



# Taxonomic study of the Japanese *Dacrymycetes*

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## Key words

*Dacrymycetes*  
Japanese species  
molecular phylogeny  
new species  
taxonomy

**Abstract** The class *Dacrymycetes* is a rather small group of brown-rot wood-decaying jelly fungi characterised by forked basidia and an orange to yellow gelatinous to cartilaginous fruit body. In Japan, dacrymycetous fungi had not been investigated for a long time, justifying a taxonomic re-examination. In the present study we attempted an investigation of the dacrymycetous fungal flora of Japan, and recognised 28 taxonomic entities, including five new taxa, i.e. *Dacrymyces ancyleus*, *D. aureosporus*, *D. pinacearum*, *D. subarcticus* and *Dacryopinax sphenocarpa*, and nine new records. Due to the present survey, the total number of dacrymycetous species recorded from Japan increased from 28 to 42. Of the newly described species, *Dacrymyces ancyleus* is characterised by recurved, cylindrical basidiocarps and hyphae with clamp connections. *Dacrymyces aureosporus* resembles *D. chrysospermus*, but differs in wall thickness of its marginal hyphae. *Dacrymyces pinacearum* and *D. subarcticus* represent new coelomycetous anamorphic species. *Dacryopinax sphenocarpa* has sharp, spathulate basidiocarps, and hyphae with clamp connections. Descriptions, illustrations and photographs of fruit bodies are presented with some taxonomic notes. Molecular phylogenetic analyses were conducted to verify the species identification, and the remaining problems in *Dacrymycetes* taxonomy are discussed based on these data.

**Article info** Received: 30 January 2009; Accepted: 30 June 2009; Published: 29 July 2009.

## INTRODUCTION

*Dacrymycetes* is a rather small class established by Doweld (2001) in the subphylum *Agaricomycotina* of *Basidiomycota* with one order, two families, nine genera and 101 species (Kirk et al. 2001, 2008, Hibbett et al. 2007). *Dacrymycetes* is characterised by forked (bifurcate) basidia, except in *Dacrymyces unisporus*. Their fruit bodies are gelatinous or cartilaginous, yellow to orange coloured, and vary in shape from thin membranous to pulvinate, spathulate and dendroid. In their hyphae, the dolipore-type septa are surrounded by parenthesomes without perforations (Wells 1994). All species belonging to this class are wood-decaying fungi that cause brown-rot (Oberwinkler 1993, Kirk et al. 2001). Recent molecular phylogenetic studies have shown that *Dacrymycetes* is a member of the *Agaricomycotina* clade with the *Agaricomycetes* and *Tremellomycetes*, and a sister group of *Agaricomycetes* (James et al. 2006, Hibbett 2006, Hibbett et al. 2007).

The only order in the class, *Dacrymycetales*, was established by Hennings (1898; as *Dacryomycetiniaceae*) composed of the single family *Dacrymycetaceae*, introduced by Schröter (1889; as *Dacryomycetini*) with several genera, until Jülich erected an additional family *Cerinomycetaceae* to accommodate the genus *Cerinomyces*, species of which produce resupinate basidiocarps (Jülich 1981, Kirk et al. 2001). In recent years, a taxonomic review of the genera in *Dacrymycetaceae* was conducted by McNabb (1964, 1965a–e, 1966, 1973). He re-examined the validity of described genera based on the type specimens and original descriptions, and finally recognised eight genera in the *Dacrymycetaceae*: *Calocera*, *Cerinomyces*, *Dacrymyces*, *Dacryopinax*, *Ditiola*, *Femsjonina*, *Guepiniopsis* and *Heterotextus*. He classified these genera mainly based on

the external shapes of basidiocarps and the wall thickness of marginal hyphae in the sterile parts of basidiocarps (McNabb & Talbot 1973). The ninth genus, *Dacryonaema*, is monotypic and rarely reported (Nannfeldt 1947). The taxonomic history of dacrymycetalean genera has been reviewed by Oberwinkler (1993). Some studies discussing the phylogenetic relationship in this class have been published (Weiss & Oberwinkler 2001, Shirouzu et al. 2007).

The fungal floristic data of a certain region adds basic information on the classification and distribution of the species occurring in this region. Some mycologists reported the taxonomic study of dacrymycetous fungi distributed in a certain country, e.g. Reid (1974; UK) and Liu & Fan (1990; China). In Japan, 28 species representing seven genera have been recorded (Table 1), but systematic investigation of Japanese dacrymycetous fungi has not been conducted for 70 years since the works of Kobayasi (1939a, b). Although he described 14 new dacrymycetous species in Japan, several have remained doubtful (McNabb 1965a, b, e, 1973), as their holotypes have not been located. Given this situation, a re-examination of dacrymycetous fungi in Japan was urgently required.

In the present study we attempt to survey the dacrymycetous fungi of Japan. Fungal specimens collected from 2005 to 2008 were examined. Their descriptions and illustrations are presented with some taxonomic notes in this paper. Molecular phylogenetic analyses are also conducted using Japanese and foreign strains to verify species identification. Finally, the problems remaining in *Dacrymycetes* taxonomy are discussed based on these data.

## MATERIALS AND METHODS

### *Fungal collections and morphological observations*

To collect basidiocarps of dacrymycetous fungi, we selected approximately 50 sites in Japan with coniferous, deciduous broad-leaved and evergreen broad-leaved forests. The 23 major sites are shown in Fig. 1. These sites were sampled from 2005

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**Table 1** Species of Japanese *Dacrymycetes*.

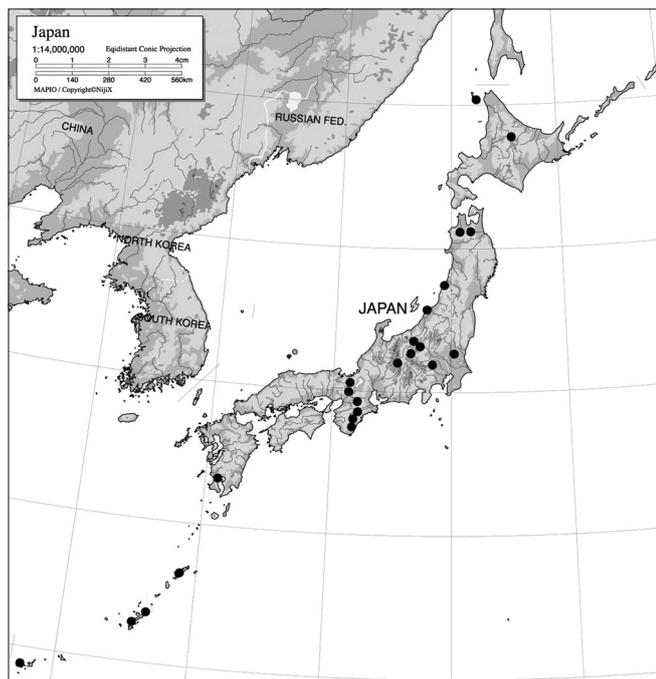
Name	Literature	McNabb's opinion <sup>1</sup>
<i>Calocera alba</i> Kobayasi	Kobayasi (1939b)	= <i>C. cornea</i> ?
<i>Calocera coralloides</i> Kobayasi	Kobayasi (1939b)	= <i>C. cornea</i> ?
<b><i>Calocera cornea</i></b> (Batsch) Fr.	Kobayasi (1939b)	distinct species
<i>Calocera cornea</i> forma <i>glacilis</i> Kobayasi	Kobayasi (1939b)	= <i>C. cornea</i> ?
<i>Calocera corniformis</i> Kobayasi	Kobayasi (1939b)	= <i>C. cornea</i> ?
<i>Calocera furcata</i> (Fr.) Fr.	Kobayasi (1939b); as <i>Calocera flavida</i> Lloyd	distinct species
<b><i>Calocera viscosa</i></b> (Pers.) Fr.	Kobayasi (1939b)	distinct species
<b><i>Cerinomyces albosporus</i></b> Boidin & Gilles	Maekawa (1986); as <i>Cerinomyces aculeatus</i> N. Maek.	–
<i>Dacrymyces albidus</i> Kobayasi	Kobayasi (1954)	distinct species?
<i>Dacrymyces applanatus</i> Kobayasi	Kobayasi (1939a)	distinct species?
<i>Dacrymyces chrysocomus</i> (Bull.) Tul.	Kobayasi (1939a)	distinct species
<b><i>Dacrymyces chrysospermus</i></b> Berk. & M.A. Curtis	Kobayasi (1939a); as <i>Dacrymyces palmatus</i> (Schwein.) Burt., <i>D. roseotinctus</i> Lloyd, <i>D. puniceus</i> Kobayasi	distinct species
<i>Dacrymyces kohyanus</i> Kobayasi	Kobayasi (1984)	–
<b><i>Dacrymyces minor</i></b> Peck	Kobayasi (1939a)	distinct species
<i>Dacrymyces nikkomontanus</i> Kobayasi	Kobayasi (1939a)	distinct species?
<i>Dacrymyces pezizoides</i> Kobayasi	Kobayasi (1939a)	= <i>D. minutus</i> ?
<i>Dacrymyces pulcher</i> Kobayasi	Kobayasi (1939a)	distinct species?
<b><i>Dacrymyces punctiformis</i></b> Newhoff	Kobayasi (1939a)	distinct species
<b><i>Dacrymyces san-augustinii</i></b> Kobayasi	Kobayasi (1939a)	distinct species
<b><i>Dacrymyces stillatus</i></b> Nees	Kobayasi (1939a); as <i>Dacrymyces deliquescens</i> (Bull.) Duby	distinct species
<b><i>Dacrymyces subalpinus</i></b> Kobayasi	Kobayasi (1939a)	distinct species?
<i>Dacrymyces tremellosus</i> Kobayasi	Kobayasi (1939a)	= <i>D. capitatus</i> ?
<i>Dacryopinax imazekiana</i> (Kobayasi) Lowy	Kobayasi (1939b); as <i>Guepinia imazekiana</i> Kobayasi	= <i>D. dennisii</i> ?
<b><i>Dacryopinax spathularia</i></b> (Schwein.) G.W. Martin	Kobayasi (1939b); as <i>Guepinia fissa</i> Berk., <i>G. spathularia</i> (Schwein.) Fr.	distinct species
<i>Femsjonia orientalis</i> Kobayasi	Kobayasi (1939b)	= <i>F. peziziformis</i> ?
<b><i>Femsjonia peziziformis</i></b> (Lév.) P. Karst.	Kobayasi (1939b); as <i>Femsjonia luteo-alba</i> Fr.	distinct species
<b><i>Guepiniopsis buccina</i></b> (Pers.) L.L. Kenn.	Kobayasi (1939a); as <i>Guepiniopsis merulinus</i> (Pers.) Pat.	distinct species
<i>Heterotextus alpinus</i> (Tracy & Earle) Martin	Kobayasi (1939a); as <i>Guepiniopsis alpinus</i> (Tracy & Earle) Brasf.	distinct species

<sup>1</sup> McNabb (1965a, b, e, 1973).

**Bold:** Species collected in this study.

to 2008. When sampling, basidiocarps were collected together with the substrata on which they occurred. The tree species or substrates were identified when possible. Collected samples were quickly air-dried, wrapped with paper and transported to the laboratory.

In the laboratory, dried samples were soaked in distilled water to observe their morphological features. Basidiocarp shapes were observed with the naked eye and under a stereomicroscope. Basidiocarps were then sliced using a freezing microtome (RUB-2100, MC-802A; Yamato Kohki, Saitama, Japan) to a thickness of 10–40 µm to make preparations for microscopic



**Fig. 1** Map of the Japanese Islands. Major sampling sites are shown as ●.

examination. The microscopic features, such as basidia and basidiospores, were observed using a high-powered light microscope (150–1500×). Species identification was performed referring to the descriptions of Kobayasi (1939a), Olive (1944), McNabb (1964, 1965a–c, e, 1973), Oberwinkler & Tschen (1989) and Reid (1974). Identified specimens were deposited in the fungal herbarium of the National Museum of Nature and Science (TNS), Tsukuba, Ibaraki, Japan.

### Fungal isolations

Pure cultures were established by means of single spore isolation. The established cultures were preserved in slants of 0.1 % cornmeal agar (0.2 % CMA; Nissui, Tokyo, Japan) + 1.25 % malt agar (2.5 % MA; Nissui, Tokyo, Japan) medium (0.2 % CMA 8.5 g, 2.5 % MA 22.5 g, yeast extract 1 g, distilled water 1 L), and deposited in the MAFF Genbank (National Institute of Agrobiological Sciences, Tsukuba, Ibaraki, Japan).

The colony growth rates and characteristics (texture, colour, etc.) were recorded based on 10 d old colonies grown in slants of 0.1 % CMA + 1.25 % MA medium at room temperature (c. 25 °C). Conidiogenesis was observed on colonies grown on 0.2 % CMA plates.

### Molecular phylogenetic analyses

Fungal cultures for DNA sequencing were obtained from Japanese *Dacrymycetes* samples collected in this study, and from the Fungal Biodiversity Centre of the Centraalbureau voor Schimmelcultures (CBS) in Utrecht, The Netherlands. The list of samples used for phylogenetic analyses is shown in Table 2.

DNA was extracted from mycelia cultured on 2.5 % malt extract liquid medium following the modified CTAB method described by Matsuda & Hijii (1999). The 28S rDNA D1/D2 region was amplified with primers D1 (Peterson 2000) and NL4 (O'Donnell 1993). Polymerase chain reactions (PCR) were performed using a HotStarTaq Master Mix (Qiagen, Mississauga, Canada). Each PCR tube contained a 50 µL mixture (21 µL distilled water,

**Table 2** Fungal samples used in molecular phylogenetic analysis.

Name	Sample no.	Specimen no. <sup>1</sup>	Culture no. <sup>2</sup>	GenBank accession no. <sup>3</sup>	
Present study					
<i>Calocera cornea</i>	HNo.267	TNS-F-15701	MAFF240116	AB299068	
	HNo.358	TNS-F-15702	MAFF240117	AB299076	
	HNo.376	TNS-F-15703	MAFF240118	AB299077	
	HNo.452	TNS-F-21061	MAFF241186	AB472722†	
	HNo.513	TNS-F-21065	MAFF241188	AB472725†	
<i>Calocera viscosa</i>	HNo.175	TNS-F-15704	MAFF240119	AB299048	
	HNo.466	TNS-F-15705	MAFF240120	AB299082	
	HNo.191	TNS-F-15706	MAFF240121	AB299050	
<i>Cerinomyces albosporus</i>	HNo.199	TNS-F-21034	MAFF241162	AB472696	
<i>Cerinomyces canadensis</i>	HNo.208	TNS-F-21035	MAFF241163	AB472697	
	HNo.216	TNS-F-21036	–	AB472698	
	HNo.219	TNS-F-21037	MAFF241164	AB472699	
<i>Cerinomyces pallidus</i>	HNo.505	TNS-F-21064	–	AB472724	
<i>Dacrymyces adpressus</i>	HNo.355	TNS-F-21045	MAFF241172	AB472707	
	HNo.554	TNS-F-21069	MAFF241191	AB472729	
<i>Dacrymyces ancyleus</i>	HNo.382	TNS-F-21051	MAFF241177	AB472713	
<i>Dacrymyces aureosporus</i>	HNo.215	TNS-F-15711	MAFF240126	AB299057	
	HNo.354	TNS-F-21044	MAFF241171	AB472706	
	HNo.385	TNS-F-21053	–	AB472715†	
	HNo.486	TNS-F-15714	MAFF240129	AB299084	
	HNo.665	TNS-F-21074	MAFF241195	AB472734†	
<i>Dacrymyces capitatus</i>	HNo.182	TNS-F-15707	MAFF240122	AB299049	
	HNo.212	TNS-F-15709	MAFF240124	AB299055	
	HNo.471	TNS-F-21062	MAFF241187	AB472723†	
	HNo.734	TNS-F-21077	MAFF241197	AB472737†	
<i>Dacrymyces capitatus</i> (anam.)	HNo.181	TNS-F-21033	MAFF241161	AB472695	
<i>Dacrymyces chrysospermus</i>	HNo.320	TNS-F-15712	MAFF240127	AB299073	
	HNo.446	TNS-F-21060	MAFF241185	AB472721†	
	HNo.468	TNS-F-15713	MAFF240128	AB299083	
	HNo.620	TNS-F-21072	MAFF241194	AB472732†	
	HNo.209	TNS-F-15716	MAFF240131	AB299053	
<i>Dacrymyces lacrymalis</i>	HNo.235	TNS-F-15717	MAFF240132	AB299062	
	HNo.243	TNS-F-21039	MAFF241166	AB472701	
	HNo.261	TNS-F-15718	MAFF240133	AB299066	
	HNo.271	TNS-F-21041	MAFF241168	AB472703	
	HNo.277	TNS-F-21042	MAFF241169	AB472704	
	HNo.279	TNS-F-21043	MAFF241170	AB472705	
	HNo.281	TNS-F-15719	MAFF240134	AB299069	
	HNo.563	TNS-F-21070	MAFF241192	AB472730	
	<i>Dacrymyces lacrymalis</i> (anam.)	HNo.250	TNS-F-21040	MAFF241167	AB472702
	<i>Dacrymyces microsporus</i>	HNo.368	TNS-F-21049	MAFF241175	AB472711
HNo.371		TNS-F-21050	MAFF241176	AB472712	
HNo.390		TNS-F-21054	MAFF241180	AB472716†	
HNo.224		TNS-F-15720	MAFF240135	AB299059	
<i>Dacrymyces minutus</i>	HNo.237	TNS-F-15721	MAFF240136	AB299063	
	HNo.282	TNS-F-15722	MAFF240137	AB299070	
<i>Dacrymyces novae-zelandiae</i>	HNo.648	TNS-F-21073	–	AB472733†	
	HNo.225	TNS-F-21038	MAFF241165	AB472700	
<i>Dacrymyces pinacearum</i> (anam.)	HNo.418	TNS-F-21056	MAFF241182	AB472718	
<i>Dacrymyces punctiformis</i>	HNo.196	TNS-F-15723	MAFF240138	AB299052	
	HNo.213	TNS-F-15724	MAFF240139	AB299056	
	HNo.285	TNS-F-15725	MAFF240140	AB299071	
	HNo.441	TNS-F-15726	MAFF240141	AB299081	
<i>Dacrymyces san-augustinii</i>	HNo.666	TNS-F-21075	MAFF241196	AB472735†	
	HNo.233	TNS-F-15727	MAFF240142	AB299061	
	HNo.256	TNS-F-15728	MAFF240144	AB299065	
<i>Dacrymyces stillatus</i>	HNo.383	TNS-F-21052	MAFF241178	AB472714	
	HNo.252	TNS-F-15729	MAFF240143	AB299064	
	HNo.411	TNS-F-21055	MAFF241181	AB472717	
	HNo.421	TNS-F-21057	MAFF241183	AB472719	
<i>Dacrymyces subalpinus</i>	HNo.228	TNS-F-15730	MAFF240145	AB299060	
	HNo.570	TNS-F-21071	MAFF241193	AB472731†	
<i>Dacrymyces subarcticus</i> (anam.)	HNo.544	TNS-F-21067	–	AB472727†	
	HNo.722	TNS-F-21076	–	AB472736†	
<i>Dacrymyces unisporus</i>	HNo.332	TNS-F-15731	MAFF240146	AB299074	
<i>Dacrymyces variisporus</i>	HNo.263	TNS-F-15732	MAFF240147	AB299067	
	HNo.300	TNS-F-15733	MAFF240148	AB299072	
	HNo.352	TNS-F-15734	MAFF240149	AB299075	
	HNo.367	TNS-F-21048	MAFF241174	AB472710	
<i>Dacryopinax spathularia</i>	HNo.379	TNS-F-15735	MAFF240150	AB299078	
	HNo.398	TNS-F-15736	MAFF240151	AB299079	
	HNo.356	TNS-F-21046	MAFF241173	AB472708	
	HNo.364	TNS-F-21047	–	AB472709	
<i>Dacryopinax sphenocarpa</i>	HNo.430	TNS-F-21059	MAFF241184	AB472720	
	HNo.534	TNS-F-21066	MAFF241189	AB472726†	
	HNo.552	TNS-F-21068	MAFF241190	AB472728	
	HNo.439	TNS-F-15737	MAFF240152	AB299080	
	HNo.562	TNS-F-15738	MAFF240153	AB299085	
<i>Femsjonia peziziformis</i>					
<i>Guepinopsis buccina</i>					

