New Zealand Journal of Botany, 2003, Vol. 41: 379–389
0028–825X/03/4103–0379 $7.00

The status of names and records of Australian macrofungi

TOM W. MAY
Royal Botanic Gardens Melbourne
Birdwood Ave
South Yarra, Victoria 3141, Australia
Email: Tom.May@rbg.vic.gov.au

Abstract On-line, regularly updated lists are available for selected groups of Australian macrofungi and for most New Zealand fungi. Such on-line lists not only provide information on names, but also act as a main reference point for general literature, especially in the absence of monographs for many groups. However, on-line lists cannot be used uncritically because the status of names and records varies considerably. Status is explored through the concepts of take-up and quality. Most species based on Australian types have been disposed among modern genera, but often are known only from the type. For species based on extra-Australian types, numerous Australian records appear to be misapplied. Rather than provide a unidimensional coding system for status, it is suggested that on-line lists provide for searching on as many informative fields as practical, so as to allow users to select the taxa of interest for their particular purpose.

Keywords macrofungi; checklist; species delimitation; Australia; New Zealand

INTRODUCTION

Despite the macrofungi (such as agarics, polypores, coral fungi, truffles, and puffballs) being the more visible components of the mycota, numerous species are yet to be described. Among known species, the level of knowledge varies considerably and up-to-date monographs are available for only a few groups. Flora treatments of fungi for Australia (*Fungi of Australia*) and New Zealand (*Fungi of New Zealand/Nga Harore o Aotearoa*) are welcome recent initiatives, but at the present rate it will be a long time before all groups of even the macrofungi are covered comprehensively.

Advances in computing, especially relational databases and the world-wide web, mean that compiling and making accessible whatever information is known about species of fungi is now relatively simple at the technical level. Nevertheless, there are few regions in the world where on-line, up-to-date comprehensive lists of fungi are available. It is notable that Australasia is well-serviced by checklists of fungi (May 2001), and for both Australia and New Zealand comprehensive on-line lists of fungi are maintained (details in next section).

Provision of lists of names can, however, obscure the very different levels of knowledge about each name, and create an impression that all species are equally well known. The purpose of this paper is to summarise the available lists of names, consider the uses to which these lists are put, and to discuss the status of names and the records of them, particularly in terms of the different users who may wish to consult lists of fungi. The focus is on Australian macrofungi, with examples from New Zealand included where relevant.

LISTS OF MACROFUNGI

McAlpine (1895) produced a list of accepted names of Australian fungi along with a comprehensive bibliography. In the 1940s Charles Brittlebank circulated a manuscript list of Australian fungi. There are a variety of other regional and taxonomic lists (May 2001) but McAlpine's list from more than 100 years ago remains the most recent published list of all groups of Australian fungi. The *Catalogue & Bibliography of Australian Fungi* is a current project published in the *Fungi of Australia* series that will compile all accepted names and synonyms applied to Australian fungi, along with a list of records

B03004; Online publication date 11 September 2003
Received 4 February 2003; accepted 8 July 2003

(including illustrations) of each accepted name and a comprehensive bibliography. The first volume of the *Catalogue* (May & Wood 1997) covered Agaricales and related groups, the second (May et al. 2003a) the Aphyllophorales, Gasteromycetes, and larger Myxomycota, and further volumes for remaining groups are in preparation. A parallel *Interactive Catalogue of Australian Fungi* is in development (May et al. 2003b), based on an updated database version of the printed volumes. For the Australian basidiomycete and myxomycete macrofungi there are some 3254 accepted names (figure compiled from May et al. (2003a,b)). There is also on average at least one synonym per accepted name, as well as numerous entries for misapplications. For New Zealand there is an online listing of fungi names at the *NZFungi* website (<http://nzfungi.landcareresearch.co.nz/html/mycology.asp?ID=33-BRF-15>). Some 13 000 names of fungi are included, under about 5500 accepted names.

Users of lists

Compilers of lists of names are usually taxonomists and those with an interest in nomenclature. It is important to remember that while taxonomists and nomenclaturalists are the constructors and will no doubt extensively consult lists, there is, at least potentially, a great variety of other users. Such users come from closely allied fields such as systematics (phylogeny), but also from a range of other disciplines such as plant pathology, ecology, and natural products chemistry, and indeed any scientist working on fungi needs to refer to the correct name of the fungus. Names also need to be applied by health workers (fungal poisoning), and those engaged in bioprospecting and in the cultivation and collection of fungi for food. Application of correct names is also important for quarantine purposes. Lists of names will form the basis for lists of rare and threatened taxa, and are also of use in arranging collections in herbaria. There are also many field naturalists and others who are collecting and recording fungi who wish to apply names to fungi.

