TREATISE ON INVERTEBRATE PALEONTOLOGY

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Part R. ARTHROPODA 4, Volume 3 (Hexapoda).
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Part E, Volume 2. PORIFERA (revised edition).
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EDITORIAL PREFACE

INTRODUCTION

During the nearly 30 years since publication of the first, slim *Treatise* volume (Part G, 1953) the Editorial Preface has undergone many evolutionary changes and has grown in length, but its scope and purpose have remained unchanged. The objectives of the Introduction of the Editorial Preface are 1) to give a brief history of a particular part of the *Treatise,* 2) to explain the aims of the *Treatise* in general terms, and 3) to make appropriate acknowledgments for support received. The bulk of the Editorial Preface is devoted to an explanation of nomenclatural practices adopted in the *Treatise,* and it concludes with listing and discussion of important stratigraphic divisions used in the text.

The present volumes deal with all Paleozoic corals, but also include description of some Mesozoic descendants, especially among the Chaetetida. The groups described in this Supplement to *Treatise* Part F were, in the original edition of Part F (1956, reprint 1967), arranged in three different sections, which were treated as orders of the class Anthozoa: Rugosa by DOROTHY HILL (p. *F*233-324), Heterocorallia by DOROTHY HILL (p. *F*324-327), and Tabulata by DOROTHY HILL and ERWIN C. STUMM (p. *F*444-477), totaling approximately 140 pages.

In early 1964, when stocks of the original edition of Part F fell below expected demand for the following few years, I began to discuss the possibility of a revised edition with the principal authors of the volume. It soon developed that, as of that date, planning for revisionary work on the Paleozoic coral groups could be begun on a realistic basis, and plans began to crystallize during a brief visit by Professor HILL to Lawrence in May 1965. There followed the usual gestation period of two to three years during which few communications were exchanged; but in the beginning of 1968, DOROTHY HILL and ERWIN C. STUMM finally committed themselves to the plan of a revised edition of the description of all Paleozoic corals, to be published as a Supplement to Part F. The material was to be divided between the two authors along the lines of the treatment in the original edition. After Professor STUMM's untimely death in 1969, DOROTHY HILL agreed to take over those groups that had originally been assigned to him. She further merged the order Heterocorallia as an order with the Rugosa, thus returning time-honored two-fold division of the Paleozoic corals into Rugosa and Tabulata, now treated as subclasses of the class Anthozoa.

At the time these arrangements were made, Professor HILL was also committed to undertake a revision of the Archaeocyatha and it was mutually agreed that this task should receive priority. In consequence, the revised treatment of Archaeocyatha was published in 1972 as *Treatise,* Part E, volume 1 (revised and enlarged edition). Immediately upon publication of this volume, DOROTHY HILL turned to work on the revision of the Paleozoic corals, a huge task, as became increasingly obvious as the work progressed. The results of these efforts are presented in these two volumes, whose contents measure up to the highest standards obtained in the *Treatise on Invertebrate Paleontology.*

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 year of publication of each individual part. Such work has value in providing a most useful summary of the collective results of multitudinous investigations and thus constitutes 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 is yielding needed foundation for future research.

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 was judged desirable to print and distribute each segment as soon as possible after it is ready for press. Pages in each part bear the assigned index letter joined with numbers beginning with 1 and running consecutively to the end of the part. Materials for several individual parts were so voluminous that these parts had to be published in two or even three volumes. In such cases, pagination is continuous through successive volumes.

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) geologic and geographic distribution, 5) evolutionary trends and phylogeny, 6) paleoecology, and 7) systematic description of genera, subgenera, and higher taxonomic units. Selected lists of references only were furnished in earlier parts of the *Treatise,* but since the mid-1960's the tendency has been to make these lists as comprehensive as possible, and in particular, to supply reliable bibliographical documentation for all taxonomic names dealt with in the text.

Features of style in the taxonomic portions of this work have been fixed by the editors with aid furnished by advice from representatives of the societies which have undertaken to sponsor the *Treatise*. It is the editors' responsibility to consult with authors and coordinate their work, seeing that manuscripts properly incorporate features of adopted style. Especially they are called on to formulate policies in respect to many questions of nomenclature and procedure. The subject of genus-group as well as family and subfamily names is reviewed briefly in a following section of this preface, and features of *Treatise* style in generic descriptions are explained.

A generous grant of $35,000 was made in 1948 by The Geological Society of America for initial work in preparing *Treatise* illustrations. Additional grants were made by the Geological Society of America in 1971 ($6,200), 1972 ($6,000), $7,000 each year for 1973 and 1974, and $20,000 each year from 1975 through 1980. Administration of expenditures has been the charge of the editors and most of the work by photographers and artists has been done under their direction at the University of Kansas, but sizable parts of this program have also been carried forward in Washington, London, Ottawa, and many other places.

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. An additional grant (No. GB 4544) of $102,800 was made by the National Science Foundation in January, 1966, for the two-year period 1966-1967, and this was extended for the calendar year 1968 by payment of $25,700 in October, 1967. This grant was extended further by payments of $57,800 in 1968 for calendar year 1969, and $66,000 each for calendar years 1970 through 1972. For the years 1973 through 1977, grants totaled $197,400. These funds were used primarily to maintain editorial operations at the University of Kansas and to provide assistance to authors in preparation of manuscripts and illustrations. 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.

Since April 1977 the University of Rochester has provided the editor with full office facilities and support without which his tasks could not have been completed; this generous assistance is gratefully acknowledged.

ZOOLOGICAL NAMES

Many questions arise in connection with zoological names, especially including those that relate to their acceptability and to alterations of some which may be allowed or demanded. Procedure in obtaining answers to these questions is guided and to a large extent governed by regulations published (1961) in the *International Code of Zoological Nomenclature*[1] (hereinafter cited simply as the *Code*). The prime object of the *Code* is to promote stability and universality in the use of the scientific names of animals, ensuring also that each name is distinct and unique while avoiding restrictions on freedom of taxonomic thought or action. Priority is a basic principle, but under specified conditions its application can be modified. This is all well and good, yet nomenclatural tasks confronting the zoological taxonomist are formidable. They warrant the complaint of some that zoology, including paleozoology, is the study of animals rather than of names applied to them.

Several ensuing pages are devoted to aspects of zoological nomenclature that are judged to have chief importance in relation to procedures adopted in the *Treatise*. Terminology is explained, and examples of style employed in the nomenclatural parts of systematic descriptions are given.

A draft of a revised edition of the *Code* was submitted to the meeting of the International Union of Biological Sciences at Helsinki, Finland, in August 1979. It is

[1] N. R. Stoll *et al.* (ed. comm.), *International Code of Zoological Nomenclature, adopted by the XV International Congress of Zoology*, xvii + 176 p. (International Trust for Zoological Nomenclature, London, 1961; 2d edit., xx + 176 p., 1964).

expected that this revised edition will not come into force before some time in 1981 (R. V. MELVILLE, written commun., October 1979) and the existing *Code* of 1961 is, therefore, strictly followed in the present volume.

TAXA GROUPS

Each taxonomic unit (taxon, pl., taxa[1]) belongs to a rank in the adopted hierarchy of classificatory divisions. In part, this hierarchy is defined by the *Code* to include a species-group of taxa, a genus-group, and a family-group. Units of lower rank than subspecies are excluded from zoological nomenclature and those higher than superfamily of the family-group are not regulated by the *Code.* It is natural and convenient to discuss nomenclatural matters in general terms first and then to consider each of the taxa groups separately. Especially important is the provision that within each taxa group, classificatory units are coordinate (equal in rank), whereas units of different taxa groups are not coordinate.

FORMS OF NAMES

All zoological names are divisible into groups based on their form (spelling). The first-published form (or forms) of a name is defined as original spelling (*Code,* Art. 32) and any later-published form (or forms) of the same name is designated as subsequent spelling (Art. 33). Obviously, original and subsequent spellings of a given name may or may not be identical and this affects consideration of their correctness. Further, examination of original spellings of names shows that by no means all can be distinguished as correct. Some are incorrect, and the same is true of subsequent spellings.

Original Spellings

If the first-published form of a name is consistent and unambiguous, the original spelling is defined as correct unless it contravenes some stipulation of the *Code* (Arts. 26-31), or 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* (Arts. 26-31).

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 and they call for correction. For example, a name originally published with a diacritic mark, apostrophe, diaeresis, 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 requires the insertion of "e" after the vowel.

Subsequent Spellings

If a name classed as a subsequent spelling is identical with an original spelling, it is distinguishable as correct or incorrect on the same criteria that apply to the original spelling. This means that a subsequent spelling identical with a correct original spelling is also correct, and one identical with an incorrect original spelling is also incorrect. In the latter case, both original and subsequent spellings require correction (authorship and date of the original incorrect spelling being retained).

