ARCYRIA CINEREA

A–**C**. Sporocarps showing diversity of morphology (bars = 1 mm). **D**. Capillitium and spores (bar = 10 µm). [Photographs: A. Michaud]

Arcyria cinerea (Bull.) Pers., *Synopsis Methodica Fungorum* **1**: 184 (1801). [*IndexFungorum* 174952; *Arcyriaceae*, *Trichiida*]

Trichia cinerea Bull., *Herbier de la France* **10**: tab. 477, fig. 3 (1790). [*IndexFungorum* 145193]

Stemonitis cinerea (Bull.) J.F. Gmel., *Systema Naturae* Edn 13, **2**(2): 1467 (1792). [*IndexFungorum* 145971]

Arcyria albida Pers., *Neues Magazin für die Botanik* **1**: 90 (1794). [*IndexFungorum* 170299]

Stemonitis glauca Trentep., in A.W. Roth, *Catalecta Botanica* **1**: 221 (1797). [*IndexFungorum* 144387]

Stemonitis glauca var. *subglobosa* Trentep., in A.W. Roth, *Catalecta Botanica* **1**: 221 (1797). [*IndexFungorum* 498970]

Stemonitis digitata Schwein., *Transactions of the American Philosophical Society* New Series **4**(2): 260 (1834) [publ. 1832]. [*IndexFungorum* 150035]

Arcyria digitata (Schwein.) Rostaf., *Śluzowce (Mycetozoa) Monografia*: 274 (1875). [*IndexFungorum* 153611]

Clathroides digitatum (Schwein.) E. Sheld., *Minnesota Botanical Studies* **1**: 467 (1895) [as '*Clatrhodes*']. [*IndexFungorum* 634752]

Arcyria cinerea var. *digitata* (Schwein.) G. Lister, in A. LISTER, *A Monograph of the Mycetozoa* A Descriptive Catalogue of the Species in the Herbarium of the British Museum, Edn 3: 232 (1925). [*IndexFungorum* 260819]

Arcyria trichioides Corda, *Icones Fungorum hucusque Cognitorum* **2**: 23 (1838). [*IndexFungorum* 190560]

Arcyria leprieurii Mont., *Annales des Sciences Naturelles* Botanique, Série 4, **3**: 141 (1855). [*IndexFungorum* 235484]

Stemonitis grisea Opiz, *Lotos* **5**: 215 (1855). [*IndexFungorum* 234308]

Arcyria bicolor Berk. & M.A. Curtis, in M.J. BERKELEY, *Journal of the Linnean Society* Botany **10**: 349 (1869). [*IndexFungorum* 169545]

Arcyria pallida Berk. & M.A. Curtis, in M.J. BERKELEY, *Grevillea* **2**(no. 17): 67 (1873). [*IndexFungorum* 242476]

Arcyria cinerea subsp. *subleionema* Rostaf., *Śluzowce (Mycetozoa) Monografia*: 274 (1875). [*IndexFungorum* 634753]

Arcyria friesii Berk. & Broome, *Annals and Magazine of Natural History* Series 4, **17**: 140 (1876). [*IndexFungorum* 168266]

Arcyria stricta Rostaf., *Śluzowce (Mycetozoa) Monografia* Suppl.: 36 (1876). [*IndexFungorum* 190758]

Lachnobolus arcyrella Rostaf., *Śluzowce (Mycetozoa) Monografia*: 431 (1875). [*IndexFungorum* 187110]

Comatricha alba Schulzer, *Oesterreichische Botanische Zeitschrift* **27**: 167 (1877). [*IndexFungorum* 183235]

Arcyria cinerea var. *cribroides* Raunk., *Botanisk Tidsskrift* **17**: 58 (1888) [publ. 1890]. [*IndexFungorum* 154049]

Arcyria cookei Massee, *A Monograph of the Myxogastres*: 154 (1892). [*IndexFungorum* 153863]

Clathroides cookei (Massee) E. Sheld., *Minnesota Botanical Studies* **1**: 467 (1895) [as '*Clatrhodes*'] [*IndexFungorum* 634754]

Arcyria tenuis J. Schröt., in P.C. HENNINGS, *Hedwigia* **35**(4): 207 (1896). [*IndexFungorum* 190466]

Arcyria digitata f. *subglobosa* Meyl., *Annuaire du Conservatoire et du Jardin Botaniques de Genève* **15-16**: 321 (1913). [*IndexFungorum* 167742]

Arcyria digitata f. *globosa* Meyl., *Bulletin de la Société Vaudoise de Sciences Naturelles* **55**: 244 (1924). [*IndexFungorum* 263201]

Arcyria cinerea f. *subglobosa* Meyl., *Bulletin de la Société Vaudoise de Sciences Naturelles* **55**: 244 (1924). [*IndexFungorum* 260813]

Arcyria cinerea f. *rubella* Y. Yamam., *Bulletin of the National Science Museum* Series B **26**(3): 107 (2000). [*IndexFungorum* 482834]

Vernacular names. Dutch: *asgrauw netwatje*. German: *Grauer Kelchstäbling*.

