TREATISE ON INVERTEBRATE PALEONTOLOGY

Prepared under the Guidance of the
Joint Committee on Invertebrate Paleontology

Paleontological Society | *Society of Economic Paleontologists and Mineralogists* | *Palaeontographical Society*

Directed and Edited by

RAYMOND C. MOORE

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PARTS

The indicated Parts (excepting the first and last) are to be published at whatever time each is ready. All may be assembled ultimately in bound volumes. The list of contributing authors is subject to change.

A—INTRODUCTION. **B**—PROTISTA 1 (chrysomonads, silicoflagellates, coccolithophorids, diatoms, xanthomonads, dinoflagellates, euglenids). **C**—PROTISTA 2 (foraminifers, testaceans). **D**—PROTISTA 3 (radiolarians, tintinnines). **E**—PORIFERA (sponges, archaeocyathids). **F**—COELENTERATA (hydrozoans, scyphozoans, anthozoans). **G**—BRYOZOA. **H**—BRACHIOPODA. **I**—MOLLUSCA 1 (chitons, scaphopods, gastropods). **J**—MOLLUSCA 2 (gastropods). **K**—MOLLUSCA 3 (nautiloid cephalopods). **L**—MOLLUSCA 4 (ammonoid cephalopods). **M**—MOLLUSCA 5 (dibranchiate cephalopods). **N**—MOLLUSCA 6 (pelecypods). **O**—ARTHROPODA 1 (trilobitomorphs). **P**—ARTHROPODA 2 (chelicerates). **Q**—ARTHROPODA 3 (ostracodes). **R**—ARTHROPODA 4 (branchiopods, cirripeds, malacostracans, myriapods, insects). **S**—ECHINODERMATA 1 (cystoids, blastoids, carpoids, eocrinoids, paracrinoids, edrioasteroids, haplozoans). **T**—ECHINODERMATA 2 (crinoids). **U**—ECHINODERMATA 3 (asterozoans, echinozoans). **V**—GRAPTOLITHINA. **W**—MISCELLANEA (worms, conodonts, conulariids, problematical fossils). **X**—ADDENDA (index).

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CONTRIBUTING AUTHORS

AMSDEN, T. W., Johns Hopkins University, Baltimore, Md.

ARKELL, W. J., Sedgwick Museum, Cambridge University, Cambridge, Eng.

BAIRSTOW, LESLIE, British Museum (Natural History), London, Eng.

BALK, CHRISTINA LOCHMAN, Socorro, N. Mex.

BARKER, R. WRIGHT, Shell Development Co., Houston, Tex.

BASSLER, R. S., U.S. National Museum, Washington, D.C.

BATTEN, ROGER L., Columbia University, New York, N.Y.

BAYER, FREDERICK M., U.S. National Museum, Washington, D.C.

BEAVER, HAROLD H., Baylor University, Waco, Tex.

BELL, W. CHARLES, University of Texas, Austin, Tex.

BERDAN, JEAN M., U.S. Geological Survey, Washington, D.C.

BOSCHMA, H., Rijksmuseum van Natuurlijke Historie, Leiden, Holl.

BOWSHER, ARTHUR L., U.S. Geological Survey, Fairbanks, Alaska.

BRANSON, CARL C., University of Oklahoma, Norman, Okla.

BULMAN, O. M. B., Sedgwick Museum, Cambridge University, Cambridge, Eng.

CAMPBELL, ARTHUR S., St. Mary's College, St. Mary's College, Calif.

CARPENTER, FRANK M., Museum of Comparative Zoology, Harvard University, Cambridge, Mass.

