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Research Article

Defining *Xerocomus s.str.* (Boletaceae) in Malesia

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ABSTRACT

Spores from Corner's (1972, 1974) type specimens of *Xerocomus* (sensu Horak, 2011) housed at Edinburgh herbarium (E) were imaged for the first time, using Scanning Electron Microscopy (SEM) to ascertain the presence of *Xerocomus* sensu Šutara (2008) in Malesia. The following taxa *Boletus chlamydosporus, B. chrysops, B. lubricus, B. microcarpus, Xerocomus microcarpoides* and *Phylloporus rufoflavipes* were found to have bacillate ornamentations. New combinations and name changes have been proposed.

Keywords: Boletaceae; Singapore; macrofungi; diversity

Introduction

In the Boletales, *Xerocomus* Quél. is a genus of fungi found throughout the world but is poorly collected and studied in Malesia.

Xerocomus was first described by Quélet (1887). The type species is *Xerocomus subtomentosus* (L.) Quél. (Quélet, 1888). For many years, the classification of basidiomycetes was based on the fungal fruiting body, or basidiocarp, and *Xerocomus* has been no exception. Based on European collections, Oolbekkink (1991) pointed out that although *Xerocomus* could indeed be distinguished from a few taxa in *Boletus* on the structure the hymenophoral trama, as suggested by Singer (1951), other species, especially non-European ones remained ambiguous. For this reason, *Xerocomus* has not had universal acceptance at generic level (Smith & Thiers 1971; Corner, 1974; Oolbekkink, 1991; Watling, 2001; Halling, 2007). When molecular techniques became available, Binder & Hibbert (2006) showed that *Xerocomus* was not monophyletic. Šutara (2008) observed that *Xerocomus* was highly variable. Through the study of spore ornamentation among other anatomical characters,

he re-delimited *Xerocomus*. The study by Wu et al. (2014), using DNA sequences of four genes (nrLSU, *tef1-a*, *rpb1*, and *rpb2*), confirmed that *Xerocomoid boletes* harbours six lineages (*Xerocomus s.str.*, *Hemileccinum* Šutara, *Xerocomellus* Šutara, and 3 other clades). The latter paper had only taken into account the European *Xerocomus,* but not the ones found elsewhere.

Unlike the European taxa of *Xerocomus s.l.*, pre-Šutara (2008) the species described from Malaya and other parts of Malesia are mostly known only from the type specimen. In a revision of Corner's works (1972, 1974), Horak (2011) neither included molecular work nor spore SEM studies despite the latter having been shown by Šutara (2008) to be a key character in defining *Xerocomus s.str*. and relied entirely on hymenophoral trama and cystidial charcters

In Malesia, Corner (1972) placed 48 *Boletus* taxa under subgenus *Xerocomus*, as they differed from subgenus *Boletus* only by their tube-trama, which were phylloporoid rather than boletoid, although Corner himself pointed out that there were intermediate states and no sharp distinctions. The tube-trama character is illustrated in detail in Šutara (2005) for European taxa.

Šutara (2008) examined the spore ornamentation across *Xerocomus s.l.* and delimited the European species on the basis of the bacillate spore ornamentation, among other characters such as the size of the fruit bodies, the hymenophoral trama, the shape and size of the spore, etc. The bacillate spore ornamentationis is only found in the genera *Xerocomus s.str*. and *Phylloporus*, which finds itself in *Xerocomus* in the latest classification. Where *Xerocomus* are poroid, *Phylloporus* are gilled.

Horak (2011) reassessed the classification of Corner's Malaysian boletes and raised his subgenus *Xerocomus* to generic level. Taxa with lost or compromised type material, or with protologue descriptions inadequate or contradicting, were placed in a list of excluded or rejected species.

While Šutara (2008) had used the bacillate spore ornamentation as the defining character that placed poroid bolete taxa in *Xerocomus* Quél. *s.str.*,Horak did not discuss this spore *ornamentation in his work*.

The Malesian species of *Xerocomus* have been neglected almost entirely by all authors. In this study, we imaged with a SEM, 23 *Xerocomus* species upgraded

by Horak (2011) in his revision of the Malesian species of Boletales *s.l.*, in addition to 13 of the taxa of *Boletus* (Xerocomus) *sensu* Corner (1972) which were subsequently excluded from his studies. The remaining 12 types from Corner's 48 taxa (1972) were not imaged as they were either too small for destructive sampling or not available during the time of study.

Materials and methods

In the present study, 36 taxa extracted from the type specimens of Corner's species were analysed. All the specimens were deposited at the Royal Botanic Garden Edinburgh (E).

Xerocomus as defined by Horak (2011). Collection details of examined taxa in appendix I.

1. *Xerocomus albipurpureus* (Corner) E. Horak
2. *Xerocomus asperipes* (Corner) E. Horak
3. *Xerocomus calocystides* (Corner) E. Horak
4. *Xerocomus calvus* (Corner) E. Horak
5. *Xerocomus catervatus* (Corner) E. Horak
6. *Xerocomus cuticulatus* (Corner) E. Horak
7. *Xerocomus cyaneirufescens* (Corner) E. Horak
8. *Xerocomus destitutus* (Corner) E. Horak
9. *Xerocomus dispersus* var. *dispersus* (Corner) E. Horak
10. *Xerocomus dispersus* var. *tembelingensis* (Corner) E. Horak
11. *Xerocomus ferruginosporus* (Corner) E. Horak
12. *Xerocomus gyrodontoides* (Corner) E. Horak
13. *Xerocomus lucescens* (Corner) E. Horak
14. *Xerocomus microcarpoides* (Corner) E. Horak
15. *Xerocomus prebadius* (Corner) E. Horak
16. *Xerocomus pseudochrysenteron* (Corner) E. Horak
17. *Xerocomus ranunculus* (Corner) E. Horak
18. *Xerocomus raphanolens* (Corner) E. Horak
19. *Xerocomus rectus* (Corner) E. Horak
20. *Xerocomus rufoflavipes* (Corner) E. Horak
21. *Xerocomus satisfactus* (Corner) E. Horak
22. *Xerocomus solitarius* (Corner) E. Horak
23. *Xerocomus tentabundus* (Corner) E. Horak

Boletus subgen. *Xerocomus* sensu Corner (1972). Collection details of examined taxa in appendix.