**Table 2** (cont.)

Name	Sample no.	Specimen no. <sup>1</sup>	Culture no. <sup>2</sup>	GenBank accession no. <sup>3</sup>
Centraalbureau voor Schimmelcultures (CBS)				
<i>Dacrymycetes</i>				
<i>Calocera cornea</i>	CBS124.84	–	–	AB472738†
	CBS125.84	–	–	AB472739†
<i>Calocera viscosa</i>	CBS292.82	–	–	AB472740†
<i>Dacrymyces capitatus</i>	CBS293.82	–	–	AB472741†
<i>Dacrymyces novae-zelandiae</i>	CBS295.82	–	–	AB472742†
<i>Dacrymyces stillatus</i>	CBS296.82	–	–	AB472743†
<i>Dacryopinax spathularia</i>	CBS197.63	–	–	AB472744†
<i>Guepiniopsis buccina</i>	CBS297.82	–	–	AB472745†
DNA Data Bank of Japan (DDBJ)				
<i>Dacrymycetes</i>				
<i>Calocera cornea</i>	AFTOL-ID 438	–	–	AY701526
<i>Calocera viscosa</i>	AFTOL-ID 1679	–	–	DQ520102
<i>Cerinomyces crustulinus</i>	–	–	–	AY600248
<i>Dacrymyces chrysospermus</i>	–	–	–	AF287855
<i>Dacrymyces stillatus</i>	–	–	–	AF291309
<i>Dacryomitra pussila</i>	–	–	–	AJ406406
<i>Dacryopinax spathularia</i>	AFTOL-ID 454	–	–	AY701525
<i>Dacryoscyphus chrysochilus</i>	–	–	–	AY604567
<i>Ditiola haasii</i>	–	–	–	AF291314
<i>Femsjonia peziziformis</i>	–	–	–	AF291330
<i>Guepiniopsis buccina</i>	AFTOL-ID 888	–	–	AY745711
<i>Agaricomycetes</i> (out group)				
<i>Exidia uvapassa</i>	AFTOL-ID 461	–	–	AY645056
<i>Pseudohydnum gelatinosum</i>	AFTOL-ID 1875	–	–	DQ520094

<sup>1</sup> Herbarium of the National Museum of Nature and Science (TNS).

<sup>2</sup> Culture collection of National Institute of Agrobiological Science (MAFF).

<sup>3</sup> † Sequenced by Macrogen, Inc.

25 µL Master Mix, 3 µL template DNA, and 0.5 µL each primer; final 0.25 µM). Each DNA fragment was amplified using a PCR thermal cycler (Eppendorf Mastercycler Gradient; Eppendorf, Hamburg, Germany). The thermal cycling schedule was as follows: the first cycle consisted of 15 min at 94 °C, followed by 45 cycles of 30 s at 94 °C, 30 s at 58 °C for annealing, 1 min at 72 °C, and the final cycle of 10 min at 72 °C. The reaction mixture was then cooled at 4 °C for 5 min, and PCR products purified with a QiAquick PCR Purification Kit (Qiagen, Ontario, Canada).

Samples with a dagger (†) in Table 2 were sent to Macrogen, Inc. (Seoul, Korea) and sequenced. Sequencing reactions were performed in a MJ Research PTC-225 Eltler Thermal Cycler using an ABI PRISMR BigDye™ Terminator Cycle Sequencing Kit with AmpliTaqR DNA polymerase (FS enzyme; PE Applied Biosystems, Foster City, CA, USA), following the protocols supplied by the manufacturer. Single-pass sequencing was performed on each template. The fluorescent-labelled fragments were purified from unincorporated terminators with an ethanol precipitation protocol. The samples were resuspended in distilled water and subjected to electrophoresis in an ABI 3730xl sequencer (PE Applied Biosystems).

Samples without a dagger (†) in Table 2 were sequenced in our laboratory. Sequencing reactions were performed using a BigDye Terminator Cycle Sequencing FS Ready Reaction Kit (PE Applied Biosystems) and an Eppendorf Mastercycler Gradient according to the manufacturer's instructions. Sequencing reaction products were purified with a DyeEx Spin Kit (Qiagen, Mississauga, Canada), and directly sequenced using an ABI PRISM 377-18 DNA Sequencing System (PE Applied Biosystems). The sequences determined in this study were deposited in GenBank; their accession numbers are shown in Table 2. In addition to the sequences generated, 13 sequences accessed from GenBank belonging to *Dacrymycetes* and *Agaricomycetes* were included in the phylogenetic analysis (Table 2). Preliminary multiple alignments of sequences were conducted using MAFFT v6 (Katoh et al. 2005, [\[kyushu-u.ac.jp/mafft/software\]\(http://kyushu-u.ac.jp/mafft/software\)\). Final alignments were manually adjusted. Alignment gaps were treated as missing data, and ambiguous positions were excluded from the analysis. Maximum-parsimony \(MP\) analyses were carried out using PAUP v4.0b10 \(Swofford 2001\). MP analyses with the heuristic search option using the tree-bisection-reconstruction \(TBR\) algorithm with 1 000 random sequence additions were performed to find the global optimum tree. All sites were treated as unordered and unweighted. To estimate clade support, the bootstrap \(BS\) procedure of Felsenstein \(1985\) was employed with 1 000 replicates in MP analyses and 100 replicates in the Maximum-likelihood \(ML\) analysis, with BS values higher than 50 % shown.](http://align.bmr.</a></p>
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## RESULTS

### Taxonomy

As a result of the field work, about 600 samples were collected and 493 samples were identified to species level. There were 28 species representing 6 genera, of which 5 were new species, including 2 new anamorphic species, and 9 already-described species which were new records for Japan (Table 3). The descriptions, illustrations and photographs of these species are as follows.

***Calocera cornea*** (Batsch) Fr., Stirp. Agric. Femis. 5: 67. 1827  
— Fig. 2a–e, 14a–d

*Basionym.* *Clavaria cornea* Batsch, Elench. Fung. 1: 139. 1783.

For other synonyms see Reid (1974).

*Basidiocarps* scattered, cylindrical, subulate, simple, slightly branched, palmate or dendroid, white to yellow, soft-cartilaginous, 1–5 mm high, 1–2 mm diam. Structure showing in transverse section composed of a central core of compact parallel hyphae surrounded by a zone of loosely interwoven hyphae enclosed by the hymenium. *Internal hyphae* branched,

**Table 3** Species identified in this study.

Species	Literature	New record for Japan <sup>1</sup>
<i>Calocera cornea</i> (Batsch) Fr.	McNabb (1965a)	—
<i>Calocera viscosa</i> (Pers.) Fr.	McNabb (1965a)	—
<i>Cerinomyces albosporus</i> Boidin & Gilles	Boidin & Gilles (1986)	—
<i>Cerinomyces canadensis</i> (H.S. Jacks. & G.W. Martin) G.W. Martin	McNabb (1964)	◦
<i>Cerinomyces pallidus</i> G.W. Martin	McNabb (1964)	◦
<i>Dacrymyces adpressus</i> Grognot	McNabb (1973)	◦
<b><i>Dacrymyces ancyleus</i></b> Shirouzu & Tokum.	This study	◦
<b><i>Dacrymyces aureosporus</i></b> Shirouzu & Tokum.	This study	◦
<i>Dacrymyces capitatus</i> Schwein.	McNabb (1973)	?
<i>Dacrymyces chrysospermus</i> Berk. & M.A. Curtis	McNabb (1973)	—
<i>Dacrymyces dendrocalami</i> Oberw.	Oberwinkler & Tschen (1989)	◦
<i>Dacrymyces lacrymalis</i> (Pers.) Sommerf.	McNabb (1973)	◦
<i>Dacrymyces microsporus</i> P. Karst.	McNabb (1973)	◦
<i>Dacrymyces minor</i> Peck	McNabb (1973)	—
<i>Dacrymyces minutus</i> (L.S. Olive) McNabb	McNabb (1973)	?
<i>Dacrymyces novae-zelandiae</i> McNabb	McNabb (1973)	◦
<b><i>Dacrymyces pinacearum</i></b> Shirouzu & Tokum.	This study	◦
<i>Dacrymyces punctiformis</i> Neuhoff	Reid (1974)	—
<i>Dacrymyces san-augustinii</i> Kobayasi	Kobayasi (1939b)	—
<i>Dacrymyces stillatus</i> Nees	McNabb (1973)	—
<i>Dacrymyces subalpinus</i> Kobayasi	Kobayasi (1939b)	—
<b><i>Dacrymyces subarcticus</i></b> Shirouzu & Tokum.	This study	◦
<i>Dacrymyces unisporus</i> (L.S. Olive) K. Wells	Olive (1944)	◦
<i>Dacrymyces variisporus</i> McNabb	McNabb (1973)	◦
<i>Dacryopinax spathularia</i> (Schwein.) G.W. Martin	McNabb (1965b)	—
<b><i>Dacryopinax sphenocarpa</i></b> Shirouzu & Tokum.	This study	◦
<i>Femsjonia peziziformis</i> (Lév.) P. Karst.	McNabb (1965e)	—
<i>Guepiniopsis buccina</i> (Pers.) L.L. Kenn.	McNabb (1965c)	—

<sup>1</sup> ◦ and — indicate new and existing Japanese records; ? unresolved.

**Bold:** newly described species in this study.

thin- or thick-walled, septate, sub-hyaline, 2–4.5 µm diam, without clamp connections. *Hymenium* amphigenous. *Probasidia* cylindrical to clavate, pale yellow, 10–28 × 3.5–5.5 µm, becoming bifurcate. *Basidiospores* subglobose to reniform, with an apiculum at the base, thin-walled, sub-hyaline, 7.5–12.5 × 3.5–6.5 µm (av. 10 × 4.5 µm; n = 20), 0–1-septate, germination via germ tubes.

**Culture characteristics** — Colonies attaining about 18 mm diam, velvety, pale orange. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose, 5–6 × 3 µm.

**Specimens examined.** JAPAN, Kyoto, Mt Daimonji, on dead branches of *Quercus* sp., 30 June 2006, T. Shirouzu, TNS-F-15702 (HNo.358); an unknown broad-leaved tree, 4 Oct. 2006, T. Shirouzu, TNS-F-21065 (HNo.513); Takaragaike, on dead branches of *Quercus* sp., 1 July 2006, T. Shirouzu, TNS-F-15703 (HNo.376); Nagano, Shioda, on dead branches of *Pinus densiflora*, 16 July 2006, T. Shirouzu, TNS-F-21061 (HNo.452); Wakayama, Mt Shirami, on dead branches of an unknown broad-leaved tree, 30 Apr. 2006, T. Shirouzu, TNS-F-15701 (HNo.267), culture MAFF240116.

**Notes** — This species is characterised by hyphae without clamp connections, comparatively small, simple basidiocarps and 1-septate basidiospores. We found two types of basidiocarps for this species: simple or slightly branched basidiocarps and palmate or dendroid basidiocarps. As in earlier studies (McNabb 1965a, Reid 1974, Tubaki & Hosoya 1987), this species was frequently found on woody materials of broad-leaved trees. This was previously reported in Japan (Kobayasi 1939b, Tubaki & Hosoya 1987).

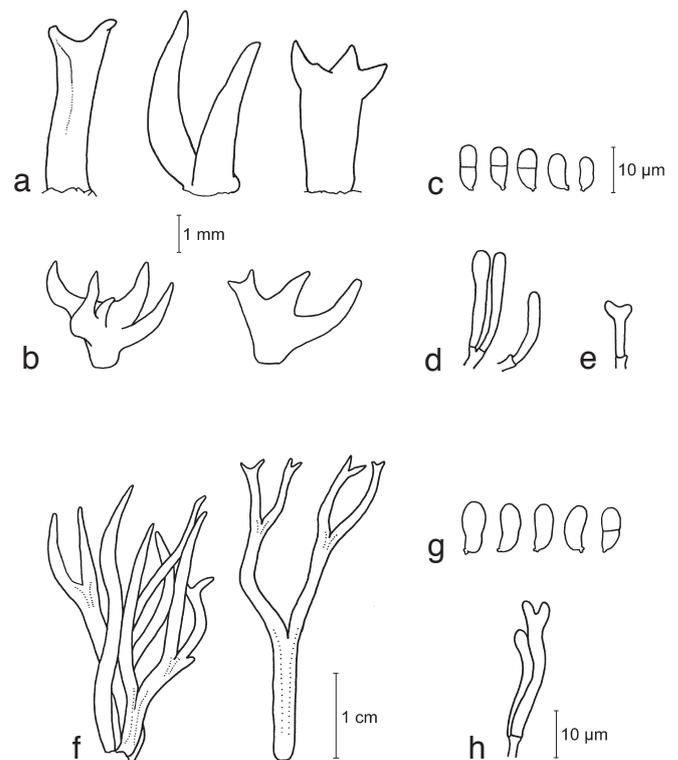
***Calocera viscosa*** (Pers.) Fr., Stirp. Agric. Femis. 5: 67. 1827 — Fig. 2f–h, 14e

*Basionym.* *Clavaria viscosa* Pers., Neues Mag. Bot. 1: 117. 1794.

For other synonyms see McNabb (1965a).

**Basidiocarps** scattered, dendroid composed of cylindrical dichotomous branches, yellow to orange, white near the base, soft-cartilaginous, 10–30 mm high, 1–2 mm diam. Structure

showing in transverse section composed of a central core of compact parallel hyphae surrounded by a zone of loosely interwoven hyphae enclosed by the hymenium. *Internal hyphae* branched, thin-walled, septate, pale yellow, 2–5 µm diam, without clamp connections. *Hymenium* amphigenous. *Probasidia* cylindrical, yellow, 25–37 × 3–5 µm, becoming bifurcate.



**Fig. 2** a–e. *Calocera cornea* TNS-F-15701 (a, c–e; HNo.267), TNS-F-21061 (b, HNo.452). a. Simple cylindrical basidiocarps; b. palmate or dendroid basidiocarps; c. basidiospores; d. probasidia; e. developing basidium. — f–h. *Calocera viscosa* TNS-F-15705 (HNo.466). f. Basidiocarps; g. basidiospores; h. probasidium and developing basidium.

**Basidiospores** subglobose to reniform, with an apiculum at the base, thin-walled, pale yellow,  $7.5\text{--}15 \times 3.5\text{--}6.5 \mu\text{m}$  (av.  $10 \times 4.5 \mu\text{m}$ ;  $n = 20$ ), 0–1-septate, germination via germ tubes.

**Culture characteristics** — Colonies attaining about 5 mm diam, velvety to lanose, white-yellow. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose,  $5 \times 3 \mu\text{m}$ .

**Specimens examined.** JAPAN, Nagano, Sugadairakougen, on litter of *Abies veitchii* Lindl., 10 Aug. 2005, T. Shirouzu, TNS-F-15704 (HNo.175), culture MAFF240119; Saitama, Chichibu, on dead branches of an unknown conifer, 20 July 2006, Y. Takahashi, TNS-F-15705 (HNo.466).

**Notes** — This species is characterised by hyphae without clamp connections and large, dichotomously branched orange-coloured basidiocarps. In contrast to *C. cornea*, *C. viscosa* has been frequently found on woody materials of coniferous trees (McNabb 1965a, Reid 1974). In Japan, this has been also reported from coniferous wood (Kobayasi 1939b).

***Cerinomyces albosporus*** Boidin & Gilles, Bull. Trimestriel Soc. Mycol. France 102: 318. 1986 — Fig. 3a–e, 14f

= *Cerinomyces aculeatus* N. Maek., Canad. J. Bot. 65: 583. 1987.

