

NOTES ON THE GENUS *JACKSONOMYCES* JÜL. (CORTICIACEAE, BASIDIOMYCOTINA), WITH SPECIAL EMPHASIS ON THE SPECIES COLLECTED IN TAIWAN

SHENG-HUA WU¹ AND ZUEI-CHING CHEN²

1. National Museum of Natural Science, Taichung, Taiwan, 40419 R.O.C.

2. Department of Botany, National Taiwan University, Taipei, Taiwan, 10764 R.O.C.

ABSTRACT—The heterogeneous genus, *Phlebia* Fr. is briefly discussed regarding the problem of its subdivision. Species of *Phlebia cretacea* group are transferred to the genus *Jacksonomyces* Jül., based on differences of morphological and cultural characters. The following new combinations are made: *J. cretaceus* (Bourd. & Galz.) S.H. Wu & Z.C. Chen, *J. furfurellus* (Bres.) S.H. Wu & Z.C. Chen, *J. georgicus* (Parm.) S.H. Wu & Z.C. Chen, *J. subcretaceus* (Litsch.) S.H. Wu & Z.C. Chen, *J. segregatus* (Bourd. & Galz.) S.H. Wu & Z.C. Chen and *J. subulatus* (John Erikss. & Hjortst.) S.H. Wu & Z.C. Chen. A new species collected in Taiwan, *J. pseudocretaceus* S.H. Wu & Z.C. Chen, is also presented.

KEY WORDS: Corticiaceae, *Jacksonomyces*, new combination, new record, new species, *Phlebia*, Taiwan.

ON THE TAXONOMIC PROBLEM OF *PHLEBIA* FR.

In the Corticiaceae, *Phlebia* is a heterogeneous (Hallenberg 1986:9-10, Wu 1990:25) and fairly big genus consisting of about sixty species (cf. Hjortstam 1987:77). The circumscription of *Phlebia* is rather vague, and subdivision of the genus is viewed by Eriksson et al. (1981:1081) as very difficult and not, with certainty, possible. It is now realized that the delimitation of *Phlebia* should be rearranged, which may result in the exclusion of some members of the genus, and a more reasonable system for subdivision of the remaining species.

In recent years, *Amethicium* Hjortst. was proposed by Hjortstam (1983) to accommodate *Phlebia* s.l. with quasi-binding hyphae (term usage, see Wu 1990). *Efibula* S.H. Wu was established for a group of clampless *Phlebia* s.l. (Wu 1990). On the other hand, some *Resinicium* species were transferred by Wu (1990) to *Phlebia* for lacking both astrocystidia and cyanophilic halocystidia, which are diagnostic for *Resinicium*. As we know, macroscopic features are currently thought to be of

secondary taxonomic importance at generic and family levels in corticiaceous Basidiomycetes. Thus, the separation of *Mycoacia* Donk from *Phlebia*, based merely on the hydroid or odontoid hymenial surfaces of *Mycoacia*, could hardly be logical (cf. also Eriksson & Ryvarden 1976:873). In the future, at least some members of *Mycoacia* should be transferred to *Phlebia*. Some *Phlebia* species, such as *P. heterocystidia* S.H. Wu, *P. odontoidea* S.H. Wu and *P. ryvardenii* Hallenb. & Hjortst. etc., have odontoid hymenial surfaces. The fact demonstrates further unacceptance of the independence of *Mycoacia* from *Phlebia*.

Information from fruit bodies is not satisfactory for the taxonomy of the genus *Phlebia*. Evidence obtained from cultural studies, as proposed mainly by Stalpers (1978), Hallenberg (1986, 1987, 1990) and Nakasone (1990), seem to be very useful in this respect. According to Hallenberg (1987), the central group of species in *Phlebia* has rapid growth in culture, astatocoenocytic nuclear behaviour and positive reaction in laccase tests. The section *Phlebia* (Parmasto 1968), or Hjortstam's (1987) "sensu stricto" concept of *Phlebia* may be representative of

this group. Morphological characters of the central group could be briefly described as following:

The hymenial surfaces, when old enough, usually are not white or pale, but are more or less colourful. Configurations of hymenial surfaces are variable, possibly tuberculate, grandinioid-odontoid, radially folded, reticulately folded or even irregularly folded, but rarely smooth. The consistency of fruit bodies may be ceraceous-gelatinous in the living state, but will become crustaceous, or more often corneous and brittle under dried condition. All species in this core group cause white rot in wood. Microscopically, the subiculum is compact in texture; the differentiation of subhymenium from subiculum is quite evident. Basidial elements are compactly arranged in a palisade condition, and the shape of basidia being narrowly clavate.