1. *Boletus aculifer* Corner
2. *Boletus blanditus* Corner
3. *Boletus chlamydosporus* Corner
4. *Boletus chrysops* Corner
5. *Boletus hastulifera* Corner
6. *Boletus honestus* Corner
7. *Boletus intentus* Corner
8. *Boletus lubricus* Corner
9. *Boletus microcarpus* Corner
10. *Boletus nugatorius* Corner
11. *Boletus polychrous* Corner
12. *Boletus sartor* Corner
13. *Boletus variisporus* Corner

Morphological (SEM) characters

Spores were examined with a LEO Supra 55vp Scanning Electron Microscope (Zeiss) at the Royal Botanic Garden, Edinburgh (RBGE), United Kingdom.

Dried herbarium material was mounted on aluminium SEM stubs with double-sided adhesive carbon stickers without treatment. Spirit material was taken through a series of chemical washes (70% ethanol (15min), 95% ethanol (10min), 100 % ethanol (5min), 100% acetone (5 min), 100% acetone (5 min)), and brought through the K850 Critical Point Dryer (Quorum Technologies) prior to being mounted on the SEM stubs. Mounted stubs were sputter coated with platinum for 1.5 min in the K575X Sputter Coater (Quorum Technologies,), at a 25mA current. Samples were scanned at magnifications of 1000X, 3000X and 10,000X and imaged at a working distance of 10mm and EHT 5kV.

Results

Scanning Electron Microscopy imaging of Malesian Xerocomoid boletes revealed the following taxa, *Boletus* (*Xerocomus*) *chlamydosporus* Corner, *Boletus* (*Xerocomus*) *chrysops* Corner, *Boletus* (*Xerocomus*) *lubricus* Corner and *Boletus* (*Xerocomus*) *microcarpus, Xerocomus microcarpoides* (Corner) E. Horak and *Xerocomus rufoflavipes* (Corner) E. Horak with bacillate ornamentations at 10000X magnification.

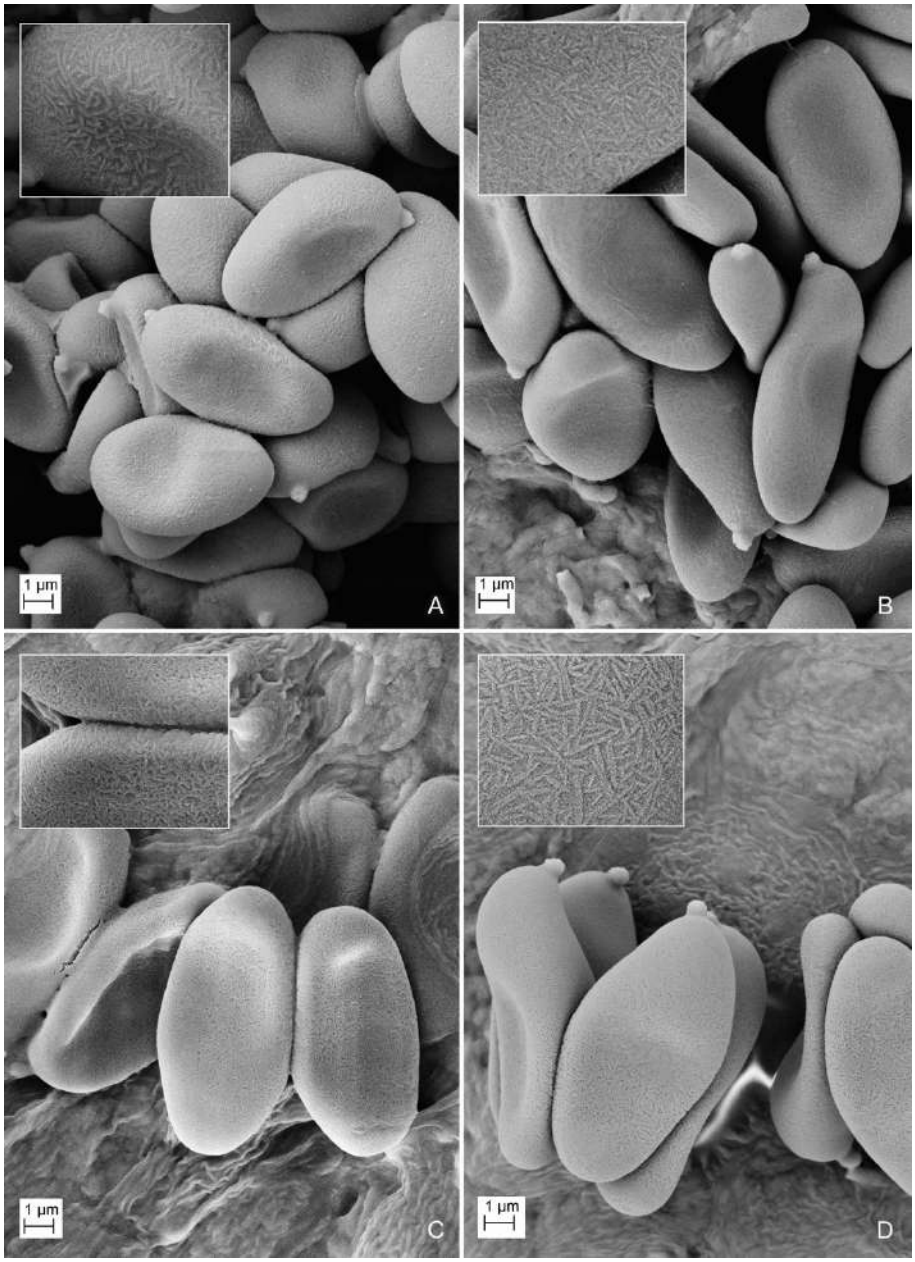

Figure 1.1. A. SEM spore images. Spores with bacillate ornamentations. **A.** *Boletus chlamydosporus* (sheet), **B.** *B. chrysops* (sheet),**C.** *B. lubricus* (sheet) and **D.** *B. microcarpus* (sheet). All holotype material.