**Basidiocarps** resupinate, grey-orange, velvety, 3–10 mm long, 2–10 mm wide, 150–350  $\mu\text{m}$  thick, covered with hymenium. **Internal hyphae** branched, thin-walled, septate, sub-hyaline, 2–3  $\mu\text{m}$  diam, with clamp connections. **Hyphal pegs** acute to cylindrical, composed of septate, thin-walled hyphae with clamp connections, up to 180  $\mu\text{m}$  above the hymenium, 30–80  $\mu\text{m}$  diam. **Probasidia** cylindrical to clavate, pale yellow,  $17.5\text{--}23.5 \times 3\text{--}5 \mu\text{m}$ , with a basal clamp connection, becoming bifurcate. **Basidiospores** cylindrical to reniform, with an apiculum at the base, thin-walled, hyaline,  $15\text{--}21 \times 5\text{--}8.5 \mu\text{m}$  (av.  $15.5 \times 6.5 \mu\text{m}$ ;  $n = 10$ ), 0-septate, germination via germ tubes.

**Cultural characteristics** — Colonies attaining about 4 mm diam, wet, white. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose,  $6 \times 3 \mu\text{m}$ .

**Specimens examined.** JAPAN, Kyoto, Mt Daimonji, on dead branches of *Pinus densiflora*, 20 Apr. 2006, T. Shirouzu, TNS-F-15706 (HNo.191), culture MAFF240121; Nagano, Sugadairakougen, on dead branches of *P. densiflora*, 18 Aug. 2006, T. Shirouzu, TNS-F-21063 (HNo.478).

**Notes** — *Cerinomyces albosporus* is characterised by hyphae with clamp connections, presence of hyphal pegs and cylindrical to reniform basidiospores. This species has been reported in Japan by Maekawa (1987) as *C. aculeatus*. All the Japanese materials have been found on wood of *Pinus densiflora*.

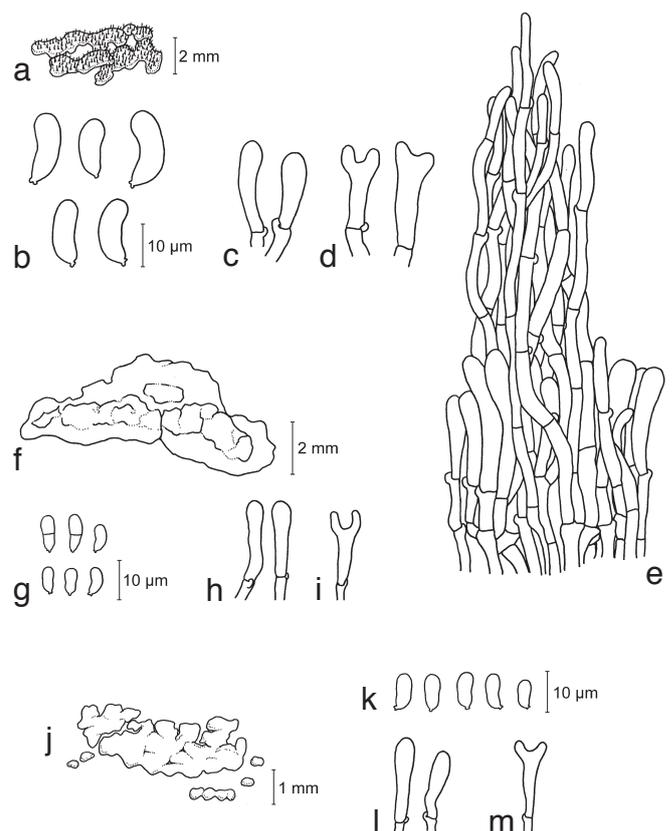
***Cerinomyces canadensis*** (H.S. Jacks. & G.W. Martin) G.W. Martin, Mycologia 41: 85. 1949 — Fig. 3f–i, 14g

**Basionym.** *Ceracea canadensis* H.S. Jacks. & G.W. Martin, Mycologia 32: 693. 1940.

**Basidiocarps** resupinate, yellow, soft-waxy, 2–5 mm long, 2–3 mm wide, 100–380  $\mu\text{m}$  thick, covered with hymenium. **Internal hyphae** branched, thin- or thick-walled, septate, sub-hyaline, 2–5  $\mu\text{m}$  diam, with clamp connections. **Probasidia** cylindrical to clavate, pale yellow,  $28.5\text{--}32.5 \times 4\text{--}5 \mu\text{m}$ , with a basal clamp connection, becoming bifurcate. **Basidiospores** subglobose to reniform, with an apiculum at the base, thin-walled, sub-hyaline,  $8\text{--}13 \times 3.5\text{--}5.5 \mu\text{m}$  (av.  $10 \times 4.5 \mu\text{m}$ ;  $n = 15$ ), 0–1-septate, germination via germ tubes.

**Culture characteristics** — Colonies attaining about 6 mm diam, velvety, white. Conidiogenesis not observed.

**Specimens examined.** JAPAN, Kyoto, Midorogaikae, on dead branches of *Rhododendron macrosepalum*, 21 Apr. 2006, T. Shirouzu, TNS-F-21036 (HNo.216); Mt Daimonji, on dead branches of *Pinus densiflora*, 20 Apr. 2006,



**Fig. 3** a–e. *Cerinomyces albosporus* TNS-F-15706 (HNo.191). a. Basidiocarp; b. basidiospores; c. probasidia; d. developing basidia; e. hyphal peg. — f–i. *Cerinomyces canadensis* TNS-F-21034 (HNo.199). f. Basidiocarp; g. basidiospores; h. probasidia; i. developing basidium. — j–m. *Cerinomyces pallidus* TNS-F-21064 (HNo.505). j. Basidiocarps; k. basidiospores; l. probasidia; m. developing basidium.

T. Shirouzu, TNS-F-21034 (HNo.199), culture MAFF241162; Mt Kiyomizu, on dead branches of *Castanopsis cuspidata*, 22 Aug. 2006, T. Shirouzu, TNS-F-21037 (HNo.219); Takaragaikae, on dead branches of *Clethra barbinervis*, 21 Apr. 2006, T. Shirouzu, TNS-F-21035 (HNo.208).

**Notes** — *Cerinomyces canadensis* is characterised by yellow-coloured basidiocarps, absence of dikaryophyses and hyphal pegs, and relatively large, 0–1-septate basidiospores. This is the first report from Japan.

***Cerinomyces pallidus*** G.W. Martin, Mycologia 41: 83. 1949 — Fig. 3j–m, 14h

**Basidiocarps** resupinate, grey-olive to amber, soft-waxy, 5–20 mm long, 2–5 mm wide, 120–160  $\mu\text{m}$  thick, covered with hymenium. **Internal hyphae** branched, thin-walled, septate, sub-hyaline, 2–5  $\mu\text{m}$  diam, with clamp connections. **Probasidia** cylindrical to clavate, pale yellow,  $22\text{--}29 \times 4\text{--}6 \mu\text{m}$ , with a basal clamp connection, becoming bifurcate. **Basidiospores** subglobose to reniform, with an apiculum at the base, thin-walled, pale yellow,  $7\text{--}12 \times 3.5\text{--}5.5 \mu\text{m}$  (av.  $9 \times 4.5 \mu\text{m}$ ;  $n = 15$ ), 0-septate, germination via germ tubes.

**Culture characteristics** — Colonies attaining about 8 mm diam, velvety, white. Conidiogenesis not observed.

**Specimen examined.** JAPAN, Nagano, Shioda, on dead branches of *Pinus densiflora*, 27 Sept. 2006, T. Shirouzu, TNS-F-21064 (HNo.505).

**Notes** — *Cerinomyces pallidus* is characterised by olive to subdued-yellow basidiocarps, absence of dikaryophyses and hyphal pegs, and relatively small, 0-septate basidiospores. Compared with the description by McNabb (1964), the size of basidiospores was slightly larger in our specimens. This is the first report from Japan.

***Dacrymyces adpressus*** Grognot, Pl. Crypt. Sâone-et-Loire: 200. 1863 — Fig. 4a–e, 14i

For synonyms see McNabb (1973).

**Basidiocarps** scattered, pulvinate to cerebriform, sometimes applanate, sessile, orange to amber, soft-cartilaginous to firm-gelatinous, 1–3 mm high, 1–5 mm diam. **Sterile parts** of basidiocarps covered with simple or branched cylindrical to clavate, septate, hyaline, thin-walled marginal hyphae. **Internal hyphae** branched, thin-walled, gelatinous, septate, sub-hyaline, 2–6 µm diam, with clamp connections. **Hymenium** limited to the superior surface of the basidiocarp. **Probasidia** cylindrical to clavate, thick-walled, pale yellow, 45–73.5 × 5–8 µm, with a basal clamp connection, becoming bifurcate. **Dikaryophyses** simple or branched, septate, thin-walled, pale yellow, 40–90 × 3–4.5 µm. **Basidiospores** cylindrical to reniform, with an apiculum at the base, thin- or thick-walled, pale yellow, 15–24 × 6–10 µm (av. 19 × 8 µm; n = 20), 3-septate, germination via germ tubes.

**Culture characteristics** — Colonies attaining about 10 mm diam, velvety, white-yellow. Conidiogenesis not observed.

**Specimens examined.** JAPAN, Kyoto, Mt Daimonji, on dead branches of an unknown broad-leaved tree, 30 June 2006, *T. Shirouzu*, TNS-F-21045 (HNo.355), culture MAFF241172; Wakayama, Mt Shirami, on dead branches of an unknown woody plant, 12 Oct. 2006, *T. Shirouzu*, TNS-F-21069 (HNo.554).

**Notes** — *Dacrymyces adpressus* is characterised by pulvinate, brown to amber-coloured basidiocarps, hyphae with clamp connections, simple dikaryophyses and relatively large, thin- or thick-walled, 3-septate basidiospores. This species sometimes produces applanate basidiocarps and it may be confused with *Cerinomyces* species. *Dacrymyces adpressus* Kobayasi was described in Japan is a later homonym, and a different species from *D. adpressus* Grognot (McNabb 1973), so this is the first record from Japan.

***Dacrymyces ancyleus*** Shirouzu & Tokum., *sp. nov.* — MycoBank MB514036; Fig. 4f–i, 14j

Basidiocarpia sparsa, cylindrica, stipitata cum pileo subgloboso vel cylindrico ancileo, flavida, cartilaginea vel gelatinosa, 1–2 mm alta, 0.5 mm lata. Hyphae interaneae ramosae, tenuitunicatae vel crassitunicatae, gelatinosae, hyalinae, 2–6 µm latae, cum colligationibus unifornibus. Probasidia cylindrica vel clavata, flavida, 30–45 × 4.5–10 µm, bifurcatascentia. Basidiosporae subglobosae vel reniformae, tenuitunicatae, sub-hyalinae, 10.5–19.5 × 4–9 µm, 0–1-septatae.

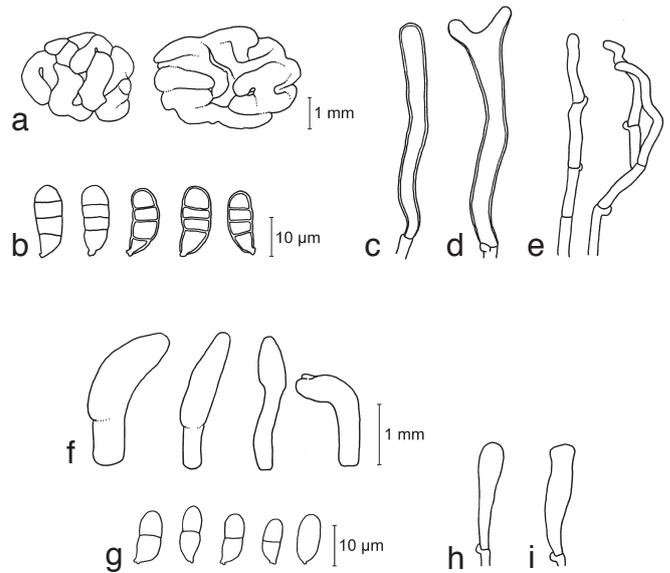
**Etymology.** Named after its recurved basidiocarps.

**Basidiocarps** scattered, cylindrical, stipitate, bearing a subglobose to cylindrical, recurved pileus, yellow, soft-cartilaginous to firm-gelatinous, 1–2 mm high, 0.5 mm diam. **Internal hyphae** branched, thin- or thick-walled, gelatinous, septate, hyaline, 2–6 µm diam, with clamp connections. **Hymenium** limited to surface of the pileus. **Probasidia** cylindrical to clavate, pale yellow, 30–45 × 4.5–10 µm, with a basal clamp connection, becoming bifurcate. **Basidiospores** subglobose to reniform, with an apiculum at the base, thin-walled, sub-hyaline, 10.5–19.5 × 4–9 µm (av. 15.5 × 7.5 µm; n = 20), 0–1-septate, germination via germ tubes.

**Culture characteristics** — Colonies attaining about 4 mm diam, velvety, white. Conidiogenesis not observed.

**Specimen examined.** JAPAN, Kyoto, Takaragaike, on dead branches of *Rhododendron* sp., 1 July 2006, *T. Shirouzu*, holotype TNS-F-21051 (HNo.382), culture ex-type MAFF241177.

**Notes** — *Dacrymyces ancyleus* is characterised by basidiocarps that are recurved, cylindrical or stipitate with a subglobose pileus, hyphae with clamp connections and 0–1-septate



**Fig. 4** a–e. *Dacrymyces adpressus* TNS-F-21045 (HNo.355). a. Basidiocarps; b. basidiospores; c. probasidium; d. developing basidium; e. dikaryophyses. — f–i. *Dacrymyces ancyleus* TNS-F-21051 (HNo.382). f. Basidiocarps; g. basidiospores; h. probasidium; i. developing basidium.

basidiospores. This fungus is likely to be included in the genus *Calocera* based on the cylindrical basidiocarps; however, the internal hyphal structure of the basidiocarp could not be divided into three zones, differing from *Calocera* species. Furthermore, this fungus is not a member of *Dacryopinax* since the hymenium is not amphigenous and cortical hairs at the sterile surface could not be recognised; therefore, we regard this dacrymycetous fungus to belong to the genus *Dacrymyces*.

*Dacrymyces microsporus* is similar in basidiocarp and basidiospore shape to *D. ancyleus*, but the hyphae composing basidiocarps of *D. microsporus* do not have clamp connections. *Dacrymyces flabelliformis* is also similar to *D. ancyleus* in basidiocarp shape and by having clamp connections on hyphae (Burdall & Laursen 2004), but *D. flabelliformis* is different from this fungus in basidiospore size (12.5–14 × 5–6 µm) and the septal number (3-septate); therefore, we consider this fungus to be a new species of *Dacrymyces*. In molecular phylogenetic analyses (Fig. 16), this species represented a monophyletic group with *Dacryopinax sphenocarpa*, but the phylogenetic position in the *Dacrymycetes* lineage was uncertain.

***Dacrymyces aureosporus*** Shirouzu & Tokum., *sp. nov.* — MycoBank MB514037; Fig. 5a–f, 14k

Basidiocarpia sparsa vel gregaria, turbinata vel cerebriformia, sessilia vel stipitata cum pileo semigloboso rugoso vel convoluto, aurantiaca, gelatinosa, 1–3 mm alta, 1–6 mm lata. Pili corticales steriles cylindrici vel clavati, tenuitunicati. Hyphae interaneae ramosae, tenuitunicatae, gelatinosae, hyalinae, 2–3 µm latae. Probasidia cylindrica, sub-hyalina, 46.5–80 × 5.5–8 µm, bifurcatascentia. Basidiosporae cylindricae vel allantoidae, tenuitunicatae, flavidae, 17–26 × 6.5–11 µm, 7-septatae.

**Etymology.** Named after its yellow basidiospores.

**Basidiocarps** scattered or gregarious, sometimes coalesced, turbinate to cerebriform, sessile or stipitate bearing a rugose to convolute semiglobose pileus, pale orange, firm-gelatinous, 1–3 mm high, 1–6 mm diam. **Sterile parts** of basidiocarps covered with simple cylindrical to clavate, septate, hyaline, thin-walled marginal hyphae. **Internal hyphae** branched, thin-walled, gelatinous, septate, hyaline, 2–3 µm diam, without clamp connections. **Hymenium** limited to the upper surface of the pileus. **Probasidia** cylindrical, sub-hyaline, 46.5–80 × 5.5–8 µm, becoming bifurcate. **Basidiospores** cylindrical to allantoid, with

an apiculum at the base, thin-walled, yellow,  $17\text{--}26 \times 6.5\text{--}11 \mu\text{m}$  (av.  $21.5 \times 8.5 \mu\text{m}$ ;  $n = 20$ ), 7-septate, germination via the production of conidia and germ tubes.

**Culture characteristics** — Colonies attaining about 6 mm diam, velvety, pale orange to orange. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose,  $5 \times 4 \mu\text{m}$ .

**Specimens examined.** JAPAN, Kyoto, Midorogaike, on dead branches of *Quercus serrata*, 21 Apr. 2006, T. Shirouzu, TNS-F-15711 (HNo.215); on dead branches of *Cryptomeria japonica*, 1 July 2006, T. Shirouzu, TNS-F-21053 (HNo.385); Mt Daimonji, on dead branches of an unknown broad-leaved tree, 30 June 2006, T. Shirouzu, TNS-F-21044 (HNo.354); Nagano, Kijimadaira, on a fallen tree of *Fagus crenata*, 2 Sept. 2006, T. Shirouzu, holotype TNS-F-15714 (HNo.486), culture ex-type MAFF240129; Okinawa, Iriomote Island, on a fallen tree of an unknown broad-leaved tree, 9 June 2007, T. Shirouzu, TNS-F-21074 (HNo.665).

**Notes** — *Dacrymyces aureosporus* is characterised by turbinate to cerebriform basidiocarps, hyphae without clamp connections, thin-walled, marginal hypha and multi-septate basidiospores. This fungus resembles *D. chrysospermus* in morphological features, except for the absence of thick-walled terminal cells on the sterile surface of the basidiocarps. *Dacrymyces aureosporus* also produces terminal cells but its walls do not become thick. Kobayasi (1939a) reported a similar dacrymycetous fungus to *D. palmatus*, which is a synonym of *D. chrysospermus*, and the terminal cells of the fungus are also thin-walled. In molecular phylogenetic analyses, *D. chrysospermus* and *D. aureosporus* were clearly separated (Fig. 16). We considered this to be a new *Dacrymyces* species closely related to *D. chrysospermus*.