Diagnostic features. Very variable in form and colour, but never red or pink; on dead wood, often in large groups; microscopically easily distinguished from other *Arcyria* species by its capillitium which is smooth proximally (near the cup) but spinulose distally; similar to *A. pomiformis* (Leers) Rostaf. which differs in having a cup inner surface ornamented with warts or a raised network whereas that of *A. cinerea* is smooth.

On natural substratum. *Amoebal state* irregular, with no transparent ectoplasm; forming filopodia during locomotion (YANG *et al.*, 2018); swarm cells biflagellate (MIMS, 1971; see also ELLIOTT, 1949). *Plasmodium* white or with a pinkish tinge, sometimes grey or greenish; plasmodial membranes and pseudopods (also called lobopods) are involved in formation of diploid myxamoebae and swarm cells; these occur when a small unit of protoplasm at the leading edge of an advancing plasmodial fan separates from a pseudopod to become a myxamoeba, eventually developing flagella and dispersing; this may also happen along the veinlets (INDIRA, 1964, 1969). *Hypothallus* discoid under isolated sporangia, and extending continuously under groups. *Sporocarps* stalked sporangia, dispersed or in groups which are often large, erect, 0·3–2·5(–4) mm tall; sometimes forming compound structures which are fused or fascicle-stalked, especially in the Tropics. *Stalks* concolorous with the sporothecae or darker, 0·2–2 mm long, filled with round cells 14–24 µm diam., sometimes clustered, or confluent and fused. *Sporothecae* subcylindrical, rarely almost spherical or ovoid, colours very variable, mostly almost white or pale grey to beige, rarely ochraceous, 0·5–0·8 mm diam. *Peridium* single, membranous, fleeting, with fragments remaining at the base as a calyculus which is small, radially furrowed, smooth, papillate, very minutely punctate or partly reticulate. *Columella* absent. *Capillitium* small-meshed, densely reticulate, expanding slightly, firmly connected to the cup, 2–6 µm diam., in the upper part strongly spinulose with numerous spinules or cogs, the basal threads nearly smooth or with thinner spinules. *Spores* globose, 6–8 µm diam., almost colourless, smooth, with a few larger warts visible under oil immersion; as with some other myxomycetes, larger spores, 10·3–12·5 µm diam., are sometimes encountered when the species is grown in moist chambers.