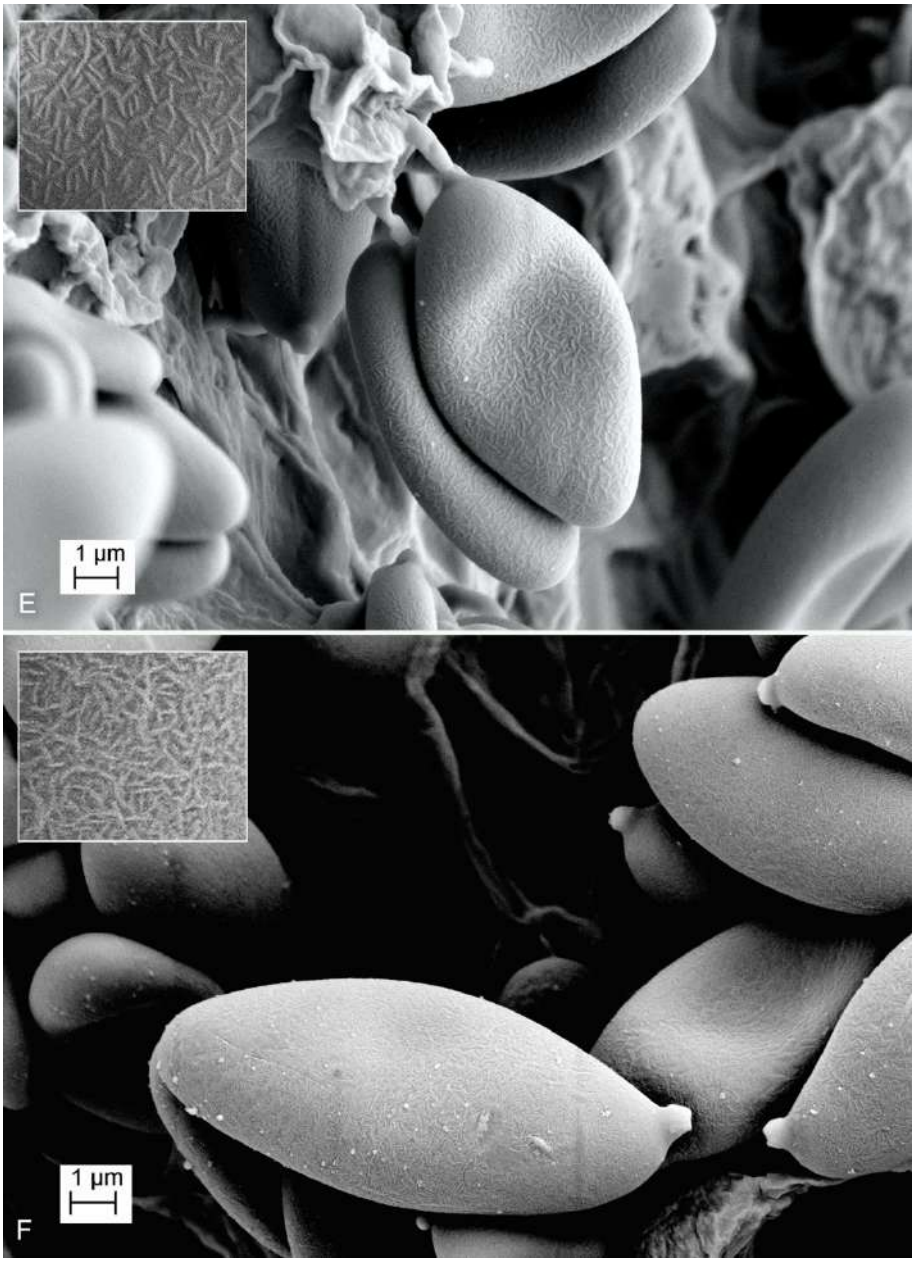

Figure 1.2. SEM spore images. Spores with bacillate ornamentations. **E.** *Xerocomus microcarpoides* (sheet). **F.** *X. rufoflavipes* (sheet). All holotype material.