***Dacrymyces capitatus*** Schwein., Trans. Amer. Philos. Soc., Ser. II, 4: 186. 1832 — Fig. 5g–j, 14l

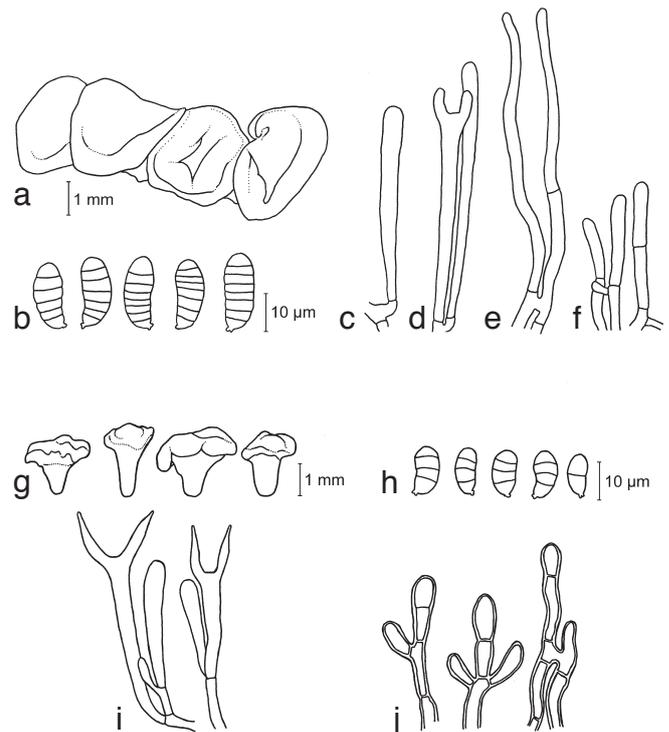
For synonyms see McNabb (1973) and Reid (1974).

**Basidiocarps** scattered, turbinate to stoutly cylindrical, stipitate bearing a concave or rugose semiglobose pileus, yellow to orange, firm-gelatinous, sometimes white tomentose at the base, 1.5–2 mm high, 2–4 mm diam. **Sterile parts** of basidiocarps densely covered with simple or branched, cylindrical to clavate, septate, hyaline, thin- or thick-walled marginal hyphae. **Internal hyphae** branched, thin-walled, gelatinous, septate, hyaline, 2–3.5  $\mu\text{m}$  diam, without clamp connections. **Hymenium** limited to the upper surface of the pileus. **Probasidia** cylindrical to clavate, pale yellow,  $25\text{--}42.5 \times 3\text{--}6 \mu\text{m}$ , becoming bifurcate. **Basidiospores** subglobose to reniform, with an apiculum at the base, thin-walled, sub-hyaline to pale yellow,  $10\text{--}15 \times 5\text{--}7.5 \mu\text{m}$  (av.  $13 \times 6.5 \mu\text{m}$ ;  $n = 20$ ), 0–3-septate, germination via conidia and germ tubes. **Anamorphic fruit bodies** sometimes present with basidiocarps, pulvinate, sessile, orange, gelatinous, 1 mm high, 1–3 mm diam. **Conidia** holoblastic, cylindrical to subglobose, with a separation scar at the base, thin- or thick-walled,  $20\text{--}30 \times 7.5\text{--}10 \mu\text{m}$ , 0–1-septate.

**Culture characteristics** — Colonies attaining about 4 mm diam, velvety, yellow to orange. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose,  $5 \times 3 \mu\text{m}$ .

**Specimens examined.** JAPAN, Kyoto, Mt Daimonji, on dead branches of *Pinus densiflora*, 29 Mar. 2006, T. Shirouzu, TNS-F-21033 (HNo.181; with anamorph stage); 20 Apr. 2006, T. Shirouzu, TNS-F-15708 (HNo.192), culture MAFF240123; TNS-F-15707 (HNo.182); Takaragaike, on dead branches of *Clethra barbinervi*, 21 Apr. 2006, T. Shirouzu, TNS-F-15709 (HNo.212); Nagano, Sugadairakougen, on dead branches of *Picea* sp., 19 July 2006, T. Shirouzu, TNS-F-21062 (HNo.471); on dead branches of *Pinus densiflora*, 7 Aug. 2007, T. Shirouzu, TNS-F-21077 (HNo.734).

**Notes** — This species is characterised by turbinate or substipitate basidiocarps, hyphae without clamp connections,



**Fig. 5** a–f. *Dacrymyces aureosporus* TNS-F-15714 (HNo.486). a. Basidiocarps; b. basidiospores; c. probasidium; d. basidium and probasidium; e. dikaryophysis; f. marginal hyphae. — g–j. *Dacrymyces capitatus* TNS-F-15708 (HNo.192). g. Basidiocarps; h. basidiospores; i. probasidia and basidia; j. marginal hyphae.

densely arranged thin- or thick-walled marginal hyphae, and thin-walled, 3-septate basidiospores. In this study, we collected material with anamorphic fruit bodies. Oberwinkler (1993) also reported that the species produced conidium-like diaspores by hyphal phragmation. According to the taxonomic opinion of McNabb (1973), *Dacrymyces capitatus* might be reported in Japan as *D. tremellosus* (Kobayasi 1939a).

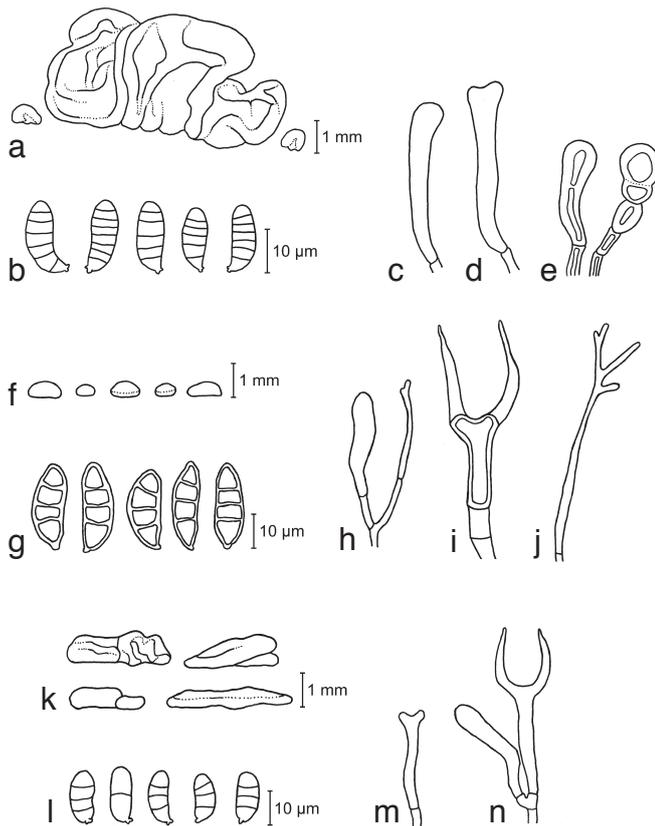
***Dacrymyces chrysospermus*** Berk. & M.A. Curtis, Grevillea 2: 20. 1873 — Fig. 6a–e, 14m

For synonyms see McNabb (1973) and Reid (1974).

**Basidiocarps** scattered or gregarious, sometimes coalesced, turbinate to cerebriform, sessile or stipitate bearing a rugose to convolute semiglobose pileus, orange, firm-gelatinous, 2–5 mm high, 6–13 mm diam. **Sterile parts** of basidiocarps covered with simple cylindrical to clavate, septate, 2–3-celled, hyaline, conspicuously thick-walled terminal cells,  $25\text{--}50 \times 7.5\text{--}16 \mu\text{m}$ . **Internal hyphae** branched, thin-walled, gelatinous, septate, pale yellow, 2–3  $\mu\text{m}$  diam, without clamp connections. **Hymenium** limited to upper surface of the pileus. **Probasidia** cylindrical to clavate, yellow to orange,  $30\text{--}48 \times 5\text{--}8 \mu\text{m}$ , becoming bifurcate. **Basidiospores** cylindrical to curved-cylindrical, with an apiculum at the base, thin-walled, yellow,  $12\text{--}23 \times 5\text{--}10 \mu\text{m}$  (av.  $18 \times 7 \mu\text{m}$ ;  $n = 20$ ), 3–7-septate, germinated by production of conidia and germ tubes.

**Culture characteristics** — Colonies of the primary mycelium attaining about 10 mm diam, velvety, orange. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose,  $6 \times 2 \mu\text{m}$ .

**Specimens examined.** JAPAN, Kagoshima, Amami Island, on dead branches of *Pinus luchuensis*, 18 Jan. 2007, T. Shirouzu, TNS-F-21072 (HNo.620); Nagano, Sugadairakougen, on dead branches of *Abies* sp., 22 June 2006, T. Shirouzu, TNS-F-15712 (HNo.320), culture MAFF240127; a log of *Larix kaempferi*, 16 July 2006, T. Shirouzu, TNS-F-21060 (HNo.446); a standing log of *L. kaempferi*, 19 July 2006, T. Shirouzu, TNS-F-15713 (HNo.468).



**Fig. 6** a–e. *Dacrymyces chrysospermus* TNS-F-15712 (HNo.320). a. Basidiocarps; b. basidiospores; c. probasidium; d. developing basidium; e. marginal hyphae. — f–j. *Dacrymyces dendrocalami* TNS-F-15715 (HNo.210). f. Basidiocarps; g. basidiospores; h. probasidium and dikaryophysis; i. basidium; j. dikaryophysis. — k–n. *Dacrymyces lacrymalis* TNS-F-15717 (HNo.235). k. Basidiocarps; l. basidiospores; m. developing basidium; n. probasidium and basidium.

**Notes** — This species is characterised by turbinate to cerebriform basidiocarps, hyphae without clamp connections, thick-walled terminal cells and multi-septate, cylindrical to curved, thin-walled basidiospores. It has previously been recorded in Japan as *Dacrymyces palmatus*, *D. roseotinctus* and *D. puniceus* (Kobayasi 1939a).

***Dacrymyces dendrocalami*** Oberw., Trans. Mycol. Soc. Japan 30: 350. 1989 — Fig. 6f–j, 14n

**Basidiocarps** scattered, pustulate to pulvinate, sessile, pale white to pale orange, firm-gelatinous, 0.2–0.5 mm high, 1–3 mm diam. **Sterile parts** of basidiocarps covered with simple or branched, septate, hyaline, thin-walled marginal hyphae. **Internal hyphae** branched, thin-walled, gelatinous, septate, 2–3 µm diam, without clamp connections. **Hymenium** limited to the superior surface of the basidiocarp. **Probasidia** cylindrical to clavate, thin- or thick-walled, hyaline to pale yellow, 24–37.5 × 5–7.5 µm, becoming bifurcate. **Dikaryophyses** simple or branched, septate, thin-walled, sub-hyaline, 2–3 µm diam. **Basidiospores** naviculate, straight or curved, with an apiculum at the base, thick-walled, sub-hyaline, 16–22.5 × 6–8 µm (av. 20 × 7 µm; n = 20), 0–3-septate, germination via germ tubes. **Culture characteristics** — Culture not obtained.

**Specimens examined.** JAPAN, Kyoto, Takaragaike, on dead branches of an unknown broad-leaved tree, 21 Apr. 2006, *T. Shirouzu*, TNS-F-15715 (HNo.210); Nara, Mt Tamaki, on dead branches of *Parabenzoin trilobum*, 7 July 2006, *T. Shirouzu*, TNS-F-21058 (HNo.426).

**Notes** — *Dacrymyces dendrocalami* is characterised by pustulate to pulvinate, sessile basidiocarps, hyphae without

clamp connections, and straight- or curved-naviculate, thick-walled basidiospores. This species has been reported only once from Taiwan (Oberwinkler & Tschien 1989). This is the second record for this species, and the first from Japan.

***Dacrymyces lacrymalis*** (Pers.) Sommerf., Suppl. Fl. Lapp. (Oslo) no. 1753: 308. 1826 — Fig. 6k–n, 14o

**Basionym.** *Tremella lacrymalis* Pers., Syn. Meth. Fung. 2: 628. 1801.

For other synonyms see McNabb (1973).

**Basidiocarps** scattered or gregarious, sometimes coalesced, pulvinate or irregularly discoid, applanate, gyrose or centrally depressed, sessile or sub-stipitate, yellow, firm-gelatinous, 0.5–2 mm high, 1–4 mm diam. **Sterile parts** of basidiocarps covered with simple or branched, septate, hyaline, thin-walled marginal hyphae. **Internal hyphae** branched, thin-walled, gelatinous, septate, hyaline, 2–3 µm diam, without clamp connections. **Hymenium** limited to the upper surface of the basidiocarp. **Probasidia** cylindrical to clavate, sub-hyaline to pale yellow, 20.5–30 × 3.5–5 µm, becoming bifurcate. **Basidiospores** sub-globose to reniform, with an apiculum at the base, thin-walled, sub-hyaline to pale yellow, 9.5–15 × 3.5–6 µm (av. 11.5 × 5 µm; n = 20), 0–3-septate, germinated by production of conidia and germ tubes. **Anamorphic fruit bodies** sometimes present with basidiocarps, pulvinate, sessile, yellow, gelatinous, 1 mm high, 1–3 mm diam. **Conidia** holoblastic, cylindrical to subglobose, with a separation scar at the base, thin-walled, 5–10 × 3–5 µm, 0–1-septate.

**Culture characteristics** — Colonies attaining about 8 mm diam, velvety, yellow. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose, 5 × 3 µm.

**Specimens examined.** JAPAN, Kyoto, Takaragaike, on dead branches of an unknown broad-leaved tree, 21 Apr. 2006, *T. Shirouzu*, TNS-F-15716 (HNo.209); Nagano, Sugadairakougen, on dead branches of *Abies* sp., 8 May 2006, *T. Shirouzu*, TNS-F-21041 (HNo.271); on dead branches of *Alnus japonica*, 14 May 2006, *D. Hirose*, TNS-F-15719 (HNo.281); on dead branches of *Larix* sp., 8 May 2006, *T. Shirouzu*, TNS-F-21042 (HNo.277); *L. kaempferi*, 28 May 2006, *T. Shirouzu*, TNS-F-21043 (HNo.279); Nara, Mt Tamaki, on dead branches of *Fagus crenata*, Nara, 27 Apr. 2006, *T. Shirouzu*, TNS-F-15718 (HNo.261); on dead branches of an unknown broad-leaved tree, 13 Oct. 2006, *T. Shirouzu*, TNS-F-21070 (HNo.563); Odaigahara, on dead branches of *F. crenata*, 24 Apr. 2006, *T. Shirouzu*, TNS-F-15717 (HNo.235), culture MAFF240132; on dead branches of an unknown conifer, 24 Apr. 2006, *T. Shirouzu*, TNS-F-21040 (HNo. 250; with anamorph stage); on dead branches of *F. crenata*, 24 Apr. 2006, *T. Shirouzu*, TNS-F-21039 (HNo.243).

**Notes** — *Dacrymyces lacrymalis* is characterised by irregularly discoid, gyrose, sessile basidiocarps, hyphae without clamp connections and thin-walled, 3-septate basidiospores. Although McNabb (1973) did not report the anamorphic stage of this species, anamorphic fruit bodies bearing holoblastic conidia were observed together with basidiocarps in this study. According to the result of this study and McNabb (1973), *D. lacrymalis* has been frequently found on woody substrata of broad-leaved trees. This record is the first for Japan.

***Dacrymyces microsporus*** P. Karst., Bidrag Kannedom Finlands Natur Folk 48: 459. 1889 — Fig. 7a–c, 14p

**Basidiocarps** scattered or gregarious, sometimes coalesced, turbinate to stoutly cylindrical, stipitate bearing a concave or rugose semiglobose pileus, pale yellow, soft-cartilaginous to firm-gelatinous, 1–1.5 mm high, 1–2 mm diam. **Sterile parts** of basidiocarps covered with simple or branched, cylindrical, septate, hyaline, thin-walled, marginal hyphae. **Internal hyphae** branched, thin-walled, gelatinous, septate, hyaline, 2–4 µm diam, without clamp connections. **Hymenium** limited to upper surface of the pileus. **Probasidia** cylindrical to clavate, sub-

hyaline,  $27.5\text{--}42.5 \times 3.5\text{--}4.5 \mu\text{m}$ , becoming bifurcate. *Basidiospores* reniform, with an apiculum at the base, thin-walled, sub-hyaline,  $10\text{--}14 \times 3.5\text{--}6.5 \mu\text{m}$  (av.  $11.5 \times 5 \mu\text{m}$ ;  $n = 20$ ), 0–1-septate, germination by means of conidial production and germ tubes.

**Culture characteristics** — Colonies of the primary mycelium attaining about 7 mm diam, wet, yellow. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose,  $6 \times 3 \mu\text{m}$ .

**Specimens examined.** JAPAN, Kyoto, Mt Kiyomizu, on dead branches of an unknown broad-leaved tree, 2 July 2007, T. Shirouzu, TNS-F-21054 (HNo.390); Takaragaiké, on a fallen tree of *Quercus* sp., 1 July 2006, T. Shirouzu, TNS-F-21050 (HNo.371), culture MAFF241176; Wakayama, Mt Nachi, on dead branches of an unknown woody plant, 6 July 2006, T. Shirouzu, TNS-F-21049 (HNo.368).

**Notes** — *Dacrymyces microspores* is characterised by basidiocarps that are turbinate to stipitate, bearing a concave or rugose, semiglobose pileus, hyphae without clamp connections and thin-walled, 0–1-septate basidiospores. This is the first record from Japan.

***Dacrymyces minor*** Peck, Ann. Rep. N. Y. State Mus. 30: 49. 1878 — Fig. 7d–g, 15a

For synonyms see McNabb (1973).

**Basidiocarps** scattered, pustulate to pulvinate, sessile or sub-stipitate, pale orange, firm-gelatinous, 0.5 mm high, 1–2 mm diam. **Sterile parts** of basidiocarps covered with simple or branched, cylindrical, septate, hyaline, thin-walled, marginal hyphae. **Internal hyphae** branched, thin-walled, gelatinous, septate, hyaline, 2–3  $\mu\text{m}$  diam, without clamp connections. **Hymenium** limited to superior surface of the basidiocarp. **Probasidia** cylindrical to clavate, sub-hyaline,  $30\text{--}47 \times 4\text{--}9 \mu\text{m}$ , becoming bifurcate. **Basidiospores** reniform, with an apiculum at the base, thin- or thick-walled, pale yellow,  $12.5\text{--}18 \times 5\text{--}9.5 \mu\text{m}$  (av.  $15 \times 6.5 \mu\text{m}$ ;  $n = 20$ ), 1–3-septate, germination by means of conidial production and germ tubes.

