TREATISE ON
INVERTEBRATE PALEONTOLOGY

Prepared under the Guidance of the
Joint Committee on Invertebrate Paleontology

Paleontological Society
Society of Economic Paleontologists and Mineralogists
Palaeontographical Society

Directed and Edited by
RAYMOND C. MOORE
Assisted by CHARLES W. PITRAT, DORIS E. N. ZELLER, and LAVON MCCORMICK

Part W
MISCELLANEA

CONODONTS
CONOIDAL SHELLS OF UNCERTAIN AFFINITIES
WORMS
TRACE FOSSILS AND PROBLEMATICA

By W. H. HASS, WALTER HÄNTZSCHEL, D. W. FISHER, B. F. HOWELL,
F. H. T. RHODES, K. J. MÜLLER, and R. C. MOORE

GEOLOGICAL SOCIETY OF AMERICA
and
UNIVERSITY OF KANSAS PRESS

1962
The *Treatise on Invertebrate Paleontology* has been made possible by (1) grants of funds from The Geological Society of America through the bequest of Richard Alexander Fullerton Penrose, Jr., for preparation of illustrations and partial defrayment of organizational expense and the United States National Science Foundation, in December, 1959, for completion of the *Treatise* project; (2) contribution of the knowledge and labor of specialists throughout the world, working in co-operation under sponsorship of The Palaeontographical Society, The Paleontological Society, and The Society of Economic Paleontologists and Mineralogists; and (3) acceptance by the University of Kansas Press of publication without cost to the Societies concerned and without any financial gain to the Press.
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EDITORIAL PREFACE

The aim of the *Treatise on Invertebrate Paleontology*, as originally conceived and consistently pursued, is to present the most comprehensive and authoritative, yet compact statement of knowledge concerning invertebrate fossil groups that can be formulated by collaboration of competent specialists in seeking to organize what has been learned of this subject up to the mid-point of the present century. Such work has value in providing a most useful summary of the collective results of multitudinous investigations and thus should constitute an indispensable text and reference book for all persons who wish to know about remains of invertebrate organisms preserved in rocks of the earth's crust. This applies to neozoologists as well as paleozoologists and to beginners in study of fossils as well as to thoroughly trained, long-experienced professional workers, including teachers, stratigraphical geologists, and individuals engaged in research on fossil invertebrates. The making of a reasonably complete inventory of present knowledge of invertebrate paleontology may be expected to yield needed foundation for future research and it is hoped that the *Treatise* will serve this end.

The *Treatise* is divided into parts which bear index letters, each except the initial and concluding ones being defined to include designated groups of invertebrates. The chief purpose of this arrangement is to provide for independence of the several parts as regards date of publication, because it is judged desirable to print and distribute each segment as soon as possible after it is ready for press. Pages in each part will bear the assigned index letter joined with numbers beginning with 1 and running consecutively to the end of the part. When the parts ultimately are assembled into volumes, no renumbering of pages and figures is required.

The outline of subjects to be treated in connection with each large group of invertebrates includes (1) description of morphological features, with special reference to hard parts, (2) ontogeny, (3) classification, (4) geological distribution, (5) evolutionary trends and phylogeny, and (6) systematic description of genera, subgenera, and higher taxonomic units. In general, paleoecological aspects of study are omitted or little emphasized because comprehensive treatment of this subject is given in the *Treatise on Marine Ecology and Paleocology* (H. S. Ladd, Editor, Geological Society of America, Memoir 67, 1957), prepared under auspices of a committee of the United States National Research Council. A selected list of references is furnished in each part of the *Treatise*.

Features of style in the taxonomic portions of this work have been fixed by the Editor with aid furnished by advice from the Joint Committee on Invertebrate Paleontology representing the societies which have undertaken to sponsor the *Treatise*. It is the Editor's responsibility to consult with authors and co-ordinate their work, seeing that manuscript properly incorporates features of adopted style. Especially he has been called on to formulate policies in respect to many questions of nomenclature and procedure. The subject of family and subfamily names is reviewed briefly in a following section of this preface, and features of *Treatise* style in generic descriptions are explained.

In December, 1959, the National Science Foundation of the United States, through its Division of Biological and Medical Sciences and the Program Director for Systematic Biology, made a grant in the amount of $210,000 for the purpose of aiding the completion of yet-unpublished volumes of the *Treatise*. Payment of this sum was provided to be made in installments distributed over a five-year period, with administration of disbursements handled by the University of Kansas. Expenditures planned are primarily for needed assistance to authors and may be arranged through approved institutions located anywhere. Important help for the Director-Editor of the *Treatise* has been made available from the grant, but no part of his stipend comes from it. Grateful acknowledgment to the Foundation is expressed on behalf of the societies sponsoring the *Treatise*, the University of Kansas, and innumerable individuals benefited by the *Treatise* project.
FORM OF ZOOLOGICAL NAMES

Many questions arise in connection with the form of zoological names. These include such matters as adherence to stipulations concerning Latin or Latinized nature of words accepted as zoological names, gender of generic and subgeneric names, nominative or adjectival form of specific names, required endings for some family-group names, and numerous others. Regulation extends to capitalization, treatment of particles belonging to modern patronymics, use of neo-Latin letters, and approved methods for converting diacritical marks. The magnitude and complexities of nomenclature problems surely are enough to warrant the complaint of those who hold that zoology is the study of animals rather than of names applied to them.

