A Synoptical Classification of the Bivalvia (Mollusca)

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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 Trigonioidoidea 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 Trigonioidoidea was derived instead from the superfamily Trigonioida. Arguments for these alternatives appear equally strong, so we presently list the Trigonioidoidea, with question, under both the Trigoniida and Unionida, with the contents of the superfamily indicated under the Trigoniida.

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

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1 Author 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, Euheteroconchia 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 taxonomic 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 Antipleuroida Krüür, 2007, is presently adopted, even though it contains the superfamilies Bivalvia and Tridacnacea, both of which are respectively valid and available typified names above the family-group. Similarly, Hhippuritida Newell, 1965, is adopted for an order that includes some families established as early as 1847 and 1848. In cases where a new name above the family-group is needed, but an appropriate typified name above the family-group is not available, the earliest valid and available typified name in the family-group is used as the root, but with a new publication date. Separate priority for names above and within the family-group is preferred because it allows for the retention of a number of widely used but otherwise lesser priority names above the family-group, such as order Hhippuritida.

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, Antinata Lamarck, 1818, is a junior homonym of Anatina Schumacher, 1817. Consequently, the suborder Anatinacea P. Fischer, 1887, based on Antinata 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 Fleurieu 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 Leptonidinae 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) Anomiina 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 unavailable in a classification that includes ancestors and descendants. This is illustrated by J. Schneider's (1995, 1998a, 1998b, 2002) revision of the superfamily Cardioidea. Schneider reduced superfamilies Tridacnacea to subfamily Tridacninae to eliminate paraphyly of Cardioidea with respect to Tridacnacea. However, this reduction in rank merely shifted paraphyly from Cardioidea to its subfamily Cerastodermatinae, the ancestral stock group for Tridacnacea.

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 polyphyley 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 Cardioidea. Those preferring a simpler classification can achieve this by disregarding some of the less familiar ranks, such as subcohort, infrasubcohort, mega-order, hyporder, minorder, 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 used herein.

The suffix -ia is commonly used for bivalve subclasses and infraclasses, e.g., Protobranchia, Autobranchia, Pteriomorphia, 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 tetrapods, 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 families rather than the -ina of some earlier authors, because -ina is more complex clades.

The taxonomically widely dispersed taxa are indicated by the symbol • before the name, e.g., Grade Euprotobranchial.

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 within an intervening hyporder, minorder, or superfamly. 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 dates priority. See Bouchet 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 type after their correlative typified name, e.g., Eupteriomorpha, Foliobranchia, Euheterodonta, Neoheterodonti, Nepiomorpha, Palaeotaxodonta. 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 italic after their most compatible typified name, e.g., Palaeoheterodonta, Heterodonta. The taxonomically widely dispersed taxa formerly assigned to the Anomalodesmata are indicated by underlining.

Table 1. Suffixes for taxonomic ranks.

|-------------|--------------------------|-------------------|--------------------------|------------------|-------|

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 Euprotobranchia! Nevesskaja, 2009
  •Order Fordillida! Pojeta, 1975
  •Order Tuarangiida MacKinnon, 1982
Clade Eubivalvia Carter, nov.
Subclass Protobranchia Pelseneer, 1894 (=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
Infraclas 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 Arcioni J. Gray, 1854a
    •Order Cyrtodontida! Scarlato & Starobogatov in Nevesskaja & others, 1971
      •Suborder Cyrtodontidina! Scarlato & Starobogatov in Nevesskaja & others, 1971
    •Suborder Praecardiidina Newell, 1965 (=Nepiomorphia Kříž, 2007)
      •Hyporder Praecardioidei Newell, 1965
      •Hyporder Antipleuroidei Kříž, 2007
  Order Arcida J. Gray, 1854a
  Subcohort Ostreioni Férussac, 1822 in 1821–1822
    •Megaorder Myalinata H. Paul, 1939
    •Order Myalinida H. Paul, 1939
  Megaorder Osttreata Férussac, 1822 in 1821–1822
  Superorder Ostreiformii Férussac, 1822 in 1821–1822 (=Eupteriomorphia Boss, 1982)
    Order Ostreida Férussac, 1822 in 1821–1822
    Suborder Ostreidina Férussac, 1822 in 1821–1822
    Suborder Malleidina! J. Gray, 1854a
    Order Pterinida J. Gray, 1854a
    (paraplesion) •Superfamily Leiopectinoidea! Krasilova, 1959
      Suborder Pterinidina J. Gray, 1854a
      Suborder Anoniidina J. Gray, 1854a
      Hyporder Anomioidei J. Gray, 1854a
        (paraplesion) Superfamily Pseudomonotoidea! Newell, 1938
          Minorder Anomioidei! J. Gray, 1854a
          Minorder Dimyoidei Ridewood, 1903
        •Hyporder Aviculopectinoidei Starobogatov, 1992
          Hyporder Limoidei R. Moore in Moore, Lalicker, & Fischer, 1952
          Hyporder Monotoidei Waterhouse, 2001
          Suborder Entoliidina Hautmann, nov.
Infraclas Heteroconchia Herrwig, 1895
  Cohort Unioiophi J. Gray, 1854a (=Palaeoheterodonta of authors)
  Subcohort Unioni J. Gray, 1854a
    (paraplesion) •Superfamily Lyrodesmatoidea! P. Fischer, 1886
  Megaorder Unioniata J. Gray, 1854a
    Order Trigoniida! Dall, 1889
    Order Unionida J. Gray, 1854a
    Suborder Unionidina J. Gray, 1854a
    Suborder Hyriidina Hoeh & others, 2009
      •Suborder Silesunionidina! Skawina & Dzik, 2011
Infraclas Cardiomiophi Férussac, 1822 in 1821–1822 (=Heterodonta of authors)
  Subcohort Carditioni Dall, 1889
    •Order Actinodontida! Deschaseaux, 1952
    Order Cardiida Dall, 1889
  Subcohort Cardiophi 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 (= Neoheterodonte! Taylor & others, 2007)
Superorder Pholadiformii J. Gray, 1854a
Order Pholadida J. Gray, 1854a

Superorder Cardiiformii Férussac, 1822 in 1821–1822
• Order Modiomorpha! Newell, 1969c
• Order Megalodontida Starobogatov, 1992
• Order Hippiuritida Newell, 1965
Order Cardiida Férussac, 1822 in 1821–1822
(paraplesion) • Superfamily Kalenteroidea! Marwick, 1953
Suborder Cardiida Férussac, 1822 in 1821–1822
(paraplesion) • Family Palaecarditidae! Chavan, 1969b
Hyporder Cardiidae Férussac, 1822 in 1821–1822
Hyporder Veneroidei J. Gray, 1854a
Minorder Veneroitei J. Gray, 1854a
Minorder Dreissenoitei R. Moore in Moore, Lalicker, & Fischer, 1952
Suborder Gastrochaenidina Morrettes, 1949
• Suborder Anthracosidina Silantiev & Carter, 2011

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

Megaorder Solenata! Dall, 1889
Order Solenida! Dall, 1889
Order Hiattellida! Carter, nov.

DETAILED CLASSIFICATION

Class Bivalvia Linnaeus, 1758 in 1758–1759
• Grade Euprotobranchia! Neveckaja, 2009
  • Order Fordillida! Pojeta, 1975
    • Superfamily Fordilloidea! Pojeta, 1975
      • Family Fordilidae! Pojeta, 1975
      • Family Camyidae! Hinz-Schallreuter, 2000
      • Order Tuarangiidae! MacKinnon, 1982
        • Family Tuarangiidae! MacKinnon, 1982
  • Order Nuculida! Dall, 1889
    • Superfamily Nuculoidea! J. Gray, 1824
      • Subfamily Nuculinae J. Gray, 1824
      • Subfamily Nuculominae! Maxwell, 1988
      • Subfamily Palaenonugulinae! Carter, 2001
      • Family Praenuculidae! McA1ester, 1969
      • Subfamily Praenugulinae! McA1ester, 1969
      • Subfamily Concaconididae! Sánchez, 1999
    • Superfamily Pristiglomoidea Sanders & Allen, 1973
      • Family Pristiglominidae Sanders & Allen, 1973
        • Subfamily Solenida! Dall, 1889
          • Superfamily Solenocoidea! J. Gray, 1824
            • Family Solenidae! J. Gray, 1824
              • Subfamily Soleninae J. Gray, 1840b
              • Subfamily Janaconeidae! Růžička & Řehoř in Hajkr & others, 1978
                • Family Clinopisthidae! Pojeta, 1988
                • Family Ctenodontidae! Wöhrmann, 1893
                • Family Ovatoconchidae! Carter, nov.
          • Superfamily Manzanellidae Chronic, 1952
            • Family Manzanellidae Chronic, 1952
        • Suborder 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 Natasinae Sánchez, 1997
    • Family Nucularcidae Pojeta & Stott, 2007
    • Family Similodontidae! Carter & Pojeta, nov.
  • Superfamily Afghanodesmatoidea! Scarlato & Starobogatov, 1979a
    • Family Afghanodesmatidae Scarlato & Starobogatov, 1979a
    • Family Erinitidae! 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
      • Family Palaonellidae! Babin, 1966
      • Family Pseudocyrtoonellidae Maillieux, 1939
    Family Stradidae Prantl & Ružička, 1954
      • Family Tindaridae Verrill & Bush, 1897
        • Subfamily Tindarininae! Verrill & Bush, 1897
      • Family Nuculanidae! Scarlato & Starobogatov, 1979a
        • Subfamily Nuculaninae! Scarlato & Starobogatov, 1979a
  • Superfamily Afghanodesmatoidea! Scarlato & Starobogatov, 1979a
  • Family Afghanodesmatidae Scarlato & Starobogatov, 1979a
  • Family Erinitidae! Cope, 2000