**Culture characteristics** — Colonies of the primary mycelium attaining about 6 mm diam, velvety, orange to white. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose,  $6 \times 3 \mu\text{m}$ .

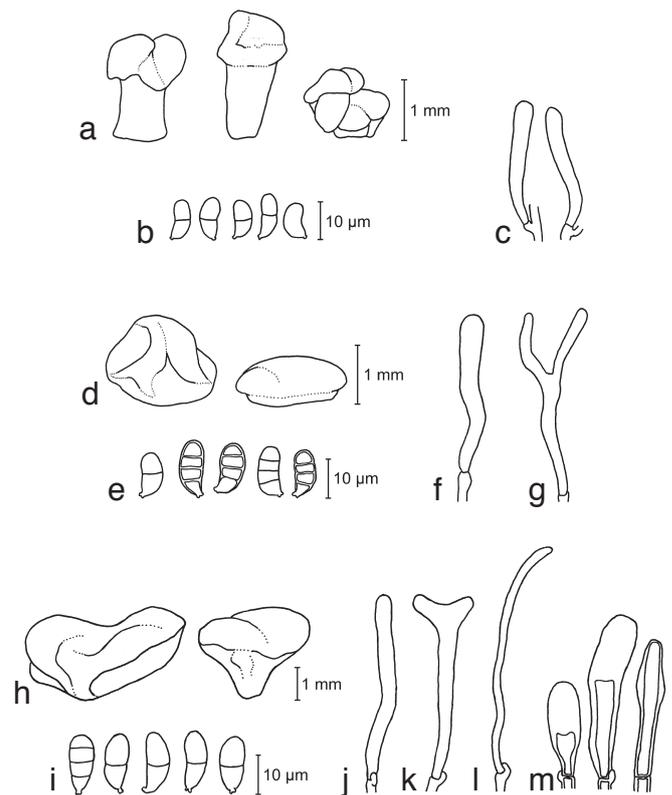
**Specimens examined.** JAPAN, Nara, Kasuga Shrine, on dead branches of *Podocarpus nagi*, 23 Apr. 2006, T. Shirouzu, TNS-F-15721 (HNo.237); Mt Kasuga, on dead branches of an unknown broad-leaved tree, 23 Apr. 2006, T. Shirouzu, TNS-F-15720 (HNo.224), culture MAFF240135.

**Notes** — *Dacrymyces minor* is characterised by relatively small, pustulate to pulvinate basidiocarps, hyphae without clamp connections, and thin- or thick-walled, 1–3-septate basidiospores. This species was first recorded from Japan by Kobayasi (1939a).

***Dacrymyces minutus*** (L.S. Olive) McNabb, New Zealand J. Bot. 11: 497. 1973 — Fig. 7h–m, 15b

**Basionym.** *Guepinopsis minuta* L.S. Olive, Bull. Torrey Bot. Club 81: 334. 1954.

**Basidiocarps** scattered, turbinate or irregularly discoid, sub-stipitate or stipitate bearing a centrally depressed semiglobose pileus, yellow-orange, firm-gelatinous, 1–3 mm high, 2–5 mm diam. **Sterile parts** of basidiocarps covered with simple cylindrical to clavate, hyaline, conspicuously thick-walled terminal cells,  $25\text{--}32 \times 6\text{--}10 \mu\text{m}$ . **Internal hyphae** branched, thin-walled, septate, hyaline, 2–3  $\mu\text{m}$  diam, with clamp connections. **Hymenium** limited to the upper surface of the pileus or disc. **Probasidia** cylindrical to clavate, sub-hyaline to pale yellow,  $30\text{--}38 \times 5\text{--}7.5 \mu\text{m}$ , with a basal clamp connection, becoming bifurcate.



**Fig. 7** a–c. *Dacrymyces microsporus* TNS-F-21050 (HNo.371). a. Basidiocarps; b. basidiospores; c. probasidia. — d–g. *Dacrymyces minor* TNS-F-15720 (HNo.224). d. Basidiocarps; e. basidiospores; f. probasidium; g. developing basidium. — h–m. *Dacrymyces minutus* TNS-F-15722 (HNo.282). h. Basidiocarps; i. basidiospores; j. probasidium; k. developing basidium; l. dikaryophysis; m. marginal hyphae.

**Dikaryophyses** cylindrical, simple, sub-hyaline,  $45\text{--}52 \times 2.5 \mu\text{m}$ , with a basal clamp connection. **Basidiospores** cylindrical to reniform, with an apiculum at the base, thin-walled, sub-hyaline to pale yellow,  $11.5\text{--}15.5 \times 4\text{--}6 \mu\text{m}$  (av.  $14 \times 5 \mu\text{m}$ ;  $n = 20$ ), 1–3-septate, germinated by production of conidia and germ tubes.

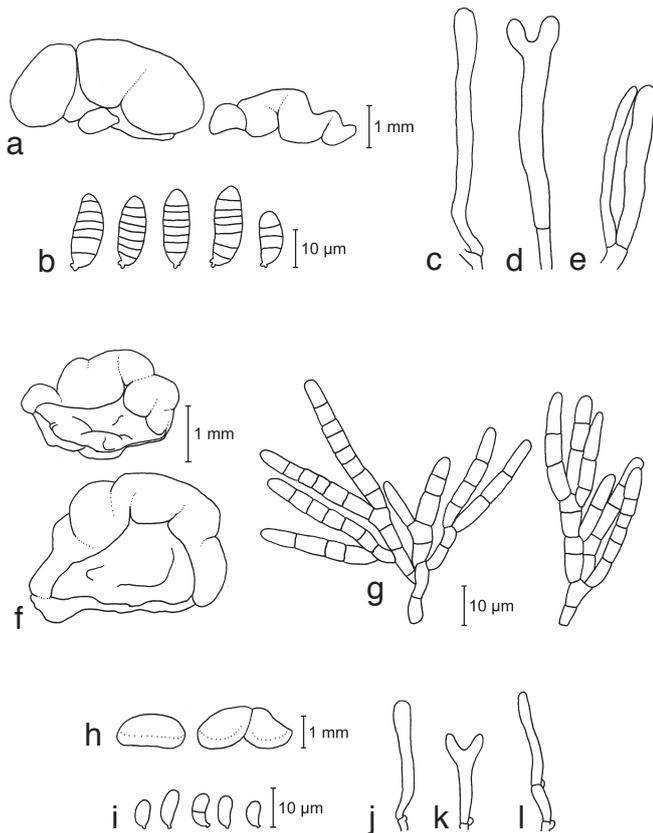
**Culture characteristics** — Colonies slow growing, attaining about 2 mm diam, velvety, orange. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose,  $5 \times 3 \mu\text{m}$ .

**Specimens examined.** JAPAN, Gunma, Mt Motoshirane, on dead branches of *Abies veitchii*, 28 May 2007, T. Shirouzu & D. Hirose, TNS-F-21073 (HNo.648); Nagano, Sugadairakougen, on dead branches of *Larix leptolepis*, 28 May 2006, T. Shirouzu, TNS-F-15722 (HNo.282), culture MAFF240137.

**Notes** — *Dacrymyces minutus* is characterised by turbinate to irregularly discoid basidiocarps, hyphae with clamp connections, cylindrical to clavate, thick-walled terminal cells, and thin-walled, 3-septate basidiospores. According to the results of our survey and that of McNabb (1973), *D. minutus* occurs frequently on woody materials of conifers. If *D. pezizoides* is thought of as a synonym of *D. minutus* as McNabb (1973) suggested, this species has already been reported from Japan by Kobayasi (1939a).

***Dacrymyces novae-zelandiae*** McNabb, New Zealand J. Bot. 11: 493. 1973 — Fig. 8a–e, 15c

**Basidiocarps** scattered or gregarious, sometimes coalesced, pulvinate to convoluted, sessile or sub-stipitate, yellow, firm-gelatinous, 1–2 mm high, 1–4 mm diam. **Sterile parts** of basidiocarps covered with simple or branched, cylindrical, septate, hyaline, thin-walled marginal hyphae. **Internal hyphae**



**Fig. 8** a–e. *Dacrymyces novae-zelandiae* TNS-F-21038 (HNo.225). a. Basidiocarps; b. basidiospores; c. probasidium; d. developing basidium; e. dikaryophysis and probasidium. — f, g. *Dacrymyces pinacearum* TNS-F-21056 (HNo.418). f. Conidiocarps; g. conidia. — h–l. *Dacrymyces punctiformis* TNS-F-15723 (HNo.196). h. Basidiocarps; i. basidiospores; j. probasidium; k. developing basidium; l. dikaryophysis.

branched, thin-walled, gelatinous, septate, sub-hyaline, 2–3 µm diam, without clamp connections. *Hymenium* limited to the upper surface of the basidiocarp. *Probasidia* cylindrical to clavate, thin-walled, pale yellow, 55–72 × 5–8.5 µm, becoming bifurcate. *Dikaryophyses* simple, thin-walled, pale yellow, 50–60 × 3–4 µm. *Basidiospores* cylindrical to reniform, with an apiculum at the base, thin-walled, yellow, 15–27 × 7–12.5 µm (av. 20.5 × 8.5 µm; n = 20), 0–7-septate, germination via the production of conidia and germ tubes.

**Culture characteristics** — Colonies attaining about 6 mm diam, velvety, white-orange. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose, 6 × 3 µm.

**Specimen examined.** JAPAN, Nara, Kasuga Shrine, on dead branches of *Podocarpus nagi*, 23 Apr. 2006, T. Shirouzu, TNS-F-21038 (HNo.225), culture MAFF241165.

**Notes** — *Dacrymyces novae-zelandiae* is characterised by pustulate to pulvinate, sessile basidiocarps, hyphae without clamp connections, simple dikaryophyses and thin-walled, multi-septate basidiospores. This is the first record from Japan.

***Dacrymyces pinacearum*** Shirouzu & Tokum., *sp. nov.* — MycoBank MB514038; Fig. 8f, g, 15d

Conidiomata sparsa, pulvinata vel flabellata, sessilia, aurantiaca, fragilia, 1 mm alta, 1–2 mm lata. Hyphae interaneae ramosae, tenuitunicatae, flavidae, 2–3 µm latae. Cellulae conidiogenae micronematicae, cylindricae, flavidae. Conidia holoblastica, ramosa, dendroidea, cum ramis cylindricis 1–8-cellularibus 27–65 × 5–9 µm tenuitunicatis aurantiacis.

**Etymology.** Named after the family name of its host.

**Basidiocarps** scattered, pulvinate to flabellate, sessile, orange, sometimes white at the lower-side, fragile, 1 mm high, 1–2 mm

diam. *Internal hyphae* branched, thin-walled, septate, pale yellow, 2–3 µm diam, without clamp connections. *Hymenium* limited to the orange part of the basidiocarp. *Conidiogenous cells* micronematous, cylindrical, pale yellow. *Conidia* holoblastic, branched, dendroid, composed of cylindrical, 1–8-celled branches of 27–65 × 5–9 µm, thin-walled, orange.

**Culture characteristics** — Colonies attaining about 8 mm diam, velvety, white to pale yellow. Conidiogenesis not observed.

**Specimen examined.** JAPAN, Nara, Oodaigahara, on a dead trunk of *Abies* sp., 4 July 2006, T. Shirouzu, holotype TNS-F-21056 (HNo.418), culture ex-type MAFF241182.

**Notes** — *Dacrymyces pinacearum* is characterised by pulvinate to flabellate conidiocarps and holoblastic, dendroid conidia. Coelomycetous anamorphs of *Dacrymycetales* are usually linked with the genus *Dacrymyces* and have pulvinate fruit bodies and arthric conidia as represented by *D. stillatus*. An unusual coelomycetous anamorph of *Dacrymycetales* having holoblastic, 2–4-armed stauroconidia was described by Kirschner & Yang (2005) as *Dacryoscyphus chrysochilus*. Our fungus resembles the anamorphic species of Kirschner & Yang, but is different from *D. chrysochilus* in having dendroid conidia composed of branches without accurate tips. In molecular phylogenetic analyses, *Dacrymyces pinacearum* was clearly separate from *Dacryoscyphus chrysochilus* and formed a clade with *Dacrymyces san-augustinii* and *D. novae-zelandiae* (Fig. 16); therefore, we consider that this fungus is a new anamorphic species of *Dacrymyces*.

***Dacrymyces punctiformis*** Neuhoff, Schweiz. Z. Pilzk. 12: 81. 1934 — Fig. 8h–l, 15e

For synonyms see Reid (1974).

**Basidiocarps** scattered or gregarious, sometimes coalesced, pustulate to pulvinate, sessile, pale yellow, firm-gelatinous, 0.5–1 mm high, 1–2 mm diam. *Sterile parts* of basidiocarps covered with simple or branched, cylindrical, septate, hyaline, thin-walled marginal hyphae. *Internal hyphae* branched, thin-walled, gelatinous, septate, sub-hyaline, 2–3.5 µm diam, with clamp connections. *Hymenium* limited to the superior surface of the basidiocarp. *Probasidia* cylindrical to clavate, thick-walled, pale yellow, 30–50 × 5 µm, with a basal clamp connection, becoming bifurcate. *Dikaryophyses* simple, septate, thin-walled, sub-hyaline, 30–50 × 2.5 µm. *Basidiospores* subglobose to reniform, with an apiculum at the base, thin-walled, sub-hyaline, 7–13 × 4–6 µm (av. 9 × 5 µm; n = 15), 0–1(–3)-septate, germination via germ tubes.

**Culture characteristics** — Colonies attaining about 4 mm diam, velvety, white. Conidiogenesis not observed.

**Specimens examined.** JAPAN, Kyoto, Mt Daimonji, on dead branches of *Pinus densiflora*, 20 Apr. 2006, T. Shirouzu, TNS-F-15723 (HNo.196), culture MAFF240138; Takaragaike, on dead branches of *Clethra barbinervi*, 21 Apr. 2006, T. Shirouzu, TNS-F-15724 (HNo.213); Nagano, Shioda, on dead branches of *Pinus densiflora*, 20 May 2006, T. Shirouzu, TNS-F-15725 (HNo.285).

**Notes** — *Dacrymyces punctiformis* is characterised by pustulate to pulvinate, sessile basidiocarps, hyphae with clamp connections, simple dikaryophyses and thin-walled, 0–1(–3)-septate basidiospores. This study as well as others (Kobayasi 1939a, McNabb 1973, Reid 1974), it was mentioned that this species frequently occurred on conifers wood.

***Dacrymyces san-augustinii*** Kobayasi, Sci. Rep. Tokyo Bunrika Daigaku, Sect. B, 4: 122. 1939 — Fig. 9a–e, 15f

**Basidiocarps** scattered or gregarious, sometimes coalesced, pustulate to pulvinate, sessile, pale orange to pale amber,

firm-gelatinous, 1–2 mm high, 1–3 mm diam. *Sterile parts* of basidiocarps covered with simple or branched, cylindrical, septate, hyaline, thin-walled marginal hyphae. *Internal hyphae* branched, thin-walled, gelatinous, septate, sub-hyaline, 2–3  $\mu\text{m}$  diam, without clamp connections. *Hymenium* limited to the upper surface of the basidiocarp. *Probasidia* cylindrical to clavate, thin-walled, pale yellow,  $38\text{--}58 \times 5.5\text{--}7 \mu\text{m}$ , becoming bifurcate. *Dikaryophyses* simple or branched, septate, thin- or thick-walled, pale yellow,  $40\text{--}120 \times 4 \mu\text{m}$ . *Basidiospores* curved-allantoid, with an apiculum at the base, thin-walled, sub-hyaline,  $16\text{--}27.5 \times 6\text{--}10 \mu\text{m}$  (av.  $21.5 \times 7.5 \mu\text{m}$ ;  $n = 20$ ), 0–7-septate, germination via conidial production and germ tubes.

**Culture characteristics** — Colonies attaining about 20 mm diam, velvety, white-orange. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose,  $5 \times 3 \mu\text{m}$ .

**Specimens examined.** JAPAN, Okinawa, Iriomote Island, on dead branches of an unknown broad-leaved tree, 10 June 2007, T. Shirouzu, TNS-F-21075 (HNo.666), culture MAFF241196; Wakayama, Mt Shirami, on dead branches of an unknown woody plant, 8 July 2006, T. Shirouzu, TNS-F-15726 (HNo.441).

**Notes** — *Dacrymyces san-augustinii* is characterised by pustulate to pulvinate, sessile basidiocarps, hyphae without clamp connections, branched dikaryophyses and thin-walled, multi-septate basidiospores. *Dacrymyces novae-zelandiae* resembles *D. san-augustinii* in morphological characteristics. McNabb (1973) noted that these species can be distinguished by the presence of branched dikaryophyses, which are present in *D. san-augustinii* and absent in *D. novae-zelandiae*. This species was described by Kobayasi (1939a) on a specimen collected from the trunk of a broad-leaved tree in Japan.

***Dacrymyces stillatus*** Nees, Syst. Mycol. 2: 250. 1822 — Fig. 9f–j, 15g

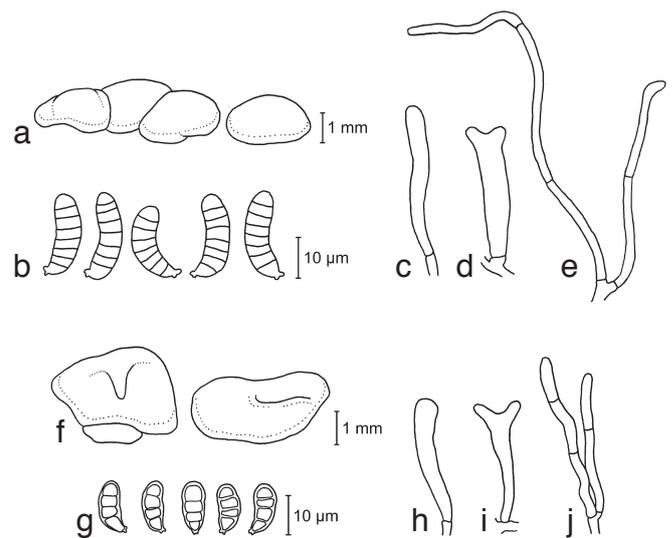
For synonyms see McNabb (1973) and Reid (1974).

