

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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 12. <http://www.guammarinelab.com/peetcukes> 2009
 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.



Figure 1. Fishermen use vernacular names such as “golden sandfish” in English or “le mouton” in French for *Holothuria lessoni* (Massin et al. 2009). (photo credit: S. Purcell)

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 *Mülleria* 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.



Figure 2. In 1886, Théel corrected *Labidodemas Selenkianum* Semper, 1868 to *Labidodemas selenkianum* Semper, 1868 — a species generally considered to be a junior subjective synonym (see below) of *Labidodemas semperianum* Selenka, 1867 (originally spelled as *Labidodemas Semperianum* Selenka, 1867). (photo credit: B. Van Bogaert)

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.



Figure 3. Rowe (1969) decided that the species *Holothuria difficilis* Semper, 1868, *Muelleria parvula* Selenka, 1867 and *Holothuria sanctori* Delle Chiaje, 1823 formed an evolutionary unit within the genus *Holothuria* Linnaeus, 1767. To accommodate these species in a natural group, he erected the subgenus *Platyperona* Rowe, 1969. The complete binominal name of *H. difficilis* thus became: *Holothuria (Platyperona) difficilis* Semper, 1868. (photo credit: Y. Samyn)

At the subspecies rank names become trinomial (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.



Figure 4. In 1921 and 1938, H.L. Clark recognized and named four different color varieties in addition to the typical form in *Holothuria impatiens* (Forsskål, 1775). Because these varietal names were given before 1961, they are now regarded to have subspecific rank. As such, the correct scientific name given to, for instance, *Holothuria impatiens* var. *pulchra* H.L. Clark, 1921 (cf. picture) is *Holothuria impatiens pulchra* H.L. Clark, 1921, a trinomen. When one adds the subgenus — *Holothuria (Thymiosycia) impatiens pulchra* H.L. Clark, 1921 — the name is still considered a trinomen. (scan of Fig. 3 in Plate 19 in H.L. Clark, 1921)

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.



Figure 5. In 1775 Forsskål described the species *Fistularia impatiens*, hence the binomen *Fistularia impatiens* Forsskål, 1775. However, as the genus name *Fistularia* was used (i.e. was pre-occupied) by Linnaeus, 1767, for a genus of fish, it had to be abandoned for the species recognized by Forsskål. Currently, the species is assigned to *Holothuria* Linnaeus, 1767, resulting in the new combination *Holothuria impatiens* (Forsskål, 1775). (photo credit: D. VandenSpiegel)

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. xxxv. Pp. 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 Synaptidæ and Molpodadiidæ, 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, Theel, Sluiter, 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. Wissenschaftliche 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 have been proposed during or after 1758 (the start of zoological nomenclature defined by the publication of the tenth edition of Linnaeus' *Systema naturae* and Clerck's *Aranei Svecici*);

- 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.



Figure 7. *Holothuria vagabunda* Selenka, 1867 is considered to be the junior subjective synonym of *H. 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 *H. 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*.



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)

- must have the oldest use of that name for that taxon. Sometimes the same name is applied to two different organisms by different authors, because the authors are not aware of each other’s work. In such cases the younger name — junior homonym — is considered invalid unless that name is protected (*nomen protectum*) by a decision of ICZN.

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, 1889 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).

- 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.



Figure 11. *Stichopus* is the type genus of the Stichopodidae; *Stichopus chloronotus* Brandt, 1835 is the type species of *Stichopus*; *Stichopus moebii* Semper, 1868 is one of the species in the genus *Stichopus*, its holotype (cf. picture) is deposited in the Zoologisches Museum zu Universität Hamburg under the acquisition number ZMH E. 2702. (photo credit: Y. Samyn)

Types can be designated by the original author (original designation) or by a later author (subsequent designation). However, a nominal species is only eligible to be fixed as the type species of a nominal genus (or subgenus) if it was originally included in the nominal genus when that genus was named.