Subclass Autobranchia Grobben, 1894
  Infraclasse Pteriomorphia Beurlen, 1944
  Cohort Mytilomorph! Férussac, 1822 in 1821–1822
    Order Mytilida! Férussac, 1822 in 1821–1822
      • Superfamily Modiolopsioidea! P. Fischer, 1886
        • Family Modiolopsidae! P. Fischer, 1886
        • Family Goniophoridae! J. A. Allen & Sanders, 1973
        • Family Polidecididae! Kumpera, Prantl, & Ružička, 1960
      Family Stiloptidae! Stoliczka, 1870 in 1870–1871
        • Subfamily Sareptinae! Stoliczka, 1870 in 1870–1871
        • Family Yoldiellidae! J. A. Allen & Hannah, 1986
        • Family Yoldiinae! Dall, 1908
      Family Zealedidae! Scarlato & Starobogatov, 1979a
        • Subfamily Zealedinidae Scarlato & Starobogatov, 1979a
      • Family Paracyrtodonta! Schileyko, 1984
    • Superfamily Afghanodesmatoidea! Scarlato & Starobogatov, 1979a
      • Subfamily Afghanodesmatidae Scarlato & Starobogatov, 1979a
      • Family Afghanodesmatidae Scarlato & Starobogatov, 1979a
  • Family Colpomyidae! Pojeta & Gilbert-Tomlinson, 1977
    • Family Colpomyidae! Pojeta & Gilbert-Tomlinson, 1977
    • Family Evyanidae! Carter, Campbell, & Campbell, 2000
Cohort Ostreomorphi Férussac, 1822 in 1821–1822
(pleston) • Family Matheriidae Scarlato & Starobogatov, 1979a
(pleston) • Family Ichthyroodontidae Scarlato & Starobogatov, 1979a
Subcohort Arcioni! J. Gray, 1854a
• Order Cyrtodontida! Scarlato & Starobogatov in Nevesskaja & others, 1971
  • Suborder Cyrtodontidina! Scarlato & Starobogatov in Nevesskaja & others, 1971
  • Family Cyrtodontidae! Ulrich in Ulrich & Scofield, 1894
    • Subfamily Cyrtodontinae! Ulrich in Ulrich & Scofield, 1894
    • Subfamily Psychodesmatinae Scarlato & Starobogatov, 1984
  • Superfamily Falcatodontoidae Cope, 1996
  • Family Falcatodontidae Cope, 1996
  • Family Pichleriidae Scarlato & Starobogatov, 1979a
  • Family Falcatodontoidae Cope, 1996
  • Family Pichleriidae Scarlato & Starobogatov, 1979a
• Suborder Praecardiidina Newell, 1965 (=Nepiomorpha Kříž, 2007)
  • Hyporder Praecardioidei Newell, 1965
    • Superfamily Praecardioidea R. Hoernes, 1884
      • Family Praecardiidae! R. Hoernes, 1884
      • Family Buchiolidae Grimm, 1998
    • Superfamily Cardioloidea 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 Dualininae! Conrath, 1887
      • Subfamily Loxopterini Nagel-Myers, Amler, & Becker, 2009
      • Family Praelucinidae Conrath, 1887
      • Family Stolidotidae Starobogatov, 1977
      • Family Spanilidae Kříž, 2007
    • Superfamily Arcoidea Lamarck, 1809
      • Family Arcidae Lamarck, 1809
        • Subfamily Arcinae! Lamarck, 1809
        • Subfamily Anadariinae Reinharst, 1935
      • Subfamily Noetiinae R. Stewart, 1930
        • Tribe Noetini R. Stewart, 1930
        • Tribe Striarcini 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
    • Superfamily Limopsioidea Dall, 1895a
      • Family Limopsidae Dall, 1895a
    • Superfamily Philobryoidea Félix Bernard, 1897
      • Family Philobyridae 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 Saikraconchidae Yancey & Ozaki, 1986
      • Family Ambonychioidae! S. A. Miller, 1877
      • Family Ambonychiidae! S. A. Miller, 1877
      • Family Limulacardidae 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, Wilson, & 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
• Superfamily Prokinoceramoidea H. Vokes, 1967
  • Family Prokinoceramidae H. Vokes, 1967
  • Subfamily Prokinocestridae H. Vokes, 1967
  • Subfamily Abellaeninae Starobogatov, 1970
  • Subfamily Concincelinae Silantiev, nov.
  • Subfamily Kinerkaellinae Scarlato & Starobogatov, 1979a
  • Family Anodontellidae Silantiev, nov.
  • Family Naiadiidae Scarlato & Starobogatov, 1979a
  • Subfamily Makrinidae Waterhouse, 1976
• Family Kolymiidae V. Kuznetsov, 1973
• Family Retroceramidae Koschelkina, 1980
• Superfamily Prokoyevskioidea H. Vokes, 1967
  • Family Prokoyevskidae H. Vokes, 1967
  • Subfamily Prokoyevskinae H. Vokes, 1967
  • Subfamily Abiellinae Starobogatov, 1970
  • Subfamily Concincelinae Silantiev, nov.
  • Subfamily Kinerkaellinae Scarlato & Starobogatov, 1979a
• Order 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 Ostreidae Férussac, 1822 in 1821–1822
• Superfamily Ostreoida Rafinesque, 1815
  • Family Ostreidae 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 Myrakeeni Harry, 1985
• Family Arctostreidae Vialov, 1983
  • Subfamily Arctostreinae! Vialov, 1983
  • Subfamily Palaeolophinae! Malchus, 1990
• Family Eligmostreae 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
  • Tribe Liostreini Scarlato & Starobogatov, 1979b
  • Tribe Neopycnodonteini Harry, 1985
Suborder Malleidina! J. Gray, 1854a
  (paraplesion) • Family Pterineidae! F. Meek, 1864b
Superfamily Pinnideo Leach, 1819
  • Family Pinnidae Leach, 1819
Superfamily Posidonioidea Neumayr, 1891
  Family Posidoniidae Neumayr, 1891
  Family Aulacomyellidae Ichikawa, 1958
    Subfamily Aulacomyellinae Ichikawa, 1958
    Subfamily Bositrinae Waterhouse, 2008
  Family Daonellidae Neumayr, 1891
  Family Halobiidae Kittl, 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
    Subfamily Pteriinae J. Gray, 1847b (Goldfuss, 1820)
      Subfamily Pteriinae J. Gray, 1847b (Goldfuss, 1820)
    Subfamily Cassianellidae Ichikawa, 1958
    Subfamily 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 Plicatostylidae Lupher & Packard, 1929
  Family Vlastidae Neumayr, 1891
    Subfamily Vlastinae Neumayr, 1891
    Subfamily Praeostreinae Kříž, 1966

Superfamily Rhombopteroidea Korobkov in Eberzin, 1960
  Family Rhombopteriidae Korobkov in Eberzin, 1960
  Family Umburridae Neumayr, 1891

Order Pectinida J. Gray, 1854a
  (paraplesion)

Superfamily Leiopectinoidea Krasilova, 1959
  Family Leiopectinidae Krasilova, 1959