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 (except that such changes as altered terminations of adjectival specific names to obtain agreement in gender with associated generic names, of family-group names to denote assigned taxonomic rank, and corrections for originally used diacritic marks, hyphens, and the like

[1] Inasmuch as the word taxon is an artificial one, not of classical origin, the plural should more properly be taxons, but the spelling taxa is now so deeply rooted in the literature that it seems inadvisable to change it.

are excluded from spelling changes conceived to produce a different name). In certain cases species-group names having variable spellings are regarded as homonyms as specified in Art. 58 of the *Code*.

Altered subsequent spellings other than the exceptions noted may be either intentional or unintentional. If demonstrably intentional, 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 that differ in any way from the original spellings, other than previously noted exceptions, and that are not classifiable as emendations are defined as incorrect subsequent spellings. They have no status in nomenclature, do not enter into homonymy, and cannot be used as replacement names. It is the purpose of the following chapters to explain in some detail the implications of various kinds of subsequent spellings and how these are dealt with in the *Treatise*.

AVAILABLE AND UNAVAILABLE NAMES

Available Names

An available zoological name is any that conforms to all mandatory provisions of the *Code*. Such names are classifiable in groups which are recognized in the *Treatise*, though not explicitly differentiated in the *Code*. They are as follows:

1) So-called *"inviolate names"* include all available names that are not subject to alteration from their originally published form. They comprise correct original spellings and commonly include correct subsequent spellings, but include no names classed as emendations. Here belong most genus-group names (including those for collective groups), some of which differ in spelling from others by only a single letter or by the sequential order of their letters.

2) Names may be termed *"perfect names"* if, as originally published, they meet all mandatory requirements, needing no correction of any kind, but nevertheless are legally alterable in such ways as changing the termination (e.g., many species-group names, family-group names). This group does not include emended incorrect original spellings (e.g., *Boucekites,* replacement of *Bouček ites*).

3) *"Imperfect names"* are available names that as originally published contain mandatorily emendable defects. Incorrect original spellings are imperfect names. Examples of emended imperfect names are: among species-group names, *guerini* (not *Guérini*), *obrienae* (not *O'Brienae*), *terranovae* (not *terra-novae*), *nunezi* (not *Nuñezi*), *Spironema rectum* (not *Spironema recta,* because generic name is neuter, not feminine); among genus-group names, *Broeggeria* (not *Bröggeria*), *Obrienia* (not *O'Brienia*), *Maccookites* (not *McCookites*); among family-group names Guembellotriinae (not Gümbellotriinae), Spironematidae (not Spironemidae, incorrect stem), Athyrididae (not Athyridae, incorrect stem). The use of "variety" for named divisions of fossil species, according to common practice of some paleontologists, gives rise to imperfect names, which generally are emendable (*Code,* Art. 45e) by omitting this term so as to indicate the status of this taxon as a subspecies. The name of a variety is always of feminine gender. If the variety is converted into a species or subspecies, the name takes on the gender of the associated genus.

4) *"Vain names"* are available names consisting of unjustified intentional emendations of previously published names. The emendations are unjustified because they are not demonstrable as corrections of incorrect original spellings as defined by the *Code* (Art. 32c). Vain names have status in nomenclature under their own authorship and date. They constitute junior objective synonyms of names in their original form. Examples are: among species-group names, *geneae* (published as replacement of original unexplained masculine, *geni,* which now is not alterable), *ohioae* (invalid change from original *ohioensis*); among genus-group names, *Graphiodactylus* (invalid change from original *Graphiadactyllis*); among family-group names, Graphi-

odactylidae (based on junior objective synonym having invalid vain name).

5) An important group of available zoological names can be distinguished as *"transferred names."* These comprise authorized sorts of altered names in which the change depends on transfer from one taxonomic rank to another, or possibly on transfers in taxonomic assignment of subgenera, species, or subspecies. Most commonly the transfer calls for a change in termination of the name so as to comply with stipulations of the *Code* on endings of family-group taxa and agreement in gender of specific names with associated generic names. Transferred names may be derived from any of the preceding groups except the first. Examples are: among species-group names, *Spirifer ambiguus* (masc.) to *Composita ambigua* (fem.), *Neochonetes transversalis* to *N. granulifer transversalis* or vice versa; among genus-group names, *Schizoculina* to *Oculina (Schizoculina)* or vice versa; among family-group names, Orthidae to Orthinae or vice versa, or superfamily Orthacea derived from Orthidae or Orthinae; among suprafamilial taxa (not governed by the *Code*), order Orthida to suborder Orthina or vice versa. The authorship and date of transferred names are not affected by the transfer, but the author responsible for the transfer and the date of his action are recorded in the *Treatise*.

6) Improved or *"corrected names"* include both mandatory and allowable emendations of imperfect names and of suprafamilial names, which are not subject to regulation as to name form. Examples of corrected imperfect names are given with the discussion of group 3. Change from the originally published ordinal name Endoceroidea (Teichert, 1933) to the presently recognized Endocerida illustrates a "corrected" suprafamilial name. Group 6 names differ from those in group 5 in not being dependent on transfers in taxonomic rank or assignment, but some names are classifiable in both groups.

7) *"Substitute names"* are available names expressly proposed as replacements for invalid zoological names, such as junior homonyms. These may be classifiable also as belonging in groups 1, 2, or 3. The glossary appended to the *Code* refers to these as "new names" *(nomina nova)* but they are better designated as substitute names, since their newness is temporary and relative. The first-published substitute name that complies with the definition here given takes precedence over any other. An example is *Marieita* Loeblich & Tappan, 1964, as substitute for *Reichelina* Marie, 1955, *non* Erk, 1942.

8) *"Conserved names"* include a relatively small number of species-group, genus-group, and family-group names which have come to be classed as available and valid by action of the International Commission on Zoological Nomenclature exercising its plenary powers to this end or ruling to conserve a junior synonym in place of a rejected "forgotten" name *(nomen oblitum)* (Art. 23b). Currently, such names are entered on appropriate "Official Lists," which are published from time to time.

It is useful for convenience and brevity of distinction in recording these groups of available zoological names to employ Latin designations in the pattern of *nomen nudum* (abbr., *nom. nud.*) and others. Thus we recognize the preceding numbered groups as follows: 1) *nomina inviolata* (sing., *nomen inviolatum,* abbr., *nom. inviol.*), 2) *nomina perfecta (nomen perfectum, nom. perf.),* 3) *nomina imperfecta (nomen imperfectum, nom. imperf.)* 4) *nomina vana (nomen vanum, nom. van.)* 5) *nomina translata (nomen translatum, nom. transl.),* 6) *nomina correcta (nomen correctum, nom. correct.),* 7) *nomina substituta (nomen substitutum, nom. subst.),* 8) *nomina conservata (nomen conservatum, nom. conserv.).* It should be noted that the *Code* does not differentiate between different kinds of subsequent intentional changes of spelling, all of which are grouped as "emendations" (see below).

Additional to the groups differentiated above, the *Code* (Art. 17) specifies that a zoological name is not prevented from availability a) by becoming a junior synonym, for under various conditions this may be reemployed, b) for a species-group name by finding that original description of the taxon relates to more than a single taxonomic entity or to parts of animals belonging to two or more such entities, c) for species-group names by determining that it first was combined with an invalid or unavailable genus-group name, d) by being based only on part of an animal, sex of a species, ontogenetic stage, or one form of a polymorphic species, e) by being originally proposed for an organism not considered to be an animal but now so regarded, f) by incorrect original spelling which is correctable under the *Code,* g) by anonymous publication before 1951, h) by conditional proposal before 1961, i) by designation as a variety or form before 1961, j) by concluding that a name is inappropriate (Art. 18), or k) for a specific name by observing that it is tautonymous (Art. 18).

Unavailable Names

All zoological names which fail to comply with mandatory provisions of the *Code* are unavailable names and have no status in zoological nomenclature. None can be used under authorship and date of original publication as a replacement name *(nom. subst.)* and none preoccupies for purposes of the Law of Homonymy. Names identical in spelling with some, but not all, unavailable names can be classed as available if and when they are published in conformance to stipulations of the *Code,* and they are then assigned authorship and take date of the accepted publication. Different groups of unavailable names can be discriminated as follows.

9) *"Naked names"* include all those that fail to satisfy provisions stipulated in Article 11 of the *Code,* which states general requirements of availability. In addition they include names that, if published before 1931, were unaccompanied by a description, definition, or indication (Arts. 12, 16), as well as names published after 1930 that lacked accompanying statement of characters purporting to serve for differentiation of the taxon, or definite bibliographic reference to such a statement, or that were not proposed expressly as replacement *(nom. subst.)* of a preexisting available name (Art. 13a), or that were unaccompanied by definite fixation of a type species by original designation or indication (Art. 13b). Examples of "naked names" are: among species-group taxa, *Valvulina mixta* PARKER & JONES, 1865 (=*Cribrobulimina mixta* CUSHMAN, 1927, available and valid); among genus-group taxa, *Orbitolinopsis* SILVESTRI, 1932 (=*Orbitolinopsis* HENSON, 1948, available but classed as invalid junior synonym of *Orbitolina* D'ORBIGNY, 1850); among family-group taxa, Aequilateralidae D'ORBIGNY, 1846 (lacking type-genus), Hélicostègues D'ORBIGNY, 1826 (vernacular not latinized by later authors, Art. 11e(iii)), Poteriocrinidae AUSTIN & AUSTIN, 1843, =family Poteriocrinoidea AUSTIN & AUSTIN, 1842 (neither 1843 or 1842 names complying with Art. 11e, which states that "a family-group name must, when first published, be based on the name then valid for a contained genus," such valid name in the case of this family being *Poteriocrinites* MILLER, 1821).