ASSOCIATED ORGANISMS & SUBSTRATA: **Animalia**. *Anisotoma basalis* (LeConte, 1853), *A. bifoveata* Wheeler, 1979, *A. horni* Wheeler, 1979; *Alces alces* (L., 1758) (dung); *Animalia* indet. (dung); *Baeocera* sp.; *Equus caballus* Boddaert, 1785 (dung); *Lepus timidus* L., 1758 (dung). **Artefacts**. Compost (bagasse); fuel (coal); thatch. **Fungi**. *Aphanocladium album* (Preuss) W. Gams; *Eutypa lata* (Pers.) Tul. & C. Tul.; *Fomes fomentarius* (L.) Fr. (basidioma); *Gliocladium album* (Preuss) Petch; *Heterobasidion annosum* (Fr.) Bref.; *Nectria peziza* (Tode) Fr.; *Nectriopsis candicans* (Plowr.) Maire, *N. exigua* (Pat.) W. Gams [as *Verticillium rexianum* (Sacc.) Sacc.]; *Neonectria coccinea* (Pers.) Rossman & Samuels [as *Nectria coccinea* (Pers.) Fr.]; *Orbilia coccinella* Fr.; *Polycephalomyces tomentosus* (Schrad.) Seifert [also as *Stilbum tomentosum* Schrad.]; *Stilbum echinatum* Ellis & Everh.; *Trichophaeopsis bicuspis* (Boud.) Korf & Erb. **Plantae**. *Abies borisii-regis* Mattf. (wood), *A. nordmanniana* subsp. *equi-trojani* (Asch. & Sint. ex Boiss.) Coode & Cullen [as *A. nordmanniana* subsp. *bornmuelleriana* (Mattf.) Coode & Cullen] (log), *A. sibirica* Ledeb., *Abies* sp. (wood); *Acer pseudoplatanus* L. (bark, wood), *A. saccharum* Marshall (wood); *Aeonium arboreum* Webb & Berthel. (leaf); *Agathis australis* (D. Don) Lindl.; *Agave lechuguilla* Torr.; *Alnus glutinosa* (L.) Gaertn. (branch), *Alnus* sp. (bark, stump); *Anisotome latifolia* Hook. f.; *Apiaceae* indet. (stem); *Arecaceae* gen. indet.; *Artemisia thuscula* Cav. (wood); *Arundo donax* L.; *Asplundia rigida* (Aubl.) Harling (stem); *Bambusa* sp. (stem); *Beilschmiedia pendula* (Sw.) Hemsl.; *Betula pendula* Roth (bark), *Betula* sp. (branch, leaf, wood); *Bromeliaceae* indet.; *Bryophyta* indet. (thallus); *Buchenavia tetraphylla* (Aubl.) R.A. Howard; *Bulbinella rossii* (Hook. f.) Cheeseman; *Bursera graveolens* (Kunth) Triana & Planch. (wood), *Bursera* sp.; *Calophyllum inophyllum* L. (wood); *Calyptronoma plumeriana* (Mart.) Lourteig; *Camellia sinensis* (L.) Kuntze (bark, root); *Carpinus betulus* L. (wood), *Carpinus* sp. (bark); *Castanea sativa* Mill. (bark), *Castanea* sp.; *Catalpa bignonioides* Walter (bark); *Cecropia peltata* L. (bark, liana); *Cirsium arvense* (L.) Scop.; *Cladium mariscus* (L.) Pohl (culm); *Cocos nucifera* L. (stem); *Coniferae* indet. (wood); *Conium maculatum* L. (stem); *Corylus avellana* L. (wood); *Crataegus monogyna* Jacq.; *Cyanus montanus* (L.) Hill [as *Centaurea montana* L.] (wood); *Cyperus papyrus* L.; *Delonix regia* (Hook.) Raf. (bark); *Dracophyllum scoparium* Hook. f.; *Elaeis guineensis* Jacq.; *Epipremnum pinnatum* (L.) Engl. (liana); *Eucalyptus* sp. (bark, wood); *Euphorbia antisyphilitica* Zucc., *E. balsamifera* Aiton, *E. canariensis* L., *E. lamarckii* Sweet, *Euphorbia* sp. (bark); *Fagus orientalis* Lipsky (bark, branch), *F. sylvatica* L. (bark, leaf, trunk, wood), *Fagus* sp.; *Falcataria moluccana* (Miq.) Barneby & J.W. Grimes; *Fraxinus americana* L. (wood), *F. excelsior* L. (bark), *Fraxinus* sp. (bark); *Frullania dilatata* (L.) Dumort. (thallus); *Glyceria maxima* (Hartm.) Holmb. (culm), *Glyceria* sp. (leaf); *Hedychium coronarium* J. Koenig (inflorescence); *Heliconia psittacorum* L. f. (inflorescence); *Hemitelia muricata* (Willd.) Fée [as *Cyathea muricata* Willd.] (frond); *Hepaticae* indet.; *Hoheria populnea* A. Cunn.; *Hypnum cupressiforme* Hedw. (thallus); *Iris pseudacorus* L. (spathe); *Juniperus excelsa* M. Bieb. (bark); *Kleinia neriifolia* Haw.; *Larix decidua* Mill. (stump), *Larix* sp. (bark); *Leptospermum* sp.; *Magnoliopsida* sp. (wood); *Malus domestica* Borkh. (bark), *Malus* sp. (bark); *Metrosideros* sp.; *Mnium hornum* Hedw.; *Muscopsida* indet.; *Myosotis arvensis* (L.) Hill; *Nothofagus fusca* (Hook. f.) Oerst., *N. fusca* var. *colensoi* (Hook. f.) Cheeseman [as *N. truncata* (Colenso) Cockayne], *N. pumilio* (Poepp. & Endl.) Krasser (wood), *Nothofagus* sp. (bark); *Palmae* indet. (log, petiole, stipe, stump, trunk); *Phoenicophorium borsigianum* (K. Koch) Stuntz (leaf); *Phoenix dactylifera* L. (leaf); *Phyllostachys* sp.; *Picea abies* (L.) H. Karst. [also as *P. excelsa* (Lam.) Link] (branch, trunk, wood), *P. sitchensis* (Bong.) Carrière (branch, wood); *Pinus caribaea* Morelet (leaf), *P. heldreichii* Christ [as *P. leucodermis* Antoine] (bark), *P. massoniana* Lamb. (bark), *P. sylvestris* L. (bark, branch, cone), *Pinus* sp. (root, stump, trunk, wood); *Plantae* indet. (bark, branch, debris, litter, log, stick, stump, trunk, wood); *Platanus orientalis* L. (bark); *Pleurophyllum* sp.; *Poa trivialis* L.; *Podocarpus* sp.; *Populus tremula* L. (twig), *Populus* sp. (branch, wood); *Porella platyphylla* (L.) Pfeiff. (thallus); *Pseudotsuga menziesii* (Mirb.) Franco (bark, stump, wood); *Pyrus communis* L. (bark), *Pyrus* sp. (bark); *Quercus petraea* (Matt.) Liebl. (bark), *Q. pubescens* Willd. (bark, branch, twig), *Q. robur* L. (bark, branch, wood), *Quercus* sp. (bark, wood); *Rhopalostylis sapida* (Sol. ex G. Forst.) H. Wendl. & Drude (frond); *Roystonea regia* (Kunth) O.F. Cook (leaf); *Rubus* sp. (stem); *Rumex lunaria* L., *Rumex* sp. (stem); *Saccharum officinarum* L. (stem); *Salix alba* L. (bark), *S. caprea* L. (wood), *S. cinerea* L. (log), *S. ×fragilis* L. (bark), *Salix* sp. (bark, branch); *Sambucus nigra* L. (bark); *Scutia spicata* (Humb. & Bonpl. ex Willd.) Weberb.; *Selaginella* sp. (leaf); *Sorbus torminalis* (L.) Crantz (bark); *Stilbocarpa polaris* (Hombr. & Jacq.) A. Gray; *Tamarix chinensis* Lour.; *Taxus baccata* L. (bark); *Terminalia* sp. (bark); *Thuja* sp. (wood); *Thunbergia grandiflora* (Roxb. ex Rottl.) Roxb. (leaf); *Tilia cordata × platyphyllos* (bark), *Tilia* sp. (bark); *Ulex europaeus* L. (branch, stem); *Ulmus laevis* Pall. (bark), *Ulmus* sp. (branch); *Urtica dioica* L. (stem); *Yucca elata* (Engelm.) Engelm. **Protista**. *Cribraria tenella* Schrad., *C. violacea* Rex; *Hemitrichia calyculata* (Speg.) M.L. Farr. **Associated organism of type specimen**. Not specified; illustration in protologue shows it on dead wood. **Comment**. This species occurs on fallen branches, dead wood, dead roots, dead stems, dead and living bark, litter, dead leaves, logs and straw of a very wide range of plants, and is also very commonly encountered on bark incubated in moist chambers. It also occurs occasionally on dung, on fungal carpophores, and on artefacts, particularly those derived from plant products. There are several records of other myxomycetes growing on the same substratum, and this species is also seen in association with a range of fungi (DUDKA & ROMANENKO, 2006), and is sometimes parasitized by them (ROGERSON & STEPHENSON, 1993). Several associations between this species and beetles have been observed in North America and Brazil (STEPHENSON *et al.*, 1994; LEMOS *et al.*, 2010). One of the associated organisms, *Phoenicophorium borsigianum*, an endemic of the Seychelles, is 'the thief palm'. The generic name comes from the Greek words φοῖνιξ (palm) and φώριος (stolen), and refers to the theft from Kew Gardens of one of the first specimens introduced in Europe. It later 'appeared' in the private greenhouse of German industrialist and passionate horticulturist, August Borsig (1804-1854), from whose name the specific epithet is derived.

