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ALBATRELLUS AND THE HERICIACEAE

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The genus *Albatrellus* has long been considered to occupy a rather isolated place in the Polyporaceae. Arguments suggesting a taxonomic position in the Hericiaceae are presented.

The taxonomic position of *Albatrellus* S.F. Gray has never been satisfactorily established. Traditionally its position was in the Polyporaceae, because the hymenophore is poroid. Closest relatives have been suggested to be *Polyporus* Mich. ex Adans.: Fr. by Bourdot & Galzin (1927), *Tyromyces* P. Karst. by Ryvarden (1976), Cantharellales or Hydnaceae s.str. by Jülich (1981) and *Hydnum* L.: Fr. or unspecified Agaricales by Gilbertson & Ryvarden (1986). It is now often placed in the small family Scutigeraceae Bond. & Sing. ex Sing. (= Albatrellaceae Nuss), together with two monotypic genera: *Jahnoporus* Nuss and *Polyporoletus* Snell.

The reason to consider *Polyporus* s.str. related to *Albatrellus* was the fact that both genera are stipitate and have a poroid hymenophore. According to modern authors the differences in the hyphal system (dimitic with binding hyphae in *Polyporus*, monomitic with inflated hyphae in *Albatrellus*) exclude a close relationship and also cultural characters differ widely. Neither are there good reasons to consider *Tyromyces* related to *Albatrellus* as these two genera have little in common, except that both are monomitic and contain some species with amyloid spores. If a relative has to be found within the poroid genera, there may not be many alternatives, but actually the relation is not very close: in typical *Tyromyces* species the spores are different, there are no gloeoplerous hyphae and its species are typically pileate, but never stipitate.

Hydnum is at first sight a better alternative. There are inflated hyphae, the hyphal system is monomitic, the spores show some resemblance, the shape of the basidiome resembles that of *Albatrellus* and its species are terrestrial. There is, however, no gloeoplerous system in *Hydnum*, amyloidity does not occur, and, contrary to *Albatrellus*, it is mycorrhizal (Maas Geesteranus, 1971). No representatives of *Hydnum* are as yet known in culture, although many efforts have been made.

As the microscopical characters of *Albatrellus* showed a number of features that are also found in the Hericiaceae Donk, a more detailed study of a number of representative species of these groups was performed.

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MATERIAL AND METHODS

Material examined

a. Herbarium specimens: *Albatrellus confluens* (Alb. & Schw.: Fr.) Kotlab. & Pouz., Norway, Akershus, Eidsvoll, Graabakken, 2.IX.1961, *R.A. Maas Geesteranus 13652*. — *Albatrellus cristatus* (Schaeff.: Fr.) Kotl. & Pouz., Poland, Ojcow National Park, 8.IX.1966, *M.A. Donk*. — *Albatrellus ovinus* (Schaeff.: Fr.) Kotl. & Pouz., Sweden, Smaland, Värnamo, Elgarydfen, 16.IX.1959, *C. Bas 1793*. — *Albatrellus peckianus* (Cooke) Niemelä, USA, Alaska, Camp Venali-Kantishna, 25.VII.1970, *H.F. van der Laan*. — *Albatrellus pes-caprae* (Pers.: Fr.) Pouz., Germany, Kreis Calw, Neubulach, 8.X.1967, *H. Haas*. — *Albatrellus syringae* (Parm.) Pouz., Sweden, Medelpad, Borgsjö, Granbodasen, on wood of *Salix*, 29.VIII.1989, *C. Eriksson 3000*. — *Dentipellis fragilis* (Pers.: Fr.) Donk, Czechoslovakia, Bohemia, Boubin Forest, on branch of *Fagus sylvatica*, 30.VIII.1960, *R.A. Maas Geesteranus 13268*; Denmark, Sjaelland, IX.1970, *L. Ryvarden 6794*. — *Jahnoporus hirtus* (Quél.) Nuss (sub *Polyporus hirtus*), USA, Oregon, Ivan Oates Park, 19.X.1969, *R.H. Petersen*, 9.IX.1974, det. M.A. Donk.