Purposes of lists

At the simplest level, a list of names provides an accepted spelling for the genus and species and a citation (author, details of publication and date). This enables effective communication, so that it is clear what species is being referred to, and allows repeatability of research and cross referencing against other studies.

One of the principles of the *International Code of Botanical Nomenclature* (Greuter et al. 2000) is that each taxonomic group has one correct name. There may be differences of opinion as to the circumscription of names, but under a given circumscription there can only be one correct name under the *Code*. Users of names relying on older general works (such as field guides) as a source of names may not be aware of updates to the accepted name in the specialist taxonomic literature. In herbaria, the less-recent accessions are often filed under names that are synonyms of the accepted name, sometimes in different genera. The bringing together of synonyms under a currently accepted name is an important function of lists.

Some name changes are due to direct application of the *Code* such as through conserving one name over another, but most changes are due to changing circumscriptions of genera. Because many genera of fungi were widely circumscribed in the 19th century and subsequently split into numerous segregate genera (often in several stages), most species described in the 19th century bear at least two names. The species concept applied in older works was also rather narrow and there are many examples of taxa that were repeatedly named. This is especially so of widely distributed non-putrescent macrofungi, such as polypores, where collections from different geographic localities which differed slightly were named as new. This has lead to very long lists of synonyms for some species. For example, considering names used for Australian material alone, for *Phellinus gilvus* there are 26 synonyms under 12 different epithets (May et al. 2003a). Accepted names will continue to evolve as new data (such as from DNA sequences) shift generic and species boundaries. Thus, even if stability is reached as far as the names that are available, a name which seems secure on present knowledge may well change in the future for taxonomic reasons.

Lists alone, as they are currently configured, will not enable users to identify fungi. However, users will be expecting lists to act as a starting point to finding information about the species, especially when there is no recent monograph for local species, as is often the case (May 2001). The lists of records accompanying the accepted name in the *Catalogue & Bibliography* are very comprehensive. There are original descriptions, type studies, and flora treatments, alongside mentions in foray lists, and in regard to a variety of fields such as chemistry and plant pathology. These records are not sorted in any

Table 1 Patterns of take-up of names of Australian fungi. Entries are number of published Australian records (counting each publication as one record and omitting listings in papers that merely compile existing records such as catalogues and censuses, and excluding known misidentifications). Figures on publications are from those listed in May et al. (2003a,b). TD, type description; TR, type revision; *, exotic species, associated with exotic hosts.

		Decade															
Species	Type	1840	1850	1860	1870	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990
Chamaeota insignis	Australia					TD	TR							TR			
Panus fasciatus	Australia	TD, 2	1		3	4	4		6	4	1		2	3	3	9	2
Mycena interrupta	Australia		TD								3	4	2	TR, 3	5	10	5
Amanita xanthocephala[1]	Australia	TD						TR								7	15
						TD, 1	1		1	1	3	2	2	1	4	TR, 3	
Gymnopilus allantopus	Australia	TD		[1][2]	[1]	[6]		[1]	[1]	[1]			[1]	TR		[5]	TR,1,[5]
Ileodictyon cibarium	New Zealand					3	6	5	2		1				1	5	6
*Amanita muscaria**	Europe									1	1	9	7	14	10	15	22
*Laccaria proxima**	Europe																2
Rhodocollybia butyracea	Europe						1			1	2			1	2	5	2

[1] Top row is *Amanita xanthocephala*, next row is the synonym *Agaricus pulchellus* (*Amanita austropulchella*).
[2] Entries in square brackets are records under *Gymnopilus hybridus*, *G. penetrans*, or *G. sapineus*, or their synonyms, many of which are likely to be misidentifications of *G. allantopus*.

Table 2 Status of species of *Collybia* and *Cortinarius* described or recorded from Australia.
Data are from published studies listed in the *Interactive Catalogue of Australian Fungi*, excluding invalid names. Generic circumscription is as currently in the *Interactive Catalogue* (*Cortinarius* exclusive of *Dermocybe*, *Rapacea*, and *Rozites*, and *Collybia* exclusive of *Gymnopus* and *Rhodocollybia*). Type: A, Australia; NH, Northern Hemisphere. Described: year of description of basionym (including of replaced names) for species from Australian types. Type study: year of most recent study of type. Last new record: date of most recent Australian record (apart from type). No. records: number of separate publications listing original or new records of the species from Australia (counting each publication as one record and omitting listings in catalogues and censuses and any other publications that merely compile existing records).

