Catalog of the Scorpions of the World (1758–1998)

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THE NEW YORK ENTOMOLOGICAL SOCIETY

To the memory of

Professor MAXIME (MAX) VACHON
(January 4, 1908, Dijon – November 3, 1991, Paris),

one of the most innovative and influential scorpiologists
of the 20th century, who pioneered modern scorpion taxonomy
and inspired research in other fields

and

to the memory of

Gary A. Polis (1946–2000)

our friend, teacher, scorpion researcher, one of the best people we know

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The paper in this book meets the minimum requirements of the American National Standard for Information Sciences—Permanence of Paper for Library Materials, ANSI Z39.48-1984.

ISBN 0-913-42424-2

This book is available from:

The New York Entomological Society
c/o Division of Invertebrate Zoology
American Museum of Natural History
Central Park West at 79th Street
New York, New York 10024, USA

TABLE OF CONTENTS

INTRODUCTION

This Catalog of all known scorpions (extant as well as fossil) is intended as a taxonomic reference book based on published scientific literature. Its purpose is to make available the most comprehensive possible information on scorpion taxonomy to the specialist as well as to the layperson. The Catalog is provided with an Index which allows the user to search for all published scorpion names. Included names and nomenclatural acts are interpreted according to the basic principles listed in the 3rd edition of the International Code of Zoological Nomenclature (ICZN, 1985). Many unclear and debatable situations are discussed in detail. We have attempted to follow the most recent, justified taxonomic arguments, but any opinion listed in this book constitutes the authors' collective opinion which may not necessarily agree with that of other researchers.

A Brief History of Scorpion Taxonomy

Scorpions (Chelicerata: Scorpiones) are a unique, well-defined, well-known (and also well-feared!) group of arthropods which have received the attention of many taxonomists, including Linnaeus (1758, 1767) himself.

Because scorpions are so prevalent in subtropical and tropical regions, their scientific discovery largely accompanied the exotic, "colonial" activities of naturalists from the late 18th century through the early 20th century. Scorpions were brought from Egypt by the scientists who followed Napoleon's conquests, from South America by the missionaries, and from India by British army naturalists. The process of discovery initiated by these individuals continues to this day, with modern scientists exploring many parts of the globe.

The only existing complete survey of the world fauna, with keys to all taxa, was published by Kraepelin (1899), and this work remains an important source for practitioners of scorpion taxonomy. Our desire to provide a complete scorpion catalog one hundred years after Kraepelin's was motivated by several factors. First, the sheer number of species and subspecies known to us now is more than four times that known to Kraepelin. Second, the classification of scorpions has been greatly modified by the addition of many new genera and even families that were unknown or unrecognized in his day. Finally, a huge amount of information on scorpion nomenclature, morphology, biogeography (including distributional information), and phylogeny has been published during this period that further justifies the need for this Catalog.

Until the 1950s, morphological characters used in scorpion taxonomy were mostly simple and repetitive, being based largely upon morphosculpture, meristics (mainly pectinal tooth counts) and coloration of the cuticle. Several early workers, however, utilized fairly sophisticated characters that are still of great importance today (e.g., Kraepelin [1894, 1912]: pedipalp chela finger dentition and trichobothrial patterns; Laurie [1896a, 1896b]: female reproductive anatomy). Beginning with the 1950s, the pioneering works of Max Vachon emphasized the dramatic importance of chaetotaxy (trichobothriotaxy and setal patterns) in scorpions as it was for other groups of arachnids (e.g., for Acari by Grandjean). Vachon (1974) documented trichobothrial patterns in almost all of the genera known in his time, a feat that perhaps ranks as the greatest single contribution to scorpion systematics to date. Other meristic and qualitative characters were introduced or developed in the 1960s–1970s (e.g., dentition of chelicerae and pedipalps, anatomy of the male hemispermatophore). Today's taxonomy still relies almost entirely on morphological characters, and the use of molecular and biochemical techniques have thus far received only modest and sporadic attention.

In the 1980s, the first works that applied the Hennigian cladistic approach to scorpion morphology appeared (Lamoral, 1980; Francke & Soleglad, 1981) but cladistic approaches to the study of scorpion systematics are still largely unexplored in the published literature, especially in the most diverse and important family, Buthidae.

