Treatise on Invertebrate Paleontology

Part H

Brachiopoda

Revised

Volume 6:
Supplement

Alwyn Williams, C. H. C. Brunton, and S. J. Carlson with
Fernando Alvarez, A. D. Ansell, P. G. Baker, M. G. Bassett, R. B. Blodgett, A. J. Boucot, J. L. Carter, L. R. M. Cocks, B. L. Cohen, Paul Copper, G. B. Curry, Maggie Cusack, A. S. Dagys, C. C. Emig, A. B. Gawthrop, Rémy Gourvennec, R. E. Grant, D. A. T. Harper, L. E. Holmer, Hou Hong-fei, M. A. James, Jin Yu-gan, J. G. Johnson, J. R. Laurie, Stanislav Lazarev, D. E. Lee, Carsten Lüter, Sarah Mackay, D. I. MacKinnon, M. O. Manceñido, Michal Mergl, E. F. Owen, L. S. Peck, L. E. Popov, P. R. Racheboeuf, M. C. Rhodes, J. R. Richardson, Rong Jia-yu, Madis Rubel, N. M. Savage, T. N. Smirnova, Sun Dong-li, Derek Walton, Bruce Wardlaw, and A. D. Wright

Prepared under Sponsorship of
The Geological Society of America, Inc.

The Paleontological Society
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The Palaeontological Association

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The Geological Society of America, Inc.
and
The University of Kansas
Boulder, Colorado, and Lawrence, Kansas
2007

Library of Congress Catalogue Card Number 53-12913
ISBN 978-0-8137-3136-0

Distributed by the Geological Society of America, Inc., P.O. Box 9140, Boulder, Colorado 80301, USA, www.geosociety.org, from which current price lists of parts in print may be obtained and to which all orders and related correspondence should be directed. Editorial office of the *Treatise:* Paleontological Institute, The University of Kansas, 1475 Jayhawk Blvd., Room 121, Lawrence, Kansas 66045-7613, USA, www.paleo.ku.edu.

Citation information: Selden, P. A., ed. 2007. Treatise on Invertebrate Paleontology. Part H, Brachiopoda, Revised, vol. 6. Geological Society of America & Paleontological Institute. Boulder, Colorado, & Lawrence, Kansas. l + 906 p., 461 fig., 38 tables.

The *Treatise on Invertebrate Paleontology* has been made possible by (1) funding principally from the National Science Foundation of the United States in its early stages, from The Geological Society of America through the bequest of Richard Alexander Fullerton Penrose, Jr., and from The Kansas University Endowment Association through the bequest of Raymond C. and Lillian B. Moore; (2) contribution of the knowledge and labor of specialists throughout the world, working in cooperation under sponsorship of The Geological Society of America, the Paleontological Society, the SEPM (Society for Sedimentary Geology), the Palaeontographical Society, and the Palaeontological Association; (3) acceptance by The University of Kansas of publication without any financial gain to the University; and (4) generous contributions by our individual and corporate sponsors.

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CONTENTS

INFORMATION ON TREATISE VOLUMES

Parts of the *Treatise* are distinguished by assigned letters with a view to indicating their systematic sequence while allowing publication of units in whatever order each is made ready for the press. Copies can be obtained from the Publication Sales Department, The Geological Society of America, 3300 Penrose Place, P.O. Box 9140, Boulder, Colorado 80301, www.geosociety.org.

PUBLISHED VOLUMES

Part A. Introduction: Fossilization (Taphonomy), Biogeography, and Biostratigraphy, xxiii + 569 p., 169 fig., 1979.

Part B. Protoctista 1 (Charophyta), xvi + 170 p., 79 fig., 9 tables, 2005.

Part C. Protista 2 (Sarcodina, Chiefly "Thecamoebians" and Foraminiferida), Volumes 1 and 2, xxxi + 900 p., 653 fig., 1964.

Part D. Protista 3 (Protozoa: Chiefly Radiolaria, Tintinnina), xii + 195 p., 92 fig., 1954.

Part E. Archaeocyatha and Porifera, xviii + 122 p., 89 fig., 1955.

Part E, Revised. Archaeocyatha, Volume 1, xxx + 158 p., 107 fig., 1972.

Part E, Revised. Porifera, Volume 2 (Introduction to the Porifera), xxvii + 349 p., 135 fig., 10 tables, 2003.

Part E, Revised. Porifera, Volume 3 (Demospongea, Hexactinellida, Heteractinida, Calcarea), xxxi + 872 p., 506 fig., 1 table, 2004.

Part F. Coelenterata, xx + 498 p., 358 fig., 1956.

Part F. Coelenterata, Supplement 1 (Rugosa and Tabulata), Volumes 1 and 2, xl + 762 p., 462 fig., 1981.

Part G. Bryozoa, xiii + 253 p., 175 fig., 1953.

Part G, Revised. Bryozoa, Volume 1 (Introduction, Order Cystoporata, Order Cryptostomata), xxvi + 625 p., 295 fig., 1983.

Part H. Brachiopoda, Volumes 1 and 2, xxxii + 927 p., 746 fig., 1965.

Part H, Revised. Brachiopoda, Volume 1 (Introduction), xx + 539 p., 417 fig., 40 tables, 1997.

Part H, Revised. Brachiopoda, Volumes 2 and 3 (Linguliformea, Craniiformea, Rhynchonelliformea [part]), xxx + 919 p., 616 fig., 17 tables, 2000.

Part H, Revised. Brachiopoda, Volume 4 (Rhynchonelliformea [part]), xxxix + 768 p., 484 fig., 3 tables, 2002.

Part H, Revised. Brachiopoda, Volume 5 (Rhynchonelliformea [part]), xlvi + 631 p., 398 fig., 2006.

Part I. Mollusca 1 (Mollusca General Features, Scaphopoda, Amphineura, Monoplacophora, Gastropoda General Features, Archaeogastropoda, Mainly Paleozoic Caenogastropoda and Opisthobranchia), xxiii + 351 p., 216 fig., 1960.

Part K. Mollusca 3 (Cephalopoda General Features, Endoceratoidea, Actinoceratoidea, Nautiloidea, Bactritoidea), xxviii + 519 p., 361 fig., 1964.

Part L. Mollusca 4 (Cephalopoda: Ammonoidea), xxii + 490 p., 558 fig., 1957.

Part L, Revised. Mollusca 4, Volume 4 (Cretaceous Ammonoidea), xx + 362 p., 216 fig., 1996.

Part N. Mollusca 6 (Bivalvia), Volumes 1 and 2 (of 3), xxxvii + 952 p., 613 fig., 1969; Volume 3, iv + 272 p., 153 fig., 1971.
Part O. Arthropoda 1 (Arthropoda General Features, Protarthropoda, Euarthropoda General Features, Trilobitomorpha), xix + 560 p., 415 fig., 1959.
Part O, Revised. Arthropoda 1 (Trilobita: Introduction, Order Agnostida, Order Redlichiida), xxiv + 530 p., 309 fig., 1997.
Part P. Arthropoda 2 (Chelicerata, Pycnogonida, Palaeoisopus), xvii + 181 p., 123 fig., 1955 [1956].
Part Q. Arthropoda 3 (Crustacea, Ostracoda), xxiii + 442 p., 334 fig., 1961.
Part R. Arthropoda 4, Volumes 1 and 2 (Crustacea Exclusive of Ostracoda, Myriapoda, Hexapoda), xxxvi + 651 p., 397 fig., 1969.
Part R. Arthropoda 4, Volumes 3 and 4 (Hexapoda), xxii + 655 p., 265 fig., 1992.
Part S. Echinodermata 1 (Echinodermata General Features, Homalozoa, Crinozoa, exclusive of Crinoidea), Volumes 1 and 2, xxx + 650 p., 400 fig., 1967 [1968].
Part T. Echinodermata 2 (Crinoidea), Volumes 1–3, xxxviii + 1,027 p., 619 fig., 1978.
Part U. Echinodermata 3 (Asterozoans, Echinozoans), xxx + 695 p., 534 fig., 1966.
Part V. Graptolithina, xvii + 101 p., 72 fig., 1955.
Part V, Revised. Graptolithina, xxxii + 163 p., 109 fig., 1970.
Part W. Miscellanea (Conodonts, Conoidal Shells of Uncertain Affinities, Worms, Trace Fossils, Problematica), xxv + 259 p., 153 fig., 1962.
Part W, Revised. Miscellanea, Supplement 1 (Trace Fossils and Problematica), xxi + 269 p., 110 fig., 1975.
Part W, Revised. Miscellanea, Supplement 2 (Conodonta), xxviii + 202 p., frontis., 122 fig., 1981.

THIS VOLUME

Part H, Revised. Brachiopoda, Volume 6 (Supplement), l + 906 p., 461 fig., 38 tables, CD of compiled references from volumes 1–6, 2007.

VOLUMES IN PREPARATION

Part B. Protista 1 (Chrysomonadida, Coccolithophorida, Diatomacea, etc.).
Part E, Revised. Porifera (additional volumes).
Part F, Revised. Cnidaria (Scleractinia).
Part G, Revised. Bryozoa (additional volumes).
Part K, Revised. Mollusca 3 (Nautiloidea).
Part L, Revised. Mollusca 4 (Ammonoidea) (additional volumes).
Part M. Mollusca 5 (Coleoidea).
Part O, Revised. Arthropoda 1 (Trilobita) (additional volumes).
Part P, Revised. Arthropoda 2 (Chelicerata).
Part Q, Revised. Arthropoda 3 (Ostracoda).
Part R, Revised. Arthropoda 4 (Crustacea Exclusive of Ostracoda).
Part T, Revised. Echinodermata 2 (Crinoidea).
Part V, Revised. Graptolithina.
Part W, Revised. Trace Fossils.

EDITORIAL PREFACE

PAUL A. SELDEN
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From the outset the aim of the *Treatise on Invertebrate Paleontology* has been to present a comprehensive and authoritative yet compact statement of knowledge concerning groups of invertebrate fossils. Typically, preparation of early *Treatise* volumes was undertaken by a small group with a synoptic view of the taxa being monographed. Two or perhaps three specialists worked together, sometimes co-opting others for coverage of highly specialized taxa. Recently, however, both new *Treatise* volumes and revisions of existing ones have been undertaken increasingly by teams of specialists led by a coordinating author. This volume, Part H, Revised, Brachiopoda, Volume 6, has been prepared by such a team of specialists whose work prior to April 2004 was coordinated by Sir Alwyn Williams at The University of Glasgow. Subsequent coordination of this volume has been handled jointly by Dr. Howard Brunton (retired, formerly at the British Museum, Natural History) and Dr. Sandy Carlson at the University of California (Davis). Editorial matters specific to this volume are discussed near the end of this editorial preface.

ZOOLOGICAL NAMES

Questions about the proper use of zoological names arise continually, especially questions regarding both the acceptability of names and alterations of names that are allowed or even required. Regulations prepared by the International Commission on Zoological Nomenclature (ICZN) and published in 1999 in the *International Code of Zoological Nomenclature,* hereinafter referred to as the *Code,* provide procedures for answering such questions. The prime objective of the *Code* is to promote stability and universality in the use of the scientific names of animals, ensuring also that each generic name is distinct and unique, while avoiding unwarranted restrictions on freedom of thought and action of systematists. Priority of names is a basic principle of the *Code;* but, under specified conditions and by following prescribed procedures, priority may be set aside by the Commission. These procedures apply especially where slavish adherence to the principle of priority would hamper or even disrupt zoological nomenclature and the information it conveys.

The Commission, ever aware of the changing needs of systematists, revised the *Code* in 1999 to enhance further nomenclatorial stability, specifying that the revised *Code* should take effect at the start of 2000. Among other requirements, the revised *Code* is clear in Chapter 14 that the type genus of family-level taxa must be specified. In this volume we have continued the practice that has characterized most previous volumes of the *Treatise*, namely that the type genus of all family-level taxa is the first listed and diagnosed. In spite of the revisions, the nomenclatorial tasks that confront zoological taxonomists are formidable and have often justified the complaint that the study of zoology and paleontology is too often merely the study of names rather than the study of animals. It is incumbent upon all systematists, therefore, at the outset of their work to pay careful attention to the *Code* to enhance stability by minimizing the number of subsequent changes of names, too many of which are necessitated by insufficient attention to detail. To that end, several pages here are devoted to aspects of zoological nomenclature that are judged to have chief importance in relation to procedures adopted in the *Treatise,* especially in this volume. Terminology is explained, and examples are given of the style employed in the nomenclatorial parts of the systematic descriptions.

GROUPS OF TAXONOMIC CATEGORIES

Each taxon belongs to a category in the Linnaean hierarchical classification. The *Code* recognizes three groups of categories, a species-group, a genus-group, and a family-group. Taxa of lower rank than subspecies are excluded from the rules of zoological nomenclature, and those of higher rank than superfamily are not regulated by the *Code.* It is both natural and convenient to discuss nomenclatorial matters in general terms first and then to consider each of these three, recognized groups separately. Especially important is the provision that within each group the categories are coordinate, that is, equal in rank, whereas categories of different groups are not coordinate.

FORMS OF NAMES

All zoological names can be considered on the basis of their spelling. The first form of a name to be published is defined as the original spelling (*Code,* Article 32), and any form of the same name that is published later and is different from the original spelling is designated a subsequent spelling (*Code,* Article 33). Not every original or subsequent spelling is correct.

