

## ON IRPEX ZONATUS

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**Summary** On *Irpex zonatus*. The type of *Irpex zonatus* Berk has been examined and the combination *Antrodiella zonata* (Berk.) Ryv. is proposed. 8 other species of which the types have been examined, are placed in synonymy with *Irpex zonatus*. The generic system of *Aphyllophorales* is discussed and proven to be illogical and in general a pragmatic system without a phylogenetic base.

*Irpex zonatus* Berk. was described on the basis of specimens collected by Hooker in Sikkim in the Himalayas. For a long time it was assumed to be restricted to this area until Lloyd (1916) reported it from Japan. He assumed that *Irpex zonatus* was the same as *Irpex noharuae* (Murr.) Sacc. a specimen of which he had received from Dr. K. Miyabe in Japan. He was indeed right in his assumption of a wide distribution of *Irpex zonatus* although his assumed synonymy was incorrect. *Irpex noharuae* (Murr.) Sacc. is actually based on a specimen of *Lopharia mirabilis* (Berk. & Br.) Pat. (see Ito 1955).

*Irpex consors* Berk. 1877 was based on a collection made in Kobe in Japan during the Challenger expedition. Cunningham (1965) examined the type of this species and correctly placed it in synonymy with *Irpex zonatus*. Some years after he had described *Irpex zonatus* received numerous specimens collected by Hooker in New Zealand and apparently overlooked his own species from Sikkim. Based on a New Zealand collection he described a new species *Irpex brevis* Berk. This species slept more or less in oblivion until Lloyd on his restless trips to Europe started to compare the many exotic species described in the last part of the 19th century. He immediately suspected that *Irpex brevis* was specific with *I. consors* Berk. and also with *I. decurrens* Berk. The latter was based on a specimen from Japan collected by J. Dickens.

Maas Geesteranus (1974) published a synopsis of the genera *Irpex* Fr. and *Steccherinum* S. F. Gray and commented upon all the species mentioned above. He was in doubt whether they all represented the same taxon as he partly had not examined their types and partly used data supported by Cunningham (Maas Geesteranus 1974: 460 and 466), which in part are in error.

I have examined the types of the following names and found them all to represent the same taxon, with *Irpex zonatus* as the prior basionym.

The taxonomic position of *Irpex zonatus* is open for debate. Cunningham (1965) left it in *Irpex*, a genus which previously was used for all types of hydroid wood-inhabiting fungi. Today *Irpex* is circumscribed in a much more restricted sense, such as seen in Maas Geesteranus (1974), Eriksson & Ryvarden (1976) and Jülich & Stalpers (1980). The genus is typified by *Irpex lacteus* (Fr.: Fr.) Fr. a species with simple septate generative hyphae, dimitic hyphal system and projecting metuloid cystidia. *Irpex zonatus* has some of these characters, i.e. it is dimitic, but its cystidia are of another type and the generative hyphae have clamps at their septa. The type of septation is usually seen as important in the current classification of polypores. There are very few genera with a variable septation of the generative hyphae. Thus, *Irpex zonatus* should be excluded from *Irpex*, which also was the conclusion of Maas Geesteranus (1974: 503).

To me it is clear that *Irpex zonatus* belongs in the group of genera around *Steccherinum*, *Junghuhnia* Corda, and *Antrodiella* Ryv. & Johans. The former is hydroid, the two others more or less poroid. In both the latter genera there are species with an irpicoid to lacerate hymenophore such as *Junghuhnia crustacea* (Jungh.) Ryv. (the type species of the genus) and *Antrodiella americana* Gilbn. & Ryv. *Junghuhnia* and *Steccherinum* are characterized microscopically by metuloid encrusted cystidia arising from skeletal hyphae. Such organs are absent in *Antrodiella* and *Irpex zonatus*. Thus, it seems logical to place *Irpex zonatus* in this genus. The type of cystidia seen in *Irpex zonatus* is also seen in *Antrodiella americana* so no new characters are introduced in the genus by including *Irpex zonatus*. Further arguments for this taxonomic disposition are given after the specific description. An

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exclamation mark in the following list of names indicate that the type has been examined. The herbaria in which the types have been examined are abbreviated according to Index Herbariorum.