10) "Denied names" include all those that are defined by the *Code* (Art. 32c) as incorrect original spellings. Examples are: specific names, *nova-zelandica, mülleri, 10-brachiatus*; generic names, *M'Coyia, Størmerella, Römerina, Westergårdia*; family name, Růžičkinidae. Uncorrected "imperfect names" are "denied names" and unavailable, whereas corrected "imperfect names" are available.

11) *"Impermissible names"* include all those employed for alleged genus-group taxa other than genus and subgenus (Art. 42a) (e.g., supraspecific divisions of subgenera), and all those published after 1930 that are unaccompanied by definite fixation of a type species (Art. 13b). Examples of impermissible names are: *Martellispirifer* GATINAUD, 1949, and *Mirtellispirifer* GAUTINAUD, 1949, indicated respectively as a section and subsection of the subgenus *Cyrtospirifer; Fusarchaias* REICHEL, 1949, without definitely fixed type species (=*Fusarchaias* REICHEL, 1952, with *F. bermudezi* designated as type species).

12) *"Null names"* include all those that are defined by the *Code* (Art. 33b) as incorrect subsequent spellings, which are any changes of original spelling not demonstrably intentional. Such names are found in all ranks of taxa. It is not always evident from the original publication whether an incorrect subsequent spelling is intentional, resulting in a "vain name" which is invalid but available (category 4 above), or unintentional, resulting in a "null name" which is invalid and unavailable. In such cases,

the decision of a subsequent author will sometimes have to be arbitrary according to his best judgment.

13) *"Forgotten names"* are defined (Art. 23b) as senior synonyms that have remained unused in primary zoological literature for more than 50 years. Such names are not to be used unless so directed by ICZN.

Latin designations for the discussed groups of unavailable zoological names are as follows: 9) *nomina nuda* (sing., *nomen nudum*, abbr. *nom. nud.*), 10) *nomina negata (nomen negatum, nom. neg.)*, 11) *nomina vetita (nomen vetitum, nom. vet.)*, 12) *nomina nulla (nomen nullum, nom. null.)*, 13) *nomina oblita (nomen oblitum, nom. oblit.)*.

VALID AND INVALID NAMES

Important distinctions relate to valid and available names, on one hand, and to invalid and 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 name, generally the oldest. Obviously, no valid name can also be an unavailable name, but invalid names may include both available and unavailable names. Any name for a given taxon other than the valid name is an invalid name.

A sort of nomenclatorial no-man's-land is encountered in considering the status of some zoological names, such as *"doubtful names," "names under inquiry,"* and *"forgotten names."* Latin designations of these are *nomina dubia, nomina inquirenda,* and *nomina oblita,* respectively. Each of these groups may include both available and unavailable names, but the latter can well be ignored. Names considered to possess availability conduce to uncertainty and instability, which ordinarily can be removed only by appealed action of ICZN. Because few zoologists care to bother in seeking such remedy, the "wastebasket" names persist.

SUMMARY OF NAME GROUPS

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

Definitions of Name Groups

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

nomen correctum (nom. correct.). Name with intentionally altered spelling of sort required or allowable by the *Code* but not dependent on transfer from one taxonomic rank to another ("improved name"). (See *Code,* Arts. 26b, 27, 29, 30a(i)(3), 31, 32c(i), 33a; in addition, change of endings for suprafamilial taxa not regulated by the *Code.*)

nomen imperfectum (nom. imperf.). Name that as originally published meets all mandatory requirements of the *Code* but contains defect needing correction ("imperfect name"). (See *Code,* Arts. 26b, 27, 29, 32c, 33a.)

nomen inviolatum (nom. inviol.). Name that as originally published meets all mandatory requirements of the *Code* and also is not correctable or alterable in any way ("inviolate name").

nomen negatum (nom. neg.). Name that as originally published constitutes invalid original spelling, and although possibly meeting all other mandatory requirements of the *Code,* cannot be used and has no separate status in nomenclature ("denied name"). It is to be corrected wherever found.

nomen nudum (nom. nud.). Name that as originally published fails to meet mandatory requirements of the *Code* and, having no status in nomenclature, is not correctable to establish original authorship and date ("naked name").

nomen nullum (nom. null.). Name consisting of an unintentional alteration in form (spelling) of a previously published name (either available name, as *nom. inviol., nom. perf., nom. imperf., nom. transl.*; or unavailable name, as *nom. neg., nom. nud., nom. van.,* or another *nom. null.*) ("null name").

nomen oblitum (nom. oblit.). Name of senior synonym unused in primary zoological literature in more than 50 years, not to be used unless so directed by ICZN ("forgotten name").

nomen perfectum (nom. perf.). Name that as originally published meets all mandatory requirements of the *Code* and needs no correction of any kind but which nevertheless is validly alterable by change of ending ("perfect name").

nomen substitutum (nom. subst.). Replacement name published as substitute for an invalid name, such as 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 rank to another within the group to which it belongs ("transferred name").

nomen vanum (nom. van.)[1]. Name consisting of an invalid intentional change in form (spelling) from a previously published name, such invalid emendation having status in nomenclature as a junior objective synonym ("vain name").

nomen vetitum (nom. vet.). Name of genus-group taxon not authorized by the *Code* or, if first published after 1930, without definitely fixed type species ("impermissible name").

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, senior synonyms classifiable as *nomina negata* or *nomina nuda,* and numerous junior synonyms which include both objective *(nomina vana)* and subjective types; rejected names are classified as completely as possible.

NAME CHANGES IN RELATION TO TAXA GROUPS

Species-group 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. correct.* Likewise, transliteration of a letter accompanied by a diacritical mark in manner now called for by the *Code* (as in changing originally published *bröggeri* to *broeggeri*) or elimination of a hyphen (as in changing originally published *cornu-oryx* to *cornuoryx*) does not require "*nom. correct.*" with it.

Genus-group 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 now are not, 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.

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

Paleomeandron Peruzzi, 1881, p. 8 [**P. elegans*; SD Häntzschel, 1975, p. *W*91] [=*Palaeomeandron* Fuchs, 1885, p. 395, *nom. van.*].

Stichophyma Pomel, 1872 [**Manon turbinatum* Römer, 1841; SD Rauff, 1893] [=*Stychophyma* Vosmaer, 1885, *nom null.; Sticophyma* Moret, 1924, *nom. null.*].

Vacuocyathus Okulitch, 1950, p. 392 [**Coelocyathus kidrjassovensis* Vologdin, 1937, p. 478, *nom. nud.*; 1939, p. 237; OD] [=*Coelocyathus* Vologdin, 1934, p. 502, *nom. nud.*; 1937, p. 472, *nom. nud.*].

Cyrtograptus Carruthers, 1867, p. 540, *nom. correct.* Lapworth, 1873, *pro Crytograpsus* Carruthers, 1867, ICZN Op. 650, 1963 [**Cyrtograpsus murchisoni*; OD].

As has been pointed out above, it is in

[1] Chorn & Whetstone (J. Paleontol., v. 52, p. 494, 1978) have called attention to the fact that the term *nomen vanum* was first proposed by Simpson (Bull. Am. Mus. Nat. Hist., v. 85, Oct., 1945, p. 27, 30) for taxa properly proposed but "which cannot be properly defined either on the basis of the original diagnosis or from the available specimens" (Simpson, *ibid.,* v. 91, July, 1948, p. 31). It appears, however, that at the time of Simpson's writings the term *nomen dubium* was already in use for the kind of name Simpson had in mind (R. Richter, *Einführung in die zoologische Nomenklatur durch Erläuterung der Internationalen Regeln,* Senckenb. Naturforsch. Ges., Frankfurt/Main, 1943, p. 102; H. M. Smith, Science, v. 102, no. 2648, Aug., 1945, p. 186). As early as 1913. the International Commission on Zoological Nomenclature had referred to a genus based on unrecognizable specimens as *genus dubium* (ICZN, Op. 54). The term *nomen dubium* was later used by authors from Schenk & McMasters (*Procedure in Taxonomy,* 2nd ed., Stanford University Press, Stanford, 1948, p. 9) to Lehmann (*Paläontologisches Wörterbuch,* Ferd. Enke, Stuttgart, 1964, p. 196). We, therefore, regard *nomen vanum sensu* Simpson (1945) as a synonym of *nomen dubium* of authors. The term *nomen vanum* for intentional, unjustified emendations of names was first defined by Moore (Editorial Preface, *Treatise,* Part E, June, 1955, p. xi) and this use was continued in all later *Treatise* volumes. It is here maintained.

many cases difficult to decide whether a change in spelling of a name by a subsequent author was intentional or unintentional, that is, whether it should be classified as *nomen vanum* or *nomen nullum,* and the decision will often have to be arbitrary.