ORIGINAL SPELLINGS

If the first form of a name to be published is consistent and unambiguous, the original is defined as correct unless it contravenes some stipulation of the *Code* (Articles 11, 27 to 31, and 34) or unless the original publication contains clear evidence of an inadvertent error in the sense of the *Code,* or, among names belonging to the family-group, unless correction of the termination or the stem of the type genus is required. An original spelling that fails to meet these requirements is defined as incorrect.

If a name is spelled in more than one way in the original publication, the form adopted by the first reviser is accepted as the correct original spelling, provided that it complies with mandatory stipulations of the *Code* (Articles 11 and 24 to 34).

Incorrect original spellings are any that fail to satisfy requirements of the *Code,* represent an inadvertent error, or are one of multiple original spellings not adopted by a first reviser. These have no separate status in zoological nomenclature and, therefore, cannot enter into homonymy or be used as replacement names. They call for correction. For example, a name originally published with a diacritical mark, apostrophe, dieresis, or hyphen requires correction by deleting such features and uniting parts of the name originally separated by them, except that deletion of an umlaut from a vowel in a name derived from a German word or personal name unfortunately requires the insertion of *e* after the vowel. Where original spelling is judged to be incorrect solely because of inadequacies of the Greek or Latin scholarship of the author, nomenclatorial changes conflict with the primary purpose of zoological nomenclature as an information retrieval system. One looks forward with hope to further revisions of the *Code* wherein rules are emplaced that enhance stability rather than classical scholarship, thereby facilitating access to information.

SUBSEQUENT SPELLINGS

If a subsequent spelling differs from an original spelling in any way, even by the omission, addition, or alteration of a single letter, the subsequent spelling must be defined as a different name. Exceptions include such changes as an altered termination of adjectival specific names to agree in gender with associated generic names (an unfortunate impediment to stability and retrieval of information); changes of family-group names to denote assigned taxonomic rank; and corrections that eliminate originally used diacritical marks, hyphens, and the like. Such changes are not regarded as spelling changes conceived to produce a different name. In some instances, however, species-group names having variable spellings are

regarded as homonyms as specified in the *Code* (Article 58).

Altered subsequent spellings other than the exceptions noted may be either intentional or unintentional. If "demonstrably intentional" (*Code,* Article 33), the change is designated as an emendation. Emendations may be either justifiable or unjustifiable. Justifiable emendations are corrections of incorrect original spellings, and these take the authorship and date of the original spellings. Unjustifiable emendations are names having their own status in nomenclature, with author and date of their publication. They are junior, objective synonyms of the name in its original form.

Subsequent spellings, if unintentional, are defined as incorrect subsequent spellings. They have no status in nomenclature, do not enter into homonymy, and cannot be used as replacement names.

AVAILABLE AND UNAVAILABLE NAMES

Editorial prefaces of some previous volumes of the *Treatise* have discussed in appreciable detail the availability of the many kinds of zoological names that have been proposed under a variety of circumstances. Much of that information, while important, does not pertain to the present volume, in which authors have used fewer terms for such names. The reader is referred to the *Code* (Articles 10 to 20) for further details on availability of names. Here, suffice it to say that an available zoological name is any that conforms to all mandatory provisions of the *Code.* All zoological names that fail to comply with mandatory provisions of the *Code* are unavailable and have no status in zoological nomenclature. Both available and unavailable names are classifiable into groups that have been recognized in previous volumes of the *Treatise,* although not explicitly differentiated in the *Code.* Among names that are available, these groups include inviolate names, perfect names, imperfect names, vain names, transferred names, improved or corrected names, substitute names, and conserved names. Kinds of unavailable names include naked names (see *nomina nuda* below), denied names, impermissible names, null names, and forgotten names.

Nomina nuda include all names that fail to satisfy provisions stipulated in Article 11 of the *Code,* which states general requirements of availability. In addition, they include names published before 1931 that were unaccompanied by a description, definition, or indication (*Code,* Article 12) and names published after 1930 that (1) lacked an accompanying statement of characters that differentiate the taxon, (2) were without a definite bibliographic reference to such a statement, (3) were not proposed expressly as a replacement (*nomen novum*) of a preexisting available name (*Code,* Article 13.1), or (4) for genus-group names, were unaccompanied by definite fixation of a type species by original designation or indication (*Code,* Article 13.2). *Nomina nuda* have no status in nomenclature, and they are not correctable to establish original authorship and date.

VALID AND INVALID NAMES

Important considerations distinguish valid from available names on the one hand and invalid from unavailable names on the other. Whereas determination of availability is based entirely on objective considerations guided by articles of the *Code,* conclusions as to validity of zoological names may be partly subjective. A valid name is the correct one for a given taxon, which may have two or more available names but only a single correct, hence valid, name, which is also generally the oldest name that it has been given. Obviously, no valid name can also be an unavailable name, but invalid names may be either available or unavailable. It follows that any name for a given taxon other than the valid name, whether available or unavailable, is an invalid name.

One encounters a sort of nomenclatorial no-man's land in considering the status of such zoological names as *nomina dubia* (doubtful names), which may include

both available and unavailable names. The unavailable ones can well be ignored, but names considered to be available contribute to uncertainty and instability in the systematic literature. These can ordinarily be removed only by appeal to the ICZN for special action. Because few systematists care to seek such remedy, such invalid but available names persist in the literature.

NAME CHANGES IN RELATION TO GROUPS OF TAXONOMIC CATEGORIES

SPECIES-GROUP NAMES

Detailed consideration of valid emendation of specific and subspecific names is unnecessary here, both because the topic is well understood and relatively inconsequential and because the *Treatise* deals with genus-group names and higher categories. When the form of adjectival specific names is changed to agree with the gender of a generic name in transferring a species from one genus to another, one need never label the changed name as *nomen correctum.* Similarly, transliteration of a letter accompanied by a diacritical mark in the manner now called for by the *Code,* as in changing originally *brögger*i to *broeggeri,* or eliminating a hyphen, as in changing originally published *cornu-oryx* to *cornuoryx,* does not require the designation *nomen correctum.* Of course, in this age of computers and electronic databases, such changes of name, which are perfectly valid for the purposes of scholarship, run counter to the requirements of nomenclatorial stability upon which the preparation of massive, electronic databases is predicated.

GENUS-GROUP NAMES

Conditions warranting change of the originally published, valid form of generic and subgeneric names are sufficiently rare that lengthy discussion is unnecessary. Only elimination of diacritical marks and hyphens in some names in this category and replacement of homonyms seem to furnish basis for valid emendation. Many names that formerly were regarded as homonyms are no longer so regarded, because two names that differ only by a single letter or in original publication by the presence of a diacritical mark in one are now construed to be entirely distinct (but see *Code,* Article 58).

As has been pointed out above, difficulty typically arises when one tries to decide whether a change of spelling of a name by a subsequent author was intentional or unintentional, and the decision has to be made often arbitrarily.

FAMILY-GROUP NAMES

Family-Group Names: Authorship and Date

All family-group taxa having names based on the same type genus are attributed to the author who first published the name of any of these groups, whether tribe, subfamily, or family (superfamily being almost inevitably a later-conceived taxon). Accordingly, if a family is divided into subfamilies or a subfamily into tribes, the name of no such subfamily or tribe can antedate the family name. Moreover, every family containing differentiated subfamilies must have a nominate subfamily (*sensu stricto*), which is based on the same type genus as the family. Finally, the author and date set down for the nominate subfamily invariably are identical with those of the family, irrespective of whether the author of the family or some subsequent author introduced subdivisions.

Corrections in the form of family-group names do not affect authorship and date of the taxon concerned, but in the *Treatise* recording the authorship and date of the correction is desirable because it provides a pathway to follow the thinking of the systematists involved.

Family-Group Names: Use of *nomen translatum*

The *Code* (Article 29.2) specifies the suffixes for tribe (-ini), subfamily (-inae), family (-idea) and superfamily (-oidea), the

formerly widely used ending (-acea) for superfamily having been disallowed. All these family-group categories are defined as coordinate (*Code*, Article 36.1): "A name established for a taxon at any rank in the family group is deemed to have been simultaneously established for nominal taxa at other ranks in the family group; all these taxa have the same type genus, and their names are formed from the stemof the name of the type genus (Art. 29.3] with appropriate change of suffix [Art. 34.1]. The name has the same authorship and date at every rank." Such changes of rank and concomitant changes of endings as elevation of a subfamily to family rank or of a family to superfamily rank, if introduced subsequent to designation of the original taxon or based on the same nominotypical genus, are *nomina translata*. In the *Treatise* it is desirable to distinguish the valid alteration in the changed ending of each transferred family-group name by the term *nomen translatum,* abbreviated to *nom. transl.* Similarly for clarity, authors should record the author, date, and page of the alteration, as in the following example.

Family HEXAGENITIDAE Lameere, 1917

[*nom. transl.* Demoulin, 1954, p. 566, *ex* Hexagenitinae Lameere, 1917, p. 74]

This is especially important for superfamilies, for the information of interest is the author who initially introduced a taxon rather than the author of the superfamily as defined by the *Code.* For example:

Superfamily AGNOSTOIDEA M'Coy, 1849

[*nom. transl.* Shergold, Laurie, & Sun, 1990, p. 32, *ex* Agnostinae M'Coy, 1849, p. 402]

The latter is merely the individual who first defined some lower-ranked, family-group taxon that contains the nominotypical genus of the superfamily. On the other hand, the publication that introduces the superfamily by *nomen translatum* is likely to furnish the information on taxonomic considerations that support definition of the taxon.

Family-Group Names: Use of *nomen correctum*

Valid name changes classed as *nomina correcta* do not depend on transfer from one category of the family group to another but most commonly involve correction of the stem of the nominotypical genus. In addition, they include somewhat arbitrarily chosen modifications of endings for names of tribes or superfamilies. Examples of the use of *nomen correctum* are the following.

Family STREPTELASMATIDAE Nicholson, 1889

[*nom. correct.* Wedekind, 1927, p. 7, *pro* Streptelasmidae Nicholson in Nicholson & Lydekker, 1889, p. 297]

Family PALAEOSCORPIDAE Lehmann, 1944

[*nom. correct.* Petrunkevitch, 1955, p. 73, *pro* Palaeoscorpionidae Lehmann, 1944, p. 177]

Family-Group Names: Replacements

Family-group names are formed by adding combinations of letters, which are prescribed for all family-group categories, to the stem of the name belonging to the nominotypical genus first chosen as type of the assemblage. The type genus need not be the first genus in the family to have been named and defined, but among all those included it must be the first published as name giver to a family-group taxon. Once fixed, the family-group name remains tied to the nominotypical genus even if the generic name is changed by reason of status as a junior homonym or junior synonym, either objective or subjective. Seemingly, the *Code* requires replacement of a family-group name only if the nominotypical genus is found to have been a junior homonym when it was proposed (*Code,* Article 39), in which case ". . . it must be replaced either by the next oldest available name from among its synonyms [Art. 23.3.5], including the names of its subordinate family-group taxa, or, if there is no such synonym, by a new name based on the valid name . . . of the former type

genus." Authorship and date attributed to the replacement family-group name are determined by first publication of the changed family-group name. Recommendation 40A of the *Code,* however, specifies that for subsequent application of the rule of priority, the family-group name ". . . should be cited with its original author and date (see Recommendation 22A.2.2), followed by the date of its priority as determined by this Article; the date of priority should be enclosed in parentheses." Many family-group names that have been in use for a long time are *nomina nuda,* since they fail to satisfy criteria of availability (*Code,* Article 11.7). These demand replacement by valid names.

The aim of family-group nomenclature is to yield the greatest possible stability and uniformity, just as in other zoological names. Both taxonomic experience and the *Code* (Article 40) indicate the wisdom of sustaining family-group names based on junior subjective synonyms if they have priority of publication, for opinions of the same worker may change from time to time. The retention of first-published, family-group names that are found to be based on junior objective synonyms, however, is less clearly desirable, especially if a replacement name derived from the senior objective synonym has been recognized very long and widely. Moreover, to displace a widely used, family-group name based on the senior objective synonym by disinterring a forgotten and virtually unused family-group name based on a junior objective synonym because the latter happens to have priority of publication is unsettling.

A family-group name may need to be replaced if the nominotypical genus is transferred to another family group. If so, the first-published of the generic names remaining in the family-group taxon is to be recognized in forming a replacement name.

SUPRAFAMILIAL TAXA: TAXA ABOVE FAMILY-GROUP

International rules of zoological nomenclature as given in the *Code* affect only lower-rank categories: subspecies to superfamily. Suprafamilial categories (suborder to kingdom) are either not mentioned or explicitly placed outside of the application of zoological rules. The *Copenhagen Decisions on Zoological Nomenclature* (1953, Articles 59 to 69) proposed adopting rules for naming suborders and higher taxa up to and including phylum, with provision for designating a type genus for each, in such manner as not to interfere with the taxonomic freedom of workers. Procedures were outlined for applying the rule of priority and rule of homonymy to suprafamilial taxa and for dealing with the names of such taxa and their authorship, with assigned dates, if they should be transferred on taxonomic grounds from one rank to another. The adoption of terminations of names, different for each category but uniform within each, was recommended.

