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ZooNom: an online thesaurus for alleviating ambiguity in the terminology of zoological nomenclature

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Abstract

Zoological nomenclature is the discipline of taxonomy responsible for regulating the scientific names of animal species. It has its roots in Carolus Linnaeus' work and has been governed by an international Code since the turn of the 20th century. Its vocabulary, on the other hand, is not always clear. Various authors have established new terminology in order to reduce ambiguity. To make these new terms, but also the classical terms used by the *International Code of Zoological Nomenclature*, accessible, an electronic thesaurus (link: https://www.loterre.fr/skosmos/FM8/en/) was created, allowing to compare existing terminologies. This thesaurus is also a tool for reflection and discussion, targeting taxonomists and experts in nomenclature.

Key words: Concepts, Vocabulary, SKOS

Introduction

Communicating is an essential part of the work of scientists, whether with peers or with society as a whole. In the field of life sciences, especially when it comes to taxonomy, ecology, genetics and population biology, being able to clearly designate an organism or a group of organisms is crucial.

Zoological nomenclature is the scientific discipline devoted to the unambiguous naming of animal taxa. It was initiated by Carolus Linnaeus, and its starting point was fixed at the tenth edition of his *Systema naturae* (Linnaeus 1758), making it more than 260 years old. Zoological nomenclature (or onymology), as a discipline, is used by scientists, as is its derived result, also called a nomenclature. The latter is also in use in legal texts, public databases and conservation policy documents. Its methodology is regulated by the *International Code of Zoological Nomenclature*, or the *Code* (Anonymous 1999, 2012). The International Commission on Zoological Nomenclature (the Commission) is in charge of its redaction and management.

Questions and exchanges on platforms such as Taxacom (http://mailman.nhm.ku.edu/cgi-bin/mailman/listinfo/taxacom) are often linked to the misunderstanding of concepts of this discipline. Zoological nomenclature, also known as Linnaean zoological nomenclature, associates a name in a Latinized form to a taxon (a classification unit, concept proper to the scientific discipline of taxonomy) in a given classification. Its underlying structure is the Linnaean classification, which makes use of ranks. The *Code* recognizes nine main ranks (as well as potential additional ones), and has authority only on the names assigned in between the most inclusive (superfamily) and the least inclusive (subspecies) of these ranks. The main ranks, in descending order, are: superfamily, family, subfamily, tribe, subtribe, genus, subgenus, species and subspecies (Anonymous 1999). These ranks belong to three nomenclatural groups, also called nominal series, namely the family series, ranging from superfamily to subtribe; the genus series, covering any name assigned to the genus and subgenus ranks and the species series, for any name designating a species, a subspecies or an aggregate of species or subspecies (Anonymous 1999). At the species level, the

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name is a double complex composed of the generic and specific names. This is known as the Principle of Binominal Nomenclature (Anonymous 1999). The term binominal nomenclature is sometimes used as a synonym of Linnaean nomenclature.

It is important to highlight the fact that the structure of zoological nomenclature was developed throughout centuries. From Linnaeus' works, through the propositions of Strickland *et al.* (1843) and Blanchard's *Règle*s (Blanchard 1905) to the last edition of the *Code* (Anonymous 1999, 2012), zoological nomenclature acquired its own traditions, usages and vocabulary. Considering its vocabulary and terms, the *Code*, for example, has an English and a French glossaries. The English glossary has approximately 360 entries.

The vocabulary of zoological nomenclature

The vocabulary of zoological nomenclature, having been constituted over a period of more than two centuries and a half, carries a heritage that is sometimes perceived as obsolete, or is misunderstood. The most well-known example is the "type" or "name-bearing type" concept. It is usually used to designates the physical specimen(s) that bear(s) the scientific Latin name of a taxon of the species series (species or subspecies). In the genus and family series, types are not specimens but nominal taxa (nominal types), respectively of the species or genus series—which ultimately refer to the specimens that are types of the nominal species concerned. Nomenclatural types are often mistaken for perfect models, representatives of their taxa, carrying the decisive (morphological) characters of their kinds (Farber 1976). The *Code* allows any specimen and any (available) name to be used as a type, as long as it belongs to the taxon it "typifies". The species series type plays the essential role of anchoring a name in the reality of material specimens and animal populations (Dubois & Ohler 1996). In all the nominal series, types are essential in the management of the names in case of conflict.