INTERACTIONS & HABITATS: For a thorough introduction to myxomycete ecology, see MADELIN (1984). The dead plant material with which myxomycetes are very widely associated, while undoubtedly a platform for their sporocarps, is not necessarily a source of nutrition. Sporocarps are the only stage in myxomycete life cycles where species can be identified by morphology. The other states, as amoebae and plasmodia, have received little attention. SHCHEPIN *et al.* (2019) suggested that populations of myxomycete amoebae may inhabit much wider ecological niches than indicated by records of their sporocarps. In their amoebal state, myxomycetes are known to feed on small organic particles and micro-organisms (including some fungi), but the identity of those micro-organisms is rarely, if ever, recorded. There is very little specific information about the ecology and nutrition of the amoebal state of *A. cinerea*, but there are published observations of changes in shape and size of *A. cinerea* amoebae during locomotion (YANG *et al.*, 2018). *Arcyria cinerea* has been observed in the following habitats: amenity & protected areas (arboreta, botanic gardens, cemeteries, churchyards, gardens, nature reserves, orchards, parklands); coastal (dunes); cultivated ground; deserts (alpine, subalpine, subantarctic); freshwater (carrs, fens, marshes, ravines, swamps); grassland (meadows, pastures); margins (edges of pools and streams, sides of tracks); montane; ruderal (quarries); and woodlands (conifer forests, conifer plantations, mixed plantations, palm forests, scrub, natural and semi-natural broadleaf woodland). It has also been observed in greenhouses.

