



A, B. Sporocarps, habit, showing colour variation (bars = 1 mm). C. Spores (bar = 10 µm). [Photographs: A. Michaud]

Physarum bogoriense Racib., *Hedwigia* **37**(1): 52 ([February] 1898). [*IndexFungorum* 162327; *Physaraceae*, *Physarales*]

Physarum pallidum Lister, *Journal of Botany London* **36**: 117 ([April] 1898). [*IndexFungorum* 237593]

Physarum bogoriense var. *matsumotoi* Y. Yamam., *Bulletin of the National Science Museum Series B*, Botany **26**(3): 116 (2000). [*IndexFungorum* 482842]

Vernacular names. Japanese: *bogohru-hukurohokori*.

Diagnostic features. Often associated with *Physarum bivalve* Pers., but distinguishable by the yellow or brown colour, the rounded plasmodiocarps on narrow bases, and dehiscence by triangular lobes instead of valves; spores are usually paler and smaller than those of *P. bivalve*; sporocarps of *P. bivalve* are strongly compressed laterally, and even when nearly terete are always much taller than wide. Differs from *P. bitectum* G. Lister which has white plasmodiocarps and clearly spinose spores 10–13 µm diam. Differs from *P. aeneum* (Lister) R.E. Fr. which has yellow or brown lime in the capillitium. In some collections,

sporocarp shape and colour call to mind *P. retisporum* G.W. Martin, but that species can be distinguished by its reticulate spores.

On natural substratum. Plasmodium appearance not known. *Hypothallus* inconspicuous. *Sporocarps* scattered to gregarious plasmodiocarps or sporangia, pale ochraceous, ochraceous brown, pale tan to brown, sometimes nearly white, making large colonies in the tropics and smaller ones in temperate zones. *Plasmodiocarps* not laterally compressed, elongate, up to 6 mm long, usually unbranched, often arcuate, reticulate. *Sporangia* globose, sessile on a narrow base, 0.3–0.6 mm diam. *Stalk* absent. *Peridium* distinctly double; the outer layer thick and leathery, calcareous with a smooth to slightly roughened, pigmented, yellow-brown outer surface; the inner surface bright white and star-shaped; the inner layer thin, membranous, colourless, transparent, iridescent and often lightly dusted with lime granules; dehiscence of the outer layer along pale, raised, preformed lines into angular lobes ± symmetrical and separate from the inner wall by a cavity, the lobes reflexing in a ± stellate manner, the inner layer dehiscing irregularly in sporocarps, along a faint apical longitudinal line in plasmodiocarps. *Capillitium* a dense network of colourless tubules, rounded, ramified, occasionally branching, with white lime nodes. *Columella* lacking, a white pseudocolumella only rarely found in larger plasmodiocarps. *Spores* dark brown *en masse*, violet brown in transmitted light, verruculose, minutely warted, 7–9(–10) µm diam.

ASSOCIATED ORGANISMS & SUBSTRATA: **Plantae.** *Abies grandis* (Douglas ex D. Don) Lindl.; *Acacia melanoxylon* R. Br. (leaf); *Acalypha indica* L. (leaf); *Aeonium* sp. (leaf); *Anacardium occidentale* L.; *Areca catechu* L. (leaf); *Arecaeae* indet.; *Attalea speciosa* Mart. (frond); *Bambusa* sp. (leaf); *Bryophyta* indet.; *Cinnamomum camphora* (L.) J. Presl (bark), *C. verum* J. Presl (leaf); *Cocos nucifera* L. (leaf); *Elaeis guineensis* Jacq.; *Ficus benghalensis* L. (leaf); *Gramineae* indet. (culm, leaf); *Heliconia* sp. (stalk); *Holodiscus discolor* (Pursh) Maxim.; *Ilex americana* Lam. (leaf), *I. vomitoria* Aiton (leaf); *Liriodendron tulipifera* L. (bark); *Magnoliophyta* indet. (leaf, twig); *Meibomia* sp.; *Musa × paradisiaca* L. (leaf), *Musa* sp. (leaf); *Palmae* indet. (leaf); *Picea* sp. (cone); *Plantae* indet. (leaf, stem, twig); *Pomaderris apetala* Labill. (leaf); *Pseudotsuga menziesii* (Mirb.) Franco; *Puya chilensis* Molina; *Quercus alba* L., *Q. glauca* Thunb., *Q. incana* Bartram (acorn); *Rhopalostylis sapida* (Sol. ex G. Forst.) H. Wendl. & Drude (frond); *Setaria* sp. (leaf, stem); *Stenotaphrum secundatum* (Walter) Kuntze (leaf); *Tabebuia pallida* (Lindl.) Miers; *Thuja plicata* Donn ex D. Don; *Ulmus* sp. **Artefacts.** Bamboo pot; plastic. **Associated organism of type specimen.** *Plantae* indet. [as ‘todten Blättern’ (‘dead leaves’)].