Suborder Pectinidina J. Gray, 1854a
Superfamily Pectinoidea Rafinesque, 1815
  Epifamily Pectinoidae Rafinesque, 1815
  Family Pectinidae Rafinesque, 1815
    Subfamily Pectininae Rafinesque, 1815
      Tribe Pectini Rafinesque, 1815
      Tribe Aequipectini Nordzieck, 1969
      Tribe Amussini Ridewood, 1903
      Tribe Austrochlamydi Jonkers, 2003
      Tribe Decatopectini T. Waller, 1986
    Subfamily Camptonectinae Habe, 1977
  Subfamily Palliolinae Korobkov in Eberzin, 1960
    Tribe Palliolini Korobkov in Eberzin, 1960
    Tribe Adamussini Habe, 1977
      Tribe Eburnepectini T. Waller, 2006
      Tribe Mesopeplini T. Waller, 2006
      Tribe Pseudotoni T. Waller, 2006
      Tribe Serripectini T. Waller, 2006
    Subfamily Pedinae Bronn, 1862
      Tribe Pedini Bronn, 1862
      Tribe Chlamydi Teppner, 1922
      Tribe Crassadomini T. Waller, 1993
      Tribe Fortipectini K. Masuda, 1963
        Subtribe Fortipectinina K. Masuda, 1963
        Subtribe Patinopectinina Habe, 1977
        Tribe Mimachlamydi T. Waller, 1993
      Subfamily Pseudopectininae Kasum-Zade, 2003
        Subfamily Webuyinae Kasum-Zade, 2003
      Family Pleuronectitidae Hautmann, nov.
        Tribe Spondylinae J. Gray, 1826
      Subfamily Spondylinae J. Gray, 1826
        Subfamily Spondylopectininae Kasum-Zade & Romanov, 1987
      Family Neitheoidae Sobetski, 1960
        Tribe Neitheidae Sobetski, 1960
        Tribe Tosapectinidae Trushichelev, 1984
    Suborder Anomidiina J. Gray, 1854a

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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 Anomioidei J. Gray, 1854a
Superfamily Anomioidea Rafinesque, 1815
  - Family Anomidae! Rafinesque, 1815
    - Subfamily Anomiinae! Rafinesque, 1815
      - Subfamily Heteranomiinae Scarlato & Starobogatov, 1979a
        - Family Permanomiidae Carter, 1990a
          - Family Placunidae Rafinesque, 1815
  - Family Pseudomonotidae! Newell, 1938

Minorder Dimyoitei Ridewood, 1903
Superfamily Dimyoida 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 Pegnamavulinae! Waterhouse, 2008
      - Family Deltopectinidae Dickins, 1957
        - Subfamily Deltopectininae! Dickins, 1957
        - Subfamily Cyrtorostrinae Newell & Boyd, 1995
        - Subfamily Squamuliferpectininae Waterhouse, 2008
      - Family Limatulinidae! Waterhouse, 2001
        - Superfamily Chaenocardioidea S. A. Miller, 1889
          - Family Chaenocardiidae! S. A. Miller, 1889
          - Family Streblochondriidae Newell, 1938
            - Subfamily Streblochondriinae Newell, 1938
            - Subfamily Guizhoupectininae M. Astafieva, 1994
          - Family Heteropectinidae Beurlen, 1954
            - Subfamily Heteropectininae! Beurlen, 1954
            - Subfamily Cassianooidae Newell & Boyd, 1995
            - Subfamily Etheripectininae! Waterhouse, 1982
            - Subfamily Girtypectininae Waterhouse, 2008
          - Family Ornithopectinidae Hautmann, nov.
            - Family Limipectinidae Newell & Boyd, 1990
              - Subfamily Limipectininae Newell & Boyd, 1990
              - Subfamily Acanthopectininae Newell & Boyd, 1995
              - Tribe Acanthopectiniini Waterhouse, 2008
              - Tribe Lamipectiniini Waterhouse, 2008
Subfamily Tesseratiinae Waterhouse, 2008
• Family Claraiidae Gavrilova, 1996
  • Subfamily Claraiinae! Gavrilova, 1996
  • Subfamily Chuluariinae Waterhouse, 2008
• Family Natalissimidae! Waterhouse, 2008
  • Subfamily Natalissiminae! Waterhouse, 2008
  • Subfamily Pseudaviculopinctininae! 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
    • Subfamily Plagiostominae Kasum-Zade, 2003
• Family Isolimeidae Kasum-Zade, 2003
  • Subfamily Pseudaviculopectininae! Waterhouse, 2008

Suborder Entoliidina! Hautmann, nov.
Superfamily Entolioidae! Teppner, 1922
• Family Entoliidae Teppner, 1922
  • Subfamily Entoliinae Teppner, 1922
  • Subfamily Palaeoentoliinae! Romanow, 1985
  • Subfamily Syncyclonematinae T. Waller, 1978
• Family Entolioidesidae Kasum-Zade, 2003
  • Subfamily Entolioidesinae! Kasum-Zade, 2003
  • Subfamily Calvaentoliinae Kasum-Zade, 2003
• Family Pernopectinidae! Newell, 1938
• Superfamily Euchondrioidea! Newell, 1938
  • Family Euchondriidae! Newell, 1938
Infraclass Heteroconchia Hertwig, 1895
Cohort Unionomorphi J. Gray, 1854a (=Palaeoheterodonta of authors)
(paraplesion) • Family Thoraliidae N. Morris, 1980
Subcohort Unioni J. Gray, 1854a
(paraplesion) • Superfamily Lyrodesmatoidea! P. Fischer, 1886
  • Family Lyrodesmatidae! P. Fischer, 1886
  • Family Pseudarcidae Scarlato & Starobogatov, 1979a
Megaorder Unioniata J. Gray, 1854a
Order Trigonida! Dall, 1889
Superfamily Trigonioidea! Lamarck, 1819
  • Family Trigonidae! Lamarck, 1819
    • Subfamily Trigoniniinae Lamarck, 1819
      • Subfamily Minetrigoniinae T. Kobayashi, 1954
      • Subfamily Nototrigoniinae Skwarko, 1963
      • Subfamily Pleurotrigoniinae van Hoeven, 1929
      • Subfamily Neuquenitrigoniinae 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