b. Cultures: *Albatrellus peckianus*, CBS 160.65, Canada, Ontario, Dunrobin, on soil under *Acer* sp., 15.VII.1956, *M.K. Nobles*. — *Albatrellus syringae*, CBS 728.85, Norway, Oyangen, on soil in *Betula-Salix* forest, without date, *P. Marstad & D. Kjelsaas*. — *Creolophus cirrhatus* (Pers.: Fr.) P. Karst., CBS 573.81, Netherlands, Arnhem, on *Fagus sylvatica*, IX.1981, *J. Hoogschagen*. — *Hericium alpestre* Pers., CBS 444.85, Czechoslovakia, Bohemia, Boubin Forest, on *Abies*, 16.IX.1982, *M. Szemerdzieva*; CBS 449.85, Czechoslovakia, Silherovice forest near Ostrava, on *Abies*, 6.IX.1969, *M. Szemerdzieva*. — *Hericium americanum* Ginns, CBS 493.63, USA, New York, Leon, on *Tsuga* sp., det. *R. Petersen*. — *Hericium coralloides* (Scop.: Fr.) S.F. Gray, CBS 447.85, Czechoslovakia, Silherovice forest near Ostrava, on *Fagus sylvatica*, 6.IX.1969, *M. Szemerdzieva*; CBS 235.87, England, Epping forest, on angiosperm wood, 9.XI.1928, *W.P.K. Findlay*, det. J. Ginns. — *Hericium erinaceus* (Bull.: Fr.) Pers., CBS 204.76, USA; CBS 302.89, USA, Virginia, Fairfax, on *Quercus rubra*, 2.XI.1938, *R.W. Davidson*. — *Steccherinum seriatum* (Lloyd) Maas G., CBS 752.81, France, *P. Lanquetin*.

Methods

Sections of basidiomes of all species were examined in Congo red in ammonia, cotton blue in lactic acid, Melzer's reagent, sulphobenzaldehyde according to Boidin (1958), and sulphovanillin according to Hjortstam (1989).

RESULTS AND DISCUSSION

Characteristics of the Scutigeraceae (Albatrellaceae) based on specimens of *Albatrellus* and *Jahnoporus*.

Basidiomes annual, fleshy, stipitate, often concrescent (or branched at the base), terrestrial or occasionally on buried wood. Stipe central, excentric or lateral; sometimes the basidiome is flabellate. Pileus surface smooth to scaly. Hymenophore poroid, but sometimes only irregularly so and then isolated spines can also be found. Dissepiments (or spines) always with a sterile edge or apex. Hyphal system monomitic. Hyphae thin- to thick-walled, especially in fleshy parts often inflated, with or without clamps, sometimes amyloid. Gloeoplerous hyphae generally present, especially in the pileus trama, but often also in the hymenophoral trama, not curving into the hymenium, not reacting with sulphobenzaldehyde. Cystidia absent. Basidia clavate, relatively broad. Spores hyaline, thin- to somewhat thick-walled, subglobose to broadly ellipsoid or ovoid, smooth, not amyloid, weakly amyloid or distinctly amyloid. Terrestrial, rarely lignicolous.

Characteristics of the Hericiaceae, based on specimens of *Clavicorona*, *Creolophus*, *Dentipellis*, *Hericium*, and *Steccherinum*.

Basidiome annual, resupinate to pileate, sometimes stalked and/or branched, membranaceous to fleshy. Hymenophore smooth or hydnoid, spines always with a sterile apex. Hyphal system monomitic. Hyphae hyaline, thin- to thick-walled, in fleshy parts inflated, with clamps, sometimes amyloid. Gloeoplerous hyphae present, sulpho-negative, often curving into the hymenium to form gloeocystidia. Basidia relatively wide, clavate. Spores hyaline, somewhat thick-walled, globose, ovoid or broadly ellipsoid, smooth or minutely ornamented, amyloid. Lignicolous.