CLASSIFICATION OF ZOOLOGICAL NAMES

In accordance with the “Copenhagen Decisions on Zoological Nomenclature” (London, 135 p., 1953), zoological names may be classified usefully in various ways. The subject is summarized here with introduction of designations for some categories which the Treatise proposes to distinguish in systematic parts of the text for the purpose of giving readers comprehension of the nature of various names together with authorship and dates attributed to them.

CO-ORDINATE NAMES OF TAXA GROUPS

Five groups of different-rank taxonomic units (termed taxa, sing., taxon) are discriminated, within each of which names are treated as co-ordinate, being transferrable from one category to another without change of authorship or date. These are: (1) Species Group (subspecies, species); (2) Genus Group (subgenus, genus); (3) Family Group (tribe, subfamily, family, superfamily); (4) Order/Class Group (suborder, order, subclass, class); and (5) Phylum Group (subphylum, phylum). In the first 3 of these groups, but not others, the author of the first-published valid name for any taxon is held to be the author of all other taxa in the group which are based on the same nominate type and the date of publication for purposes of priority is that of the first-published name. Thus, if author A in 1800 introduces the family name X-idae to include 3 genera, one of which is X-us; and if author B in 1850 divides the 20 genera then included in X-idae into subfamilies called X-inae and Y-inae; and if author C in 1950 combines X-idae with other later-formed families to make a superfamily X-acea (or X-oidea, X-icae, etc.); the author of X-inae, X-idae and X-acea is A, 1800, under the Rules. Because taxonomic concepts introduced by authors B and C along with appropriate names surely are not attributable to author A, some means of recording responsibility of B and C are needed. This is discussed later in explaining proposed use of “nom. transl.”

The co-ordinate status of zoological names belonging to the species group is stipulated in Art. 11 of the present Rules; genus group in Art. 6 of the present Rules; family group in paragraph 46 of the Copenhagen Decisions; order/class group and phylum group in paragraphs 65 and 66 of the Copenhagen Decisions.

ORIGINAL AND SUBSEQUENT FORMS OF NAMES

Zoological names may be classified according to form (spelling) given in original publication and employed by subsequent authors. In one group are names which are entirely identical in original and subsequent usage. Another group comprises names which include with the original subsequently published variants of one sort or another. In this second group, it is important to distinguish names which are inadvertent changes from those constituting intentional emendations, for they have quite different status in nomenclature. Also, among intentional emendations, some are acceptable and some quite unacceptable under the Rules.

VALID AND INVALID NAMES

Valid names. A valid zoological name is one that conforms to all mandatory provisions of the Rules (Copenhagen Decisions, p. 43-57) but names of this group are divisible into subgroups as follows: (1) “inviolate names,” which as originally published not only meet all mandatory requirements of the Rules but are not subject to any sort of alteration (most generic and subgeneric names); (2) “perfect names,” which as they
appear in original publication (with or without precise duplication by subsequent authors) meet all mandatory requirements and need no correction of any kind but which nevertheless are legally alterable under present Rules (as in changing the form of ending of a published class/order-group name); (3) "imperfect names," which as originally published and with or without subsequent duplication meet mandatory requirements but contain defects such as incorrect gender of an adjectival specific name (for example, *Spironema recta* instead of *Spironema rectum*) or incorrect stem or form of ending of a family-group name (for example, *Spironemidae* instead of *Spironematidae*); (4) "transferred names," which are derived by valid emendation from either of the 2nd or 3rd subgroups or from a pre-existing transferred name (as illustrated by change of a family-group name from -inae to -idae or making of a superfamily name); (5) "improved names," which include necessary as well as somewhat arbitrarily made emendations allowable under the Rules for taxonomic categories not now covered by regulations as to name form and alterations that are distinct from changes that distinguish the 4th subgroup (including names derived from the 2nd and 3rd subgroups and possibly some alterations of 4th subgroup names). In addition, some zoological names included among those recognized as valid are classifiable in special categories, while at the same time belonging to one or more of the above-listed subgroups. These chiefly include (7) "substitute names," introduced to replace invalid names such as junior homonyms; and (8) "conserved names," which are names that would have to be rejected by application of the Rules except for saving them in their original or an altered spelling by action of the International Commission on Zoological Nomenclature in exercising its plenary powers to this end. Whenever a name requires replacement, any individual may publish a "new name" for it and the first one so introduced has priority over any others; since newness is temporary and relative, the replacement designation is better called substitute name rather than new name. Whenever it is considered desirable to save for usage an otherwise necessarily rejectable name, an individual cannot by himself accomplish the preservation, except by unchallenged action taken in accordance with certain provisions of the Copenhagen Decisions; otherwise he must seek validation through ICZN.


**Invalid names.** Invalid zoological names consisting of originally published names that fail to comply with mandatory provisions of the Rules and consisting of inadvertent changes in spelling of names have no status in nomenclature. They are not available as replacement names and they do not preoccupy for purposes of the Law of Homonomy. In addition to *nomen nudum*, invalid names may be distinguished as follows: (1) "denied names," which consist of originally published names (with or without subsequent duplication) that do not meet mandatory requirements of the Rules; (2) "null names," which comprise unintentional alterations of names; and (3) "vain or void names," which consist of invalid emendations of previously published valid or invalid names. Void names do have status in nomenclature, being classified as junior synonyms of valid names.