CASEY, RAYMOND, Geological Survey of Great Britain, London, Eng.
CASTER, KENNETH E., University of Cincinnati, Cincinnati, Ohio.
CHAVAN, ANDRÉ, Thoiry (Ain), France.
CLARK, AUSTIN H., U.S. National Museum, Washington, D.C.
CLINE, LEWIS M., University of Wisconsin, Madison, Wis.
COLE, W. STORRS, Cornell University, Ithaca, N.Y.
COOPER, G. ARTHUR, U.S. National Museum, Washington, D.C.
COX, L. R., British Museum (Natural History), London, Eng.
CURRY, DENNIS, Pinner, Middlesex, Eng.
DAVIES, L. M., Edinburgh, Scot.
DAVIS, A. G., Anerley, London, Eng.
DECHASEAUX, C., Laboratoire de Paléontologie à la Sorbonne, Paris, France.
DURHAM, J. WYATT, Museum of Palaeontology, University of California, Berkeley, Calif.
EAMES, F. E., Anglo-Iranian Oil Company, London, Eng.
ELLIOTT, GRAHAM F., Kensington, Eng.
EMERSON, W. K., University of California, Berkeley, Calif.
EXLINE, HARRIET, Rolla, Mo.
FISHER, D. W., New York State Museum, Albany, N.Y.
FLOWER, ROUSSEAU H., New Mexico Bureau of Mines, Socorro, N.Mex.
FRIZZELL, DONALD L., Missouri School of Mines, Rolla, Mo.
FURNISH, WILLIAM M., State University of Iowa, Iowa City, Iowa.
GARDNER, JULIA, U.S. Geological Survey, Washington, D.C.
GEORGE, T. NEVILLE, Glasgow University, Glasgow, Scot.
GLAESSNER, M. F., University of Adelaide, Adelaide, S.Austral.
HAAS, FRITZ, Chicago Natural History Museum, Chicago, Ill.
HANNA, G. DALLAS, California Academy of Sciences, San Francisco, Calif.
HÄNTZSCHEL, WALTER, Geologisches Staatsinstitut, Hamburg, Ger.
HARRINGTON, H. J., University of Kansas, Lawrence, Kans.
HASS, WILBERT H., U.S. Geological Survey, Washington, D.C.
HATAI, KOTORA, Tohoku University, Sendai, Japan.
HAWKINS, H. L., Reading University, Reading, Eng.
HEDGPETH, JOEL, Scripps Institution of Oceanography, University of California, La Jolla, Calif.
HERTLEIN, L. G., California Academy of Sciences, San Francisco, Calif.
HESSLAND, IVAR, University of Stockholm, Stockholm, Swed.
HILL, DOROTHY, University of Queensland, Brisbane, Queensl.
HOWE, HENRY V., Louisiana State University, Baton Rouge, La.
HOWELL, B. F., Princeton University, Princeton, N.J.
HYMAN, LIBBIE H., American Museum of Natural History, New York, N.Y.
JAANUSSON, VALDAR, Paleontological Inst., Uppsala, Sweden.
KEEN, MYRA, Stanford University, Stanford, Calif.
KESLING, ROBERT V., Paleontological Museum, University of Michigan, Ann Arbor, Mich.
KING, RALPH H., University of Kansas, Lawrence, Kans.
KNIGHT, J. BROOKES, U.S. National Museum, Washington, D.C.
KUMMEL, BERNHARD, Museum of Comparative Zoology, Harvard University, Cambridge, Mass.
LA ROCQUE, AURÈLE, Ohio State University, Columbus, Ohio.
LAUBENFELS, M. W. DE, Oregon State College, Corvallis, Ore.
LECOMPTE, MARIUS, Institut Royal des Sciences Naturelles, Brussels, Belg.
LEONARD, A. BYRON, University of Kansas, Lawrence, Kans.
LEVINSON, S. A., Humble Oil & Refining Company, Houston, Tex.
LOEBLICH, A. R., JR., U.S. National Museum, Washington, D.C.
LOEBLICH, HELEN TAPPAN, U.S. Geological Survey, Washington, D.C.
LOHMAN, KENNETH E., U.S. Geological Survey, Washington, D.C.
LOWENSTAMM, HEINZ A., California Institute of Technology, Pasadena, Calif.
LUDBROOK, N. H., Department of Mines, Adelaide, S.Austral.
MARWICK, J., New Zealand Geological Survey, Wellington, N.Z.
MELVILLE, R. V., Geological Survey and Museum, London, Eng.

