

WHAT SHOULD WE CALL THE FORAMINIFERA?

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ABSTRACT

Shelled granuloreticulose microorganisms have had a complex etymological history that began in 1826 when d’Orbigny gave his new order the name Foraminifères and characterized the group. Soon afterwards, further examination and proper Latinization established them as class Foraminifera. D’Orbigny should be credited with the suprafamilial group name, regardless of rank, because he provided defining characteristics, and also because higher taxa are not governed by ICZN rules; in addition, we should consider the history of its attribution and what is traditional and customary in zoological nomenclature. The name Foraminifera is the source of a variety of informal terms, including foraminifera, foraminifer, foraminiferan, and for-am. Long after being demoted to order, the Latinized name was modified to Foraminiferida in 1964 by Loeblich and Tappan, the informal foraminiferid was introduced later. Here, we briefly examine these terms as sets of singular and plural nouns, and their derived adjectives and nouns that begin with *foram-*. Authors can choose any of the derived terms, but they should be consistent by using only one term-set throughout their paper. Other nouns derived from *foraminifer-*, such as foraminiferologist for a student of the group, are not usually part of a term-set.

The informal term *foram* is a valid derivation and it is the most common of the names used in conversation among earth scientists and biologists. It is already accepted in major dictionaries and literature, and it has been used in specific word pairs found in scientific publications. In addition, *foram* eases communication by its multilingual applicability; it is also the easiest of the terms to pronounce, write, and read. For all these reasons, its use may increase in scientific literature.

INTRODUCTION

Protist Protest

Little protists of the sea

How do we treat thee?

As foraminifers, Oh wee beasties of the sea?

Or, shall it be, foraminifera,

for the plural or the singular?

Perhaps we can float the word “foraminiferan”

but then again,

it still would mean a single cell,

but how in hell

can foraminifera be for one and two,

when so many live in the ocean blue?

Please, please tell me Dr. Foram Man or M’am,

Is it -minifer, -minifera, or -miniferan? —S.E.W.

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Authors, editors, and readers of articles on Foraminifera continue to ask, “How should we refer to this group of fascinating protists?” This is entirely appropriate since the community of foraminiferal workers have never reached a consensus. None of us, however, is ever confused about the group to which we refer. Here is the problem: when referring to these granuloreticulopods, a variety of nouns and adjectives are used for individual specimens, species, assemblages, and communities. Those who study these organisms, and some who don’t, often wonder which term is technically correct and which is preferred. How then should we refer to this group of protists? Is a consensus possible? We think it is, but first we must go back to their etymological beginning with “the father of micropaleontology” Alcide d’Orbigny (Heron-Allen, 1917; Le Calvez, 1974, Vénec-Peyré, 2002, 2004).

ORIGIN OF THE GROUP NAME

D’Orbigny, like his predecessors, thought the shells of foraminifera represented tiny molluscs (gastropods and cephalopods), worms, or other invertebrates. He observed the granuloreticulopods of living species and thought they were tiny tentacles, and he also recognized that many of the planispiral shells resembled *Nautilus*, just as had von Linnaeus (1758). Hence, d’Orbigny (1826) included foraminifera as a distinct order within the class Céphalopodes, distinguishing them from the naked Cryptodibranches by their shell and from the shelled Siphonifères by their possession of a hole through each septum. This unique feature led d’Orbigny to combine two neo-Latin words (previously derived from old Latin) *foramen/foramin* (from *forare*), meaning an opening, hole, or passage, and *fer* (from *ferre*), meaning “bearing”, when he introduced the order Foraminifères in his presentation to the Académie de Sciences on November 7, 1825. His 1826 paper clearly defined the group as the new taxon Foraminifères, and did so in a scientific manner (Galloway, 1928, 1933; Cifelli, 1990; Heron-Allen, 1917; Lipps, 2002; Vénec-Peyré, 2002, 2004). Cuvier (1828) included the name in his second edition of *Le Règne Animal*, and Von Eichwald (1830) further Latinized it by dropping the diacritical mark accenting the first “e” and adding the terminal “-a” as Foraminiferea. The name Foraminifera first appeared in the English translation, with substantial additions, of Cuvier’s “Animal Kingdom” by Griffith and Pidgeon (1834). Since then, Foraminifera has been ranked as order, class, subphylum, and phylum, with and without appropriate zoological Latin terminations.