Species	Type	Described	Type study	Last new record	No. records	Notes
Collybia alcalinolens	NH			1946	1	
C. alutacea	A	1931	1997	type only		
C. atratoides	NH			1946	1	
C. coagulata	A	1883		type only		
C. coracicolor	NH			1893	1	
C. endota	A	1997		type only		type collected 1942
C. eradicata	A	1880	1983	type only		
C. eucalypti	A	1899		type only		
C. eucalyptorum	A	1931	1997	1989	3	
C. hepatica	A	1846	1965	type only		
C. iris	A	1900		type only		
C. kurara	A	1997		type only		type collected 1932
C. laccatina	A	1881	1965	type only		also NZ
C. lepidopus	A	1846	1988: type not found	type only		
C. moola	A	1997		type only		
C. morula	A	1859		type only		
C. muscipula	A	1893		type only		
C. nijerria	A	1997		type only		type collected 1942
C. nivosula	A	1892		type only		also Cuba
C. nummularia	NH			1901	3	
C. percava	A	1933	1997	1971	2	
C. pinicolens	A	1934	1997	type only		
C. porrea	NH			1919	1	
C. protracta	NH			1920	1	
C. subcyathiformis	NH			1958	1	
C. subdryophila	A	1931	1997	1997	2	
C. tuberosa	NH			1890	1	
C. veluticeps	A	1887		type only		
C. xanthopus	NH			1885	1	
C. xylophila	NH			1892	1	
C. yerilla	A	1997		type only		type collected 1929
Cortinarius abnormis	A	1992		1993	2	
C. alboviolaceus	NH			1998	5	
C. archeri	A	1859	1990	1999	>10	
C. areolatoimbricatus	A	1933	1997	1946	2	
C. australiensis	A	1918	1997	2002	>10	
C. austroalbidus	A	1933	1997	1989	4	
C. austropallescens	A	1934	1997	1975	3	
C. austroviolaceus	A	2001		type/paratypes only		
C. bambrus	A	1997		type only		type collected 1927
C. basibulbosus	A	1948	1997: type not found	1997	2	
C. basirubescens	A	1948	1997	1998	7	
C. bovinus	NH			1892	1	
C. brunneus	NH			1982	1	
C. bundarus	A	1997		type only		type collected 1928
C. camurus	NH			1918	1	
C. castaneofulvus	A	1928	1997	1997	10	
C. cinnamoneobadius	A	1948	1997: type not found	type only		
C. corrosus	NH			1918	1	

Table 2 (*continued*)

Species	Type	Described	Type study	Last new record	No. records	Notes
C. decoloratus	NH			1971	3	
C. erythraeus	A	1845	1990	2002	9	
C. fiveashianus	A	1997		type/paratypes only		
C. fragilipes	A	1933	1997	1971	2	
C. globuliformis	A	1986		2001	7	
C. grantalius	A	1997		type only		type collected 1917
C. ianthinus	A	1948	1997	type only		
C. kiambramensis	A	1997		type only		type collected 1931
C. kilpanius	A	1997		type only		type collected 1927
C. largus	NH			1993	2	
C. lavendocaeruleus	A	1948	1997: type not found	type only		
C. lavendulensis	A	1928	1997	1990	8	
C. lilacinofulvus	A	1933	1997	type only		
C. magellanicus	Argentina			1983	1	"?" record
C. microarcheri	A	1933	1997	1997	8	
C. nemorensis	NH			1918	1	
C. ochraceofulvus	A	1933	1997	1946	2	
C. paleaceus	NH			1992	2	
C. phalaris	A	1989		1998	2	
C. purpurascens	NH			1976	1	
C. rotundisporus	A	1918	1997	1998	>10	
C. russeocinnamomeus	A	1928	1997: type not found	1997	2	
C. sinapicolor	A	1933	1997	1998	>10	
C. subarcheri	A	1927	1997	1998	>10	
C. subarvinaceus	A	1927	1997	1946	3	
C. sublargus	A	1928	1997	1998	>10	
C. venetus	NH			1971	2	
C. veronabrunneus	A	1948	1997: type not found	type only		
C. vibratilis	NH			1918	1	
C. vinaceocinereus	A	1928	1997	1963	4	
C. vinaceolamellatus	A	1933	1997	1998	6	
C. vinosipes	A	2001		type/paratypes only	1	
C. violaceohinnuleus	A	1948	1997	type only		
C. violaceus	NH			1998	10	
C. walkeri	A	1893	1962	1971	2	
C. yerillus	A	1997		type only		

way, so it may still be difficult for users to select out those references which are most of use to them.

