, 1889
    (pleon) • Family Archaeocardiidae Khalfin, 1940
    (parapleon) • Family Eodonidae! Carter, Campbell, & Campbell, 2000
    Superfamily Crassatelloidea Férussac, 1822 in 1821–1822
      Family Crassatellidae Férussac, 1822 in 1821–1822
        • Subfamily Crassatellinae! Férussac, 1822 in 1821–1822
          • Subfamily Ptychomyinae Keen, 1969b
          • Subfamily Scambulinae Chavan, 1952a
        • Subfamily Psychomayinae Keen, 1969b
        • Subfamily Scambulinae Chavan, 1952a
      • Family Aenigmoconchidae Betekhtina in Betekhtina & Soukhov, 1968
      Family Astartidae! d’Orbigny, 1844 in 1844–1848 (J. Gray, 1840b)
        • Subfamily Astartinae! d’Orbigny, 1844 in 1844–1848 (J. Gray, 1840b)
        • Subfamily Astartellinae! Boyd & Newell, 1968
        • Subfamily Eriphylinae Chavan, 1952b
        • Subfamily Opinae! Chavan, 1952b
        • Subfamily Pinzonellinae Beurlen, 1954
        • Subfamily Terrainae Scarlato & Starobogatov, 1979a
Subfamily Trigonopinae R. N. Gardner & Campbell, 2002
• Family Cardiniidae Zittel, 1881

Family Carditidae! Férussac, 1822 in 1821–1822
• Subfamily Carditininae Férussac, 1822 in 1821–1822
• Subfamily Cardinamerinae! Chavan, 1969b
• Subfamily Carditesinae! Chavan, 1969b
• Subfamily Miodomeridinae Chavan, 1969b
• Subfamily Thecaliinae Dall, 1903
• Subfamily Venericardiinae Chavan, 1969b
Family Condylocardiiidae Félix Bernard, 1896
• Subfamily Condylocardinae Félix Bernard, 1896
• Subfamily Coninidae Chavan, 1969b
• Family Myophoricardiidae Chavan in Cox & Chavan, 1969

Subcohort Cardioni Férussac, 1822 in 1821–1822 (=Euheterodonta Giribet & Distel, 2003)

Infrasubcohort Lucinidia J. Gray, 1854a
( paraplesion ) • Superfamily Babinkoidea! Horný, 1960
• Family Babinkidae! Horný, 1960
• Family Coxiconchiidae Babin, 1977

Order Lucinida J. Gray, 1854a
Superfamily Lucinoidea! J. Fleming, 1828
• Family Lucinidae J. Fleming, 1828
• Subfamily Lucininae J. Fleming, 1828
• Family Fimbriidae Nicol, 1950 (Stoliczka, 1870 in 1870–1871)
• Subfamily Ilioniinae Scarlato & Starobogatov, 1979a
• Subfamily Milthinidae! Chavan, 1969a
• Subfamily Myrteinidae Chavan, 1969a
• Family Mactromyidae Cox, 1929 (P. Fischer, 1887)
• Family Paracyclidae! P. A. Johnston, 1993

Superfamily Thyasiroidoidea Dall, 1900 (Dall, 1895a)
• Family Thyasiroidae Dall, 1900 (Dall, 1895a)
• Subfamily Thyasirinae! Dall, 1900 (Dall, 1895a)
• Subfamily Axinopsidinae Frank Bernard, 1983

Infrasubcohort Cardidiida Férussac, 1822 in 1821–1822
(paraplesion) • Superfamily Grammysioidea! S. A. Miller, 1877
• Family Grammysiidae! S. A. Miller, 1877
• Subfamily Grammysinae S. A. Miller, 1877
• Subfamily Cuneaminidae! N. Morris, Dickins, & Astafeva-Urbajtis, 1991
• Family Sanguinolitidae! S. A. Miller, 1877
• Subfamily Sanguinolitinae! S. A. Miller, 1877
• Subfamily Alulinae N. Morris, Dickins, & Astafeva-Urbajtis, 1991
• Subfamily Paleodorinae Carter, nov.
• Subfamily Pholadellinae S. A. Miller, 1877
• Subfamily Undulomyinae Astafeva-Urbajtis, 1983

Megaorder Cardiata Férussac, 1822 in 1821–1822 (=Neoheterodonta Taylor & others, 2007)
Superorder Cardiformia Férussac, 1822 in 1821–1822
• Order Modiomorphida! Newell, 1969c
• Superfamily Modiomorphoidea! S. A. Miller, 1877
• Family Modiomorphidae! S. A. Miller, 1877
• Subfamily Modiomorphinae! S. A. Miller, 1877
• Subfamily Butoviciellinae Kříž, 1965
• Subfamily Healevinae! Hautmann, 2008
• Subfamily Joannininae Carter, nov.
• Family Cypricardiniidae Ulrich in Ulrich & Scofield, 1894
• Family Hippopodiidae Cox in Cox & LaRocque, 1969
• Family Palaeopharidae Marwick, 1953
• Family Tusayanidae Scarlato & Starobogatov, 1979a

• Order Megalodontida! Starobogatov, 1992
• Superfamily Megalodontoidea! Haffer, 1959
• Family Megalodontidae! Haffer, 1959
• Family Reichuaniidae Liu Xie-zhang & Gu in Hou Hong-fei, Wan, & Xian, 1988
• Family Congeriomorphidae Saul, 1976
• Family Plethocardiidae! Scarlato & Starobogatov, 1979a
• Family Prosocoeidae! Karczewski, 1992
• Superfamily Megalodontoidea! J. Morris & Lycett, 1853
• Family Megalodontidae! J. Morris & Lycett, 1853
• Family Ceratomyopsidae Cox, 1964
• Family Dicerocardiidae! Kutass, 1934
• Family PachyrismatidaeScarlatato & Starobogatov, 1979a
• Family WallowaconchidaeYancey & Stanley, 1999

Order HippuritidaNewell, 1965
• Superfamily RequienioideaKutassy, 1934
  • Family RequieniidaeKutassy, 1934
  • Subfamily RequieniinaeKutassy, 1934
  • Subfamily MatheroniinaeR. Scott & others, 2010
• Family EpipodecididaeRengarten, 1950

Superfamily Radiolitoidea d’Orbigny, 1847b
• Family Radiolitidae d’Orbigny, 1847b
• Subfamily Antillocaprinidae Mac Gillavry, 1937
• Family Caprinidae d’Orbigny, 1847b
  • Subfamily Caprininae d’Orbigny, 1847b
  • Subfamily CaprinuloideinaeDamestoy, 1971
• Family CaprinulidaeYanin, 1990
• Family CaprotinidaeJ. Gray, 1848
• Family DiceratidaeDall, 1895a
• Family Hippuritidae J. Gray, 1848
• Family Ichthyosarcolitidae Douvillé, 1887 (T. Gill, 1871)
• Family Monopleuridae Munier-Chalmas, 1873
• Family Plagioptychidae Douvillé, 1888
• Family Polyconitidae Mac Gillavry, 1937
• Family Trechmannellidae Cox, 1934

Order Cardiida Férussac, 1822 in 1821–1822
(paraplesion) • Superfamily Kalenteroidea Marwick, 1953
• Family Kalenteridae! Marwick, 1953
  • Subfamily Kalenterinae! Marwick, 1953
  • Subfamily Myoconchinae! Newell, 1957

Suborder Cardiida Férussac, 1822 in 1821–1822
(paraplesion) • Family Palaeocarditidae! Chavan, 1969b

Hyporder Cardioidae Férussac, 1822 in 1821–1822
Superfamily Cardioididea Lamarck, 1809
• Family PterocardidaeScarlatato & Starobogatov, 1979a
  • Subfamily Pterocardinae Scarlatato & Starobogatov, 1979a
  • Subfamily Tulangocardinae! J. Schneider, 1995
Family Cardiidae! Lamarck, 1809
• Subfamily Lahillinae Finlay & Marwick, 1937
Subfamily Protocardinae Reuss, 1846 in 1845–1846
Clade Neocardiids J. Carter, Hylleberg, & Popov, nov.
  • Subfamily Laevicardiinae Keen, 1951
  • Subfamily Pleurocardinae! J. Schneider, 1995
Clade Eucardiids J. Schneider, 1995