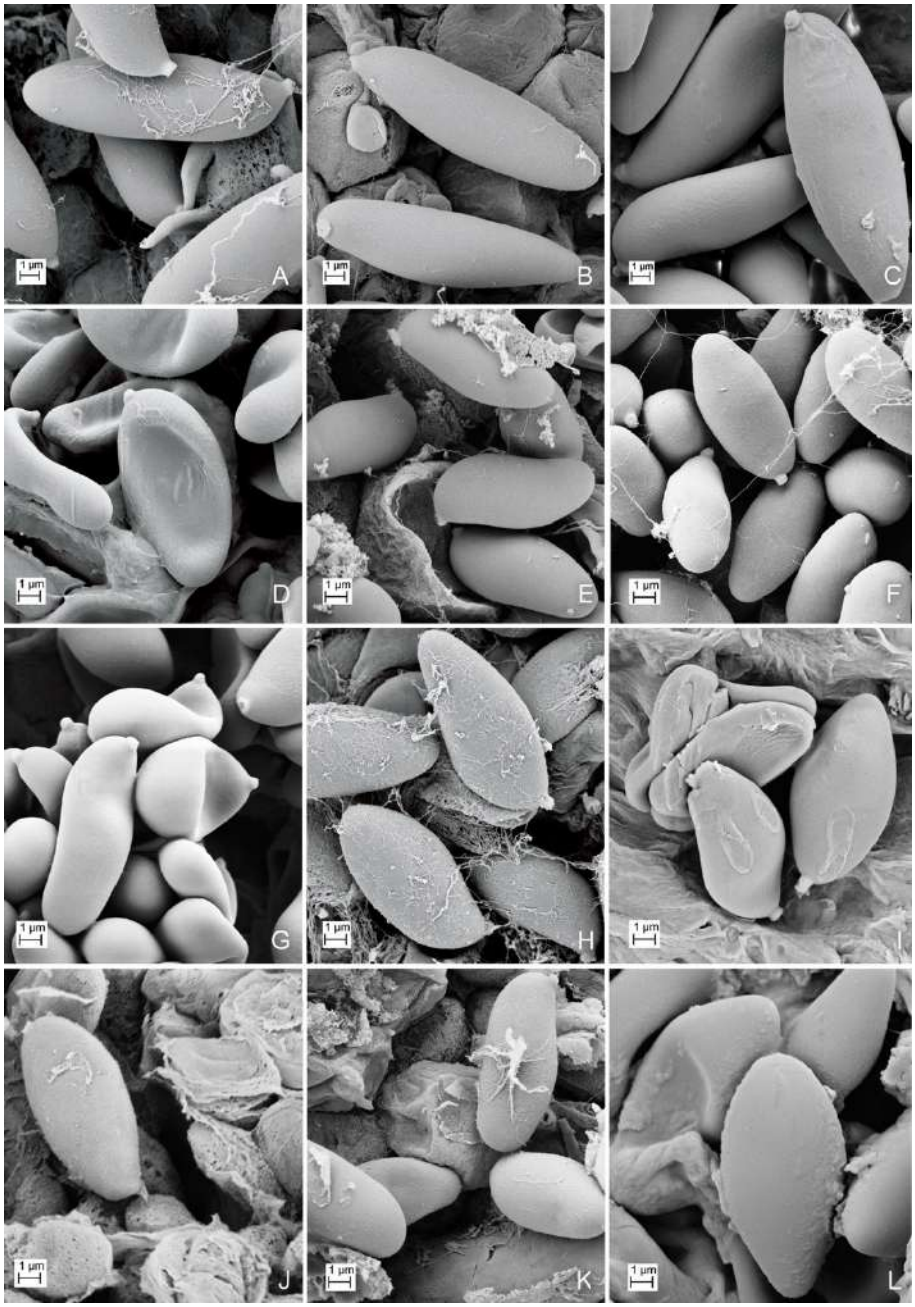

Figure 2.1. SEM images. **A.** *Xerocomus albipurpureus* (spirit). **B.** *X. ferruginosporus* (spirit). **C.** *X. raphanolens* (sheet). **D.** *X. asperipes* (sheet). **E.** *X. calvus* (spirit). **F.** *X. catervatus* (spirit). **G.** *X. cyaneirufescens* (sheet). **H.** *X. dispersus* var. *dispersus* (spirit) **I.** *X. dispersus var. tembelingensis* (sheet). **J.** *X. gyrodontoides* (spirit). **K.** *X. prebadius* (spirit). **L.** *X. ranunculus* (sheet). All holotype material except for *X. calvus* (holotype not found, but material (E00458467) cited by Corner, 1972).

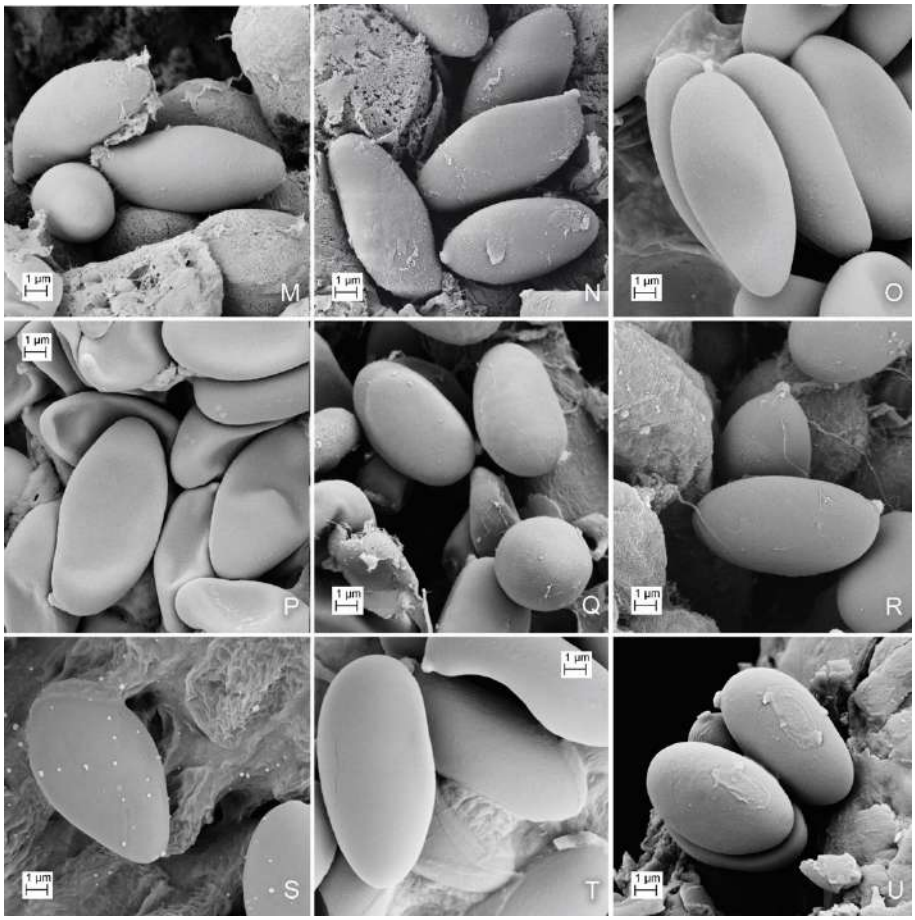

Figure 2.2.: SEM images. **M.** *Xerocomus rectus* (spirit). **N.** *X. satisfactus* (spirit). **O.** *X. solitarius* (sheet). **P.** *X. tentabundus* (sheet). **Q.** *X. calocystides* (spirit). **R.** *X. cuticulatus* (spirit). **S.** *X. lucescens* (sheet). **T.** *X. pseudochrysenteron* (sheet). **U.** *X. destitutus* (sheet). All holotype material.

All other *Xerocomus sensu* Horak which have smooth spores. See **figures 2.1 and 2.2.** Remaining species of *Boletus* (*Xerocomus*) *sensu* Corner (1972, 1974) which have smooth spores. See **figure 3.**

