IMI Descriptions of Fungi and Bacteria
No. 2113

PHYSARUM CRATERIFORME

A, **B**. Sporocarps, habit, young and unopened (**A**), and older and open (**B**) (bars = 1 mm). **C**. Spores (bar = 10 µm). [Photographs: A. Michaud]

Physarum crateriforme Petch, *Annals of the Royal Botanic Gardens* Peradeniya **4**: 304 (1909). [*IndexFungorum* 206226; *Physaraceae*, *Physarales*]

Physarum columellatum Nann.-Bremek. & Y. Yamam., *Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen* Series C, Biological and Medical Sciences **90**(3): 327 (1987). [*IndexFungorum* 130407]

Physarum crateriforme var. *columellatum* (Nann.-Bremek. & Y. Yamam.) D.W. Mitch., in McHugh, Stephenson, Mitchell & Brims, *New Zealand Journal of Botany* **41**(3): 495 (2003), nom. inval., *ICN* Art. 41.4, Note 1, Art. 41.5 (Melbourne). [*IndexFungorum* 488022]

Diagnostic features. Without typical sporangia present, certain identification to species level is impossible because other features, such as spore size and ornamentation, fall within the range of so many other species. The characteristic columella, however, and large capillitial nodes, dark stalk and pale spores help to distinguish this species.

On natural substratum. *Plasmodium* greyish white, pale or dull ochraceous. *Hypothallus* inconspicuous. *Sporocarps* stipitate, short-stalked or occasionally sessile, 1–2 mm tall, usually occurring as widely scattered sporangia or in small groups of usually less than six. *Sporangia* typically white, but often appearing brownish in the absence of calcification. *Sporothecae* globose or clavate, cylindrical to obovate, becoming crateriform, 0·4–0·6 mm diam., greyish white or very pale brown. *Stalk* when present opaque, conical, either completely black or black below and white above. *Peridium* membranous, white, the calcareous deposits often clustered, giving an uneven, mottled effect (but if sporangia are exposed to weather for long periods, the peridial surface may undergo dramatic changes leading to precipitation of lime as plates, giving the surface a roughened appearance, or leaving lime on the sporangial surface). *Capillitium* strongly calcareous, with calcareous tubes not connected by colourless tubules, the nodes either massed about the columella or rod-like and ascending; in the absence of lime the capillitium may consist of a columella with colourless threads lacking lime knots. *Columella* usually present, white, concolorous with the stalk or paler, variable, sometimes cylindrical and attaining the apex of the sporotheca, or shorter and then clavate or conical, with broad conical outgrowths connected to the capillitium, looking like a ladder in section. *Spores* dark brown *en masse*, dull lilac in transmitted light, closely spinulose, 10–13 μm diam.

ASSOCIATED ORGANISMS & SUBSTRATA: **Plantae**. *Acer platanoides* L. (bark), *A. rubrum* L.; *Araucaria* sp. (trunk); *Aristolochia macrophylla* Lam. (liana); *Artocarpus integer* (Thunb.) Merr. [as *A. integrifolius* L. f.] (bark, twig); *Azadirachta indica* A. Juss. (bark, leaf); *Carya* sp. (bark); *Cinnamomum camphora* (L.) J. Presl (bark); *Diospyros* sp. (bark); *Elaeis guineensis* Jacq.; *Euphorbia* sp.; *Fraxinus americana* L., *F. excelsior* L. (bark); *Ilex aquifolium* L. (leaf); *Juglans* sp. (bark); *Juniperus virginiana* L. (bark); *Mangifera indica* L. (leaf); *Metasequoia glyptostroboides* Hu & W.C. Cheng (bark); *Musa sapientum* L.; *Muscopsida* indet. [as 'moss']; *Pinus* sp. (wood); *Plantae* indet. (bark, liana, stalk, stem, wood); *Platanus occidentalis* L. (bark); *Populus nigra* L. (bark); *Quercus alba* L. (bark), *Quercus* sp. (bark, log, trunk); *Rubus fruticosus* [agg.]. (stem), *Rubus* sp. (stem); *Salvadora persica* L. (bark); *Sambucus nigra* L. (bark); *Solanum* sp.; *Terminalia catappa* L.; *Ulmus* sp. (bark); *Vitis aestivalis* Michx., *V. vulpina* L.; *Wrightia tinctoria* R. Br. (bark). **Associated organism of type specimen**. *Artocarpus integer* [as *A. integrifolius*].