Subfamily Cardiinae! Lamarck, 1809
  Tribe Cardiini! Lamarck, 1809
  Tribe Vepricardiini Kafanov & Starobogatov in Kafanov & Popov, 1977
Subfamily Cerastodermatinae! Nordsieck, 1969
  Tribe Cerastodermatini! Nordsieck, 1969
  • Tribe Chokrakiini S. V. Popov in Nevesskaja, Paramonova, & Popov, 2001
  • Tribe Parvicardiini! Kafanov & Starobogatov in Kafanov & S. V. Popov, 1977
Subfamily Clinocardiinae Kafanov, 1975
Subfamily Fraginiae R. Stewart, 1930
  Tribe Fragini R. Stewart, 1930
  • Tribe Goniocardini Scarlatato & Starobogatov, 1979a
Subfamily Lymnocardiinae! Stoliczka, 1870 in 1870–1871
  • Tribe Lymnocardiini! Stoliczka, 1870 in 1870–1871
  • Tribe Acobaecardiini Paramonova in Nevesskaja, Paramonova, & Popov, 1986
  • Tribe Adacnini! T. Gill, 1871
  • Tribe Arcicardiini Nevell, 1871
  • Tribe Avicardiini Scarlatato & Starobogatov, 1979a
  • Tribe Aviculocardiini Paramonova in Nevesskaja, Paramonova, & Popov, 1986
  • Tribe Planacardiini Paramonova in Nevesskaja, Paramonova, & Popov, 1986
• Tribe Plicatiformini! Paramonova in Nevesskaja, Paramonova, & Popov, 2001
• Tribe Pontalmynini! Taktakishvili, 1987
• Tribe Prosodacnini Keen, 1937
• Tribe Pseudocarditini Keen, 1969b
Subfamily Orthocardinae J. Schneider, 2002
• Subfamily Profraginae Badve, 1977
• Subfamily Trapenicardiinae Kanjilal & Srinivasan, 2002
Subfamily Tridacninae Lamarck, 1819

Superfamily Tellinoidea Blainville, 1814
Family Tellinidae Blainville, 1814
• Family Icanotiidae R. Casey, 1961
Family Psammobiidae J. Fleming, 1828
• Family Quenstedtiidae Cox, 1929
Family Semelidae Stoliczka, 1870 in 1870–1871 (Latreille, 1825)
• Subfamily Semelinae! Stoliczka, 1870 in 1870–1871 (Latreille, 1825)
Subfamily Erviliinae Dall, 1895b
• Subfamily Scrobiculariinae H. Adams & A. Adams, 1856
Family Solecurtidae d’Orbigny, 1846
• Family Sowerbyidae Cox, 1929
• Family Tancrediidae F. Meek, 1864a
• Family Unicardiopsidae Chavan, 1969c

Hypoder Veneroidei J. Gray, 1854a
Minorder Veneroitei J. Gray, 1854a

Superfamily Arcticoidea! R. Newton, 1891 (d’Orbigny, 1844 in 1844–1848)
• Family Arcticidae! R. Newton, 1891 (d’Orbigny, 1844 in 1844–1848)
Family Euloxidae J. A. Gardner, 1944
• Family Pollicidae L. Stephenson, 1953
Family T rapezidae Lamy, 1920 (Dall, 1895a)
Superfamily Gaimardioidaia Hedley, 1916
Family Gaimardiidae Hedley, 1916
Superfamily Glossoidea J. Gray, 1847b (J. Gray, 1853)
Family Glossidae J. Gray, 1847b (J. Gray, 1840b)
Family Kelliellidae P. Fischer, 1887
Family Vesicomyidae Dall & Simpson, 1901
Superfamily Hemidonoidea Scarlato & Starobogatov in Nevesskaja & others, 1971
Family Hemidonoidea Scarlato & Starobogatov in Nevesskaja & others, 1971
Superfamily Mactroidea Lamarck, 1809
Family Mactridae! Lamarck, 1809
• Subfamily Mactrinae! Lamarck, 1809
• Subfamily Darininae Signorelli, nov.
• Subfamily Kymatoxinae Stenzel & Krause in Stenzel, Krause, & Twining, 1957
• Subfamily Lutrariniae J. Gray, 1853
• Subfamily Tanysiphoninae Scarlato & Starobogatov in Nevesskaja & others, 1971
Family Anatinellidae Deshayes in J. Gray, 1853
Family Cardilliidae P. Fischer, 1887
Family Mesodesmatidae J. Gray, 1840b
• Subfamily Mesodesmatinae J. Gray, 1840b
• Subfamily Davilinae Dall, 1895b
Superfamily Ungulinoidea J. Gray, 1854b
Family Unguliiidae J. Gray, 1854b
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Tribes

- Subtribe Meretricina! J. Gray, 1847b (J. Gray, 1838)
- Subtribe Callocardiina! Dall, 1895a
- Subtribe Clementiina! Frizzell, 1936
- Subtribe Cyclinina! Frizzell, 1936
- Subtribe Gemmina Dall, 1895a
- Subtribe Petricolina d’Orbigny, 1840
- Subtribe Samarangiina Keen, 1969c
- Subtribe Sunettina Stoliczka, 1870 in 1870–1871
- Subtribe Turtoniina W. Clark, 1855

- Subtribe Gouldiina! R. Stewart, 1930
- Subtribe Lioconchina Habe, 1977

Minorder Dreissenoidae R. Moore in Moore, Lalicker, & Fischer, 1952
- Superfamily Dreissenoidae J. Gray, 1840a
- Family Dreissenidae J. Gray, 1840a
- Subfamily Dreisseninae J. Gray, 1840a
- •Subfamily Dreissenomyinae Babak, 1983

- Superfamily Sphaerioidae! Deshayes, 1855b (Rafinesque, 1820)
- Family Sphaeridae! Deshayes, 1855b (Rafinesque, 1820)
- Subfamily Sphaeriinae! Deshayes, 1855b (Rafinesque, 1820)
- Subfamily Euperinae Heard, 1965
- Subfamily Pisidiinae J. Gray, 1857

- •Family Neomiodontidae R. Casey, 1955
- •Subfamily Neomiodontinae R. Casey, 1955
- •Subfamily Eomiodontinae Hayami, 1965

Suborder Gastrochaenidina Morreteres, 1949
- Superfamily Gastrochaenoidea J. Gray, 1840b
- Family Gastrochaenidae J. Gray, 1840b
- Subfamily Gastrochaeninae J. Gray, 1840b
- Subfamily Eufistulaninae Carter, nov.
- Subfamily Spengleriinae! Carter, nov.

- •Suborder Anthracosidina Silantiev & Carter, 2011
- •Superfamily Anthracosioidea Amalitzky, 1892
- •Family Anthracosioidea Amalitzky, 1892
- •Family Ferganococonchidae Martinson, 1961
- •Family Shaanxiconchidae Liu Ben-pei in Liu Ben-pei & Li, 1980
- •Superfamily Palaeanodontoidae Modell, 1964
- •Family Palaeanodontidae Modell, 1964
- •Superfamily Prilukielloidea Starobogatov, 1970
- •Family Prilukiellidae Starobogatov, 1970
- •Family Senderzoniellidae Betekhtina, Starobogatov, & Jatsuk, 1987

Suborder Leptonidina Dall, 1889
- Superfamily Cyamioidea! G. O. Sars, 1878
- Family Cyamiidae G. O. Sars, 1878
- Family Basterotiidae Cossmann in Cossmann & Peyrot, 1909
- Family Galatheavalvidae Knudsen, 1970
- Family Sportellidae! Dall, 1899
- Superfamily Galeommatoidae J. Gray, 1840b
- Family Galeommatidae J. Gray, 1840b
- Family Lasaecidae J. Gray, 1842

Superorder Pholadiformes J. Gray, 1854a
- Order Pholadida J. Gray, 1854a
- Superfamily Pholadoidea Lamarck, 1809
- Family Pholadidae! Lamarck, 1809
- Subfamily Pholadinae Lamarck, 1809
- Tribe Pholadini! Lamarck, 1809
- •Tribe Euxinibarneini Zhgenti, 1991
- •Subfamily Jouannetiinae Tryon, 1862b
- •Subfamily Martesiinae U. Grant & Gale, 1931
- •Subfamily Xylophaginae! Purchon, 1941
- Family Teredinidae Rafinesque, 1815
- Subfamily Teredininae Rafinesque, 1815
- Tribe Teredinini Rafinesque, 1815
- Tribe Bankiini Turner, 1966
- Subfamily Kuphinae Tryon, 1862b
- •Superfamily Pleuromyoidae! Zittel, 1895
- •Family Pleuromyidae! Zittel, 1895

Superfamily Pleuromyoidae! Zittel, 1895
- Family Pleuromyidae! Zittel, 1895
• Family Ceratomyidae! Arkell, 1934
  • Subfamily Ceratomyinae! Arkell, 1934
  • Subfamily Myopholadinae! Cox, 1964
• Family Vacunellidae! Astafeva-Urbajtis, 1973