Another important example is the distinction between two kinds of synonymies, i.e., the fact that a taxon has two or more names assigned to it. The first one is "subjective synonymy", and happens when two names, based on different types, are deemed to designate the same taxon by the subjective taxonomic decision of an author. The second one, called "objective synonymy" happens when two names are based on the same type. In both cases, among these two names, the older one (the senior synonym) is potentially (if not invalid for another reason) considered valid (i.e., the correct one to use under the rules of the *Code*) under the Principle of Priority (Anonymous 1999). Even though these two concepts seem similar, and are usually treated indifferently as "synonyms" in biodiversity or genetic databases, they actually are not. The first kind of synonyms is potentially valid, if a taxonomy separates the two designated taxa, while a junior objective synonym always remains invalid, and thus should not be used to designate a taxon (unless its senior synonym is itself invalid—e.g. by being preoccupied and thus a junior homonym—or unless the Commission exceptionally acts on it) (Anonymous 1999).

The confusion created by the misuses of these and other terms led some authors to design a more precise vocabulary. The term "onomatophore" (Simpson 1940) has been proposed to replace "type", keeping only the essential name-bearing quality of the entity (ὄνομα [onoma], name—φέρω [phero], I bear, I carry), leaving aside the notion of "model". Several other terms were also created and cover different domains of zoological nomenclature, even the most controversial ones—e.g. aspidonym, for a scientific name protected from "taxonomic vandalism" (Wüster *et al.* 2021).

These terms published over decades by various authors in various sources are not always easily accessible. To overcome this situation, all the terms found during this work were analyzed and assembled in a thesaurus of zoological nomenclature (called *ZooNom*) and made available online. Unlike NOMEN (Dmitriev & Yoder 2020), an ontology covering all biological names based on the official Codes of their respective disciplines, *ZooNom* focuses only on zoological nomenclature and on the diversity of terms that have been coined in this discipline, even outside of the official *Code*.

Methods

ZooNom is a controlled vocabulary in the form of a thesaurus. The World Wide Web Consortium presents vocabularies as follows: "On the Semantic Web, vocabularies define the concepts and relationships [...] used to describe

and represent an area of concern" (Anonymous 2015) and a thesaurus as a structure that "identifies and describes, through natural language and other informal means, a set of distinct ideas or meanings" (Anonymous 2009). It was built using Opentheso (Rousset 2021), an open-source thesaurus-making software. It complies with the most recent standards i.e., ISO 25964-1: 2011 and ISO 25964-2: 2013. The thesaurus is accessible online through the LOTERRE platform (Linked Open TERminology REssources). It was built following the Essential Thesaurus Construction guidelines (Broughton 2006).

The search for terms was conducted in 58 publications (Appendix 1), including the *Code* and the articles referencing A. Dubois' vocabulary, as well as publications from other authors introducing new nomenclatural terms. D. L. Hawksworth's *Terms used in bionomenclature* (Hawksworth 2010) was also consulted, but only part of the terms proposed are included at this point. In fact, Hawksworth presents terms that come from different nomenclatural disciplines, some that are considered obsolete and other that are simply comical e.g. "vampirotype: (zool[ogy]., unoff[icial].) a type specimen, usually an insect, mounted with an oversized pin for the size of the specimen so that it appears impaled (!)"(p. 209). As he does not provide an exact bibliography, further terms are to be added on a case by case basis after a thorough additional research.