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• Family Scaphellinidae Newell & Ciriacks, 1962
• Family Schizodidae! Newell & Boyd, 1975
  • Subfamily Schizodinae Newell & Boyd, 1975
  • Subfamily Eoastartinae Newell & Boyd, 1975
  • Subfamily Sinodorinae Povertya & Zhang, 1984
• Superfamily Myophysorelloidea T. Kobayashi, 1954
  • Epifamily Myophysorelloidae T. Kobayashi, 1954
  • Family Myophysorellidae T. Kobayashi, 1954
    • Subfamily Myophysorellinae T. Kobayashi, 1954
    • Tribe Myophysorellini T. Kobayashi, 1954
    • Tribe Steinmannellini 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 Apiotrignioni Tashiro, 1979
    • Subtribe Apiotrignoniini Tashiro, 1979
    • Subtribe Heterotrignoniini M. Cooper, 1991
  • Subfamily Pterotrigoniinae van Hoepen, 1929
    • Tribe Pterotrignoniini van Hoepen, 1929
    • Tribe Scabrotignoni M. Cooper, 1989
  • Family Iotrigonioidae Saveliev, 1958
    • Series Rutitrignonitae van Hoepen, 1929
    • Family Rutitrignidioidae van Hoepen, 1929
    • Superfamily Pseudocardinioidea Martinson, 1961
      • Family Pseudocardinidae Martinson, 1961
    • Family Utschamiellidae C. M. Kolesnikov, 1977
    • Superfamily Trigonioidoidea Cox, 1952 (or in Unionida?)
      • Family Trigonioididae Cox, 1952
        • Subfamily Trigonioidinae Cox, 1952
        • Subfamily Peregrinococonchidae Gu Zhi-wei & others in Ma & others, 1976
      • Family Nakamuranaiadidae Guo, 1981
    • Family Nippononaiadida Chen Jin-hua, 1987
      • Subfamily Nippononaiinae Chen Jin-hua, 1987
    • Family Sinonaiadidae Chen Jin-hua, 1987
    • Family Plicatounionidae Chen Jin-hua, 1987
    • Family Pseudohyriidae T. Kobayashi, 1968
    • Superfamily Trigonodoidea! Modell, 1942
      • Family Trigonodidae! Modell, 1942
      • Family Desertellidae Dechaseaux, 1947
Order Unionida J. Gray, 1854a
Suborder Unionizina J. Gray, 1854a
Superfamily Unionoidoidea Rafinesque, 1820
  Family Unionidae Rafinesque, 1820
    • Subfamily Unioninae Rafinesque, 1820
      • Tribe Unionini Rafinesque, 1820
      • Tribe Anodontini Rafinesque, 1820
    Subfamily Amblemnieae Rafinesque, 1820
      • Tribe Amblemini Rafinesque, 1820
      • Tribe Lampisilini Ihering, 1901
      • Tribe Pleurobemini Hannibal, 1912
      • Tribe Quadruolini Ihering, 1901
    • Subfamily Gonioidinae Ortmann, 1916
    • Subfamily Modellinae Brandt, 1974
    • Subfamily Parreysiinae Henderson, 1935
    • Subfamily Qiyangiinae Chen Jin-hua, 1983
    • Subfamily Rectidentinae Modell, 1942
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 Monocondylacinae Modell, 1942
    Subfamily Mycetopodinae J. Gray, 1840b
  Family Etheriidae Deshayes, 1832a
  Family Iridinidae Swainson, 1840
    Subfamily Iridininae Swainson, 1840
    Subfamily Aplathariinae Modell, 1942
  • Superfamily Trigoniodoidea Cox, 1952 (or in Trigonida, which see)
Suborder Hyriidina Hoch & 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 Silesunionidae 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 Carditiidae Dall, 1889
  • Order Actinodontida! Deschaseaux, 1952
    • Superfamily Anodontopsioidea! S. A. Miller, 1889
      • Family Anodontopsidae! S. A. Miller, 1889
      • Family Actinodontaide! Davies, 1933
      • Family Baidiostraciidae Fang & Cope, 2008
    • Family Cycloconchidae! Ulrich in Ulrich & Scofield, 1894
      • Subfamily Cycloconchinae! Ulrich in Ulrich & Scofield, 1894
      • Subfamily Taselasmoinidae Fang & Cope, 2008
    • Family Intihuarellidae! Sánchez in Sánchez & Vaccari, 2003
    • Family Redonidae! Babin, 1966
    • Superfamily Nyassoidea! S. A. Miller, 1877
      • Family Nyassidae! S. A. Miller, 1877
    • Superfamily Palaeomuteloidea Lahusen, 1897
      • Family Palaeomutelidae Lahusen, 1897
      • Family Ammigenioidea Khalîn, 1948
    • Family Amphigenidae Khalîn, 1948
    • Family Montanariidae! Scarlato & Starobogarov, 1979a
    • Family Zadimeroidea! Guo, 1988
    • Superfamily Oriocrassatelloidea Boyd & Newell, 1968
      • Family Oriocrassatellidae Boyd & Newell, 1968
      • Family Crassatellopsidae! Carter, 2004
Order Carditiidae Dall, 1889
(plesion) • Family Archaeocardiodidae Khalîn, 1940
(paraplesion) • 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 Psychomyinae 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 Erhythrinae Chavan, 1952b
          • Subfamily Opinae! Chavan, 1952b
          • Subfamily Pinzonellinae Beurlen, 1954
          • Subfamily Terrinae Scarlato & Starobogarov, 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 Carditamerinae! Chavan, 1969b
• Subfamily Miodomeridinae Chavan, 1969b
• Subfamily Thecaliinae Dall, 1903
• Subfamily Venericardiinae Chavan, 1969b
Family Condylocardiidae Félix Bernard, 1896
• Subfamily Condylocardiinae Félix Bernard, 1896
Subfamily Cuninae Chavan, 1969b
• Family Myophoricardiidae Chavan in Cox & Chavan, 1969
Subcohort Cardioni Férussac, 1822 in 1821–1822 (= Euheterodonta Giribet & Distel, 2003)
Infracohort 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
• Subfamily Fimbriinae Nicol, 1950 (Stoliczka, 1870 in 1870–1871)
• Subfamily Ilioniinae! Scarlato & Starobogatov, 1979a
• Subfamily Milthinae! Chavan, 1969a
• Subfamily Myrteinae Chavan, 1969a
• Family Mactromyidae Cox, 1929 (P. Fischer, 1887)
• Family Paracyclidae! P. A. Johnston, 1993
Superfamily Thyasiroidea Dall, 1900 (Dall, 1895a)
• Family Thyasiridae Dall, 1900 (Dall, 1895a)
• Subfamily Thyasirinae! Dall, 1900 (Dall, 1895a)
• Subfamily Axinopsidinae Frank Bernard, 1983
Infracohort Cardidiida Férussac, 1822 in 1821–1822
(paraplesion) • Superfamily Grammysioidea! S. A. Miller, 1877
• Family Grammysiidae! S. A. Miller, 1877
• Subfamily Grammysininae! S. A. Miller, 1877
• Subfamily Cuneamminae! N. Morris, Dickins, & Astafieva-Urbajtis, 1991
• Family Sanguinolitidae S. A. Miller, 1877
• Subfamily Sanguinolitininae! S. A. Miller, 1877
• Subfamily Alulinae! N. Morris, Dickins, & Astafieva-Urbajtis, 1991
• Subfamily Paleodorinae Carter, nov.
• Subfamily Pholadellinae S. A. Miller, 1877
• Subfamily Undulomyinae Astafieva-Urbajtis, 1983
Megaorder Cardiata Férussac, 1822 in 1821–1822 (= Neoheterodonti Taylor & others, 2007)
Superorder Cardiiformii Férussac, 1822 in 1821–1822
• Order Miodiomorphida! Newell, 1969c
• Superfamily Miodiomorphoidea! S. A. Miller, 1877
• Family Miodiomorphidae! S. A. Miller, 1877
• Subfamily Miodiomorphinae! S. A. Miller, 1877
• Subfamily Butovicellinae! Kržiž, 1965
• Subfamily Healevinae! Hautmann, 2008
• Subfamily Joannininae Carter, nov.
• Family Cypricardinidae Ulrich in Ulrich & Scofield, 1894
• Family Hippopodimyidae Cox in Cox & LaRocque, 1969
• Family Palaeophasiaidae Marwick, 1953
• Family Tusayanidae Scarlato & Starobogatov, 1979a
• Order Megalodontida! Starobogatov, 1992
• Superfamily Mecynodontoiidea! Haffer, 1959
• Family Mecynodontidae! Haffer, 1959
• Family Reichuaniidae Liu Xie-zhang & Gu in Hou Hong-fei, Wan, & Xian, 1988
• Family Congeriomiidae Saul, 1976
• Family Plerthocardiidae Scarlato & Starobogatov, 1979a
• Family Prosoceolidae! Karczewski, 1992
• Superfamily Megalodontoiidea! J. Morris & Lycett, 1853
• Family Megalodontidae! J. Morris & Lycett, 1853
• Family Ceratomyopsidae Cox, 1964
• Family Dicerocardiidae! Kutassy, 1934
• Family Pachyrismatidae: Scarlato & Starobogatov, 1979a
• Family Wallowaconchidae: Yancey & Stanley, 1999

• Order Hippuritida: Newell, 1965
• Superfamily Requienioidea: Kutassy, 1934
  • Subfamily Requieniinae: Kutassy, 1934
  • Subfamily Matheroninae: R. Scott & others, 2010
• Family Epidiceratidae: Rengarten, 1950

• Superfamily Radiolitoidea: d’Orbigny, 1847b
  • Family Radiolitidae: d’Orbigny, 1847b
  • ? Family Antilocaprinidae: Mac Gillavry, 1937
• Family Caprinidae: d’Orbigny, 1847b
  • Subfamily Caprininae: d’Orbigny, 1847b
  • Subfamily Caprinuloideinae: Damestoy, 1971
• Family Caprinulidae: Yanin, 1990
• Family Caprothinidae: J. Gray, 1848
• Family Diceratidae: Dall, 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 Cardiidae: Férussac, 1822 in 1821–1822
(paraplesion) • Superfamily Kalenteroidea: Marwick, 1953
  • Family Kalenteridae: Marwick, 1953
    • Subfamily Kalenterinae: Marwick, 1953
    • Subfamily Myoconchinae: Newell, 1957

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

Hyporder Cardioidei: Férussac, 1822 in 1821–1822
Superfamily Cardioidea: Lamarck, 1809
  • Family Pterocarditiidae: Scarlato & Starobogatov, 1979a
    • Subfamily Pterocarditiinae: Scarlato & Starobogatov, 1979a
    • Subfamily Tulonocarditiinae: J. Schneider, 1995

Family Cardiidae: Lamarck, 1809
  • Subfamily Lahlillinae: Finlay & Marwick, 1937
  • Subfamily Protocarditiinae: Reuss, 1846 in 1845–1846

Clade Neocardiids: J. Carter, Hylleberg, & Popov, nov.
  • Subfamily Laevicardiinae: Keen, 1951
  • Subfamily Pleuricardiinae: J. Schneider, 1995