A number of impressive revisions and taxonomic works appeared since 1940; the most notable of these were published by L. de Armas, L. di Caporiacco, H. Couzijn, O. Francke, W. Gertsch, M. González-Sponga, L. E. Koch, B. Lamoral, G. Levy and P. Amitai, W. Lourenço, E. Maury, M. Soleglad, H. Stahnke, M. Vachon, and S. Williams. Various regional faunas, catalogs and checklists were published, including, but not limited to, those for South America (Mello-Leitão, 1945), the Middle East and North Africa (Vachon, 1952d; Levy & Amitai, 1980; El-Hennawy, 1992), the Aegean (Kinzelbach, 1975), sub-Saharan Africa (Lamoral & Reynders, 1975), Australia (L. E. Koch, 1977), the Caribbean (Francke, 1978; Armas, 1988), Namibia (Lamoral, 1979), Baja California (Williams, 1980), India (Tikader & Bastawade, 1983), Chile (Cekalovic, 1983), Venezuela (González-Sponga, 1984b, 1996b), Costa Rica (Francke & Stockwell, 1987), and the former USSR (Fet, 1989b). In 1985, Francke compiled a list ("conspectus") of scorpion generic names. Despite these efforts, many geographic areas remain poorly studied, and most of the taxonomic information on scorpions is scattered over hundreds of small publications in different languages, often obscure and hard to locate. We attempted to index all of this information in order to make it available under one cover.

Our Catalog is by no means a revision: a complete revision of all scorpion taxa will occupy dozens of taxonomists and collectors for decades. However, besides providing a mere checklist of scorpion names, our goal was to facilitate the work of individuals who will conduct future revisions and new descriptions.

There has been a clear revival of scorpion research in recent decades, especially in ecology, systematics, and physiology; in addition, the important studies on venoms and their action have continued. Comprehensive general information on scorpion biology is now available from two biological treatises: *The Biology of Scorpions*, edited by G. A. Polis (1990), and *Scorpion Biology and Research*, edited by P. H. Brownell and G. A. Polis (in press). A large and important bibliography of all works on scorpions has been recently published by Dupré (1998). It is hoped that our Catalog will complement these monographs by providing future researchers with a solid taxonomic foundation.

The work was divided between the authors as follows. Victor Fet compiled data on all Old World scorpions, the New World Ischnuridae, and all fossil taxa; he also is responsible for the manuscript assembly and general editing. W. David Sissom compiled all Chactidae, Superstitioniidae, and Vaejovidae, as well as the New World Diplocentridae, Euscorpiidae, Iuridae, and Troglotayosicidae. Graeme Lowe compiled the New World Buthidae and Bothriuridae. Matt E. Braunwalder researched and provided the bulk of the literature sources for the Old World fauna, and participated in the compilation of the Bibliography.

Taxonomic Layout of the Catalog

Taxa Included: In the tenth edition of "Systema Naturae" (Linnaeus, 1758: 624–625), five species were mentioned under the single genus *Scorpio*. The faunal review of C. L. Koch (1837c) listed four families and 11 genera, and that of Peters (1861b), four families and 19 genera. Kraepelin (1899) included six families and 64 genera in the only complete revision of the order. The review by Sissom (1990a) listed nine families and 115 genera of extant scorpions.

This Catalog includes the following currently valid extant scorpion taxa: 16 families, 16 subfamilies, 155 genera, 31 subgenera (including 10 nominotypical), 1259 species, and 356 subspecies (including 114 nominotypical). We have also attempted to account for all published scorpion names which are currently considered invalid, unavailable, or dubious.

Following the example of Harvey's (1990) pseudoscorpion catalog, we decided to include in this volume all known species of fossil scorpions. We list 42 extinct families, 74 genera, 96 species, and one subspecies. Of these, three genera and five species belong to two extant families (Buthidae: genus *Palaeolychas*; fossil species of *Microtityus* and *Tityus*, and Scorpionidae: genera *Mioscorpio* and *Sinoscorpius*; for the latter two taxa their placement still has to be confirmed). A fossil (Devonian) genus *Tiphoscorpio* Kjellesvig-Waering, 1986 was described as a scorpion but later transferred to the extinct arthropod class Arthropleurida (Shear & Selden, 1992, 1995). The trace fossils (fossil tracks) ascribed to scorpions are not included in the Catalog since their taxonomy is not regulated by the Code.

A number of names for which generic or familial placement is unclear are listed under "incertae sedis" sections following the closest identifiable higher taxon. The Catalog does not account for any junior homonyms of scorpion generic names belonging to other groups (e.g., a crustacean genus *Belisarius*; a fish genus *Eoscorpius*; a lizard genus *Leiurus*). Finally, the Catalog obviously does not include references to any generic names which resemble those of scorpions or contain roots such as "scorpius" or "scorpio" but belong to different groups—e.g., *Carcinoscorpius* (a horseshoe crab), *Glyptoscorpius* (a eurypterid), or *Lioscorpius* (a fish).