After Dujardin (1835) recognized Foraminifères as protozoans, d’Orbigny elevated the group to the rank of class (Loeblich and Tappan, 1964; Richardson, 1990), and he continued to use Foraminifères in all of his subsequent publications. The name Foraminifera was used by the 19th-Century British school of foraminiferologists, notably

Carpenter, Williamson, Parker, Jones, and Brady, although Foraminifera was recognized as early as 1838, in the *Penny Cyclopaedia*, and the American naturalist Jacob Whitman Bailey (1841) may have first used it in a micropaleontological publication. Among their contemporaries in Germany and Austria, who were using the Germanic name Foraminiferen, Reuss (1862) may have been the first to write the formal name as Foraminifera when he split the group into unilocular and multilocular forms that he titled "Foraminifera monomera" and "Foraminifera polymera", respectively. Brady (1884) acknowledged d'Orbigny for the group name, but believed a different name would have been more appropriate because some thought Foraminifera referred to the perforated surface of the calcareous test. Some people remain confused today, but d'Orbigny clearly referred to the aperture and older apertures, not the pores on so many foraminiferal tests.

Once microfossils became generally useful in the oil industry in the mid-1920s, the field of foraminiferology blossomed. The need for a detailed manual on the group was soon fulfilled by Cushman (1928) and Galloway (1933). Both classified them as order Foraminifera (Cushman did not indicate its author; Galloway credited d'Orbigny 1826), which was universally accepted by the vast majority of workers until Loeblich and Tappan's volume for the *Treatise on Invertebrate Paleontology* in 1964. The International Code of Zoological Nomenclature (ICZN), however, was formulated in the 20th Century and it never included taxa above the family group. The editorial preface in Loeblich and Tappan (1964) indicates that the *Treatise* had its own policy for suprafamilial names based on proposals that the ICZN rejected in 1958 to avoid freezing taxonomy. That policy called for suprafamilial names to be followed by the author who first spelled and ranked the taxon as written. Loeblich and Tappan (1964, 1987) may have interpreted the "rule" that a suprafamilial name must be Latinized without any diacritical marks, so they considered Foraminifères (d'Orbigny, 1826) a vernacular French word unavailable for modification, while Foraminifera (von Eichwald, 1830) was the first formally Latinized name for the group. Thus they credited von Eichwald with the ordinal name Foraminiferida. Much of the scientific community simply used this. However, d'Orbigny clearly considered Foraminifères a formal name because of his concept and description of it, his designation of it as a new group, and his consistent capitalization of Foraminifères. In 1990, Lee classified the group as phylum Granuloreticulosa (phylum Foraminifera) and divided it into naked and testate classes, calling the latter Foraminifera, but he did not indicate authors. No ICZN rules apply to whether the person's name that follows a higher taxon should be its original author, the person who first spelled it as shown, or the one who reclassified it at the level indicated. The *Treatise* policy allowed its authors to choose, but it recommended that the original author and date be maintained even if the rank and termination were changed. Loeblich and Tappan (1992, 1994) indicated von Eichwald as author of the order Foraminifera, which is technically correct based on the fully Latinized spelling, but historically wrong. D'Orbigny remains the rightful originator and definer of the term. Since no rules apply to ranks above the

familial level, d'Orbigny's designation as author is an accurate history of the origin of the word representing the group that micropaleontologists have studied for the past 185 years. Sen Gupta (1999) was therefore correct in attributing class Foraminifera to d'Orbigny 1826. Unfortunately, the taxon spelling and the criterion for authorship have been inconsistent throughout the literature of the past 50 years, and without an ICZN rule, a consensus on this matter is unlikely. D'Orbigny 1826 is the correct designation as author of name Foraminifera, no matter where Foraminifera are placed among the higher taxa of testate and related granuloreticulopods. Now that Foraminifera have been genetically sequenced, and the naked forms formerly assigned to the order Athalamida are nested among the testate foraminifera, the name Foraminifera applies to the entire group of granuloreticulopods.