The Colloquium on Zoological Nomenclature, which met in London during the week just before the 15th International Congress of Zoology convened in 1958, thoroughly discussed the proposals for regulating suprafamilial nomenclature, as well as many others advocated for inclusion in the new *Code* or recommended for exclusion from it. A decision that was supported by a wide majority of the participants in the colloquium was against the establishment of rules for naming taxa above family-group rank, mainly because it was judged that such regulation would unwisely tie the hands of taxonomists. For example, a class or order defined by an author at a given date, using chosen morphologic characters (*e.g.,* gills of bivalves), should not be allowed to freeze nomenclature, taking precedence over another class or order that is proposed later and distinguished by different characters (*e.g.,* hinge teeth of bivalves). Even the fixing of type genera for suprafamilial taxa would have little, if any, value, hindering taxonomic work rather than aiding it. Beyond mere tidying up, no basis for establishing such types and for naming these taxa has yet been provided.

The considerations just stated do not prevent the editors of the *Treatise* from making rules for dealing with suprafamilial groups of animals described and illustrated in this publication. Some uniformity is needed, especially for the guidance of *Treatise* authors. This policy should accord with recognized general practice among zoologists; but where general practice is indeterminate or nonexistent, our own procedure in suprafamilial nomenclature needs to be specified as clearly as possible. This pertains especially to decisions about names themselves, about citation of authors and dates, and about treatment of suprafamilial taxa that, on taxonomic grounds, are changed from their originally assigned rank. Accordingly, a few rules expressing *Treatise* policy are given here, some with examples of their application.

1. The name of any suprafamilial taxon must be a Latin or Latinized, uninominal noun of plural form or treated as such, with a capital initial letter and without diacritical mark, apostrophe, diaeresis, or hyphen. If a component consists of a numeral, numerical adjective, or adverb, this must be written in full.

2. Names of suprafamilial taxa may be constructed in almost any manner. A name may indicate morphological attributes (*e.g.,* Lamellibranchiata, Cyclostomata, Toxoglossa) or be based on the stem of an included genus (*e.g.,* Bellerophontina, Nautilida, Fungiina) or on arbitrary combinations of letters (*e.g.,* Yuania); none of these, however, can end in -idae or -inae, which terminations are reserved for family-group taxa. No suprafamilial name identical in form to that of a genus or to another published suprafamilial name should be employed (*e.g.,* order Decapoda Latreille, 1803, crustaceans, and order Decapoda Leach, 1818, cephalopods; suborder Chonetoidea Muir-Wood, 1955, and genus *Chonetoidea* Jones, 1928). Worthy of notice is the classificatory and nomenclatorial distinction between suprafamilial and family-group taxa that, respectively, are named from the same type genus, since one is not considered to be transferable to the other (*e.g.,* suborder Bellerophontina Ulrich & Scofield, 1897 is not coordinate with superfamily Bellerophontacea McCoy, 1851 or family Bellerophontidae McCoy, 1851).

3. The rules of priority and homonymy lack any force of international agreement as applied to suprafamilial names, yet in the interest of nomenclatorial stability and to avoid confusion these rules are widely applied by zoologists to taxa above the family-group level wherever they do not infringe on taxonomic freedom and long-established usage.

4. Authors who accept priority as a determinant in nomenclature of a suprafamilial taxon may change its assigned rank at will, with or without modifying the terminal letters of the name, but such changes cannot rationally be judged to alter the authorship and date of the taxon as published originally. A name revised from its previously published rank is a transferred name (*nomen translatum*), as illustrated in the following.

Order CORYNEXOCHIDA Kobayashi, 1935

[*nom. transl.* Moore, 1959, p. 217, *ex* suborder Corynexochida Kobayashi, 1935, p. 81]

A name revised from its previously published form merely by adoption of a different termination without changing taxonomic rank is a *nomen correctum.*

Order DISPARIDA Moore & Laudon, 1943

[*nom. correct.* Moore in Moore, Lalicker, & Fischer, 1952, p. 613, *pro* order Disparata Moore & Laudon, 1943, p. 24]

A suprafamilial name revised from its previously published rank with accompanying change of termination, which signals the change of rank, is recorded as a *nomen translatum et correctum.*

Order HYBOCRINIDA Jaekel, 1918

[*nom. transl. et correct.* Moore in Moore, Lalicker, & Fischer, 1952, p. 613, *ex* suborder Hybocrinites Jaekel, 1918, p. 90]

5. The authorship and date of nominate subordinate and supraordinate taxa among suprafamilial taxa are considered in the *Treatise* to be identical since each actually or potentially has the same type. Examples are given below.

Subclass ENDOCERATOIDEA Teichert, 1933

[*nom. transl.* Teichert in Teichert & others, 1964, p. 128, *ex* order Endoceroidea Teichert, 1933, p. 214]

Order ENDOCERIDA Teichert, 1933

[*nom. correct.* Teichert in Teichert & others, 1964, p. 165, *pro* order Endoceroidea Teichert, 1933, p. 214]

TAXONOMIC EMENDATION

Emendation has two distinct meanings as regards zoological nomenclature. These are alteration of a name itself in various ways for various reasons, as has been reviewed, and alteration of the taxonomic scope or concept for which a name is used. The *Code* (Article 33.1 and Glossary) concerns itself only with the first type of emendation, applying the term to intentional, either justified or unjustified changes of the original spelling of a name. The second type of emendation primarily concerns classification and inherently is not associated with change of name. Little attention generally has been paid to this distinction in spite of its significance.

Most zoologists, including paleontologists, who have emended zoological names refer to what they consider a material change in application of the name such as may be expressed by an importantly altered diagnosis of the assemblage covered by the name. The abbreviation *emend.* then must accompany the name with statement of the author and date of the emendation. On the other hand, many systematists think that publication of *emend.* with a zoological name is valueless because alteration of a taxonomic concept is introduced whenever a subspecies, species, genus, or other taxon is incorporated into or removed from a higher zoological taxon. Inevitably associated with such classificatory expansions and restrictions is some degree of emendation affecting diagnosis. Granting this, still it is true that now and then somewhat more extensive revisions are put forward, generally with a published statement of the reasons for changing the application of a name. To erect a signpost at such points of most significant change is worthwhile, both as an aid to subsequent workers in taking account of the altered nomenclatorial usage and to indicate where in the literature cogent discussion may be found. Authors of contributions to the *Treatise* are encouraged to include records of all especially noteworthy emendations of this nature, using the abbreviation *emend.* with the name to which it refers and citing the author, date, and page of the emendation. Examples from *Treatise* volumes follow.

Order ORTHIDA Schuchert & Cooper, 1932

[*nom. transl. et correct.* Moore in Moore, Lalicker, & Fischer, 1952, p. 220, *ex* suborder Orthoidea Schuchert & Cooper, 1932, p. 43; *emend.,* Williams & Wright, 1965, p. 299]

Subfamily ROVEACRININAE Peck, 1943

[Roveacrininae Peck, 1943, p. 465; *emend.,* Peck in Moore & Teichert, 1978, p. 921]

STYLE IN GENERIC DESCRIPTIONS

CITATION OF TYPE SPECIES

In the *Treatise* the name of the type species of each genus and subgenus is given immediately following the generic name with its accompanying author, date, and page reference or after entries needed for definition of the name if it is involved in homonymy. The originally published combination of generic and trivial names of this species is cited, accompanied by an asterisk (*), with notation of the author, date, and page of original publication, except if the species was first published in the same paper and by the same author as that containing definition of the genus of which it is the type. In this instance, the initial letter of the generic

name followed by the trivial name is given without repeating the name of the author and date. Examples of these two sorts of citations follow.

Orionastraea Smith, 1917, p. 294 [**Sarcinula phillipsi* McCoy, 1849, p. 125; OD].

Schoenophyllum Simpson, 1900, p. 214 [**S. aggregatum;* OD].

If the cited type species is a junior synonym of some other species, the name of this latter is given also, as follows.

Actinocyathus d'Orbigny, 1849, p. 12 [**Cyathophyllum crenulate* Phillips, 1836, p. 202; M; *=Lonsdaleia floriformis* (Martin), 1809, pl. 43; validated by ICZN Opinion 419].

In some instances the type species is a junior homonym. If so, it is cited as shown in the following example.

Prionocyclus Meek, 1871b, p. 298 [**Ammonites serratocarinatus* Meek, 1871a, p. 429, *non* Stoliczka, 1864, p. 57; *=Prionocyclus wyomingensis* Meek, 1876, p. 452].

In the *Treatise* the name of the type species is always given in the exact form it had in the original publication except that diacritical marks have been removed. Where other mandatory changes are required, these are introduced later in the text, typically in the description of a figure.

Fixation of Type Species Originally

It is desirable to record the manner of establishing the type species, whether by original designation (OD) or by subsequent designation (SD). The type species of a genus or subgenus, according to provisions of the *Code,* may be fixed in various ways in the original publication; or it may be fixed subsequently in ways specified by the *Code* (Article 68) and described in the next section. Type species fixed in the original publication include (1) *original designation* (in the *Treatise* indicated by OD) when the type species is explicitly stated or (before 1931) indicated by n. gen., n. sp. (or its equivalent) applied to a single species included in a new genus, (2) defined by use of *typus* or *typicus* for one of the species included in a new genus (adequately indicated in the *Treatise* by the specific name), (3) established by *monotypy* if a new genus or subgenus has only one originally included species (in the *Treatise* indicated as M), and (4) fixed by *tautonymy* if the genus-group name is identical to an included species name not indicated as the type.

Fixation of Type Species Subsequently

The type species of many genera are not determinable from the publication in which the generic name was introduced. Therefore, such genera can acquire a type species only by some manner of subsequent designation. Most commonly this is established by publishing a statement naming as type species one of the species originally included in the genus. In the *Treatise* such fixation of the type species by subsequent designation in this manner is indicated by the letters SD accompanied by the name of the subsequent author (who may be the same person as the original author) and the publication date and page number of the subsequent designation. Some genera, as first described and named, included no mentioned species (for such genera established after 1930, see below); these necessarily lack a type species until a date subsequent to that of the original publication when one or more species is assigned to such a genus. If only a single species is thus assigned, it becomes automatically the type species. Of course, the first publication containing assignment of species to the genus that originally lacked any included species is the one concerned in fixation of the type species, and if this publication names two or more species as belonging to the genus but did not designate a type species, then a later SD designation is necessary. Examples of the use of SD as employed in the *Treatise* follow.

Hexagonaria Gurich, 1896, p. 171 [**Cyathophyllum hexagonum* Goldfuss, 1826, p. 61; SD Lang, Smith, & Thomas, 1940, p. 69].

Mesephemera Handlirsch, 1906, p. 600 [**Tineites lithophilus* Germar, 1842, p. 88; SD Carpenter, herein].

Another mode of fixing the type species of a genus is through action of the Internation-

al Commission of Zoological Nomenclature using its plenary powers. Definition in this way may set aside application of the *Code* so as to arrive at a decision considered to be in the best interest of continuity and stability of zoological nomenclature. When made, it is binding and commonly is cited in the *Treatise* by the letters ICZN, accompanied by the date of announced decision and reference to the appropriate numbered opinion.

Subsequent designation of a type species is admissible only for genera established prior to 1931. A new genus-group name established after 1930 and not accompanied by fixation of a type species through original designation or original indication is invalid (*Code,* Article 13.3). Effort of a subsequent author to validate such a name by subsequent designation of a type species constitutes an original publication making the name available under authorship and date of the subsequent author.

HOMONYMS

Most generic names are distinct from all others and are indicated without ambiguity by citing their originally published spelling accompanied by name of the author and date of first publication. If the same generic name has been applied to two or more distinct taxonomic units, however, it is necessary to differentiate such homonyms. This calls for distinction between junior homonyms and senior homonyms. Because a junior homonym is invalid, it must be replaced by some other name. For example, *Callophora* HALL, 1852, introduced for Paleozoic trepostomate bryozoans, is invalid because Gray in 1848 published the same name for Cretaceous–Holocene cheilostomate bryozoans. Bassler in 1911 introduced the new name *Hallophora* to replace Hall's homonym. The *Treatise* style of entry is given below.

Hallophora BASSLER, 1911, p. 325, *nom. nov. pro Callophora* HALL, 1852, p. 144, *non* GRAY, 1848.

In like manner, a replacement generic name that is needed may be introduced in the *Treatise* (even though first publication of generic names otherwise in this work is generally avoided). An exact bibliographic reference must be given for the replaced name as in the following example.

Mysterium DE LAUBENFELS, herein, *nom. nov. pro Mystrium* SCHRAMMEN, 1936, p. 183, *non* ROGER, 1862 [**Mystrium porosum* SCHRAMMEN, 1936, p. 183; OD].

Otherwise, no mention is made generally of the existence of a junior homonym.

Synonymous Homonyms

An author sometimes publishes a generic name in two or more papers of different date, each of which indicates that the name is new. This is a bothersome source of errors for later workers who are unaware that a supposed first publication that they have in hand is not actually the original one. Although the names were published separately, they are identical and therefore definable as homonyms; at the same time they are absolute synonyms. For the guidance of all concerned, it seems desirable to record such names as synonymous homonyms. In the *Treatise* the junior of one of these is indicated by the abbreviation *jr. syn. hom.*

Not infrequently, identical family-group names are published as new names by different authors, the author of the name that was introduced last being ignorant of previous publication(s) by one or more other workers. In spite of differences in taxonomic concepts as indicated by diagnoses and grouping of genera and possibly in assigned rank, these family-group taxa, being based on the same type genus, are nomenclatorial homonyms. They are also synonyms. Wherever encountered, such synonymous homonyms are distinguished in the *Treatise* as in dealing with generic names.