The fact that more than 6000 names of Australian macrofungi are now arranged in a list, along with all the relevant literature, can easily create a false impression of precision about the application of names, and the reliability of the records. All names appear at first glance of equal status. This is not so, as is demonstrated by consideration of take-up and quality.

TAKE-UP OF NAMES

Take-up refers to how widely and with what confidence names are applied, considered over the time since the original description of a species. Take-up is discussed by using individual species as examples of the different patterns (Table 1), and through consideration of patterns across all species of two genera (Table 2).

Take-up: species

Chamaeota insignis is an example of a name whose basionym was described in the 1880s, and where the type has been revised (in the 1890s and 1960s) resulting in a transfer to a more appropriate genus. However, the species remains known only from the type. The types (where extant) of most names of Australian macrofungi have been revised since their original description. In some groups, such as the polypores (Cunningham 1965; Ryvarden 1991), type studies have established correct synonymy and

generic placement, and most species have sufficient information to allow application of names to further collections. However, particularly for the agarics, type revision may do no more than establish a new generic placement. For such names, there may be mentions of the species in as many as ten or more papers, but with no additional material having been assigned to the species.

Transfers to a more appropriate genus can give the appearance of some certainty as far as applying a name, yet the ability to apply the name may not improve. It is likely that many names remain unused, not because the fungi are rare, or even difficult to identify, but merely because there is not enough information to match modern collections to the names. In time, names can accumulate, all correctly placed according to genus, but which may well be synonymous, and are difficult to apply since features necessary at the level of species discrimination are unknown or not retrievable from the type. Of the 117 agaric names based on Australian types dealt with by Pegler (1965), almost half (47%) are known only from the type or occasionally also from paratypes. Similarly, for the agarics revised by Horak (1971), few names appear to have been applied in the literature since their initial publication.

Panus fasciatus is an example of a name applied regularly since first described. It was one of the first agarics to be named from Australia, with the basionym described in 1840 on material from Tasmania. The species was subsequently recorded from additional material from a number of states (Cooke 1892). The species was also re-described under various names which were brought into synonymy by Pegler (1965, 1983). Those species which have the best take-up, in terms of density of records over time, tend to be those which are highly distinctive, whether by a general character (such as luminescence in *Omphalotus nidiformis*) or by being distinctive within their genus (such as the red *Amanita xanthocephala*).

Even for distinctive species, there can be a considerable delay between initial description and the wide take-up of names. For example, *Mycena interrupta* is common and readily recognisable, being one of the few blue macrofungi. There was, however, a delay of 75 years between the description of the species in 1859 and its further recording in the 1930s. The lack of use of the name in this period could in part be due to the description of the colour by the less-evocative term "livid", even though the accompanying illustration depicts the cap as sky blue (Berkeley 1859). The species was initially re-recorded under the name "Pixie's Parasol" (Stewart & Hooke 1934) and this name connected with *Mycena interrupta* by Willis (1941), who stated that "a glance at the coloured figure" in Berkeley (1859) "will surely convince anyone that this is indeed our small blue *Mycena*". *Amanita xanthocephala* was described in 1845 in *Agaricus* subgenus *Volvaria*. The type was revised by Massee (1893), who did not change the placement, and the name was not otherwise applied until Reid (1980) realised that it was an earlier name for *Amanitopsis pulchella*. This latter species was taken up relatively quickly after its initial description in 1887. The accurate colour illustration included in Cooke (1890) and the description of the cap as "vermilion" by Cooke (1892) no doubt assisted in allowing identification.

A feature of lists of Australasian fungi is the large number of entries which are records of species first described from the Northern Hemisphere. It is clear, however, that misapplication of names of Northern Hemisphere fungi to Australasian material is common. Recent studies are consistently finding a high level of endemism for Australian fungi for both saprotrophic and biotrophic (including mycorrhizal) fungi, although there are some groups such as the Poriales where endemism is low (May & Simpson 1997; Grgurinovic 2001). Certainly, where voucher material has been examined, most records of names based on European types have been shown to be erroneous. For the material of New Zealand agarics examined by Horak (1971), not one of the previous records under Northern Hemisphere names was confirmed.

Gymnopilus allantopus was first described in 1845, and the type was revised by Pegler (1965) who suggested the placement in *Gymnopilus*. The name was not applied more widely until Rees & Strid (2001) connected the name to "the most commonly occurring *Gymnopilus* in Australia", for which they cited numerous collections. The species had likely been recorded previously from Australia under the names *G. sapineus*, *G. hybridus*, or *G. penetrans*, although due to the lack of voucher specimens, it is not possible to re-identify these records with certainty. Where misapplied Northern Hemisphere names are widely used, there could be other situations where there is already a correct name for the antipodean material which has not yet been connected to the widely used misapplied name.