MILLER, ARTHUR K., State University of Iowa, Iowa City, Iowa.
MOORE, RAYMOND C., University of Kansas, Lawrence, Kans.
MORRISON, J. P. E., U.S. National Museum, Washington, D.C.
MUIR-WOOD, H. MARGARET, British Museum (National History), London, Eng.
NEWELL, NORMAN D., American Museum of Natural History (and Columbia University), New York, N.Y.
OKULITCH, VLADIMIR K., University of British Columbia, Vancouver, B.C.
OLSSON, AXEL A., Coral Gables, Florida.
PALMER, KATHERINE VAN WINKLE, Paleontological Research Institution, Ithaca, N.Y.
PECK, RAYMOND E., University of Missouri, Columbia, Mo.
PETRUNKEVITCH, ALEXANDER, Osborn Zoological Laboratory, Yale University, New Haven, Conn.
POULSEN, CHR., University of Copenhagen, Copenhagen, Denm.
POWELL, A. W. B., Auckland Institute and Museum, Auckland, N.Z.
PURI, HARBANS, Florida State Geological Survey, Tallahassee, Fla.
RASETTI, FRANCO, Johns Hopkins University, Baltimore, Md.
REGNÉLL, GERHARD, Lunds Universitets, Lund, Swed.
REICHEL, M., Bernouillanum, Basel University, Basel, Switz.
RICHTER, EMMA, Senckenberg Natur-Museum, Frankfurt-a.-M., Ger.
RICHTER, RUDOLF, Universität Frankfurt-a.-M., Frankfurt-a.-M., Ger.
ROBERTSON, ROBERT, Stanford University, Stanford, Calif.
SCHINDEWOLF, O. H., Geolog. Paläontolog. instit., Tűbingen, Ger.
SCHMIDT, HERTA, Senckenbergische Naturforschende Gesellschaft, Frankfurt-a.-M., Ger.
SCOTT, HAROLD W., University of Illinois, Urbana, Ill.
SHAVER, ROBERT, University of Mississippi, University, Miss.
SIEVERTS-DORECK, HERTHA, Stuttgart-Degerloch, Ger.
SINCLAIR, G. WINSTON, Ohio Wesleyan University, Delaware, Ohio.
SOHN, I. G., U.S. Geological Survey, Washington, D.C.
SPENCER, W. K., Beaulieu-sur-mer, Alpes Maritimes, France.
STAINBROOK, MERRILL A., Brandon, Iowa.
STEHLI, FRANK, California Institute of Technology, Pasadena, Calif.
STENZEL, H. B., University of Texas, Austin, Tex.
STEPHENSON, LLOYD W., U.S. Geological Survey, Washington, D.C.
STØRMER, LEIF, Paleontologisk Institutt, University of Oslo, Oslo, Nor.
STUBBLEFIELD, C. J., Geological Survey and Museum, London, Eng.
STUMM, ERWIN C., Museum of Paleontology, University of Michigan, Ann Arbor, Mich.
SWAIN, FREDERICK M., University of Minnesota, Minneapolis, Minn.
SYLVESTER-BRADLEY, P. C., University of Sheffield, Sheffield, Eng.
TASCH, PAUL, North Dakota Agricultural College, Fargo, N.Dak.
TEICHERT, CURT, U.S. Geological Survey, Federal Center, Denver, Colo.
THOMPSON, M. L., University of Kansas, Lawrence, Kans.
THOMPSON, R. H., University of Kansas, Lawrence, Kans.
TIEGS, O. W., University of Melbourne, Melbourne, Victoria, Austral.
UBAGHS, G., Université de Liège, Liège, Belg.
VOKES, H. E., Johns Hopkins University, Baltimore, Md.
WANNER, J., Scheidegg (Allgäu), Bayern, Ger.
WEIR, JOHN, University of Glasgow, Glasgow, Scot.
WELLER, J. MARVIN, University of Chicago, Chicago, Ill.
WELLS, JOHN W., Cornell University, Ithaca, N.Y.
WHITTINGTON, H. B., Museum of Comparative Zoology, Harvard University, Cambridge, Mass.
WILLIAMS, ALWYN, University of Glasgow, Glasgow, Scot.
WILLS, L. J., University of Birmingham, Birmingham, Eng.
†WITHERS, T. H., Bournemouth, Eng.
WRIGHT, C. W., Kensington, Eng.
†WRIGLEY, ARTHUR, Norbury, London, Eng.
YOCHELSON, ELLIS L., U.S. Geological Survey, Washington, D.C.

†—Deceased.