Family-group Names; Use of "nom. transl."

The *Code* specifies the endings only for subfamily (-inae) and family (-idae) but all family-group taxa are defined as coordinate, signifying that for purposes of priority a name published for a taxon in any category and based on a particular type genus shall date from its original publication for a taxon in any category, retaining this priority (and authorship) when the taxon 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 alteration 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 alteration. 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 *Code,* 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 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.* VERRILL, 1864, *ex* Stylinidae D'ORBIGNY, 1851]

Superfamily ARCHAEOCTONOIDEA Petrunkevitch, 1949

[*nom. transl.* PETRUNKEVITCH, 1955, *ex* Archaeoctonidae PETRUNKEVITCH, 1949]

Superfamily ANCYLOCERATACEAE Meek, 1876

[*nom. transl.* WRIGHT, 1957, *ex* Ancyloceratidae MEEK, 1876]

Family-group Names: Use of "nom. correct."

Valid name changes 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 modifications of endings for names of tribes or superfamilies. Examples of the use of *"nom. correct."* are the following.

Family STREPTELASMATIDAE Nicholson, 1889

[*nom. correct.* WEDEKIND, 1927, *pro* Streptelasmidae NICHOLSON, 1889]

Family PALAEOSCORPIIDAE Lehmann, 1944

[*nom correct.* PETRUNKEVITCH, 1955, *pro* Palaeoscorpionidae LEHMANN, 1944]

Family AGLASPIDIDAE Miller, 1877

[*nom. correct.* STØRMER, 1959, *pro* Aglaspidae MILLER, 1877]

Superfamily AGARICIICAE Gray, 1847

[*nom. correct.* WELLS, 1956 (*pro* Agaricioidae VAUGHAN & WELLS, 1943, *nom. transl.* WELLS, 1956, *ex* Agaricidae GRAY, 1847)]

Family-group Names: Replacements

Family-group names are formed by adding letter combinations (prescribed for family and subfamily) to the stem of the name belonging to the genus (nominate genus) first chosen as type of the assemblage. The type genus need not be the oldest in terms of receiving its name and definition, but it must be the first-published as name-giver to a family-group taxon among all those included. Once fixed, the family-group name remains tied to the nominate genus even if its 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 in the event that the nominate genus is found to have been invalid when it was proposed (Arts.

11e, 39), and then a substitute family-group name is accepted if it is formed from the oldest available substitute name for the nominate genus. Authorship and date attributed to the replacement family-group name are determined by first publication of the changed family-group name, but for purposes of the Law of Priority, they take the date of the replaced name. Numerous long-used family-group names are incorrect in being *nomina nuda,* since they fail to satisfy criteria of availability (Art. 11e). These also demand replacement by valid names.

The aim of family-group nomenclature is greatest possible stability and uniformity, just as in other zoological names. Experience indicates the wisdom of sustaining family-group names based on junior subjective synonyms if they have priority of publication, for opinions of different workers as to the synonymy of generic names founded on different type species may not agree and opinions of the same worker may alter from time to time. The retention similarly of first-published family-group names which are found to be based on junior objective synonyms is less clearly desirable, especially if a replacement name derived from the senior objective synonym has been recognized very long and widely. To displace a much-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.

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 the 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 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 the *Treatise* it is desirable to record the authorship and date of the correction.

Suprafamilial Taxa

International rules of zoological nomenclature as given in the *Code* are limited to stipulations affecting lower-rank categories (subspecies to superfamily). Suprafamilial categories (suborder to phylum) are either unmentioned or explicitly placed outside of the application of zoological rules. The *Copenhagen Decisions on Zoological Nomenclature*[1] (1953, Arts. 59-69) proposed to adopt rules for naming suborders and higher taxonomic divisions up to and including phylum, with provision for designating a type genus for each, hopefully in such manner as not to interfere with the taxonomic freedom of workers. Procedures for applying the Law of Priority and Law of Homonymy to suprafamilial taxa were outlined and for dealing with the names for such units and their authorship, with assigned dates, when 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 XVth International Congress of Zoology convened in 1958

[1] Francis Hemming, ed., *Copenhagen Decisions on Zoological Nomenclature. Additions to, and modifications of, the Règles Internationales de la Nomenclature Zoologique,* xxix + 135 p. (International Trust for Zoological Nomenclature, London, 1953).

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 which 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, later-proposed class or order distinguished by different characters (e.g., hinge-teeth of bivalves). Even the fixing of type genera for suprafamilial taxa might have small value, if any, hindering taxonomic work rather than aiding it. At all events, no legal 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. At least a degree of uniform policy is thought to be 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 which 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, a) with a capital initial letter, b) without diacritical mark, apostrophe, diaeresis, or hyphen, and c) if a component consisting of a numeral, numerical adjective, or adverb is used, this must be written in full (e.g., Stethostomata, Trionychi, Septemchitonina, Scorpiones, Subselliflorae). No uniformity in choice of ending for taxa of a given rank is demanded (e.g., orders named Gorgon*acea,* Millepor*ina,* Rug*osa,* Scleractin*ia,* Stromatopor*oidea,* Phalang*ida*).

2) Names of suprafamilial taxa may be constructed in almost any way, a) intended to indicate morphological attributes (e.g., Lamellibranchiata, Cyclostomata, Toxoglossa), b) based on the stem of an included genus (e.g., Bellerophontina, Nautilida, Fungiina), or c) arbitrary combinations of letters (e.g., Yuania), but none of these can be allowed to end in -idae or -inae, 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 nomenclatural distinction between suprafamilial and family-group taxa which 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; superfamily Bellerophontacea M'Coy, 1851; family Bellerophontidae M'Coy, 1851). Family-group names and suprafamilial names are not coordinate.

3) The Laws of Priority and Homonymy lack any force of international agreement as applied to suprafamilial names, yet in the interest of nomenclatural stability and the avoidance of confusion these laws 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 change(s) cannot rationally be judged to alter the authorship and date of the taxon as published originally. a) A name revised from its previously published rank is a "transferred name" *(nom. transl.),* as illustrated in the following.

Order CORYNEXOCHIDA Kobayashi, 1935

[*nom. transl.* MOORE, 1959, *ex* suborder Corynexochida KOBAYASHI, 1935]

b) A name revised from its previously published form merely by adoption of a different termination, without changing taxonomic rank is an "altered name" *(nom. correct.)*. Examples follow.

Order DISPARIDA Moore & Laudon, 1943

[*nom. correct.* MOORE in MOORE, LALICKER, & FISCHER, 1952, *pro* order Disparata MOORE & LAUDON, 1943]

Suborder AGNOSTINA Salter, 1864

[*nom. correct.* HARRINGTON & LEANZA, 1957, *pro* suborder Agnostini SALTER, 1864]

c) A suprafamilial name revised from its previously published rank with accompanying change of termination (which may or may not be intended to signalize the change of rank) is recorded as *nom. transl. et correct.*

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 superordinate 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 *et al.*, 1964, p. *K*128 (*ex* superorder Endoceratoidea SHIMANSKIY & ZHURAVLEVA, 1961, *nom. transl.* TEICHERT in TEICHERT *et al.*, 1964, p. *K*128, *ex* order Endoceroidea TEICHERT, 1933)]

Order ENDOCERIDA Teichert, 1933

[*nom. correct.* TEICHERT in TEICHERT *et al.*, 1964, p. *K*165, *pro* order Endoceroidea TEICHERT, 1933]

Suborder ENDOCERINA Teichert, 1933

[*nom. correct.*, herein, *ex* Endoceratina SWEET, 1958, suborder]

TAXONOMIC EMENDATION

Emendation has two distinct meanings as regards zoological nomenclature. These are: 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. The *Code* (Art. 33a and Glossary p. 148) concerns itself with only the first type of emendation, applying the term to either justified or unjustified changes, both intentional, of the original spelling of a name. These categories are identified in the *Treatise* as *nomina correcta* and *nomina vana,* respectively. 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 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, many 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 worthwhile, 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.

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]

Subfamily ROVEACRININAE Peck, 1943

[Roveacrininae PECK, 1943, p. 465; *emend.* PECK in MOORE & TEICHERT, eds., 1978, p. *T*921]

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, 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 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 that 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. Examples of these two 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 SCHWEIGGER, 1819 [**A. baltica*; M; =**Madrepora ananas* LINNÉ, 1758].

In the *Treatise,* the name of the type species is always given in the exact form it had in the original publication; in cases where mandatory changes are required, these are introduced later in the text, mostly in a figure caption. Examples are:

Ceratostreon BAYLE, 1978, pl. 133-134 explanations [**Exogira spinosa* MATHERON, 1843, p. 192]. Misspelling of *Exogyra.*
Obinautilus KOBAYASHI, 1954 [**O. pulchra*]. Wrong gender for species name *(recte pulcher).*

It is desirable to record the manner of establishing the type species, whether by original designation or by subsequent designation.