Practically, if based on the above-mentioned description, clear separation of the core group from the other members of *Phlebia* is, sometimes difficult. Besides the core group, other members in *Phlebia* may represent differentially related species, including some unconnected members. Some representatives of the latter could be considered independent from the genus *Phlebia*.

ON THE GENUS *JACKSONOMYCES* JÜL.

During the study of Formosan *Phlebia*, we have noticed one deviating group of the genus, i.e. the *P. cretacea* group, which was presented by Eriksson et al. (1981). According to morphologies, they included six species in this group, i.e. *P. cretacea*, *P. georgica* Parm., *P. phlebioides* (Jacks. & Deard.) Donk, *P. segregata* (Bourd. & Galz.) Parm., *P. subcretacea* (Litsch.) M.P. Christ. and *P. subulata* John Erikss. & Hjortst. Within the above-mentioned species, *P. cretacea*, *P. segregata* and *P. subcretacea* have been presented for their cultural studies by Hallenberg (1987, 1990). Cultures of these three species grew very slowly, which is different from the rapid growth of the *Phlebia* s.str. The three species have basically normal nuclear behaviour, while *Phlebia* s.str. has astatocoenocytic nuclear behaviour. As to polarity, *P. segregata* is tetrapolar, unlike the bipolarity of *Phlebia* s.str. The polarity of *P. cretacea* and *P. subcretacea* is not yet known. *Phlebia* s.str. usually has laccase-positive reactions, *P. segregata* also has this positive reaction, while the reaction of *P. cretacea* and *P.*

subcretacea is negative. Fruit bodies of the *P. cretacea* group have white, whitish or fairly pale hymenial surfaces, which are normally smooth. Microscopically, this group may not have as compact subiculum texture, as tightly arranged hymenial elements or as narrow basidia shape as those existing in the core group of *Phlebia*.

For this study, we have examined limited specimens belonging to the *P. cretacea* group and deposited at Gothenburg University, Sweden. They are listed below.

Phlebia cretacea (as *P. romellii*) -- Sweden. Småland: Rumsquilla Par., N. Kvill National Park, on decayed trunk of *Picea*, 10.X.1972 N. Hallenb. (Fungi Suecici 0341).

P. georgica -- Sweden. Dalsland: Ödeborg, near Alekusen, on ?*Picea*, IX.1977 leg. Hjortst. & Larss. (KHL 1699).

P. phlebioides -- Canada. Montana: Univ. of Montana Bio. Sta., Flathead Lake, on *Larix occidentalis*, 4.VIII.1964 R.L. Gilb. 4931. Det. John Erikss.

P. subcretacea -- Canada. Ontario: Algonquin Prov. Park, along Highland Hiking Trail, mixed forest with *Abies*, on a fallen log of *Pinus strobus*. 19.IX.1982 N. Hallenb. 7393.

P. segregata -- Sweden. Gasterikland: Valbosin, Mackmyra, Krono Park, on *Picea abies*, 19.VIII.1978 J. Jeppson 1374.

P. subulata -- Sweden. Dalarna: Venjan Par., Lybergsgnupen, on *Picea*, 7.VIII.1982 Larsson & Hallingbäck (KHL 3361).

All the above-mentioned specimens, collected from Canada and from Sweden, are on brown-rotted or partly brown-rotted wood. Differences in fruit bodies, as well as in cultural studies including growth rate, nuclear behaviour and, possibly, polarity, oxidase reactions and, even, rot pattern, indicate that *P. cretacea* group should be treated as the genus separate from *Phlebia*.