Northern Hemisphere names, such as *Rhodocollybia butyracea*, may have been used quite widely for over a century for local material. However, although local collections match the

macroscopic appearance well, critical comparison with Northern Hemisphere material is still required. There are also numerous examples of one-off records of Northern Hemisphere names. Until comprehensive field guides are available for local fungi, it is likely that the tendency to use Northern Hemisphere names will continue. With very comprehensive works available for European and American fungi, including excellent illustrations and simplified descriptions, such as Phillips (1981), local material can often be matched tolerably well, especially on macroscopic characters.

There are some valid occurrences of Northern Hemisphere fungi, but these are mainly as exotics. Examples are mycorrhizal species like *Amanita muscaria* and *Laccaria proxima*, usually strictly associated with exotic trees. *Amanita muscaria* has been confirmed from Australia since the 1940s (see references cited in May & Wood 1997), but most truly exotic fungi have been recorded only in recent times, such as is the case for *Laccaria proxima* (May 1991). It is not clear if this delay is because they were overlooked, or were recent introductions.

Names based on extra-Australian types which have been applied to Australian material come not only from Europe, but also from tropical and other Southern Hemisphere countries. Whereas the identity of all records under European names is suspect, for names from other extra-Australian regions, it is less clear how reliable records from Australia will be. Names such as *Ileodictyon cibarium* (type from New Zealand) have been used over many decades for Australian collections. There are other well-known examples of circum-Gondwanan distributions (Horak 1983). However, the level of overlap between the mycota of Australia and New Zealand appears very low overall (May unpubl. data), especially when considering groups where recent revisions exist for both countries (Grgurinovic 2001). Thus, records of tropical and Southern Hemisphere names also need to be evaluated critically.

Take-up: genera

Consideration of the agaric genera *Collybia* and *Cortinarius* demonstrates that take-up of names applied to Australian collections is generally poor (Table 2). Of the 20 species of *Collybia* based on Australian types, all but three are known only from the type, and these three have been recorded from no more than three records, with the most recent record in 1989. In *Cortinarius*, there are some names based on Australian types that have been widely applied (seven species with ten or more records), such as *Cortinarius archeri*, *C. australiensis*, and *C. rotundisporus*. However, about a quarter of the species are known only from the type (11 of the 40 species based on Australian types), a further three species are known from the type and paratypes only, and in total more than half (65%) are known from less than five records.

Where names based on extra-Australian types (mainly European) have been applied to Australian material, there are usually few records; for *Collybia*, 9 of 10 are single records and the other is recorded 3 times, and for *Cortinarius*, 12 of 15 are recorded 1 or 2 times. For some cases where Northern Hemisphere names are considered misapplied to Australian material, and novel taxa have been introduced for Australian material, there remain records under the misapplied name that were not critically evaluated by the examination of voucher material when the novel taxon was introduced, as is the case for Australian records of *Cortinarius violaceus* in relation to *C. austroviolaceus* (Gasparini 2001). In both *Collybia* and *Cortinarius*, a number of new species were introduced by Grgurinovic (1997) based on misidentified or unidentified herbarium material, almost all without recent collections, with the types being collected no more recently than 1942. In *Collybia* all four such species were based on the type alone, and in *Cortinarius* seven species were based on such material, with six based on the type alone.

The take-up of names throughout the fleshy macrofungi (such as Agaricales, Boletales, Cantharellales, and Cortinariales) follows a similar pattern to that exemplified by *Collybia* and *Cortinarius*. The only exceptions are groups which have been recently monographed, such as among the sequestrate fungi, for which monographs are listed by Bougher & Lebel (2001). For the less putrescent groups (such as Poriales, Stereales, and Lycoperdales) there seem to be more specimens available, due to the ease of collecting, and specimens are also more readily identified in the absence of field notes. This has meant that fewer species are known from the type alone, and it has been possible to reject more of the records of species from non-Australian types, despite dealing with old voucher material without field notes. Even in such groups, however, there are species whose names have not been applied except to the type or in revisionary studies by experts in the respective groups.

In all groups of fungi there are obviously some taxa that will be infrequently found, or else belong

to particularly intractable groups as far as identification, resulting in few reliable records and poor take-up. On the other hand, inclusion in field guides appears to act as a stimulus for the wider take-up of names by non-taxonomists. The most important factor in the general lack of take-up of names of Australian fungi appears to have been the lack of active mycological taxonomists—to write monographs, carry out identifications, teach others to do so, and write general guides.