EDITORIAL PREFACE

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

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

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

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

A generous grant of $25,000 has been made by the Geological Society of America for the purpose of preparing *Treatise* illustrations. Administration of expenditures has been in charge of the Editor and most of the work by photographers and artists has been done under his direction at the University of Kansas, but sizable parts of this program have also been carried forward in Washington and London.

FORM OF ZOOLOGICAL NAMES

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

CLASSIFICATION OF ZOOLOGICAL NAMES

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

CO-ORDINATE NAMES OF TAXA GROUPS

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

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

ORIGINAL AND SUBSEQUENT FORMS OF NAMES

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

VALID AND INVALID NAMES

Valid names. A valid zoological name is one that conforms to all mandatory provisions of the Rules (Copenhagen Decisions, p. 43-57) but names of this group are divisible into subgroups as follows: (1) *"inviolate names,"* which as originally published not only meet all mandatory requirements of the Rules but are not subject to any sort of alteration (most generic and subgeneric names); (2) *"perfect names,"* which as they appear in original publication (with or without precise duplication by subsequent authors) meet all mandatory requirements and need no correction of any kind but which nevertheless are legally alterable under present Rules (as in changing the form of ending of a published class/order-group name); (3) *"imperfect names,"* which as originally published and with or without subsequent duplication meet mandatory requirements but contain defects such as incorrect gender of an adjectival specific name (for example, *Spironema recta* instead of *Spironema rectum*) or incorrect stem or form of ending of a family-group name (for example, Spironemidae instead of Spironematidae); (4) *"transferred names,"* which are derived by valid emendation from either of the 2nd or 3rd subgroups or from a pre-existing transferred name (as illustrated by change of a family-group name from -inae to -idae or making

of a superfamily name); and (5) *"improved names,"* which include necessary as well as somewhat arbitrarily made emendations allowable under the Rules for taxonomic categories not now covered by regulations as to name form and alterations that are distinct from changes that distinguish the 4th subgroup (including names derived from the 2nd and 3rd subgroups and possibly some alterations of 4th subgroup names).

It is useful for convenience and brevity of distinction in recording these subgroups of valid zoological names to introduce Latin designations, following the pattern of *nomen nudum, nomen novum,* etc. Accordingly, the subgroups are (1) *nomina inviolata* (sing., *nomen inviolatum,* abbr., *nom. inviol.*); (2) *nomina perfecta* (sing., *nomen perfectum,* abbr., *nom. perf.*); (3) *nomina imperfecta* (sing., *nomen imperfectum,* abbr., *nom. imperf.*); (4) *nomina translata* (sing., *nomen translatum,* abbr., *nom. transl.*); (5) *nomina correcta* (sing., *nomen correctum,* abbr., *nom. correct.*).

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

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

SUMMARY OF NAME CLASSES

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

Definitions of Name Classes

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

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

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

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

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

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

name"). (*See* Copenhagen Decisions, paragraphs 71-2-b, 73-4.)

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

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

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

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

NAME CHANGES IN RELATION TO GROUP CATEGORIES

SPECIFIC AND SUBSPECIFIC NAMES

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

GENERIC AND SUBGENERIC NAMES

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

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

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

Stichophyma POMEL, 1872 [**Manon turbinatum* RÖMER, 1841; SD RAUFF, 1893] [=*Stychophyma* VOSMAER, 1885 *(nom. null.); Sticophyma* MORET, 1924 *(nom. null.)*].

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

Placotelia OPPLIGER, 1907 [**Porostoma marconi* FROMENTEL, 1859; SD DELAUBENFELS, herein] [=*Plakotelia* OPPLIGER, 1907 *(nom. neg.)*].

FAMILY-GROUP NAMES; USE OF *"NOM. TRANSL."*

The Rules now specify the form of endings only for subfamily (-inae) and family (-idae) but decisions of the Copenhagen Congress direct classification of all family-group assemblages (taxa) as co-ordinate, signifying that for purposes of priority a name published for a unit in any category and based on a particular type genus shall date from its original publication for a unit

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

Examples of the use of *"nom. transl."* are the following.