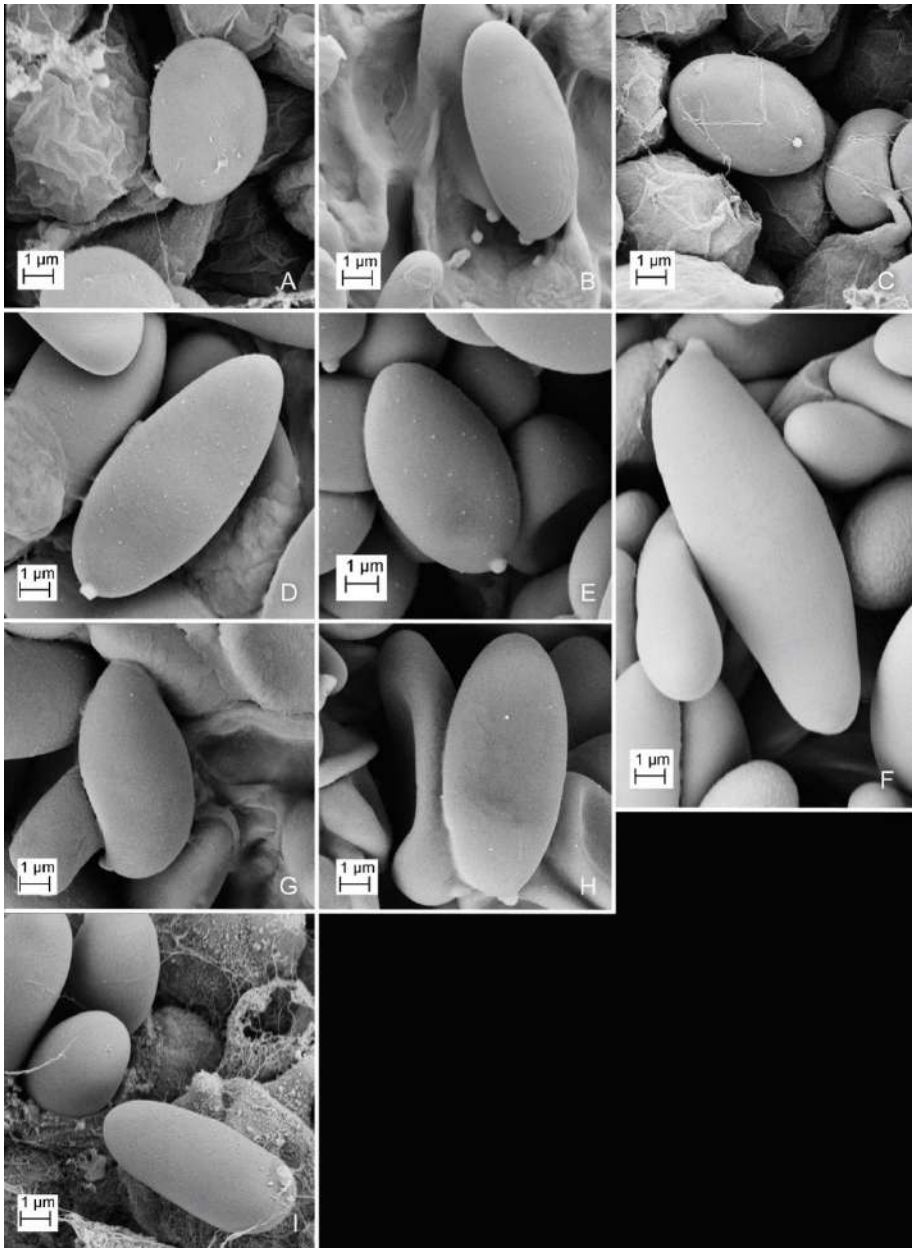

Figure 3. SEM images at 10000X magnification. Species from *Boletus* (Xerocomus) sensu Corner having smooth spores. **A.** *Boletus aculifer* (spirit), **B.** *B. blanditus* (sheet), **C.** *B. hastulifera* (spirit), **D.** *B. honestus* (sheet), **E.** *B. intentus* (sheet), **F.** *B. nugatorius* (sheet), **G.** *B. polychrous* (sheet), **H.** *B. sartor* (sheet) and **I.** *B. variisporus* (spirit). All holotype material.

Discussion

Assessment on the generic concept of Xerocomus in Malesia

Šutara's (2008) morphological investigation and the molecular evidence given by Binder and Hibett (2006) have resulted in a much better defined delimitation of the genus. However, their conclusions were derived from the study of the European species of *Xerocomus*, which often have much larger basidiocarps than the Malesian ones. Many of these other features are not clearly visible in the specimens available for this study, as the majority of the Malesian species of *Xerocomus s.str*. are diminutive and shorter than 50 mm, with the exception of *Boletus* (Xerocomus) *chlamydosporus* Corner. From our study of the taxa that Horak (2011) upgraded to *Xerocomus* in Malesia, we found that only *Xerocomus microcarpoides* has the bacillate spore ornamentation that Šutara (2008) described as one of the features differentiating *Xerocomus* from *Boletus*. All the other samples of *Xerocomus* (Horak, 2011) examined have smooth spores. The only other genus to have bacillate spore ornamentation is *Phylloporus*, of which we have studied the species *Phylloporus rufoflavipes* (*Xerocomus rufoflavipes*). *Phylloporus* has been separated from *Xerocomus* based on the lamellate hymenophore and clusters within the *Xerocomus subtomentosus* group (Binder & Hibett, 2006). Spore ornamentation seems to be the most crucial and defining *Xerocomus*, together with the absence of gills in most taxa. Of the other characters listed by Šutara (2008), the pore size did not quite match our putative *Xerocomus*. The other characters have to be redefined as more *Xerocomus* species are found in Malesia, starting with the knowledge of these five species.

Placement of our study taxa

On the basis of spore ornamentation alone, it can be concluded that *Xerocomus microcarpoides* is the only Malaysian species which should remain in *Xerocomus* whereas all remaining taxa included in our study, with the exception of *Xerocomus rufoflavipes* (Corner) E. Horak now placed in *Phylloporus* (Horak, 2011), should be retained meantime under *Boletus* until molecular sequences from novel DNA isolation methods for old types shed new light on generic delimitations.

In this work, an attempt was also made to sequence material available to us and samples follow general classical degradation as DNA yield gets less with time and from this exercise we can see that specimens from 1930 gave limited and low concentrations of genomic DNA in Qubit readings of 0.0265–0.082ng/µl, compared to those in 1964 and beyond with 0.156–37ng/µl, many of which when sequences yield very fragmented DNA.

There should also be an attempt to gather material from type sites where possible.

A preliminary SEM spore scan of other species described by Corner under *Boletus* subgen. *Xerocomus*, but treated by Horak (2011) as doubtful, rejected or excluded species, yields four other *Xerocomus s.str.* species: *Boletus* (*Xerocomus*) *chlamydosporus* Corner, *Boletus* (*Xerocomus*) *chrysops,Boletus* (*Xerocomus*) *lubricus* Corner and *Boletus* (*Xerocomus*) *microcarpus* Corner.

Taxonomy and nomenclature

As a result of our morphological investigation, we recommend the following nomenclatural changes from Horak's (2011) circumscription of *Xerocomus*:

Xerocomus as defined by Horak (2011) be retained as such:

1. ***Xerocomus microcarpoides* (Corner) E. Horak**

Xerocomus as defined by Horak (2011) to revert to back to Corner's names:

1. ***Boletus albipurpureus* Corner**
   Syn.: *Xerocomus albipurpureus* (Corner) E. Horak

2. ***Boletus asperipes* Corner**
   Syn.: *Xerocomus asperipes* (Corner) E. Horak

3. ***Boletus calocystides* Corner**
   Syn.: *Xerocomus calocystides* (Corner) E. Horak

4. ***Boletus calvus* Corner**
   Syn.: *Xerocomus calvus* (Corner) E. Horak

5. ***Boletus catervatus* Corner**
   Syn.: *Xerocomus catervatus* (Corner) E. Horak

6. ***Boletus cuticulatus* Corner**
   Syn.: *Xerocomus cuticulatus* (Corner) E. Horak

7. ***Boletus cyaneirufescens* Corner**
   Syn.: *Xerocomus cyaneirufescens* (Corner) E. Horak

8. ***Boletus destitutus* Corner**
   Syn.: *Xerocomus destitutus* (Corner) E. Horak

9. ***Boletus dispersus* var. *dispersus* Corner**
   Syn.: *Xerocomus dispersus* var. *dispersus* (Corner) E. Horak

10. ***Boletus dispersus* var. *tembelingensis* Corner**
    Syn.: *Xerocomus dispersus* var. *tembelingensis* (Corner) E. Horak