**Basidiocarps** scattered, pustulate, pulvinate to applanate, sometimes centrally depressed, sessile, pale yellow to pale amber, firm-gelatinous, 0.5–1 mm high, 1–3 mm diam. *Sterile parts* of basidiocarps covered with simple or branched, cylindrical, septate, hyaline, thin-walled marginal hyphae. *Internal hyphae* branched, thin-walled, gelatinous, septate, hyaline, 2–3  $\mu\text{m}$  diam, without clamp connections. *Hymenium* limited to the upper surface of the basidiocarp. *Probasidia* cylindrical to clavate, sub-hyaline,  $25\text{--}42.5 \times 4.5\text{--}7 \mu\text{m}$ , becoming bifurcate. *Basidiospores* reniform, with an apiculum at the base, thick-walled, pale yellow,  $12.5\text{--}17 \times 5\text{--}8 \mu\text{m}$  (av.  $14.5 \times 6 \mu\text{m}$ ;  $n = 20$ ), 1–3-septate, germination via the production of conidia and germ tubes. *Anamorphic fruit bodies* pustulate to pulvinate, sessile, orange, firm-gelatinous, 0.5 mm high, 0.5–1.5 mm diam. *Conidia* arthric, cylindrical, thin-walled, pale orange,  $7.5\text{--}12.5 \times 2.5\text{--}3.5 \mu\text{m}$ , 0–1-septate.

**Culture characteristics** — Colonies attaining about 15 mm diam, velvety, pale orange. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose,  $5 \times 3 \mu\text{m}$ .

**Specimens examined.** JAPAN, Kyoto, Midorogaike, on dead branches of *Quercus glauca*, 1 July 2006, T. Shirouzu, TNS-F-21052 (HNo.383); Nara, Kasuga Shrine, on dead branches of *Podocarpus nagi*, 23 Apr. 2006, T. Shirouzu, TNS-F-15727 (HNo.233), culture MAFF240142; Mt Tamaki, on dead branches of *Deutzia crenata*, 27 Apr. 2006, T. Shirouzu, TNS-F-15729 (HNo.252; anamorphic stage); on dead branches of an unknown conifer, 27 Apr. 2006, T. Shirouzu, TNS-F-15728 (HNo.256); Oodaigahara, on dead branches of *Fagus crenata*, 4 July 2006, T. Shirouzu, TNS-F-21057 (HNo.421; anamorphic stage); on dead branches of an unknown conifer, 4 July 2006, T. Shirouzu, TNS-F-21055 (HNo.411; anamorphic stage).

**Notes** — *Dacrymyces stillatus* is characterised by pustulate to pulvinate basidiocarps, hyphae without clamp connections and thick-walled, 1–3-septate basidiospores. This species is



**Fig. 9** a–e. *Dacrymyces san-augustinii* TNS-F-21075 (HNo.666). a. Basidiocarps; b. basidiospores; c. probasidium; d. developing basidium; e. dikaryophysis. — f–j. *Dacrymyces stillatus* TNS-F-15727 (HNo.233). f. Basidiocarps; g. basidiospores; h. probasidium; i. developing basidium; j. dikaryophysis.

similar to *D. minor* in morphology on the whole, but McNabb (1973) emphasised that these species could be distinguished by the difference in basidiocarp size. In this study, we identified materials with basidiocarps of 2 mm or more in diameter as *D. stillatus*, but from the results of molecular phylogenetic analyses, these two species were nested in the same clade (Fig. 16). This species was reported in Japan by Kobayasi (1939a; as *D. deliquescens*) and Tubaki & Hosoya (1987).

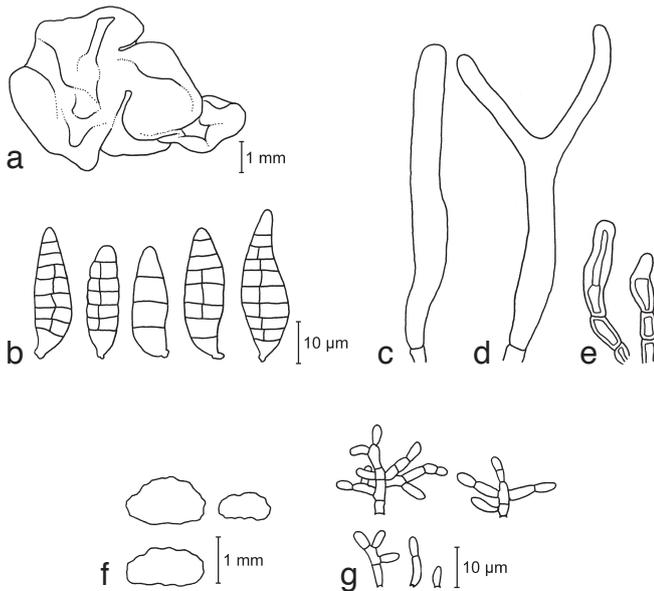
***Dacrymyces subalpinus*** Kobayasi, Sci. Rep. Tokyo Bunrika Daigaku, Sect. B, 4: 120. 1939 — Fig. 10a–e, 15h

**Basidiocarps** scattered or gregarious, sometimes coalesced, turbinate to cerebriform, sessile or stipitate, bearing a rugose to convoluted, semiglobose pileus, yellow to orange, firm-gelatinous, 1–2 mm high, 4–6 mm diam. *Sterile parts* of basidiocarps covered with simple, cylindrical to clavate, septate, 2–3-celled, hyaline, conspicuously thick-walled terminal cells,  $38\text{--}50.5 \times 7\text{--}12 \mu\text{m}$ . *Internal hyphae* branched, thin-walled, gelatinous, septate, hyaline, 2–4  $\mu\text{m}$  diam, without clamp connections. *Hymenium* limited to superior surface of the pileus. *Probasidia* cylindrical, yellow,  $63.5\text{--}90 \times 8\text{--}11.5 \mu\text{m}$ , becoming bifurcate. *Basidiospores* cylindrical to curved-naviculate, with an apiculum at the base, thin-walled, yellow,  $32\text{--}54 \times 9.5\text{--}17 \mu\text{m}$  (av.  $41.5 \times 12 \mu\text{m}$ ;  $n = 20$ ), 0–14-transverse septate, occasionally with 0–7-vertical septa, germinated by production of conidia and germ tubes.

**Culture characteristics** — Colonies attaining about 6 mm diam, velvety, pale yellow to white. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose,  $6\text{--}7 \times 4 \mu\text{m}$ .

**Specimens examined.** JAPAN, Gifu, Mt Kiso-ontake, on dead branches of *Tsuga sieboldii*, 25 Oct. 2006, T. Osono, TNS-F-21071 (HNo.570), culture MAFF241193; Nara, Mt Kasuga, on dead branches of *Abies firma*, 23 Apr. 2006, T. Shirouzu, TNS-F-15730 (HNo.228).

**Notes** — *Dacrymyces subalpinus* is characterised by hyphae without clamp connections and curved-naviculate, multi-transverse and vertically septate basidiospores. Although McNabb (1973) noted that the holotype was destroyed during the Second World War, he recognised this as a distinct species based on the descriptions by Kobayasi (1939a).



**Fig. 10** a–e. *Dacrymyces subalpinus* TNS-F-21071 (HNo.570). a. Basidiocarp; b. basidiospores; c. probasidium; d. basidium; e. marginal hyphae. — f, g. *Dacrymyces subarcticus* TNS-F-21067 (HNo.544). f. Conidiocarps; g. conidia.

***Dacrymyces subarcticus*** Shirouzu & Tokum., *sp. nov.* —  
Mycobank MB514039; Fig. 10f, g, 15i

Conidiomata sparsa, papilliformia vel pulvinata, sessilia, flavida, fragilia, 0.5–1 mm alta, 1–2 mm lata. Hyphae interaneae ramosae, tenuitunicatae, flavidae, 2–3 µm latae. Cellulae conidiogenae micronematice, cylindricae, flavidae. Conidia holoblastica, irregulariter ramosa, cum ramis cylindricis 1–4-cellularibus 6–22.5 × 2–4 µm tenuitunicatis flavidis.

*Etymology.* Named after its subarctic habitat.

*Conidiocarps* scattered, pustulate to pulvinate, sessile, yellow, fragile, 0.5–1 mm high, 1–2 mm diam. *Internal hyphae* branched, thin-walled, septate, pale yellow, 2–3 µm diam, without clamp connections. *Hymenium* limited to the upper surface of the basidiocarp. *Conidiogenous cells* micronematous, cylindrical, pale yellow. *Conidia* holoblastic, irregularly branched, composed of cylindrical, 1–4-celled branches of 6–22.5 × 2–4 µm, with a separation scar at the base, thin-walled, pale yellow.

*Culture characteristics* — Colonies attaining about 6 mm diam, velvety, white to pale yellow. Conidiogenesis not observed.

*Specimens examined.* JAPAN, Gunma, Mt Motoshirane, on a dead trunk of an unknown conifer, 23 July 2007, T. Shirouzu & D. Hirose, TNS-F-21076 (HNo.722); Nara, Oodaigahara, on dead branches of *Abies* sp., 9 Oct. 2006, T. Shirouzu, holotype TNS-F-21067 (HNo.544).

*Notes* — *Dacrymyces subarcticus* is characterised by pulvinate conidiocarps and holoblastic, irregularly branched conidia. This anamorphic fungus has pulvinate conidiocarps and is similar to sporodochial anamorphs, such as *D. stillatus*, in the shape of conidiocarps. However, *D. subarcticus* differs from other sporodochial anamorphs of *Dacrymyces* in bearing holoblastic, irregularly branched conidia. We described this fungus as a new anamorphic species of *Dacrymyces*. In molecular phylogenetic analyses, *D. subarcticus* formed a monophyletic group with *Dacryoscyphus chrysochilus* (Fig. 16).

***Dacrymyces unisporus*** (L. S. Olive) K. Wells, *Mycologia* 86:  
31. 1994 — Fig. 11a–c, 15j

*Basionym.* *Platyglaea unispora* L.S. Olive, *J. Elisha Mitchell Sci. Soc.* 60: 17. 1944.

*Basidiocarps* scattered, pustulate or pulvinate, sometimes centrally depressed, sessile, olive-orange to yellow-orange, firm-gelatinous, 0.5 mm high, 0.5–1 mm diam. *Sterile parts* of basidiocarps covered with simple or branched, cylindrical, septate, hyaline, thin-walled, marginal hyphae. *Internal hyphae* branched, thick-walled, septate, hyaline, 3–5 µm diam, with clamp connections. *Hymenium* limited to the superior surface of the basidiocarp. *Basidia* cylindrical to clavate, tapering toward the apex bearing a sterigma, sub-hyaline, 40–58 × 4–7 µm, with a basal clamp connection. *Basidiospores* globose to sub-globose, with an apiculum at the base, thin-walled, sub-hyaline, 11–17.5 × 8.5–13 µm (av. 14 × 11.5 µm; n = 20), 2–4-celled, germinated by germ tubes.

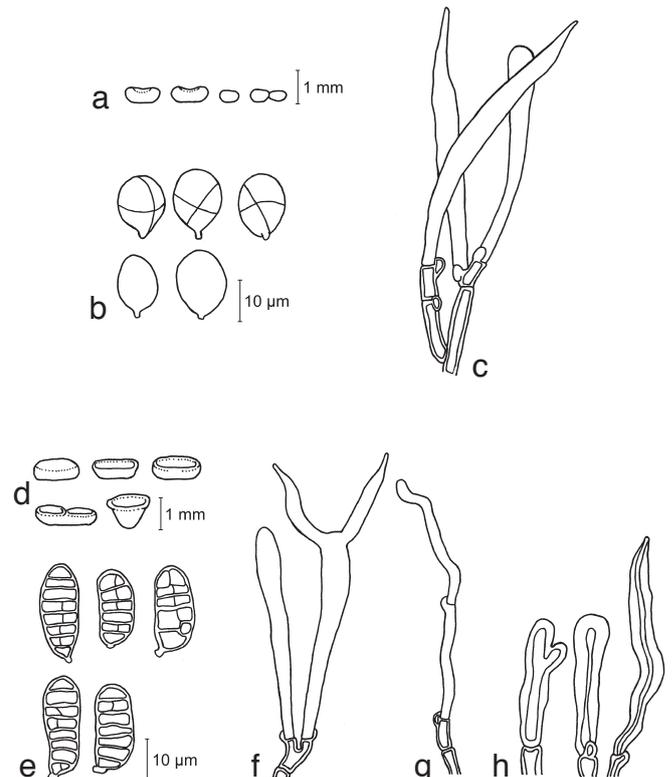
*Culture characteristics* — Colonies slow growing, attaining about 2 mm diam, lanose, white. Conidiogenesis not observed.

*Specimen examined.* JAPAN, Nagano, Sugadairakougen, on dead branches of *Pinus densiflora*, 16 June 2006, T. Shirouzu, TNS-F-15731 (HNo.332), culture MAFF240146.

*Notes* — The most remarkable morphological feature of *Dacrymyces unisporus* is a simple, not bifurcate, cylindrical basidium producing a single, globose basidiospore. This species was initially described as a species of *Platyglaea* (Olive 1944). In 1994, Wells transferred this fungus to the genus *Dacrymyces* based on the fact that “very often the epibasidium and sterigma arise eccentrically suggesting a derivation from the furcated, dacrymycetoid basidium” (Wells 1994). This is the first record from Japan.

***Dacrymyces variisporus*** McNabb, *New Zealand J. Bot.* 11:  
504. 1973 — Fig. 11d–h, 15k

*Basidiocarps* scattered or gregarious, sometimes coalesced, turbinate, pulvinate or discoid, centrally depressed, sessile or sub-stipitate, orange, firm-gelatinous, 0.5–1 mm high, 0.5–1.5 mm diam. *Sterile parts* of basidiocarps covered with cylindrical-



**Fig. 11** a–c. *Dacrymyces unisporus* TNS-F-15731 (HNo.332). a. Basidiocarps; b. basidiospores; c. basidia and probasidium. — d–h. *Dacrymyces variisporus* TNS-F-15733 (HNo.300). d. Basidiocarps; e. basidiospores; f. probasidium and basidium; g. dikaryophysis; h. marginal hyphae.

clavate or narrowly naviculate, simple or branched, straight or flexuous, conspicuously thick-walled, hyaline terminal cells,  $17.5\text{--}32 \times 5\text{--}10 \mu\text{m}$ . *Internal hyphae* branched, thin- or thick-walled, septate, hyaline,  $2\text{--}4.5 \mu\text{m}$  diam, with clamp connections. *Hymenium* limited to the superior surface of the basidiocarp. *Probasidia* cylindrical to clavate, yellow,  $44.5\text{--}62.5 \times 4.5\text{--}7.5 \mu\text{m}$ , with a basal clamp connection, becoming bifurcate. *Dikaryophyses* cylindrical, simple, septate, pale yellow,  $30\text{--}50 \times 3 \mu\text{m}$ . *Basidiospores* cylindrical to curved-cylindrical, with an apiculum at the base, thick-walled, yellow,  $18\text{--}25 \times 8\text{--}10.5 \mu\text{m}$  (av.  $22 \times 9 \mu\text{m}$ ;  $n = 20$ ), 1–7-transverse septate, occasionally with 1–4-vertical septa, germination via the production of conidia and germ tubes.

**Culture characteristics** — Colonies attaining about 4 mm diam, velvety, sulcate, yellow-orange. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose,  $5 \times 3 \mu\text{m}$ .

**Specimens examined.** JAPAN, Kyoto, Mt Daimonji, on dead branches of *Pinus densiflora*, 30 June 2006, T. Shirouzu, TNS-F-15734 (HNo.352); Naganu, Sugadairakougen, on dead branches of *P. densiflora*, 21 May 2006, T. Shirouzu, TNS-F-15733 (HNo.300), culture MAFF240148; Nara, Mt Tamaki, on dead branches of *P. densiflora*, 27 Apr. 2006, T. Shirouzu, TNS-F-15732 (HNo.263).

**Notes** — *Dacrymyces variisporus* is characterised by relatively small, turbinate to pulvinate basidiocarps, hyphae with clamp connections, cylindrical to clavate, thick-walled terminal cells, and thick-walled, multi-septate basidiospores. All our materials were collected from woody substrata of conifers. This is the first record from Japan.

***Dacryopinax spathularia* (Schwein.) G.W. Martin, Lloydia 11: 116. 1948. — Fig. 12a–e, 15l**

**Basionym.** *Merulius spathularia* Schwein., Schr. Naturf. Ges. Leipzig 1: 97. 1882.

For other synonyms see McNabb (1965b).

**Basidiocarps** scattered or gregarious, spathulate, stipitate bearing sinuate flabellate to petaloid pileus, orange, white-yellow at the sterile surface of basidiocarps, soft-cartilaginous, 5–13 mm high, 1–2 mm diam at stipe, 3–7 mm diam at pileus. *Sterile parts* of basidiocarps covered with solitary or fasciculate, cylindrical, simple or branched, straight or flexuous, septate, thick-walled, pale yellow marginal hypha of  $30\text{--}140 \times 5\text{--}6 \mu\text{m}$ . *Internal hyphae* branched, thin-walled, septate, pale yellow,  $2\text{--}5 \mu\text{m}$  diam, without clamp connections. *Hymenium* unilateral. *Probasidia* cylindrical to clavate, pale yellow,  $23.5\text{--}34 \times 3.5\text{--}7.5 \mu\text{m}$ , becoming bifurcate. *Basidiospores* subglobose to reniform, with an apiculum at the base, thin-walled, pale yellow,  $9\text{--}13.5 \times 3.5\text{--}7.5 \mu\text{m}$  (av.  $10.5 \times 5 \mu\text{m}$ ;  $n = 20$ ), 0–1-septate, germinated by germ tubes.

**Culture characteristics** — Colonies attaining about 10 mm diam, velvety, yellow to white. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose,  $5 \times 3 \mu\text{m}$ .