A rare but special case of homonymy exists when identical family names are formed from generic names having the same stem but differing in their endings. An example is the family name Scutellidae RICHTER & RICHTER, 1925, based on *Scutellum* PUSCH, 1833, a trilobite. This name is a junior homonym of Scutellidae GRAY, 1825, based on the echinoid genus *Scutella* LAMARCK, 1816.

The name of the trilobite family was later changed to Scutelluidae (ICZN, Opinion 1004, 1974).

SYNONYMS

In the *Treatise,* citation of synonyms is given immediately after the record of the type species. If two or more synonyms of differing date are recognized, these are arranged in chronological order. Objective synonyms are indicated by accompanying designation *obj.,* others being understood to constitute subjective synonyms, of which the types are also indicated. Examples showing *Treatise* style in listing synonyms follow.

Mackenziephyllum PEDDER, 1971, p. 48 [**M. insolitum;* OD] [=*Zonastraea* TSYGANKO in SPASSKIY, KRAVTSOV, & TSYGANKO, 1971, p. 85, *nom. nud.; Zonastraea* TSYGANKO, 1972, p. 21 (type, *Z. graciosa,* OD)].

Kodonophyllum WEDEKIND, 1927, p. 34 [**Streptelasma Milne-Edwardsi* DYBOWSKI, 1873, p. 409; OD; =*Madrepora truncata* LINNE, 1758, p. 795, see SMITH & TREMBERTH, 1929, p. 368] [=*Patrophontes* LANG & SMITH, 1927, p. 456 (type, *Madrepora truncata* LINNE, 1758, p. 795, OD); *Codonophyllum* LANG, SMITH, & THOMAS, 1940, p. 39, obj.].

Some junior synonyms of either the objective or the subjective sort may be preferred over senior synonyms whenever uniformity and continuity of nomenclature are served by retaining a widely used but technically rejectable name for a genus. This requires action of the ICZN, which may use its plenary powers to set aside the unwanted name, validate the wanted one, and place the concerned names on appropriate official lists.

OTHER EDITORIAL MATTERS

BIOGEOGRAPHY

Purists, *Treatise* editors among them, would like nothing better than a stable world with a stable geography that makes possible a stable biogeographical classification. Global events of the past few years have shown how rapidly geography can change, and in all likelihood we have not seen the last of such change as new, so-called republics continue to spring up all over the globe. One expects confusion among readers in the future as they try to decipher such geographical terms as U.S.S.R., Yugoslavia, or Ceylon. Such confusion is unavoidable, as books must be completed and published at some real time. Libraries would be limited indeed if publication were always to be delayed until the political world had settled down. In addition, such terms as central Europe and western Europe are likely to mean different things to different people. Some imprecision is introduced by the use of all such terms, of course, but it is probably no greater than the imprecision that stems from the fact that the work of paleontology is not yet finished, and the geographical ranges of many genera are imperfectly known.

Special considerations are necessary when referring to parts of the former Soviet Union. To some authors the term Central Asia, referring to Uzbekistan, Turkmenistan, Tadzhikistan, Kirgizistan, and sometimes all or part of Kazakhstan, has a distinct meaning from the less formal term central Asia, which is used more widely in the West. Accordingly, we have attempted to substitute the Russian term *Srednii Azii* to refer to Central Asia, as opposed to central Asia. Unfortunately, we are by no means certain that we have been fully consistent in this usage throughout the volume.

Other geographic terms can also have varying degrees of formality. In general, *Treatise* policy is to use adjectives rather than nouns to refer to directions. Thus we have used *southern* and *western* in place of *South* and *West* unless a term has been formally defined as a geographic entity (e.g., South America or West Virginia). Note that we have referred to western Texas rather than West Texas, which is said to be not a state but a state of mind.

NAMES OF AUTHORS: TRANSLATION AND TRANSLITERATION

Chinese scientists have become increasingly active in systematic paleontology in the past two decades. Chinese names cause anguish among English-language bibliographers for two reasons. First, no scheme exists for one-to-one transliteration of Chinese characters into roman letters. Thus, a

Chinese author may change the roman-letter spelling of his name from one publication to another. For example, the name Chang, the most common family name in the world reportedly held by some one billion people, has been spelled more recently Zhang. The principal purpose of a bibliography is to provide the reader with entry into the literature. Quite arbitrarily, therefore, in the interest of information retrieval, the *Treatise* editorial staff has decided to retain the roman spelling that a Chinese author has used in each of his publications rather than attempting to adopt a common spelling of an author's name to be used in all citations of his work. It is entirely possible, therefore, that the publications of a Chinese author may be listed in more than one place under more than one name in the bibliography.

Second, most but by no means all Chinese list their family name first followed by given names. People with Chinese names who study in the West, however, often reverse the order, putting the family name last as is the Western custom. Thus, for example, Dr. Yi-Maw Chang, formerly of the staff of the Paleontological Institute, was Chang Yi-Maw when he lived in Taiwan. When he came to America, he became Yi-Maw Chang. In the *Treatise,* authors' names are used in the text and listed in the references as they appear in the source being cited.

Several systems exist for transliterating the Cyrillic alphabet into the roman alphabet. On the recommendation of skilled bibliographic librarians, we have adopted the American Library Association/Library of Congress romanization table for Russian and other languages using the Cyrillic alphabet.

MATTERS SPECIFIC TO THIS VOLUME

False cognates are the bane of inexperienced translators. The transliterated Russian term *gorizont*, usually translated *horizon*, is one such false cognate. The term horizon, of course, has no formal status in stratigraphic nomenclature and, in fact, should be used to refer to a surface and not to a thickness of strata. Thus, fossils cannot occur in a horizon, but their ranges may begin or end at a horizon. In some places we have translated *gorizont* as *beds*; in others, where *beds* is not an adequate usage, we have translated it as *stage*.

Authorship entails both credit and responsibility. As the knowledge of paleontology grows and paleontologists become more specialized, preparation of *Treatise* volumes must necessarily involve larger and larger teams of researchers, each focusing on increasingly narrow aspects of the higher taxon under revision. In this volume, we have taken special pains to acknowledge authorship of small subsections. Readers citing the volume are encouraged to pay close attention to the actual authorship of a section or subsection.

Stratigraphic ranges of taxa have been compiled from the ranges of lower taxa. In all instances, we have used the *range-through* method of describing ranges. In instances, therefore, where the work of paleontology is not yet finished, some ranges of higher taxa will not show gaps between the ranges of their subtaxa and may seem to be more complete than the data warrant. Stratigraphic range charts typical of previous *Treatise* volumes will present a much more precise picture of the biostratigraphy of the brachiopods. The range chart for this revision on the Brachiopoda will be presented in the final volume of the series.

This volume breaks new ground for the *Treatise* series in that color is used for the first time. The stratigraphic charts (Curry, p. 2901–2965) would have been effectively unreadable without it. Also, this volume being the last in the part, we have taken the opportunity to present the reference list for all the Brachiopoda volumes in digital format on compact disk and hope that this will be useful to readers.

ACKNOWLEDGMENTS

The Paleontological Institute's Assistant Editor for Text, Jill Hardesty, and the Assistant Editor for Illustrations, Jane Kerns, have faced admirably the formidable task

of moving this volume through the various stages of editing and into production. In this they have been ably assisted by other members of the editorial team including Mike Cormack with his outstanding computer skills, Denise Mayse with her work on illustrations and general support, and Sounithta Vilayvanh with her work on illustrations. The editorial team would also like to extend special thanks to Dr. Albert J. Rowell for his support and help with various taxonomic and manuscript issues and to Dr. Stephen T. Hasiotis and Dr. Bruce S. Lieberman for their support and guidance.

This editorial preface and other, recent ones are extensive revisions of the prefaces prepared for previous *Treatise* volumes by former editors, including the late Raymond C. Moore, the late Curt Teichert, Richard A. Robison, and the late Roger L. Kaesler. I am indebted to them for preparing earlier prefaces and for the leadership they have provided in bringing the *Treatise* project to its present status.

Finally, on behalf of the members of the staff of the Paleontological Institute, both past and present, it is my privilege to honor the memory of the late Sir Alwyn Williams by expressing gratitude for the unwavering scholarship, dedication to the task, and scrupulous attention to detail that marked his involvement with this project from the outset and, indeed, throughout his entire career as a specialist on the Brachiopoda.

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Paul A. Selden
Lawrence, Kansas
August 17, 2007

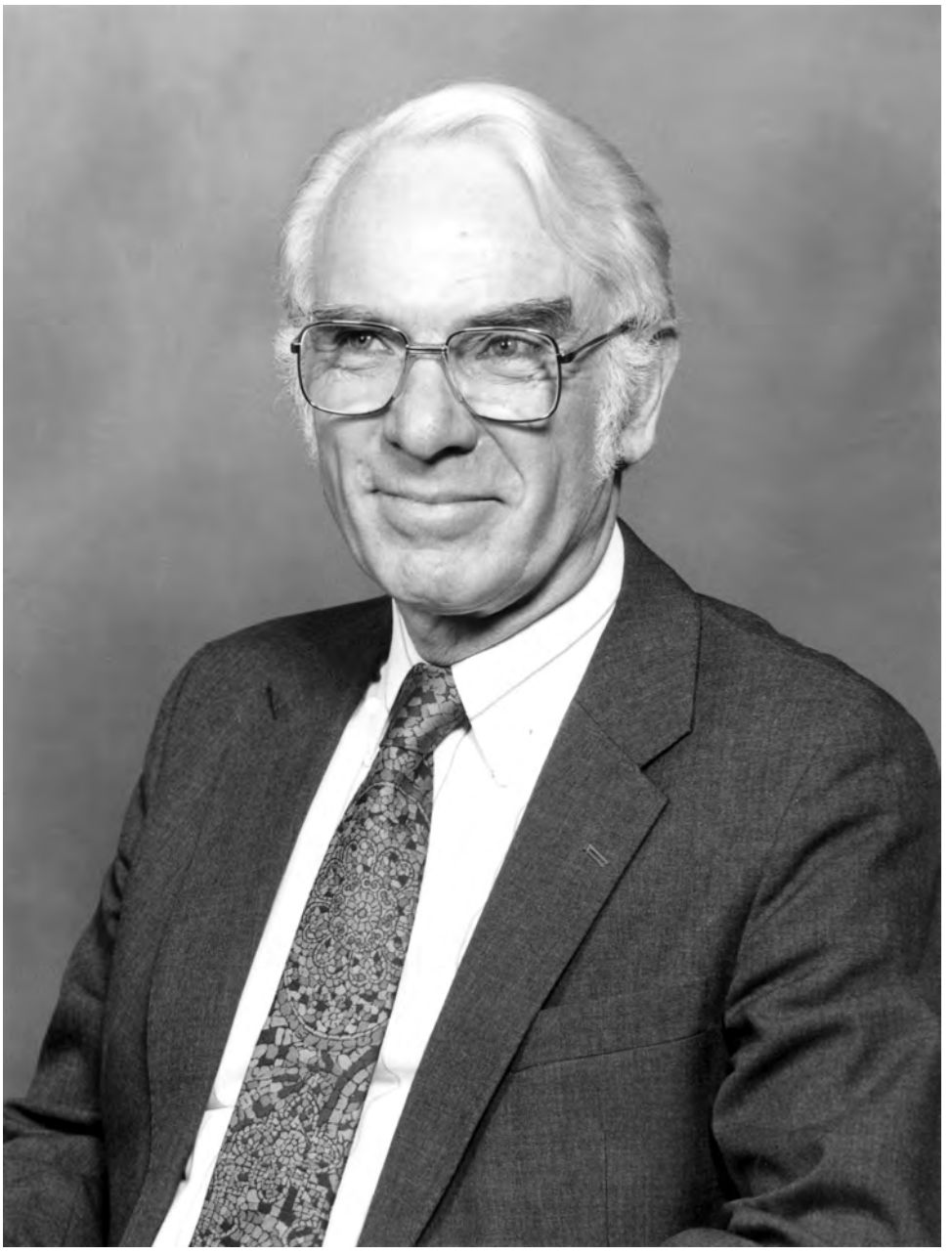
STRATIGRAPHIC DIVISIONS

The major divisions of the geological time scale are reasonably well established throughout the world, but minor divisions (*e.g.,* subseries, stages, and substages) are more likely to be provincial in application. The stratigraphical units listed here represent an authoritative version of the stratigraphic column for all taxonomic work relating to the revision of Part H. They are adapted from the International Union of Geological Sciences 1989 Global Stratigraphic Chart, compiled by J. W. Cowie and M. G. Bassett. An updated time scale was published by the IUGS and UNESCO in 2000.