11. ***Boletus ferruginosporus* Corner**

Syn.: *Xerocomus ferruginosporus* (Corner) E. Horak

12. ***Boletus gyrodontoides*** **Corner**
Syn.: *Xerocomus gyrodontoides* (Corner) E. Horak

13. ***Boletus lucescens*** **Corner**
Syn.: *Xerocomus lucescens* (Corner) E. Horak

14. ***Boletus prebadius*** **Corner**
Syn.: *Xerocomus prebadius* (Corner) E. Horak

15. ***Boletus ranunculus*** **Corner**
Syn.: *Xerocomus ranunculus* (Corner) E. Horak

16. ***Boletus raphanolens*** **Corner**
Syn.: *Xerocomus raphanolens* (Corner) E. Horak

17. ***Boletus rectus*** **Corner**
Syn.: *Xerocomus rectus* (Corner) E. Horak

18. ***Boletus satisfactus*** **Corner**
Syn.: *Xerocomus satisfactus* (Corner) E. Horak

19. ***Boletus solitarius*** **Corner**
Syn.: *Xerocomus solitarius* (Corner) E. Horak

20. ***Boletus tentabundus*** **Corner**
Syn.: *Xerocomus tentabundus* (Corner) E. Horak

Species classified as *Boletus* subgen. *Xerocomus* sensu Corner (1972), but rejected or excluded by Horak (2011), whose spores have bacillate ornamentations, the following new generic upgrades proposed for the following species.

1. ***Xerocomus chlamydosporus*** **(Corner) S.M.L. Lee**
Syn.: *Boletus chlamydosporus* Corner [listed as doubtful species by Horak (2011)]

2. ***Xerocomus chrysops*** **(Corner) S.M.L. Lee**
Syn.: *Boletus chrysops* Corner [listed in the excluded list by Horak (2011)]

3. ***Xerocomus lubricus*** **(Corner) S.M.L. Lee**
Syn.: *Boletus lubricus* Corner [listed in the excluded list by Horak (2011)]

Boletus (*Xerocomus*) *microcarpus* has already been made *Hourangia microcarpa* (Corner) G. Wu, Xue T. Zhu & Zhu L. Yang (Zhu et al., 2015) as it was found to be monophyletic with *Xerocomus s.str.* and *Phylloporus*, differing

from the other two genera by a hymenium 3–7 times thicker than the pileal context found in *Xerocomus s.str*. Hence *Xerocomus microcarpoides* which similarly follows the above character could potentially be a *Hourangia*. DNA sequence data from a new collection would be useful to test generic delimitations in the wider group. *Boletus* (*Xerocomus*) *pseudochrysenteron* spores which also has no bacillate ornamentations is currently accepted as *Xerocomellus corneri* Xue T. Zhu & Zhu L. Yang (Wu et al., 2016).

Conclusions

With the evidence of spore ornamentations, it can be concluded that *Xerocomus* s.l. has its presence in Malesia where *Xerocomus chlamydosporus, X. chrysops*, *X. lubricus*, *X. microcarpus and X. microcarpoides* occur. The delimitation based on other aspects of *Xerocomus* besides spores need to be addressed with newer collections as they do not concur with Šutara (2008).

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Appendix

Appendix-I Specimens studied

Barcode	EDNA	Working labels	Collection type	Type	Genus (Corner / Horak)	Taxa	Collector	Prefix	no.	Collection date (dd/mm/yyyy)			Country	Gazetteer
E00458479		SL74	wet	Holo	Boletus /Gyroporus	aculifer	Corner, E.J.H.		s.n.	22	9	1940	Peninsular Malaysia	Pahang, Fraser's Hill
E00083993	EDNA16-0045143	SL01	dry	Holo	Boletus /Xerocomus	albipurpureus	Corner, E.J.H.	P	155	6	8	1972	Borneo	Sarawak, Kuching, Bako NP
E00458457		SL31	wet	Holo	Boletus /Xerocomus	albipurpureus	Corner, E.J.H.	P	155	6	8	1972	Borneo	Sarawak, Kuching, Bako NP
E00084006		SL02	dry	Holo	Boletus /Xerocomus	asperipes	Corner, E.J.H.		s.n.	24	9	1939	Peninsular Malaysia	Johor, Johor Bahru, Tebrau
E00458466		SL40	wet	Iso	Boletus /Xerocomus	asperipes	Corner, E.J.H.		s.n.	24	9	1939	Peninsular Malaysia	Johor, Johor Bahru, Tebrau
E00084008		SL53	dry	Holo	Boletus /[excluded]	blanditus	Corner, E.J.H.		s.n.	25	5	1930	Peninsular Malaysia	Pahang, Fraser's Hill
E00458463		SL37	wet	Holo	Boletus /Xerocomus	calocystides	Corner, E.J.H.		s.n.	26	6	1961	Borneo	Sabah, Kinabalu, Mt. Kinabalu
E00458467		SL41	wet		Boletus /Xerocomus	calvus	Corner, E.J.H.		s.n.	6	9	1942	Singapore	Bukit Timah NR
E00458468		SL42	wet	Holo	Boletus /Xerocomus	catervatus	Corner, E.J.H.		s.n.	28	11	1940	Singapore	MacRitchie, Reservoir Jungle
E00084026		SL54	dry	Holo	Boletus /[excluded]	chlamydosporus	Holttum, R.E.		s.n.	27	3	1930	Peninsular Malaysia	Johor, Kota Tinggi, Gunung Panti
E00084025		SL55	dry	Holo	Boletus /[excluded]	chrysops	Corner, E.J.H.		s.n.	18	2	1959	Borneo	Brunei, Temburong, Amo, Ulu Belalong
E00084030	EDNA16-0044928	SL04	dry	Holo	Boletus /Xerocomus	cuticulatus	Corner, E.J.H.	RSNB	5759	12	3	1964	Borneo	Sabah, Kinabalu, Mesilau
E00458458		SL32	wet	Holo	Boletus /Xerocomus	cuticulatus	Corner, E.J.H.	RSNB	5759	12	3	1964	Borneo	Sabah, Kinabalu, Mesilau
E00458406	EDNA16-0044929	SL26	dry		Boletus /Xerocomus	cuticulatus	Ana		26748	9	2	1996	Peninsular Malaysia	Negeri Sembilan, Jelebu, Pasoh Forest Reserve
E00084029	EDNA16-0045144	SL03	dry	Holo	Boletus /Xerocomus	cyaneirufescens	Corner, E.J.H.		s.n.	27	12	1930	Singapore	Reservoir Jungle
E00458469		SL43	wet		Boletus /Xerocomus	cyaneirufescens	Corner, E.J.H.		s.n.	8	11	1940	Singapore	Seletar
E00084557	EDNA16-0044931	SL05	dry	Holo	Boletus /Xerocomus	destitutus	Corner, E.J.H.		s.n.	16	11	1930	Peninsular Malaysia	Pahang, Tembeling
E00084558	EDNA16-0044932	SL06	dry		Boletus /Xerocomus	destitutus	Corner, E.J.H.	P	68	0	0	1972	Peninsular Malaysia	Penang, Penang Hill
E00458470		SL44	wet		Boletus /Xerocomus	destitutus	Corner, E.J.H.	P	68	0	0	1972	Peninsular Malaysia	Penang, Penang Hill
E00458454		SL28	dry		Boletus /Xerocomus	destitutus	Watling, R.		24785	23	2	1992	Peninsular Malaysia	Selangor, Gombak, FRIM, Kepong
E00458455		SL29	dry		Boletus /Xerocomus	destitutus	Sims, K.		25593	29	6	1993	Philippines	Luzon, Quezon Province, Quezon NP
E00458407	EDNA16-0044930	SL27	dry		Boletus /Xerocomus	destitutus	Watling, R.		25800	24	2	1994	Peninsular Malaysia	Selangor, Gombak, FRIM, Kepong
E00084567		SL09	dry		Boletus /Xerocomus	dispersus var. dispersus	Corner, E.J.H.		s.n.	20	5	1930	Peninsular Malaysia	Pahang, Fraser's Hill
E00084565		SL07	dry	Holo	Boletus /Xerocomus	dispersus var. dispersus	Corner, E.J.H.	RSNB	8172	8	4	1964	Borneo	Sabah, Kinabalu, Mesilau
E00458459		SL33	wet	Holo	Boletus /Xerocomus	dispersus var. dispersus	Corner, E.J.H.	RSNB	8172	8	4	1964	Borneo	Sabah, Kinabalu, Mesilau
E00458456		SL30	dry		Boletus /Xerocomus	dispersus var. dispersus	Conveny, R.		78	14	4	1984	Australia	New South Wales
E00084566		SL08	dry		Boletus /Xerocomus	dispersus var. dispersus	Corner, E.J.H.		s.n.	1	7	1930	Peninsular Malaysia	Negeri Sembilan, Gunung Ansi