INTERACTIONS & HABITATS: Most information about this species is based on sporocarps and spores (the dispersal phase), and observed associations with other organisms usually only indicate the physical substratum on which sporocarps form. Other observations are rare, particularly of trophic phases (myxamoebae and swarm cells [individual haploid amoeba-like cells], and plasmodia [multi-nucleate, diploid, and often extensive cytoplasm]), and dormant phases (microcysts and sclerotia). As a result, very little is known about nutrition and interactions beyond broad statements that myxomycetes feed on living bacteria and fungi, and on non-living organic material (MARTIN & ALEXOPOULOS, 1969). In Tennessee, this species has been recorded from tree canopies (SNELL *ET AL.*, 2003). In New Zealand, fallen fronds of *Rhopalostylis sapida* provide a specialized microhabitat which is exploited particularly by members of the *Physarales* and *Trichiales*, including the present species (STEPHENSON, 2003). A study of temperate secondary forest in Japan, including the present species, showed that myxomycete diversity is greater when leaf litter is derived from more than one tree species and from tree species with different peaks for leaf fall (TAKAHASHI, 2013). A similar study, in warm temperate forest, also in Japan, investigated seasonality in myxomycete sporocarp production, and noted a peak of sporocarps of the present species in late June and early July (TAKAHASHI & HADA, 2012). This species is found predominantly on dead fallen leaves, litter, stems, twigs, wood and other plant debris, but has also been recorded on living leaves, stems and twigs. There are particular records of it on lianas (WRIGLEY DE BASANTA *ET AL.*, 2008) and on living leaves of *Stenotaphrum* grass. Most records are from woodland, particularly broadleaf forest. This species has been recorded from the following habitats: amenity & protected areas; ruderal habitats; woodland. Beyond what is known generally about the nutrition of *Physarum*, there is no information about any specific associations with animals, fungi or micro-organisms.

GEOGRAPHICAL DISTRIBUTION: AFRICA: Angola, Democratic Republic of Congo, Kenya, Liberia, Morocco, Nigeria, Rwanda, South Africa, Tanzania. CENTRAL AMERICA: Costa Rica, Honduras, Nicaragua, Panama. NORTH AMERICA: Canada (British Columbia, Ontario, Quebec), Mexico, USA (Arkansas, California, Colorado, Florida, Georgia, Idaho, Iowa, Kansas, Louisiana, Massachusetts, Mississippi, New York, North Carolina, Pennsylvania, South Carolina, Texas, Virginia). SOUTH AMERICA: Argentina, Bolivia, Brazil (Acre, Bahia, Pernambuco, Piauí, São Paulo, Santa Catarina, Sergipe), Chile, Colombia, Ecuador, French Guiana, Guyana, Peru, Surinam, Uruguay, Venezuela. ASIA: China (Fujian, Heilongjiang, Hong Kong, Jilin, Shaanxi, Shandong, Quinhai), India (Assam, Chandigarh, Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Uttarakhand, Uttar Pradesh, West Bengal), Indonesia, Japan, Nepal, Papua-New Guinea, Philippines, Singapore, Taiwan, Thailand, Vietnam. ATLANTIC OCEAN: Bermuda, Spain (Canary Islands). AUSTRALASIA: Australia (Tasmania), New Zealand. CARIBBEAN: American Virgin Islands, Antigua and Barbuda, Cuba, Dominica, Jamaica, Puerto Rico, Trinidad and Tobago. EUROPE: Austria, former Czechoslovakia. France, Italy, Malta, Portugal, Romania, Spain. INDIAN OCEAN: Seychelles. PACIFIC OCEAN: Ecuador (Galapagos), Japan (Bonin Islands), USA (Hawaii).