Comparison of structures (Table I)

The hymenophore in *Albatrellus* is in principle poroid, but in some species quite irregularly so. *Albatrellus pes-caprae*, for example, has wide and rather irregular and shallow pores, interspersed with spines. The hymenium at the bottom of the pores and between the spines is fully fertile and continues uninterrupted. There is every reason to assume that the pores have been developed from an originally hydnoid fungus, as has also been concluded for the genera *Junghuhnia* Corda (poroid), *Steccherinum* S.F. Gray (hydnoid), *Grandinia* Fr. (= *Hyphodontia* J. Erikss.) (hydnoid, odontioid), and *Schizopora* Velen. (poroid). It is likely that all Aphyllophorales with pores with a sterile edge did arise from hydnoid ancestors.

The hyphae of the pileus trama are thin- to thick-walled and distinctly inflated in most species of *Albatrellus* (e.g. *A. confluens, A. ovinus*) and thus perfectly agreeing with typical Hericiaceae. However, this type of hyphae is generally not dominant and often nearly absent

Table. I. Characters of Hericiaceae s.l. – Basidiome: 1 = effused, 2 = stipitate, 3 = branched from base, 4 = branched laterally; hymenophore: 1 = even, 2 = hydnoid, 3 = poroid; hyphae: 1 = amyloid; gloeoplerous hyphae: 1 = curving into hymenium, 2 = long, aseptate, 3 = shorter, often septate, 4 = sulphonegative; spores: 1 = blue in Melzer's, 2 = grey in Melzer's, 3 = unchanged in Melzer's, 4 = ornamented; habitat: 1 = on soil, 2 = on wood.

	basidiome				hymenoph.			hyph.	gloeopl. hyph.				spores				hab.	
	1	2	3	4	1	2	3	1	1	2	3	4	1	2	3	4	1	2
Jahnoporus hirtus		+	+	+			+				+	+			+			+
Albatrellus cristatus		+					+	+			+	+		+			+	
Albatrellus confluens		+	+				+	+			+	+	+				+	
Albatrellus pes-caprae		+	+			+	+			+	+	+	+				+	
Albatrellus peckianus		+	+				+	+		+		+		+			+	+
Albatrellus syringae		+	+				+	+		+		+		+			+	+
Albatrellus ovinus		+	+				+	+		+		+			+		+	
Clavicorona pyxidata		+	+	+	+				+	+	+	+	+					+
Creolophus cirrhatus				+		+			+	+		(+)	+					+
Hericium alpestre				+		+		+	+	+		+	+			+		+
Hericium americanum				+		+		+	+	+		+	+			+		+
Hericium coralloides				+		+		+	+	+		+	+			+		+
Hericium erinaceus			+			+		+	+	+		+	+			+		+
Stecchericium seriatum	+					+			+	+		(+)	+			+		+
Dentipellis fragilis	+					+			+	+	+	(+)	+			+		+

from the hymenophoral trama. In *A. cristatus*, *A. ovinus*, and *A. peckianus* amyloid hyphae were occasionally seen. Domanski & al. (1967) mention such hyphae also for *A. syringae* (positive after several hours of staining) and *A. subrubescens* (Murrill) Pouzar.

In most species of *Albatrellus* gloeoplerous hyphae are found; Gilbertson & Ryvarden (1986) neither mentioned them for *A. caeruleoporus* (Peck) Pouzar or *A. dispansus* (Lloyd) Canfield & Gilbertson, nor for *A. cristatus* in which they are definitively present, at least in European material. Gloeoplerous hyphae are always found in the pileus trama, often also in the hymenophoral trama, but only very rarely curve into the hymenium. In *Albatrellus* the gloeoplerous hyphae may be rather long, but in some species they are short and rare. In typical Hericiaceae (e.g. *Hericium, Dentipellis*) the gloeoplerous hyphae are long, abundant and often curving into the hymenium, but there are no principal differences. It seems, that the gloeoplerous hyphae are gradually disappearing from *Albatrellus*, as they are also in *Mucronella*, another genus of the Hericiaceae.