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Barcode	EDNA	Working labels	Collection type	Type	Genus (Corner / Horak)	Taxa	Collector	Prefix	no.	Collection date (dd/mm/yyyy)			Country	Gazetteer
E00084568		SL10	dry	Holo	Boletus /Xerocomus	dispersus var. tembelingensis	Corner, E.J.H.		s.n.	26	5	1931	Peninsular Malaysia	Pahang, Tembeling
E00458471		SL45	wet	Holo	Boletus /Xerocomus	ferruginosporus	Corner, E.J.H.		s.n.	3	3	1940	Singapore	Bukit Timah NR
E00458464		SL38	wet	Holo	Boletus /Xerocomus	gyrodontoides	Corner, E.J.H.		s.n.	18	12	1939	Singapore	Bukit Timah NR
E00458480		SL75	wet	Holo	Boletus /Boletochaetae	hastulifera	Corner, E.J.H.		8286	14	4	1964	Borneo	Sabah, Kinabalu, Mesilau
E00084975		SL56	dry	Holo	Boletus /[excluded]	honestus	Corner, E.J.H.		s.n.	29	11	1930	Peninsular Malaysia	Pahang, Fraser's Hill
E00084979		SL57	dry	Holo	Boletus /[excluded]	intentus	Corner, E.J.H.		s.n.	21	3	1931	Singapore	MacRitchie, Reservoir Jungle
E00084980		SL58	dry		Boletus /[excluded]	intentus	Corner, E.J.H.		s.n.	19	8	1939	Singapore	MacRitchie, Reservoir Jungle
E00458481		SL76	wet		Boletus /[excluded]	intentus	Corner, E.J.H.		s.n.	28	11	1940	Singapore	MacRitchie, Reservoir Jungle
E00458490		SL59	dry		Boletus /[excluded]	intentus	Watling, R.	Wat.	25803	27	2	1994	Peninsular Malaysia	Selangor, Gombak, FRIM, Kepong
E00085031		SL61	dry	Holo	Boletus /[excluded]	lubricus	Corner, E.J.H.	RSBN	5612	3	3	1964	Borneo	Sabah, Kinabalu, Mt. Kinabalu, Bembangan river
E00458482		SL77	wet	Holo	Boletus /[excluded]	lubricus	Corner, E.J.H.	RSBN	5612	3	3	1964	Borneo	Sabah, Kinabalu, Mt. Kinabalu, Bembangan river
E00458473		SL47	wet		Boletus /Xerocomus	lucescens	no label			0	0	0		
E00085005	EDNA16-0044935	SL13	dry		Boletus /Xerocomus	lucescens	Corner, E.J.H.	RSNB	1866	19	8	1961	Borneo	Sabah, Kinabalu, Mt. Kinabalu, Bembangan river
E00085004	EDNA16-0044934	SL12	dry		Boletus /Xerocomus	lucescens	Corner, E.J.H.	RSNB	1867	19	8	1961	Borneo	Sabah, Kinabalu, Mt. Kinabalu, Bembangan river
E00458472		SL46	wet		Boletus /Xerocomus	lucescens	Corner, E.J.H.	RSNB	1867	19	8	1961	Borneo	Sabah, Kinabalu, Mt. Kinabalu, Bembangan river
E00085003	EDNA16-0044933	SL11	dry	Holo	Boletus /Xerocomus	lucescens	Corner, E.J.H	RSNB	1882	19	8	1961	Borneo	Sabah, Kinabalu, Mt. Kinabalu, Bembangan river
E00458465		SL39	wet	Holo	Boletus /Xerocomus	lucescens	Corner, E.J.H.	RSNB	1882	19	8	1961	Borneo	Sabah, Kinabalu, Mt. Kinabalu, Bembangan river
E00085029	EDNA16-0045763	SL14	dry	Holo	Boletus /Xerocomus	microcarpoides	Corner, E.J.H.		s.n.	23	5	1930	Peninsular Malaysia	Pahang, Fraser's Hill
E00085030		SL62	dry	Holo	Boletus /[excluded]	microcarpus	Corner, E.J.H.	RSBN	8073	2	4	1964	Borneo	Sabah, Kinabalu, Mesilau
E00458483		SL78	wet	Holo	Boletus /[excluded]	microcarpus	Corner, E.J.H.	RSBN	8073	2	4	1964	Borneo	Sabah, Kinabalu, Mesilau
E00458489		SL63	dry		Boletus /[excluded]	microcarpus	Watling, R.	Wat.	25437	22	3	1993	Peninsular Malaysia	Selangor, Gombak, FRIM, Kepong
E00085043		SL64	dry	Holo	Boletus /[excluded]	nugatorius	Corner, E.J.H.		94327	8	8	1960	Borneo	Sabah, Kinabalu, Ranau
E00154954		SL66	dry		Boletus /[excluded]	nugatorius	Woods, P.J.B.		6	30	5	1962	Peninsular Malaysia	
E00085044		SL65	dry		Boletus /[excluded]	nugatorius	Corner, E.J.H.	J	6	11	4	1972	Indonesia	Java, Cibodas
E00458484		SL79	wet		Boletus /[excluded]	nugatorius	Corner, E.J.H.	J	6	11	4	1972	Indonesia	Java, Cibodas
E00085070		SL68	dry	Holo	Boletus /[excluded]	polychrous	Corner, E.J.H.			21	8	1939	Singapore	Bukit Timah NR
E00085069		SL69	dry	Holo	Boletus /[excluded]	polychrous	Corner, E.J.H.			21	8	1939	Singapore	Bukit Timah NR