Superfamily Myoidea Lamarck, 1809
Family Myidae Lamarck, 1809
  • Subfamily Myinae Lamarck, 1809
  • Subfamily Cryptomyinae Habe, 1977
  • Subfamily Spheniinae! Frank Bernard, 1983
Family Corbulidae! Lamarck, 1818
  • Subfamily Caestocorbulinae H. Vokes, 1945
  • Subfamily Caryocorbulinae H. Vokes, 1945
  • Subfamily Erodoninae Winckworth, 1932
  • Subfamily Pachydontinae H. Vokes, 1945
• Family Pleurodesmatidae Cossmann in Cossmann & Peyrot, 1909
• Family Raetomyidae R. Newton, 1919

Megaorder Poromyata Ridewood, 1903
Order Poromyidae Ridewood, 1903
  • Superfamily Poromyoidea Dall, 1886
    • Family Poromyidae! Dall, 1886
    • Family Cetoconchidae Ridewood, 1903
  • Superfamily Cuspidarioidea Dall, 1886
    • Family Halonymphidae Scarlato & Starobogatov, 1983
    • Family Protocuspidariidae Scarlato & Starobogatov, 1983
? Family Spheniopsidae J. A. Gardner, 1928
• Superfamily Parilimyoidea! B. Morton, 1981
  • Family Parilimyidae! B. Morton, 1981
• Superfamily Verticordioidea! Stoliczka, 1870 in 1870–1871
  • Family Verticordiidae! Stoliczka, 1870 in 1870–1871
  • Family Euciroidae! Dall, 1895a
• Order Pandorida! Newell, 1965
  • Superfamily Pandoroidea! Rafinesque, 1815
    • Family Pandoridae Rafinesque, 1815
    • Family Laternulidae! Hedley, 1918 (J. Gray, 1840b)
    • Family Lyonsiidae! P. Fischer, 1887
• Superfamily Clavagelloidea! d’Orbigny, 1844 in 1844–1848
  • Family Clavagellidae! d’Orbigny, 1844 in 1844–1848
  • Family Penicillidae! J. Gray, 1858
• Order Thraciida! Carter, nov.
  • Superfamily Thracioidae! Stoliczka, 1870 in 1870–1871 (Couthouy, 1839)
    • Family Thraciidae! Stoliczka, 1870 in 1870–1871 (Couthouy, 1839)
    • Family Burmesiidae M. Healey, 1908
    • Family Cleidothaeridae Hedley, 1918 (Stoliczka, 1870 in 1870–1871)
• Family Myochamidae P. P. Carpenter, 1861
• Family Periplomatidae Dall, 1895a

Megaorder Solenata Dall, 1889
Order Solenida Dall, 1889
• Superfamily Orthonotoidea! S. A. Miller, 1877
  • Family Orthonoridae! S. A. Miller, 1877
  • Family Konduridae! Sánchez in Sánchez & Benedetto, 2007
  • Family Prothyridae S. A. Miller, 1889
  • Family Solenomorphidae Cockerell, 1915
    • Subfamily Solenomorphinae Cockerell, 1915
    • Subfamily Promacrinae Scarlato & Starobogatov, 1979a
• Superfamily Solenoidea Lamarck, 1809
  • Family Solenidae Lamarck, 1809
  • Family Pharidae! H. Adams & A. Adams, 1856
Subfamily Calpellinae A. Davies, 1935
Subfamily Novaculininae Ghosh, 1920
Subfamily Pharellinae Stoliczka, 1870 in 1870–1871
Subfamily Rzhakiinae Korobkov, 1954
Subfamily Siliquinae! Bronn, 1862
Order Hiatellida Carter, nov.

Superfamily Hiatelloidea J. Gray, 1824
Family Hiatellidae J. Gray, 1824
Subfamily Panopeinae! Bronn, 1862
Family Saxicavellidae! P. H. Scott, 1994

Superfamily Edmondioidea! W. King, 1850
Family Edmondioidea! W. King, 1850
Family Pachydomidae! P. Fischer, 1887

Subfamily Pachydominae! P. Fischer, 1887
Tribe Pachydomini P. Fischer, 1887
Tribe Astartilini Waterhouse, 1969
Tribe Holdhuaussellini Beurlen, 1954
Tribe Pleiocyprianellini Simões & others, 1997

Subfamily Myoniinae Scarlato & Starobogatov, 1979a

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APPENDIX 1. NEW SUPRAGENERIC TAXA AND UNRANKED CLADE NAMES

Abbreviations: CL, simple crossed lamellar; CCL, complex crossed lamellar; ISP, irregular simple prismatic; RSP, regular simple prismatic.


Anadontellidae Silantiev, herein, fam. nov. Type genus, Anadon-
tella Betekhtina in Betekhtina, Starobogatov, & Jatsuk, 1987, p. 41. Family diagnosis: members of the superfamily Prokopievskioidea with relatively thin, elongate, subtriangular (Anhazracama-like) or subrectangular, equivale or slightly inequivale shells, with an edentulous hinge, distinctly multilayered shells with fine, commarginal growth lines, and no radial microsculpture. Some forms (e.g., Synjaella) are strongly tapered posteroventrally and have a sinuses-like concavity on the posterior and ventral margins. Ligament opisthodetic, possibly submersed, with single, narrow ligament groove appearing on internal molds, possibly representing secondarily simplified duplivincular ligament. Outer shell layer calcitic irregular simple prismatic or fibrous prismatic, middle and inner shell layers nacreous, except immediately internal to ISP pallial myostracum, where irregular CCL is developed. Nonmarine. Anadontellida resembles Naiaditidae but differs from Prokopievskioidea in lacking radial microsculpture. At least Anadontella differs from some Prokopievskioidea and Naiaditidae in having a distinct sublayer of irregular CCL between the pallial myostracum and the nacreous inner part of the inner shell layer. Anadontellidae differs from Naiaditidae in having a single, narrow, opisthodetic ligament groove instead of an amphidetic, duplivincular ligament. This family also contains Soanellina Betekhtina, 1990, and Synjaella Kaney, 1993.

Antijaniridae Hautmann, herein, fam. nov. Type genus, Antijanira Bittner, 1901, p. 49. Family diagnosis: small shells with well-developed radial ribs occasionally bearing spines; ribs either equal in strength or intercalated in two or more ranks; discs circular to slightly retrocrescent, biconvex or with right disc flatter; dorsal margin straight and relatively short; beaks located close to midpoint of dorsal margin; byssal notch well developed; ctenolium not observed; ligament alivincular-areate, with centrally or slightly posteriorly located resilifer; shell with calcitic outer shell layer, regular simple prismatic in right valve and predominantly homogeneous in left valve, plus aragonitic crossed lamellar middle and inner shell layers. Comparisons: the ligament system indicates affinity with taxa presently classified with Aviculopectinoidea or Heterpectinoidea, contrary to Hertlein’s (1969, p. 355) placement of the “Antijinira group” in Pectinidae. The style of ornamentation in Antijaniridae is not observed in other Triassic Aviculopectinoidea or Heterpectinoidea, except for Ornithopecten (Ornithopectinoidea), which differs in having a broad right posterior wing and a delicate right anterior auricle. This family also contains Amphijanira Bittner, 1901, and Oxyperia Waagen, 1907. The affinity of Oxyperia to this group was first recognized by Allasinaz (1972, p. 266).

Arenigomyidae Carter, herein, fam. nov. Type genus, Arenigo-
mya Cope, 1996, p. 1017. Cope (1996, p. 1017) gave the following diagnosis for Arenigomya, which is also the present family diagnosis: “Equivalve, edentulous, trapezoidal bivalve with length one-and-a-half times greater than height. Surface with fine concentric undulose ornament, radial striae and anteriorly prominent commarginal rugae. Surface detail of finely granulose ornament. Strong carina runs from posterior side of umbo to postero-ventral margin of valves. Each valve with subumbonal articulation device.” This family is monogenic.

Aulacomyinae Carter, herein, tribe nov. Type genus, Aula-
comya Mörrch, 1853 in 1852–1853, p. 53. This new tribe is proposed because Perninae Scarlato & Starobogatov, 1979b, p. 24, is invalid;
its type genus was given without author or date but is inferred from the context to be *Perna* Philipsson in Retzius, 1788. This *Perninae* is a junior homonym of Pernaeidae J. Fleming, 1828 (spelling corrected by Zittel, 1895, to *Perninae*, the latter based on *Perna* Bruguère, 1789, in Bruguère, Lamarck, & Deshayes, 1789–1832, a junior synonym of *Isognomon* Lightfoot, 1786). Tribe Aulacomyini diagnosis: smooth or radially ribbed, mytiliform members of Mytilinina in which the anterior adductor muscle is present only in the juvenile stage. Other than the type genus, this tribe contains *Ischadium* Jukes-Browne, 1905, *Perna* Philipsson in Retzius, 1788, and *Choromytilus* T. Soot-Ryen, 1952.