Distribution 'predominantly tropical' (STEPHENSON *ET AL.*, 1999) and particularly abundant in the tropics and subtropics, but undoubtedly very widespread. Native to New Zealand [*Landcare*, accessed 10 August 2017], and presumably throughout all of its known range. Records up to 3300 m above sea level in Mexico and 1950 m above sea level in Colombia.

ECONOMIC IMPACTS: No evaluation has been made of any possible positive economic impact of this organism (e.g. as a recycler, as a source of useful products, as a provider of checks and balances within its ecosystem, etc.). No reports of negative economic impacts have been found.

INFRASPECIFIC VARIATION: The only subspecific taxon described, *P. bogoriense* var. *matsumotoi*, is not accepted by *SpeciesFungorum* [accessed 22 August 2017].

DISPERSAL & TRANSMISSION: Primarily by airborne spores, particularly for longer distances; some local dispersal may also occur by movement of myxamoebae and plasmodia.

CONSERVATION STATUS: **Previous evaluations.** None. **Information base.** Well over 1000 records (specimens, databases and bibliographic sources combined, excluding duplicates) from at least 1898 to July 2016, with observations in every month of the year. A study in Thailand showed inconclusive evidence of seasonality in appearance of sporocarps (KO *ET AL.*, 2011). **Estimated extent of occurrence** [calculated using <http://geocat.kew.org>]. Over 104.5 million km² (Africa: 26.3 million km²; Asia: 31.6 million km²; Australasia: 1.0 million km²; Caribbean, Central America and North America: 21.3 million km²; Europe: 2.1 million km²; Pacific Ocean: 7.2 million km²; South America: 15.0 million km²). **Estimated area of occupancy** [calculated using <http://geocat.kew.org>]. Well over 750 km². The method for estimating area of occupancy has produced an artificially low figure. The species is likely to be under-recorded, despite the admirable and well-organized enthusiasm of often amateur myxomycete experts, because compared with recording of flowering plants and vertebrates, so few people have the skills to search for and identify it. Many of the plants with which it is associated are common and widespread species. **Threats.** *Climate change.* May be a threat. Insufficient information to enable other threats to be identified. **Population trend.** In general, not known. Reported by MARTIN & ALEXOPOULOS (1969) as abundant in the tropics of both hemispheres. Occasional in south India (STEPHENSON *ET AL.*, 1993). Rare in Vietnam (TRAN *ET AL.*, 2014). Scarce on *Attalea speciosa* in Piauí, Brazil (MOURA PARENTE & HOLANDA CAVALCANTI, 2013). Of datable records, c. 13% are pre-1961, 66% post-1960 but pre-2001, and 21% post-2000. **Evaluation.** Using IUCN criteria (IUCN SPECIES SURVIVAL COMMISSION. 2006 *IUCN Red List of Threatened Species* [www.iucnredlist.org]. Downloaded on 15 May 2006), the species is assessed globally as Least Concern. **In situ conservation actions.** None explicitly directed at this species, but many of the sites from which it has been recorded are protected, for example as nature reserves. **Ex situ conservation actions.** This species grows readily in culture (CLARK, 1995) and, using simple techniques, can be induced to sporulate (VENKATARAMANI *ET AL.*, 1977). There are, however, no living strains of this species listed by the Straininfo website [www.straininfo.net, accessed 4 August

2017]. Three partial nucleotide sequences of small subunit ribosomal RNA were found in a search of the NCBI GenBank database [www.ncbi.nlm.nih.gov, accessed 13 August 2017].

NOTES: Using transmission electron microscopy, ALDRICH & MIMS (1970) studied meiosis in a collection of this species from Florida, demonstrating that meiosis occurs within 24 hours of spore cleavage. Also using transmission electron microscopy, DEMAREE & KOWALSKI (1975) studied the fine structure of spores of five myxomycete species, including collections with clustered spores which they identified as *P. bogoriense*. Their identification may, however, be questioned, as WHITNEY & KELLER (1982) showed that collections with clustered spores identified as *P. bogoriense* from western states of the USA correctly relate to a superficially similar but different species, which they named *Badhamia crassipella*. Using simple techniques, the complete life cycle of this species, including the plasmodial phase and sporulation, has been observed in pure culture (VENKATARAMANI *ET AL.*, 1977). For further help with identification, the excellent keys provided by POULAIN *ET AL.* (2011) should be consulted.

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