Proposed Latin designations for the indicated kinds of invalid names are as follows: (1) *nomina negata* (sing., *nomen negatum*, abbr., *nom. neg.*); (2) *nomina nulla* (sing., *nomen nullum*, abbr., *nom. null.*); (3) *nomina vana* (sing., *nomen vanum*, abbr., *nom. van.*). It is desirable in the *Treatise* to identify invalid names, particularly in view of the fact that many of these names

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(nom. neg., nom null.) have been considered incorrectly to be junior objective synonyms (like nom. van.), which have status in nomenclature.

SUMMARY OF NAME CLASSES

Partly because only in such publications as the Treatise is special attention to classes of zoological names called for and partly because new designations are now introduced as means of recording distinctions explicitly as well as compactly, a summary may be useful. In the following tabulation valid classes of names are indicated in bold-face type, whereas invalid ones are printed in italics.

Definitions of Name Classes

nomen conservatum (nom. conserv.). Name otherwise unacceptable under application of the Rules which is made valid, either with original or altered spelling, through procedures specified by the Copenhagen Decisions or by action of ICZN exercising its plenary powers.

nomen correctum (nom. correct.). Name with intentionally altered spelling of sort required or allowable under the Rules but not dependent on transfer from one taxonomic category to another (“improved name”). (See Copenhagen Decisions, paragraphs 50, 71-2-a-i, 74, 75, 79, 80, 87, 101; in addition, change of endings for categories not now fixed by Rules.)

nomen imperfectum (nom. imperf.). Name that as originally published (with or without subsequent identical spelling) meets all mandatory requirements of the Rules but contains defect needing correction (“imperfect name”). (See Copenhagen Decisions, paragraphs 50-1-b, 71-1-b-i, 71-1-b-ii, 79, 80, 87, 101.)

nomen inviolatum (nom. inviol.). Name that as originally published meets all mandatory requirements of the Rules and also is uncorrectable or alterable in any way (“inviolate name”). (See Copenhagen Decisions, paragraphs 152, 153, 155-157.)

nomen negatum (nom. neg.). Name that as originally published (with or without subsequent identical spelling) constitutes invalid original spelling and although possibly meeting all other mandatory requirements of the Rules, is not correctable to establish original authorship and date (“denied name”). (See Copenhagen Decisions, paragraph 71-1-b-iii.)

nomen nudum (nom. nud.). Name that as originally published (with or without subsequent identical spelling) fails to meet mandatory requirements of the Rules and having no status in nomenclature, is not correctable to establish original authorship and date (“naked name”). (See Copenhagen Decisions, paragraph 122.)

nomen nullum (nom. null.). Name consisting of an unintentional alteration in form (spelling) of a previously published name (either valid name, as nom. inviol., nom. perf., nom. imperf., nom. transl.; or invalid name, as nom. neg., nom. nud., nom. van., or another nom. null.) (“null name”). (See Copenhagen Decisions, paragraphs 71-2-b, 73-4.)

nomen perfectum (nom. perf.). Name that as originally published meets all mandatory requirements of the Rules and needs no correction of any kind but which nevertheless is validly alterable (“perfect name”).

nomen substitutum (nom. subst.). Replacement name published as substitute for an invalid name, such as a junior homonym (equivalent to “new name”).

nomen translatum (nom. transl.). Name that is derived by valid emendation of a previously published name as result of transfer from one taxonomic category to another to which it belongs (“transferred name”).

nomen vanum (nom. van.). Name consisting of an invalid intentional change in form (spelling) from a previously published name, such invalid emendations having status in nomenclature as junior objective synonyms (“vain or void name”). (See Copenhagen Decisions, paragraphs 71-2-a-ii, 73-3.)

Except as specified otherwise, zoological names accepted in the Treatise may be understood to be classifiable either as nomina inviolata or nomina perfecta (omitting from notice nomina correcta among specific names) and these are not discriminated. Names which are not accepted for one reason or another include junior homonyms, a few senior synonyms classifiable as nomina negata or nomina nuda, and numerous junior synonyms which include both objective (nomina vana) and subjective (all classes of valid names) types; effort to classify the invalid names as completely as possible is intended.

NAME CHANGES IN RELATION TO GROUP CATEGORIES

SPECIFIC AND SUBSPECIFIC NAMES

Detailed consideration of valid emendation of specific and subspecific names is unnecessary here because it is well understood and relatively inconsequential. When the form of adjectival specific names is changed to obtain agreement with the gender of a generic name in transferring a
species from one genus to another, it is never needful to label the changed name as a nom. transl. Likewise, transliteration of a letter accompanied by a diacritical mark in manner now called for by the Rules (as in changing originally published bröggeri to broeggeri) or elimination of a hyphen (as in changing originally published cornuoryx to cornuoryx does not require “nom. correct.” with it. Revised provisions for emending specific and subspecific names are stated in the report on Copenhagen Decisions (p. 43-46, 51-57).

**GENERIC AND SUBGENERIC NAMES**

So rare are conditions warranting change of the originally published valid form of generic and subgeneric names that lengthy discussion may be omitted. Only elimination of diacritical marks of some names in this category seems to furnish basis for valid emendation. It is true that many changes of generic and subgeneric names have been published, but virtually all of these are either nomina vana or nomina nulla. Various names which formerly were classed as homonyms are not now, for two names that differ only by a single letter (or in original publication by presence or absence of a diacritical mark) are construed to be entirely distinct. Revised provisions for emendation of generic and subgeneric names also are given in the report on Copenhagen Decisions (p. 43-47).