Fixation of type species originally. 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 in specified ways subsequent to the original publication as stipulated by the *Code* (Art. 68) in order of precedence as 1) *original designation* (in the *Treatise* indicated as "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 type belonging to one of the three preceding categories.

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 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" and "SM" as employed in the *Treatise* follow.

Hexagonaria GÜRICH, 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 is action of the International Commission on 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.

It should be noted that *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*, Art. 13b). 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. This provision of the *Code* has not been consistently applied in all earlier *Treatise* volumes, but is rigidly adhered to in the present volume.

Type species of synonyms. In about 1969 a decision was made by the editors to include the names of type species of genera that were placed in subjective synonymy. Such species are simply identified as "type." An example is:

Trachycardium MORCH, 1853 [**Cardium isocardia* LINNÉ, 1758; SD VON MARTENS, 1870] [=*Kathocardia* TUCKER & WILSON, 1932 (type, *Cardium (K.) aclinense*, OD)].

Fixation of types of type species. The present Supplement to Part F introduces an important innovation in that documentation on the type specimen (or specimens) of type species is supplied, which has not been included in any previous *Treatise* volume. Citation of type species and indication of the manner of its designation is followed by a symbol (†) that precedes the museum designation, usually a number of the type specimen or specimens and the name and location of the repository. The status of the types is indicated next. When no information follows the repository citation, it is understood that a holotype was satisfactorily designated in the original publication (including designation by monotypy in species established on the basis of only one specimen). When syntypes only are available, this has been indicated. If no holotype was selected by the original author, subsequent choice of a lectotype, if any, is indicated by author and date, and where the original holotype has been lost, the same procedure is followed for the neotype if one has been selected. Holotype, paratypes and syntypes, lectotype, and neotype are the only categories of types recognized in this Supplement.

The procedure described and followed here does not establish a precedent to be followed necessarily in future *Treatise* parts and supplements.

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, 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-Holocene 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, *nom. subst. 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 generally 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, as shown in the following example.

Mysterium DE LAUBENFELS, herein, *nom. subst. pro Mystrium* SCHRAMMEN, 1936, p. 60, *non* ROGER, 1862 [**Mystrium porosum* SCHRAMMEN, 1936].

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

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 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 synonymous 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 synonymous homonyms are distinguished in the *Treatise* as in dealing with generic names.

A special, though rare, case of synonymy 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 R. & E. RICHTER, 1925, based on *Scutellum* PUSCH, 1833, a trilobite. This name is a junior synonym of Scutellidae GRAY, 1825, based on *Scutella* LAMARCK, 1816, an echinoid. The name of the trilobite family was later changed to Scutelluidae (ICZN, Op. 1004, 1974).

Synonyms

Citation of synonyms is given next following record of the type species and 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.

Modiomorpha HALL & WHITFIELD, 1869, p. 72 [**Pterinea concentrica* CONRAD, 1838; SD HALL, 1885] [=*Palanatina* HALL & WHITFIELD, 1870 (type, *P. typa,* OD)].

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

Graphiocrinus DE KONINCK & LE HON, 1854, p. 115 [**G. encrinoides*; M] [=*Scaphiocrinus* HALL, 1858b, p. 550 (type, *S. simplex,* OD)].

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.

STRATIGRAPHIC DIVISIONS

It has been customary in previous *Treatise* parts to conclude the Editorial Preface with a tabulation of condensed versions of the subdivisions of the geologic timetable as they are applied in stratigraphic practice in Europe and in North America. In this Supplement the Cambrian and all Mesozoic and Cenozoic systems may be ignored because no undoubted rugose and tabulate corals are known to occur in them (with the possible exception of some Chaetetida). The correlation of the subdivisions of each of the remaining systems (Ordovician, Silurian, Devonian, Carboniferous, and Permian) to which all undisputed Rugosa and Tabulata are restricted presents some problems, which are discussed below.

Ordovician System

The Ordovician System is subdivided rather differently in Europe and North America. The most essential units of the two schemes are as follows.

Europe	**North America**
	Upper Ordovician (Cincinnatian Series)
Ashgillian Series	Richmondian Stage
	Maysvillian Stage
Caradocian Series	Edenian Stage
	Middle Ordovician (Champlainian Series)
	Trentonian Stage
	Blackriverian Stage
Llandeilian Series	
	Chazyan Stage
Llanvirnian Series	Whiterockian Stage
Arenigian Series	Lower Ordovician (Canadian Series)
Tremadocian Series	

The European standard is based on stratotypes in Great Britain (Williams *et al.,* 1972). There, it is not customary to divide the Ordovician into lower and upper, or lower, middle, and upper series as is the practice with other systems. If a Lower and Upper Ordovician Series are recognized at all, the boundary is placed at the base of the Zone of *Nemagraptus gracilis,* which lies within the Llandeilian in Britain and corresponds to the Kukruse Stage of the Viruan Series in Estonia. In North America, the base of the *Nemagraptus gracilis* Zone lies at the top of the Chazyan. In Estonia, the Viruan Series is often classified as Middle Ordovician (Jaanusson, 1976). If recognized at all in Europe, Middle Ordovician includes the equivalents of the Llandeilian and Llanvirnian of English usage.

In Britain, the Tremadocian Series is traditionally included in the Cambrian System (Cowie *et al.,* 1972), but this practice does not affect its correlation with the lower part of the Canadian Series in North America.

Outside Europe, other than in North America, the British subdivisions are in general use, although locally, e.g. in southeastern Australia, a special stage nomenclature has been developed (see *Treatise,* Part V, revised edition, p. *V*102).

Silurian System

The internationally recognized major subdivisions of the Silurian System are as follows, listed from oldest to youngest: Llandoverian Series, Wenlockian Series, Ludlovian Series, Pridolian Series.

Until recently, a threefold division of the Silurian was recognized in North America, based on the stratigraphic sequence known in New York State: Alexandrian (or Medinan) Series, Niagaran Series, Cayugan Series.

Berry and Boucot (1970) advocated restriction of this terminology to its type area, New York State, and adoption, in North America, of the international type sequence as known and used in the British Isles, Scandinavia, and Czechoslovakia. The name Niagaran is still widely used in North America and is frequently cited in this *Treatise* Supplement. In general, this age designation is more or less synonymous with Wenlockian, but, if applied to western North America, may include somewhat older or younger Silurian rocks.

The name Downtonian was formerly widely used for the uppermost series (or stage) of the Silurian in Europe, but is now restricted to the nonmarine beds of that age in the area of the so-called Old Red continent.

Devonian System

The internationally recognized major subdivisions of the Devonian System are as follows, oldest to youngest. Lower Devonian Series: Gedinnian Stage, Siegenian Stage, Emsian Stage; Middle Devonian Series: Couvinian Stage, Givetian Stage; Upper Devonian Series: Frasnian Stage, Famennian Stage.

In previous *Treatise* parts, the stratigraphic nomenclature applied to the Devonian sequence in New York State was given for North America, with the restriction that in western North America the "European" stage terminology is used (see *Treatise,* Part A, p. xxiii). New York State nomenclature is not used in this Supplement.

In earlier European literature, the name Coblentzian (or Coblenzian) was widely used, first for all of the Lower Devonian above the Gedinnian, later restricted to what is now known as Emsian. "Coblentzian," as quoted from older literature in this Supplement, is probably mostly synonymous with Emsian, but may include equivalents of the Siegenian (RICHTER, 1954; ZIEGLER, 1979).

The term Eifelian which occurs frequently in this supplement is, in most cases, probably synonymous with Couvinian, but may, in some authors, refer to the upper Couvinian only, and, in others, include part of the upper Emsian (Assise de Bure) (see R. & E. RICHTER, 1950; LECOMPTE, 1955, 1968; ZIEGLER, 1979).

In Czechoslovakia, the following subdivisions of the Lower Devonian Series are accepted: Lochkovian Stage, Pragian Stage, Zlichovian Stage. These three stages are roughly, though not exactly, equivalent to the three stages of the standard sequence.