Take-up: the future

The concept of take-up not only relates to interpreting the history of usage of names, but is also relevant to new names. It is worthwhile considering the ease with which names will be able to be taken up. Part of the "mission statement" of taxonomists should be to enable as many people as possible to apply as many names as possible with a high degree of certainty and repeatability. An important facet of taxonomic work, allowing better take-up, is the issue of "quality", particularly as it relates to producing clear delimitations of species that allows ready application of names.

QUALITY OF NAMES AND RECORDS

Names

For names as such, quality is achieved by adherence to the *Code of Nomenclature* (Greuter et al. 2000). In practice there is a surprising degree of interpretation required in applying the rules. A cursory comparison between the Australian *Interactive Catalogue* and *NZFungi* found examples of differences in citation, particularly for names described by Northern Hemisphere workers of the 18th and early 19th centuries. Some nomenclatural interpretation are dealt with in publications (e.g., Pennycook & McKenzie 2002), but others are not explicitly noted. It would be very useful if the reasoning behind decisions could be stored in databases along with the name and citation chosen, both so as to explain the choices, and also to remove the need for others to follow down what are often obscure literary and nomenclatural paths in order to decide on the correct name.

Species

Whereas there are more than 100 pages of detailed proscriptions about the names of plants in the *Code* (Greuter et al. 2000), there are no formal guidelines for delimiting the species to which the names apply. Delimitation is the act of drawing boundaries. In other words, deciding which sets of collections belong to which species and, in so doing, finding out how characters vary within and between species. Taxonomy is often referred to as an art, but it is worth emphasising that the delimitation of a species is a hypothesis, to be tested by each piece of new information, whether it be further collections, further data on existing collections, or the use of novel characters. Robust species delimitation requires assessment of a range of characters across a range of collections. The number of collections and characters depends on the pattern of variation in the group. In some groups (such as *Hygrocybe* and *Mycena*) characters such as basidiome colour, cystidia form, and pellis structure appear to vary considerably and in such a way as to aid species delimitation. In other groups there can be few characters that vary usefully, and when genera contain many species (such as in *Cortinarius*) delimitation is difficult. In *Laccaria*, species can only be successfully delimited from morphology by use of multivariate pattern analysis across all macro- and micro-morphological characters (although once species boundaries are set, there may be smaller sets of characters that can be relied on for identification) (May 1991).

Given that many species are described from single or very few collections there is a danger of not appreciating the pattern of variation within and between taxa. If a taxon has a wide range of variation that is more or less continuous when a large number of collections is considered, it is quite possible to describe what appear to be distinct new taxa based on outliers of this range. Basing taxa on single collections was the norm in the 19th century, but has also happened frequently in recent times. May (1997) found that of a sample of 139 new taxa from Australia described in the period 1980–1993, most (55%) were based on specimens from a single locality (usually a single collection), with only 10% of new taxa based on material from five or more localities.

It should be stressed that the "quality" of species delimitation does not relate to how carefully or thoroughly the characters of collections are recorded and illustrated, but concerns how well the species boundaries have been drawn. Greater quality is achieved when there is an attempt to lessen the likelihood that boundaries will need to be redefined when further material or further characters are recorded, and also relates to how easy it is to apply the name to further collections.

The best outcomes in terms of increased quality of species delimitation and ready take-up of names are likely to come from intensive revisionary work on particular groups, leading to monographic treatments. Monographs sift out bad names and make good names easier to apply. Such monographic work is very time consuming when done comprehensively from a geographic and taxonomic perspective. The load of bad records and poorly circumscribed species can be a considerable burden for the conscientious monographer. It is also necessary to undertake description of single new taxa and prepare floristic treatments (which deal with collections from a range of taxa from the one region or habitat). Resources, in terms of active mycologists in the region, are very limited, and given that a generic revision may take many years, it is difficult to strike a satisfactory balance between the two approaches.

Records

For records, quality is more readily discernible, whether dealing with new taxa or records of already described taxa. The "best" records are those where there is a voucher specimen and sufficient associated information (published, or at least with the specimen) to allow confirmation of the identity of the specimen. It is important that voucher material be lodged in a publicly accessible herbarium, and that the material is ample and well preserved. For non-taxonomic studies, vouchers appear to be rarely lodged. Encouragement is needed to increase the lodgment of vouchers for studies in areas such as fungal chemistry, plant pathology, ecology, and general biology.