*Concinellinae Silantiev, herein, subfam. nov.* Type genus, *Concinella* Betekhtina, 1966, p. 108, 198. Subfamily diagnosis: members of family *Prokopieskiidae* with thin, subcircular to subtriangular, inequivalve or equivalue, edentulous shells, probably an opisthodetic, possibly submerged ligament with a single, narrow ligament groove appearing on internal molds, possibly representing a secondarily simplified, duplivincular ligament. Ornamentation of regularly imbricated growth lines and fine radial striae. Outer shell layer calcitic irregular simple prismatic; middle and inner shell layers nacreous. Nonmarine. This subfamily is monogenic.

*Crasstellopidae Carter, herein, fam. nov.* Type genus, *Crasstellopsis* Beushausen, 1895, p. 146. The following family diagnosis is modified from the description of *Crasstellopsis* by P. A. Johnston (1993): two cardinal teeth in right valve, one anterior and one central, the latter bordered posteriorly by a narrow shell; two cardinal teeth in left valve, left cardinal tooth immediately posterior to left pivalo cardinal is slender and directed posterorventrally; right cardinal tooth anterior to right pivalo cardinal is slender and directed anterorventrally; no lateral teeth and no shell marginal teeth. Shell shape similar to *Astarte*, trigonally suboval or subcircular; umbos pointed, progostrate; shell margin broadly concave immediately anterior to umbos, convex elsewhere; lunule and escutcheon absent; exterior ornament of commarginal ribs, rugae, and growth lines; ribs generally prominent and regularly spaced in early growth stages, in some cases diminishing gradually throughout ontogeny. Hinge plate narrow or broad. Anterior adductor muscle scar reniform or moderately elongate; posterior adductor muscle scar larger. Anterior pedal retractor scar positioned above and separate from anterior adductor scar; above this scar 2 to possibly 4 subumbonal muscle scars are positioned at the junction of hinge plate and the shell interior, with the dorsalmost of these scars most prominent and usually positioned directly below the left or right principal cardinal tooth or its socket in the opposite valve. Posterior internal radial ridge present immediately anterior to posterior adductor muscle scar. Pallial line continuous, nonnissuate, relatively close to shell margin ventrally. Lamellar sublayer of ligament inserting into opisthodetic, narrow, submarginal fossette, but fibrous sublayer of ligament inserting within a strongly oblique, short resilifer; ligament sublayers separated by indistinct ridge on posterior margin of resilifer. This family is monogenic.

*Darininae Signorelli, herein, subfam. nov.* Type genus, *Darina* J. Gray, 1853, p. 42. Subfamily diagnosis: members of Mactridae with thin, fragile, oval to subcircular, elongate, anteriorly and posteriorly gaping shells, nearly median umbo, a rudimentary, external ligament, a large resilium on a ventrally to posterorventrally strongly projecting chondrophore, a subduded posterior umbonal ridge, and hinge dentition that is concentrated on the central part of the hinge. This subfamily also contains *Daricina* B. Clark & Durham, 1946. Darininae differs from Mactridae in having a more elongate shell shape, thinner, more pellucid valves, and more medially concentrated hinge dentition. It differs from *Kymotoxinae* in having a more elongate, more nearly equilateral shell shape, anterior as well as posterior gapes, less prominent sculpture, and stronger anterior lateral teeth. It differs from *Lutrariinae* in having a more projecting chondrophore and more median umbo.

*Entoliidina Hautmann, herein, subord. nov., nom. transl. et correct.* M. Hautmann, herein, *ex* *Entoliinae* Teppner, 1922, p. 89. A suborder proposed for the superfamilies Euchondrioidae and Entolioidae, as indicated above.

*Eubivalvia Carter, herein, unranked clade nov.* A descriptive clade name proposed for the subclasses Protobranchia and Autobranchia.

*Eufistulinae Carter, herein, subfam. nov.* Type genus, *Eufistulana* Eames, 1951, p. 445. Subfamily diagnosis: obligate tube-dwelling *Gastrochaenidae* with long, straight-sided tubes; long, largely fused siphons sensu strictior, minute siphonal papillae on incurrent but not excurrent siphonal aperture; anterior pedal retractor muscles passing around visceral mass as they approach the foot; the ventral surface of the foot elongate-ovate in the lateral direction. This subfamily differs from *Spengleriinae* and *Gastrochaeninae* in having obligate tube-dwelling life habits in which the tube is very elongate and straight sided, in lacking papillae on the excurrent siphon, and in having a laterally expanded instead of round to anteroposteriorly elongate ventral pedal surface. This family also contains *Kummelia* L. Stephenson, 1937.

*Hiatellida Carter, herein, ord. nov., nom. transl. et correct.* Carter, herein, *ex* *Hyatellidae* J. Gray, 1824, based on *Hyatella*, an incorrect subsequent spelling of *Hiatella* Bosc *ex* Daudin MS, 1801; =suborder Saxicavidea Morretes, 1949, p. 47, invalid, based on the junior synonym *Saxicava* Fleurieu de Bellevue, 1802 (= *Hiatella* Bosc *ex* Daudin MS, 1801). Taxonomic content indicated above.

*Joanninae Carter, herein, subfam. nov.* Type genus, *Joannina* Waagen, 1907, p. 94. Subfamily diagnosis: edentulous members of Modiomorphidae differing from the sister superfamilies Modiomorphinae and Healeyinae in having more dorsally projecting umbos, better defined anterior auricles, a narrower hinge plate, and, with the exception of *Leidapococha*, a shorter, more external ligament nymph and growth lines not continuing from a lunule onto the subumbonal hinge plate. This subfamily also contains *Propostula* Kirtl, 1904, *Waijiaoella* Stillier & Chen, 2006, *Qingyaniola* Stillier & Chen, 2006, and *Leidapococha* Stillier & Chen, 2006.

*Neocardiidae Carter, Hylleberg, & Popov, herein, unranked clade nov.* A descriptive name proposed for the clade of *Laevicardiinae* + *Pleurociardiinae* + *Euercardiidae* sensu J. Schneider (1995, 1998a).

*Omnithopectinidae Hautmann, herein, fam. nov.* Type genus, *Omnithopecten* Cox, 1962, p. 596. Family diagnosis: discs inequalities, retrocrescent, posteriorly slightly expanded; beaks located well in front of midpoint of dorsal margin; right anterior auricle delicate, with narrow subauricular byssal notch; right posterior wing broad, poorly differentiated but distally pointed; left anterior auricle poorly...
differentiated, with indistinct auricular sinus; ornament with radial ribs usually intercalated in different ranks, superimposed by regularly spaced commarginal ribs. Comparisons: Ornithopectinidae differs from the closely related Antianidraidae chiefly in the anteriorly positioned beaks, retrocrescent dics, and broad posterior wing. This family is monogenic.

**Ovatoconchiidae Carter, herein, fam. nov.** Type genus, *Ovatoconcha* Cope, 1996, p. 988. Family diagnosis: members of superfamily Solemyoidea with anteriorly produced shell, as in *Ctenodonta* and *Solemya*, but lacking parivincular nymphs and possibly also lacking palaeotaxodont hinge teeth in adult shell. This family is monogenic.

**Paleodorinae Carter, herein, subfam. nov.** Type genus, *Paleodora* Carter & Pojeta, 1995, p. 190. Subfamily diagnosis: members of family Solemyidae, but lacking parivincular nymphs and possibly also lacking palaeotaxodont hinge teeth in adult shell. This family is monogenic.

**Pleuronecitidae Hautmann, herein, fam. nov.** Type genus, *Pleuronectites* Schlotheim, 1820, p. 217. Family diagnosis: discs procrescent, height of valves greater than length, left valve more convex than right; shell exterior smooth or with radial ribs; right anterior auricle with auricular scroll and deep byssal notch; ctenolium present; right posterior auricle obtuse but well delimitated, not projecting above hinge margin; auricles of left valve lacking auricular sinuses and dorsally levelling with hinge margin; ligament alivincular-ate, small bourrelets may be present; hinge lacking residual teeth; shell interior without buttresses; shell with thin, calcitic outer shell layer, divided into radial sectors with irregular foliated to radially fibrous prismatic structure; aragonitic middle and inner shell layers with evidence of linear to slightly branching crossed lamellar structure. Comparisons and comment: Pleuronectitidae differs from other families of Pectinoidea (as defined by the presence of both an alivincular-ate ligament and a ctenolium, thus excluding the Entoloiidea) in having procrescent discs, a flat right valve, a well-developed right anterior auricular scroll, and in lacking teeth and internal buttresses. This family tentatively also contains Lower and Middle Triassic *Peritriaria* Li Jin-hua & Ding, 1981.