**Antrodiella zonata** (Berk.) Ryv. *comb. nov.*

Basionym: *Irpex zonatus* Berk. Hook. *J. Bot.* 6: 168, 1854 (K!). *Irpex brevis* Berk. *Flora Nov. Zeal.* 2: 181, 1855 (K!). *Irpex consors* Berk. *J. Linn. Soc.* 16: 51, 1877 (K!). *Irpex decurrens* Berk. *Grevillea* 19: 109, 1891 (K!). *Irpex kusanoi* Henn. & Shirai *Bot. Jahrb.* 28: 267, 1900 (teste Ito 1955). *Irpiciporus japonicus* Murr. *Mycologia* 1: 166, 1909 (NY!). *Daedalea gollanii* Mass. *Kew Bull.* 1908: 217, 1908 (K!). *Irpex cingulatus* Lloyd, *Lloyd Mycol. Writ.* 5: 795, 1918 (BPI!). *Irpex ochrosimilis* Lloyd, *Lloyd Mycol. Writ.* 7: 1273, 1924 (BPI!).

*Basidiocarp* pileate, usually effused reflexed and imbricate with several individual pilei arising from the same context, coriaceous when fresh, dense and fragile cartilaginous when dry, pileus up to 1.5 cm wide, rarely wider, 1-2 cm long, but sometimes fused with adjacent pilei to more elongated wavy shelf like pilei, margin sharp when fresh, usually strongly curved inward when drying, upper surface first white to pale ochraceous, later pale buff to straw coloured, in old and hibernating specimens often darker from the base with dingy spots, glabrous, wavy and usually with radial lines or narrow folds or furrows.

*Hymenophore* first poroid, but soon dentate to hydroid as the pores split, teeth flattened to round and pointed, when young pruinose, later smoother, concolorous with the upper surface. *Trama* and *context* dense, tough, whitish to pale beige, up to 2 mm thick.

*Hyphal system* dimitic, generative hyphae with clamps at the septa, hyaline, thin-walled, 2.5-4  $\mu\text{m}$  wide, skeletal hyphae common, straight, smooth, thick-walled, hyaline, 3-7  $\mu\text{m}$  wide, protruding in the dissepiments in a semi-parallel fashion, not projecting obliquely through the fertile hymenium along the spines.

*Cystidia* present, but often difficult to locate, smooth, thin walled, tubular to bladder like or ventricose with swollen base and tube-like elongated neck, hyaline and negative with sulfo benzaldehyde, embedded in the hymenium, scarcely projecting beyond the basidia, up to 120  $\mu\text{m}$  long and 5-18  $\mu\text{m}$  wide at the base, arising from a clamp on the generative hyphae. In the dissepiments the skeletal hyphae are pointed and partly projecting, smooth to finely encrusted and may be interpreted as skeletocystidia, but their encrustation is variable and they are not projecting into the hymenium as normally seen for true skeletocystidia.

*Basidia* clavate, 4 sterigmate, 12-18 x 4-8  $\mu\text{m}$ .

*Basidiospores* oblong ellipsoid, smooth thin-walled, hyaline, negative in Melzer's solution, (4.5) 5-6 x (2.5) 3-3.5  $\mu\text{m}$ .

*Type of rot*: White rot in hardwoods.

*Substrate*: On dead hardwoods of many genera.

*Distribution*: New Zealand, Australia, China, Sri Lanka, Thailand, India, Japan.

*Obs.*: The species are usually easy to recognize in the field because of the effused basidiocarp with numerous imbricate pilei, with whitish, pale buff or pinkish colour. The bladder to bottleshaped cystidia occur irregularly in most examined specimens and are easily overlooked. This is one reason for the many synonyms cited above.

*Antrodiella* is as mentioned above, closely related to *Steccherinum*, *Junghuhnia*, and *Irpex*. The first three genera have generative hyphae with clamps, dimitic hyphal system with skeletal hyphae, and the spores are small, in general less than 5  $\mu\text{m}$  in longest dimension. The basidiocarps have in most species a rather dense consistency and become semitranslucent to cartilaginous when dry. The sexuality is tetrapolar and all species in all genera produce a white rot in the attacked wood. *Irpex* is only separated from the others with its simple septate generative hyphae. However, in *Steccherinum* there are species with simple septate hyphae, such as *S. cremealbum* Hjortst. and *S. subcrinale* (Pack) Ryv., (for descriptions of these species see Eriksson, Hjortstam & Ryvarden 1984). It is logically difficult to defend their place in *Steccherinum* and not in *Irpex*, since they share all generic characters with the latter. A key to the two hydroid genera will break down with those two species unless they are keyed out as species. If so, it indicates only that the generic concept is highly artificial. The characters further separating these genera are type of hymenophore and the presence or absence of skeletocystidia. *Junghuhnia* and *Antrodiella* are poroid, while *Steccherinum* and *Irpex* are irpicoïd to hydroid. All genera except *Antrodiella* are characterized by metuloid cystidia.

