Using sea cucumbers to illustrate the basics of zoological nomenclature

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Abstract

In addition to a brief account of the need to have unique and unambiguous scientific names for taxa, this paper, annotated with examples of sea cucumbers, explains the basics of zoological nomenclature. In doing so it aims to reduce the confusion that exists among various breeds of end-users of taxonomists who may not fully understand the seemingly arbitrary and often volatile nature of scientific names. This paper also aims to provide teachers and students with a comprehensible account of the basic principles of zoological nomenclature.

Introduction

We, a group of profoundly enthusiastic sea cucumber taxonomists, were recently given the opportunity by the National Science Foundation Partnerships for Enhancing Expertise in Taxonomy program12 to undertake an integrative taxonomic revision of aspidochirotid sea cucumbers, with the main focus on the commercially important families: the Holothuriidae and the Stichopodidae. In order to drive this daunting project to success, several interlinked lines of research are currently being undertaken: literature is compiled, scientific names extracted and judged, types are tracked down and their taxonomic status assessed, finally field surveys are carried out to generate novel systematic and biogeographical knowledge. Each of these tasks demands specific expertise and skill.

In the present paper we succinctly explain the basic rules for establishing scientific names and their standards of reference: their so-called types.

Why do we need scientific names?

When Shakespeare had Juliet say the famous words “What’s in a name? That which we call a rose by any other name would smell as sweet”, he meant that a name is an arbitrary construct, that if replaced by any other name, will not change the identity of the name-bearer. This concept might work for common names used by romantic authors, but it does not apply to the scientific names of taxa. A taxon13 is a named or unnamed group of real organisms that can be recognized as a formal entity at any level of a hierarchical classification. But what is a scientific name?

A scientific name is the unique identifier of a taxon. Such names are necessary to avoid a nomenclatural Tower of Babel where different names are used for the same taxonomic unit by different authors, as this would obstruct efficient communication. Despite the existence of a rigorous set of rules governing scientific names, all too often multiple names have been given to the same taxon (synonyms, see below) or, conversely, multiple taxa have been endowed with the same name (homonyms, see below). The universally accepted rules for assigning names are known as the codes of nomenclature. In zoological nomenclature, the code used today is published in the fourth edition of the International Code of Zoological Nomenclature (ICZN 1999, the “Code”).

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13. Taxa= plural, taxon= singular
In addition to a scientific name, species may also have one or more vernacular names. These names are non-unique and not universally understood. They are used for general, non-scientific purposes and are not further discussed here.

What is in a scientific name?

The Code specifies that scientific names are spelled in the 26 letters of the (ISO basic) Latin alphabet, and that numbers, diacritical and other marks such as apostrophes or hyphens may not be employed. If such marks have been used in the original spelling, subsequent taxonomists correct them in their publications, in accordance with the rules expressed in the Code. Such corrections do however not affect the nomenclatural value of the name.

Example 1 The genus name Mühleria was corrected to Muelleria because the Code stipulates that the umlaut is to be deleted from a vowel and the letter “e” inserted after that vowel.

Example 2 Holothuria fusco-rubra was corrected to Holothuria fuscorubra to unite component words (i.e. fuscorubra, meaning dark red) without a hyphen.

The number of words in a scientific name depends on the taxonomic rank; that is, the level of the taxon in the taxonomic hierarchy (e.g. species, genus, family) of the named taxon. Above the species rank, a scientific name is composed of only a single word (a uninomen) and always begins with an upper-case letter. Family-group names are derived from the stem of the genus type, with the addition of a suffix: -oidea for a superfamily, -idae for a family, -inae for a subfamily, -ini for a tribe, and -ina for a subtribe. Higher and lower ranks have no regulated suffixes. To determine the stem in a generic name, one must delete the case ending of the genitive singular of the type genus.

Example Cucumaria (genitive Cucumariae; stem Cucumari-) gives the family name Cucumariidae.

The scientific name of a species is binominal (i.e. two names); the first name is the generic or genus name and the second the specific name. The generic name always commences with an upper-case letter; while the specific name never has an upper-case letter, regardless of the original spelling or regardless whether or not that name was derived from a person’s or a locality name.

Example In 1883, Ludwig established a new species from the Strait of Magellan: Holothuria Magellani Ludwig, 1883. Even though the specific name refers to a geographical locality, it cannot take an upper-case letter. This species is now thought to belong to the genus Mesothuria and hence its valid scientific name is Mesothuria magellani (Ludwig, 1883).

When used, the scientific name of a subgenus is interpolated in parentheses between the generic and the specific names. Like the generic name, it is capitalized. Addition of a subgeneric name does not make the name a trinomen.
At the subspecies rank names become trinominal (three names), and subspecies names, like species names, begin with a lower-case letter. The Code does not recognize names below the subspecies level, except that “varieties” established before 1961, are automatically regarded as subspecific names.

Whose name? And since when?