The gloeoplerous hyphae of all specimens of *Albatrellus*, *Creolophus* Karst., *Hericium* Pers., and *Steccherinum* Reid showed no colour change with sulphobenzaldehyde or sulphovanillin (as an exception in some specimens of *Hericium* a slightly ochraceous discoloration occurred with sulphovanillin, the gloeoplerous hyphae of *Steccherinum* produced a golden yellow colour with that reagent and those of *Dentipellis* a bluish one).

The reaction with sulphoaldehydes is generally considered to have taxonomic importance (Donk, 1964; Boidin, 1966). However, the literature contains conflicting data: Boidin (1966) found a consistently negative reaction with sulphobenzaldehyde in the Hericiaceae, Hjortstam (1989) noted brownish reactions in the Hericiaceae with sulphovanillin and Maas Geesteranus (1975) recorded a purplish brown reaction with sulphoanisaldehyde in *Hericium alpestre*, *H. coralloides*, and *H. erinaceus*. Larsen & Burdsall (1976) tested a number of gloeocystidial species with sulphobenzaldehyde. They found the results inconsistent and even variable within the same specimen and concluded that 'sulphuric benzaldehyde was found to be extremely erratic in reacting with gloeocystidial contents, making this character, in our opinion, of questionable taxonomic value.'

These data and our results indicate that various aldehydes produce different results, but these results are rather consistent, especially when fresh solutions and fresh material are used. When herbarium material is examined, one has to keep in mind, that it may have been treated with various chemicals prior to storage and that the reaction with dried material is often less distinct. However, the results in *Albatrellus* and the Hericiaceae are consistently negative (except in *Dentipellis*), contrary to the vast majority of other species of fungi with gloeocystidia or gloeoplerous hyphae which react positively.

The spores in *Albatrellus* are subglobose, broadly ellipsoid or ovoid to tear-shaped, smooth and thin- to slightly thick-walled, thus similar to the Hericiaceae, although in that family a spiny ornamentation also occurs. Spores of the Hericiaceae always turn blue in Melzer's, while in *Albatrellus* variable results are found. *Albatrellus subrubescens* is reported to be strongly amyloid (Domanski et al., 1967; Pouzar, 1972; Ryvarden, 1976). In the material examined in the present study the majority of the spores of *A. confluens* were distinctly amyloid, the spores of *A. pes-caprae* were weakly amyloid, those of *A. cristatus*, *A. peckianus* and *A. syringae* showed a grey hue. The spores of *A. ovinus* and *Jahnoporus (Albatrel-*

lus) hirtus showed no reaction with Melzer's. It should also be noted, that in every specimen examined always a number of spores showed no reaction. Like the gloeoplerous hyphae, amyloidity seems to be gradually disappearing from *Albatrellus*.

Contrary to the members of the Hericiaceae, the species of *Albatrellus* are generally terrestrial and not necessarily connected with buried wood; only *A. dispansus*, *A. peckianus* and *A. syringae* are occasionally found on wood. This seems another example of a change of substrate from wood to soil (or vice versa). It is also known in for example the genera *Abortiporus* Murrill, *Polyporus* Mich. ex Adans., *Thelephora* Ehrh. ex Willd., and *Trechispora* P. Karst. Cultures of *Albatrellus peckianus* and *A. syringae* are good producers of laccase, indicating the ability to degrade lignin. There is no indication of mycorrhiza.

CONCLUSION

The evidence presented here clearly suggests that *Albatrellus* is more closely related to the Hericiaceae than to any other family in the Aphyllophorales. It is acknowledged that the inclusion of *Albatrellus* into that family causes problems for the family diagnosis, as several distinguishing characters are gradually disappearing in that genus, but it certainly reflects the evolutionary lines of nature. Maintenance of the family Scutigeraceae (or Albatrellaceae) is only useful if the relationship of other genera, for example *Grifola* Gray, or *Meripilus* P. Karst. will prove to be closer to *Albatrellus* than to other genera. Until then its maintenance does not reflect natural relationships and only contributes to the inflation of ranks.

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