Clade Eucardiids: J. Schneider, 1995
  • Subfamily Cardiinae: Lamarck, 1809
    • Tribe Cardini: Lamarck, 1809
      • Tribe Vepricardiini: Kafanov & Starobogatov in Kafanov & Popov, 1977
    • Subfamily Ceratoderminae: Nordsieck, 1969
      • Tribe Ceratoderminae: 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 Clinocardiinae: Kafanov, 1975
    • Tribe Lymnocardiini: Stoliczka, 1870 in 1870–1871
      • Tribe Lymnocardiini: Stoliczka, 1870 in 1870–1871
    • Tribe Acobaecardiini: Paramonova in Nevesskaja, Paramonova, & Popov, 2001
    • Tribe Merklinicardiini: S. V. Popov in Nevesskaja, Paramonova, & Popov, 2001
    • Tribe Obsoletiformini: Paramonova in Nevesskaja, Paramonova, & Popov, 2001
    • Tribe Pachyacardiini: Andreevu, 1975
    • Tribe Paradacnini: Eberzin, 1967
    • Tribe Phyllocardiini: Nevesskaja in Nevesskaja & others, 1986
    • Tribe Planacardiini: Nevesskaja, Paramonova, & Popov, 2001
• Tribe Plicatiformini! Paramonova in Nevesskaja, Paramonova, & Popov, 2001
• Tribe Pontalmyrini! Taktakishvili, 1987
• Tribe Prosodacnini Keen, 1937
• Tribe Pseudocarditini Keen, 1969b
Subfamily Orthocardinae J. Schneider, 2002
• Subfamily Profraginae Badwe, 1977
• Subfamily Trapenocardinae Kanjilal & Srinivasan, 2002
Subfamily Tridacninae Lamarck, 1819

Superfamily Tellinoidea Blainville, 1814
Family Tellinidae Blainville, 1814
• Family Icacinidae R. Casey, 1961
Family Psammobiidae J. Fleming, 1828
• Family Quesadriidae 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 Tancredidae F. Meek, 1864a
• Family Unicardiopsidae Chavan, 1969c

Hydropod Veneroidei J. Gray, 1854a
Minorder Veneroidei 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 Eucloridae J. A. Gardner, 1944
• Family Pulicidae L. Stephenson, 1953
Family Trapceidae Lamy, 1920 (Dall, 1895a)
• Family Veneridae Dall, 1895a
Superfamily Chamoidea Lamarck, 1809
Family Chamidae Lamarck, 1809
Superfamily Cyrenoidea J. Gray, 1840b
Family Cyrenidae! J. Gray, 1840b
Family Cyrenoidea H. Adams & A. Adams, 1857 (J. Gray, 1853)
Family Glauconomidae J. Gray, 1853
Superfamily Gaimardioida Hedley, 1916
Family Gaimardiidae Hedley, 1916
Superfamily Glossoseidae J. Gray, 1847b (J. Gray, 1840b)
Family Glossidae J. Gray, 1847b (J. Gray, 1840b)
Family Kellieidae P. Fischer, 1887
Family Vesicomyidae Dall & Simpson, 1901
Superfamily Hemidonoideae Scarlato & Starobogatov in Nevesskaja & others, 1971
Family Hemidonoidea Scarlato & Starobogatov in Nevesskaja & others, 1971
Superfamily Mactroidea Lamarck, 1809
Family Mactidae! Lamarck, 1809
• Subfamily Mactrinae! Lamarck, 1809
• Subfamily Darininae Signorelli, nov.
• Subfamily Kymatoxinae Stenzel & Krause in Stenzel, Krause, & Twining, 1957
• Subfamily Lutrariinae J. Gray, 1853
• Subfamily Tanysiphoninae Scarlato & Starobogatov in Nevesskaja & others, 1971
Family Anatinellidae Deshayes in J. Gray, 1853
Family Cardiliidae P. Fischer, 1887
Family Mesodesmatidae J. Gray, 1840b
• Subfamily Mesodesmatinae! J. Gray, 1840b
• Subfamily Davilinae Dall, 1895b
Superfamily Ungulinoidea J. Gray, 1854b
Family Ungulinoidea J. Gray, 1854b
Superfamily Venerioidea Rafinesque, 1815
• Family Isocyprinidae! R. N. Gardner, 2005
Family Veneridae! Rafinesque, 1815
• Subfamily Venerinae Rafinesque, 1815
Tribe Venerini Rafinesque, 1815
• Subtribe Venerina Rafinesque, 1815
• Subtribe Chionina Frizzell, 1936
Tribe Dosiniini Deshayes, 1853
• Tribe Tapetini! J. Gray, 1851
Subfamily Meretricinae J. Gray, 1847b (J. Gray, 1838)
Tribe Meretricini J. Gray, 1847b (J. Gray, 1838)
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 Samarangini Keen, 1969c
Subtribe Sunettina Stoliczka, 1870 in 1870–1871
Subtribe Turtoniina W. Clark, 1855

?Tribe Gouldiini R. Stewart, 1930
Subtribe Gouldiina! R. Stewart, 1930
Subtribe Lioconchina Habe, 1977

Minorder Dreissenoitei R. Moore in Moore, Lalicker, & Fischer, 1952
Superfamily Dreissenoidea J. Gray, 1840a
Family Dreissenidae J. Gray, 1840a
  Subfamily Dreisseninae J. Gray, 1840a
    •Subfamily Dreissenomyinae Babak, 1983
Superfamily Sphaerioidoea J. Deshayes, 1855b (Rafinesque, 1820)
Family Sphaeriidae J. Deshayes, 1855b (Rafinesque, 1820)
  Subfamily Sphaeriinae J. 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 Morretes, 1949
Superfamily Gastrochaenoidea J. Gray, 1840b
  Family Gastrochaenidae J. Gray, 1840b
    •Subfamily Gastrochaeninae J. Gray, 1840b
    •Subfamily Eufistulaninae Carter, 1965
    •Subfamily Spengleriinae Carter, 1965
  •Suborder Anthracosidina Silantiev & Carter, 2011
    •Superfamily Anthracosioidea Amalitzky, 1892
      •Family Anthracosiodidae Amalitzky, 1892
      •Family Ferganocochidae Martinson, 1961
      •Family Shaaxniconchidae Liu Ben-pei in Liu Ben-pei & Li, 1980
    •Superfamily Palaeanodontoidoea Modell, 1964
      •Family Palaeanodontidae Modell, 1964
    •Superfamily Prilukielloidea Starobogatov, 1970
      •Family Prilukiellidae Starobogatov, 1970
      •Family Senderzoniellidae Betekhtina, Starobogatov, & Jatsuk, 1987

Suborder Lepronidina 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 Galeommatoidoea J. Gray, 1840b
  Family Galeommatidae J. Gray, 1840b
  Family Lasaeidae J. Gray, 1842
Superorder Pholadiformii J. Gray, 1854a
Order Pholadida J. Gray, 1854a
  Superfamily Pholadoidea Lamarck, 1809
    Family Pholadidae Lamarck, 1809
      •Subfamily Pholadinae Lamarck, 1809
        •Tribe Pholadini! Lamarck, 1809
          •Subfamily 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 Pleuromyoidoea Zittel, 1895
              •Family Pleuromyidae Zittel, 1895

•Superfamily Pleuromyoidoea Zittel, 1895
•Family Pleuromyidae Zittel, 1895
• Family Ceratomyidae
  • Subfamily Ceratomyinae
  • Subfamily Myopholadinae
  • Family Vacuellidae