**Saturnopectininae D. Campbell, herein, subfam. nov.** Nom. subst. D. Campbell, herein, *pro* Saturnellinae Astafieva, 1994, p. 12, invalid, based on *Saturnella Astafieva*, 1994, a preoccupied name. Type genus, *Saturnopetes* C. Fleming, 1957, p. 943. Subfamily diagnosis: members of family *Sanguinolitidae* with elongate, subrectangular, slightly sickle-shaped shell with anterior end short and rounded, posterior end longer; posteriorly rounded and dorsoposteriorly truncate; ornament of low, commarginal ribs, replaced by fine growth lines on the relatively flat, dorsoposterior area; hinge unknown, possibly lacking distinct teeth; sharply elevated, internal shell lamellae radiating from area below beaks anteroventrally and toward the posterior. This subfamily is monogenic.

**Spengleriinae Carter, herein, subfam. nov.** Type genus, *Spengleria* Tryon, 1862a, p. 472, 485. Subfamily diagnosis: obligate endolithic *Gastrochaenidae* with short to long, entirely separated siphons *sensu stricto*, and with little or no extension of ctenidia and mantle cavity posterior to shell margins. Beaks slightly to moderately anterior, never far anterior or terminal. Numerous, minute siphonal papillae surround each siphonal aperture. Anterior pedal retractor muscles pass around visceral mass as they approach the sole of the foot; ventral surface of foot nearly circular to elongate-ovate in anteroposterior direction. This subfamily differs from *Gastrochaeninae* in having siphons *sensu stricto* that are entirely separated, and by having little or no extension of the ctenidia and mantle cavity posterior to the shell margins. It differs from *Eufustulinae* in having entirely separated siphons *sensu stricto*, and in having obligate endolithic instead of obligate tube dwelling habits. This family also contains *Gastrochaenopsis* Chavan, 1952c, and *Spengleriachaena* Carter, *gen. nov.*


**APPENDIX 2. NEW GENERA AND SPECIES**

**Superfamily Gastrochaenoidea J. Gray, 1840b**

**Family Gastrochaenidae J. Gray, 1840b**

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**Stenoachaena Carter, herein, gen. nov.**

Figure 1

*Type species.—*Gastrochaena lacera* Belokrys, 1991, p. 10.

**Discussion.—**The genus *Stenoachaena* is presently proposed for Middle Eocene *Gastrochaena lacera* Belokrys, 1991 (p. 10, pl. 1, 1–3, fig. 1a, 2), from the Dnepropetrovsk region of Ukraine. The name *Stenoachaena* derives from the Greek *stenos* for narrow, and from a variation of *cheniskos* for the upturned prow of a boat, as in *Gastrochaena*. The new genus name is feminine. The name *Stenoachaena* reflects the extremely small pedal gape and boatlike shape of the united valves. In addition to *Stenoachaena lacera*, this genus includes Upper Jurassic *Gastrochaena zitteli* Boehm, 1883, from Sramberk, Czech Republic, and Jurassic *Gastrochaena valfinensis* de Loril, 1888, in de Loril & Bourgeat, 1886–1888, from Valfin, eastern France (possibly a juvenile of *Stenoachaena zitteli*).

**Generic diagnosis and description.—**Members of *Gastrochaeninae* with a greatly posteriorly elongated, small- to medium-sized shell (9.5–38 mm long), with far anterior but not terminal beaks, a very small, anteriorly restricted pedal gape (comprising less than 12% of shell length), and pedal gape margins oriented at a high angle (over 60°) relative to the hinge axis. The shell’s posterior is narrowly ovate.
and ornamented with regularly spaced, erect, commarginal lamellae (Stenochaena zitteli) or irregularly spaced growth lines (Stenochaena lacera). There are no mineralized periostracal spikes or spines cemented to the shell. The boring’s shell chamber is subcylindrical, tapering far anteriorly and far posteriorly to conform with the shell’s shape. The anterior half of the siphonal boring appears like a slightly narrower extension of the shell chamber, without a strong constriction in boring width at the base of the siphons. The posterior half of the siphonal boring is divided into incurrent and excurrent areas that diverge at an angle of 20°–25°. The hinge is thin, edentulous, and lacks myophores. Posterior to the beaks, the hinge is slightly convex and nearly parallel with the ventral shell margin; anterior to the beaks, it is very short, dorsally slightly deflected, and laterally strongly deflected (about 60°) from the subumbonal hinge axis. This lateral deflection frames a distinct, triangular opening between the dorsoanterior shell margins. The ligament is opisthodetic and parivincular, with very thin, not strongly dorsally projecting nymphs. The anterior adductor muscle scar is positioned immediately adjacent to the deflected dorsoanterior shell margin. Other muscle scars are not visible, despite excellent preservation of the aragonitic shells.

Comparisons.—No other member of Gastrochaenidae approaches Stenochaena in its combination of a very anteriorly restricted, high-angle pedal gape and greatly posteriorly extended, nearly cylindrical shell shape.

Distribution.—Stenochaena is known only from the Upper Jurassic and Middle Eocene of Europe.

Ecology.—Specimens of Stenochaena lacera from Belokrys (1991) came from borings in the dome-shaped coral Astraeopora sphaeroidalis (Mich.). Belokrys speculated that juveniles of this species bored through living coral tissue. Although this cannot be certain, the borings are sometimes partially overgrown by coral, indicating close proximity to living coral tissue at the time of settlement. Calcareous laminae are sometimes present in the anterior of the boring’s shell chamber, indicating that the bivalves sometimes bored in a posterior direction to keep pace with coral growth.

Boehm’s (1883) specimen of Stenochaena zitteli came from an Upper Jurassic limestone at Stramberk, Czech Republic (Boehm, 1883, p. 495, pl. 53, 6–7). Boehm indicated that his specimen occupied a calcareous tube that is anteriorly thin walled and posteriorly rather thick walled. This putative tube is probably the calcareous lining of
a boring, thickened posteriorly to conform with the shell’s shape, as in modern endolithic gastrochaenids. The British Museum has in its collections an upper Tithonian, Upper Jurassic specimen of *S. zitteli*, also from Stramberk (British Museum Geology Department L23855), with impressions of a coral substratum on the exterior of its boring cast.

**Superfamily Gastrochaenoidea J. Gray, 1840b**

**Family Gastrochaenidae J. Gray, 1840b**

**Subfamily Spengleriinae Carter, herein, subfam. nov.**

**Spenglerichaena** Carter, herein, gen. nov.

Figure 2

*Type species.*—*Gastrochaena apertissima* Deshayes, 1855a, p. 326.

*Discussion.*—The genus *Spenglerichaena* is presently proposed for Recent, Indo-Pacific *Gastrochaena apertissima* Deshayes, 1855a, the type species. The name derives from *Spengleria* and *Gastrochaena*, in recognition of anatomical similarities with *Spengleria* and shell similarities, especially the lack of a raised posterior triangular area, with *Gastrochaena*. The new genus name is feminine.

*Generic diagnosis and description.*—Members of *Spengleriinae* with anteriorly strongly laterally inflated shells, moderately anterior umbo, completely divided, relatively long siphons *sensu stricto*, little or no extension of the ctenidia and posterior mantle cavity posterior to the shell margins, no raised, posterior triangular area, and no distinct umbonal-posteroventral sulcus. The shell posterior has irregular, commarginal growth lamellae and a thin, nonmineralized periostracum. The ctenidia are nonplicate, the pedal probing organ is spatulate, and the calcareous boring linings lack an annular septum and spiny baffles at the base of the siphonal boring.

*Comparisons.*—*Spenglerichaena* resembles *Spengleria* in its completely separated siphons *sensu stricto* and anterior pedal retractor muscles that pass around the visceral mass as they approach the foot. However, *Spenglerichaena* lacks the raised posterior triangular area, aragonitic periostracal spikes, distinct umbonal-posteroventral sulcus, pointed calcareous baffles in the boring lining at the base of the siphons, plicate ctenidia, and more medially positioned umbos of *Spengleria*. Its nonplicate ctenidia, spatulate pedal probing organ, lack of a raised, posterior triangular area, and lack of mineralized periostracal spikes are more typical of *Gastrochaena* and *Rocellaria*, but in those genera, the siphons *sensu stricto* and *sensu lato* are largely fused, and the ctenidia and mantle cavity are extended at least slightly into the siphonal part of the boring, posterior to the shell margins. *Spenglerichaena* differs from *Gastrochaenopsis* in having a wider, longer pedal gape, no raised posterior triangular area, and greater lateral inflation of the shell.