Based on *Peniophora phlebioides* Jacks. & Deard., Jülich (1979) established a monotypic genus, *Jacksonomyces*. In his remark, Jülich distinguishes *Jacksonomyces* from *Phlebia* in having different shape and size of the basidia. Due to differences of fruit bodies and the known cultural characteristics between *Phlebia* s.str. and *P. cretacea* group, other members of the latter besides the generic type are, therefore, also transferred to the genus *Jacksonomyces*. New combinations of these species are made below:

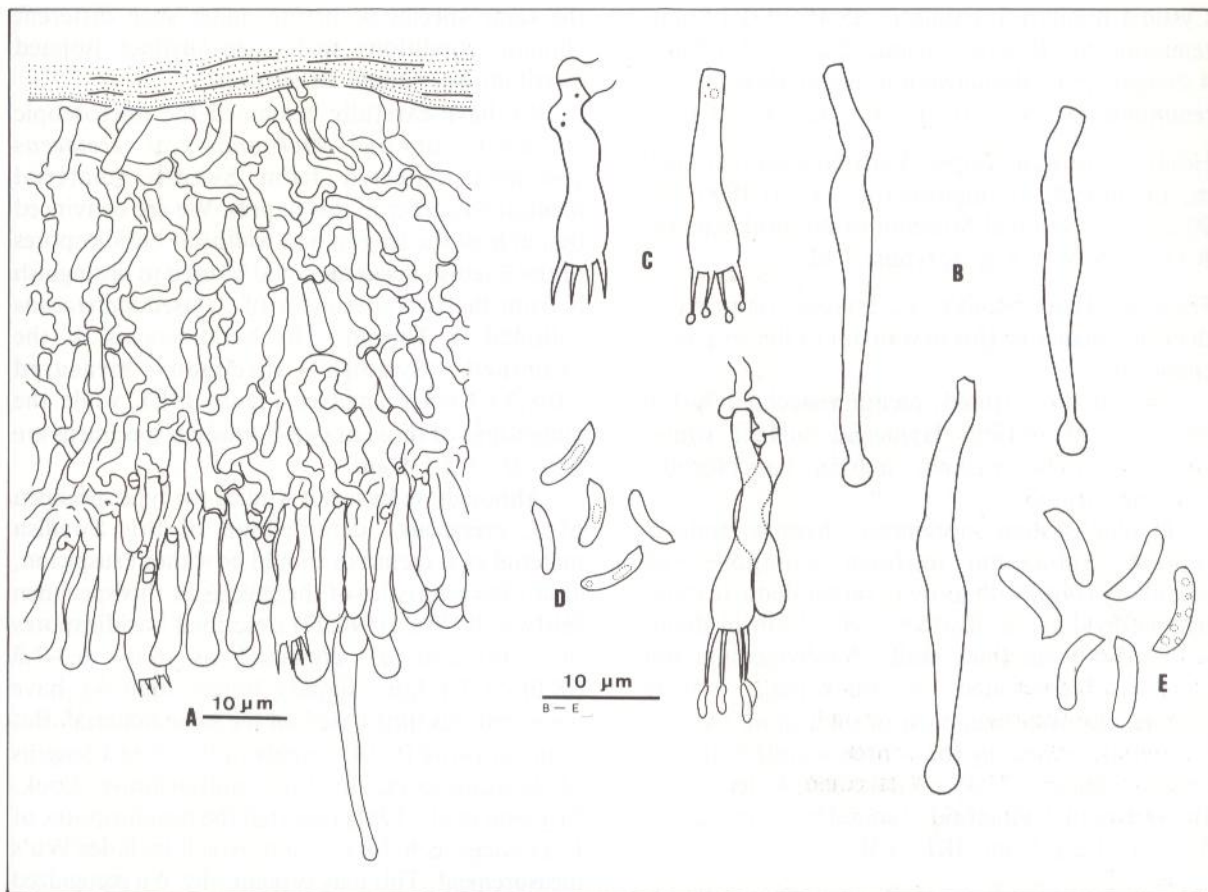


Figure 1. A-D. *Jacksonomyces pseudocretaceus* (holotype); 1E. *J. cretaceus* (Fungi Suecici 3041.) A) Fruit body section, B) capitate cystidia, C) basidia, D-E) basidiospores.