Cenozoic Erathem
- **Quaternary System**
  - Holocene Series
  - Pleistocene Series
- **Neogene System**
  - Pliocene Series
  - Miocene Series
- **Paleogene System**
  - Oligocene Series
  - Eocene Series
  - Paleocene Series

Mesozoic Erathem
- **Cretaceous System**
  - Upper Cretaceous Series
  - Lower Cretaceous Series
- **Jurassic System**
  - Upper Jurassic Series
  - Middle Jurassic Series
  - Lower Jurassic Series
- **Triassic System**
  - Upper Triassic Series
  - Middle Triassic Series
  - Lower Triassic Series

Paleozoic Erathem
- **Permian System**
  - Upper Permian Series
  - Lower Permian Series
- **Carboniferous System**
  - Upper Carboniferous Subsystem
    - Stephanian Series
    - Westphalian Series
    - Namurian Series (part)
  - Lower Carboniferous Subsystem
    - Namurian Series (part)
    - Viséan Series
    - Tournaisian Series
- **Devonian System**
  - Upper Devonian Series
  - Middle Devonian Series
  - Lower Devonian Series
- **Silurian System**
  - Prídolí Series
  - Ludlow Series
  - Wenlock Series
  - Llandovery Series
- **Ordovician System**
  - Upper Ordovician Subsystem
    - Cincinnatian Series
    - Champlainian Series (part)
  - Lower Ordovician Subsystem
    - Champlainian Series (part)
    - Canadian Series
- **Cambrian System**
  - Upper Cambrian Series
  - Middle Cambrian Series
  - Lower Cambrian Series



Sir Alwyn Williams, 8 June 1921–4 April 2004. World renowned brachiopod specialist and coauthor for the two-volume brachiopod *Treatise*, 1965, and co-ordinating author for the revision volumes from 1988 until his death in 2004 (photo dated 1983, courtesy of Mrs. Joan Williams).

COORDINATING AUTHORS' PREFACE

C. Howard C. Brunton and Sandra J. Carlson

[retired, formerly of the Natural History Museum, London; and University of California, Davis]

[with contributions by A. J. (Bert) Rowell, Professor Emeritus, The University of Kansas, Lawrence]

This volume completes the revision of the *Treatise on Invertebrate Paleontology, Part H, Brachiopoda.* It has developed from the concept of a simple supplement covering the latest taxa to a volume with much new information in its own right. The review chapters, forming the first part of the volume, bring up to date many topics concerning brachiopods. The first chapter by Lüter brings up to date recent work on the anatomy and particularly embryology of brachiopods. Studies of larval and early developmental stages in brachiopod ontogeny is leading to an improved understanding of phylogeny, general relationships, and the working brachiopod organism. Cohen provides an update of the research on the genome of brachiopods, which suggests that Phoronida may be nested within the Brachiopoda, rather than present as its sister group. The chapter by Williams and Carlson summarizes evolutionary trends in morphology and discusses the phylogenetic affinities of brachiopods among metazoans. Carlson's chapter, to be read in conjunction, provides a more recent update of these issues.

The shell chemicostructure chapter by Williams and Cusack discusses the unexpected and exciting discovery of siliceous tablets covering the surface of the first-formed organophosphatic shells of *Discinisca*. These tablets were predicted by Williams, Lüter, and Cusack (2001) a few years before Lüter (2004) demonstrated their existence through TEM and SEM studies. In addition a chapter by Cusack and Williams reviews biochemical diversity, and another short chapter by Parkinson and Cusack focuses on the interpretation and use of oxygen isotopes.

The chapter on the stratigraphical distribution of brachiopods through time, by Curry and Brunton, was introduced in the Preface to Volume 5 (Kaesler, 2006, p. xxix). Here the subject is developed further with a description of the technique used by Curry, brief discussions on the resulting distribution charts, and the publication of many of the charts derived from the *Treatise* data. Logan discusses, tabulates, and maps the distribution of extant articulated brachiopods in a separate chapter.

The second part of the volume is devoted to bringing up to date the record of newly described genera and other taxa described from the closing dates for each volume until September 2004. Those published since that date are listed here with author, date, and references, allowing readers to locate the newest descriptions of brachiopods. Thus the genera recorded herein amount to 380, making a total for the revised *Treatise* of 4322 genera described in the series, as compared to almost 1700 in the 1965 edition of the *Treatise.* All described genera, other than those with questionable age, locality, or classification, are included in the review chapter on stratigraphical distribution through time. We also include a list of errata found in previous volumes and submitted by our contributors and a comprehensive index from all six volumes.

Publication of this volume represents the final major achievement for Sir Alwyn Williams, who played a pivotal role as leading coordinator in the revision of these six *Treatise* volumes. He looked upon the *Treatise* revision as his most important job over the past 20 years, and he looked forward earnestly to seeing the job completed. Although he set completion well on its way, sadly he was denied the ultimate pleasure of seeing the full series published. His enormous contributions to international paleontology are partly reflected in his publication list. The breadth of subject material he covered and the novelty of approach he brought to bear on the study of brachiopods was both

exceptional and unique. His remarkably broad experience with brachiopods, genial personality, and expert administrative abilities made him the ideal choice as coordinator for the first brachiopod *Treatise* (1965), and he rose to the occasion again 25 years later when asked to take on the full revision. Until his death in 2004, he shepherded the revision forward; by 2004 the path was well charted, and authors knew what was required to complete the remaining volumes.

The *Treatise* office, under the invaluable guidance of Roger L. Kaesler at the Paleontological Institute, University of Kansas, recognizes the enormous importance of Alwyn Williams in this revision. A. J. (Bert) Rowell, who assisted as a co-author of several chapters and wrote the systematic section on the Inarticulata in the first edition (1965), contributes the following acknowledgment to Alwyn's extraordinary efforts, with help from Jill Hardesty, Managing Editor at the Paleontological Institute.

Much has changed in the world in general and brachiopods in particular between the two editions of the *Treatise on Invertebrate Paleontology, Part H, Brachiopoda.* Some 19 authors were responsible for just under 1700 genera in the first edition, which was printed by linotype in two volumes in 1965. The six-volume revision has involved just over twice as many authors to cover nearly three times as many genera. Linotype is almost as extinct as the Productida and a few authors' names are common to both editions, but the most notable common factor other than topic and format is the hand of Alwyn Williams as overall coordinator of both editions.

At least from 1959, when Rowell joined the team of authors for the first edition, Williams coordinated the work with a very light rein. Subsequent to dividing the work into major chapters and assigning authors, coordination was more the product of cooperation between colleagues, many of whom were friends, rather than the result of a complex and ongoing planning process. When Williams and Rowell wrote the general chapters on brachiopod anatomy, morphology, evolution and phylogeny, and classification, they did so literally sitting side by side. They had both prepared draft text and draft illustrations of agreed-upon sections, Rowell working in Nottingham and Williams in Belfast. On two occasions between academic terms in 1961, Rowell, lacking administrative responsibilities, traveled to Belfast and lived in the Williams' household for several days. The authors spliced their contributions together, cutting and pasting sections, and where appropriate, writing and rewriting connective paragraphs and sentences. A day's work would be retyped the following day and commonly edited by the authors on the evening of the same day. Further polishing of text and refinement of figures was accomplished separately in Nottingham and Belfast before the final retyped version was mailed to Kansas. Individual systematic contributions were mailed directly to Kansas by the authors, who were asked to follow format instructions that were provided in a blue spiral-bound *Manual for Authors* by R. C. Moore himself! In the majority of cases, individual authors of systematic sections also provided photographs of specimens from which the final figures were assembled and labelled by illustrator Roger Williams in Kansas. Proof copy was available to contributors several months before the final version was printed and bound.

The need for a revision of the brachiopod *Treatise* was broached at the First Brachiopod Congress in Brest in 1985. The concept was accepted by the *Treatise* Advisory Board, and by late 1986, Editor Roger Kaesler had recruited Alwyn Williams to be coordinating author of the revision. Williams accepted the invitation on the understanding that he would be unable to commence work on the revision until October 1988, by which time he, Williams, would have stepped down from his position as Principal of the University of Glasgow and completed obligations as president of the Royal Society of Edinburgh. Kaesler and Williams met in Scotland in the summer of 1988, and by the end of the year, Williams had submitted a draft list of contents, provisional authors of the various chapters, and a very optimistic projection of

publication in 1994.

What followed in the next few months revealed clearly the effects and experience of many years of senior-level management on Williams' administrative style. He recognized early that he was not immune to the passage of time and appointed Howard Brunton as his deputy coordinating author. This action was shortly followed by a list of 20 or so authors with suggested responsibilities, which Kaesler sent out to 4 experienced brachiopod workers for review. A few of the 20 potential authors had to decline because of prior long-term commitments or ill health, but by the middle of 1989, a group of authors, subsequently called senior authors with responsibility to produce copy for major sections of the text, had agreed to be involved in the revision and to provide an annual progress report.

At the turn of 1989, Williams and Brunton distributed a tentative glossary of morphological terms to all authors with the intention that it be discussed at the Second International Brachiopod Congress in Dunedin in February 1990. This glossary, accompanied by a circular letter, provided a brief synopsis of the state of progress of revised Part H and listed all authors and their assignments. The circular also introduced the possibility of senior authors co-opting junior contributors under appropriate circumstances and, furthermore, promised all contributors full minutes of the *Treatise* discussion session at Dunedin.

Such activity was typical of Williams' approach: he would expect much of those who worked with him but would do his utmost to ensure all were kept informed of overall progress and afford a platform for all voices to be heard. His subsequent guidance of the project was intense, and correspondence between Williams and the *Treatise* office in the intervening years now amounts to a 30-cm-tall stack!

Within a few days of completion of the Dunedin meeting, the fourth circular appeared and gave the first indication of the possibility of utilizing a cladistically based classification of major taxa in the revised Part H. Because of the possibility of using a cladistic approach to the classification, Sandy Carlson was invited to join the coordinating team in 1992. All senior authors were then asked to submit an exhaustive list of characters used in classifying taxa within their assignments. This request was repeated in the seventh circular letter of June 1990 together with a reminder of the need for authors to submit their annual report of progress. Circular letters and annual reports became a feature of Williams' style: he wrote 47 of the former and issued Annual Reports that covered the years from 1989–2003.

By mid-1992, Williams had appointed Carlson to handle the more derived brachiopod groups, pentamerides through terebratulides, and to help with the overall cladistic revision of the phylum. This self-inflicted task of producing a new higher-level classification of the Brachiopoda Williams regarded as the most important duty of his position as coordinating author. The plan he implemented with Brunton and Carlson was to develop a supraordinal classification, and he, as coordinating author of the revised Part H, would insert text received from senior authors, typically covering orders and subordinate taxa, into this new framework. Senior authors would have the opportunity to discuss this taxonomic placement in their own introductory sections.

The new classification appeared in 1996 (Williams & others, 1996), and reprints were made available to all senior authors. The classification has a strong cladistic flavor, although many higher taxa remain paraphyletic. The position of several inarticulated calcareous-shelled groups centering on the craniids is somewhat unstable. This latter group was treated as a third small subphylum, the Craniiformea, together with the well-defined phosphatic-shelled inarticulated subphylum, the Linguliformea, and the major group of largely articulated calcareous-shelled brachiopods constituting the subphylum Rhynchonelliformea. The classification, although something of a compromise, will likely be used well into this century.

The estimated number of volumes required to revise the brachiopods slowly increased over the years as the magnitude of the task became apparent. Twelve years ago, Williams was estimating that an introductory volume followed by the taxonomic sections in two volumes would suffice. The introductory volume dealing with general topics appeared in 1997, and even as late as that year Williams considered that a total of four volumes would complete the task. Time was to show otherwise. Volumes 2 and 3 were, "…numbered consecutively but issued simultaneously, like overweight twins after a long gestation, whose seniority is merely a matter of delivery" (WILLIAMS, 2000, p. xxvi). This allowed volume 4, published in late 2002, to commence with the pentamerides, the sister group of the remaining rhynchonelliformeans. Volume 5, published in early 2006, finished the systematic volumes of the series and covered the remaining groups of the Rhynchonelliformea.

Sadly, volume 4 was the last volume for which Williams would write the coordinating author's preface. Alwyn died on 4 April 2004. He would have smiled to realize that the numerical form of the date, 04/04/04, was unambiguous to both his Celtic ancestors and his American friends! He worked almost to the end. His last circular letter was dated 23 March 2004. He wrote separately to both Jill Hardesty and Bert Rowell 2 days before he died to discuss *Treatise* matters. We miss him terribly!

Alwyn Williams established a pattern and style of work ably continued by his deputy coordinating authors, and the completed revision of Part H is a fitting tribute to his influence on the study of brachiopods.

In total 48 people contributed scripts to the *Treatise* revision, without whom the project would not have been possible. But we are also particularly mindful of and grateful for the vast amount of work that has continued over the years in the Kansas *Treatise* office, particularly the meticulous editing of texts and reproduction to such high standards of the illustrations we nominated to illustrate our scripts.

At the start of the project Alwyn Williams set up a *Treatise* office at the University of Glasgow with a series of brilliant secretaries keeping the records, sending out mail, and communicating with Kansas. The last of these is Patricia Peters, who has eased our jobs considerably. The Glasgow office has been supported by the University of Glasgow and by the *Treatise* office at the University of Kansas. All these individuals and organizations deserve our appreciation, and as remaining coordinators, we want to thank you all for your support, and especially since 2004.

During the publication of volumes 1 to 5 (1997 to 2006) sadly we have had to record the deaths of five authors, Alan Ansell, Algirdas Dagys, Richard Grant, Jess Johnson, and Alwyn Williams. Since then Jin Yu-gan died in Nanjing in June 2006; he was a renowned paleontologist and stratigrapher specializing in the Permian system. This revised brachiopod *Treatise* provides clear evidence of their varied and eminent scholarship.

Finally, we deeply regret having to record the death of Roger Kaesler on 11th August 2007, just at a time when the final stages of editing and proof reading this volume were in progress. Roger had been the Editor for the *Treatise* series since 1987, during which time he had seen the publication of 13 volumes covering many phyla. However, brachiopods had always held a particular interest for him, and Roger followed the progress of this major brachiopod revision closely. Roger had a close and fruitful relationship with Alwyn Williams, so that as other *Treatise* commitments had to be dealt with, delays in this revision were minimized. Roger was always available to provide advice about any matter of concern to authors or coordinating authors, advice that was thoughtful and to the point. Besides being a powerful and productive figure in paleontology, Roger was a real gentleman, and it was a pleasure to be with him on such occasions as the 2000 International Brachiopod Congress held in London. The *Treatise* series owes him much, and he will be remembered for long through these volumes.