Superfamily Myoidea Lamarck, 1809
  • Family Myidae Lamarck, 1809
    • Subfamily Myinae Lamarck, 1809
    • Subfamily Cryptomyinae Habe, 1977
    • Subfamily Spheniinae Frank Bernard, 1983
  • Family Corbulidae
    • Subfamily Corbulinae
      • Subfamily Caestocorbulinae H. Vokes, 1945
      • Subfamily Caryocorbulinae H. Vokes, 1945
    • 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 Poromyoidae Dall, 1886
    • Family Poromyidae Dall, 1886
    • Family Cetoconchidae Ridewood, 1903
    • Superfamily Cuspidarioidea Dall, 1886
      • Family Cuspidariidae Dall, 1886
      • Family Halonymphidae Scarlato & Starobogatov, 1983
      • Family Protocuspidariidae Scarlato & Starobogatov, 1983
    • ?Family Spheniopsidae J. A. Gardner, 1928
    • Superfamily Parilimyoidae 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
      • Family Lyonsiellidae 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 Pandorida R. Stewart, 1930
    • Superfamily Pandoroidae 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 Thracioida Carter, nov.
    • Superfamily Thracioidea S. A. Miller, 1889
      • Family Thraciidae S. A. Miller, 1889
      • Family Burmisidae M. Healey, 1908
      • Family Cleidothaeridae Hedley, 1918 (S. A. Miller, 1870–1871)
      • Family Myochamidae P. P. Carpenter, 1861
      • Family Periplomatidae Dall, 1895a
  • Order Solenoidea Lamarck, 1809
    • Superfamily Orthonotoidea S. A. Miller, 1877
      • Family Orthonorididae S. A. Miller, 1877
      • Family Kondurididae Sánchez in Sánchez & Benedetto, 2007
      • Family Prothyridae S. A. Miller, 1889
      • Family Solenomorphidae Cockerell, 1915
        • Subfamily Solenomorphininae Cockerell, 1915
        • Subfamily Promacrinae Scarlato & Starobogatov, 1979a
    • Superfamily Solenoidae Lamarck, 1809
      • Family Solenidae Lamarck, 1809
      • Family Pharidae H. Adams & A. Adams, 1856
Subfamily Pharinae! H. Adams & A. Adams, 1856
Subfamily Culfinellae A. Davies, 1935
Subfamily Novaculinae 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 Hiatellinae J. Gray, 1824
Subfamily Panopeinae! Bronn, 1862
Family Saxicavellidae P. H. Scott, 1994
•Superfamily Edmondioidea! W. King, 1850
•Family Edmondiidae! W. King, 1850
•Family Pachydomiae! P. Fischer, 1887
•Subfamily Pachydominae! P. Fischer, 1887
•Tribe Pachydomini P. Fischer, 1887
•Tribe Astartilini Waterhouse, 1969
•Tribe Holdhausellini Beuren, 1954
•Tribe Pleiocyprinellini Simões & others, 1997
•Subfamily Myroniinæ 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 superfam Prokopievskioidea with relatively thin, elongate, subtriangular (Anbrazimavata-like) or subrectangular, equivale or slightly inequivalve 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 sinus-like concavity on the posterior and ventral margins. Ligament opisthostodetic, 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. Anadontellidae resembles Naiaditidae but differs from Prokopievskiidae in lacking radial microsculpture. At least Anadontella differs from some Prokopievskiidae 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 Heteropectinoidea, contrary to Hertlein’s (1969, p. 355) placement of the “Antijanira group” in Pectinidae. The style of ornamentation in Antijaniridae is not observed in other Triassic Aviculopectinoidea or Heteropectinoidea, except for Ornithopecten (Ornithopectinidae), which differs in having a broad right posterior wing and a delicate right anterior auricle. This family also contains Amphiljamina Bittner, 1901, and Oxypteria Waagen, 1907. The affinity of Oxypteria to this group was first recognized by Allasinaz (1972, p. 266).

Arenigomyidae Carter, herein, fam. nov. Type genus, Areni
goya Cope, 1996, p. 1017. Cope (1996, p. 1017) gave the following diagnosis for Arenigomya, which is also the present family diagnosis: “Equivale, 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.

Aulacomyni Carter, herein, tribe nov. Type genus, Aulacom
yra Möörk, 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 *Pernaeae* J. Fleming, 1828 (spelling corrected by Zittel, 1895, to Perninae, the latter based on *Perna* Bruguière, 1789, in Bruguère, Lamarck, & Deshayes, 1789–1832, a junior synonym of *Isochomia* Lightfoot, 1786). Tribe *Aulacomyiina* diagnosis: smooth or radially ribbed, mytiliform members of *Mytilinae* in which the anterior adductor muscle is present only in the juvenile stage. Other than the type genus, this tribe contains *Iscadium* 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 Prokopevskieidae 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.

**Crassatellopsidae Carter, herein, fam. nov.** Type genus, *Crassatellopsis* Beushausen, 1895, p. 146. The following family diagnosis is modified from the description of *Crassatellopsis* 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 pivotal cardinal is slender and directed posteroventrally; right cardinal tooth anterior to right pivotal cardinal tooth is slender and directed anteroventrally; no lateral teeth and no shell marginal teeth. Shell shape similar to *Astarte*, trigonally suboval or subcircular; umbos pointed, prosogyrate; shell margin broadly concave immediately anterior to umbos, convex elsewhere; lunule and escutcheon absent; external 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, nonnionate, 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 umbos, a rudimentary, external ligament, a large resilium on a ventrally to posteroventrally strongly projecting chondrophore, a subdued 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 *Mactridinae* in having a more elongate shell shape, thinner, more pellucid valves, and more medially concentrated hinge dentition. It differs from *Kymatoxinae* in having a more elongate, more nearly equilateral shell shape, anterior as well as posterior gaps, less prominent sculpture, and stronger anterior lateral teeth. It differs from *Lutrariinae* in having a more projecting chondrophore and more median umbos.

**Entoliodida Hautmann, herein, subord. nov., nom. transl. et correct.** M. Hautmann, herein, ex *Entoliinae* Teppner, 1922, p. 89. A subborder proposed for the superfamilies Euchondrioidea and *Entolioida*, as indicated above.

**Euëbivalvia Carter, herein, unranked clade nov.** A descriptive clade name proposed for the subclasses Protophanchia and Autobanchia.

**Euëfistulinae Carte, herein, subfam. nov.** Type genus, *Euëfistula* Eames, 1951, p. 445. Subfamily diagnosis: obligate tube-dwelling *Gastrochaenidae* with long, straight-sided tubes; long, largely fused siphons *sensu stricto*, minute siphonal papillae on incumbent but not excursive 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 excursive siphon, and in having a laterally expanded instead of round to anteroposteriorly elongate ventral pedal surface. This family also contains *Kummelia* L. Stephenson, 1937.

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

**Joannininae Carter, herein, subfam. nov.** Type genus, *Joannina* Waagen, 1907, p. 94. Subfamily diagnosis: edentulous members of *Modiomorphidae* differing from sister superfamilies *Miodomorphinae* and *Healeyinae* in having more dorsally projecting umbos, better defined anterior auricles, a narrower hinge plate, and, with the exception of *Leidapacona*, a shorter, more external ligament nymph and growth lines not continuing from a lunule onto the subumbonal hinge plate. This subfamily also contains *Propotis* Kiriti, 1904, *Waijiaella* Stiller & Chen, 2006, *Qiningioli Stiller & Chen, 2006, and *Leidapacona* Stiller & Chen, 2006.

**Neocardiidi Carter, Hylleberg, & Popov, herein, unranked clade nov.** A descriptive name proposed for the clade of *Laevicardinae* + *Pleuricardiinae* + *eucardiids* sensu J. Schneider (1995, 1998a).

**Ornithopectinidae Hautmann, herein, fam. nov.** Type genus, *Ornithopecten* Cox, 1962, p. 596. Family diagnosis: discs inequilateral, 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 Antijaniridae chiefly in the anteriorly positioned beaks, retrocrescent dics, and broad posterior wing. This family is monogenic.

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

Paleodorininae Carter, herein, subfam. nov. Type genus, Paleodora 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; posteroventrally rounded and dorsoventrally truncate; ornament of low, commarginal ribs, replaced by fine growth lines on the relatively flat, dorsoventral 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.

Pleuronectitidae Hauptmann, 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; ctenium present; right posterior auricle obtuse but well delimited, not projecting above hinge margin; auricles of left valve lacking auricular sinuses and dorsally levelling with hinge margin; ligament alivincular-alarate, 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 line 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-alarate ligament and a ctenium, thus excluding the Entolioidea) in having procrescent discs, a flat right valve, a well-developed right anterior auricular scroll, and in lacking external buttresses. This family tentatively also contains Lower and Middle Triassic Periclaratia Li Jin-hua & Ding, 1981.


Similodontidae Carter & Pajecka, herein, fam. nov. Type genus, Similodonta H. Soot-Ryen, 1964, p. 498. Family diagnosis: members of superfamly Tronucoidea with low hinge angle (65–100°) and only slightly, if at all, anteroventrally expanded shell. Increased anterior shell gape achieved by orienting ligament axis more nearly perpendicular to the anteroventral shell margins. Anterior hinge teeth convexodont to orthomorphodont and inclined. Posterior hinge teeth convexodont in most genera, to orthomorphodont and inclined. Anterior and posterior tooth rows generally form continuous series below the beaks, but posterior tooth row may overlap anterior tooth row below beaks. Anterior and posterior tooth rows typically nearly equal in length, but the posterior tooth row may be slightly shorter. This family also contains Australonucula Sánchez, 1989, Trigononucula Sánchez, 1999, Viliuncia Sánchez, 1999, and doubtfully Upper Ordovician Palaeoconcha S. A. Miller, 1889.