Jacksonomyces cretaceus (Bourd. & Galz.) S.H. Wu & Z.C. Chen, comb. nova

Basionym: *Peniophora cretacea* Bourd. & Galz., Hyménomyc. France: 288. 1928.

J. georgicus (Parm.) S.H. Wu & Z.C. Chen, comb. nova

Basionym: *Phlebia georgica* Parm., Eesti NSV Tead. Akad. Toim. Biol. 16:390. 1967.

J. segregatus (Bourd. & Galz.) S.H. Wu & Z.C. Chen, comb. nova

Basionym: *Peniophora segregata* Bourd. & Galz., Hyménomyc. France: 284. 1928.

J. subcretaceus (Litsch.) S.H. Wu & Z.C. Chen, comb. nova

Basionym: *Corticium subcretaceum* Litsch., Öst. bot. Zeitschrift 88:110. 1939.

J. subulatus (John Erikss. & Hjortst.) S.H. Wu & Z.C. Chen, comb. nova

Basionym: *Phlebia subulata* John Erikss. & Hjortst., Cort. Nor. Eur. 6:1175. 1981.

According to morphological characters of fruit bodies, two additional species, collected from Taiwan, should also belong to the genus *Jacksonomyces* and are described as follows.

Jacksonomyces pseudocretaceus S.H. Wu & Z.C. Chen, sp. nova (Figure 1 A-D)

Basidiocarpum effusum, membranaceum, 30-120 μm crassum; superficies hymenialis plana. Systema hypharum monomiticum; hyphae fibulatae.

Cystidia numerosa, capitata, $25-45 \times 3.0-4.5 \mu\text{m}$, tenuitunicata. Basidia clavata, $12-22 \times 3.5-4.5 \mu\text{m}$, 4 sterigmatibus. Basidiosporae allantoideae, laeves, tenuitunicatae, $5.5-7.0 \times 1.2-1.5 \mu\text{m}$, IKI-, CB-.

Holotypus: Taiwan. Taipei: Yangmingshan, alt. 600 m, on branch of angiosperm, 13.XII.1990 Wu 901213-18 (National Museum of Natural Science, R.O.C. (N.M.N.S.); *isotypus*: TAI).

Etymology: From pseudo- + cretacea, referring to the resemblance of this new taxon to the species *J. cretaceus*.

Fruit bodies effused, membranaceous, 30-120 μm thick in section. Hymenial surface white, smooth, rarely cracked; margin concolorous, thinning, pruinose.

Hyphal system monomitic; hyphae nodose-septate. Subiculum uniform, composed of medullary layer, with loose to rather dense texture; hyphae hyaline, \pm distinct, $1.8-3.3 \mu\text{m}$ in diam, with $0.3-0.9 \mu\text{m}$ thick walls. Subhymenium not clearly differentiated, \pm thickening; hyphae hyaline, narrower than those of subiculum. Cystidia numerous, projecting for approximately half their lengths, capitate, $25-45 \times 3.0-4.5 \mu\text{m}$, 4-sterigmate. Basidiospores allantoid, smooth, thin-walled, $5.5-7.0 \times 1.2-1.5 \mu\text{m}$, IKI-, CB-.

Additional specimen examined.: Taiwan. Taipei: Beside highway between Hsintien and Pinglin, alt. 200 m, on partly brown-rotted branch of *Ficus fistulosa*, 17.IV.19 Wu 880417-7 (H, TAI, S.H.W.).

Distribution: Taiwan.

Remarks: Due to the resemblance of both macroscopic and microscopic characters, based on specimen no. Wu 880417-7, this new species has been determined by Wu (1990) to be *Phlebia cretacea*. According to Eriksson et al. (1981), reliable distribution areas of *P. cretacea* in the world are Sweden, Norway and Finland, all in North Europe. They also indicated that this species grows on decorticate coniferous wood (*Pinus*, *Picea*) in open biotopes. As of finding *P. cretacea* in Taiwan, Wu (1990:118-119) has noticed the differences in climatic zones between North Europe and subtropical Taiwan, as well as the distance between these two places. Wu thus suggested that it may represent some kind of adaptive speciation, but such differentiation was not clearly evident in the microscopic characters. Nevertheless, that they are

the same species occurring under such different climatic conditions with such distinct isolated distributions, should be suspect.