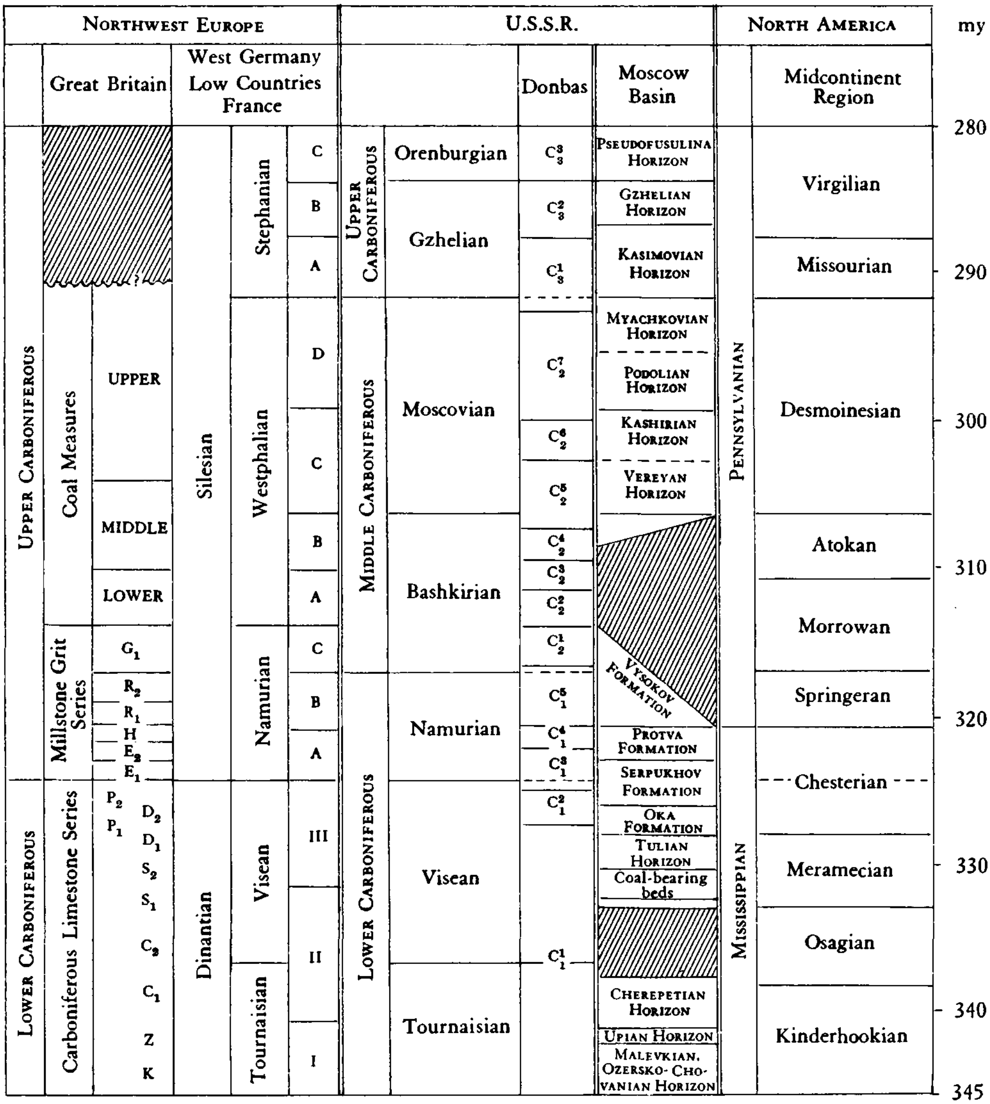
Carboniferous System

Traditionally, since the late nineteenth century, the Carboniferous System has been divided into two parts, called Lower Carboniferous Series and Upper Carboniferous Series. The first of these was divided into the Tournaisian and Visean stages, the second into Namurian, Westphalian, and Stephanian. In eastern Europe, however, a threefold division of the Carboniferous into Lower, Middle, and Upper Carboniferous has been in vogue at least since the earliest part of this century. In the United States, the rocks of the corresponding time interval have long been subdivided into two systems, called Mississippian and Pennsylvanian, and the term Carboniferous is not used at all. Generally, in these volumes the terms Mississippian and Pennsylvanian and the names for their subdivisions are used to denote the ages of occurrences in the United States only. The term Carboniferous and the names for its subdivisions are employed for occurrences in most of the rest of the world. In Canada, both stratigraphic scales are in use (see DOUGLAS, 1979).

Each series (or system) in these stratigraphic schemes has been subdivided into stages (or series), but it is not possible to construct a correlation table for these subdivisions that would do justice to all opinions expressed by many authors. The correlations presented in the chart are a compromise at best and some explanatory notes are offered below.

The Etroeungt beds of Belgium, constituting the "Strunian Stage," are a facies of Oberdevonstufe VI (*Wocklumeria*-Stufe) of West Germany. This is placed as the topmost Famennian by German authors (see ERBEN & ZAGORA, 1967) and as lowermost Tournaisian (or as the lowest Carboniferous stage below the Tournaisian) by English, Belgian, and Soviet authors (see GEORGE *et al.,* 1976; STEPANOV, 1964). It is not considered by us to be a chronostratigraphic unit of international validity.

The Namurian presents a problem in that it has been variously assigned to the Lower, Middle, or Upper Carboniferous. In western Europe (including Britain), the Namurian is regarded as the lowermost stage of the Upper Carboniferous, but its upper part (Namurian C) is correlated with the lower Bashkirian of the U.S.S.R., which is there classified as Middle Carboniferous. In earlier Soviet literature, the Namurian was generally classified in its entirety as uppermost Lower Carboniferous, overlain by the Middle Carboniferous Bashkirian Stage (STEPANOV *et al.,* 1962). Subsequently, the Namurian was divided between the Lower and Middle Carboniferous (STEPANOV, 1964) or placed



Correlation chart for the Carboniferous System in western Europe, the Soviet Union, and North America (greatly modified from Francis & Woodland, 1964, Table 1). Units identified as "horizon" and "formation" in the column for the Moscow Basin are best regarded as equivalent to stages or substages in western European usage; the orthography of their names is that used by Nalivkin (1973). The subdivisions of the Mississippian and Pennsylvanian of North America are treated as series by most authors, but as stages by some. Subdivisions of stages (or series) into lettered units are still widely used in Europe and the Soviet Union.

entirely in the Middle Carboniferous (see Nalivkin, 1973, who called this the "correct solution," although retaining the Namurian in the Lower Carboniferous in his Table 8).

In the stratigraphic charts of this supplement the twofold division of the Carboniferous System is maintained and the Namurian is placed as the lowest subdivision of the Upper Carboniferous. In the systematic descriptions the age of the Namurian is, in many cases, indicated to be Early Carboniferous, in accordance with the practice of the authors from which the information was copied.

Permian System

A great many names have been proposed for divisions of stage and substage rank of the Permian System in various parts of the world (see WATERHOUSE, 1976).

The stratotype of the system is in the eastern part of the Russian Platform and the western slopes of the Ural Mountains. The classical sequence for this area (STEPANOV, 1973) is below juxtaposed with the standard divisions of the Permian in the western United States.

U.S.S.R.	U.S.A.
Upper Permian Series	Upper Permian Series
Tatarian Stage	Ochoan Stage
Kazanian Stage	Guadalupian Stage
Ufimian Stage	
Lower Permian Series	Lower Permian Series
Kungurian Stage	
Artinskian Stage	Leonardian Stage
Sakmarian Stage	Wolfcampian Stage
Asselian Stage	

A drawback of these classical schemes is that both in the United States and in the Soviet Union, the latest Permian is a time of regression of the sea and formation of evaporite deposits. In the Tethys area, more or less complete sections of marine deposits are known in Soviet Armenia, northwestern Iran, and southern China. A composite stage scheme for the Upper Permian Series of the Tethys is this, oldest to youngest: Guadalupian Stage, Dzhulfian Stage, Changxingian Stage.

A near equivalent of the Changxingian Stage, whose stratotype is in southern China, is the Dorashamian Stage with the stratotype in the Nakhichevan ASSR of the southern Soviet Union (Tozer, 1979).

Other important sequences are found in central Asia, specifically the Pamir, where the following stage nomenclature is in use (NALIVKIN, 1973). Lower Permian Series: Karachatyrian Stage, Darvazian Stage; Upper Permian Series: Murgabian Stage, Pamirian Stage. This nomenclature has also been applied to parts of the section in northwestern Iran.

Additional, more elaborate stratigraphic subdivisions have been proposed for Japan and New Zealand, but are not used in this Supplement.

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CURT TEICHERT

MUSEUM AND REPOSITORY ABBREVIATIONS

Letter symbols and locations for depositories holding type material, which are used throughout the systematic sections of the text, are listed and defined below.