INFORMAL (DERIVED) NAMES FOR FORAMINIFERA

Supraspecific taxonomic names derived from Greek or Latin are often informalized by dropping the capitalization and by eliminating the gender-compliant endings. Thus, kingdom Animalia is informally referred to as animals, phylum Mollusca as molluscs, class Crustacea as crustaceans, order Primata as primates, and so on down to the genus-group level. In similar fashion, Foraminifera was simply uncapitalized as **foraminifera** for general usage in English, and that is where the problem begins. As with deer and fish, **foraminifera** can be either singular or plural. The singular **foraminifer**, to which an *-s* is added to form the plural **foraminifers**, was introduced in an 1842 dictionary by Brande, and then used in a zoological textbook by Jones in 1861. This should have resolved the problem, but these words became alternatives rather than replacements for foraminifera, which remains the dominant term in use today. **Foraminiferan** originated as an adjective in an 1864 translation from German to English, and **foraminiferal** appeared in a geological book in 1875 (see next section). After Loeblich and Tappan (1964) used the ordinal name Foraminiferida and foraminifer(s), the derivative **foraminiferid(s)** was added to our vernacular. In Loeblich and Tappan's 1987 compendium on genera, they still considered the group as order Foraminiferida and informally used foraminifers, foraminiferans, and foraminiferal, but not foraminiferids. Hence, both past and modern literature incorporates four basic terms that differ only in termination: foraminifera, foraminifer, foraminiferid, and foraminiferan. These terms, plus **foram(s)**, are recognized in current versions of the Oxford English Dictionary, Merriam-Webster Dictionary, and AGI Glossary of Geology. Some indicate first year of usage, but the dates are not always accurate and they do not cite the literature. Despite their incredible abundance and diversity in both the fossil record and the modern world, and their many scientific applications, forams are relatively unknown to the general public; otherwise they likely would have been given a short common name, as gastropods are snails, decapods are crabs, and felines are cats.

Here we provide, and briefly comment on, the various sets of English terms derived from the formal Latinized name Foraminifera:

- 1) **foraminifera** (singular and plural): Foraminifera was initially informalized ca. 1836 by not capitalizing the first letter. It is both singular and plural for one or more specimens or taxa; therefore, its usage as singular or plural must be determined from context. Two adjectives are formed from this word: **foraminiferal** and **foraminiferous**. Both begin with the Latin stem *foraminifer-* and end with either *-al* or *-ous* that mean “belonging to” or “representing”. Syllabifications are fo·ra·mi·nif·er·a, fo·ra·mi·nif·er·al, and fo·ra·mi·nif·er·ous with the accent stressing *nif*. These are the most commonly used terms. The English pronunciation of both foraminifera and the Latinized name Foraminifera is the same.
- 2) **foraminifer** (singular), **foraminifers** (plural): These were derived from foraminifera (Brande, 1842, p. 462) by dropping the Latin gender-related *-a*. While correct, they are awkward to pronounce because the basic syllabification and accent, fo·ra·min·i·fer(s), differ from all of the other terms. Adjectives: foraminifer (not used); **foraminiferal** (used); **foraminiferous** (rare).
- 3) **foraminiferan** (singular), **foraminiferans** (plural). These words seem to have originated with the 1864 English translation of an abstract presented by Felix Karrer in 1863 on the “*Foraminiferen fauna*” of the Vienna Basin at the Proceedings of the Imperial Academy of Vienna. The translator of Karrer’s abstract, M. Count, apparently created the first English adjective for the group in referring to the “*Foraminiferan fauna*” of the Vienna Basin, which was likely created from the Latin by the addition of the suffix *-an*, following other zoological names like mammalian, crustacean, and molluscan. Foraminiferan is Latinized in both stem and suffix and is a derivative that means “belonging to” as in place (e.g., Russian) or, in zoology, as a class or order (e.g., mammalian). The adjectives are **foraminiferan**, **foraminiferous**, or **foraminiferal**. Pronunciation is similar to foraminifera, except for the termination.
- 4) **foraminiferid** (singular), **foraminiferids** (plural). These are used when considering the group as the order Foraminiferida and derived by removing the capitalization and terminal letter. **Foraminiferid** is also the adjective. Pronunciation is similar to foraminifera, except for the termination.
- 5) **foram** (singular), **forams** (plural). These contractions are common in conversational English, as well as some other languages, but are generally considered inappropriate for professional journals. Nevertheless, some dictionaries consider them valid words, and **foram** has been infrequently used since it first appeared in a whimsical letter to the editor of *The Geological Magazine* (Anon., 1871) by someone who referred to himself as “an elderly amateur” and signed off as “*Rustican expectans*”. He began his postscript with “I am troubled too by what seems to be a Rhizopodal madness among palaeontologists, upsetting my old notions, and offering such new ones that a course of reading in the existing manuals does not enable me to digest. In fact, nearly every obscure little thing, and many big things once safely registered among corals and such like, become foraminiferal now-a-days.” His rhetorical questions that follow include “... are wide