We have carefully examined the microscopic characters of one *Jacksonomyces cretaceus* specimen collected from Sweden (material mentioned earlier in this paper). We are convinced that at least the lengths and widths of basidiospores of the Swedish material, could be used to distinguish it from the two specimens of *J. pseudocretaceus* collected in Taiwan. The basidiospores of the examined Swedish specimen measured $7.0-8.3 \times 1.6-1.9 \mu\text{m}$ (see Figure 1 E), while the dimensions of those of two Formosan specimens are $5.5-7.0 \times 1.2-1.5 \mu\text{m}$.

Although we have not studied the type specimen of *J. cretaceus*, identification of this Swedish material as *J. cretaceus* should be without suspicion, as all characteristics of the species fit this specimen fairly well. Wu (1990:27) described basidiospores of "Formosan *P. cretacea*" as $(6.0-)$ $6.3-7.3$ $(-8.0) \times 1.3-1.5 \mu\text{m}$, slightly longer than we have measured this time based on the same material. But in his drawing (f. 14) reveals fairly correct lengths of basidiospores. In their authoritative book, Eriksson et al. (1981) reported the basidiospores of *P. cretacea* as $6-9 \times 1.3-2 \mu\text{m}$, which includes Wu's measurement. This may explain why Wu recognized the Formosan specimen as the same species as *P. cretacea*. Differences in basidiospores, climatic adaptation, host species and distributional area can separate these two species without suspicion.

Jacksonomyces fufurellus (Bres.) S.H Wu & Z.C. Chen, comb. nova (Figure 2)

Basionym: *Odontia fufurella* Bres., Mycologia 17:71. 1925.

Odontia verrukawa Furukawa, Bull. Gov. For. Exp. Sta. Tokyo 261:26. 1974., syn. nov.

Fruit bodies effused, adnate, membranaceous when young, subceraceous when old, 50-130 μm thick in section (aculei excluded). Hymenial surface whitish and grandinioid when young, odontoid-hydroid and ivory yellow when old, rarely cracked; margin paler, thinning, arachnoid-pruinose. Aculei variable in density and in size due to different developmental degree; separate when young, sometimes fused at bases when old, 4-12 per mm, conical when young, subulate when old, with obtuse or \pm acute apices, up to ca. $800 \times 200 \mu\text{m}$.