Arcyria cinerea is regularly reported from substrata over a wide pH range. It is one of the most consistently abundant and widespread myxomycete species associated with lianas, aerial woody remnants, leaves and inflorescences (all substrata with near-neutral pH values, 5·4–8·5, suitable for many species of myxomycetes) in tropical forests, and in mangrove forests (CAVALCANTI *et al.*, 2015, 2016). These microhabitats were investigated for neotropical forests (LADO *et al.*, 2003; MCHUGH, 2005; SCHNITTLER & STEPHENSON, 2002; WRIGLEY DE BASANTA *et al.*, 2008), forests in northern Queensland in Australia (BLACK *et al.*, 2004) and in southeast Asia (KO KO *et al.*, 2010). In one study in Thailand, collections of this species were found only during the warm wet season, and not during the cool dry season (Ko Ko *et al.*, 2011). Takahashi (2004) suggested substratum hardness and state of decay may be significant when this species occurs on wood. The senior authors have observed this species in the Seychelles on fallen wood of *Falcataria moluccana* (with a neutral pH of 7·26), and on *Calophyllum inophyllum* (with an acid pH of 4·61).

GEOGRAPHICAL DISTRIBUTION: Africa: Algeria, Angola, Burundi, Cameroon, Democratic Republic of the Congo, Egypt, Equatorial Guinea, Gambia, Kenya, Liberia, Madagascar, Malawi, Mayotte, Morocco, Mozambique, Nigeria, Rwanda, Sierra Leone, Somalia, South Africa, Tanzania, Tunisia, Uganda, Western Sahara, Zambia, Zimbabwe. North America: Canada (Alberta, British Columbia, Manitoba, New Brunswick, Ontario, Quebec, Saskatchewan), Mexico, USA (Alaska, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, West Virginia). Central America: Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama. South America: Argentina, Bolivia, Brazil (Alagoas, Amazonas, Bahia, Ceará, Mato Grosso, Minas Gerais, Paraiba, Paraná, Pernambuco, Rio Grande do Norte, Rio Grande do Sul, Rondônia, Roraima, Santa Catarina, São Paulo, Sergipe), Chile, Colombia, Ecuador (including Galapagos), French Guiana, Guyana, Paraguay, Peru, Surinam, Venezuela. Antarctica: Antarctica. Asia: China (Anhui, Guangdong, Guangxi, Heilongjiang, Hong Kong, Jiangsu, Kwangtung, Yunnan), Christmas Island, Georgia, India (Assam, Chandigarh, Himachal Pradesh, Jammu & Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Uttarakhand, Uttar Pradesh, West Bengal), Indonesia, Iran, Japan, Kazakhstan (Aktobe, Atyrau, Pavlodar, West Kazakhstan), Laos, Nepal, Papua-New Guinea, Philippines, Russia (Altai Krai, Altai Republic, Chukotka Autonomous Okrug, Irkutsk Oblast, Khabarovsk Krai, Khanty-Mansi Autonomous Okrug, Krasnoyarsk Krai, Magadan Oblast, Primorsky Krai, Republic of Buryatia, Sakhalin Oblast, Tyumen Oblast, Yamalo-Nenets Autonomous Okrug), Singapore, Sri Lanka, Taiwan, Thailand, Turkey, Uzbekistan, Vietnam. Atlantic Ocean: Ascension Island, Spain (Canary Islands). Australasia: Australia (New South Wales, Northern Territory, Queensland, Tasmania, Victoria, Western Australia), New Zealand, Raoul Island. Caribbean: American Virgin Islands, Antigua and Barbuda, Bahamas, Cuba, Dominica, Dominican Republic, Grenada, Guadeloupe, Haiti, Jamaica, Martinique, Puerto Rico, Trinidad & Tobago. Europe: Andorra, Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Lithuania, Luxembourg, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia (Astrakhan Oblast, Chelyabinsk Oblast, Kalinigrad Oblast, Komi Republic, Krasnodar Krai, Kursk Oblast, Leningrad Oblast, Moscow Oblast, Murmansk Oblast, Orenburg Oblast, Perm Krai, Republic of Bashkortostan, Republic of Karelia, Rostov Oblast, Smolensk Oblast, Tver Oblast, Voronezh Oblast, Volgograd Oblast, Vologda Oblast), Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, UK. Indian Ocean: Mauritius, Réunion, Seychelles. Pacific Ocean: French Polynesia, New Caledonia, USA (Hawaii).