Subfamily STYLININAE d'Orbigny, 1851

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

Superfamily ARCHAEOCTONOIDEA Petrunkevitch, 1949

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

Superfamily CRIOCERATITACEAE Hyatt, 1900

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

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

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

Family STREPTELASMATIDAE Nicholson, 1889

[*nom. correct.* Wedekind, 1927 (*ex* Streptelasmidae Nicholson, 1889, *nom. imperf.*)]

Family PALAEOSCORPIIDAE Lehmann, 1944

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

Family AGLASPIDIDAE Miller, 1877

[*nom. correct.* Størmer, herein (*ex* Aglaspidae Miller, 1877, *nom. imperf.*)]

Superfamily AGARICIICAE Gray, 1847

[*nom. correct.* Wells, herein (*ex* Agaricioidae Vaughan & Wells, 1943, *nom. transl. ex* Agariciidae Gray, 1847)]

FAMILY-GROUP NAMES; REPLACEMENTS

Family-group names are formed by adding letter combinations (prescribed for family and subfamily but not now for others) to the stem of the name belonging to 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. According to the Copenhagen Decisions, the family-group name requires replacement only in the event that the nominate genus is found to be a junior homonym, 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.

The aim of family-group nomenclature is greatest possible stability and uniformity, just as in case of 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 ob-

jective 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. Conversely, a long-used family-group name founded on a junior objective synonym and having priority of publication is better continued in nomenclature than a replacement name based on the senior objective synonym. The Copenhagen Decisions (paragraph 45) take account of these considerations by providing a relatively simple procedure for fixing the desired choice in stabilizing family-group names. In conformance with this, the *Treatise* assigns to contributing authors responsibility for adopting provisions of the Copenhagen Decisions.

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

FAMILY-GROUP NAMES; AUTHORSHIP AND DATE

All family-group taxa having names based on the same type genus are attributed to the author who first published the name for any of these assemblages, whether tribe, subfamily, or family (superfamily being almost inevitably a later-conceived taxon). Accordingly, if a family is divided into subfamilies or a subfamily into tribes, the name of no such subfamily or tribe can antedate the family name. Also, every family containing differentiated subfamilies must have a nominate *(sensu stricto)* subfamily, which is based on the same type genus as that for the family, and the author and date set down for the nominate subfamily invariably are identical with those of the family, without reference to whether the author of the family or some subsequent author introduced subdivisions.

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

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

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

Order DISPARIDA Moore & Laudon, 1943

[*nom. correct.* MOORE, 1952 (*ex* Disparata MOORE & LAUDON, 1943)]

Suborder FAVIINA Vaughan & Wells, 1943

[*nom. correct.* WELLS, herein (*ex* Faviida VAUGHAN & WELLS, 1943)]

Suborder FUNGIINA Verrill, 1865

[*nom. correct.* WELLS, herein (*ex* Fungiida DUNCAN, 1884, *ex* Fungacea VERRILL, 1865)]

TAXONOMIC EMENDATION

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

Most zoologists, including paleozoologists, who have signified emendation of zoological names refer to what they consider a material change in application of the name such as may be expressed by an importantly altered diagnosis of the assemblage covered by the name. The abbreviation *"emend."* then may accompany the name, with statement of the author and date of the emendation. On the other hand, a multitude of

workers concerned with systematic zoology think that publication of *"emend."* with a zoological name is valueless because more or less alteration of taxonomic sort is introduced whenever a subspecies, species, genus, or other assemblage of animals is incorporated under or removed from the coverage of a given zoological name. Inevitably associated with such classificatory expansions and restrictions is some degree of emendation affecting diagnosis. Granting this, still it is true that now and then somewhat radical revisions are put forward, generally with published statement of reasons for changing the application of a name. To erect a signpost at such points of most significant change is worth while, both as aid to subsequent workers in taking account of the altered nomenclatural usage and as indication that not-to-be-overlooked discussion may be found at a particular place in the literature. Authors of contributions to the *Treatise* are encouraged to include records of all specially noteworthy emendations of this nature, using the abbreviation *"emend."* with the name to which it refers and citing the author and date of the emendation.