REPOSITORIES AND THEIR ABBREVIATIONS

Abbreviations and locations of museums and institutions holding type material, which are used throughout the systematic sections of this volume, are listed below.

AM: Australian Museum, Sydney, Australia
AMF: Australian Museum, Sydney, Australia
AMNH: American Museum of Natural History, New York, USA
ANU: Australian National University, Canberra, Australia
AU: Geology Department, Auckland University, Auckland, Australia
BAU: Buenos Aires University, Buenos Aires, Argentina
BGS, GSM, IGS: British Geological Survey (formerly Geological Survey Museum; Institute of Geological Sciences, London) Keyworth, Nottinghamshire, United Kingdom
BMNH: The Natural History Museum, London, United Kingdom [formerly British Museum (Natural History)]
BMR: see CPC
Br: see TAGI Br
BSM: Bavarian State Museum, Munich, Germany
BU: Department of Geology, Birmingham University, Birmingham, United Kingdom
BUM: Bristol University Museum, Bristol, United Kingdom
CAGS: Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China
CAS: California Academy of Sciences, Types Collections, San Francisco, California, USA
CB: Muséum d'Histoire Naturelle, Geneva, Switzerland
CEGH: see CORD-PZ
CFP UA: Compagnie Française Petroles, Paris, France
CGS: Czech Geological Survey, Prague, Czech Republic
CIGMR: Chengdu Institute of Geology and Mineral Resources, Chengdu, China
CMB: City Museum and Art Gallery, Bristol, UK
CMNH: Carnegie Museum, Pittsburgh, USA
CNIGR: Central Scientific Geological Exploration Museum (Tschernyshev Museum), St. Petersburg, Russia
CORD-PZ: Universidad Nacional de Córdoba, Argentina
CPC: Commonwealth Palaeontological Collections, Australian Geological Survey Organisation, Canberra, Australia
CRMGE: Central Research Museum of Geological Explorations, St. Petersburg, Russia
D, EM, ENSM, FSI, FSL, SSL, TA: Université Claude Bernard, Lyon I, Villeurbanne, France
DNGM: Servicio Nacional Minero Geológico, Buenos Aires, Argentina
DP, DPO: Departamento de Geología, Oviedo University, Oviedo, Spain
DPO: see DP
DPUCM: Departamento de Paleontologia, Universidad Complutense, Madrid, Spain
EM: see D
ENSM: see D
FD: Geological College of Eastern China, Fuzhou, China
FSI: see D
FSL: see D
GB: Xian Institute of Geology and Mineral Resources, Xian, China
GBA: Geologisches Bundesanstalt Museum, Vienna, Austria
GIB: Geological Institute, Bonn, Germany
GIBAS: Geological Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria
GIN KAZ: Institute of Geology, Kazakh Academy of Sciences, Alma-Ata, Kazakhstan
GIN TAD: Institute of Geology, Dushanbe, Tadzhikistan
GIN UZ: Institute of Geology, Uzbek Academy of Sciences, Tashkent, Uzbekistan
GIUS: Department of Earth Sciences, Silesian University, Sosnowiec, Poland
GLAHM: Hunterian Museum, Glasgow University, Scotland, United Kingdom
GMC, IV: Geological Museum of China, Beijing, China
GMG: State Museum of Georgia (named after S. N. Djanashia), Academy of Sciences of the Georgian SSR, Tbilisi
GMUT: see TUG
GM YaRGTS: Geological Museum of the Regional Geological Centre, Yakutsk, Yakutia
GPIBo: Palaontological Institute, Bonn, Germany
GPIT: Geological and Palaeontological Institute, University of Tübingen, Germany (Geologisch-Paläontologisches Institut, Tübingen Universität)
GPZ: Department of Geology and Palaeontology, Zagreb, Croatia
GSC: Geological Survey of Canada, Ottawa, Ontario, Canada
GSE: see IGS GSE
GSI: Geological Survey of India, Calcutta, India
GSM: see BGS
GSQ: Geological Survey, Queensland, Australia
GSV: Geological Survey of Victoria, Australia
GSWA: Geological Survey of Western Australia, Perth, Australia
GS YA: see CGS
HB: Bureau of Geology and Mineral Resources of Hunan Province, Hunan, China
HGI: Hungarian Geological Institut, Budapest, Hungary
HIGS: Hangzhou Institute for Geological Science, Hangzhou, China
HM: see GLAHM

HNHMB: Hungarian Natural History Museum, Budapest, Hungary
HUB: see MB
I: New York State Geological Survey, Albany, New York, USA
ICPSB: Institute of Geology, University of Padua, Italy
IG: Palaeontological Collections of L'Institut Royal des Sciences Naturelles de Belgique, Brussels
IGAS: Institute of Geology, Chinese Academy of Sciences, Beijing, China
IGiG: Institute of Geology and Geophysics, Siberian Branch, Academy of Sciences, Akademgorodok, Russia
IGM: Instituto de Geología, Universidad Autónoma de México, Ciudad Univesitaria, México City, Mexico
IGN: Institute of Geological Sciences, Kiev, Ukraine
IGN SO RAN: Geological Museum of the Institute of Geological Sciences of Yakutia Sakha Scientific Centre, Siberian Division, Russian Academy of Sciences, Yakutsk, Yakutia
IGNA: Geological Museum of the Institute of Geological Sciences, Almaty, Kazakhstan
IGR: Institute of Geology, University of Rennes, Rennes, France
IGS GSE: Institute of Geological Sciences, Edinburgh, United Kingdom
IGS GSM: see BGS
IMGPT: Geological-Paleontological Institute and Museum of Tübingen University, Germany
Inst. Geol.: Geological Institute, Bishkek, Kyrgyzstan
IO: P. P. Shirshov Institute of Oceanology, Moscow, Russia
IV: see GMC
IPW: Institut für Paläontologie der Universität (Geozentrum), Vienna, Austria
IRScNB: Palaeontological Collections of L'Institut Royal des Sciences Naturelles de Belgique, Brussels
JCF: James Cook University, Townsville, Queensland, Australia
KAS, MANK: Geological Museum of Institute of Geological Sciences, Almaty, Kazakhstan
KHGU: Kharkov State University, Ukraine
KIGLGU: Geology Faculty of Leningrad State University, Paleontology-Stratigraphy Museum, St. Petersburg, Russia
L: National Museum, Prague, Czech Republic, Barrande specimens
LGE: St. Petersburg State University, St. Petersburg, Russia
LGI: Leningrad Geological Institute, Leningrad, Russia
LM: see LO
LMT: Loodus Museum, Tallinn, Estonia
LO (formerly LM): Lund University Museum, Sweden
LPB: Laboratoire de Paléontologie, Université de Bretagne Occidentale, Brest, France
LS: Linnean Society of London, United Kingdom
MANK: see KAS
MB (formerly HUB): Humboldt University, Berlin, Germany
M.Ch: Museum Chabarovsk, Verkhoyan, eastern Siberia, Russia
MBHR: Museum of Dr. B. Horák, Rokycany, Czech Republic
MCMB: Department of Geology, University of Beijing, Beijing, China
MCZ: Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA
MDSGF: Museo del Dipartimento di Scienze Geolgiche dell'Università di Ferrara, Ferrara, Italy
MDSGF: Museo del Dipartimento di Scienze Geolgiche dell'Università di Ferrara, Ferrara, Italy
MDTF: see MDSGF
MFLV: Museo dei Fossili della Lessinia, Verona, Italy
MFMGB: Museum of the Faculty of Mining and Geology, Belgrade University, Belgrade, Yugoslavia
MG: Institute of Geology, Ashkhabad, Turkmenistan
MGBW: Museum of the Geologische Bundesanstalt of Wien, Austria
MGRI: Moscow Geological Prospecting Institute, Moscow, Russia
MGSB: Museo Geológico del Seminario de Barcelona, Barcelona, Spain
MGU: Moscow State University, Russia
MGUH: Geological Museum, Copenhagen, Denmark
MGUP: Museum of Geology, University of Palermo, Sicily, Italy
MIP: see MLP
MLP: Invertebrate Paleontology Department, La Plata Natural Sciences Museum, La Plata, Argentina
MM: Geological Survey, Prague, Czech Republic
MM: Moravian Museum, Brno, Czech Republic
MMF: Geological and Mining Museum, Department of Mines, Sydney, Australia
MNB: see MB
MNHN: Muséum National d'Histoire Naturelle, Paris, France
MONZ: see NMNZ
MPL: see MLP
MPM: Milwaukee Public Museum, Milwaukee, Wisconsin, USA
MPUM: Museo di Paleontologia del Dipartimento di Scienze della Terra dell'Università degli Studi di Milano, Italy
MUGT: see GIN TAD
Muz IG: Geological Museum of the Geological Institute, Warsaw, Poland
MV: see NMVP
NHM: Natural History Museum, London, UK
NHMB: Natural History Museum, Basel, Switzerland (Naturhistorisches Museum Basel)
NHMW: Natural History Museum in Vienna, Naturhistorisches Museum, Wien, Austria
NIGP: Nanjing Institute of Geology and Palaeontology, Academia Sinica, Nanjing, China
NM: National Museum, Prague, Czech Republic
NMING: National Museum of Ireland, Dublin, Ireland
NMNZ: Te Papa, Museum of New Zealand, Wellington, New Zealand

NMVP: Victoria Museum, Melbourne, Victoria, Australia
NMW: National Museum of Wales, Cardiff, United Kingdom
NMV P: Department of Invertebrate Palaeontology, Museum of Victoria, Australia
NS: Northeastern Institute of Geology, Inner Mongolia
NUF: Department of Geology, University of Newcastle, New South Wales, Australia
NYSM: New York State Museum, Albany, USA
NZGS: New Zealand Geological Survey, Lower Hutt, New Zealand (presently called Institute of Geological and Nuclear Sciences)
NZOI: New Zealand Oceanographic Institute, National Institute of Water and Atmospheric Research, Wellington, New Zealand
OKGS: Oklahoma Geological Survey, Norman, Oklahoma, USA
OMR: District Museum, Rokycany, Czech Republic
OMR VH: see OMR
OSU: Orton Geological Museum, Ohio State University, Columbus, Ohio, USA
OU: University of Oklahoma, Norman, USA
OUM: Oxford University Museum, United Kingdom
OU NZ: Geology Department, Otago University, Dunedin, New Zealand
PAN: see PIN
PCZCU: Department of Biology, Západočeská univerzita, Plzeň, Czech Republic
PIN: Palaeontological Institute, Russian Academy of Sciences, Moscow, Russia
PIN RAS: see PIN
PIW: Paleontological Institute, Würzburg University, Würzburg, Germany
PKUM: Geological Museum of Beijing University, China
PM (formerly PMU): Palaeontological Museum, Uppsala University, Uppsala, Sweden
PMNUF: Paleontological Museum, University of Naples 'Federico II', Naples, Italy
PMO: Paleontologisk Museum, University of Oslo, Norway
PMU: see PM
PRI: Paleontological Research Institute, Ithaca, New York, USA
PUM: Geology, Peking University, Beijing, China
QMF: Queensland Museum, South Brisbane, Australia
RCCBYU: Research Center for the Chengjiang Biota, Yunnan University, Yunnan, China
RGF VR: Institute of Regional Geology and Paleontology, Faculty of Mining and Geology, University of Belgrade, Belgrade, Serbia **RM, RMS:** Swedish Museum of Natural History, Stockholm, Sweden
ROM: Royal Ontario Museum, Toronto, Ontario, Canada
RX: Rowley Collection, University of Illinois, Urbana, Illinois, USA
SAM.P: South Australian Museum, Adelaide, South Australia
SBNML: National Museum, Prague, Czech Republic
SGU: Geological Survey of Sweden, Uppsala, Sweden
SIGM: Shenyang Institute of Geology and Mineral Resources, Shenyang, Liaoning, China
SM (formerly SMA): Sedgwick Museum, University of Cambridge, United Kingdom
SMF: Senckenbergische Museum, Frankfurt, Germany
SNM: Slovakian National Museum, Bratislava, Slovakia (Slovenské Narodné Múzeum, Bratislava)
SSL: see D
SUI: University of Iowa, Department of Geology, Iowa City, USA
SUP: Palaeontological collections, University of Sydney, New South Wales, Australia
T: Paleontological Museum, University of Naples, Naples, Italy
TA: see D
TAGI BR: Geological Museum, Institute of Geology, Tallinn Technical University, Tallinn, Estonia
TBR: see TF
TF: Geological Survey Division, Department of Mineral Resources, Bangkok, Thailand
TsGM: see CNIGR
TsNIGRA: see CNIGR
TUBr: Paläontologische Sammlung, Institut für Geowissenschaften, Universität Tübingen, Germany
TUG: Museum of Geology, University of Tartu, Tartu, Estonia
UA: Geology Department, University of Alberta, Edmonton, Canada
UC: Field Museum of Natural History, Chicago, Illinois, USA
UCF: The University, Calgary, Canada
UCLA: University of California at Los Angeles, Los Angeles, California,
USA
UCM: University of Canterbury, Christchurch, New Zealand
UCMP: University of California, Museum of Paleontology, USA
UD: University of Dijon, Dijon, France
UHR: Hokkaido University, Sapporo, Japan
UI: University of Illinois, Urbana, Illinois, USA
UL: Department of Geology and Palaeontology, University of Ljubljana, Slovenia
UM: Museum of Paleontology, University of Michigan, Ann Arbor, Michigan, USA
UMC (formerly UMO): University of Missouri, Columbia, Missouri, USA
UMMF: Department of Geology, University of Montpellier, Montpellier, France
UMUT: University Museum of the University of Tokyo, Tokyo, Japan
UND: University of Notre Dame, Indiana, USA
U.N.E: University of New England, Armidale, Australia
UPS: Université de Paris-Sud, France
UQF: University of Queensland, Department of Geology, Brisbane, Australia
USNM: United States National Museum, Washington, D.C., USA