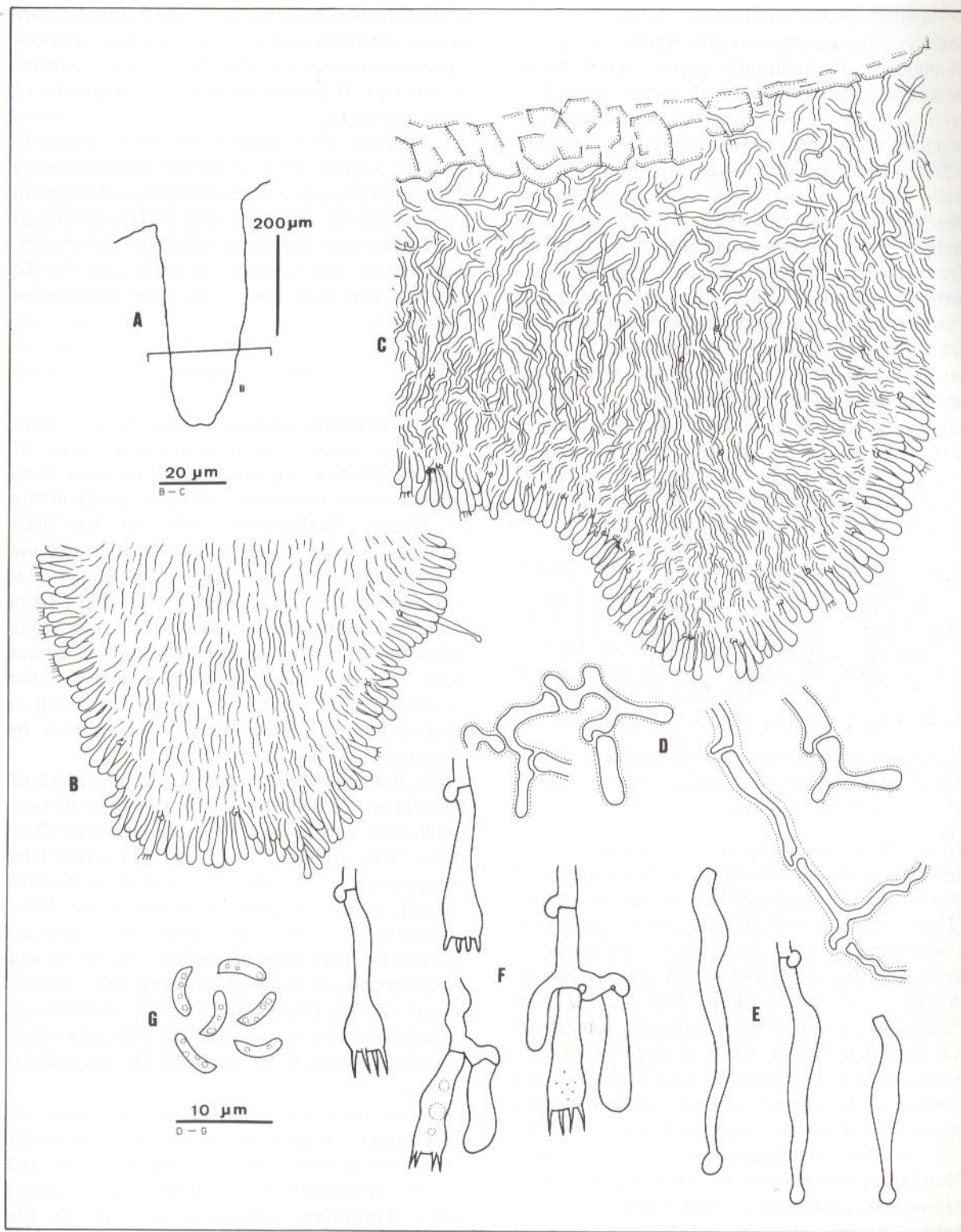


Figure 2. *Jacksonomyces furfurellus* (Wu 901125-23). A) Aculeus of fruit body section. B) aculeal apex, C) fruit body section, D) subicular hyphae, E) capitate cystidia, F) basidia, G) basidiospores.

Hyphal system monomitic; hyphae nodose-septate. Subiculum usually fairly uniform, composed of medullary layer. Basal layer occasionally present in old fruit bodies. Medullary layer with fairly loose texture when young, fairly compact when old; hyphae hyaline, \pm tortuous, 1.5-3.3 μm in diam, with 0.4-0.9 μm thick walls, the walls sometimes indistinct. Subhymenium not clearly differentiated, \pm thickening, hyphae more vertical and narrower than those of subiculum. Trama with compact texture, hyphae more vertically arranged than those in subiculum. Cystidia numerous, projecting for approximately half their lengths, usually capitate, 14-32 \times 2.7-3.5 μm , thin-walled. Basidia clavate, 11-22 \times 3.5-4.5 μm , 4-sterigmate. Basidiospores allantoid, smooth, thin-walled, sometimes with several small oil-drops, (4.0-) 4.3-5.3 \times 1.0-1.4 μm , IKI-, CB-.

Specimens examined.: U.S.A. Virginia: Great Falls, on *Pinus virginiana*, J.R. Weir 20087, 9.IX.1921 (lectotype of *O. furfurella*, BPI); Great Falls, on brown-rotted *Pinus virginiana*, J.R. Weir 20064, 20.IX. 1921 (BPI). Japan. Tokyo: Asakawa, on bark and stem of dead *Pinus*, 25. X.1965, K.A. (TFM 11268, holotype of *O. verrukawa*). Taiwan. Ilan: Kungliao, alt. 200 m, on partly brown-rotted branch, 12. XI.1990 Wu 901125-1, 901125-23 (N.M.N.S., TAI), Lin 178 (N.M.N.S., TAI).