**Specimens examined.** JAPAN, Kyoto, Midorogaike, on a bench made from an unknown conifer, 1 July 2006, T. Shirouzu, TNS-F-15735 (HNo.379), culture MAFF240150; Nara, Kasuga Shrine, on a handrail made from an unknown conifer, 3 July 2006, T. Shirouzu, TNS-F-15736 (HNo.398); Wakayama, Mt Nachi, on a fallen tree of an unknown palm, 6 July 2006, T. Shirouzu, TNS-F-21048 (HNo.367).

**Notes** — *Dacryopinax spathularia* is characterised by spathulate to stipitate basidiocarps with a flabellate pileus, thick-walled marginal hypha, and 0–1-septate basidiospores. This species has been reported from Japan by Kobayasi (1939b) as *Guepinia spathularia*.

***Dacryopinax sphenocarpa* Shirouzu & Tokum., sp. nov. — MycoBank MB514040; Fig. 12f–j, 15m, n**

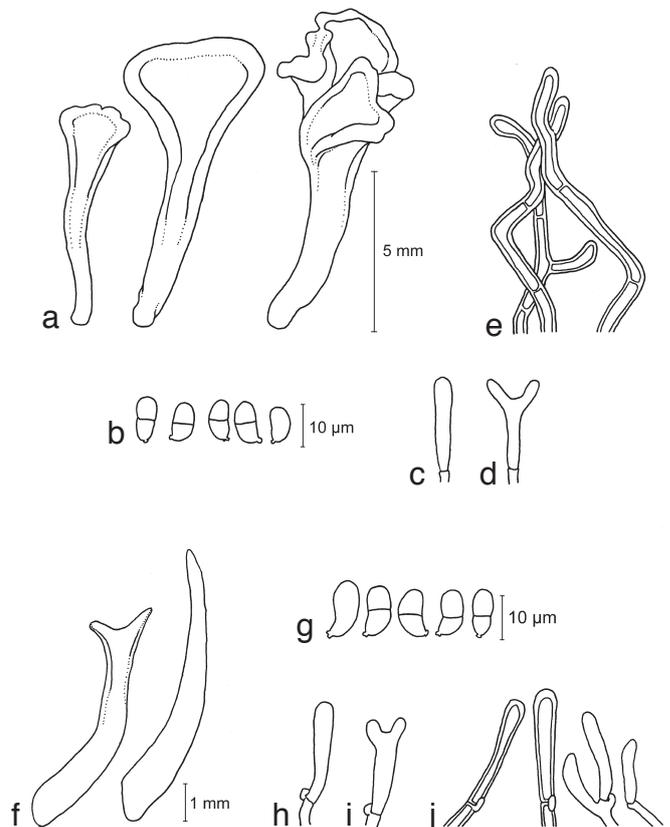
**Basidiocarpia** sparsa vel gregaria, spathulata vel subulata, albo-flavida vel sub-succinea, cartilaginea, 2–6 mm alta, 0.5–1 mm lata. Pili corticales steriles solitarii vel fasciculati, cylindrici vel clavati, tenuitunicati vel crassitunicati, sub-hyalini,  $15\text{--}25 \times 3.5\text{--}6 \mu\text{m}$ . Hyphae interaneae ramosae, tenuitunicatae, hyalinae,  $2\text{--}4 \mu\text{m}$  latae, cum colligationibus unciniformibus. Probasidia cylindrica vel clavata, hyalina,  $15\text{--}34 \times 3.5\text{--}8 \mu\text{m}$ , bifurcata-scentia. Basidiosporae subglobosae vel reniformae, tenuitunicatae, hyalinae,  $10\text{--}16 \times 4.5\text{--}8.5 \mu\text{m}$ , 0–1-septatae.

**Etymology.** Named after its subulate basidiocarps.

**Basidiocarps** scattered or gregarious, spathulate to subulate, sometimes slightly branched at apex, yellow-white to pale amber, sometimes with simple root, soft-cartilaginous, 2–6 mm high, 0.5–1 mm diam. *Sterile parts* of basidiocarps covered with solitary or fasciculate, cylindrical to clavate, simple or branched, straight or flexuous, septate, thin- or thick-walled, sub-hyaline marginal hypha,  $15\text{--}25 \times 3.5\text{--}6 \mu\text{m}$ . *Internal hyphae* branched, thin-walled, septate, hyaline,  $2\text{--}4 \mu\text{m}$  diam, with clamp connections. *Hymenium* unilateral, sometimes amphigenous. *Probasidia* cylindrical to clavate, hyaline,  $15\text{--}34 \times 3.5\text{--}8 \mu\text{m}$ , with a basal clamp connection, becoming bifurcate. *Basidiospores* subglobose to reniform, with an apiculum at the base, thin-walled, hyaline,  $10\text{--}16 \times 4.5\text{--}8.5 \mu\text{m}$  (av.  $12.5 \times 6 \mu\text{m}$ ;  $n = 20$ ), 0–1-septate, germination via germ tubes.

**Culture characteristics** — Colonies attaining about 6 mm diam, wet, yellow to orange. Conidiogenesis not observed.

**Specimens examined.** JAPAN, Kyoto, Mt Daimonji, on dead branches of an unknown conifer, 30 June 2006, T. Shirouzu, holotype TNS-F-21046 (HNo.356), culture ex-type MAFF241173; Mt Kiyomizu, on dead branches of *Pinus densiflora*, 7 Oct. 2006, T. Shirouzu, TNS-F-21066 (HNo.534); Nara, Mt Tamaki, on dead branches of *P. densiflora*, 7 July 2006, T. Shirouzu, TNS-F-21059 (HNo.430); Wakayama, Mt Nachi, on dead branches of *Cryptomeria japonica*, 6 July 2006, T. Shirouzu, TNS-F-21047 (HNo.364); 11 Oct. 2006, T. Shirouzu, TNS-F-21068 (HNo.552).



**Fig. 12** a–e. *Dacryopinax spathularia* TNS-F-15735 (HNo.379). a. Basidiocarps; b. basidiospores; c. probasidium; d. basidium; e. marginal hyphae. — f–j. *Dacryopinax sphenocarpa* TNS-F-21046 (HNo.356). f. Basidiocarps; g. basidiospores; h. probasidium; i. basidium; j. marginal hyphae.

Notes — *Dacryopinax sphenocarpa* is characterised by sharp, spatulate basidiocarps, hyphae with clamp connections, solitary or fasciculate, thin- or thick-walled marginal hypha, and thin-walled, 0–1-septate basidiospores. This dacrymycetous fungus belongs to the genus *Dacryopinax* because of its basidiocarp morphology, having a unilateral hymenium and fasciculate, thick-walled marginal hypha. Only *D. taibaishanensis* is known as a species having hyphae with clamp connections in this genus (Liu & Fan 1990). *Dacryopinax sphenocarpa* is different from *D. taibaishanensis* in the shape of basidiocarps (*D. taibaishanensis* is discoid) and in the size (20–35 × 7–10 µm) and septal number (5–7-septate) of basidiospores. In molecular phylogenetic analyses, this species did not cluster in a monophyletic clade with another species of *Dacryopinax*, *D. spathularia*, but represented a monophyletic group with *Dacrymyces ancyleus* (Fig. 16).

***Femsjonina peziziformis*** (Lév.) P. Karst., Bidrag Kannedam Finlands Natur Folk 31: 352. 1876 — Fig. 13a–f, 150

*Basionym.* *Exidia peziziformis* Lév., Ann. Sci. Nat., Bot. 9: 127. 1848.

For other synonyms see McNabb (1965e).

**Basidiocarps** scattered or gregarious, turbinate to discoid, centrally depressed, sessile, yellow at hymenium, white rough tomentose at the sterile surface of basidiocarps, firm-gelatinous, 3–10 mm high, 5–10 mm diam. **Sterile parts** of basidiocarps densely covered with cylindrical to clavate, straight or flexuous, conspicuously thick-walled, hyaline to pale yellow terminal cells, 40–80 µm long, 4–7.5 µm diam. **Internal hyphae** branched, thin-walled, septate, hyaline, 2–5 µm diam, with clamp connections. **Hymenium** limited to the superior surface of the basidiocarp. **Probasidia** cylindrical to clavate, pale orange, 40–80 × 5.5–10.5 µm, with a basal clamp connection, becoming bifurcate. **Dikaryophyses** cylindrical, simple, septate, pale orange, 48–80 × 3–4 µm. **Basidiospores** cylindrical to curved-cylindrical, with an apiculum at the base, thin-walled, pale orange, 22–36 × 8.5–13 µm (av. 26.5 × 9.5 µm; n = 20), 1–13-septate, germinated by production of conidia and germ tubes.

**Culture characteristics** — Colonies attaining about 10 mm diam, wet, white-orange. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose, 6 × 3 µm.

*Specimen examined.* JAPAN, Nagano, Sugadairakougen, on dead branches of *Pinus densiflora*, 27 Sept. 2006, T. Shirouzu & T. Hosoya, TNS-F-15737 (HNo.439), culture MAFF240152.

Notes — *Femsjonina peziziformis* is characterised by turbinate to discoid basidiocarps that are tomentose in the sterile part, with cylindrical, thick-walled terminal cells, and multi-septate basidiospores. Reid (1974) treated this genus as a synonym of *Ditiola peziziformis* (as *D. pezizaeformis*). In this study, we classified this fungus in *Femsjonina* according to the opinion of McNabb (1965e). This species has been recorded from Japan by Kobayasi (1939b) as *F. luteoalba*, a synonym of *F. peziziformis*.

***Guepiniopsis buccina*** (Pers.) L.L. Kenn., Mycologia 50: 888. 1958 — Fig. 13g–k, 15p

*Basionym.* *Peziza buccina* Pers., Syn. Meth. Fung. 2: 659. 1801.

For additional synonyms see Reid (1974).

**Basidiocarps** scattered, stipitate bearing a cupulate pileus, pale orange, firm-gelatinous, 4–5 mm high, 1.5–3 mm diam at the stipe, 2–3 mm high, 3–4 mm diam at the pileus. **Sterile parts** of basidiocarps densely covered with simple, cylindrical to clavate, septate, 2–3-celled, hyaline, conspicuously thick-walled terminal cells, 35–50 × 8–14.5 µm. **Internal hyphae** branched, thin-walled, gelatinous, septate, hyaline, 2–5 µm diam, without clamp connections. **Hymenium** limited in the cup of the pileus. **Probasidia** cylindrical, sub-hyaline, 31.5–55 × 3.5–8 µm, becoming bifurcate. **Basidiospores** subglobose to reniform, with an apiculum at the base, thin-walled, sub-hyaline, 10–16 × 5–7 µm (av. 13 × 6 µm; n = 10), 0–3-septate, germinated by germ tubes.

**Culture characteristics** — Colonies attaining about 5 mm diam, velvety, yellow to orange. Conidiogenous cells on vegetative hyphae, polyblastic, sympodial. Conidia subglobose, 4 × 3 µm.

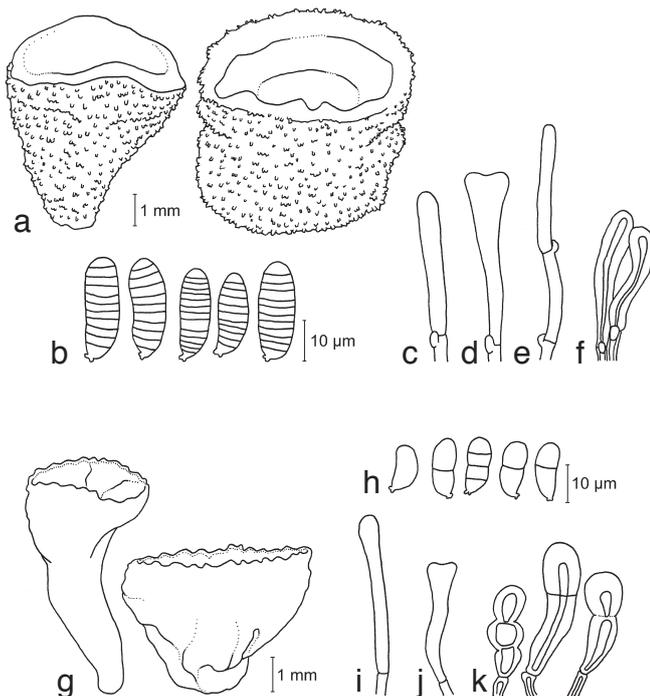
*Specimen examined.* JAPAN, Nara, Mt Tamaki, on dead branches of an unknown broad-leaved tree, 13 Oct. 2006, T. Shirouzu, TNS-F-15738 (HNo.562), culture MAFF240153.

Notes — *Guepiniopsis buccina* is characterised by stipitate basidiocarps with cupulate pilei, thick-walled terminal cells, and 0–3-septate basidiospores. This species has been recorded from Japan as *G. melurinus* (Kobayasi 1939a).

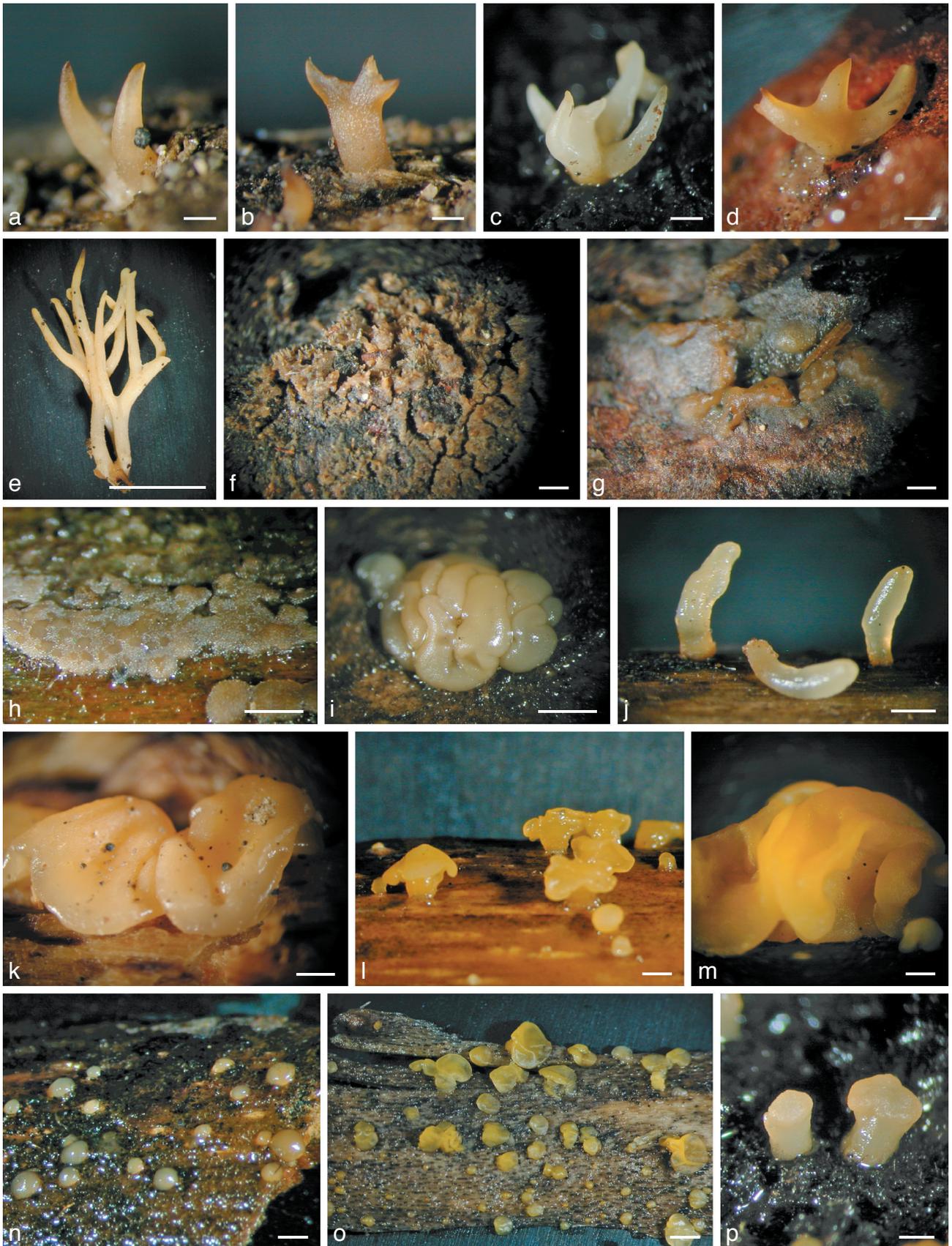
### Molecular phylogenetic analysis

The molecular phylogenetic tree using D1/D2 sequences is shown in Fig. 16. Four clades in Fig. 16 were defined as *Dacrymycetes*, *Dacrymycetales*, *Cerinomycetaceae* and *Dacrymycetaceae*, of which the *Dacrymycetes*, *Dacrymycetales* and *Cerinomycetaceae* clades were well supported (BS value (MP/ML) = 84/95 %, 90/93 %, 100/100 %, respectively). However, the *Dacrymycetaceae* clade (BS value (MP/ML) = 68/55 %) and other relatively higher-level nodes, were not well supported. At the species level, several clades such as the *Guepiniopsis buccina*, *Calocera viscosa* and *Dacrymyces punctiformis* clades were well supported (BS values = 100 %).