UT: Department of Geology, University of Texas, Austin, Texas, USA
UTC: Department of Geology, University of Toronto, Toronto, Canada
UTGD: University of Tasmania Geology Department, Hobart, Tasmania, Australia
U.W.A.: University of Western Australia, Nedlands, Western Australia
VH: see OMR
VSEGEI: Russian Geology Institute, St. Petersburg, Russia
XAGM: Xi'an Institute of Geology and Mineral Resources, Shaanxi, China
XB: Palaeontological Collections of the Xi'an Institute of Geology and Mineral Resources, Chinese Academy of Geological Sciences, Xi'an, Shaanxi Province, China
XIGMR: Xi'an Institute of Geology and Mineral Resources, Shaanxi, China
YaTGU: Geological Museum, Yakutsk, Yakutia
YIGM: Yichang Institute of Geology and Mineral Resources, Yichang, China
YPM: Yale University, Peabody Museum of Natural History, New Haven, Connecticut, USA
ZI: Zhejiang Institute of Geology and Mineralogy, Zhejiang, China
ZPAL Br: Institute of Palaeobiology, Polish Academy of Sciences, Warsaw, Poland

OUTLINE OF SUPRAFAMILIAL CLASSIFICATION AND AUTHORSHIP

ALWYN WILLIAMS,[1] SANDRA J. CARLSON,[2] and C. HOWARD C. BRUNTON[3]
[[1]Deceased; formerly of The University of Glasgow; [2]The University of California, Davis; and [3]formerly of The Natural History Museum London]

The following outline of the classification of the Brachiopoda is an amended version of that published at the beginning of Volume 2 of the *Treatise on Invertebrate Paleontology, Part H (Revised), Brachiopoda,* edited by R. L. KAESLER (2000, p. 22–27). It lists all suprafamilial taxa recognized and described in the four systematic volumes (vols. 2–5) already published and those included in this last volume, volume 6. The main changes are the inclusion of suprafamilial taxa of uncertain order or class. The thirty-four contributors identified in the list were responsible for authorship of diagnoses for the listed taxa. In the case of orders, suborders, and superfamilies, the authors were also responsible for all lower-ranking taxa down to genera and subgenera. The systematic sections herein may include introductions in which alternative or slightly emended classifications to the section are discussed. The authors of these sections are responsible for their opinions on the classification of their particular taxonomic groups.

Linguliformea. Lower Cambrian–Holocene.
Alwyn Williams, S. J. Carlson, & C. H. C. Brunton
Lingulata. Lower Cambrian–Holocene.
L. E. Holmer & L. E. Popov
Lingulida. Lower Cambrian–Holocene.
L. E. Holmer & L. E. Popov
Linguloidea. Lower Cambrian–Holocene.
L. E. Holmer & L. E. Popov
Discinoidea. Ordovician–Holocene.
L. E. Holmer & L. E. Popov
Acrotheloidea. Lower Cambrian–Lower Ordovician.
L. E. Holmer & L. E. Popov
Acrotretida. Lower Cambrian–Middle Devonian, ?Upper Devonian.
L. E. Holmer & L. E. Popov
Acrotretoidea. Lower Cambrian–Middle Devonian, ?Upper Devonian.
L. E. Holmer & L. E. Popov
Siphonotretida. Middle Cambrian–Ordovician.
L. E. Holmer & L. E. Popov
Siphonotretoidea. Middle Cambrian–Ordovician.
L. E. Holmer & L. E. Popov
Paterinata. Lower Cambrian–Upper Ordovician.
J. R. Laurie
Paterinida. Lower Cambrian–Upper Ordovician.
J. R. Laurie
Paterinoidea. Lower Cambrian–Upper Ordovician.
J. R. Laurie
Craniiformea. ?Lower Cambrian, Middle Cambrian, Ordovician–Holocene.
Alwyn Williams, S. J. Carlson, & C. H. C. Brunton
Craniata. ?Lower Cambrian, Middle Cambrian, Ordovician–Holocene.
L. E. Popov, M. G. Bassett, & L. E. Holmer
Craniopsida. ?Lower Cambrian, Middle Cambrian, Ordovician–Lower Carboniferous.
L. E. Popov & L. E. Holmer
Craniopsoidea. ?Lower Cambrian, Middle Cambrian, Ordovician–Lower Carboniferous.
L. E. Popov & L. E. Holmer
Craniida. Lower Ordovician–Holocene.
M. G. Bassett
Cranioidea. Ordovician–Holocene.
M. G. Bassett

ERRATA

Since publication of the first revised volume of the brachiopod *Treatise* in 1997, a few mistakes have been noted, largely by contributing authors. Simple and obvious spelling mistakes have not been included, unless they involve taxonomic names or make recognition or understanding difficult. Factual errors are included along with corrections to issues that may not have been clearly defined when written.

Volume 1

page 75, Caption for Figure 72: "*1–2,* recent rhynchonellids" should read "*1, 3,* recent rhynchonellides"; "*3*, terebratulide*"* should read "*2*, terebratulide."

page 164, Caption for Figure 164: 5 p.t. and 8 p.t. stages should be reversed.

page 334, right column, 7 lines from bottom: replace *Athyris* with *Hexarhytis* in the following sentence:

Regularly spaced lamellae of *Athyris* can extend forward as recurved microfrills more than 300 mm long (Fig. 296.1).

page 336, caption for Figure 296.1: Replace *Athyris campanesi* with *Hexarhytis campomanesi.*

page 397, "Morphology" chapter, 3rd line down, left column:

In some retzioids (e.g., *Nucleospira*), a juvenile median ridge grew ventroposteriorly into a hooklike structure extending into the ventral umbo (Fig. 363.1). This resembles a small version of the bilobed cardinal process of orthotetidine meekellids, but is built of medially united cardinal flanges. Unlike the bilobed cardinal process of strophomenates, which preserves growth traces of the myophores on the external (posterior) surfaces (Fig. 364), the retzioid structure is smooth as if secreted by conventional epithelium during growth.

The term "retzioid" should be replaced by "nucleospiroid."

page 398, last lines of left column:

The early terebratulides tend to display diductor attachment characters similar to those of athyridides with a dorsal foramen, and in stringocephaloid genera, with strongly developed ventral umbones, the cardinal process grew posteroventrally in an exaggerated fashion like those of some retzioids.

The term "retzioids" should be replaced by "nucleospiroids."

page 417, right column, 12th line: (Fig. 381.6) should read (Fig. 381.7).

In the chapter "Ecology of Articulated Brachiopods" (p. 441–462), references to *Magasella sanguinea* should read *Terebratella sanguinea.*

page 485, Figure 413, depth scale on left-hand side should read 200, 400, 600, 800, 1000, 1200 m.

Volume 2

page 30, diagnosis for Linguliformea: "tentacles in double row throughout ontogeny" should be changed to "ablabial tentacles added to adlabial tentacles in post-trocholophe stage of development."

page 30, diagnosis for Lingulata: "two rows of filaments during trocholophe stage" to "one row of filaments during trocholophe stage."

page 59, Figure 24: *Libyaeglossa* figures are views *2ab, Rafanoglossa* are views *4ab.*

page 106, Figure 53: view *4f* is *Linnarssonella*. See p. 114, Figure 58.

page 114, Figure 58: views 3d and 3f are *Apsotreta*. See p. 106, Figure 53.

page 398, genus *Aseptonetes* Isaacson, 1977, p. 177 [**A. boucoti;* M]: its type species was fixed by monotypy and is regarded as valid among Devonochonetinae; it should not be listed as an objective synonym of *Pleurochonetes* Isaacson, 1977, on page 402.

page 400, left column, lines 14–15 from bottom: *Strophonema* should read *Strophomena*.

page 402, genus *Pleurochonetes* Isaacson, 1977: synonym *Gamonetes* Isaacson, 1977, p. 168 [**G. anteloi;* M]: its type species was fixed by monotypy, and it is a subjective synonyn*,* NOT an objective synonym.

page 404, genus *Austronoplia,* within genus description, line 14, spelling should be *Austronoplia,* NOT *Austranoplia.*

Volume 3

page 518: Figure 357, 2d, ×l.5 should read ×1.

page 569, genus entry for *Licharewiella* Sokolskaya, 1960: delete reference to synonym *Magniderbyia* Ting, 1965, p. 265, which is regarded as an objective synonym of *Licharewiella* Ustritsky, 1960 *non* Sokolskaya, 1960 (family Strophalosiidae), as well as an objective synonym of *Licharewiella* Sokolskaya, 1960 *non* Ustritsky, 1960 (family Derbyidae, on p. 657, left column, near bottom).

page 804, genus *Heterorthina.* Stratigraphic and geographic range is Upper Ordovician (Caradoc–Ashgill): Europe and North America.

page 904, Index, spelling should be Austronoplia, NOT Austranoplia.

Volume 4

page 943: genus *Talovia* is from the Lower Ordovician (Caradoc), NOT lower Llanvirn, and the Bugrishikhinskii Gorizont, NOT Rudnikova Formation.

page 993, Figure 672,3 should read c–e, lateral, ventral, dorsal views, ×1; f–g, posterior, ventral interiors, ×2.

page 1196: genus *Sanjuania,* description for Figure 816,3a–b, should read ventral, dorsal.

page 1225–1227, Figures 834–836: captions should read Psilocamaridae, NOT Stenoscismatidae.

page 1325: Genus *Sphenarina,* description for Figure 898,*4f,* illustrated specimen number (USNM 549318a) should read (USNM 549381a).

page 1335: Genus *Pararhactorhynchia*, description for Figure 904,*3e–l* should read 904,*4e–l.*

page 1335: Genus *Yulongella*, description for Figure 904,*4e–k* should read 904,*3e–k*.

page 1462: Genus *Australina*, description for Figure 992,*1a–e,* enlargement (×2) should read ×3.

Volume 5

page xlv, page 2029, Superfamily Dielasmatoidea: stratigraphic range is Carboniferous (Mississippian)–Lower Jurassic, NOT Upper Devonian (Frasnian).

page 2188: Genus *Xenorina* Cooper, 1989, p. 115 [**X. ovata;* M] was fixed by monotypy.

page 2194: Stratigraphic range for subfamily Aulacothyropsinae should be Middle Triassic–Lower Cretaceous.

page 2197: Spelling for genus *Katchathyris* should be *Kachathyris.*

SUPPLEMENTAL GENERA LIST

The following genera have been published or found in the literature since September 2004, the cutoff date for inclusion of full generic descriptions for volume 6. This list represents a late-stage attempt at a complete generic record of the Brachiopoda. Generic names have been submitted by the contributing authors of previous sections of the brachiopod *Treatise*.

Order Productida, Suborder Productidina, Superfamily Productoidea, Family Productellidae

Dongpanoproductus He, Shen, Feng, & Gu, 2005, p. 931 [**D. elegans;* OD]. Type species, fig. 5.1–5.11, type specimen, holotype, DP730 (Micropalaeontology laboratory, Faculty of Earth Sciences, Wuhan, China); upper Changhsingian, Talung Formation, Dongpan Section, southern Guangxi, South China.

Weihong He, Shu-Zhong Shen, Qinglai Feng, & Songzhu Gu. 2005. A late Changhsingian (Late Permian) deepwater brachiopod fauna from the Talung Formation at the Dongpan section, southern Guangxi, South China. Journal of Paleontology 79(5):927–938.

Order Productida, Suborder Lyttoniidina, Superfamily Lyttonioidea, Family Lyttoniidae, Subfamily Linoldhamininae

Linoldhamina Xu, Shen, & Cheng, 2005, p. 1014 [**L. xainzaensis;* OD]. Holotype, NIGP137072, mid-Guadalupian, northern Tibet, China.

Han-Kui Xu, Shu-Zhong Shen, & Li-Ren Cheng. 2005. Linoldhamininae, a new subfamily of Lyttoniidae Waagen, 1883 (Brachiopoda) from the Guadalupian (middle Permian) Xiala Formation in the Xainza area, northern China. Journal of Paleontology 79(5):1012–1018.

Order Orthida?

Bethia Sutton, Briggs, Siveter, & Siveter, 2005, p. 1013 [**B. serraticulma*; OD]. Holotype, OUM C.29586, Wenlock, Silurian, Herefordshire.

Sutton, Mark D., Derek E. G. Briggs, David J. Siveter, & Derek J. Siveter. 2005. Silurian brachiopods with soft-tissue preservation. Nature 436/18:1013–1015.

Order Pentamerida, Suborder Syntrophiidina, Superfamily Porambonitoidea, Family Porambonitidae

Eoporambonites Popov, Egerquist, & Zuykov, 2005, p. 756 [**Porambonites latus* Pander, 1830, p. 98; OD]. Lower Arenig, Billingen Regional Stage, Maekula Member, St. Petersburg District, Russia, North Estonia.