The underlying problem in how to draw the generic line in this group, is of course that the whole taxonomic system in the *Aphylllophorales* is artificial. Even if most mycologists working with the group are willing to admit this, it is not often stated. The lack of fossils among *Aphylllophorales* makes it very difficult to decide what are adaptive characters and what are conservative and can be a base for a phylogenetic system. This problem is seen easy if several genera are compared. A character taken as basic in the circumscription of one genus is neglected in another. Some examples may illustrate the situation:

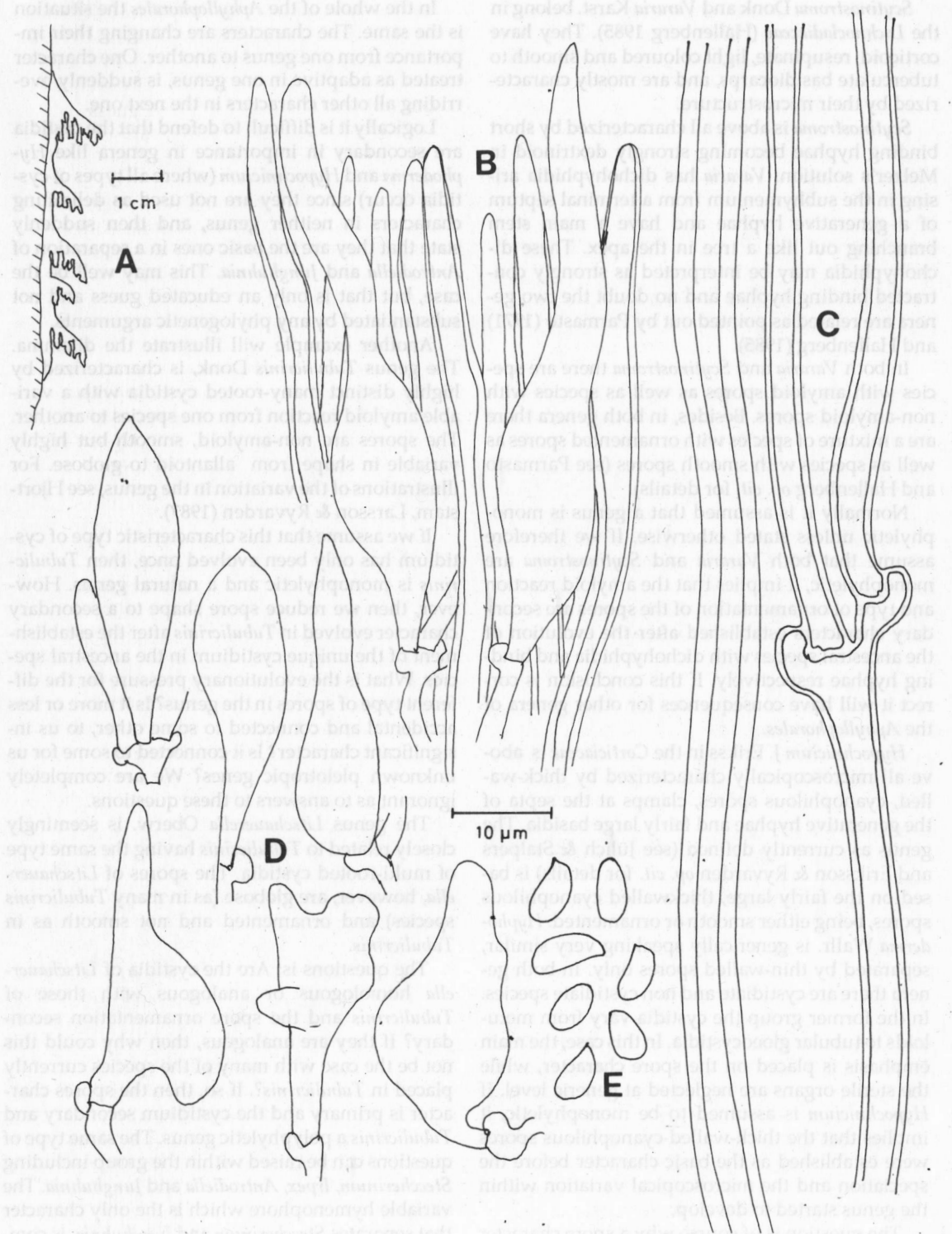


Fig. 1. *Antrodidiella zonata*, A) basidiocarp, B) cystidia in the dissepiments, C) generative and skeletal hyphae from the context, D) cystidia from the hymenium, E) spores. A: Coll. Petch 1912 (Sri Lanka), B-D: Coll. Hooker, type of *Irpex zonatus* from Sikkim and E: Coll. Kobe, Japan, type of *Irpex consors*.