Class/Order-Group Taxa: Scorpions are a well-defined group, commonly considered an order (Scorpiones) in the class Arachnida (subphylum Chelicerata, phylum Arthropoda).

The class/order-group levels of scorpion taxonomy are usually discussed only when fossil taxa are of concern. A number of authors, mainly paleontologists, have elevated scorpions to a subclass or even class within Chelicerata (e.g., Dubinin, 1957, 1962; van der Hammen, 1977; Selden, 1993; Jeram, 1994b). The highest taxonomic rank of scorpions and their relationship with other arachnids and the extinct Eurypterida are subjects of significant past discussion, and undoubtedly will be further discussed in the future.

Thorell & Lindström (1885: 23–24) were first to introduce a division of scorpions into two suborders: Apoxypodes for fossil Silurian scorpions, and Dionychopodes (divided in two "series", Anthracoscorpii for Carboniferous forms, and Neoscorpii for all extant and Cenozoic forms). This division was followed by Birula (1917). Wills (1910) suggested a separate order, Mesophonidea, to accommodate Triassic scorpions, and later (Wills, 1947) treated it as a suborder. Pocock (1911) introduced division into two suborders, Lobosterni and Orthosterni. Petrunkevitch (1913) followed Thorell & Lindström (1885) in distinguishing Apoxypoda and Dionychopoda. Later, Petrunkevitch still recognized two suborders but called them Protoscorpiones and Euscorpiones (Petrunkevitch, 1949, 1953), or Protoscorpionina and Euscorpionina (Petrunkevitch, 1955).

The most (and likely overly) detailed recent system (Kjellesvig-Waering, 1986) includes two suborders (Neoscorpionina and Branchioscorpionina), five infraorders, 21 superfamilies and 48 families of extinct scorpions. Several modifications of this system were introduced since 1986, but there is currently no adopted consensus classification. Starobogatov (1990) recognized for scorpions two orders: Scorpioniformes and Palaeophoniformes; the latter name was originally introduced as Palaeophonida (Weygoldt & Paulus, 1979). Starobogatov (1990) further divided his Palaeophoniformes in seven suborders; he retained Branchioscorpionoidei Kjellesvig-Waering, 1986; and added five new suborders: Loboarchaeoctonoidei, Palaeophonoidei, Proscorpioidei, Archaeoctonoidei, Mesophonoidei, and Allopalaeophonoidei.

On the other hand, Selden (1993) and Jeram (1994a, 1994b, 1998) adopted a scheme which followed a classification of Stockwell (unpublished as of 1998). This scheme treats scorpions as a class Scorpionida, with three orders: Protoscorpiones, Palaeoscorpiones and Scorpiones. Of these, the order Scorpiones was divided in two suborders, Mesoscorpionina (extinct) and Neoscorpionina. The latter included two infraorders, Palaeosterni (extinct) and Orthosterni (Palaeopisthacanthidae and all extant families). Most recently, Jeram (1998) conducted a cladistic analysis of all known genera of Silurian and Devonian scorpions in which all scorpions again were treated as an order, and the suborder name Mesoscorpionina (or Mesoscorpiones) was used.

It is beyond the scope of this Catalog to analyze or coordinate classification of scorpions at the class/order-group levels. Formally, this task is complicated because the Code does not regulate names above family-group rank. We retained the system of Kjellesvig-Waering (1986) (with the family-group synonymies introduced later) as the only existing comprehensive system while realizing that its thorough reanalysis will result in further significant changes.

Family-Group Taxa: A number of authors (e.g., Birula, 1917) accepted an arrangement of the extant families in two or more superfamilies; see Sissom (1990a) for a review. Thus, superfamily names Bothriuroidea, Buthoidea, Chactoidea, and Scorpionoidea were introduced earlier this century (Birula, 1917a; Mello-Leitão, 1945). However, Kjellesvig-Waering (1986) included all extant scorpions under the same superfamily, Scorpionoidea.

We accept 16 extant families in the order Scorpiones, namely: Bothriuridae, Buthidae, Chactidae, Chaerilidae, Diplocentridae, Euscorpiidae, Heteroscorpionidae, Ischnuridae, Iuridae, Microcharmidae, Pseudochactidae, Scorpionidae, Scorpiopidae, Superstitioniidae, Troglotayosicidae, and Vaejovidae (Sissom, 1990a; Stockwell, 1992; Lourenço, 1996e, 1998d, 1998e; Gromov, 1998).