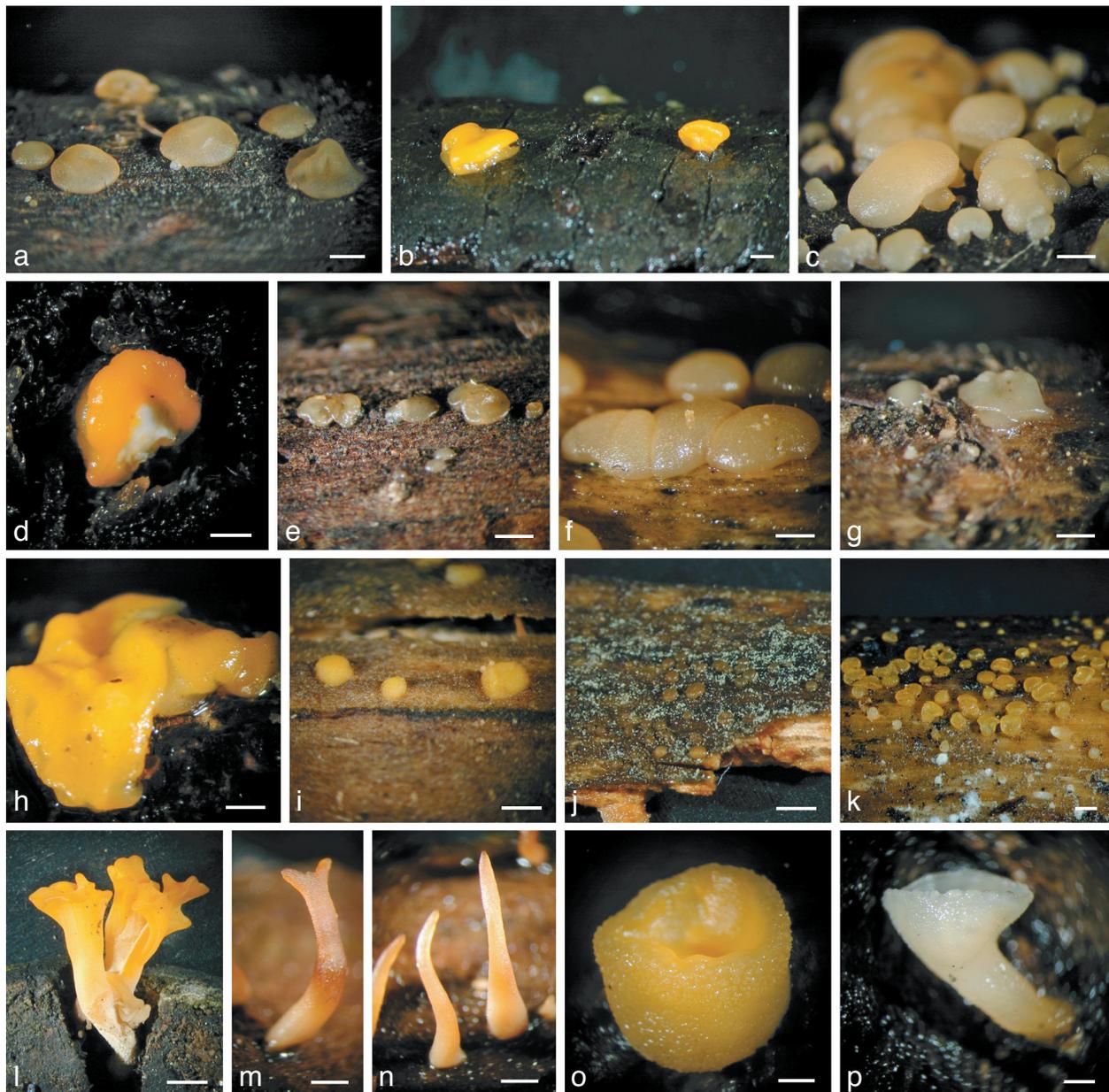
Species of the genus *Dacrymyces* were dispersed widely over the *Dacrymycetes* lineage. *Dacrymyces stillatus* and *D. minor* formed a clade with *Guepiniopsis buccina* (BS value (MP/ML) = 75/64 %), and *Dacrymyces punctiformis* formed a well-supported monophyletic group with *Cerinomyces* species (BS value (MP/ML) = 100/100 %).



**Fig. 13** a–f. *Femsjonina peziziformis* TNS-F-15737 (HNo.439). a. Basidiocarps; b. basidiospores; c. probasidium; d. developing basidium; e. dikaryophysis; f. marginal hyphae. — g–k. *Guepiniopsis buccina* TNS-F-15738 (HNo.562). g. Basidiocarps; h. basidiospores; i. probasidium; j. developing basidium; k. marginal hyphae.



**Fig. 14** Basidiocarps. a, b. *Calocera cornea* TNS-F-15701 (HNo.267); c, d. *Calocera cornea* TNS-F-21061 (HNo.452); e. *Calocera viscosa* TNS-F-15705 (HNo.466); f. *Cerinomyces albosporus* TNS-F-15706 (HNo.191); g. *Cerinomyces canadensis* TNS-F-21034 (HNo.199); h. *Cerinomyces pallidus* TNS-F-21064 (HNo.505); i. *Dacrymyces adpressus* TNS-F-21045 (HNo.355); j. *Dacrymyces ancyleus* TNS-F-21051 (HNo.382); k. *Dacrymyces aureosporus* TNS-F-15714 (HNo.486); l. *Dacrymyces capitatus* TNS-F-15708 (HNo.192); m. *Dacrymyces chrysospermus* TNS-F-15712 (HNo.320); n. *Dacrymyces dendrocalami* TNS-F-15715 (HNo.210); o. *Dacrymyces lacrymalis* TNS-F-15717 (HNo.235); p. *Dacrymyces microsporus* TNS-F-21050 (HNo.371). — Scale bars: a–d, f–p = 1 mm; e = 10 mm.



**Fig. 15** Basidiocarps. a. *Dacrymyces minor* TNS-F-15720 (HNo.224); b. *Dacrymyces minutus* TNS-F-15722 (HNo.282); c. *Dacrymyces novae-zelandiae* TNS-F-21038 (HNo.225); d. *Dacrymyces pinacearum* TNS-F-21056 (HNo.418); e. *Dacrymyces punctiformis* TNS-F-15723 (HNo.196); f. *Dacrymyces san-augustinii* TNS-F-21075 (HNo.666); g. *Dacrymyces stillatus* TNS-F-15727 (HNo.233); h. *Dacrymyces subalpinus* TNS-F-21071 (HNo.570); i. *Dacrymyces subarcticus* TNS-F-21067 (HNo.544); j. *Dacrymyces unisporus* TNS-F-15731 (HNo.332); k. *Dacrymyces variisporus* TNS-F-15733 (HNo.300); l. *Dacryopinax spathularia* TNS-F-15735 (HNo.379); m, n. *Dacryopinax sphenocarpa* TNS-F-21046 (HNo.356); o. *Femsjonnia peziziformis* TNS-F-15737 (HNo.439); p. *Guepinopsis buccina* TNS-F-15738 (HNo.562). — Scale bars: a–p = 1 mm.

*Dacrymyces stillatus* and *D. minor* were paraphyletic. Morphologically similar species, *D. aureosporus* and *D. chrysospermus*, represented a monophyletic group, but they were distributed in different sub-clades (BS value (MP/ML) = 74/69 %, 62/<50 %, respectively). *Dacrymyces unisporus* was located in the *Dacrymycetetes* clade. *Dacrymyces subarcticus* formed a monophyletic group with *Dacryoscyphus chrysochilus* (BS value (MP/ML) = 100/100 %). Two *Dacryopinax* species, *D. shenocarpa* and *D. spathularia*, did not form a monophyletic group.

## DISCUSSION

### Japanese *Dacrymycetetes*

In this study we recognised 28 species, including 5 new species and 9 species that were newly recorded from Japan (Table 3). Based on our survey, the total number of dacrymycetous species recorded from Japan increased from 28 to 42, although we were unable to recollect all species recorded by Kobayasi (1939a, b).

This result suggests that the species diversity of dacrymycetous fungi in Japan is richer than previously thought.

The basidiocarps of *Dacrymycetetes* could be widely collected throughout the Japanese Islands, from Hokkaido (subarctic coniferous forests) to the Yaeyama Islands (subtropical evergreen forests). However, dacrymycetous species and samples were more commonly collected from coniferous and deciduous broad-leaved forests in the subarctic and cool-temperate zone, than in the evergreen, broad-leaved forests in the warm-temperate and subtropical zone. The main diversity of *Dacrymycetetes* may thus be from the cool-temperate to the subarctic zone.

To date, anamorphic stages with conidiocarps are known in *Dacrymyces lacrymalis* (present study), *D. capitatus*, *D. minor* and *D. stillatus*, (Oberwinkler 1993). A unique coelomycetous species, *Dacryoscyphus chrysochilus* (Kirschner & Yang 2005), and a hyphomycetous species, *Cerinosterus luteoalbus*, have also been reported (Moore 1987, Middelhoven et al. 2000). Among the newly described *Dacrymyces* species in this study,



using multi-gene sequences, which succeeded in revealing more detailed relationships in fungal lineages (e.g. James et al. 2006), may resolve the higher phylogenetic relationships in *Dacrymycetes*.

A cushion-shaped *Dacrymycetaceae* species, *Dacrymyces punctiformis*, was included in the *Cerinomycetaceae* clade (Fig. 16). In addition, an exceptional species having non-bifurcate basidia, *D. unisporus*, was located basally in the *Dacrymycetales* clade (Fig. 16). These results suggest that a reconsideration of not only the taxonomical circumscriptions of genera, but also that of families and orders is required in this class. To solve these taxonomic problems, we may have to search for other informative criteria that correlate with the higher classification.

The molecular phylogenetic analysis of the present study in most cases supported the validity of the species identifications (Fig. 16), and also revealed the polyphyletic arrangement of *Dacrymyces* and *Dacryopinax* species throughout the *Dacrymycetes* lineage (Fig. 16). The classification of dacrymycetous genera is mainly based on the external morphology of the basidiocarp, and the wall thickness of marginal hyphae (McNabb & Talbot 1973), but our results underline the difficulty of using these criteria as primary characters for generic classification. Taxonomic rearrangement of dacrymycetous genera is thus necessary (Shirouzu et al. 2007). At this time, however, we have no phenotypic clues to rearrange dacrymycetous genera; therefore, it is appropriate that the newly described species such as *Dacrymyces ancyleus* and *Dacryopinax sphenocarpa* belong to genera '*Dacrymyces*' and '*Dacryopinax*' according to the existing taxonomic framework. Presently we are working on phylogenetic analyses that incorporate more taxa and DNA sequences, with the eventual aim to present a new interpretation to the remaining taxonomic problems.

**Acknowledgements** We wish to thank Dr Takashi Osono of Kyoto University, Dr Tsuyoshi Hosoya of the Natural Museum of Nature and Science, and Dr Yukiko Takahashi of The University of Tokyo for their support during field trips. We also thank Prof. Susumu Takamatsu of Mie University, and Dr Keiichi Motohashi of Gifu University for their guidance and valuable advice on the molecular phylogenetic study, and Dr Kazuaki Tanaka of Hiroasaki University for his revision of the Latin descriptions. We want to thank Prof. Pedro Crous, Prof. Dominik Begerow and two reviewers for their constructive comments on this manuscript. We acknowledge the Institute for Fermentation, Osaka (IFO) and the Fujiwara Natural History Foundation for their financial support.

## REFERENCES

- Boidin J, Gilles G. 1986. Basidiomycètes Aphyllophorales de l'île de la Réunion. VI. Le genre *Cerinomyces* Martin. Bulletin trimestriel de la Société mycologique de France 102: 315–319.
- Burdsall HH, Laursen GA. 2004. Fungi of New Zealand's subarctic islands I: Two new species of *Dacrymyces* (Basidiomycota). In: Miller OK, Cripps CL (eds), Fungi in forest ecosystems: systematics, diversity and ecology: 107–111. New York Botanical Garden, USA.
- Doweld A. 2001. Prosyllabus tracheophytorum: Tentamen systematis plantarum vascularium (Tracheophyta). Geos, USSR.
- Felsenstein J. 1985. Confidence limits on phylogenies: an approach using the bootstrap. Evolution 39: 783–791.
- Hennings P. 1898. *Dacrymycetinae*, *Exobasidiineae*, *Hymenomycetinae*. In: Engler A, Prantl K (eds), Die Natürlichen Pflanzenfamilien I Teil. Abteilung 1: 96–102. Engelmann, Germany.
- Hibbett DS. 2006. A phylogenetic overview of the Agaricomycotina. Mycologia 98: 917–925.
- Hibbett DS, Binder M, Bischoff JF, Blackwell M, Cannon PF, et al. 2007. A higher-level phylogenetic classification of the Fungi. Mycological Research 111: 509–547.
- James TY, Kauff F, Schoch CL, Matheny PB, Hofstetter V, et al. 2006. Reconstructing the early evolution of fungi using a six-gene phylogeny. Nature 443: 818–822.
- Jülich W. 1981. Higher taxa of Basidiomycetes. Bibliotheca Mycologica 85: 1–845.
- Katoh K, Kuma K, Toh H, Miyata T. 2005. MAFFT v5: improvement in accuracy of multiple sequence alignment. Nucleic Acids Research 33: 511–518.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Dictionary of the Fungi. 9th ed. CABI Publishing, UK.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Dictionary of the Fungi. 10th ed. CABI Europe, UK.
- Kirschner R, Yang LZ. 2005. *Dacryoscyphus chrysochilus*, a new staurosporous anamorph with cupulate conidiomata from China and with affinities to the *Dacrymycetales* (Basidiomycota). Antonie van Leeuwenhoek 87: 329–337.
- Kobayasi Y. 1939a. On the *Dacrymyces*-group (Fungorum ordinis Tremellalium studia monographica III). Science reports of the Tokyo Bunrika Daigaku, Sect. B, 4: 105–128.
- Kobayasi Y. 1939b. On the genera *Femsonia*, *Guepinia* and *Calocera* from Japan (Fungorum ordinis Tremellalium studia monographica IV). Science reports of the Tokyo Bunrika Daigaku, Sect. B, 4: 215–227.
- Kobayasi Y. 1954. Monographic studies of Japanese Tremellaceous fungi VI. Nagaoa 4: 36–47.
- Kobayasi Y. 1984. Miscellaneous notes of fungi (5). The Journal of Japanese Botany 59: 187–189.
- Liu B, Fan L. 1990. New species and new variety of *Dacrymycetaceae* in China. Acta Mycologica Sinica 9: 12–19.
- Maekawa N. 1987. A new species of the genus *Cerinomyces*. Canadian Journal of Botany 65: 538–588.
- Matsuda Y, Hiji N. 1999. Characterization and identification of *Strobilomyces confusus* ectomycorrhizas on momi fir by RFLP analysis of the PCR-amplified ITS region of the rDNA. Journal of Forest Research 4: 145–150.
- McNabb RFR. 1964. Taxonomic studies in the *Dacrymycetaceae* I. *Cerinomyces* Martin. New Zealand Journal of Botany 2: 415–424.
- McNabb RFR. 1965a. Taxonomic studies in the *Dacrymycetaceae* II. *Calocera* (Fries) Fries. New Zealand Journal of Botany 3: 31–58.
- McNabb RFR. 1965b. Taxonomic studies in the *Dacrymycetaceae* III. *Dacryopinax* Martin. New Zealand Journal of Botany 3: 59–72.
- McNabb RFR. 1965c. Taxonomic studies in the *Dacrymycetaceae* IV. *Guepinopsis* Patouillard. New Zealand Journal of Botany 3: 159–169.
- McNabb RFR. 1965d. Taxonomic studies in the *Dacrymycetaceae* V. *Heterotextus* Lloyd. New Zealand Journal of Botany 3: 215–222.
- McNabb RFR. 1965e. Taxonomic studies in the *Dacrymycetaceae* VI. *Femsonia* Fries. New Zealand Journal of Botany 3: 223–228.
- McNabb RFR. 1966. Taxonomic studies in the *Dacrymycetaceae* VII. *Ditiola* Fries. New Zealand Journal of Botany 4: 546–558.
- McNabb RFR. 1973. Taxonomic studies in the *Dacrymycetaceae* VIII. *Dacrymyces* Nees ex Fries. New Zealand Journal of Botany 11: 461–524.
- McNabb RFR, Talbot PHB. 1973. Holobasidiomycetidae: Exobasidiales, Brachybasidiales, *Dacrymycetales*. In: Ainsworth GC, Sparrow FK, Sussman AS (eds), The fungi. Vol IV B: 317–325. Academic Press, USA.
- Middelhoven WJ, Gueho E, Hoog GS de. 2000. Phylogenetic position and physiology of *Cerinosterus cyanescens*. Antonie van Leeuwenhoek 77: 313–320.
- Moore RT. 1987. Micromorphology of yeasts and yeast-like fungi and its taxonomic implications. Studies in Mycology 30: 203–226.
- Nannfeldt JA. 1947. *Sphaenonaema rufum* Fr., a misunderstood member of the *Dacrymycetaceae*. Svensk Botanisk Tidskrift 11: 301–338.
- O'Donnell K. 1993. *Fusarium* and its near relatives. In: Reynolds DR, Taylor JW (eds), The fungal holomorph: mitotic, meiotic and pleomorphic speciation in fungal systematics: 225–233. CAB International, UK.
- Oberwinkler F. 1993. Genera in a monophyletic group: the *Dacrymycetales*. Mycologia Helvetica 6: 35–72.
- Oberwinkler F, Tschern J. 1989. A new *Dacrymyces* species from Taiwan. Transactions of the Mycological Society of Japan 30: 349–356.
- Olive LS. 1944. New or rare heterobasidiomycetes from North Carolina-I. The Journal of the Elisha Mitchell Scientific Society 60: 17–26.
- Peterson SW. 2000. Phylogenetic analysis of *Penicillium* species based on ITS and *lsu*-rDNA nucleotide sequences. In: Samson RA, Pitt JI (eds), Integration of modern taxonomic methods for *Penicillium* and *Aspergillus* classification: 163–178. Harwood, The Netherlands.
- Reid DA. 1974. A monograph of the British *Dacrymycetales*. Transactions of the British Mycological Society 62: 433–494.
- Schröter J. 1889. Die Pilze Schlesiens Vol. 3. J.U. Kern's Verlag, Germany.
- Shirouzu T, Hirose D, Tokumasu S. 2007. Sequence analyses of 28S rRNA gene D1/D2 region suggests *Dacrymyces* (Heterobasidiomycetes, *Dacrymycetales*) is polyphyletic. Mycoscience 48: 388–394.
- Swofford DL. 2001. PAUP Phylogenetic analysis using parsimony (and other methods), v4.0b10. Sinauer Associates, UK.
- Tubaki K, Hosoya T. 1987. Cultural studies of *Dacrymycetales*. Tsukuba Environmental Studies 10: 53–59. [In Japanese].
- Weiss M, Oberwinkler F. 2001. Phylogenetic relationships in *Auriculariales* and related groups – hypotheses derived from nuclear ribosomal DNA sequences. Mycological Research 105: 403–415.
- Wells K. 1994. Jelly fungi, then and now! Mycologia 86: 18–48.