*Scytinostroma* Donk and *Vararia* Karst. belong in the *Lachnocladiaceae* (Hallenberg 1985). They have corticoid, resupinate, light coloured and smooth to tuberculate basidiocarps, and are mostly characterized by their microstructure.

*Scytinostroma* is above all characterized by short binding hyphae becoming strongly dextrinoid in Melzer's solution. *Vararia* has dichohyphidia arising in the subhymenium from a terminal septum of a generative hyphae and have a main stem branching out like a tree in the apex. These dichohyphidia may be interpreted as strongly contracted binding hyphae and no doubt the two genera are related as pointed out by Parmasto (1971) and Hallenberg (1985).

In both *Vararia* and *Scytinostroma* there are species with amyloid spores as well as species with non-amyloid spores. Besides, in both genera there are a mixture of species with ornamented spores as well as species with smooth spores (see Parmasto and Hallenberg *op. cit.* for details).

Normally it is assumed that a genus is monophyletic unless stated otherwise. If we therefore assume that both *Vararia* and *Scytinostroma* are monophyletic, it implies that the amyloid reaction and type of ornamentation of the spores are secondary characters established after the evolution of the ancestral species with dichohyphidia and binding hyphae respectively. If this conclusion is correct it will have consequences for other genera of the *Aphyllophorales*.

*Hypochnicium* J. Erikss in the *Corticaceae* is above all microscopically characterized by thick-walled, cyanophilous spores, clamps at the septa of the generative hyphae and fairly large basidia. The genus as currently defined (see Jülich & Stalpers and Eriksson & Ryvarden *op. cit.* for details) is based on the fairly large, thickwalled cyanophilous spores, being either smooth or ornamented. *Hyphoderma* Wallr. is generically speaking very similar, separated by thin-walled spores only. In both genera there are cystidiate and non cystidiate species. In the former group the cystidia vary from metuloids to tubular gloecystidia. In this case, the main emphasis is placed on the spore character, while the sterile organs are neglected at generic level. If *Hypochnicium* is assumed to be monophyletic, it implies that the thick-walled cyanophilous spores were established as the basic character before the speciation and the microscopical variation within the genus started to develop.

The question is of course why a spore character is assumed to be secondary compared to the sterile organs in *Vararia* and *Scytinostroma* while the opposite is the case in *Hypochnicium* in its separation from *Hyphoderma*.

In the whole of the *Aphyllophorales* the situation is the same. The characters are changing their importance from one genus to another. One character treated as adaptive in one genus, is suddenly overriding all other characters in the next one.

Logically it is difficult to defend that the cystidia are secondary in importance in genera like *Hyphoderma* and *Hypochnicium* (where all types of cystidia occur) since they are not used as delimiting characters in neither genus, and then suddenly state that they are the basic ones in a separation of *Antrodiella* and *Junghuhnia*. This may well be the case, but that is only an educated guess and not substantiated by any phylogenetic arguments.

Another example will illustrate the dilemma. The genus *Tubulicrinis* Donk, is characterized by highly distinct many-rooted cystidia with a variable amyloid reaction from one species to another. The spores are non-amyloid, smooth but highly variable in shape from allantoid to globose. For illustrations of the variation in the genus, see Hjortstam, Larsson & Ryvarden (1987).

If we assume that this characteristic type of cystidium has only been evolved once, then *Tubulicrinis* is monophyletic and a natural genus. However, then we reduce spore shape to a secondary character evolved in *Tubulicrinis* after the establishment of the unique cystidium in the ancestral species. What is the evolutionary pressure for the different type of spores in the genus? Is it more or less accidental and connected to some other, to us insignificant character? Is it connected to some for us unknown pleiotropic genes? We are completely ignorant as to answers to these questions.

The genus *Litschauerella* Oberw. is seemingly closely related to *Tubulicrinis* having the same type of multi-rooted cystidia. The spores of *Litschauerella*, however, are globose (as in many *Tubulicrinis* species) and ornamented and not smooth as in *Tubulicrinis*.