sea-floors coated thickly with siliceous casts of small Forams?” Later, Blake (1876) cited Carpenter’s 1862 book by abbreviating it as *Intro. to Study of Forams*. Berry (1920) was the first to use **forams** in a scientific article in which he discussed their geologic and commercial value in light of Cushman’s (1918a, b) work on the Panama Canal Zone. Scientific word pairs that originally used the adjective “foraminiferal” have increasingly appeared in print with the shorter adjective, such as **foram limestone**, **foram ooze**, and **foram number** (e.g., Berger, 1973; Berner, 1973; Rau and others, 2002). The best-known international foraminiferal meeting, held every four years, is known as **Forams+year** it takes place. The contraction is not slang, as it is derived in much the same way as the other English derivatives of the word foraminifera. In addition, foram(s) is the easiest of the words to speak, write, and read, and it is independent of the group’s taxonomic rank. Further, it has multilingual appeal because it can similarly be derived from other languages based on the Latin alphabet, including French (foraminifère), German (Foraminifere), Spanish (foraminífero), and Italian (foraminiferi). Given the popularity of the term foram(s), authors and editors might choose to use it in their papers as well. No loss of meaning will accrue and it will save space and enhance readability.

One last word without a Linnaean concept has been used for Foraminifera: **bug(s)**. The term was adopted as slang by the American oil industry to facilitate communication among explorationists soon after they began to use forams routinely for stratigraphic correlation in the mid-1920s. Oil company micropaleontologists have been fondly referred to as bug-men (Anon., 1932; Kleinpell, 1971). Although we micropaleontologists can converse clearly among ourselves with these terms, we should avoid doing so, and never use them in formal communications.

DISCUSSION

Any of the words rooted with foram can be used in other contexts too. For example, predators that eat foraminifera, foraminifers, foraminiferids, or foraminiferans can be called **foraminiferivorous** and the process would be **foraminiferivory** (see Hickman and Lipps, 1983). And scientists who study the subject of **foraminiferology** are **foraminiferologists** (Sen Gupta, 1999). The use of **forams** could imply that “foramologists study foramology and the foramivorous animals that prey upon forams”, although somewhat confusing, is technically correct. Whereas those other simplifications have never been used and they do not ease communication, there is no reason to use them now.

Not all words beginning with *foramin-* refer to forams. Biology and medicine commonly refer to a structural opening as a foramen, pluralizing it as foramina, foramina, or foramines. For obvious reasons, **foraminiferological** vernacular favors other words like aperture, opening, and orifice. A densely perforate object or feature is foraminous or foraminated, or more specifically foraminulous if the holes are miniscule. Yet the AGI Glossary of Geology defines **foraminite** as “a sedimentary rock composed

predominantly of the remains of foraminifers". "Foraminiferite" or "foramite" would be more sensible because the stem *foramin-* implies it is a rock full of holes and it would only apply to forams if those holes were molds or voids left by test dissolution, which would be a foraminifera "foraminiferite". As it stands, foraminifera sounds no less confusingly redundant but is technically correct. Fortunately, entomologists have no etymological basis to refer to the termite subfamily Foraminitermitinae as forams! Let us hope that foram dissection is never referred to as foramotomy, which is a type of spinal surgery to treat foraminal stenosis in humans.

Popularizing foram as a noun and adjective should not lead to confusion with the non-foraminiferal *foramin-* words as long as foraminous and foraminifera are restricted to texture. Using or creating any derivatives of foram, such as foramology, foramivory, foramous, foramate, or foramite, could blur the distinction between texture and the organism, and the longer *foraminifer-* versions are not used frequently enough to hinder communication.

When communicating about Foraminifera in English, use any of the English derivatives that appeal to you, although editors may be less flexible. No confusion is likely to result because those who know the term foraminifera will recognize what those words with the foram root refer to. Although Loeblich and Tappan (1987) classified the group as order Foraminiferida, they used foraminifers, foraminiferans, and foraminiferal, not foraminiferids or foraminiferid. Such mixing of term-sets may unsettle or confuse the reader; it would therefore be prudent to maintain consistency throughout your text and its Linnaean placement of the group.

CONCLUDING REMARKS

D'Orbigny (1826) was the first to distinguish the foraminifera as having foramina (apertures between chambers) and to combine neo-Latin terms to create a new name for the group that is most often formally referred to as Foraminifera. Regardless of rank and suffix, the group name and definition should be credited to d'Orbigny 1826.

Although considered informal and inappropriate for scientific literature, foram(s) is as valid a derivative in English (and several other languages) of the *foraminifer-* stem of the group name as the other words that are used. Foram(s) is the most commonly used of the terms in the spoken language because its two syllables make it easy to pronounce. Furthermore, it does not have restrictions or shortcomings like its longer multisyllabic synonyms that do not distinguish singular and plural, and are awkward to pronounce or dependent on group rank. Because the word foram(s) enables effective communication among specialists and nonspecialists and the public alike, it is likely to gain wider acceptance in technical literature. Traditionalists and purists may object to it, but such transformations are an integral part of how languages evolve. We expect to see it more commonly used in the future.

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