The bibliography of the thesaurus is documented on its main webpage. The collected terms were classified in semantic sets (called 'collections' on Opentheso and 'groups' on LOTERRE), 20 in total (Table 1), and aggregated in semantic units—called 'concepts' by the World Wide Web Consortium (Anonymous 2009).

TABLE 1. The twenty semantic collections of the *ZooNom* thesaurus in alphabetical order.

Name of the collection	Definition	Name of the collection	Definition
Allocation and Identification	The set of terms relating to the designation and identification of a type	Nomenclature Theory	The lexical field related to the theory of nomenclature and the theoretical concepts of this discipline
Assignment of Nomina to Ranks	The vocabulary referring to the assignment of a name to a nomenclatural rank and the properties of these ranks	Priority and Usage	All the terms referring to the concepts of priority and usage
Availability	All terms relating to the lexical field of availability in zoological nomenclature	Registration	The lexical field related to registration and nomenclatural databases
Classification	All the rank names used in nomenclature, in addition to the vocabulary around the notion of animal	Relationships between taxa	All terms that relate to the position of one taxon relative to another in a classification
First reviser	The set of terms that relate to the first reviser and the first reviser action	Spelling	All terms relating to the lexical field of spelling in zoological nomenclature
Homonymy	All the terms that relate to the notion of homonymy	Synonymy	All the terms that relate to the notion of synonymy
Languages and Grammar	The set of terms that relate to the languages of zoological nomenclature and to the grammar and spelling rules that apply to them	Taxonomy	All terms that relate to taxonomy, diagnosis, and nomenclatural treatment of a given taxonomy
Locality	The lexical field related to type-locality	The Code and the Commission	All the terms specific to the structure of the Code, and to the publications and actions of the Commission
Names	All the terms referring to names and the vocabulary that describe them	Types	All the terms around the concept of name-bearing type
Nomenclatural publications	All the vocabulary surrounding scientific publications, authors and publication media	Validity	All terms relating to the lexical field of validity in zoological nomenclature

A concept is named by a preferred English term. The criteria for the choice for the preferred term are: (1) the fact that the term is an alternative to the *Code*'s, as this thesaurus aims to give them visibility; (2) the fact that the term is introduced with its own definition; (3) similarly to the *Code*'s Principle of Priority, in case of multiple possible terms, the older one prevails. A crosslinking with NOMEN, for the relevant terms, has been introduced with the 1.3 version..

Each concept also contains the synonyms, abbreviations, other terms of the same word family and, if relevant, different spellings. With each concept comes its definition and its *Code* equivalent term and definition, if existing. If more than one definition is attached to the concept, the *Code* definition is placed in the application note field for ease of reading, and other definitions stay in the definition field, in order of priority. Furthermore, and if relevant, its etymology, its translation in French, the author of the term and/or the definition as well as the bibliographical source are also cited. The concepts were then put in a vertical hierarchy (a "broader concept" containing a "narrower concept") and linked to one another horizontally ("related concept") for ease of use and navigation (see fig. 1).