ASSESSMENT OF NAMES

In considering how to indicate to users of lists of fungi the different patterns of take-up and the differences in "quality", one approach is to provide a unidimensional ranking for each name, rather like a "Michelin-guide to macrofungi". Species could be assessed on criteria such as whether there is a voucher, whether the name had been applied in the last 50 years, whether the type had been revised, and so on. A species which was well delimited and widely used and whose type has been revised in the modern taxonomic system would be highest in the ranking. At the other end of the scale would be a record of a Northern Hemisphere agaric unsupported by a voucher specimen or any description or illustration, such as the records compiled by May & Wood (1997) of *Laccaria bicolor* and *Mycena vulgaris*.

In attempting to devise such a ranking, much difficulty has been encountered in constructing a simple set of categories that combines all the different sorts of information that might be required, especially taking into consideration the range of users. Rather, it seems desirable to attach to names as many fields as practical in the underlying database, and to allow users to construct searches that utilise the particular combination of data relevant to their interest. A worker revising a genus would want to see all names used in the genus, valid or not and currently accepted or not. For quarantine purposes, the presence of voucher specimens and with what degree of authority these have been determined is of great importance. For certain classes of users, a filter could be applied to the list before presenting it for searching that eliminated names that would not be of interest. An example would be a search page constructed specifically for general users who wished to find out about names to apply to fungi they have seen; here there is no need to provide invalid names or names of Northern Hemisphere fungi unsupported by vouchers. In practice this would mean several options for the general type of search required, and then a search page tailored for the particular search. Subsets of the main list would also be useful as taxonomic skeletons for regional distribution and conservation status lists.

To cater for a range of users, searching on all fields should be possible, with any sort of combination search allowable, as well as searches on truncated terms. An example of the latter would be a nomenclaturalist interested in the use of compounding forms searching for a stem used in epithets such as "rubro". Consideration also needs to be given to the most effective database structure. In the Australian *Interactive Catalogue* the records for each name are stored in one field for each name, whereas in *NZFungi*, each name+record combination is stored separately. The latter setup has the advantage that additional information can be linked to a name+record combination, such as whether the record is vouchered, and selecting the earliest or most recent record is also possible.

An important consideration in how to structure on-line lists is the resources needed for maintenance. Updating may require considerable effort, both in adding new names and in moving around names into appropriate genera and according to new synonymy. For the Australian list, a comparison of May & Wood (1997) and May et al. (2003b) shows that

more than 350 accepted names were added between 1997 and 2003 (a 24% increase). The number of fields used, in practical terms, is unlikely to be the full set of information that might be coded. The lack of resources in the first place is the heart of the problem in accessing information. In most countries there are very few fungal taxonomists. For Australia this is certainly true, especially in relation to the magnitude of fungal biodiversity. A balance must be achieved between allocating scarce resources to maintenance of databases and lists (to act as pro tempore summaries), as opposed to carrying out the monographic work that is necessary to fill gaps in knowledge. Consideration needs to be given to a minimum set of fields that maximises utility of lists, without being too cumbersome to maintain.

CONCLUSION

Lists of names are valuable not only to taxonomists. In the absence of floras and monographs, lists are an important starting point in seeking information. Variation in the take-up and quality of names and records needs to be considered when using lists, and on-line lists should be structured so as to assist in the interpretation of the status of names. When launching a new name, taxonomists should equip that name with as much information as necessary to allow it to survive (and not be synonymised) and to thrive (in terms of being used as widely as possible).

ACKNOWLEDGMENTS

I would like to thank Jerry Cooper (Landcare Research), Marco Duretto, Teresa Lebel, and Peter Neish (Royal Botanic Gardens Melbourne), and Sara Maroske for feedback and stimulating discussions, Peter Buchanan (Landcare Research) for organising the symposium at IMC7 in Oslo, and the Friends of the Royal Botanic Gardens Melbourne for support which enabled me to travel to Oslo. The *Catalogue and Bibliography* and *Interactive Catalogue* projects have been supported by the Australian Biological Resources Study.

REFERENCES

Berkeley, M. J. 1859: Fungi. *In*: Hooker, J. D. The Botany of the Antarctic Voyage of H.M. Discovery Ships Erebus and Terror, in the Years 1839–1843 ... Part III Flora Tasmaniae. Vol. 2 Monocotyledones and Acotyledones. London, Lovell Reeve. Pp. 241–282.

Bougher, N. L.; Lebel, T. 2001: Sequestrate (truffle-like) fungi of Australia and New Zealand. *Australian Systematic Botany 14*: 439–484.

Cooke, M. C. 1890: Australian fungi. *Grevillea 18 (supplement)*: 1–8.

Cooke, M. C. 1892: Handbook of Australian fungi. London, Williams & Norgate.

Cunningham, G. H. 1965: Polyporaceae of New Zealand. *DSIR Bulletin 164*. 304 p.