Examples in use of classificatory designations for generic names as previously given are the following, which also illustrate designation of type species, as explained later.

*Kurnatiophyllum* THOMSON, 1875 [*K. concentricum*; SD Gregory, 1917] [=Kurnatiophyllum THOMSON, 1876 (nom. null.); Cymatophyllum THOMSON, 1901 (nom. van.); Cymatophyllum LANG, SMITH & THOMAS, 1940 (nom. van.)].

*Stichophyuma* POMEL, 1872 [*Manon turbinatum* RÖMER, 1841; SD RAUFF, 1893] [=Stichophyuma VOSSAER, 1885 (nom. null.); Sticophyuma MORET, 1924 (nom. null.)].

*Stratophyllum* SMYTH, 1933 [*S. tenue*] [=Ethmooplax SMYTH, 1939 (nom. van. pro Stratophyllum); Stratophyllum LANG, SMITH & THOMAS, 1940 (nom. van. pro Stratophyllum SMYTH) (non Stratophyllum SCHEFFEN, 1933)].

Placotelia OPPLIGER, 1907 ["Porostoma marconi FROMENTEL, 1859; SD DELAUBENFELD, herein] [=Placotelia OPPLIGER, 1907 (nom. neg.)].

Walcottella DELAUB., nom. subst., 1955 ["Rhopalicus SCHRAMM., 1936 (non FORSTER, 1856)].

*Cytophragrus* CARRUTHERS, 1867 [nom. correct. LAFWORTH, 1873 ["Cytophragrus CARRUTHERS, 1867], nom. conserv. proposed BULMAN, 1955 (ICZN pend.)]

**FAMILY-GROUP NAMES; USE OF “NOM. TRANSL.”**

The Rules now specify the form of endings only for subfamily (-inae) and family (-idae) but decisions of the Copenhagen Congress direct classification of all family-group assemblages (taxa) as co-ordinate, signifying that for purposes of priority a name published for a unit in any category and based on a particular type genus shall date from its original publication for a unit in any category, retaining this priority (and authorship) when the unit is treated as belonging to a lower or higher category. By exclusion of -inae and -idae, respectively reserved for subfamily and family, the endings of names used for tribes and superfamilies must be unspecified different letter combinations. These, if introduced subsequent to designation of a subfamily or family based on the same nominate genus, are nomina translata, as is also a subfamily that is elevated to family rank or a family reduced to subfamily rank. In the Treatise it is desirable to distinguish the valid emendation comprised in the changed ending of each transferred family group name by the abbreviation “nom. transl.” and record of the author and date belonging to this emendation. This is particularly important in the case of superfamilies, for it is the author who introduced this taxon that one wishes to know about rather than the author of the superfamily as defined by the Rules, for the latter is merely the individual who first defined some lower-rank family-group taxon that contains the nominate genus of the superfamily. The publication of the author containing introduction of the superfamily nomen translatum is likely to furnish the information on taxonomic considerations that support definition of the unit.
Examples of the use of "nom. transl." are the following.

Subfamily STYLININAE d'Orbigny, 1851
[nom. transl. Edwards & Haime, 1857 (ex Stylinidae d'Orbigny, 1851)]

Superfamily ARCHAEOCTONOIDEA Petrunkevitch, 1949
[nom. transl. Petrunkevitch, herein (ex Archaeoctonidae Petrunkevitch, 1949)]

Superfamily CRIOCERATITACEAE Hyatt, 1900
[nom. transl. Wright, 1952 (ex Crioceratitidae Hyatt, 1900)]

FAMILY-GROUP NAMES; USE OF "NOM. CORRECT."

Valid emendations classed as nomina correcta do not depend on transfer from one category of family-group units to another but most commonly involve correction of the stem of the nominate genus; in addition, they include somewhat arbitrarily chosen modification of ending for names of tribe or superfamily. Examples of the use of "nom. correct." are the following.

Family STREPTELASMATIDAE Nicholson, 1889
[nom. correct. Wedekind, 1927 (ex Strepotelasmidae Nicholson, 1889, nom. imperf.)]

Family PALAEOSCORPIIDAE Lehmann, 1944
[nom. correct. Petrunkevitch, herein (ex Palaeoscorpionidae Lehmann, 1944, nom. imperf.)]

Family AGLASPIDIDAE Miller, 1877
[nom. correct. Stormer, herein (ex Aglaspidae Miller, 1877, nom. imperf.)]

Superfamily AGARICIICAE Gray, 1847
[nom. correct. Wells, herein (ex Agaricidae Vaughan & Wells, 1943, nom. transl. ex Agaricidae Gray, 1847)]

FAMILY-GROUP NAMES; USE OF "NOM. CONSERV."

It may happen that long-used family-group names are invalid under strict application of the Rules. In order to retain the otherwise invalid name, appeal to ICZN is needful. Examples of use of nom. conserv. in this connection, as cited in the Treatise, are the following.

Family ARIETITIDAE Hyatt, 1874
[nom. correct. Haag, 1885 (pro Arietidae Hyatt, 1875), nom. conserv. proposed Akeel, 1955 (ICZN pend.)]