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

STYLE IN GENERIC DESCRIPTIONS

DEFINITION OF NAMES

Most generic names are distinct from all others and are indicated without ambiguity by citing their originally published spelling accompanied by name of the author and date of first publication. If the same generic name has been applied to 2 or more distinct taxonomic units, however, it is necessary to differentiate such homonyms, and this calls for distinction between junior homonyms and senior homonyms. Because a junior homonym is invalid, it must be replaced by some other name. For example, *Callopora* HALL, 1851, introduced for Paleozoic trepostome bryozoans, is invalid because GRAY in 1848 published the same name for Cretaceous-to-Recent cheilostome bryozoans, and BASSLER in 1911 introduced the new name *Hallopora* to replace HALL's homonym. The *Treatise* style of entry is:

Hallopora BASSLER, 1911 [*pro Callopora* HALL, 1851 (*non* GRAY, 1848)].

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

Mysterium DELAUBENFELS, *nom. nov.* [*pro Mystrium* SCHRAMMEN, 1936 (ref. 40, p. 60) (*non* ROGER, 1862)] [**Mystrium porosum* SCHRAMMEN, 1936].

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

Diplophyllum HALL, 1851 [*non* SOSHKINA, 1939] [**D. caespitosum*].

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

CITATION OF TYPE SPECIES

The name of the type species of each genus and subgenus is given next following the generic name with its accompanying author and date, or after entries needed for definition of the name if it is involved in homonymy. The originally published combination of generic and trivial names for this species is cited, accompanied by an

asterisk (*), with notation of the author and date of original publication. An exception in this procedure is made, however, if the species was first published in the same paper and by the same author as that containing definition of the genus which it serves as type; in such case, the initial letter of the generic name followed by the trivial name is given without repeating the name of the author and date, for this saves needed space. Examples of these 2 sorts of citations are as follows:

Diplotrypa NICHOLSON, 1879 [**Favosites petropolitanus* PANDER, 1830].

Chainodictyon FOERSTE, 1887 [**C. laxum*].

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

Acervularia SCHWEIGGER, 1819 [**A. baltica* (=**Madrepora ananas* LINNÉ, 1758)].

It is judged desirable to record the manner of establishing the type species, whether by original designation or by subsequent designation, but various modes of original designation are not distinguished. According to convention adopted in the *Treatise,* absence of any indication as to manner of fixing the type species is to be understood as signifying original designation. If the type species has been fixed by subsequent designation, this is indicated by the letters "SD" followed by the name of the author and date of such subsequent designation, as follows:

Hexagonaria GÜRICH, 1896 [**Cyathophyllum hexagonum* GOLDFUSS, 1826; SD LANG, SMITH & THOMAS, 1940].

SYNONYMS

Citation of synonyms is given next following record of the type species and if 2 or more synonyms of differing date are recognized, these are arranged in chronological order. Objective synonyms are indicated by accompanying designation "(obj.)," others being understood to constitute subjective synonyms. Examples showing *Treatise* style in listing synonyms follow.

Calapoecia BILLINGS, 1865 [**C. anticostiensis;* SD LINDSTRÖM, 1833] [=*Columnopora* NICHOLSON, 1874; *Houghtonia* ROMINGER, 1876].

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

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

Lyopora NICHOLSON & ETHERIDGE, 1878 [**Palaeopora? favosa* M'COY, 1850] [=*Liopora* LANG, SMITH & THOMAS, 1940 (*non* GIRTY, 1915)].

ABBREVIATIONS

Some authors' names and most stratigraphic and geographic names are abbreviated in order to save space. General principles for guidance in determining what names should be abbreviated are frequency of repetition, length of name, and avoidance of ambiguity. Abbreviations used in this division of the *Treatise* are explained in the following alphabetically arranged list.

Abbreviations of Stratigraphic and Place Names and Words Used in Bibliographic Citations

Abh., Abhundlung, -en
Acad., Académie, Academy
Afr., Africa
Akad., Akademie
Alg., Algeria
Am., America, American
Ann., Annals
Antarct., Antarctica
Arg., Argentina
Atl., Atlantic
Aus., Austria
Austral., Australia
B.C., British Columbia
Bd., Band, Bände
Belg., Belgium
Br., British
Bull., Bulletin, -s
C., Central
Cam., Cambrian
Can., Canada
Carb., Carboniferous
Cenom., Cenomanian
Cenoz., Cenozoic
Coll., Collection, -s; College
Colo., Colorado
Comm., Commission, Committee
Comp., Comparative
Cosmop., Cosmopolitan
Cret., Cretaceous
Czech., Czechoslovakia
Dev., Devonian
E., East
Eng., England
Eoc., Eocene
Eu., Europe
fig., figure, -s
Fla., Florida
Fr., France
Geol., Geological, Geology, Geologie
Ger., Germany
Gesell., Gesellschaft
GulfMexico, Gulf of Mexico
Helv., Helvetian
Hist., History
I., Island, -s
Ill., Illinois
Ind., Indian, Indiana
Inst., Institute
Ire., Ireland