Distribution: Eastern U.S.A. (Gilbertson 1963), Brazil (Hjortstam & Bononi 1987), Japan (Furukawa 1974), Taiwan.

Remarks: Taxonomic placement of this species was not certain among mycologists. Hjortstam and Bononi (1987) established a monotypic genus, *Skvortzovia* Bononi & Hjortst., for *O. furfurella*. Considering the close similarity of this species to *Resinicium meridionale* (Burds. & Nakas.) Nakas. in their cultural studies, Nakasone (1990) transferred it to the genus *Resinicium*. *Resinicium* was delimited by Wu (1990) as species with both astrocystidia and cyanophilic halocystidia. If Wu's concept of this genus is adopted, both *Mycoacea meridionalis* Burds. & Nakas. and *O. furfurella* do not fit the circumscription of this genus. Morphological features of *O. furfurella*, such as the colour and consistency of fruit bodies, as well as hyphal nature, capitate cystidia and allantoid basidiospores are very typical of the genus *Jacksonomyces*, even if the hymenial surface of this

species is grandinioid to odontoid-hydroid. Other species of *Jacksonomyces* normally have smooth hymenial surfaces, but this macroscopic character may not be of prime importance in taxonomy of the Corticiaceae.

This species is reported for the first time in Taiwan. Strong dispersal ability and incomplete floristic investigation of the subtropical and tropical Corticiaceae (cf. Wu 1990), may explain the distant and fragmentary global-distribution of this species. Accordingly, more countries could be added to the distributional areas, if more extensive investigation is made.

DISCUSSION

It is difficult to clearly delimit species groups in *Phlebia* according to morphological studies of fruit bodies alone. Cultural studies, however, were proved to be important in discussing the taxonomy of *Phlebia* (Hallenberg 1987). As has been mentioned in this paper, cultural studies of some *Jacksonomyces* species may provide sufficient evidence for the separation of this genus from *Phlebia*. Unfortunately, we have not succeeded in obtaining single-sporous and polysporous cultures from Formosan *Jacksonomyces* species. As the investigation of Formosan Corticiaceae is still in progress, more *Jacksonomyces* species may be expected from this island in future.

In Stalpers' (1978:56) studies, the culture of *Phlebia phlebioides* has fairly rapid growth rate, unlike the slow growth of *Jacksonomyces*. But, there are different opinions regarding the conspecificity of *P. phlebioides* and *P. subserialis* (Bourd. & Galz.) Donk (Eriksson et al. 1981, Nakasone et al. 1982, Hjortstam 1987); they are thought by Eriksson et al. as different species and the latter considered as not belonging to *P. cretacea* group. If *P. phlebioides* and *P. subserialis* are regarded as different species, cultural data which have been presented for *J. phlebioides* may still be suspect.

It is interesting that many specimens of *Jacksonomyces* grew on brown-rotted or partly brown-rotted wood, such as some Canadian and Swedish specimens mentioned earlier in this paper, many Formosan collections, as well as the specimens of *Phlebia cretacea* and *P. segregata* served for Hallenberg's (1987) cultural studies. Gilbertson (1963) mentioned that white pitted rot

is associated with *O. furfurellus*. The enzymatic activities of *Jacksonomyces* and actual rotten type caused by this genus deserve further study.

It is practical and convenient to treat the *P. cretacea* group in the broader sense of the genus *Phlebia*. But *Jacksonomyces* should be taxonomically independent from *Phlebia*, based on differences of morphological and cultural characters. This paper has not made a clear demarcation between the genus *Jacksonomyces* and the rest of *Phlebia* s.l., mainly because results of culture and other studies have not been obtained for many species. However, the clear subdivision of *Phlebia* s.l., is anticipated in the studies of the future.

ACKNOWLEDGEMENTS

We are very indebted to Dr. Nils Hallenberg, Gothenburg University, Sweden, for providing some of the specimens examined in this study, and for his valuable comments upon reviewing the manuscript of this paper. We are also obliged to curators of the herbaria BPI and TFM for loans of specimens in this study. Sincere thanks also go to anonymous reviewers who provided valuable comments on this manuscript.