The author of the scientific name of a taxon is placed without intervening mark or punctuation after the name, except when a species name is combined with a different generic name than what was originally designated. In this case the author’s name is placed in parentheses. The year of publication of the name may also be appended after the author’s name, separated by a comma, and included within parentheses when the author’s name is so delineated. The author and year do not form part of the taxon name per se, but citing them once in a paper is recommended because this allows detection of homonyms (see below) and facilitates access to other relevant scientific literature.

In some cases, obtaining the correct date of a publication can be problematic. For instance, when the date of actual publication is not in agreement with the date printed on the work itself, or when a work was separately published in parts over a given period of time.
The Apodous Holothurians. By H. L. Clark. Smithsonian Contributions to Knowledge, Part of vol. xxv. P. 231. (Washington: Smithsonian Institution, 1907.)

The author of this valuable memoir has had the advantage of studying more than two thousand specimens of the species included in the families Synaptidae and Molpadidae, and he has taken the opportunity of collecting together in the form of a handsome volume the information we possess concerning all the species of this interesting group. There are three coloured and ten monochrome plates of figures, illustrating the form and anatomy of the different species, of which several are original, and the others copied from the works of Semper, Thed, Shicht, and other zoologists. Eight new genera are described, and a new generic name is proposed for an old genus. The monograph will undoubtedly be of great service to all those who are interested in the study of the Echinodermata.

Figure 6. H.L. Clark’s important monograph, “The Apodous Holothurians”, is cited alternatively with two publication dates (1907 and 1908; see Pawson et al. 2001). According to the Code the date printed on the publication should be accepted unless there is evidence to the contrary. H.L. Clark (1921) himself indicated that, even though 1907 is the publication date on the title page, the work actually appeared in 1908. Accordingly, new taxa introduced in that work all date from 1908 (e.g. *Acaudina Clark, 1908*) (screenshot taken from the book review that appeared in volume 78 of the journal *Nature*).

Example The exact dates of publication of Semper’s *Reisen im Archipel der Philippinen. Wissenschaftlige Resultate Holothurien* are difficult to assess as this work was published in several parts. Johnson (1969), having the complete and original work at his disposition, showed that pages 1–70 and plates 1–15 were published in 1867, whereas pages 71–228 and plates 16–40 were published in 1868. As a consequence all names introduced in the first part are dated 1867, whereas those from page 71 onwards are dated 1868 (e.g. *Colochirus cylindricus* Semper, 1867 (p. 56), but *Colochirus peruanus* Semper, 1868 [p. 233]).

Generic, subgeneric, specific and subspecific names are to be placed in *italics*, or underlined, in text. The name of the author and date of publication are in normal type face.

What is the status of a scientific name?

To be used, a scientific name needs to be available and valid, as defined by the Code.

To be available, a scientific name:
- must appear in a work that consistently applied the Principle of Binominal Nomenclature;
- must be accompanied by a taxonomic description or reference (e.g. a previous work that describes, but does not validly name, the species) to such a description;
- may have to satisfy additional criteria. For example, descriptions of species published after 1999 have to include designation of a type specimen(s) (see below).

Example *Holothuria fisheri* Domantay, 1953 and *Holothuria mortenseni* Domantay, 1953 are two names that appeared in a checklist without descriptions. As a result, the species concepts *Holothuria fisheri* and *Holothuria mortenseni* as proposed by Domantay in 1953 are not available. In fact, the same names could be validly used for other species in the future, and if so used would take their authorship and date of publication from that usage.

To be valid, a scientific name:
- must be the oldest available name for the taxon (i.e. be the senior synonym). The same taxon may have been described subsequently, if so, these names are considered junior synonyms. Junior synonyms, although they may be available, are not valid.

Synonyms can be based on different types (see also below) in which case they are considered subjective synonyms.

Example *Holothuria vagabunda* Selenka, 1867 is considered to be the junior subjective synonym of *Holothuria leucospilota* (Brandt, 1835). The name *Holothuria vagabunda* is available but is not valid in the opinion of the specialist who treated it as a junior subjective synonym of *Holothuria leucospilota*. Another specialist can remove *H. vagabunda* from synonymy with *H. leucospilota*, and thus treat *H. vagabunda* as a valid name. (photo credit: A. Kerr)
Synonyms can also be based on the same type(s) in which case they are considered objective synonyms.

Figure 8. The subgenus Ludwigothuria Deichmann, 1958 is the junior synonym of Halodeima Pearson, 1914. Ludwigothuria and Halodeima are objective synonyms because they are based on the same type species, namely Holothuria atra Jaeger, 1833, species here depicted from the Comores. (photo credit: D. VandenSpiegel)

Figure 9. Cherbonnier introduced Bohadschia cousteaui twice: once in 1954 and once in 1955. But both descriptions were based on the same syntypes. Bohadschia cousteaui Cherbonnier, 1955 is thus the junior objective synonym of B. cousteaui Cherbonnier, 1954. (photo credit: Y. Samyn)

• It cannot have been suppressed. A scientific name can be made invalid by the Commission on Zoological Nomenclature when its usage threatens the stability and universality of well-established names or may cause confusion. Suppressed names are placed on the “Official Lists and Indexes of Names in Zoology” (available at: http://www.iczn.org 2009), together with a reference to the ruling of the Commission published in the Bulletin of Zoological Nomenclature.