Jour., Journal
Jur., Jurassic
K., Kaiserlich, Königlich
Kans., Kansas
Ky., Kentucky
L., Lower
loc., locality, -ies
long., longitudinal
M., Middle
Mag., Magazine
Manch., Manchuria
Mem., Memoir
Mém., Mémoire
Mesoz., Mesozoic
Minn., Minnesota
Mio., Miocene
Misc., Miscellaneous
Miss., Mississippian
Mitt., Mitteilungen
Mon., Monograph, Monographie
Mus., Musée, Museum
N., North
N.Am., North America
nat., natural
Natl., National
naturf., naturforschende
Nev., Nevada
Newf., Newfoundland
nom., nomen
nov., nova, -us, -um
NW., Northwest
N.Y., New York
N.Z., New Zealand
O., Ocean
obj., objective
Okla., Oklahoma
Ord., Ordovician
p., page, -s
Pa., Pennsylvania
Pac., Pacific
Palaeontogr., Palaeontographica, -l
Paläont., Paläontologie
Paleont., Paleontology, -ical
Penn., Pennsylvanian
Perm., Permian
pl., plate, -s
Pleisto., Pleistocene
Precam., Precambrian
Prof., Professional
Pub., Publication, -s
Quart., Quarterly
Que., Quebec
Rec., Recent
Rept., Report, -s
Rev., Review, Revue
Roy., Royal, Royale
Russ., Russia
S., Sea, South
Santon., Santonian
Sci., Science, -s; Scientific
Scot., Scotland
SD, subsequent designation
sec., -s, section, -s
Sib., Siberia
Sil., Silurian
Sitzungsber., Sitzungsberichte
Soc., Société, Society
Sp., Spain
Suppl., Supplement
SW., Southwest
Tenn., Tennessee
Tert., Tertiary
Tex., Texas
Trans., Transactions
transv., transverse
Trias., Triassic
U., Upper
Univ., University
U.S.A., United States
U.S.S.R., Union of Soviet Socialist Republics
Va., Virginia
Ver., Verein
Verh., Verhandlung, -en
vol., volume, -s
Vt., Vermont
W., West
Wiss., Wissenschaft, -en
Wyo., Wyoming
Zool., Zoology, -ical

Abbreviations of Authors' Names

Bedf.-B., Bedford, R., & Bedford, J.
Bill., Billings, Elkanah
Blainv., Blainville, H. M. D. de
Blum., Blumenbach, D. J. F.
Bolk., Bolkhovitinova, M.
Born., Bornemann, J. G.
Bow., Bowerbank, J. S.
Brongn., Brongniart, A.
Chalmas, Chalmas, M. Munier
Coss., Cossmann, Maurice
Court., Courtiller, A.
Dawson-H., Dawson, J. W., & Hinde, G. J.
Defr., Defrance, M. J. L.
deLaub., Laubenfels, M. W. de
Död., Döderlein, L.
Edw.-H., Edwards, H. Milne, & Haime, Jules
Ehr., Ehrenberg, O. G.
Eichw., Eichwald, C. E. von
Étal., Étallon, A.
Fenton-F., Fenton, C. L., & Fenton, M. A.
Fischer, Fischer von Waldheim, G.
From., Fromentel, E. de
Goldf., Goldfuss, G. A.
Hall-C., Hall, James, & Clarke. J. M.
Hinde-H., Hinde, G. J., & Holmes, W. M.
His., Hisinger, W.
Hkl., Haeckel, Ernst
Lam., Lamarck, J. B. P. A. de M. de
Lamx., Lamouroux, J. V. F.
Lesq., Lesquereux, Leo
Lonsd., Lonsdale, William
Meek-W., Meek, F. B., & Worthen, A. H.
Mich., Michelin, J. L. H.
Miller-D., Miller, S. A., & Dyer,
Murch., Murchison, R. I.
Ok., Okulitch, V. J.
Oppl., Oppliger, F.
Orb., Orbigny, A. D. d'
Phill., Phillips, John
Quenst., Quenstedt, F. A.
Raf., Rafinesque, C. S.
Ray.-O., Raymond, P. E., & Okulitch, V. J.
Rued., Ruedemann, Rudolf
Schloth., Schlotheim, E. F.
Schram., Schrammen, A.
Spriest., Spriestersbach, J.
Steinm., Steinmann, G.
Stuck., Stuckenberg, A.
Term.-T., Termier, Henri, & Termier, Geneviève
Toll, Toll, E. von
Traut., Trautschold, H.
Tschern., Tschernyschew, T.
Ulr., Ulrich, E. O.
Vinassa, Vinassa de Regny, P. E.
Vol., Vologdin, A. G.
Waag.-W., Waagen, William, & Wentzel, Joseph
Walc., Walcott, C. D.
Whitf., Whitfield, R. P.
Y.-Y., Young, John, & Young, John
Zittel-E., Zittel, K. A. von, & Eastman, C. R.