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). A study of bark microenvironments for myxomycetes in Japan, including the present species, found that higher calcium levels in bark and neutral bark pH determined abundance of *Physarum* species (TAKAHASHI, 2014). In Tennessee, this is a tree canopy inhabiting species (SNELL *ET AL.*, 2003). The main substratum is bark of living trees, but it is also occasionally seen on fallen branches, and, in the Old World tropics, on dead wood and herbaceous stalks. It is also known from aerial reproductive structures of vascular plants (KILGORE *ET AL.*, 2009). In temperate zones it is likely to occur wherever elms, junipers, oaks and vines are abundant and ample rainfall occur between June and September. This species has been recorded predominantly from woodland (including natural and semi-natural mixed broadleaf woodland), but also from the following habitats: amenity & protected areas (including nature reserves, parkland and cemeteries); coastal grassland; savanna; and margin areas (including hedgerows and woodland adjacent to reservoirs). 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: Kenya, Madagascar, Nigeria, South Africa, Tanzania. CENTRAL AMERICA: Belize, Costa Rica, Panama. NORTH AMERICA: Mexico, USA (Arizona, Arkansas, California, Colorado, Florida, Georgia, Indiana, Iowa, Kansas, Kentucky, Mississippi, Montana, North Carolina, Oklahoma, Tennessee, Texas, Virginia, West Virginia). SOUTH AMERICA: Brazil (Pernambuco,

Sergipe), Ecuador, Paraguay, Peru. ASIA: China (Fujian, Guangxi, Hong Kong, Shandong, Sichuan), India (Assam, Delhi, Tamil Nadu, Uttarakhand, Uttar Pradesh), Japan, Laos, Russia (Altai krai, Novosibirsk oblast), Singapore, Sri Lanka, Taiwan, Thailand, Vietnam. ATLANTIC OCEAN: Ascension, Spain (Canary Islands). AUSTRALASIA: Australia (Western Australia). CARIBBEAN: Antigua and Barbuda, Cuba, Dominican Republic, Martinique, Puerto Rico, St Lucia. EUROPE: France, Ireland, Portugal, Russia (Voronezh oblast), Spain, Sweden, UK. INDIAN OCEAN: Seychelles. PACIFIC OCEAN: Ecuador (Galapagos), USA (Hawaii).

Probably cosmopolitan and presumably native throughout its entire known range. Records up to *c.* 1200 m above sea level in the USA [a record at 4067 m listed by *GBIF*, accessed 4 August 2017, seems unlikely and may be an error attributing metres where the original unit of measurement was feet], but also reported as preferring lower elevations (STEPHENSON *ET AL.*, 2001).

ECONOMIC IMPACTS: Studies in Japan including this species suggest that myxomycetes may be useful as indicators of environmental pollution (TAKAHASHI, 2014). No other evaluation has been made of any possible positive economic impact of this fungus (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 for this species, *P. crateriforme* var. *columellatum* [*IndexFungorum*, accessed 29 August 2017], is not accepted by *Nomen.mycetozoa.com* [accessed 29 August 2017], and is listed in the synonymy above.

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**. Over 460 records (specimens, databases and bibliographic sources combined, excluding duplicates) from at least 1909 to March 2011, with observations in every month of the year. **Estimated extent of occurrence** [calculated using *http://geocat.kew.org*]. Over 55·3 million km^2 (Africa (including Seychelles): 9·7 million km^2; Asia: 22·2 million km^2; Atlantic Ocean: insufficient data; Australasia: insufficient data; Caribbean, Central America and North America: 14·3 million km^2; Europe: 3·0 million km^2; Pacific Ocean: insufficient data; South America: 6·1 million km^2). **Estimated area of occupancy** [calculated using *http://geocat.kew.org*]. Well over 636 km^2. 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. *Pollution*. Studies in Japan indicate that this and other species of *Physarum* are sensitive to acid air pollution (TAKAHASHI, 2014). Insufficient information to enable other threats to be identified. **Population trend**. In general, not known. Very common in the USA on living trees, especially *Juniperus virginiana*. Common in banana plantations and low elevation forest in Thailand (TRAN *ET AL.*, 2008). Rare in south India (STEPHENSON *ET AL.*, 1993) and Vietnam (TRAN *ET AL.*, 2014). Apparently uncommon in Europe (ELIASSON & ADAMONYTE, 2009). Of datable records, *c.* 5% are pre-1961, 75% post-1960 but pre-2001, and 20% 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**. *Physarum* species grow readily in culture and, using simple techniques, can be induced to sporulate. There are, however, no living strains of this species listed by the Straininfo website [*www.straininfo.net*, accessed 4 August 2017]. One partial nucleotide sequence of small subunit ribosomal RNA was found in a search of the NCBI GenBank database [*www.ncbi.nlm.nih.gov*, accessed 13 August 2017].

NOTES: In moist chamber bark cultures a wide range of shapes may be found in the same dish, from small, globose sporangia, reminiscent of *Physarum robustum* (Lister) Nann.-Bremek., to tall, cylindrical forms looking like *Physarum compressum* Alb. & Schwein. In virtually all cases the distinctive columella is diagnostic. For further help with identification, the excellent keys provided by POULAIN *ET AL.* (2011) should be consulted.

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- *USDA Fungal Databases* [*https://nt.ars-grin.gov/fungaldatabases*].

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