Elevation (m above sea level). Records up to 4200 (Argentina); 3450 (Guatemala); over 3300 (Mexico); over 3250 (Rwanda); 3000 (China); up to 2050 (New Zealand); up to 2000 (Spain: Canary Islands).

Comment. Recorded from every continent including Antarctica, and from many oceanic islands. Probably native throughout.

ECONOMIC IMPACTS: There is experimental evidence that this species can accumulate heavy metals (Kryvomaz, 2015*a*; Kryvomaz *et al.*, 2015, 2016, 2017*c*). In a study on ultramafic and volcanic soils containing high levels of heavy metals in the Philippines, Rea-Maminta *et al.* (2015) reported higher Cr and Mn content in myxomycetes, including the present species, than in the leaves on which they were found. Kryvomaz (2017*a*) measured metal levels in samples of *A. cinerea*, and in its substrata and surrounding soil. The levels of different elements were, in descending order, as follows (µg of metal per g of myxomycete tissue): Ca (27686·46), Al (11184·5), Fe (2550·26), Mg (1793·48), Si (489·65), Mn (87·99), Zn (34·28), Cu (15·82), Pb (2·6), Ni (2·33), As (0·55), Cd (0·44), Cr (0·3). Analysis of those results showed that Al was accumulated much more strongly by this species than by the others included in the study. An accumulation coefficient was used to calculate the concentration ratios between myxomycete and substratum, and between myxomycete and soil. The ratios revealed different accumulation patterns. These were termed by KRYVOMAZ (2017*a*) as:

- accumulation [concentration in myxomycetes much higher than in substrata and soil]: in *A. cinerea* this pattern was observed for Al, Cu, Si;
- substratum-dependent accumulation [concentration in myxomycetes less than in substratum, but higher than in soil]: in *A. cinerea* this pattern was observed for Ca, Cd, Mg, Mn, Pb, Zn, Ni;
- soil-dependent accumulation [concentration in myxomycetes less than in soil, but more than in substrata]: in *A. cinerea* this pattern was observed for Fe, Cr, As.

Heavy metal accumulating properties are likely to have significant positive economic potential (STEPHENSON & MCQUATTIE, 2000). Although nothing has yet been developed for the present species, there is considerable interest in use of fungi with similar abilities for bioremediation and other applications (GADD, 2007).

In a search for novel compounds in the Czech Republic, ŘEZANKA (2002) isolated multibranched polyunsaturated fatty acid ((2E,4E,7S,8E,10E,12E,14S)-7,9,13,17-tetramethyl-7,14-dihydroxy-2,4,8,10,12,16-octadecahexaenoic acid) and two of its glycoside derivatives from *A. cinerea*. These are surfactants of potential commercial interest particularly in the food and pharmaceutical industries. ISHIBASHI (2005) reported a wide range of bioactive compounds from *A. cinerea*, including some with possible application against human cancers. In another study exploring the cytotoxicity of bisindole alkaloids to cultured human cancer cell lines, *A. cinerea* was shown to produce a range of metabolites, including the previously unknown fatty acid bisindole alkaloids cinereapyrrole A and cinereapyrrole B (KAMATA *et al.*, 2005). SHINTANI *et al.* (2010) isolated a new alkaloid, 6,9'-dihydroxystaurosporinone (4), from *A. cinerea*.