Popov, L. E., Eva Egerquist, & M. A. Zuykov. 2005. Ordovician (Arenig-Caradoc) syntrophiidine brachiopods from the East Baltic region. Palaeontology 48(4):739–761, fig. 6A–I, K.

Order Rhynchonellida, Superfamily Rhynchotrematoidea, Family Leptocoeliidae

Antelocoelia Isaacson, 1977, p. 171 [**A. johnsoni;* M]. Lower Devonian–Middle Devonian. Bolivia.

Isaacson, P. E. 1977. Devonian stratigraphy and brachiopod paleontology of Bolivia. Part B, Spiriferida and Terebratulida. Palaeontographica (Abt. A) 156(4-6):168–217, pl. 1–9.

Order Rhynchonellida, Superfamily Pugnacoidea, Family Basiliolidae, Subfamily Pamirorhynchiinae

Jakubirhynchia Tomašových, 2006, p. 213 [**Rhynchonella latifrons* Geyer, 1889; OD]. Lower Jurassic (Hettangian–Sinemurian). West Carpathians–Eastern Alps (Slovakia, Austria).

Tomašových, Adam. 2006. A new Early Jurassic rhynchonellid brachiopod from the western Tethys and implications for systematics of rhynchonellids from the Triassic-Jurassic boundary. Journal of Paleontology 80(2):212–228.

Order Rhynchonellida, Superfamily Pugnacoidea, Family Basiliolidae

Mondegia Andrade, 2006, p. 59 [**M. limica;* OD]. Middle Jurassic (Bajocian). Portugal.

Andrade, Benito. 2006. Los braquiópodos del tránsito Jurásico Inferior-Jurásico Medio de la Cuenca Lusitánica (Portugal). Coloquios de Paleontología 56:5–194.

Order Spiriferida, Suborder Spiriferidina, Superfamily Cyrtospiriferoidea, Family Cyrtospiriferidae, Subfamily Cyrtiopsinae

Cratospirifer Tong, 1986, p. 682[684] [**C. biconvexus;* OD]. Lower Carboniferous. China (Sichuan).

Tong, Zheng-xiang. 1986. Early Early Carboniferous brachiopod fauna in northwest Sichuan. Acta Palaeontologica Sinica, 25(6):672–686, pl. 1–3.
In Chinese, with English summary.

Order Spiriferida, Suborder Spiriferidina, Superfamily Cyrtospiriferoidea, Family Cyrtospiriferidae, Subfamily Cyrtospiriferinae

Plicapustula Ma & Day, 2007, p. 298 [**Spirifer (Sinospirifer) gortanioides* Grabau, 1931; OD]. Upper Devonian (Famennian). Southern China, North America.

Ma Xueping, & Jed Day. 2007. Morphology and revision of Late Devonian (Early Famennian) Cyrtospirifer (Brachiopoda) and related genera from South China and North America. Journal of Paleontology 81(2):286–311.

Order Strophomenida, Superfamily Strophomenoidea, Family Douvillinidae, Subfamily Protodouvillininae

Undifossula Gratsianova & Yazikov, 1998, p. 65 [**Douvillina grandicula* Gratsianova, 1975; OD]. Lower Devonian (Givetian)–Middle Devonian (Emsian). Siberia. [Originally proposed as a subgenus of *Protodouvillina*.]

Gratsianova, R. T., & A. Yu. Yazikov. 1998. Rod *Protodouvillina* (Brakhiopody, Devon): reviziya sostava, novye taksony, filogeniya i filozony [=Genus *Protodouvillina* (Brachiopoda, Devonian): Revision, new taxa, phylogeny, phylozones]. Novosti Paleontologii i Stratigrafii, Vypusk 1 (supplement to Geologiya i Geofizika, 39): 57–79, pl. 1–3.

In Russian with English abstract.

Order Rhynchonellida, Superfamily ?Hemithiridoidea, Family Uncertain

Chathamirhynchia Lee & Motchurova-Dekova, 2007 [**C. kahuitara*; OD]. Upper Cretaceous (Campanian–Maastrichtian). New Zealand.

Lee, D. E., & Neva Motchurova-Dekova. 2007. *Chathamirhynchia kahuitara*, a new genus and species of Late Cretaceous rhynchonellide brachiopod from the Chatham Islands, New Zealand: Shell structure, paleoecology and biogeography. *In* Brachiopod Research into the Third Millennium, Transactions of the Royal Society of Edinburgh, Earth and Environmental Science, vol. 98(parts 3 and 4). Edinburgh.

Order Rhynchonellida, Superfamily Wellerelloidea, Family ?Allorhynchidae

Livarirhynchia V. Radulovič, 2007 [**L. rajkae*; OD]. Lower Jurassic (Pliensbachian). Montenegro and Italy.

Radulovič, Vladan. 2007 (in press). A new Pliensbachian rhynchonellide brachiopod from Livari (Rumija Mountain, Montenegro). Proceedings of the Fifth International Brachiopod Congress, Copenhagen 2005, Fossils and Strata 47.

Order Rhynchonellida, Superfamily Pugnacoidea, Family Basiliolidae

Basiliocostella Dulai, Bitner, & Müller, 2007 [**B. kambueheli;* OD].

Dulai, Alfréd, M. A. Bitner, & Pál Müller. 2007 (in press). A monospecific assemblage of a new rhynchonellide brachiopod from the Paleocene of Austria. Proceedings of the Fifth International Brachiopod Congress, Copenhagen 2005, Fossils and Strata 47.

Class Rhynchonellata, Order Uncertain, Family Apodosiidae

Apodosia Smirnova & MacKinnon, 1995, p. 686 [**Argyrotheca lorioli* Smirnova, 1972; OD]. Middle Jurassic (Bajocian), England; Lower Cretaceous (Berriasian), Ukraine (Crimea).

Smirnova, T. N., & D. I. MacKinnon. 1995. *Apodosia,* an enigmatic new genus of micromorphic brachiopod from the Cretaceous of Crimea, Ukraine, and the Jurassic of England. Journal of Paleontology 69(4):686–692.

Class Rhynchonellata, Order Uncertain

Arzonella Sulser, 2004, p. 423 [**A. exotica;* OD]. Lower Jurassic. Southern Alps.

Sulser, H. 2004. *Arzonella exotica* n. g. n. sp., a new brachiopod of indeterminate systematic position from the Lower Liassic (Broccatello) of Arzo (Southern Alps of Switzerland): A short note. Eclogae Geologica Helvetica 97(3):423–428.

Order Spiriferinida, Superfamily Spiriferinoidea, Family Spiriferinidae

Cisnerospira Manceñido, 2004, p. 272 [**Spiriferina adscendens* Deslongchamps, 1859; OD]. Lower Jurassic (Sinemurian–Pliensbachian). Mediterranean Europe.

Manceñido, M. O. 2004. Las "espiriferinas" del Jurásico Inferior: una mirada retrospectiva a los estudios de Daniel Jiménez de Cisneros. GeoTemas 7:269–272 + Errata: 1-2 (2005).

Order Athyridida, Suborder Athyrididina, Superfamily Athyridoidea, Family Comelicaniidae

Subfamily Araxathyriinae Shen, Grunt, & Jin, 2004, p. 888.

Order Athyridida, Suborder Athyrididina, Superfamily Athyridoidea, Family Comelicaniidae, Subfamily Sprigerellinae

Transcaucasathyris Shen, Grunt, & Jin, 2004, p. 893 [**Araxathyris araxensis* Grunt in Ruzhentsev & Sarytcheva, 1965, p. 247; OD].

Shen Shu-Zhong, T. A. Grunt, & Jin Yu-Gan. 2004. A comparative study of Comelicaniidae Merla, 1930 (Brachiopoda: Athyridida) from the Lopingian (Late Permian) of south China and Transcaucasia in Azerbaijan and Iran. Journal of Paleontology 78(5):884–899.

Order Athyridida, Suborder Athyrididina, Superfamily Athyridoidea, Family Athyrididae, Subfamily Cleiothyridininae

Baliqliqia Chen & Shi, 2006, p. 29 [**B. baliqliqensis;* OD].

Chen Z. Q., & Shi G. R. 2006. Artinskian-Kungurian (Early Permian) brachiopod faunas from the Tarim Basin, Northwest China. Part 2: Paleobiogeography, and systematics of Orthotetida, Orthida, Spiriferida, Spiriferinida, Rhynchonellida, Athyridida and Terebratulida. Palaeontographica (Abt. A) 275(1-3):1–53.

Order Athyridida, Suborder Athyrididina, Superfamily Athyridoidea, Family Athyrididae, Subfamily Spirigerellinae

Tarimathyris Chen & Shi, 2006, p. 31 [**Athyris postambigua* Ustritsky, 1960; OD].

Chen Z. Q., & Shi G. R. 2006. Artinskian-Kungurian (Early Permian) brachiopod faunas from the Tarim Basin, Northwest China. Part 2: Paleobiogeography, and systematics of Orthotetida, Orthida, Spiriferida, Spiriferinida, Rhynchonellida, Athyridida and Terebratulida. Palaeontographica (Abt. A) 275(1-3):1–53.

Order Terebratulida, Suborder Terebratulidina, Superfamily Cryptonelloidea, Family Cryptonellidae

Albelenina Perez-Huerta, 2004, p. 1528 [**A. alvarezi* Perez-Huerta, 2004, p. 1531; OD].

Pérez-Huerta, Alberto. 2004. New Carboniferous brachiopods from the eastern Great Basin, Nevada, USA: Implications for loop ontogeny and evolution in Late Paleozoic terebratuloids. Palaeontology 47(6):1519–1537.

Order Terebratulida, Suborder Terebratulidina, Superfamily Loboidothyridoidea, Family Muirwoodellidae

Lusothyris Andrade, 2006, p. 85 [**L. atlantica*; OD]. Middle Jurassic (Bajocian). Portugal.

Andrade, Benito. 2006. Los braquiópodos del tránsito Jurásico Inferior-Jurásico Medio de la Cuenca Lusitánica (Portugal). Coloquios de Paleontología 56:5–194.

Order Terebratulida, Suborder Terebratulidina, Superfamily Stringocephaloidea, Family Rhenorensselaeriidae

Crassirensselaeria Schemm-Gregory & Jansen, 2007, p. 415 [**Rensselaeria crassicosta* Koch in Kayser, 1881, p. 387; M]. Lower Devonian. Germany.

Kayser, E. 1881. Beitrag zur Kenntniss der Fauna des Taunusquarzits. Neues Jahrbuch fur Mineralogie, Geologie und Palaontologie 1881:386–387.

Schemm-Gergory, M., & U. Jansen. 2007. A new genus of terebratulid brachiopod from the Siegenian of the Rheinisches Scheifergebirge. Acta Palaeontologica Polonica 52(2): 413–422.

Order Terebratulida, Suborder Terebratellidina, Superfamily Zeillerioidea, Family Zeilleriidae

Neozeilleria Andrade, 2006, p. 119 [**Terebratula (Waldheimia) sharpei* Choffat, 1947; OD]. Lower Jurassic (Toarcian)–Middle Jurassic (Bajocian). Portugal, Spain, England, France, Germany.

Andrade, Benito. 2006. Los braquiópodos del tránsito Jurásico Inferior-Jurásico Medio de la Cuenca Lusitánica (Portugal). Coloquios de Paleontología 56:5–194.

Order Terebratulida, Suborder Terebratellidina, Superfamily Laqueoidea, Family Laqueidae

Lusitanina Andrade, 2006, p. 143 [**L. bituminis;* OD]. Middle Jurassic (Bajocian). Portugal.

Andrade, Benito. 2006. Los braquiópodos del tránsito Jurásico Inferior-Jurásico Medio de la Cuenca Lusitánica (Portugal). Coloquios de Paleontología 56:5–194.

Order Terebratulida, Superfamily Compositelasmatoidea, Family Compositelasmatidae

Compositelasma Smirnova, 2006.

Smirnova, T. N. 2006. New Upper Permian Superfamily Compositelasmatoidea (Brachiopoda, Terebratulida) from the East of the Russian Platform: The Specificity of Ontogenetic Transformations. Paleontological Journal 40(1):66–74.

Order Rhynchonellida, Superfamily Hemithiridoidea, Family Tetrarhynchiidae, Subfamily Viarhynchiinae

Antulanella B. Radulovič in Radulovič, Motchurova-Dekova, & Radulovič, 2007 [**Rhynchonella Pancici* Antula, 1903; OD]

Radulovič, Barbara, Neda Motchurova-Dekova, & Vladan Radulovič. 2007. New Barremian rhynchonellide brachiopod from Serbia and the shell ultrastructure of Tetrarhynchiidae. Acta Palaeontologica Polonica, in press [cf. Abstracts, Fifth International Brachiopod Congress, Copenhagen 2005: 46–47].

Order Terebratulida, Suborder Terebratellidina, Superfamily ?Kingenoidea

Laurinia Zezina, 2005, p. 31 [**Fallax neocaledonensis* Laurin, 1997, p. 444; OD]. Holocene. West Pacific (New Caledonia, Norfolk Ridge). [This genus is probably a synonym of *Fallax*.]

Zezina, O. N. 2005. On the systematic position of some recent brachiopod species from the Norfolk Ridge (West Pacific). Invertebrate Zoology, Moscow University 2(1):29–33.
In Russian.