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

- Brandt J.F. 1835. Echinodermata ordo Holothurina. p. 42-62. In: *Prodromus descriptionis animalium ab H. Mertensio in orbis terrarum circumnavigatione observatorum*. Petropolis: Sumptibus Academiae.
- de Chamisso A. and Eysenhardt C.C. 1821. De animalibus quibusdam e classe vermium lineana, in circumnavigatione terrae, auspicante Comite N. Romanzoff, Duce Ottone de Kotzebue, 1815–1818 peracta observatis. II. *Nova Acta (Verhandlungen) Academia Caesarea Leopoldino-Carolina Germanica Naturae Curisorum* 10:345–374., pls. 24–31.
- Clark A.M. and Rowe F.W.E. 1967. Proposals for the stabilization of the names of certain genera and species of Holothurioidea, Z.N. (S) 1782. *Bulletin of zoological Nomenclature* 24:98–115.
- 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.
- Clark H.L. 1921. The Echinoderm fauna of Torres Strait: its composition and its origin. *Carnegie Institution of Washington Publication* 214. 233 p., 10 pls.
- Clark H.L. 1938. Echinoderms from Australia. An account of collections made in 1929 and 1932. *Memoirs Museum Comparative Zoology, Harvard*. 55. 596 p., 64 figs., 28 pls.
- Deichmann E. 1958. The Holothurioidea collected by the Veleró III and IV during the years 1932 to 1954, part II. *Aspidochirotida*. *Allan Hancock Pacific Expedition* 11:239–349, pls 1–9.
- Delle Chiaje S. 1823. *Memorie sulla Storia e Notomia degli Animali senza vertebre del Regno di Napoli*. Fratelli Fernandes, Napoli 1:1–184.
- Domantay J.S. 1933. Littoral Holothurioidea of Port Galera Bay and Adjacent Waters. *Natural Applied Science Bulletin, University Philippines* 3:41–101.
- Forsskål P. 1775. *Descriptiones animalium avium, amphibiorum, piscium, insectorum, vermium quae in itinere orientali obseravit Petrus Forskål*. Post mortem auctoris edidit Carsten Nieburh. *Adjuncta est materia medica kahirina atque tabula maris rubri geographica, Auniae*. 140 p.
- ICZN (International Commission on Zoological Nomenclature). 1999. *International Code of Zoological Nomenclature*, 4th edition. International Trust for Zoological Nomenclature, London: i–xxix, 306 p.
- Jaeger G.F. 1833. *De Holothuriis*. *Dissertatio Inauguralis*. Turici. 40 p., 3 pls.
- Johnson R.I. 1969. *Semper's Reisen im Archipel der Philippinen, Wissenschaftliche Resultate, 1867–1916*. *Journal of the Society for Bibliography of Natural History* 5: 144–147.
- Kuhl H. and van Hasselt J.C. 1896. *Echinodermes peintes d'après nature par les soins de membres de la commission pour l'exploration physique des possessions d'outre-mer Pays-Bas, publiées d'après les cartons du Musée royal d'Histoire naturelle à Leiden (Herklots, JA. ed.)*. *Bijdragen Dierkunde, Amsterdam*. Aflev. 9. 12 p.

- de Lamarck J.B.P.A. 1816. Histoire Naturelles des Animaux sans Vertèbres, présentant les caractères généraux et particuliers des ces animaux, leur distribution, leurs classes, leurs familles, leurs genres, et la citation des principales espèces qui s'y rapportent. 7 Volumes. Verdrière, Paris.
- Lesueur C.A. 1825. Description of several new Species of *Holothuria*. Journal Academy Natural Sciences, Philadelphia. 4:155–163.
- Linnaeus C. 1758. Systema naturæ per regna tria naturæ, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus I. Editio decima, reformata. Holmiæ: Laurentii Salvii.
- Linnaeus C. 1766. Systema naturæ, per regna tria naturæ, secundum classes, ordines, genera, species, cum characteribus, differentiis, svnonymis, locis. Tomus I. Editio duodecima reformata. Laurentii Salvii: Holmiae.
- Ludwig H.L. 1886. Die von G. Chierchia auf der Fahrt der Kgl. Ital. Corvette 'Vettor Pisani' gesammelten Holothurien. Zoologische Jahrbücher für Systematik, Geographie und Biologie 2:1–36.
- Ludwig, H.L. 1889–92. Echinodermen: Die Zeewalzen. In: H.G. Bronn, ed. Bronn's Klassen und Ordnungen des Their-Reichs, Bd 2, Abt. 3, Buch 1: i–vi, 460 p, 17 pls. C.F. Winter'sche, Leipzig.
- Mortensen T. 1938. Contributions to the study of the development and larval forms of Echinoderms. IV. Danske Videnskabernes Selskabs Skrifter, Naturvidenskabelig matematisk Afdeling Series 9. Tome 7. No. 3. 59 p.
- Pawson D.L., Vance D.J. and Ahearn C. 2001. Western Atlantic sea cucumbers of the Order Molpadiida (Echinodermata: Holothuroidea). Bulletin of the Biological Society of Washington 10:311–327.
- Pearson J. 1914. Proposed re-classification of the genera *Mülleria* and *Holothuria*. Spolya Zeylanica 9:163–172.
- Quoy J.R.C. and Gaimard J.P. 1833. Holothuries. p. 108–133. In: Voyage de la corvette de l'Astrolabe. Exécuté par ordre du roi pendant les années 1826–1829 sous le commandement de M.J. Dumont d'Urville – Zoologie: Zoophytes. J. Tastu, Paris. 390 p, 26 pls.
- Rowe F.W.E. 1969. A review of the family Holothuriidae (Holothuroidea: Aspidochirotida). Bulletin of the British Museum (Natural History) Zoology 18:119–170.
- Selenka E. 1867. Beiträge zur Anatomie and Systematik der Holothurien. Zeitschrift für wissenschaftliche Zoologie 17:291–374, pls. 17–20.
- Semper C. 1867–1868. Reisen im Archipel der Philippinen. Holothurien. 2. Wissenschaftliche Resultate: i–x, 288 p., 40 pls. Leipzig.
- Simpson G.G. 1961. Principles of Animal Taxonomy. Columbia University Press, New York and London. 247 p.
- Sluiter C.P. 1881. Vorläufige Mittheilung über einige neue Holothurien von der Westküste Java's. Verslagen en Mededelingen van de Koninkelijke Akademie van Wetenschappen te Amsterdam, Afdeling Natuurkunde 16:282–285.
- Sluiter C.P. 1889. Nachträgliches Über die Echinodermen Fauna des Java-Meeres. Natuurkundig Tijdschrift voor Nederlandsch-Indië 49, 8ste serie, 10:105–110, 1pl.
- Théel H. 1886. Report on the Holothuroidea dredged by HMS. Challenger during the years 1873–1876. Part II. Scientific Results of HMS. Challenger 1873–1876. Zoology. IV(34): 290 p., 16 pls.