No evaluations have been found for any other 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.). In a study of human seasonal allergic rhinitis, LIERL (2013) found that 42% of patients were sensitized to myxomycete spores, including those of the present species. *Arcyria cinerea* has also been reported on wood from mushroom-growing farms in Taiwan as a weed and potential parasite (CHUNG *et al.*, 1998). No other reports of negative economic impacts have been found.

INFRASPECIFIC VARIATION: Several subspecific taxa have been described for *A. cinerea*. All but one are treated by *Nomen.mycetozoa.com* [accessed 27 June 2019] as synonyms of typical *A. cinerea*, and appear in the above synonymy. The other, *Arcyria cinerea* var. *carnea* Lister, is a synonym of *A. minuta* Buchet [*Nomen.mycetozoa.com*, accessed 27 June 2019]. The synonyms *A. cinerea* var. *digitata* and *A. digitata* (the basionym from which it is derived), both included in the above list, have sometimes been used for collections of *A. cinerea*, particularly from the Tropics, with smaller compound and fascicle-stalked sporocarps (ROSTAFIŃSKI, 1875). These infraspecific taxa may represent separate cryptic species, but to date molecular evidence is inconclusive (NOVOZHILOV *et al.*, 2017).

In recent extensive biosystematic studies of *A. cinerea*, most isolates fitted standard species descriptions of the species, but there were often small variations from the norm, for example, in sporotheca shape (CLARK *et al.*, 2004; CLARK & HASKINS, 2010). These authors showed that what is treated in basic monographic works as a species may in certain cases comprise a mixture of nonheterothallic, as well as heterothallic and apomictic strains, which in turn may comprise sexually incompatible biological species.

DISPERSAL & TRANSMISSION: For a general discussion about myxomycete dispersal, see KRYVOMAZ & STEPHENSON (2017). Myxomycete spores are dispersed considerable distances by wind. Field experiments and mathematical modeling (including, specifically, *A. cinerea*, SCHNITTLER *et al.*, 2006) have shown that, with winds of 0·1 m/s, spores can travel up to *c.* 1·8 km, and when wind speed reaches 28 m/s, this rises to over 500 km (TESMER & SCHNITTLER, 2007). Spores and myxamoebae may be dispersed by rainwater and water in soil. Some local dispersal may also occur by movement of myxamoebae and plasmodia. Insects and other invertebrates feed on sporophores, as probably do terrestrial vertebrates including birds, and myxomycete spores have been found in insect faeces, suggesting that animals may play a part in their dispersal. Plant debris floating in seawater may also contribute to dispersal between land masses.

CONSERVATION STATUS: The IUCN's Red Listing Criteria were originally designed for evaluation of vertebrate animals and flowering plants, and present challenges to those trying to apply them to organisms like myxomycetes which are unicellular for a significant part of their life cycle. A discussion of those challenges, particularly in respect of myxomycetes and climate change, is provided by KRYVOMAZ & STEPHENSON (2017). **Previous evaluations**. Many authors comment on the frequency with which *A. cinerea* is encountered. It is, for example, common in Mexico (LIZÁRRAGA *et al.*, 1998), the most common species on foliicolous liverworts in Costa Rica, Ecuador and Puerto Rico (SCHNITTLER, 2001), common to abundant in northern Thailand (TRAN *et al.*, 2006), common in the canopies of deciduous trees in Germany (SCHNITTLER *et al.*, 2006), on Mount Makulot, Philippines (CHENG *et al.*, 2013), and in forests of Anhui and Jiangsu provinces, China (DAI *et al.*, 2013); abundant in northeast Brazil Atlantic Forests (COSTA *et al.*, 2014; BARBOSA *et al.*, 2016); and common in southern Vietnam (NOVOZHILOV *et al.*, 2017). **Information base**. Over 10,000 records (specimens, databases and bibliographic sources combined, excluding duplicates) from at least 1790 to August 2019, with observations in every month of the year, peaking in the northern hemisphere from June to September. **Estimated extent of occurrence** [calculated using *http://geocat.kew.org*]. Well over 180·4 million km^2 (Africa [sub-Saharan only, but including Ascension Island]: 27·6 million km^2; Antarctica: insufficient data; Asia [excluding Turkey]: 67·4 million km^2; Australasia [including New Caledonia]: 16·2 million km^2; Europe [including north Africa, Georgia and Turkey]: 20·6 million km^2; North America [including the Caribbean and Central America]: 24·0 million km^2; Pacific Ocean: insufficient data; South America: 24·6 million km^2). **Estimated area of occupancy** [calculated using *http://geocat.kew.org*]. Well over 4456 km^2. The method for estimating area of occupancy has produced an artificially low figure. The species is likely to be under-recorded, particularly because of the small number of people with the skills to search for and identify it. One of the most widespread and common myxomycete species. Many of the plants with which it is associated are common and widespread species. **Threats**. Insufficient information to enable threats to be identified. In particular, possible vulnerabilities of the amoebal and plasmodial states of this species are currently completely overlooked. *Arcyria cinerea* is tolerant of a wide range of pH in its environment (WRIGLEY DE BASANTA, 2004), suggesting it is less susceptible to acid rain than some other myxomycetes. **Population trend**. In general, not known. Moderately frequent and increasing in Saxony, Germany (HARDTKE *et al.*, 2015). Of datable records, *c.* 20% are pre-1961, 55% post-1960 but pre-2001, and 25% 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 noted. ***Ex situ* conservation actions**. 16 nucleotide sequences, 3 PopSet sequences and 5 protein sequences were found in a search of the NCBI GenBank database [*www.ncbi.nlm.nih.gov*, accessed 11 November 2019]. Although this species can be grown *in vitro*, in moist chamber conditions (HÄRKÖNEN, 1981) and in pure culture on agar (ALEXOPOULOS, 1960), no living strains of this species are listed by the ATCC, CABI and Westerdijk Institute [formerly CBS] culture collections.