REFERENCES

- Eriksson, J., K. Hjortstam and L. Ryvarde, 1981. The Corticiaceae of North Europe 6. *Phlebia-Sarcodontia*. pp. 1048-1276. Fungiflora, Oslo.
- Eriksson, J. and L. Ryvarde, 1976. The Corticiaceae of North Europe 4. *Hyphodermella-Mycoacia*. pp. 547-886. Fungiflora, Oslo.
- Furukawa, H., 1974. Taxonomic studies of the genus *Odontia* and its allied genera in Japan. Bull. Gov. For. Exp. Sta. Tokyo 261:1-87.
- Gilbertson, R.L., 1963. Resupinate hydnceous fungi of North America. II. Type studies of species described by Breasadola, Overholts, and Lloyd. Pap. Michigan Acad. Sci. 48:137-149.
- Hallenberg, N., 1986. Culture studies in Corticiaceae (Basidiomycetes). Windahlia 15:9-18.
- Hallenberg, N., 1987. Culture studies in Corticiaceae (Basidiomycetes) II. Windahlia 17:43-47.
- Hallenberg, N., 1990. Culture studies in Corticiaceae (Basidiomycetes) III. Windahlia 18:25-30.
- Hjortstam, K., 1983. Studies in tropical Corticiaceae (Basidiomycetes) 5. Specimens from East Africa, collected by L. Ryvarde. Mycotaxon 17:555-572.
- Hjortstam, K., 1987. A check-list to genera and species of corticioid fungi (Hymenomycetes). Windahlia 17:55-85.
- Hjortstam, K. and V.L.R. Bononi, 1987. A contribution to the knowledge of Corticiaceae s.l. (Aphylophorales) in Brazil. Mycotaxon 28:1-15.
- Jülich, W., 1979. Studies in resupinate Basidiomycetes-VI. Persoonia 10:325-336.
- Nakasone, K.K., H.H. Burdsall, Jr. and L.A. Noll, 1982. Species of *Phlebia* section *Leptocystidia* (Aphylophorales, Corticiaceae). Mycotaxon 14:3-12.
- Nakasone, K.K., 1990. Cultural studies and identification of wood-inhabiting Corticiaceae and selected Hymenomycetes from North America. Mycologia Mem. 15:1-412.
- Parmasto, E., 1968. Conspectus systematis Corticiacearum. 261 pp. Inst. Zool. Bot. Acad. Sci. Estonicae, Tartu.
- Stalpers, J.A., 1978. Identification of wood-inhabiting Aphylophorales in pure culture. Centraalb. Schimelc. Stu. Mycol. 16:1-248.
- Wu, S.H., 1990. The Corticiaceae (Basidiomycetes) subfamilies Phlebioideae, Phanerochaetoideae and Hyphodermoideae in Taiwan. Acta Bot. Fennica 142:1-123.

論傑克森菌屬(*Jacksonomyces* JÜL.)(皮殼菌科,擔子菌亞群)(Corticiaceae, Basidiomycotina)及臺灣之種類

吳聲華 陳瑞青

摘要

一異源性屬，射脈菌屬(*Phlebia*)之屬內細分問題在文中討論之。依據形態特徵及培養特徵之不同，文中將白射脈菌群(*P. cretacea* group)移置於傑克森菌屬(*Jacksonomyces* Jül.)內，並提出新組合如下：白傑克森菌(*J. cretaceus*)、粉鱗傑克森菌(*J. furfurellus*)、喬治傑克森菌(*J. georgicus*)、隔傑克森菌(*J. segregatus*)、次白傑克森菌(*J. subcretaceus*)、以及錐形傑克森菌(*J. subulatus*)；其中粉鱗傑克森菌為台灣新記錄種。本文並描述台灣產一新種，偽白傑克森菌(*J. pseudoretaceus*)。

關鍵詞：皮殼菌科，傑克森菌屬，新組合，新記錄，新種，射脈菌屬，臺灣。