

Outlineoffungi.org - Note 923 Too many Boletales?

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During the last couple of years, there have been many new genera described in *Boletales*, which begs the question as to whether we need all these new genera. This is of course not a simple question to answer, and it does to some extent boil down to opinions. Here we will give our analysis of why there are so many new genera of *Boletales*. We will show that it is a combination of recent advances in our understanding of the group, but also to some extent our lack of understanding, and classical questions such as what variation can be accepted within a genus and if it is better to amend a genus to include more variation or describe a new genus.

The genus *Boletus* was proposed by Linnaeus (Linnaeus 1753), but has been amended many times since then. Linnaeus used it for all poroid fungi, including polypores. Fries used it in a more restricted sense and in a way that corresponds to what we think of, as boletoid taxa today (Fries 1821). Many boletoid taxa already were separated from *Boletus* by some authors early on, such as *Leccinum* and *Suillus* (Gray 1821). However, *Boletales* include many more sporocarp morphologies than boletoid, such as gasteroid, corticioid, and agaricoid types. The molecular phylogenetic data has shown that the evolution between these different forms is complex and none of the morpho-groups represent monophyletic taxa ([Binder & Hibbett 2006](#)). As in many other taxa within *Agaricomycetes* the gasteroid morphology has evolved repeatedly from pilate- stipitate forms in *Boletales*, resulting in the species with pilate-stipitate sporocarps forming a highly polyphyletic group. While it is now widely accepted that gasteroid species may be included in other genera otherwise dominated by pilate-stipitate species (Peintner et al. 2002, Justo et al. 2010, Elliot & Trappe 2018), this does not seem to be common in *Boletales* (but see Kou & Ortiz-Santana 2019). It also seems like agaricoid forms have evolved many times from boletoid forms, contributing to that the species with boletoid morphology form a paraphyletic group ([Binder & Hibbett 2006](#)). In addition, many other characters have been used to separate boletoid taxa into separate subfamilies and genera, but also many of these characters seem to have a complex evolution ([Wu et al. 2014](#)). It has therefore turned out that many previously recognized taxa are not monophyletic. This has contributed to a situation where many new taxa have been described in recent years.

Many new genera have therefore been described to accommodate species (often newly described Table 1) that do not form a monophyletic group with other similar species ([Vadthananat et al. 2019](#), [Sulzbacher et al. 2020](#), [Badou et al. 2022](#), [Magnago et al. 2022](#), Wu et al. 2022). The situation is often complicated by poor resolution, the optimal tree shows that the new genus is not monophyletic with any genus with similar morphology, but the branch support values do not confidently show where in the phylogeny the clade/tip belongs (Crouse et al. 2020, [Hosen et al. 2021](#), [Magnago et al. 2022](#), [Vadthananat et al. 2022](#)). There are even cases where new genera are described when it cannot be rejected that they are monophyletic with similar described genera, contrary to the recommendations of Velinga et al. (2015). In *Boletaceae*, the largest family of *Boletales*, there are many relations that are not well-resolved ([Wu et al. 2014](#)), and it seems like what is described as separate genera are often based on what clades get strong support, and what clades do not. A more resolved phylogeny of *Boletaceae* would therefore be a great advancement for developing the taxonomy in the group. So recent advancements in our understanding of the phylogeny of *Boletales*, and the fact that many characters that have been used to delimit taxa do not delimit monophyletic groups are one major explanation as to why there are so many new genera described. Possibly in addition to that, many new species are being discovered from new areas, and that adds new

information about the evolution of traits important to delimit taxa ([Alvarado et al. 2021](#), [Hosen et al. 2021](#), [Badou et al. 2022](#), [Lebel et al. 2022](#)). For example, when it turns out that the characters used to diagnose a genus are plesiomorphic in respect to the characteristics of another genus, rather than apomorphies for the genus in question. In these cases, one of the genera can be amended to incorporate the species of both the previously recognized genera, or new genera can be described to remove the conflict. The second option seems to be commonplace, but as descriptions are only needed for the new genus, the old genus is often not amended so that the diagnosis excludes the new genus ([Hosen et al. 2021](#), [Alvarado et al. 2021](#)). As it is also commonplace that the new genus only has one or two species it is not unlikely that further discoveries of closely related species may lead to that the description will have to be amended later. This has contributed to that fact that 2.8% of the genera in *Boletales* are monotypic and 1.9% only have two species. These numbers are about 3 times as high as for *Agaricales* (0.9% respectively 0.6%; www.speciesfungorum.org).

Table 1. Genera that have been described in *Boletales* since 2019 to accommodate species that are described as new in the same publication.

Family	Genus	Author	Year
<i>Boletaceae</i>	<i>Abtylophilus</i>	Yan C. Li & Zhu L. Yang	2021
<i>Boletaceae</i>	<i>Amoenoboletus</i>	G. Wu, E. Horak & Zhu L. Yang	2021
<i>Boletaceae</i>	<i>Amylotrama</i>	Bloomfield, Davoodian, Trappe & T. Lebel	2022
<i>Boletaceae</i>	<i>Anthracoporus</i>	Yan C. Li & Zhu L. Yang	2021
<i>Boletaceae</i>	<i>Brasilioporus</i>	A.C. Magnago, Alves-Silva & T.W Henkel	2022
<i>Boletaceae</i>	<i>Cacaoporus</i>	Raspé & Vadthanarat	2019
<i>Boletaceae</i>	<i>Kaziboletus</i>	Hosen & Zhu L. Yang	2021
<i>Boletaceae</i>	<i>Longistriata</i>	Sulzbacher, Orihara, Grebenc, M.P. Martín & Baseia	2020
<i>Boletaceae</i>	<i>Neotropicomus</i>	A.C. Magnago, Alves-Silva & T.W Henkel	2022
<i>Boletaceae</i>	<i>Paxilloboletus</i>	Furneaux, De Kesel & F.K. Khan	2022
<i>Boletaceae</i>	<i>Rubinosporus</i>	Vadthanarat, Raspé & Lumyong	2022
<i>Boletaceae</i>	<i>Veloboletus</i>	Fechner & Halling	2020
<i>Coniophoraceae</i>	<i>Penttilamyces</i>	Zmitr., Kalinovskaya & Myasnikov	2019
<i>Paxillaceae</i>	<i>Paralpova</i>	Cabero & P. Alvarado	2021

The many new taxa described in *Boletales* is probably mainly a consequence of discoveries of many new lineages that do not fit well with the genus concept of its sister group, or for which the sister group consists of more than one genus. When dealing with individual taxonomic problems (such as describing one or a few new species) the easiest solution, and the solution requiring the fewest name changes, may often be to describe a new

genus. A more holistic perspective on whole suborders/families/subfamilies may however highlight other solutions and address issues such as having too many genera, and many monotypic genera (invalidating the idea of binomial nomenclature). We, therefore, see the need for monograph style studies of higher taxa in *Boletales* to evaluate the delimitations of genera in relation to each other. This work will however also require advances in our understanding of the phylogeny in many groups.

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Entry by

Martin Ryberg, 1. Department of Organismal Biology, Uppsala University, Uppsala, Sweden

Maria Alice Neves, 2. Universidade Federal de Santa Catarina, Florianópolis, Santa Catarina, Brazil

(Edited by **Kevin D. Hyde & Maryam Tavakol Noorabadi**)

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