*Distribution.*—Borings similar to those made by *Spenglerichaena* are known from the Lutetian, Middle Eocene near Verona, Italy, but the associated shells are unknown (Savazzi, 1980). *Spenglerichaena* is therefore definitely known only from the Recent tropical Indo-West Pacific Region.
Ecology.—Spengleriachaena bores primarily into thicker coral substrata that are less subject to breakage.

Superfamily Modiomorphoidea S. A. Miller, 1877
Family Modiomorphidae S. A. Miller, 1877
Subfamily Modiomorphinae S. A. Miller, 1877

Goniophora Carter, herein, gen. nov.

Type species.—Goniophora hamiltonensis J. Hall & Whitfield, 1869, p. 36.

Discussion.—The genus Goniophora is presently proposed for sharply carinate, posteriorly obliquely truncate, subumbonally irregularly dentate modiomorphids formerly classified as Megalodon J. de C. Sowerby, 1827, in James Sowerby, 1812–1845, or Goniophora J. Phillips, 1848. The type species is presently designated as Middle Devonian Goniophora hamiltonensis J. Hall & Whitfield, 1869. The name Goniomorpha derives from Goni- (from Goniophora Phillips, 1848) and morpha (from Modiomorpha J. Hall & Whitfield, 1869).

Johnston (1993, p. 76) was aware that "Goniophora hamiltonensis is "almost certainly not congeneric with Goniophora J. Phillips, 1848, and he pointed out that it differs from true Goniophora in having a depressed, striated lunule, the growth lines of which continue onto the subumbonal hinge plate, as in Modiomorpha concentrica (Conrad, 1838) (see J. Hall, 1884 in 1883–1884, pl. 43,18–19; Bailey, 1983, fig. 47; Carter, 1990a, fig. 50A). Carter (1990a, p. 266) indicated that "Goniophora hamiltonensis belongs in Modiomorphidae, noting that it is microstructurally similar to M. concentrica, and Johnston (1993) also assigned "Goniophora hamiltonensis to Modiomorphidae.

True Goniophora is a mecygnodontid based on upper Silurian Goniophora cymbaeformis Sowerby in Murchison, 1839. This mecygnodontid resembles Goniophora in having an equiplate, strongly inequilateral, posteriorly elongate shell with simple, commarginal ornament, and a sharp, angular carina extending from the beak to the posterioventral shell margin. However, it differs from Goniophora in having prominent anterior and posterior internal ridges (Johnston, 1993, p. 74–76; Liljedahl, 1994, p. 74, fig. 521). The hinge and ligament of Goniophora cymbaeformis are unknown, but other species of this genus differ from Goniophora in having a narrower hinge plate, largely restricted to the subumbonal area, with finer, more regularly shaped cardinal teeth, an opisthodetic, parivincular ligament with shorter, more external nymphs, no strong growth lines on the subumbonal hinge plate, and no deeply impressed lunule (Liljedahl, 1994, p. 74).

Goniomorpha hamiltonensis was described and illustrated by J. Hall (1885, p. 296, pl. 43,8–15, 17–21), Carter and Tevesz (1978), Carter (1990a, p. 266–268, fig. 50), Carter, Lutz, and Tevesz (1990, p. 391), and Johnston (1993, p. 76). Other species presently included in Goniomorpha lack posterior lateral teeth, and they all have at least one, weakly to strongly developed, irregular but more or less triangular cardinal tooth in the left valve. A second, weaker cardinal tooth may be present posterior to the principal cardinal tooth in the left valve, e.g., in Lower Devonian Goniomorpha stueritzii (Beushausen, 1895) (see Maillieux, 1937, p. 136), or a large, rounded cardinal tooth may be present in the right valve, anterior to the right, principal cardinal socket, as in Lower Devonian Goniomorpha cognata (Drevermann, 1902) (see Drevermann, 1902, p. 88, pl. 10,15–16).

Carter (1990a, p. 266) incorrectly indicated that "Goniophora hamiltonensis has a very weak left posterior lateral tooth overlapping a weak right posterior lateral tooth. This was based on a misinterpretation of a shallow flexure near the base of the posterior hinge plate in an isolated left valve. Subsequent sections through united valves from the Hamilton Group near Morrisville, New York, along with the observations by C. F. Römer (1844) and Maillieux (1937), indicate a lack of lateral hinge teeth in this genus.

Generic diagnosis and description.—Goniomorpha encompasses members of subfamily Modiomorphinae with a sharply defined, umbonal-posterioventral carina, an angular, rostrate posterior, and no posterior lateral hinge teeth. Like other Modiomorphinae, the shell is equivalved, posteriorly elongate, and strongly inequilateral, with low umbos, a deeply impressed, growth-lined lunule with growth lines extending from the lunule onto a wide, subumbonal hinge plate, a weakly or more strongly developed, irregular, more or less triangular, left cardinal tooth, a flat, wide, posterior hinge plate, and slightly submerged, elongate, parivincular ligament nymphs. In some species, a second, smaller, more posterior, left cardinal tooth is also present, or a rounded cardinal tooth is present in front of the principal cardinal socket in the right valve. The adductors are heteromyarian, the anterior one deeply impressed and positioned just below the hinge, and bounded posteriorly by a low, umbonal ridge or buttress. The posterior adductor muscle scar is more shallowly impressed. The anterior pedal retractor scar is separated from
the anterior adductor scar, but the posterior pedal retractor scar is partially confluent with the posterior adductor scar. The pallial line is unknown for the type species, but it was probably integriplioidate, judging from other members of Modiomorphinae. The shell mineralogy and microstructure resemble Modiomorpha concentrica, except that mineralized periosteal spikes are fused to the shell’s exterior anteriorly (see Carter, 1990a, p. 268).

Comparisons.—Goniomorpha resembles Modiomorpha in having a crudely shaped cardinal tooth in the left valve, but Goniomorpha has a more sharply defined posterior carina, a more sharply truncate posterior, a more variable subumbonal dentition, and no posterior lateral teeth. A posterior lateral tooth is variably developed in Modiomorpha (see Carter, 1990a, p. 266).


Paleoecology.—Goniomorpha hamiltonensis occurs in the Middle Devonian Hamilton Group of central New York State also containing a high diversity of other marine invertebrates, especially the bivalves Pycnochera (Pterineidae), rare pectinoids, and the gastropods Paleaegyphaleuma and Bembexia. Goniomorpha hamiltonensis is not usually found in large concentrations.

The strongly and sharply truncate, elongate posterior and a crudely shaped posterior carina, a more sharply truncate posterior, a more variable subumbonal dentition, and no posterior lateral teeth. A posterior lateral tooth is variably developed in Modiomorpha (see Carter, 1990a, p. 266).

Type species.—Nacrolophula carolae Carter & Malchus, herein, gen. nov.

Figure 4

Type species.—Nacrolophula carolae Carter & Malchus, herein, gen. et sp. nov.

The new genus Nacrolophula is presently proposed for the new species, Carnian, Upper Triassic Nacrolophula carolae Carter & Malchus (Fig. 4), with the holotype of the latter being a well-preserved left valve from Alpe di Specie, Cassiano Formation (alt. 1900–2000 m), Italy (UNC 13497b). The holotype was described and illustrated as an unknown genus and species by Carter (1990a, p. 217–220, fig. 32). The genus name derives from the nacreous microstructure and Lophur-like shape of the type species. The species is dedicated to Carol Elizabeth Via Carter. The holotype, which has been sectioned for microstructural analysis, is deposited in the paleontological collection of the Yale University Peabody Museum of Natural History, New Haven, Connecticut.

Generic and species diagnosis.—Nacrolophula is characterized by a posteriorly instead of postero-dorsally positioned posterior adductor scar, a posterior pedal retractor scar that is partially confluent with the posterior adductor scar, a minute, anterior adductor scar, and a nacreopristic left valve that lacks siliquolitic structure, structural chambering, and chalky deposits. This diagnosis applies to the genus and to its type species.