Family STEPHANOCERATIDAE Neumayr, 1875
[nom. correct. Fischer, 1882 (pro Stephanoceratinae Neumayr, 1875, invalid vernacular name), nom conserv. proposed Akeel, 1955 (ICZN pend.).]
nym. The Copenhagen Decisions (paragraph 45) take account of these considerations by providing a relatively simple procedure for fixing the desired choice in stabilizing family-group names. In conformance with this, the Treatise assigns to contributing authors responsibility for adopting provisions of the Copenhagen Decisions.

Replacement of a family-group name may be needed if the former nominate genus is transferred to another family-group. Then the first-published name-giver of a family-group assemblage in the remnant taxon is to be recognized in forming a replacement name.

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 for any of these assemblages, 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. Also, every family containing differentiated subfamilies must have a nominate (sensu stricto) subfamily, which is based on the same type genus as that for the family, and the author and date set down for the nominate subfamily invariably are identical with those of the family, without reference as to whether the author of the family or some subsequent author introduced subdivisions.

Changes in the form of family-group names of the sort constituting nomina correcta, as previously discussed, do not affect authorship and date of the taxon concerned, but in publications such as the Treatise it is desirable to record the authorship and date of the correction.

ORDER/CLASS-GROUP NAMES; USE OF "NOM. CORRECT."

Because no stipulation concerning the form of order/class-group names is given yet by the Rules, emendation of all such names actually consists of arbitrarily devised changes in the form of endings. Nothing precludes substitution of a new name for an old one, but a change of this sort is not considered to be an emendation. Examples of the use of "nom. correct." as applied to order/class-group names are the following.

Order DISPARIDA Moore & Laudon, 1943
[nom. correct. Moore, 1952 (ex Disparata Moore & Laudon, 1943)]

Suborder FAVIINA Vaughan & Wells, 1943
[nom. correct. Wells, herein (ex Faviida Vaughan & Wells, 1943)]

Suborder FUNGIINA Verrill, 1865
[nom. correct. Wells, herein (ex Fungida Duncan, 1884, ex Fungaces Verrill, 1865)]

TAXONOMIC EMENDATION

Emendation has two measurably distinct aspects as regards zoological nomenclature. These embrace (1) alteration of a name itself in various ways for various reasons, as has been reviewed, and (2) alteration of taxonomic scope or concept in application of a given zoological name, whatever its hierarchical rank. The latter type of emendation primarily concerns classification and inherently is not associated with change of name, whereas the other type introduces change of name without necessary expansion, restriction, or other modification in applying the name. Little attention generally has been paid to this distinction in spite of its significance.

Most zoologists, including paleozoologists, who have signified emendation of 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 may accompany the name, with statement of the author and date of the emendation. On the other hand, a multitude of workers concerned with systematic zoology think that publication of "emend." with a zoological name is valueless because more or less alteration of taxonomic sort is introduced whenever a subspecies, species, genus, or other assemblage of animals is incorporated under or removed from the coverage of a given zoological name. 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 radical revisions are put forward, generally with published statement of reasons for
changing the application of a name. To erect a signpost at such points of most significant change is worth while, both as aid to subsequent workers in taking account of the altered nomenclatural usage and as indication that not-to-be-overlooked discussion may be found at a particular place in the literature. Authors of contributions to the Treatise are encouraged to include records of all specially noteworthy emendations of this nature, using the abbreviation "emend." with the name to which it refers and citing the author and date of the emendation.

In Part G (Bryozoa) and Part D (Protista 3) of the Treatise, the abbreviation "emend." is employed to record various sorts of name emendations, thus conflicting with usage of "emend." for change in taxonomic application of a name without alteration of the name itself. This is objectionable. In Part E (Archaecyatha, Porifera) and later-issued divisions of the Treatise, use of "emend." is restricted to its customary sense, that is, significant alteration in taxonomic scope of a name such as calls for noteworthy modifications of a diagnosis. Other means of designating emendations that relate to form of a name are introduced.

**STYLE IN GENERIC DESCRIPTIONS**

**CITATION OF TYPE SPECIES**

The name of the type species of each genus and subgenus is given next following the generic name with its accompanying author and date, or after entries needed for definition of the name if it is involved in homonymy. The originally published combination of generic and trivial names for this species is cited, accompanied by an asterisk (*), with notation of the author and date of original publication. An exception in this procedure is made, however, if the species was first published in the same paper and by the same author as that containing definition of the genus which it serves as type; in such case, the initial letter of the generic name followed by the trivial name is given without repeating the name of the author and date, for this saves needed space. Examples of these 2 sorts of citations are as follows:

**Diplotrypa Nicholson, 1879 ["Favosites petropolitanus Pander, 1830].**

**Chainodictyon Foerste, 1887 ["C. laxum].**

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

**Acervularia Schwepgoer, 1819 ["A. balica (="Madrepora ananas Linne, 1758)].**

It is judged desirable to record the manner of establishing the type species, whether by original designation or by subsequent designation, but various modes of original designation are not distinguished.

**Fixation of type-species originally.** The type-species of a genus or subgenus, according to provisions of the Rules, may be fixed in various ways originally (that is, in the publication containing first proposal of the generic name) or it may be fixed in specified ways subsequent to the original publication. Fixation of a type-species originally may be classified as automatic if the new genus was introduced for a single species (monotypy), or if the names of species referred to the genus are objectively synonymous. In addition, fixation of a type-species originally may be established in several ways by original designation, as by explicit statement given by an author, by use of typus or typicus as a new specific name, and by absolute tautonymy (e.g., Mesolobus mesolobus). According to convention adopted in the Treatise, the absence of indication as to the manner of fixing the type-species is to be understood as signifying fixation of the type-species in one way or another originally. Where an author wishes to specify the mode of original fixation, however, this may be done by such abbreviations as “M” (monotypy), “OS” (objective synonymy), and “OD” (original designation), the first- and last-mentioned being most common and the other very rare.