Example 1 In 1889, Sluiter introduced the name Holothuria lamperti. Sluiter (1889) was however not aware that Ludwig, in 1886, had introduced exactly the same species name for another species. Holothuria lamperti Sluiter, 1886 is the junior primary homonym of Holothuria lamperti Ludwig, 1886 and is thus invalid. Ludwig (1891) set aside Holothuria lamperti Sluiter, 1886 and introduced the replacement name Holothuria kurti Ludwig, 1891.

Example 2 Holothuria maculata Lesueur, 1824, H. maculata Brandt, 1835 and H. maculata Kuhl and van Hasselt, 1869 are all three junior primary homonyms of H. maculata Chamisso & Eysenhardt, 1821 and thus are invalid. If such happens, the species concepts behind each of these names established after 1821, automatically take the name of their oldest other available name. For instance Holothuria maculata Brandt, 1835 was replaced by its valid junior subjective synonym Holothuria (Microthele) nobilis (Selenka, 1867).

Figure 10. Holothuria guamensis Quoy and Gaimard, 1833 was suppressed by the Commission because it was judged that there was confusion about how the name was applied in the absence of both type specimens and an adequate description. Even though the specimen shown here corresponds remarkably well with the description of H. guamensis, that name cannot be validly used for it (photo credit: G. Paulay)
cannot be a so-called nomen dubium: a scientific name given to a particular species that has an unidentifiable name-bearing type. It will be up to the taxonomist to decide how to treat such a name; either stabilization through re-description of material from (roughly) the same type locality or by replacement where an unidentifiable name-bearing type is replaced by a neotype (see below). The latter option requires approval from the ICZN.

Example Ananus holothuroides Sluiter, 1881 of which Théel (1886) thought that the name represents probably a deformed Holothuria pyxis Selenka, 1867 or some other species, is a nomen dubium.

Type(s) as permanent and objective standards of reference to scientific names

Each scientific name recognized by the Code is (or should be) objectively defined by a name-bearing type. This applies from the family-group down to the species-group. Thus:

- each family-group taxon (including subfamilies and tribes) has a type genus;
- each genus-group taxon (including subgenera) has a type species;
- each species-group taxon (including subspecies) has one or several type specimens.

Example In 1958, Deichmann designated Holothuria sanctori Delle Chiaje, 1823 as type species of Microthele Brandt, 1835. This, as Clark & Rowe (1967) noted, is inadmissible because H. sanctori was not originally listed by Brandt in Microthele. The species H. (Microthele) maculata Brandt, 1835 was subsequently (by Clark & Rowe, 1967; not by Brandt, 1835) designated as type-species. Clark and Rowe’s (1967) typification stabilized the original concept of Microthele. H. sanctori (cf. picture) was later referred to a new subgenus: Platyperona Rowe, 1969.

The identities of species-group taxa are established by the designation of type specimens. To eliminate the potential for conflict among multiple specimens thought to represent a species, which may turn out to represent more than one species, only a single type specimen, the primary type, has relevance in establishing the identity of a species.

All species described after 1999 have to be accompanied by the designation of a primary type, but older descriptions were not required to and often lacked any type designation. This creates a problem when either no types were designated by the author, or when multiple types (= syntypes) were established. For the former, subsequent revisers of that species can search for and attempt to establish what specimen(s) were studied by the describing author(s) and treat such specimens, if found, as syntypes (if several) or as holotype (if clearly only a single specimen was used to establish the species concept). For the latter (i.e. when an author did not establish a specimen as the primary type, either because he designated a series of specimens, or it is clear that he has studied multiple specimens, then these specimens are considered to constitute a type series, and they are referred to as syntypes). Subsequent authors may then select a single specimen from this type series and designate it as the primary type. That action makes the selected specimen a lectotype (i.e. subsequently designated primary type), and at the same time renders all other specimens in the type series to be paralectotypes (i.e. subsequently designated secondary types). If it is found later that the designated lectotype was not a syntype, it loses its status as lectotype.

If no specimens can be identified to remain from the author’s study, then a reviser may establish a neotype to solidify the concept of that species and as such stabilize its name. Neotype designation is however not to be taken lightly and the Code stipulates a number of conditions that must be met. Most important is that a neotype is not to be designated as a curatorial routine but as way to clarify the taxonomic status or type locality of a species. Authors must also prove that the remaining name-bearing
types (holotype, lectotype, all syntypes or earlier established neotype) is lost or destroyed.

Figure 12. In 2009, Massin et al. stabilized the identity of the commercial species *Holothuria scabra* Jaeger, 1833. Such designation was needed because the taxonomic identity of the species was unclear (photo credit: S. Purcell).

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References


Clark H.L. 1908. The apodous holothurians: A monograph of the Synaptidae and Molpadiidae, including a report on the representatives of these families in the collections of the United States National Museum. Smithsonian Contributions to Knowledge 35:1–231, 14 pls.