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Barcode	EDNA	Working labels	Collection type	Type	Genus (Corner / Horak)	Taxa	Collector	Prefix	no.	Collection date (dd/mm/yyyy)			Country	Gazetteer
E00458485		SL80	wet	Holo	Boletus /[excluded]	polychrous	Corner, E.J.H.			21	8	1939	Singapore	Bukit Timah NR
E00458413		SL70	dry		Boletus /[excluded]	polychrous	Watling, R.		25808	2	3	1994	Peninsular Malaysia	Negeri Sembilan, Jelebu, Pasoh Forest Reserve
E00458474		SL48	wet	Holo	Boletus /Xerocomus	prebadius	Corner, E.J.H.		s.n.	28	11	1940	Singapore	MacRitchie, Reservoir Jungle
E00085074	EDNA16-0045145	SL15	dry	Holo	Boletus /Xerocomus	pseudochrysenteron	Corner, E.J.H.	RSNB	1565	30	9	1961	Borneo	Sabah, Kinabalu, Mt. Kinabalu
E00085075		SL16	dry	Holo	Boletus /Xerocomus	pseudochrysenteron	Corner, E.J.H.	RSNB	1565	30	9	1961	Borneo	Sabah, Kinabalu, Mt. Kinabalu
E00458460		SL34	wet	Holo	Boletus /Xerocomus	pseudochrysenteron	Corner, E.J.H.	RSNB	1565	30	9	1961	Borneo	Sabah, Kinabalu, Mt. Kinabalu
E00086541	EDNA16-0045146	SL17	dry	Holo	Boletus /Xerocomus	ranunculus	Corner, E.J.H.	s.n.		1	12	1930	Peninsular Malaysia	Pahang, Tembeling
E00086542	EDNA16-0045147	SL18	dry	Holo	Boletus /Xerocomus	raphanolens	Corner, E.J.H.	RSNB	8668	5	5	1964	Borneo	Sabah, Kinabalu, Mesilau
E00086549	EDNA16-0045148	SL19	dry	Holo	Boletus /Xerocomus	rectus	Corner, E.J.H.	RSNB	1869	19	8	1961	Borneo	Sabah, Kinabalu, Fl. Benbangan
E00458461		SL35	wet	Holo	Boletus /Xerocomus	rectus	Corner, E.J.H.	RSNB	1869	19	8	1961	Borneo	Sabah, Kinabalu, Fl. Benbangan
E00086569		SL21	dry		Boletus /Phylloporus	rufoflavipes	Corner, E.J.H.	RSNB	5756	12	3	1964	Borneo	Sabah, Kinabalu, Mesilau
E00086570		SL22	dry		Boletus /Phylloporus	rufoflavipes	Corner, E.J.H.	RSNB	5756	17	3	1964	Borneo	Sabah, Kinabalu, Mesilau
E00086571	EDNA16-0045765	SL23	dry		Boletus /Phylloporus	rufoflavipes	Corner, E.J.H.	RSNB	5756	13	3	1964	Borneo	Sabah, Kinabalu, Mesilau
E00458475		SL49	wet		Boletus /Phylloporus	rufoflavipes	Corner, E.J.H.	RSNB	5756	13	3	1964	Borneo	Sabah, Kinabalu, Mesilau
E00086568	EDNA16-0045764	SL20	dry	Holo	Boletus /Phylloporus	rufoflavipes	Corner, E.J.H.	RSNB	5810	16	3	1964	Borneo	Sabah, Kinabalu, Mt. Kinabalu
E00458462		SL36	wet	Holo	Boletus /Phylloporus	rufoflavipes	Corner, E.J.H.	RSNB	5810	16	3	1964	Borneo	Sabah, Kinabalu, Mt. Kinabalu
E00088001		SL71	dry	Holo	Boletus /[excluded]	sartor	Corner, E.J.H.	RSBN	5861	18	3	1964	Borneo	Sabah, Kinabalu, Mesilau
E00458486		SL81	wet	Holo	Boletus /[excluded]	sartor	Corner, E.J.H.	RSBN	5861	18	3	1964	Borneo	Sabah, Kinabalu, Mesilau
E00458476		SL50	wet	Holo	Boletus /Xerocomus	satisfactus	Corner, E.J.H.		s.n.	8	11	1940	Singapore	
E00088005	EDNA16-0045149	SL24	dry	Holo	Boletus /Xerocomus	solitarius	Corner, E.J.H.		s.n.	16	5	1930	Peninsular Malaysia	Pahang, Fraser's Hill
E00458477		SL51	wet		Boletus /Xerocomus	solitarius	Corner, E.J.H.		s.n.	30	6	1940	Singapore	Bukit Timah NR
E00088015		SL25	dry	Holo	Boletus /Xerocomus	tentabundus	Corner, E.J.H.		s.n.	24	9	1939	Peninsular Malaysia	Johor, Johor Bahru, Tebrau
E00458478		SL52	wet	Holo	Boletus /Xerocomus	tentabundus	Corner, E.J.H.		s.n.	24	9	1939	Peninsular Malaysia	Johor, Johor Bahru, Tebrau
E00088033		SL73	dry	Holo	Boletus /[excluded]	variisporus	Corner, E.J.H.	RSBN	2726	3	9	1961	Borneo	Sabah, Kinabalu, Fl. Liwag
E00458487		SL82	wet	Holo	Boletus /[excluded]	variisporus	Corner, E.J.H.	RSBN	2726	3	9	1961	Borneo	Sabah, Kinabalu, Fl. Liwag