**Fixation of type-species subsequently.** The type species of many genera are not determinable from the publication in which the generic name was introduced and 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, and in the Treatise fixation of the type species 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 date of publishing the subsequent designation. Some genera, as first described and named, included no mentioned species and these necessarily lack a type species until a date subsequent to that of the original publication when one or more species are assigned to such a genus. If only a single species is thus assigned, it automatically becomes the type species and in the *Treatise* this subsequent monotypy is indicated by the letters "SM." Of course, the first publication containing assignment of species to the genus which originally lacked any included species is the one concerned in fixation of the type species, and if this named 2 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" and "SM" as employed in the *Treatise* follow.

**Hexagonaria** Gülich, 1896 [*Cyathophyllum hexagonum* Goldfuss, 1826; SD Lang, Smith & Thomas, 1940].

**Muriceides** Studer, 1887 [*M. fragilis* Wright & Studer, 1889; SM Wright & Studer, 1889].

Another mode of fixing the type-species of a genus that may be construed as a special sort of subsequent designation is action of the International Commission on Zoological Nomenclature using its plenary powers. Definition in this way may set aside application of the Rules 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 (generally) reference to the appropriate numbered Opinion.

**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 2 or more distinct taxonomic units, however, it is necessary to differentiate such homonyms, and 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, *Callopora* Hall, 1851, introduced for Paleozoic trepostome bryozoans, is invalid because Gray in 1848 published the same name for Cretaceous-to-Recent cheilostome bryozoans, and Bassler in 1911 introduced the new name *Hallopora* to replace Hall's homonym. The *Treatise* style of entry is:

**Hallopora** Bassler, 1911 [pro *Callopora* Hall, 1851 (non Gray, 1848)].

In like manner, a needed replacement generic name may be introduced in the *Treatise* (even though first publication of generic names otherwise in this work is avoided). The requirement that an exact bibliographic reference must be given for the replaced name commonly can be met in the *Treatise* by citing a publication recorded in the list of references, using its assigned index number, as shown in the following example.

**Mysterium** deLaubenfels, nom. subst. [pro *Mystrium* Schrammen, 1936 (ref. 40, p. 60) (non Roger, 1862)] [*Mystrium porosum* Schrammen, 1936].

For some replaced homonyms, a footnote reference to the literature is necessary. A senior homonym is valid, and in so far as the *Treatise* is concerned, such names are handled according to whether the junior homonym belongs to the same major taxonomic division (class or phylum) as the senior homonym or to some other; in the former instance, the author and date of the junior homonym are cited as:

**Diplophyllum** Hall, 1851 [non Soshkina, 1939] [*D. caespitosum*].

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

**Homonyms by misidentification.** When an author uses a generic name for species not congeneric with the type-species, it is needful to record the misuse of the generic name, even though this is only determinable subjectively. In the *Treatise* homonyms by misidentification are cited in synonymies as illustrated in the following example.
Asmussia Pacht, 1849 [*A. membranacea* [=Posidonomya Pacht, 1852 (non Bronn, 1834); Estheria Jones, 1856 (non Robineau-Desvoidy, 1830; nec Rueppell, 1837)]. . . .

Synonymic 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 which they have in hand is not actually the original one. Although the names were separately published, 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 synonymic homonyms and in the Treatise the junior one of these is indicated by the abbreviation "jr. syn. hom."

Identical family-group names not infrequently are published as new names by different authors, the author of the later-introduced name 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 are nomenclatural homonyms, based on the same type-genus, and they are also synonyms. Wherever encountered, such synonymic homonyms are distinguished in the Treatise as in dealing with generic names.

SYNONYMS

Citation of synonyms is given next following record of the type species and if 2 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. Examples showing Treatise style in listing synonyms follow.

Calopezia Billings, 1865 [*C. anticostiensis; SD Lindström, 1883] [=Columnopora Nicholson, 1874; Houghtonia Rominger, 1876].

Staurocyclia Häckel, 1882 [*S. cruciata Häckel, 1887] [=Coccostaurus Häckel, 1882 (obj.); Phacostaurus Häckel, 1887 (obj.)].

A synonym which also constitutes a homonym is recorded as follows:

Lyopora Nicholson & Etheridge, 1878 [*Palaeopora? favosa M'Coy, 1850] [=Liopora Lang, Smith & Thomas, 1940 (non Girty, 1915)].

Some junior synonyms of either objective or subjective sort may take precedence desirably over senior synonyms wherever uniformity and continuity of nomenclature are served by retaining a widely used but technically rejectable name for a generic assemblage. This requires action of ICZN using its plenary powers to set aside the unwanted name and validate the wanted one, with placement of the concerned names on appropriate official lists. In the Treatise citation of such a conserved generic name is given in the manner shown by the following example.

Tetragraptus Salter, 1863 [nom. conserv. proposed Bulman, 1955, ICZN pend.] [*Fucoides serra Brongniart, 1828 (=Grapto lithus bryonoides Hall, 1858)].