AGS, Peking [Beijing]: Institute of Geology, Academy of Geological Sciences

AM, Sydney: Australian Museum

AMNH, New York: American Museum of Natural History

Anglo-Iranian Oil Co.: location of specimens not traced

ANU, Canberra: Department of Geology, Australian National University

AU, Aberdeen: Aberdeen University

BA, Clausthal-Zellerfeld: Technische Universität Clausthal

BM(NH), London: British Museum (Natural History)

BPI, Vladivostok: Biologo-pochvenniy institut

CU, Peking: Chinghua [Tsinghua] University; the undergraduate section of the Geology Department now moved to Wuhan but the postgraduate section remains in Beijing (Peking)

DI, Kilmarnock: Dick Institute

DPI, Donetsk: Donetskiy polytekhnicheskiy institut

DPO, Oviedo: Departamento de Paleontologia, Universidad de Oviedo

EGM, Tallinn: Eesti NSV Teaduste Akadeemia, Geoloogia Instituudi

EM, Paris: École nationale supérieure des Mines; collection deposited in 1980 in Département des Sciences de la Terre, Université Claude Bernard, Lyons

FM, Chicago: Field Museum; houses also the Walker Museum collections

GB, Guiyang [Kweiyang]: Geological Bureau of Guizhou [Kweichow] Province, Huishi County, No. 108 Geological Team

GB, Nanjing [Nanking]: Geological Bureau, Jiangsu [Kiangsu] Province

GB, Nanning: Geological Bureau of Guangxi [Kwangsi] Province

GC, Changchun: Geological College, Jilin [Kilin] Province

GFC, Lille: Géologie-Faculté Catholique de Lille

GGI, Ufa: Gorno-geologicheskiy institut Akademii nauk SSSR

GI, Prague: Geological Institute of the Czechoslovakian Academy of Sciences

GPI, Münster/Westfalen: Geologisch-Paläontologisches Institut der Westfälischen Wilhelms-Universität Münster

GPI, Tübingen: Geologisch-Paläontologisches Institut und Museum, Eberhard-Karls-Universität

GSC, Ottawa: Geological Survey of Canada, National Type Collection

GSGI, Peking: Graduate School of the Geological Institute (H. C. Wang's specimens of 1950)

GSI, Calcutta: Geological Survey of India, Type Collection

GSM, London: Institute of Geological Sciences, London; Carboniferous corals housed at IGS, Leeds

GSM, Sydney: New South Wales Geological Survey Museum

GSQ, Brisbane: Geological Survey of Queensland

GSV, Melbourne: Geological Survey of Victoria; as of 1978, collections transferred to NM, Melbourne

HM, Glasgow: Hunterian Museum, University of Glasgow

HPRIGS, Yichang: Hubei [Hupei] Provincial Research Institute of Geological Sciences

HU, East Berlin: Haupt-Sammlung, Paläontologische Abteilung des Naturkunde-Museums der Humboldt-Universität

IAGG, Osaka: Osaka University of Liberal Arts and Education

IG, Alma-Ata: Institut geologicheskikh nauk, Akademiya nauk Kazakh. SSR
IG, Dushanbe: Institut geologii, Akademiya nauk Tadzhik. SSR
IG, Kielce: Instytut Geologiczny [Holy Cross Branch of Geological Institute, IG, Warsaw]
IG, Kiev: Institut geologicheskikh nauk, Akademiya nauk Ukrain. SSR
IG, Louvain: Institut géologique, Université de Louvain
IG, Rennes: Institut de Géologie
IG, Syktyvkar: Institut geologii Komi filiala Akademii nauk SSSR
IG, Ufa: Institut geologii Baskhir. filiala Akademii nauk SSSR
IG, Warsaw: Institut Geologiczny
IG, Yakutsk: Institut geologii Yakutskogo filiala Sibirskogo otdeleniya Akademii nauk SSSR
IGEd, Tokyo: Institute of Geology, Tokyo University of Education
IGG, Novosibirsk: Monograficheskii otdel muzeya instituta geologii i geofiziki Sibirskogo otdeleniya Akademii nauk SSSR
IGMR, Chengdu: Institute of Geology and Mineral Resources
IGMR, Shenyang [Mukden]: Research Institute of Geological and Mineralogical Resources, Liaoning Province [South Manchuria]
IGMR, Sian [Xian]: Institute of Geology and Mineral Resources, Shensi [Shaanxi] Province
IGP, Nanking [Nanjing]: Nanjing Institute of Geology and Palaeontology, Academia Sinica
IGS, Leeds: Institute of Geological Sciences
IP, Bonn: Institut für Paläontologie, Rheinische Friedrich-Wilhelms-Universität
IRSN, Brussels: Institut royal des Sciences naturelles de Belgique
ISGS, Urbana: Illinois State Geological Survey and Museum
KM, Glasgow: Kelvingrove Museum
KU, Kanazawa: Kanazawa University
KUMIP, Lawrence: Kansas University Museum of Invertebrate Paleontology
LG, Caen: Laboratoire de Géologie, Faculté des Sciences, Université de Caen
LGI, Leningrad: Gornyy muzey Leningradskogo gornogo instituta
LGU, Leningrad: Monograficheskii otdel muzeya Kafedra istoricheskoy geologii Leningradskogo gosudarstvennogo universiteta
LP, Brest: Laboratoire de Paléontologie, Faculté de Sciences, Université de Bretagne occidentale
MCZ, Cambridge: Museum of Comparative Zoology, Harvard University
MG, Hanoi: Musée géologique de Hanoi
MGU, Moscow: Muzey Kafedra istoricheskoy i regionalnoy geologii Moscovskogo gosudarstvennego universiteta
MGU, Tashkent: Muzey Ministerstva geologii Uzbek. SSR
MM, Copenhagen: Universitetets Mineralogisk Museum, Mineralogisk-Geologiske Instituter
MMM, Kimberley: Alexander McGregor Memorial Museum
MN, Paris: Institut de Paléontologie, Muséum national d'Histoire naturelle
MPUC, Berkeley: Museum of Paleontology, University of California at Berkeley
MSG, Saigon: Musée du Service géologique
MTA, Ankara: Maden Tetkik ve Arama Enstitüsi [Mineral Research and Exploration Institute]
MU, Melbourne: University of Melbourne Geology Museum
NM, Basel: Naturhistorisches Museum
NM, Dublin: National Museum of Ireland
NM, Melbourne: National Museum of Victoria
NM, Prague: Narodní Museum
NMBM, Socorro: New Mexico Bureau of Mines and Mineral Resources
NNII, Ufa: Ufimskiy neftyanoy nauchno-issled. institut
NYSM, Albany: New York State Museum, Type Collections
NZGS, Auckland: New Zealand Geological Survey
OSU, Columbus: Ohio State University
OU, Norman: University of Oklahoma
PAU, Liège: Laboratoire de Paléontologie animale, Université de Liège
PIN, Moscow: Paleontoligicheskiy institut, Akademiya nauk SSSR
PIU, Modena: Istituto di Paleontologia, Università di Modena
PM, Oslo: Paleontologisk Museum, Universitet i Oslo
PM, Uppsala: Museum of the Paleontological Institute, University of Uppsala
PRI, Ithaca: Paleontological Research Institution
PU, Princeton: Princeton University
PZI, Poznan: Poznan Branch, Palaezoological Institute of the Polish Academy of Sciences
PZI, Warsaw: Palaeozoological Institute of the Polish Academy of Sciences
RGM, Leiden: Rijksmuseum van Geologie en Mineralogie
RM, Stockholm: Paleozoologiska sectionen, Naturhistoriska Riksmuseet
ROM, Toronto: Royal Ontario Museum
RSM, Edinburgh: Royal Scottish Museum
SGI, Sverdlovsk: Sverdlovskiy gornyy institut
SGM, Rabat: Service géologique du Maroc
SM, Cambridge: Sedgwick Museum, University of Cambridge
SM, Frankfurt: Natur-Museum Senckenberg, Frankfurt-am-Main
SNIIGGIMS, Novosibirsk: Muzey Sibirskogo nauchno-issledovatelskogo instituta geologii, geofiziki i mineralnogo syrya
SU, Sydney: Department of Geology, University of Sydney
SVTGUp, Magadan: Severo-vostocknoe geol. upravlenie

TC, Dublin: Department of Geology, Trinity College

TH, Delft: Mineralogisch-Geologisch Museum, Technische Hoogeschool

TohU, Sendai: Institute of Geology and Paleontology, Tohoku University

TGU, Tomsk: Paleontòlogicheskiy musey Tomskogo gosudarstvennogo universiteta

TsGM, Leningrad: Tsentralnyy nauchno-issledovatelskiy geologorazvedochnyy musey

UA, Edmonton: University of Alberta

UCGM, Cincinnati: Geological Museum, University of Cincinnati

UG, Graz: Abteilung für Paläontologie und Historische Geologie der Universität Graz

UGUp, Sverdlovsk: Uralskoe geologicheskoe upravlenie

UH, Sapporo: Department of Geology and Mineralogy, Hokkaido University

UI, Iowa City: The University of Iowa

UIl, Urbana: University of Illinois Paleontology Collection

UMMP, Ann Arbor: University of Michigan Museum of Paleontology

UNE, Armidale: Department of Geology of the University of New England, New South Wales

UNSM, Lincoln: University of Nebraska State Museum

UpG, Dushanbe: Upravlenie geologii i okhrany nedr pri Sovete Ministrov Tadzhik. SSR

UpG, Frunze: Upravlenie geologii Kirgiz. SSR

UQ, Brisbane: Department of Geology, University of Queensland

US, Stockholm: University of Stockholm

USC, Los Angeles: University of Southern California

USNM, Washington: United States National Museum

UT, Tokyo: Institute of Geology, Tokyo University

UTBEG, Austin: University of Texas, Bureau of Economic Geology

UUG, Prague: Ústředni Ústav Geologický

UW, Madison: University of Wisconsin

UWA, Perth: Department of Geology, University of Western Australia

VNIGNI, Moscow: Vsesoyuznyy institut nauchno-issledovatelskyy geologorazvedochnyy neftyanoy institut

VNIGRI, Leningrad: Musey, Vsesoyuznyy neftyanoy nauchno-issledovatskiy geologorazvedochnoy institut

VU, Auckland: Department of Geology, Victoria University

WM, Chicago: Walker Museum of Paleontology, University of Chicago; see also FM, Chicago

YM, York: York Museum

YPM, New Haven: Peabody Museum, Yale University

ZGI, East Berlin: Zentrales Geologisches Institut

ZSGUp, Novokuznetsk: Zapadno-Sibirskoe geologicheskoe upravlenie

ABBREVIATIONS

Abbreviations used in this division of the *Treatise* are explained in the following alphabetically arranged list. Standard abbreviations or those found only in the references are not included.