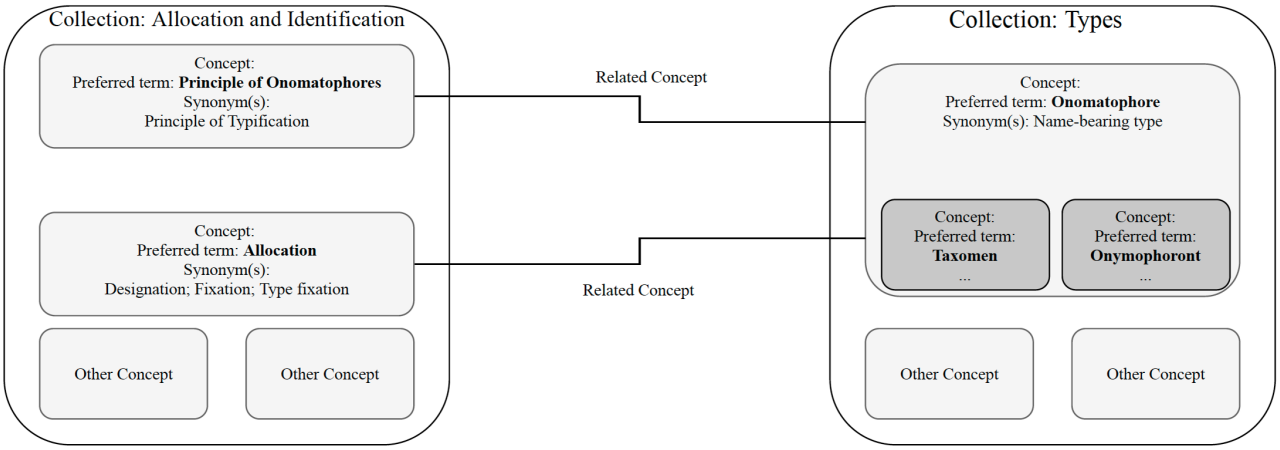

FIGURE 1. A simplified visualization of the structure of the thesaurus, with the example of the concept "*Onomatophore"*. The color gets darker for every entity contained ("narrower") in another.

Results

Currently, the *ZooNom* thesaurus (fig. 2) is findable at https://www.loterre.fr/skosmos/FM8/en/ in its 1.3 version. It contains 929 terms (excluding terms from the same word families, like plurals), distributed across 798 concepts, 406 etymologies and 60 references. It covers every aspects of zoological nomenclature, from theoretical nomenclature to database registration of names, as well as languages and grammar.

The thesaurus can be used as a classical glossary, using the search bar, or the alphabetical order, but that's not all it has to offer. Gathering different terms under one same concept also offers the possibility to compare the terminologies, and thus to choose an optimal equivalent term. For example, *subjective synonym* would lead to *doxisonym*, and *objective synonym* to *isonym* (Dubois 2000). Even though the definitions are quite close, distinguishing the two situations with precise and different words can help reduce the tendency of mixing them up. Keeping this difference in mind would result in clearer biodiversity databases. Synonymic lists would then differentiate between names that can potentially designate another independent taxon and those which cannot.

Moreover, thanks to the hierarchical structure of the thesaurus, one can find a more precise term for a given nomenclatural situation. For example, under the concept *onomatophore*, as a "narrower concept", one can find the concept *onymophoront* (Dubois 2005), which applies strictly to a type specimen and not a nominal type.

In terms of machine-actionability, this thesaurus can be useful in tagging correctly, and in a non-ambiguous way, different cases and stages of decisions in the reasoning path of nomenclature.

Curation and call for submission of terms

ZooNom is destined to be updated at least once a year. Any new concepts proposals are highly welcomed, if relevant. For this, we require the new candidate term, its definition, the bibliographic reference, and if possible, the

etymology. We are especially interested in terms frequently used in a part of the taxonomic community, or associated with a certain taxon, but unfamiliar or unknown outside of these applications.