The subfamily category is in use within several scorpion families (Bothriuridae, Diplocentridae, Iuridae, Microcharmidae, Scorpionidae, Superstitioniidae and Troglotayosicidae), but only in a few cases is its recognition justified cladistically. Over the years, a number of authors have attempted to subdivide the diverse Buthidae into subfamilies, but none of their proposals has met with widespread approval.

The tribe category was almost never used in scorpion taxonomy; currently no valid tribes are accepted.

Genus-Group Taxa: We must emphasize here that genera and subgenera should (like all other taxonomic groupings) represent or attempt to best represent monophyletic lineages. The goal of phylogenetic reconstruction elevates modern taxonomy to the status of a real and respectable science instead of a mechanical activity concerned merely with the description and categorization of objects. Polyphyletic or paraphyletic groups are no longer acceptable and revisions must aim to purge such groups from the taxonomic system. New contributions should try not to create any more of them.

In practice, the concept of genus used in scorpion taxonomy is highly subjective and personal. This derives from the historical development of taxonomic theory, coupled with the fact that true phylogenetic analyses using Hennigian principles have rarely been conducted. As a result, it is difficult to say how many of the recognized scorpion genera are actually monophyletic. Genera are usually proposed simply because the taxa involved do not fit within accepted genera. In many cases, however, diagnoses of existing genera are modified to accommodate new and somewhat different species, but the extent and degree of diagnostic modification is subjective. In general, workers may start to split up genera when they get "too big" and encompass a diverse range of phenotypes representing radiation into diverse niches. However, taxonomists have had different splitting thresholds. For example, a number of Old World buthid genera are monotypic and narrowly delineated, as a result of this "splitting" activity, whereas New World buthid genera *Tityus* and *Centruroides* are highly "lumped". Thus, taxonomic criteria have not been applied uniformly. In extreme cases, some scorpion genera may have been created because an author simply felt a desire to create a new genus.

We list information on type species and, for genera described before 1932, specify the method of its designation (by original designation, by subsequent designation, by monotypy, or by indication). Full synonymy and indication of homonymy of generic names is provided, as well as a list of the most important references and geographic range of taxa. The Catalog includes 250 valid genus-group names (176 extant and 74 fossil taxa).

Species-Group Taxa: For species-group taxa, we provide complete list of synonyms, homonyms, references and geographical ranges. In some cases, the opinions of specialists on generic placement and species synonymy differ significantly. In such cases, we have invariably attempted to identify the "last reviser", thereby complying with the most recent "revisionary act". For the purposes of this catalog, a published opinion qualified as a "revisionary act" if it was based on the study and analysis of material and was provided with explicit justification, such as statement and discussion of evidence in support of the opinion, or the inclusion of a new or revised diagnosis of the taxa in question. Mere listing of a new or old combination without justification was not considered a "revisionary act".

It is common in the literature to find numerous subspecies and geographic races defined by not more than minor differences in coloration or meristic counts (e.g., pectinal tooth counts, setation counts). Confirming the validity of subspecies should always be a major goal of taxonomic revision. The results of such revision can obviously lead to the elevation of subspecies to species level or to placing invalid subspecies into synonymy.

In this Catalog, a number of nominotypical subspecific names were created by default, due to the existence of other subspecies in the same species and the fact that the nominotypical names were never proposed. In such cases, the scope and geographic range of nominotypical forms are often not well defined.

Most animal catalogs do not carry any information on type specimens. Having a luxury of dealing with less than 2000 species-group names, we decided to list such (published) data in order to facilitate revisionary work in scorpion taxonomy. In a great number of cases, as is to be expected, older type materials are lost. We could not personally reconfirm current accuracy of published depositories for all types, especially for many older publications, and therefore we usually relied just on published statements in listing the museum depository and accession numbers (some of those types may have been moved, had their accession numbers changed, or may be lost). We have attempted to indicate the status of all classes of nomenclatural types (holotype, neotype, lectotype, paratypes, paralectotypes, syntypes) as defined by the current Code (Article 72a). Also included (if known) are depository names with accession numbers, sexes of type specimens, and type localities. Designation of an allotype (a specimen of opposite sex to the holotype) is not required by the Code, and nomenclatural status of an allotype is not different from other paratypes. "Homotypes" (e.g., Lamoral, 1979) are not recognized by the Code and are not listed in this Catalog.

The Catalog includes 1607 valid species-group names (1510 extant and 97 fossil taxa).

Bibliographic Sources

Our Bibliography list includes publications up to December 31, 1998. We tried to limit publications referenced in this Catalog to taxonomic and faunistic literature; a number of ecological, physiological, or popular works are included as far as they provide new faunistic/geographic information. Otherwise, we did not include references to general biological, physiological, or toxicological publications on scorpions.