Afghan., Afghanistan
Afr., Africa
Akkan., Akkanian
Alg., Algeria
Algonk., Algonkian
Alleghen., Alleghenian
Anasu., Anasuian
approx., approximately
Arch., Archipelago
Ariz., Arizona
Ark., Arkansas
Armen. SSR., Armenian Soviet Socialist Republic
Artinsk., Artinskian
Ashgill., Ashgillian
Asia M., Asia Minor
auct., *auctorum* (of authors)
Aus., Austria
Aynasu., Aynasuan

Baluch., Baluchistan
Bashkir., Bashkirian
Bathon., Bathonian
B.C., British Columbia
Belg., Belgium
Bend., Bendian
Blackriv., Blackriveran
Boh., Bohemia
Borshchov., Borshchovian
Brit. I., British Isles
Bur., Bureau

C., Central
Cal., California
C. Am., Central America
Cam., Cambrian
Camb., Cambodia
Can., Canada
Caradoc., Caradocian
Carb., Carboniferous
Carn., Carnian
Cenoman., Cenomanian
Chazy., Chazyan
Chester., Chesterian
Chihs., Chihsian
Co., co., County
Coblenz., Coblenzian
coll., collection
Colo., Colorado
comb., combination
commun., communication
congl., conglomerate
cosmop., cosmopolitan
Couvin., Couvinian
Cr., Creek
Cret., Cretaceous
Czech., Czechoslovakia

Dalyan., Dalyanian
Dev., Devonian
diagr., diagram
diagram., diagrammatic
diam., diameter
Dinant., Dinantian
distr., district
Dol., Dolomite
Dolbor., Dolborian
Donbas, Donets Basin
Downton., Downtonian

Dzhung., Dzhungaria
Dzhungar., Dzhungarian

E., East
Easton., Eastonian
Eifel., Eifelian
emend., *emendatus(-a)*, emendation; see editorial preface
Ems., Emsian
Eng., England
enl., enlarged
Eoc., Eocene
err., *errore* (by error)
Est., Estonia
Etroeungt., Etroeungtian
Eu., Europe
ext., exterior

F., Formation
Famenn., Famennian
Fengnin., Fengninian
Fla., Florida
fn., footnote
Frasn., Frasnian

G. Brit., Great Britain
Gedinn., Gedinnian
Geol., Geology, Geological, etc.
Ger., Germany
Girvan., Girvanian
Gisborn., Gisbornian
Givet., Givetian
Gotl., Gotland
Gr., Group
Greben., Grebenian
Greenl., Greenland
Gshel., Gshelian
Guat., Guatemala

Helderberg., Helderbergian
Holo., Holocene
Hung., Hungary

I., Island, Isle
ICZN, International Commission on Zoological Nomenclature
Ida., Idaho
Ill., Illinois
Ind., Indiana
Indoch., Indochina
Ire., Ireland

Jur., Jurassic

Kans., Kansas
Karachatyr., Karachatyrian
Kazakh., Kazakhstan
Kazan., Kazanian
Kinderhook., Kinderhookian
Kirg., Kirgiz Steppes
Kunzhak., Kunzhakian

Ky., Kentucky

L., Lower, Lake
lat., lateral
Leonard., Leonardian
Lias., Liassic
Lith., Lithuania
Llandov., Llandoverian
loc., locality
Lochkov., Lochkovian
long., longitudinal
low., lower
Ls., Limestone
Ludlov., Ludlovian
Lutet., Lutetian

M., Middle
M, monotypy
Manit., Manitoba
Maping., Mapingian
Mauret., Mauretania
Mbr., Member
Md., Maryland
Me., Maine
Meramec., Meramecian
Mex., Mexico
Mich., Michigan
mid., middle
Minn., Minnesota
Miss., Mississippi, Mississippian
Missour., Missourian
Mo., Missouri
Mont., Montana
Moroc., Morocco
Morrow., Morrowan
Moscov., Moscovian
MS, manuscript
Mt(s)., Mount(s), Mountain(s)
Murgab., Murgabian
Myachkov., Myachkovian

n, new
N., North
Nadaynasu., Nadaynasuian
Nakichev., Nakhichevan ASSR
N. Am., North America
Namur., Namurian
Neb., Nebraska
Nev., Nevada
Newf., Newfoundland
New S. Wales, New South Wales
Niag., Niagaran
N. Mex., New Mexico
nom. correct., *nomen correctum* (corrected or intentionally altered name)
nom. inval., invalid name
nom. nov., *nomen novum* (new name)
nom. nud., *nomen nudum* (naked name)

nom. null., nomen nullum (null, void name)
nom. subst., *nomen substitutum* (substitute name)
nom. transl., *nomen translatum* (transferred name)
nom. van., *nomen vanum* (vain, void name)
Nor., Norway
NW., Northwest
NW. Territ., Northwest Territories
N.Y., New York
N.Z., New Zealand
N. Zemlya, Novaya Zemlya

obj., objective [synonym]
OD, original designation
Okla., Oklahoma
Onesquethaw., Onesquethawian
Onondag., Onondagan
Ont., Ontario
Op., Opinion
Ord., Ordovician
Ore., Oregon
Osag., Osagian
Oxford., Oxfordian

Pak., Pakistan
Penn., Pennsylvania, Pennsylvanian
Perm., Permian
Pleist., Pleistocene
Pol., Poland
Porkun., Porkunian
Port., Portugal
Portland., Portlandian
Prag., Pragian
Precam., Precambrian
Pref., Prefecture
Pridol., Pridolian
Prov., Province
pt., part
Pt., Point

Queensl., Queensland

R., River
Ra., Range
rec., recent
reg., region
Richmond., Richmondian
Russ. Platf., Russian Platform

S., South
Sakmar., Sakmarian
S. Am., South America
Scot., Scotland
SD, subsequent designation
SE., Southeast
sec., section

ser., serial
Serpukhov., Serpukhovian
Sev. Zemlya, Severnaya Zemlya
sh., shale
Sib., Siberia
Sib. Platf., Siberian Platform
Siegen., Siegenian
Sil., Silurian
Skal., Skalian
Spits., Spitsbergen
ss., sandstone
s.s., *sensu stricto* (in the strict sense)
SW., Southwest
Swed., Sweden
syn., synonym

Tadzhik., Tadzhikstan
tang., tangential
Tasm., Tasmania
Tatar., Tatarian
Tenn., Tennessee
Terr., Territory
Tithon., Tithonian
Tournais., Tournaisian
Transcauc., Transcaucasian region
transl., translation
transv., transverse

U., Upper
U.K., United Kingdom
up., upper
USA, United States of America
USSR, Union of Soviet Socialist Republics
Uzbek., Uzbekistan

Va., Virginia
var., variety
Vasalemm., Vasalemmian
Venez., Venezuela
Vestspits., Vestspitsbergen
Vict., Victoria
Virgil., Virgilian
Vormsi., Vormsian

W., West
Wash., Washington
Weining., Weiningian
Wenlock., Wenlockian
Westphal., Westphaliam
Wis., Wisconsin
Wolfcamp., Wolfcampian
Wyo., Wyoming

Yugo., Yugoslavia

Z., zone
Zlich., Zlichovian

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Each part of the *Treatise* is accompanied by a list or lists of references to the paleontological literature. In *Treatise* parts published in the 1950's and early 1960's, these lists were highly selective, consisting of recent and comprehensive monographs, but also including some important older works. In time, however, *Treatise* authors and readers pressed for more exhaustive documentation, complete with author, publication year, and page number, for all publications to which reference is made anywhere in the text.

The following is a statement of the full names of serial publications cited in abbreviated form in the list of references in this volume. The list is alphabetized according to the serial titles that were employed at the time of publication. Those following in parentheses 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 references, these titles, which may be abbreviated, are accompanied by transliterated authors' names and titles, with English translation of the title. Titles of works in Chinese only are enclosed in brackets. The place of publication is added if it is not included in the serial title.

The method of transliterating Cyrillic letters is that suggested by the Geographical Society of London and the U.S. Board on Geographic Names. It follows that names of some Russian authors in transliterated form derived in this way differ from other forms, possibly including one used by the author himself. In *Treatise* reference lists the alternative form is given in brackets.

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