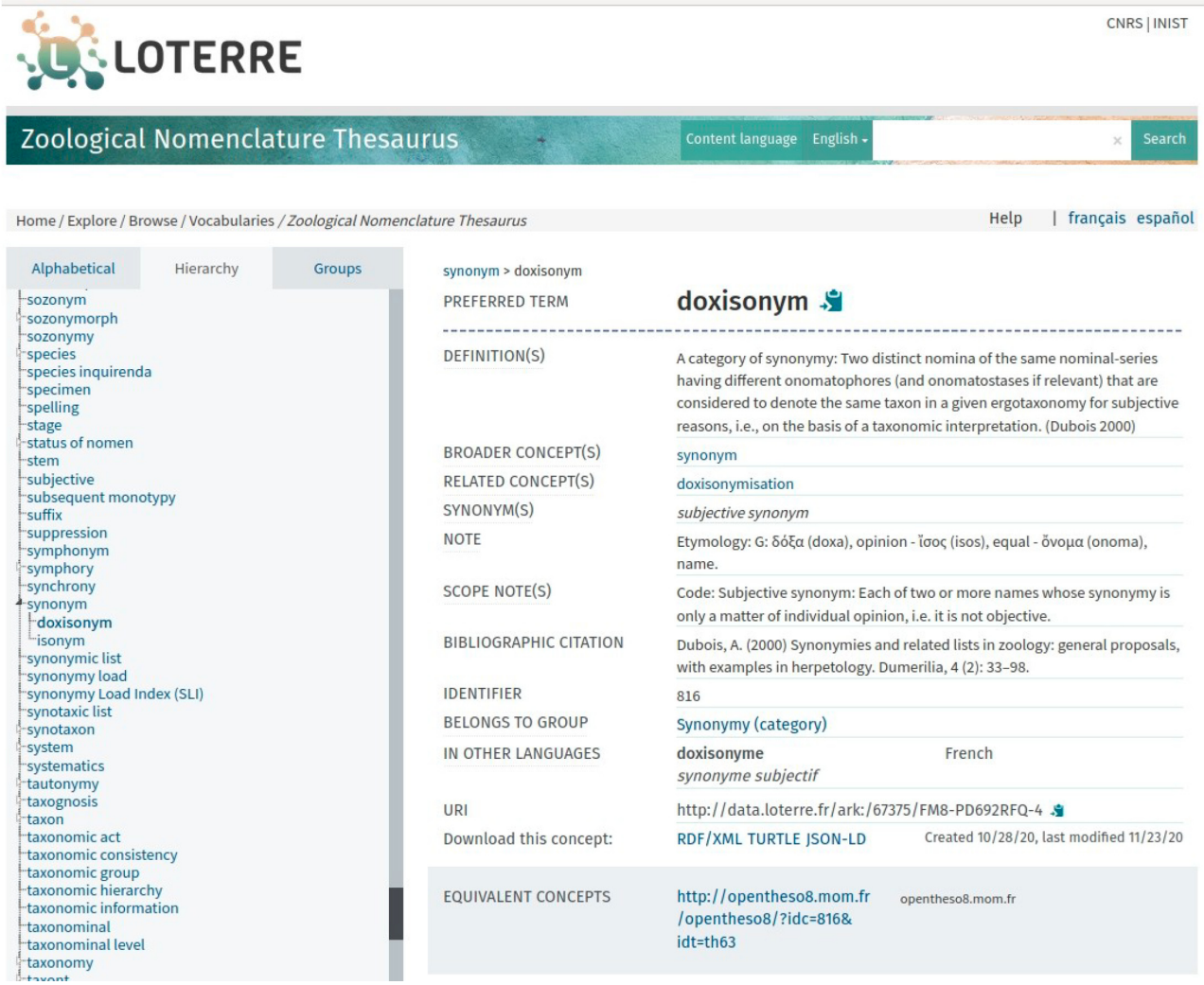

FIGURE 2. A screenshot of *ZooNom* taken on 10/11/2021. The concept shown is "doxisonym" (URL: https://www.loterre.fr/skosmos/FM8/en/page/-PD692RFQ-4). The "note" field contains the etymology, and the "scope note" field presents the *Code*'s equivalent (objective synonym) and definition.

Conclusion and perspectives

We hope that this thesaurus can be a reference for the terminology of zoological nomenclature, for both beginners and experts. This compilation of the concepts that covers zoological nomenclature could also be a medium in the process of computerization of the *Code*'s rules that govern this discipline, or the development of better data mining tools. Unlike humans, computers are not capable of managing ambiguity. As a matter of fact, having the most precise vocabulary and circumscribed concepts is crucial in applying the nomenclatural procedure to the machine, be it in programming, in databases and or in the field of Semantic Web.

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APPENDIX 1. List of the 60 publications searched for nomenclatural terms compiled in *ZooNom*.

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