Gasparini, B. 2001: A contribution to the knowledge of *Cortinarius* and allied genera of southern Tasmania, Australia. 1. *Cortinarius* subgenus *Cortinarius*. *Australasian Mycologist 20*: 49–54.

Greuter, W.; McNeill, J.; Barrie, F. R.; Burdet, H.-M.; Demoulin, V.; Filgueiras, T. S.; Nicolson, D. H.; Silva, P. C.; Skog, J. E.; Trehane, P.; Turland, N. J.; Hawksworth, D. L. 2000: International Code of Botanical Nomenclature (Saint Louis Code). Königstein, Koeltz Scientific Books.

Grgurinovic, C. A. 1997: Larger fungi of South Australia. Adelaide, The Botanic Gardens of Adelaide and State Herbarium and The Flora and Fauna of South Australia Handbooks Committee. 725 p.

Grgurinovic, C. A. 2001: The Agaricales in Australasia. *Australian Systematic Botany 14*: 395–406.

Horak, E. 1971: A contribution towards the revision of the Agaricales (Fungi) from New Zealand. *New Zealand Journal of Botany 9*: 403–462.

Horak, E. 1983: Mycogeography in the south Pacific region: Agaricales, Boletales. *Australian Journal of Botany*, *Supplementary Series 10*: 1–41.

Massee, G. 1893: Notes on type specimens in The Royal Herbarium, Kew. *Grevillea 21*: 77–82.

May, T. W. 1991: A taxonomic study of the Australian species of *Laccaria*. Unpublished PhD thesis, Monash University, Clayton, Australia.

May, T. W. 1997: Fungi. *In*: Scott, G. A. M.; Entwisle, T. J.; May, T. W.; Stevens, G. N. *ed*. A conservation overview of Australian non-marine lichens, bryophytes, algae and fungi. Canberra, Environment Australia. Pp. 49–74.

May, T. W. 2001: Documenting the fungal biodiversity of Australasia: from 1800 to 2000 and beyond. *Australian Systematic Botany 14*: 329–356.

May, T. W.; Simpson, J. A. 1997: Fungal diversity and ecology in eucalypt ecosystems. *In*: Williams, J.; Woinarski, J. *ed*. Eucalypt ecology: individuals to ecosystems. Cambridge, Cambridge University Press. Pp. 246–277.

May, T. W.; Wood, A. E. 1997: Catalogue and bibliography of Australian macrofungi 1. Basidiomycota *p.p*. *Fungi of Australia 2A*.

May, T. W.; Milne, J.; Shingles, S.; Jones, R. H. 2003a: Catalogue and bibliography of Australian fungi. 2. Basidiomycota *p.p.* & Myxomycota *p.p. Fungi of Australia 2B*.

May, T. W.; Milne, J.; Wood, A. E.; Shingles, S.; Jones, R. H.; Neish, P. 2003b: Interactive Catalogue of Australian Fungi. Version 2.0. Canberra, Australian Biological Resources Study and Melbourne, Royal Botanic Gardens Melbourne. <http://www.rbg.vic.gov.au/fungi/cat/> (accessed January 2003).

McAlpine, D. 1895: Systematic arrangement of Australian fungi. Melbourne, Government Printer.

Pegler, D. N. 1965: Studies on Australasian Agaricales. *Australian Journal of Botany 13*: 323–356.

Pegler, D. N. 1983: The genus *Lentinus*: a world monograph. *Kew Bulletin*, *Additional Series 10*: 1–281.

Pennycook, S. R.; McKenzie, E. H. C. 2002: *Scoleciasis atkinsonii*, an earlier name for *Phaeophleospora hebes*; and a note on G.H. Cunningham's epithets *hebe* and *pseudopanax*. *Mycotaxon 82*: 145–146.

Phillips, R. 1981: Mushrooms and other fungi of Great Britain and Europe. London, Pan Books.

Rees, B. J.; Strid, A. 2001: Relationships between Australian and northern hemisphere *Gymnopilus* species 1: new species and common misconceptions regarding earlier names. *Australasian Mycologist 20*: 29–48.

Reid, D. A. 1980: A monograph of the Australian species of *Amanita* Pers. ex Hook. (Fungi). *Australian Journal of Botany*, *Supplementary Series 8*: 1–96.

Ryvarden, L. 1991: Genera of Polypores. Nomenclature and taxonomy. Synopsis Fungorum 5. Oslo, Fungiflora.

Stewart, H. C. E.; Hooke, A. G. 1934: Excursion to Kallista and Kinglake. *Victorian Naturalist 51*: 51.

Willis, J. H. 1941: Victorian Fungi. Field Naturalists' Club of Victoria.