We listed, wherever possible, full names of journals and other sources. We tried to reference as many original publications as possible, especially those which contained new names or nomenclatural acts. For languages of non-Germanic or non-Romance origin (e.g., Russian or Japanese), we provide an English translation of the title.

Works published by the same author in the same year are listed as follows: e.g., Vachon, 1969a; Vachon, 1969b; Vachon, 1969c; etc. Such a format, by our convention, follows the alphabetical order of the sources (journal name, book name) rather than alphabetical order of the paper titles. Such indexation does not necessarily follow the actual precedence of publications. We tried to investigate all cases of conflicting publication dates and their precedence. Some dates quoted in this Catalog differ from those usually given by other authors. In many cases, especially those

with old publications, separate parts were available on an earlier date than the bound volume (e.g., Peters, 1861, often quoted as 1862 which is the date of appearance of a bound volume). Conversely, some publications which bear a certain year on their cover were in fact published the following year or even later (e.g., Vachon, 1974, published in January 1974 but often quoted as 1973 due to the date on the cover).

The modern technology of copying and desktop publishing has relaxed publication standards; the availability of "self-made" bulletins (such as the French "Arachnides" and the Egyptian "Serket") is not really different from low-circulation journals published by editorial boards. There is no requirement that taxonomic publications be peer-reviewed; therefore, if such publications complied with the definition of a published work as given by the Code, they were included in the Catalog. Consequently, we treated new names and nomenclatural acts appearing in such bulletins as satisfying the requirements for publication. Thesis and dissertation manuscripts produced for the purpose of obtaining an academic degree (e.g., Master's, Ph.D. or the equivalent) are unpublished by taxonomic standards since they are not produced in an edition containing simultaneously obtainable copies as specified in Article 8a(3) of the Code.

How to Use This Catalog

The alphabetical Index lists all published scorpion names included in the body of the Catalog (valid or invalid, available or unavailable, original or in a subsequent combination) and allows one to search for the current status of any name. Several options can be found in the Index, with examples given below:

(a) a reader that discovers a name of a scorpion species as *Buthus occitanus* should first search for the word *occitanus* in the Index. The entry appears as:

occitanus, *Buthus* (Androctonus)

Therefore, *Buthus occitanus* is currently a valid name/combination; the Index will address the reader to the corresponding page of the text where the complete synonymy for the species is listed. The italicized generic name listed in front of the parentheses is the one currently used for this species. Other generic names under which this species was listed in literature are found in alphabetical order in parentheses, non-italicized.

(b) a reader that discovers a name *Opisthacanthus heurtaultae* should first search for the word *heurtaultae* in the Index. The entry appears as:

heurtaultae (Opisthacanthus), see *Opisthacanthus cayaporum*

This means that *Opisthacanthus heurtaultae* is currently considered an invalid name (a synonym); note that in this case the entry is not italicized because the name and/or combination is invalid. The reader finds the currently accepted name (*Opisthacanthus cayaporum*) following the original entry. To find more information, the reader should then look up the name "*cayaporum*, *Opisthacanthus*" in the Index as described in (a) above.

Also included in the Index are misidentifications and incorrect spellings of scorpion names; in all such cases, the reader is referred to the correct name or spelling.

Misidentifications (MIS) abound in scorpion literature, and it was not possible to include all of them. Clearly, not all misidentifications are (or can be) recognized, as this might require examination of the actual specimens (which are sometimes lost) to confirm their identities. Nevertheless, we tried to account for as many of the published cases as possible.

An incorrect spelling can originate from the author who originally introduced the name (listed in the Catalog as "IOS", or incorrect original spelling); an IOS is subsequently changed according to the Code (a justified emendation). However, some attempts to correct the spellings of names

are unjustified emendations (listed as "UE"). Still other misspellings are listed as "ISS" (incorrect subsequent spellings), which are merely misspellings of the correct name. The latter often result from printing errors followed by failure of the author to properly correct page proofs.

A special comment should be given on the correct use of eponyms, i.e., endings "-ii" or "-i" derived from proper masculine names. In the old taxonomic literature, it was common to see the ending "-ii", but the current Code prescribes only the ending "-i" for the species derived from a male's name (e.g., *kraepelini*, *birulai*). However, the Code requires for original spellings to be retained. Confusion is caused by the assumed latinization of proper names in the old literature; e.g., a correct name derived from "Fabricius" is "*fabricii*", not "*fabriciusi*". According to the current Code, both spellings are equally allowable. This means that old-fashioned eponyms (e.g., *pocockii*) should not be "corrected" to a modern form, and, moreover, that all such corrections constitute unjustified emendations (UE).