REFERENCES TO LITERATURE

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

SOURCES OF ILLUSTRATIONS

At the end of figure captions an index number is given to supply record of the author of illustrations used in the *Treatise,* reference being made to an alphabetically arranged list of authors' names which follows.

RAYMOND C. MOORE

SUPPLEMENTAL NOTE

VALUE OF RECORDING DISTINCTIONS AMONG INVALID ZOOLOGICAL NAMES

Further consideration of the various categories of zoological names as defined and discussed in foregoing pages has suggested the desirability of calling special attention to some aspects of the subject which, although important to the *Treatise,* were passed over. The intention to record information which may most clearly and precisely set forth grounds for rejecting some names and accepting others was stated, but except for illustration by a few examples designed to show *Treatise* style, that is about all. What criteria may be recognized for reliable distinction between valid and invalid names, and if a name is found to be invalid, what good is served by classifying it further? Of course, junior homonyms require notice because they must be renamed; junior objective synonyms cannot be overlooked, because they preoccupy and are available as replacement names for junior homonyms; junior subjective synonyms need to be recorded because they also preoccupy, are available as replacement names, and may be recognized as valid by anyone at any time when they are removed from synonymy. This brings us to invalid names which have no status in nomenclature *(nomina nuda, nomina negata, nomina nulla)*. Is there any point in recording such names (taking space also for citation of author, date, and type of name), since for all intents of zoological nomenclature these names do not exist? A reasonable answer seems to be that definition of their status is necessary before correct treatment of them under the Rules is possible; once this is known, the names may be rejected and neglected.

Recognition of the status of some zoological names as *nomina nuda, nomina negata,* or *nomina nulla* may be very simple, but accurate determination of others may be difficult, requiring careful study. In either case, specialists who are thoroughly acquainted with the literature relating to a particular taxonomic unit such as phylum, class, order, or smaller division and who have made themselves familiar with the regulations pertaining to zoological names are best able to furnish needed information, and comprehensive publications like the

Treatise are appropriate for compilation and indexing of such records. Examples of each of the 3 mentioned classes of invalid names may be found in each of the 5 groups of taxa (species group, genus group, etc.), but they are most common and important for notice in the species and genus groups. Convenient over-brief characterization of a *nomen nudum* emphasizes its lack of "indication" associated with the name, whether the name itself is formed correctly or incorrectly (including a so-called family-group taxon not based on a type genus). *Nomina negata* are rare. A *nomen nullum* rightly may be defined as comprising any unexplained deviation from original spelling of a zoological name; this readily serves for distinction of most *nomina nulla* from *nomina vana.*

It is important to distinguish and record all *nomina vana* because automatically they are junior objective synonyms, although all junior objective synonyms are by no means classifiable as *nomina vana.* For example, a subjective junior synonym of a generic name may be converted to a junior objective synonym under circumstances permitting fixation of an identical type species; this does not produce a *nomen vanum.*

Previously published parts of the *Treatise,* as well as Part E and others nearing readiness for press, largely omit information relating to invalid names, many of which are not listed at all. Parts issued in future will include notice of as many such names as authors are able and willing to furnish.

RAYMOND C. MOORE