Spengleriinae Carter, herein, subfam. nov. Type genus, Spengleria Tryon, 1862a, p. 472, 485. Subfamily diagnosis: obligate endolith 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 Eufistulinae 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

Subfamily Gastrochaeninae J. Gray, 1840b

Stenochna Carter, herein, gen. nov.

*Figure 1*

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

Discussion.—The genus *Stenochna* is presently proposed for Middle Eocene *Gastrochaena lacera* Belokryks, 1991 (p. 10, pl. 1, fig. 1a, 2), from the Dnepropetrovsk region of Ukraine. The name *Stenochna* 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 *Stenochna* reflects the extremely small pedal gape and boatlike shape of the united valves. In addition to *Stenochna lacera*, this genus includes Upper Jurassic *Gastrochaena zitteli* Boehm, 1883, from Stramberk, Czech Republic, and Jurassic *Gastrochaena valfinensis* de Loriol, 1888, in de Loriol & Bourget, 1886–1888, from Valfin, eastern France (possibly a juvenile of *Stenochna 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 (\textit{Stenochaena zitteli}) or irregularly spaced growth lines (\textit{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.

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

\textbf{Distribution}.—\textit{Stenochaena} is known only from the Upper Jurassic and Middle Eocene of Europe.

\textbf{Ecology}.—Specimens of \textit{Stenochaena lacera} from Belokrys (1991) came from borings in the dome-shaped coral \textit{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 \textit{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 \textit{S. zitteli}, also from Stramberk (British Museum Geology Department L23855), with impressions of a coral substratum on the exterior of its boring cast.

\textbf{Superfamily Gastrochaenoidea J. Gray, 1840b}

\textbf{Family Gastrochaenidae J. Gray, 1840b}

\textbf{Subfamily Spengleriinae Carter, herein, subfam. nov.}

\textit{Spenglerichaena} Carter, herein, \textit{gen. nov.}

\textbf{Type species.}—\textit{Gastrochaena apertissima} Deshayes, 1855a, p. 326.

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

\textbf{Generic diagnosis and description.}—Members of Spengleriinae with anteriorly strongly laterally inflated shells, moderately anterior umbo, completely divided, relatively long siphons \textit{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 umbalonal-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.

\textbf{Comparisons.}—\textit{Spenglerichaena} resembles \textit{Spengleria} in its completely separated siphons \textit{sensu stricto} and anterior pedal retractor muscles that pass around the visceral mass as they approach the foot. However, \textit{Spenglerichaena} lacks the raised posterior triangular area, aragonitic periostracal spikes, distinct umbalonal-posteroventral sulcus, pointed calcareous baffles in the boring lining at the base of the siphons, plicate ctenidia, and more medially positioned umbos of \textit{Spengleria}. Its nonplicate ctenidia, spatulate pedal probing organ, lack of a raised, posterior triangular area, and lack of mineralized periostracal spines are more typical of \textit{Gastrochaena} and \textit{Rocellaria}, but in those genera, the siphons \textit{sensu stricto} and \textit{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. \textit{Spenglerichaena} differs from \textit{Gastrochaenopsis} in having a wider, longer pedal gape, no raised posterior triangular area, and greater lateral inflation of the shell.

\textbf{Distribution.}—Borings similar to those made by \textit{Spenglerichaena} are known from the Lutetian, Middle Eocene near Verona, Italy, but the associated shells are unknown (Savazzi, 1980). \textit{Spenglerichaena} is therefore definitely known only from the Recent tropical Indo-West Pacific Region.
Ecology.—Spenglerichaena 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

Goniomorpha Carter, herein, gen. nov.

Figure 3

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

Discussion.—The genus Goniomorpha 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 Goniomorpha 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, fig. 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 mecyndodontid based on upper Silurian Goniophora cymbaeformis Sowerby in Murchison, 1839. This mecyndodontid resembles Goniomorpha in having an equivaleve, strongly inequilateral, posteriorly elongate shell with simple, commarginal ornament, and a sharp, angular carina extending from the beak to the posteroventral shell margin. However, it differs from Goniomorpha in having prominent anterior and posterior internal ridges (Johnston, 1993, p. 74–76; Liljedahl, 1994, p. 74, fig. 52I). The hinge and ligament of Goniomorpha cymbaeformis are unknown, but other species of this genus differ from Goniomorpha 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 stuertzii (Beuhsaun, 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-posteroventral 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 intergipallial, judging from other members of Modiomorphinae. The shell mineralogy and microstructure resemble *Modiomorphina concentrica*, except that mineralized periostracal 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 in clay-rich sandstones also containing a high diversity of other marine invertebrates, especially the bivalves *Pychopteria* (Pterineidae), rare pelecypods, and the gastropods *Palaeozyglopleura* and *Bembexia*. *Goniomorpha hamiltonensis* is not usually found in large concentrations. The strongly and sharply truncate, elongate posterior and lack of a distinct byssal notch suggest a shallow infaunal life habit, with the shell’s posterior end at or just above the sediment-water interface. The species is never associated with abundant nuculoids and muddy, fine grained sediments, suggesting suspension feeding habits and low tolerance of resuspended, muddy substrata.

**Superfamily Ostreoidea Rafinesque, 1815**

**Family Arctostreidae Vialov, 1983**

**Subfamily Palaeolophinae Malchus, 1990**

**Nacrolopha Carter & Malchus, herein, gen. nov.**

**Figure 4**

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

*The new genus *Nacrolopha* is presently proposed for the new species, *Carnian, Upper Triassic Nacrolopha 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.**—*Nacrolopha* is characterized by a posteriorly instead of posterodorsally 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 nacreous prismatic left valve that lacks foliated 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 prosygogate 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 alivincular-arcuate, with the fibrous attachment area distinctly impressed below narrow, distinct, anterior and posterior bourrelets. The “incipient crura” that Carter (1990a, p. 219) described for this specimen are actually the flanks of the alivincular-arcuate ligament (Hautmann, 2004, 2006). The ligament insertion area is covered by a very thin aragonitic ligostracum 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 6–10μm 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 myostracum is finely ISP. The inner shell layer is aragonitic and mostly coarsely textured ISP, with minor nacreous lensatic sublayers.

**Comparisons.**—*Nacrolopha 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. *Palaeolophina montiscaprilis* (Klipstein, 1843) (Klipstein, 1843, p. 247, pl. 16, 5) appears externally similar to *N. carolae* (see also Wöhrmann, 1889, p. 200, pl. 6, 1–3), but illustrations of that species do not show an anterior adductor or posterior pedal retractor muscle scar. Possible congener of *Nacrolopha* include certain other species assigned by Malchus (1990) to *Palaeolophina*, such as Carnian, Upper Triassic *Palaeolophina medicostata* (Wöhrmann, 1889), and *Palaeolophina 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. carulate* resembles some Triassic bavevelliids and gryphaeids, e.g., the Middle Triassic bavevelliid *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 *Praceygyna hebridaica* (Forbes, 1851) (Carter, 1990c, p. 356–359).

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

**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 pleurotomomorphs and parapleurotomomorphs. 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 Fordilida! Pojeta, 1975: •Superfamily Fordilloidea! Pojeta, 1975
  • Order Tuarangiida MacKinnon, 1982

Clade Eubivalvia, *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 Pristiglomoidea Sanders & Allen, 1973
  Order Solenyyida Dall, 1889: Superfamily Manzanelloidea Chronic, 1952; Superfamily Solemyoidea! J. Gray, 1840b

Superorder Nuculaniformii! Carter, Campbell, & Campbell, 2000
  • Order Afghanodesmatida! Carter, *nov.*: •Superfamily Afghanodesmatoidea! Scarlato & Starobogatov, 1979a; •Superfamily Tironucleoidea Babin in Babin & others, 1982
  Order Nuculanida Carter, Campbell, & Campbell, 2000: Superfamily Malletioidea! H. Adams & A. Adams, 1858 (d’Orbigny, 1846); Superfamily Tuarangiida MacKinnon, 1982

Subclass Autobranchia Pelseneer, 1894

Infraclass Pteryomorphia Beurlen, 1944

Cohort Mytilomorphi! Férussac, 1822 in 1821–1822
  Order Mytilida! Férussac, 1822 in 1821–1822: •Superfamily Modioloisoidea! P. Fischer, 1886; Superfamily Mytiloidea Rafinesque, 1815
  • Order Colpomyida Carter, *nov.*: •Superfamily Colpomyoidea Pojeta & Gilbert-Tomlinson, 1977

Cohort Ostreomorphi! Férussac, 1822 in 1821–1822
  (plesion) •Family Matheriidae Scarlato & Starobogatov, 1979a
  (plesion) •Family Ischyrodontidae Scarlato & Starobogatov, 1979a