Generic and species description.—The following description of N. carolae is based on left valve UNC 13497b. The beak is prophygose in the juvenile stage and orthogyrate in the adult stage. The hinge is slightly arched and smooth except for 9 shallow pits (possible preparation artifacts) posterior and ventral to the cardinal area. There are no chomata. The ventral and lateral internal shell margins vary from nearly smooth to slightly radially costate. The exterior has about 25 coarse, radial costae immediately adjacent to the attachment area; these increase to about 30 at the shell margins through intercalation and branching, but mostly through intercalation. A pallial line is not visible, but this could be covered by an attached brachiopod and adherent sediment. The posterior adductor muscle scar (5.1 × 3.5 mm) is ovate, higher than wide, and much larger than the anterior adductor muscle scar (1.4 × 0.8 mm); both scars are positioned near their respective shell margins, and both are elevated by a shelly buttress, that supporting the anterior adductor being more prominent by virtue of its position on a more steeply inclined shell surface. The posterior pedal retractor scar measures 1.2 × 1.0 mm, and its center is 40% from the ventral shell margin toward the dorsal end of the shell. The ligament insertion area is acutely triangular and alivinarcuate, with the fibrous attachment area distinctly impressed below narrow, distinct, anterior and posterior bourses. The “incipient” crura that Carter (1990a, p. 219) described for this specimen are actually the flanks of the alivinarcuate ligament (Hautmann, 2004, 2006). The ligament insertion area is covered by a very thin aragonitic ligamiscum of nearly vertical irregular simple prisms (ISP) and steeply dipping fibrous prisms. The underlying hinge is nacreous. The outer shell layer is very thin and varies from ISP to regular simple prismatic to homogeneous mosaic, with prisms 6–10 µm wide. The middle shell layer is nacreous and closely approaches the shell margins. Where marginal radial folds are present, the nacreous laminae are strongly reflected outward. The adductor myostromus is finely ISP. The inner shell layer is aragonitic and mostly coarsely textured ISP, with minor nacreous lensatic sublayers.

Comparisons.—Nacrolophula carolae differs from all other presently known members of Palaeolophinae in having nacre, an anterior adductor muscle scar, and a posterior pedal retractor scar. Because these features are internal, the composition of the genus is poorly known. Palaeolopha montiscaprilis (Klipstein, 1843) (Klipstein, 1843, p. 247, pl. 16,5) appears externally similar to N. carolae (see also Wöhrmann, 1889, p. 200, pl. 6, f.1–3), but illustrations of that species do not show an anterior adductor or posterior pedal retractor muscle scar. Possible congeners of Nacrolophula include certain other species assigned by Malchus (1990) to Palaeolopha, such as Carnian, Upper Triassic Palaeolopha medicus (Wöhrmann, 1889), and Palaeolopha calceoformis (Broili, 1904). However, these species are unknown both microstructurally and in the details of their muscle scars.
Figure 4. *Nacrolopha carolae* Carter & Malchus, *gen. et sp. nov.*, holotype, left valve, University of North Carolina 13497b; Carnian, Upper Triassic, Cassiano Formation, Alpe di Specie, altitude 1900–2000 m, Dolomitic Alps, northeast of Cortina d’Ampezzo, Italy: 1, interior of left valve, showing alivincular-arcuate ligament insertion area, muscle scars for posterior adductor (*PA*), anterior adductor (*AA*, supported by a slight buttress), and posterior (Continued on facing page.)
The presence of ISP and homogeneous mosaic structure in the outer shell layer of the left valve of *N. carolae* resembles some Triassic bakevelliids and gryphaeids, e.g., the Middle Triassic bakevelliid *Hoernia socialis* (Schlotheim, 1823 in 1822–1823) (Carter, 1990b, p. 337) and the Upper Triassic gryphaeid *Gryphaea nevadensis* McRoberts, 1992 (McRoberts & Carter, 1994). Some Jurassic gryphaeids retained homogeneous mosaic structure in their outer shell layer, typically between an RSP outermost sublayer and the foliated middle shell layer, e.g., in Jurassic *Gryphaea arcuata* (Lamarck, 1801) and in *Praceocypris hebridica* (Forbes, 1851) (Carter, 1990c, p. 356–359).

The dorsally rounded posterior adductor muscle scar in *N. carolae* resembles Gryphaeidae and differs from the dorsally flattened or concave posterior adductor scar in Ostreidae (Harry, 1985).

*Nacrolopha carolae* resembles Norian–Rhaetian, Upper Triassic *Umbrostrea emamii* Hautmann, 2001b, from the Nayband Formation of Iran, in having some calcitic RSP in its outer shell layer and nacre in its inner shell layers. However, *U. emamii* differs in having a regularly to irregularly foliated instead of nacreous middle shell layer. In *U. emamii*, the outer layer of the right valve is RSP to slightly ISP, whereas that of the left valve is coarsely ISP (Hautmann, 2001b, pl. 7; 2006). Structural chambers are lacking in the foliated layer. *Umbrostrea* lacks an adult anterior adductor muscle scar and adult posterior pedal retractor muscle scars (Hautmann, 2001b).

**Distribution.** — *Nacrolopha carolae* is presently known only from the Carnian, Upper Triassic, Cassiano Formation at Alpe di Specie, Italy.

### APPENDIX 3. CLASSIFICATION ABOVE FAMILY RANK

The following abstract includes all taxa at or above the rank of superfamily (superfamilies are listed in alphabetical order), plus all ple- sions and paraplesions. Taxa above the rank of order are highlighted with bold face type. Symbols: • = extinct; ! = paraphyletic.

**Class Bivalvia Linnaeus, 1758 in 1758–1759**

- **Grade Euprotobranchia! Nevesskaja, 2009**
  - Order Fordillida! Pojeta, 1975: •Superfamily Fordillioidea! Pojeta, 1975
  - Order Tuarangiida MacKinnon, 1982

- **Clade Eubivalvia Carter, nov.**
  - **Subclass Protobranchia Pelseneer, 1889 (=Palaeotaxodonta Korobkov, 1954)**
    - **Superorder Nuculiformii! Dall, 1889 (=Foliobranchia Ménégaux, 1889)**
      - Order Nuculida! Dall, 1889: Superfamily Nuculoidea! J. Gray, 1824; Superfamily Pectinomyoidea Sanders & Allen, 1973
      - Order Solemyida Dall, 1889: Superfamily Manzanelloidea Chronic, 1952; Superfamily Solemyoidea! J. Gray, 1840b
  - **Superorder Nuculaniformii Carter, Campbell, & Campbell, 2000**
    - Order Afghandesmatida! Carter, nov.: •Superfamily Afghandesmatoidea! Scarlato & Starobogatov, 1979a; •Superfamily Tironuculoidea Babin in Babin & others, 1982
  - **Subclass Autobranchia Grobben, 1894**
    - **Infraclasse Pteriomorphia Beurlen, 1944**
      - **Cohort Mytilomorphi! Férussac, 1822 in 1821–1822**
        - Order Mytilida! Férussac, 1822 in 1821–1822: •Superfamily Modioloidea! P. Fischer, 1886; Superfamily Mytiloidea Rafinesque, 1815
        - Order Colpomyida Carter, nov.: •Superfamily Colpomyoidea Pojeta & Gilbert-Tomlinson, 1977
      - **Cohort Ostraeomorphi Férussac, 1822 in 1821–1822**
        - (plesion) •Family Matheriidae Scarlato & Starobogatov, 1979a
        - (plesion) •Family Mytilidae Scarlato & Starobogatov, 1979a
  - **Subcohort Accioni! J. Gray, 1854a**
    - •Order Cyrtodontida! Scarlato & Starobogatov in Nevesskaja & others, 1982
    - •Suborder Cyrtodontidina! Scarlato & Starobogatov in Nevesskaja & others, 1971: •Superfamily Cyrtodontoidea! Ulrich in Ulrich & Scofield, 1894; •Superfamily Falcatoontoidea Cope, 1896; •Superfamily Pichlerioidea Scarlato & Starobogatov, 1979a
    - •Suborder Praecardiidina Newell, 1965 (=Nepiomorphia Krž, 2007)
    - •Hytopdermioidea Newell, 1965: •Superfamily Cardiolioidea R. Hoernes, 1884; •Superfamily Praecardiioidea R. Hoernes, 1884

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Figure 4 (continued from facing page). pedal retractor (PPR); a brachiopod (Brach) is cemented to shell’s interior; 2, horizontal acetate peel through aragonitic ISP inner shell layer also visible in view 3, scale bar = 100 μm; 3, anterior-posterior, vertical acetate peel showing nacreous middle shell layer (above, darker layer) and the underlying aragonitic ISP inner shell layer, scale bar = 0.5 mm; 4, SEM, vertical fracture through nacreous middle shell layer (barely visible at extreme top of figure) and the aragonitic ISP inner shell layer, scale bar = 25 μm; 5, vertical fracture through the nacreous middle shell layer and aragonitic ISP adductor myostracum, scale bar = 5 μm; calcitic outer shell layer does not appear in any of these figures (new).
Paleontological Contributions