The questions is: Are the cystidia of *Litschauerella* homologous or analogous with those of *Tubulicrinis* and the spore ornamentation secondary? If they are analogous, then why could this not be the case with many of the species currently placed in *Tubulicrinis*? If so, then the spores character is primary and the cystidium secondary and *Tubulicrinis* a polyphyletic genus. The same type of questions can be raised within the group including *Steccherinum*, *Ipex*, *Antrodiella* and *Junghuhnia*. The variable hymenophore which is the only character that separates *Steccherinum* and *Junghuhnia*, is completely neglected in other genera of *Polyporaceae* such as *Spongipellis* Pat. and *Trichaptum* Murr. In the latter for example the hymenophore varies from strictly poroid *T. abietinum* (Dicks.: Fr.) Ryv.,

lamellate *T. laricinus* (Karst.) Ryv. to hydroid *T. fuscoviolaceus* (Fr.) Ryv. Microscopically all these species are almost identical, indicating that the type of hymenophore is adaptive and secondary while the microscopical characters (including cystidia) are conservative and primary. If this interpretation is accepted in *Trichaptum*, there is no logic defence for not doing so in *Steccherinum* and *Junghuhnia*. We are left with an illogical pragmatic generic system acting primarily as a sorting mechanism without phylogenetic foundation. The reason why the situation is accepted is of course that no one for the time being has a better system.

Before any fundamental changes are implemented, we should have a much better understanding of the evolutionary processes behind the establishment of the characters currently used for generic separation in *Aphylllophorales*. Any large change will unavoidably also have serious nomenclatorial consequences, a most undesirable situation. When more basic knowledge on the evolution of the group has been gained, it is my prediction that *Irpex* will regain its status as a large comprehensive genus. In principle it is only the type of septation that separates it from *Steccherinum* and it may be proper to mention that there are many genera like *Athelia* Pers., *Botryobasidium* Donk, *Hyphodontia* J. Erikss., *Phanerochaete* Karst., *Sistotrema* Fr. and *Antrodiella* Ryv. where both types of septation occur.

In some genera for example *Bondarzewia* Sing. and *Stereum* Pers. ex S. F. Gray the generative hyphae of the basidiocarp are invariably simple septate. Nevertheless, clamps are present when these species are cultivated (Stalpers 1978 and Chamuris

1988). We do not know why the development of these clamps is suppressed in nature. However, such cases raise some doubts whether the type of septation is so important as seen for example in the classification of the polypores (see Ryvarden 1991 for details).

#### BIBLIOGRAPHY

- CHAMURIS, G. P. 1988. The non-stipitate steroid fungi in the northeastern United States and adjacent Canada. *Mycol. Mem.* 14: 1-247.
- CUNNINGHAM, G. H. 1965. *Polyporaceae* of New Zealand. *Bull. N. Z. Dep. Sci. Ind. Res.* 164: 1-304.
- ERIKSSON, J. & RYVARDEN, L. 1976. The *Corticiciaeae* of North Europe 4: 547-886.
- & HJORTSTAM, K. & RYVARDEN, L. 1984. The *Corticiciaeae* of North Europe 7: 1279-1449.
- HALLENBERG, N. 1985. *The Lachnocladiaceae and Coniophomaceae of North Europe. Fungiflora*, 96 pages.
- ITO, S. 1955. Mycological flora of Japan. Vol. '2 *Basidiomycetes*, n° 4: *Auriculariales, Tremellales, Dacrymycelales, Aphylllophorales (Polyporales)*: 1: 450.
- JÜLICH, W. & STALPERS, J. 1980. The resupinate nonporoid *Aphylllophorales* of the temperate Northern Hemisphere. *Verhand. Kon. Nederl. Akad. Wetensch. Naturkunde* 2, ser. 74: 1-335.
- LLOYD, C. G. 1916. Rare species of fungi received from correspondents. *Lloyd Mycol. Writ.* 5: 595-604.
- MAAS GEESTERANUS, R. A. 1974. Studies in the genera *Irpex* and *Steccherinum*. *Persoonia* 7: 443-581.
- PARMASTO, E. 1971. The *Lachnocladiaceae* of the Soviet Union. *Acad. Sci. Estonian SSR*, 168 pp.
- RYVARDEN, L. 1991. Genera of polypores, nomenclature and taxonomy. *Syn. Fungorum* 5: 1-363.
- STALPERS, J. A. 1978. Identification of wood-inhabiting *Aphylllophorales* in pure culture. *Stud. Mycol.* 16: 1-248.