Subcohort Anthrobranchia Grobben, 1894

Infraclasse Pteryomorphia Beurlen, 1944

Cohort Mytilomorphi! Férussac, 1822 in 1821–1822
  • Order Cyrtodonta! Scarlato & Starobogatov in Nevesskaja & others, 1971
  • Suborder Cyrtodontidina! Scarlato & Starobogatov in Nevesskaja & others, 1971: •Superfamily Cyrtodontoidea! Ulrich in Ulrich & Scofield, 1894; •Superfamily Falcodorantoidea Cope, 1996; •Superfamily Pichlerioidea Scarlato & Starobogatov, 1979a
  • Suborder Praecardiidina Newell, 1965 (=Nepiomorphia Krůž, 2007)
  • Hypoder praecardioidae Newell, 1965: •Superfamily Cardioloidea R. Hoernes, 1884; •Superfamily Praecardioida R. Hoernes, 1884

Figure 4 (continued from facing page).

pedal retractor (PPR); a brachiopod (Brachi) 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).
• Hyporder Antipleuroidei Kříž, 2007: • Superfamily Dualinoidea Conrath, 1887
Order Arcida J. Gray, 1854a: Superfamily Arcoidea Lamarck, 1809; • Superfamily Glyptarcoidea Cope, 1996; Superfamily Limopsoidea 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. T ermier, Termier, & Lapparent, 1974; • Superfamily Ambonychoidea! 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 T unnicliff, 1987

Superfamily Pinnoidea Leach, 1819; • Superfamily Posidonioidea Neumayr, 1891; Superfamily Pterioidea! J. Gray, 1847b (Goldfuss, 1820); • Superfamily Rhombopterioidea! Korobkov in Eberzin, 1960
Order Pectinida J. Gray, 1854a
(paraplesion) • Superfamily Leiopectinoidea! Krasilova, 1959
Suborder Pectinidina J. Gray, 1854a: Superfamily Pectinoidea Rafinesque, 1815
Suborder Anomiidina J. Gray, 1854a

Hyporder Anomioidei J. Gray, 1854a
(plesion) ? Family Saharopteriidae G. T errier, 1850 in Pareyn, Termier, & Termier, 1972
(paraplesion) Superfamily Pseudomonotoidea! Newell, 1938
Minorder Anomioitei H. Paul, 1939
Superfamily Myalinata H. Paul, 1939: • Superfamily Alatoconchoidea H. T ermier, Termier, & Lapparent, 1974; • Superfamily Ambonychoidea! S. A. Miller, 1877; • Superfamily Inoceramoidea C. Giebel, 1852; • Superfamily Prokopievskioidea H. Vokes, 1967

Superorder Ostreata Férussac, 1822 in 1821–1822
(plesion) • Family Myodakryotidae T unnicliff, 1987

Superorder Aviculopectinoidei Starobogatov, 1992: • Superfamily Aviculopectinoidea! F . Meek & Hayden, 1865; • Superfamily Chaenocardioidea S. A. Miller, 1889; • Superfamily Heteropectinoidea! Beurlen, 1954; • Superfamily Pterinopectinoidea! Newell, 1938

Hyporder Limoidei R. Moore in Moore, Lalicker, & Fischer, 1952: Superfamily Limoidea Rafinesque, 1815

Subcohort Unioni J. Gray, 1854a
• Superfamily Lyrodesmatoidea! P. Fischer, 1886

Infraclasse Heteroconchia Hertwig, 1895

Cohort Uniomorphi J. Gray, 1854a (= Paleobeterodonta of authors)
(plesion) • Family Thoraliidae N. Morris, 1980

Subcohort Unio J. Gray, 1854a
(paraplesion) • Superfamily Lyrodesmatoidea! P. Fischer, 1886
Megaorder Uniononata J. Gray, 1854a
Order Trigonida! Dall, 1889: • Superfamily Myophorelloidea T. Kobayashi, 1954; • Superfamily Pseudocardinioidea Martinson, 1961; • Superfamily Trigonioidea Lamarck, 1819; • Superfamily Trigonioidea Cox, 1952 (or in Unionida?); • Superfamily Trigonodoidea! Modell, 1942
Order Unionida J. Gray, 1854a
Suborder Unioninida J. Gray, 1854a: Superfamily Mullerioidea Deshayes, 1832a; • Superfamily Trigonioidea Cox, 1952 (or in Trigoniida?); Superfamily Unionioidea Rafinesque, 1820
Suborder Hyridina Hoeh & 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 Lipanellidae Sánchez, 2005

Subcohort Carditioni Dall, 1889
• Order Actinodontida! Deschaseaux, 1952; • Superfamily Amnigioidea Khalfin, 1948; • Superfamily Anodontopsioidea! S. A. Miller, 1889; • Superfamily Nyasoida! S. A. Miller, 1877; • Superfamily Oriocrassatelloidea Boyd & Newell, 1968; • Superfamily Palaemuletelloidea Lahusen, 1897
Order Carditida Dall, 1889
(plesion) • Family Archaeocardiidae Khalfin, 1940
(paraplesion) • Family Eodonidae! Carter, Campbell, & Campbell, 2000
Superfamily Crassatelloidea Férussac, 1822 in 1821–1822

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

Infrasupercohort Lucinidia J. Gray, 1854a
(paraplesion) •Superfamily Babinioideidae! Horný, 1960
Order Lucinida J. Gray, 1854a: Superfamily Lucinooidae! J. Fleming, 1828; Superfamily Thysarioidea Dall, 1900 (Dall, 1895a)

Infrasupercohort Cardiidia Férussac, 1822 in 1821–1822
(paraplesion) •Superfamily Grammysioidea! S. A. Miller, 1877

Megaorder Cardiata Férussac, 1822 in 1821–1822

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 & Lyce, 1853
•Order Hippuritida Newell, 1965: •Superfamily Radiolitoidea d’Orbigny, 1847b; •Superfamily Requienioidea Kutassy, 1934
Order Cardiida Férussac, 1822 in 1821–1822 (paraplesion) •Superfamily Kalenteroidea! Marwick, 1953
Suborder Cardiida in 1821–1822
(paraplesion) •Family Palaeocarditidae! Chavan, 1969b
Hyporder Cardioidei Férussac, 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 Cyreneoida J. Gray, 1840b; Superfamily Gaimardioidea Hedley, 1916; Superfamily Glossioidea J. Gray, 1847b (J. Gray, 1840b); Superfamily Hemidiconoidea specularis! Hafner & Starobogatov in Nevesskaja & others, 1971; Superfamily Macroidea Lamarck, 1809; Superfamily Ungulinoidea J. Gray, 1854b; Superfamily Veneroidea Rafinesque, 1815
Minorder Dreissenoida R. Moore in Moore, Lalicker, & Fischer, 1952: Superfamily Dreissenidea J. Gray, 1840a; Superfamily Sphaerioidea! Deshayes, 1855b (Rafinesque, 1820)
Suborder Cardiida Férussac, 1822 in 1821–1822
(paraplesion) •Superfamily Kalenteroidea! Marwick, 1953
Suborder Cardiida in 1821–1822
(paraplesion) •Family Palaeocarditidae! Chavan, 1969b
Hyporder Cardioidei Férussac, 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 Cyreneoida J. Gray, 1840b; Superfamily Gaimardioidea Hedley, 1916; Superfamily Glossioidea J. Gray, 1847b (J. Gray, 1840b); Superfamily Hemidiconoidea specularis! Hafner & Starobogatov in Nevesskaja & others, 1971; Superfamily Macroidea Lamarck, 1809; Superfamily Ungulinoidea J. Gray, 1854b; Superfamily Veneroidea Rafinesque, 1815
Minorder Dreissenoida R. Moore in Moore, Lalicker, & Fischer, 1952: Superfamily Dreissenidea J. Gray, 1840a; Superfamily Sphaerioidea! Deshayes, 1855b (Rafinesque, 1820)
Suborder Gastrochaenidina Morretes, 1949: Superfamily Gastrochaenidae J. Gray, 1840b
•Suborder Anthracosidina Silantiev & Carter, 2011: •Superfamily Anthracosioidea Amalitzky, 1892; •Superfamily Palaeoanchoidea Modell, 1964; •Superfamily Prilukielloidea Starobogatov, 1970
Suborder Leptonidae Dall, 1889: Superfamily Cyamioida! G. O. Sars, 1878; Superfamily Galeonmaidae 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 Poromyidae Ridewood, 1903: Superfamily Cuspidarioidea Dall, 1886; Superfamily Parilimoidea! 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! Rafinesque, 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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