- Hyporder Antipleuroidei Kříž, 2007: •Superfamily Dualinoidea Conrath, 1887
- Order Arcida J. Gray, 1854a: Superfamily Arcoidae Lamarck, 1809; •Superfamily Glyptarcoidea Cope, 1996; Superfamily Limopsioidea Dall, 1895a; Superfamily Philobryoidea Félix Bernard, 1897

**Subcohort Ostreioni Férussac, 1822 in 1821–1822**

- Megaorder Myalina H. Paul, 1939
  - Order Myalinida H. Paul, 1939: •Superfamily Alatoconchoidea H. Termier, Termier, & Lapparent, 1974; •Superfamily Ambonychioidea! S. A. Miller, 1877; •Superfamily Inoceramoidea C. Giebel, 1852; •Superfamily Prokopievskioidea H. Vokes, 1967

**Superorder Ostreiformii Férussac, 1822 in 1821–1822 (=Eupteriomorphia Boss, 1982)**

Order Ostreida Férussac, 1822 in 1821–1822

- Suborder Ostreidina Férussac, 1822 in 1821–1822: Superfamily Ostreoidea Rafinesque, 1815
- Suborder Malleidina! J. Gray, 1854a
  - (paraplesion) •Family Myodakryotidae Tunnicliff, 1987

**Superorder Ostreata Férussac, 1822 in 1821–1822**

(plesion) •Family Myodakryotidae Tunnicliff, 1987

**Hyporder Anomioidei J. Gray, 1854a**

- (plesion) ?Family Saharopteriidae G. Termier & H. Termier in Pareyn, Termier, & Termier, 1972
- (paraplesion) Superfamily Pseudomonotoidea! Newell, 1938

**Hyporder Limoidei R. Moore in Moore, Lalicker, & Fischer, 1952**

**Hyporder Monotoidei Waterhouse, 2001**

- (paraplesion) Superfamily Buchioidea! Cox, 1953 (P. Fischer, 1886); •Superfamily Eurydesmatoidea! Reed, 1932; •Superfamily Oxytomoidea Ichikawa, 1958

**Infraclass Heteroconchia Hertwig, 1895**

**Cohort Uniomorphi J. Gray, 1854a (=Palaeobeterodonta of authors)**

(plesion) •Family Thoraliidae N. Morris, 1980

**Subcohort Unioni J. Gray, 1854a**

(paraplesion) •Superfamily Pseudomonotoidea! Newell, 1938

**Superorder Unionata J. Gray, 1854a**

- Order Trigonida! Dall, 1889: •Superfamily Myophorelloidea T. Kobayashi, 1954; •Superfamily Pseudocardioidea Martinson, 1961; Superfamily Trigonoidoidea! Lamark, 1819; •Superfamily Trigonoidoidea Cox, 1952 (or in Unionida?); •Superfamily Trigonodoidea! Modell, 1942
- Order Unionida J. Gray, 1854a
  - Suborder Unionidina J. Gray, 1854a: Superfamily Mulleroidea Deshayes, 1832a; •Superfamily Trigonoidoidea Cox, 1952 (or in Trigonida?); •Superfamily Unionoidea Rafinesque, 1820
- Suborder Hyridina Hoe & others, 2009: Superfamily Hyrioida Swainson, 1840
  - •Suborder Silesunionidina! Skawina & Dzik, 2011; •Superfamily Silesunionoidea! Skawina & Dzik, 2011

**Cohort Cardiomorphi Férussac, 1822 in 1821–1822 (=Heterodonta of authors)**

(plesion) •Family Lipaneliidae Sánchez, 2005

**Subcohort Carditioni Dall, 1889**

- Order Actinodontida! Deschaseaux, 1952; •Superfamily Amnigenioidea Khalfin, 1948; •Superfamily Anodontopsoidea! S. A. Miller, 1889; •Superfamily Nyassoidea! S. A. Miller, 1877; •Superfamily Oriocrassatelloidea Boyd & Newell, 1968; •Superfamily Palaeomuteloidea Lahusen, 1897
- Order Carditida Dall, 1889
  - (plesion) •Family Archeocaardiidae Khalfin, 1940
  - (paraplesion) •Family Eodonidae! Carter, Campbell, & Campbell, 2000
Superfamily Crassatelloidea Féruassac, 1822 in 1821–1822

Subcohort Cardioni Féruassac, 1822 in 1821–1822 (=Euheterodonta Giribet & Distel, 2003)

Infrasubcohort Lucinidia J. Gray, 1854a
(paraplesion) •Superfamily Babinkoidea! Horný, 1960
Order Lucinida J. Gray, 1854a: Superfamily Lucinoidea! J. Fleming, 1828; Superfamily Thyasioida Dall, 1900 (Dall, 1895a)

Infrasubcohort Cardididia Féruassac, 1822 in 1821–1822
(paraplesion) •Superfamily Grammysioidea! S. A. Miller, 1877

(Megaorder Cardiata Férussac, 1822 in 1821–1822 (=Neoheterodonte Taylor & others, 2007)

Superorder Cardiiformii Férussac, 1822 in 1821–1822
•Order Modiomorphida! Newell, 1969c: •Superfamily Modiomorphoidea! S. A. Miller, 1877
•Order Megalodontida! Starobogatov, 1992: •Superfamily Mecynodontoidea! Haffer, 1959; •Superfamily Megalodontoidea! J. Morris & Lycett, 1853
•Order Hippuritida Newell, 1965: •Superfamily Radiolitoidea d’Orbigny, 1847b; •Superfamily Requienioidea Kutassy, 1934

Order Cardiida Féruassac, 1822 in 1821–1822
(paraplesion) •Superfamily Kalenteroidea! Marwick, 1953

Suborder Cardiidina Férussac, 1822 in 1821–1822
(paraplesion) •Family Palaeocarditidae! Chavan, 1969b

Hyporder Cardioidei Féruassac, 1822 in 1821–1822: Superfamily Cardioidea Lamarck, 1809; Superfamily Tellinoidea Blainville, 1814

Hyporder Veneroidei J. Gray, 1854a

Minorder Veneroitei J. Gray, 1854a: Superfamily Arcticoidea! R. Newton, 1891 (d’Orbigny, 1844 in 1844–1848); Superfamily Chamoidea Lamarck, 1809; Superfamily Cyrenoidea J. Gray, 1840b; Superfamily Gaimardioidea Hedley, 1916; Superfamily Glossioidea J. Gray, 1847b (J. Gray, 1840b); Superfamily Hemindonacoidea Scarlato & Starobogatov in Neveskaja & others, 1971; Superfamily Macroidea Lamarck, 1809; Superfamily Ungulinoidea J. Gray, 1854b; Superfamily Veneroidea Raffnesque, 1815

Minorder Dreissenoida R. Moore in Moore, Lalicker, & Fischer, 1952: Superfamily Dreissenoida J. Gray, 1840a; Superfamily Sphaeroida Raffnesque, 1815 (Raffnesque, 1820)

Suborder Gastrochaenidina Morretes, 1949: Superfamily Gastrochaenoidea J. Gray, 1840b
•Suborder Anthracosidina Silantiev & Carter, 2011: •Superfamily Anthracosidina Amalitzky, 1892; •Superfamily Palaeonidae Modell, 1964; •Superfamily Prilukielloidea Starobogatov, 1970

Suborder Leptonidina Dall, 1889: Superfamily Cyamoida! G. O. Sars, 1878; Superfamily Galeommatoida J. Gray, 1840b

Superorder Pholadiformii J. Gray, 1854a

Order Pholadida J. Gray, 1854a: Superfamily Myoidea Lamarck, 1809; Superfamily Pholadoidea Lamarck, 1809; •Superfamily Pleuromyoidea! Zittel, 1895

Megaorder Poromyata Ridewood, 1903

Order Poromyida Ridewood, 1903; Superfamily Cuspidarioidea Dall, 1886; Superfamily Parilimyoidea! B. Morton, 1981; Superfamily Poromyoidea Dall, 1886; Superfamily Verticordioidea Stoliczka, 1870 in 1870–1871

Order Pholadomyida! Newell, 1965: Superfamily Pholadomyoidea! W. King, 1844

Order Pandorida R. Stewart, 1930: Superfamily Clavagelloidea d’Orbigny, 1844 in 1844–1847; Superfamily Pandoroidea! Raffnesque, 1815

Order Thracida Carter, nov.: Superfamily Thracioidea! Stoliczka, 1870 in 1870–1871 (Couthouy, 1839)

Megaorder Solenata Dall, 1889.

Order Solenida Dall, 1889: •Superfamily Orthonotoidea! S. A. Miller, 1877; Superfamily Solenoidea Lamarck, 1809

Order Hiattellida Carter, nov.: •Superfamily Edmondioidea! W. King, 1850; Superfamily Hiattelloidea J. Gray, 1824

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