ABBREVIATIONS

Abbreviations used in this division of the Treatise are explained in the following alphabetically arranged list.

\begin{verbatim}
Abs., abstract
Aff., affinis
Afr., Africa, -an
Ala., Alabama
Alb., Albion
Algonk., Algonkian
Alter., alternate
Alta., Alberta
Am., America, -n
Ant., anterior
Antarct., Antarctic
Append., appendix
Approx., approximately
Apt., Aptian
Arenig., Arenigian
Arg., Argentina
Ariz., Arizona
AsiaM., Asia Minor
Auctt., auctorum
Aus., Austria
Austral., Australia
Balt., Baltic
Barton., Bartonian
B.C., British Columbia
Belg., Belgium, Belgique
Bob., Bohemia
Bol., Bolivia
Br.I., British Isles
Brit., Britain, British
C., Central
c.a., circa
Calif., California
Cam., Cambrian
Campan., Campanian
Can., Canada
Caradoc., Caradocian
\end{verbatim}
REFERENCES TO LITERATURE

Each part of the Treatise is accompanied by a selected list of references to paleontological literature consisting primarily of recent and comprehensive monographs available but also including some older works recognized as outstanding in importance. The purpose of giving these references is to aid users of the Treatise in finding detailed descriptions and illustrations of morphological features of fossil groups, discussions of classifications and distribution, and especially citations of more or less voluminous literature. Generally speaking, publications listed in the Treatise are not original sources of information concerning taxonomic units of various rank but they tell the student where he may find them; otherwise it is necessary to turn to such aids as the Zoological Record or Neave’s Nomenclator Zoologicus. References given in the Treatise are arranged alphabetically by authors and accompanied by index numbers which serve the purpose of permitting citation most concisely in various parts of the text; these citations of listed papers are enclosed invariably in parentheses and are distinguishable from dates because the index numbers comprise no more than 3 digits. Ordinarily, index numbers for literature references are given at the end of generic or family diagnoses.

The following is a statement of the full names of serial publications which are cited in abbreviated form in the Treatise lists of references. The information thus provided should be useful in library research work. The list is alphabetized according to the serial titles which were employed at the time of original publication. Those following it in brackets are those under which the publication may be found currently in the Union List of Serials, the United States Library of Congress listing, and most library card catalogues. The names of serials published in Cyrillic are transliterated; in the reference lists these titles, which may be abbreviated, are accompanied by transliterated authors’ names and titles, with English translation of the title. The place of publication is added (if not included in the serial title).

List of Serial Publications

Académie des Sciences URSS, Comptes Rendus [Akademiya Nauk SSSR, Leningrad].
Académie Impériale des Sciences, St. Pétersbourg, Mémoires [Akademiya Nauk SSSR, Leningrad].
Académie Tchèque des Sciences, Bulletin International, Classe des Sciences Mathématiques, Naturelles et de la Médecine [Česká Akademie věd a umění v Praze].
Academy of Natural Sciences of Philadelphia, Proceedings.
Akademie der Wissenschaften und der Literatur, Mainz, mathematisch-naturwissenschaftliche Klasse, Abhandlungen.
Akademie der Wissenschaftlichen zu München, mathematische-physikalische Klasse, Sitzungsberichten.
Akademie der Wissenschaftlichen zu Wien, mathematisch-naturwissenschaftliche Klasse, Denkschriften.
Akademiya Nauk SSSR, Leningrad, Doklady; Geologicheskii Institut; Izvestiya, Seriya Biologicheskaya.
American Geologist. Minneapolis, Minn.
American Journal of Science. New Haven, Conn.
Annals and Magazine of Natural History. London.
Archives de Musée Teyleri. Haarlem.
Arquivos do Museu Paraense. Curitiba, Brazil.

1 K. preceding a serial title stands for all forms meaning royal, imperial, e.g., Königliche, Kaiserliche, Kongelig, etc.
STRATIGRAPHIC DIVISIONS

Classification of rocks forming the geologic column as commonly cited in the Treatise in terms of units defined by concepts of time is reasonably uniform and firm throughout most of the world as regards major divisions (e.g., series, systems, and rocks representing eras) but it is variable and unfirm as regards smaller divisions (e.g., substages, stages, and subseries), which are provincial in application. Users of the Treatise have suggested the desirability of publishing reference lists showing the stratigraphic arrangement of at least the most commonly cited divisions. Accordingly, a tabulation of European and North American units, which broadly is applicable also to other continents, is given here.

Generally Recognized Divisions of Geologic Column

<table>
<thead>
<tr>
<th>Europe</th>
<th>North America</th>
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<tbody>
<tr>
<td>ROCKS OF CENOZOIC ERA</td>
<td>ROCKS OF CENOZOIC ERA</td>
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<tr>
<td>NEOGENE SYSTEM</td>
<td>NEOGENE SYSTEM</td>
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<tr>
<td>Pleistocene Series (including Recent)</td>
<td>Pleistocene Series (including Recent)</td>
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<tr>
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<td>Pliocene Series</td>
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<tr>
<td>Miocene Series</td>
<td>Miocene Series</td>
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<tr>
<td>PALEOGENE SYSTEM</td>
<td>PALEOGENE SYSTEM</td>
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<td>Oligocene Series</td>
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<tr>
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<td>Paleocene Series</td>
<td>Paleocene Series</td>
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<tr>
<td>ROCKS OF MESOZOIC ERA</td>
<td>ROCKS OF MESOZOIC ERA</td>
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<td>Upper Cretaceous Series</td>
<td>Gulfian Series (Upper Cretaceous)</td>
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<td>Maastrichtian Stage</td>
<td>Navarroan Stage</td>
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<td>Tayloran Stage</td>
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<td>Santonian Stage</td>
<td>Austinian Stage</td>
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<td>Coniacian Stage</td>
<td>Woodbinian (Tuscaloosan) Stage</td>
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<td>Turonian Stage</td>
<td>Comanchean Series (Lower Cretaceous)</td>
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<td>Cenomanian Stage</td>
<td>Washitan Stage</td>
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<tr>
<td>Lower Cretaceous Series</td>
<td>Fredericksburgian Stage</td>
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<td>Albion Stage</td>
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<td>Barremian Stage</td>
<td>Nuevoleonian Stage</td>
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<td>Hauterivian Stage</td>
<td>Durangoan Stage</td>
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<td>Valanginian Stage</td>
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<td>Berriasian Stage</td>
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<tr>
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<td>Portlandian Stage</td>
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<td>Kimmeridgian Stage</td>
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<td>Oxfordian Stage</td>
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<td>Callovian Stage</td>
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<td>Bathonian Stage</td>
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<td>Bajocian Stage</td>
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</tbody>
</table>

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Lower Jurassic Series (Liassic)
  Toarcian Stage
  Pliensbachian Stage
  Sinemurian Stage
  Hettangian Stage

TRIASSIC SYSTEM
Upper Triassic Series
  Rhaetian Stage
  Norian Stage
  Carnian Stage
Middle Triassic Series
  Ladinian Stage
  Anisian Stage (Virglorian)
Lower Triassic Series
  Scythian Series (Werfenian)

ROCKS OF PALEOZOIC ERA
PERMIAN SYSTEM
Upper Permian Series
  Tartarian Stage
  Kazanian Stage
  Kungurian Stage
Lower Permian Series
  Artinskian Stage
  Sakmarian Stage

CARBONIFEROUS SYSTEM
Upper Carboniferous Series
  Stephanian Stage
  Westphalian Stage

Lower Carboniferous Series
  Viséan Stage
  Tournaisian Stage
  Strunian Stage

DEVONIAN SYSTEM
Upper Devonian Series
  Famennian Stage
  Frasnian Stage

Lower Permian Series
  Ochoan Stage
  Guadalupian Stage

Lower Permian Series
  Leonardian Stage
  Wolfcampian Stage

PENNYSYLVANIAN SYSTEM
Kawvian Series (Upper Pennsylvanian)
  Virgilian Stage
  Missourian Stage
Oklan Series (Middle Pennsylvanian)
  Desmoinesian Stage
  Bendian Stage
Adrian Series (Lower Pennsylvanian)
  Morrowan Stage

MISSISSIPPIAN SYSTEM
Tennesseean Series (Upper Mississippian)
  Chesteran Stage
  Meramecian Stage
Waverlyan Series (Lower Mississippian)
  Osagian Stage
  Kinderhookian Stage

Chautauquan Series (Upper Devonian)
  Conewangoan Stage
  Cassadagan Stage
Senecan Series (Upper Devonian)
  Chemungian Stage
  Fingerlakesian Stage

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<th>Period</th>
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<th>Stage</th>
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<td>Givetian Stage</td>
<td>Taghanian Stage</td>
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<td></td>
<td>Couvinian Stage</td>
<td>Tioughniogan Stage</td>
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<tr>
<td><strong>Lower Devonian</strong></td>
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<td>Coblenzian Stage</td>
<td>Cazenovian Stage</td>
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<td></td>
<td></td>
<td>Gedinnian Stage</td>
<td>Ulsterian Series (Lower Devonian)</td>
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<td>Upper Silurian</td>
<td>Ludlovian Stage</td>
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<td>Deerparkian Stage</td>
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<tr>
<td></td>
<td>Middle Silurian</td>
<td>Wenlockian Stage</td>
<td>Helderbergian Stage</td>
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<td></td>
<td></td>
<td>Llandoverian Stage (upper part)</td>
<td></td>
</tr>
<tr>
<td><strong>Lower Silurian</strong></td>
<td></td>
<td>Llandoverian Stage (lower part)</td>
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<td>Ashgillian Stage</td>
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<td>Rocks of Precambrian Age</td>
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1 Considered by some to exclude post-Pliocene deposits.
2 Classed as division of Senonian Subseries.
3 Classed as division of Neocomian Subseries.
4 Includes Purbeckian deposits.
5 Includes Lower Triassic and equivalent to upper Thuringian (Zechstein) deposits.
6 Equivalent to lower Thuringian (Zechstein) deposits.
7 Equivalent to upper Autunian and part of Rotliegend deposits.
8 Classed as uppermost Cambrian by some geologists.

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PART W
MISCELLANEA


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INTRODUCTION

By Raymond C. Moore
[University of Kansas]

The letter “W,” assigned to this volume of the Treatise, indicates a position next to last in the planned sequence of units. This is explained readily by its intended content of “left-over”—mostly groups of fossils set apart as unknown or very doubtful as to taxonomic affinities. Such a residuum might be expected to follow the publication of all other units, possibly with a miscellany of minor groups that for some reason had been omitted from already-issued volumes in which they would logically have found place. Obviously, the presumption expressed does not accord with fact, since several important divisions of the Treatise are yet unfinished. Readers may be reminded that an initial feature of this collaborative project was to publish each planned volume whenever it could be made ready for the press. No good end would be served by withhold-