NOTES: SHI & LI (2012) provide a description of the life cycle of *A. cinerea* in pure culture. Scanning electron micrographs of spores were provided by LIZÁRRAGA *et al.* (1998). For detailed transmission electron microscope studies of *A. cinerea* – stalk formation (including light microscopy), capillitial formation, precleavage mitosis, meiosis, spore wall formation, spore germination and formation of amoebae – see MIMS & ROGERS (1975), MIMS (1969), MIMS (1972*b*), ALDRICH & MIMS (1970), MIMS (1972*a*) and MIMS (1971), respectively. KARPOV *et al.* (2003) made a detailed study of the cytoskeleton of spores of *A. cinerea*. This species is sufficiently well known to have a presence on YouTube [e.g. *www.youtube.com/watch?v=J-YtTN2Q2h4*, accessed 20 November 2019].

LITERATURE & OTHER SOURCE MATERIAL: (Literature on *A. cinerea* is very extensive, and the following citations should be regarded as indicative rather than exhaustive.) ALDRICH, H.C. & MIMS, C.W. Synaptonemal complexes and meiosis in myxomycetes. *American Journal of Botany* **57**(8): 935-941 (1970). ALEXOPOULOS, C.J. Gross morphology of the plasmodium and its possible significance in the relationships among the myxomycetes. *Mycologia* **52**(1): 1-20 (1960). BARBOSA, D.Í., BEZERRA, A.C.C., LIMA, V.X. DE & CAVALCANTI, L. DE H. Corticolous myxobiota of the Pernambuco Center of Endemism, Brazil. *Acta Botanica Brasilica* **30**(4): 549-559 (2016) [DOI: 10.1590/0102-33062016abb0209]. BELTRÁN-TEJERA, E., MOSQUERA, J. & LADO, C. Myxomycete diversity from arid and semiarid zones of the Canary Islands (Spain). *Mycotaxon* **113**: 439-442 (2010). BLACK, D.R., STEPHENSON, S.L. & PEARCE, C.A. Myxomycetes associated with the aerial litter microhabitat in tropical forests of northern Queensland, Australia. *Systematics and Geography of Plants* **74**(1): 129-132 (2004). CAMINO, M., STEPHENSON, S.L., KRIVOMAZ, T., WRIGLEY DE BASANTA, D., LADO, C. & ESTRADA-TORRES, A. Biodiversity survey for myxomycetes in the mountains of central Cuba. *Revista Mexicana de Micología* **27**: 39-51 (2008). CAVALCANTI, L. DE HOLLANDA, DAMASCENO, G., COSTA, A.A.A. & BEZERRA, A.C.C. Myxomycetes in Brazilian mangroves: species associated with *Avicennia nitida*, *Laguncularia racemosa* and *Rhizophora mangle*. *Marine Biodiversity Records* **9**: 1-7 (2016). CAVALCANTI, L. DE HOLLANDA, FERREIRA, I.N., BEZERRA, A.C. & COSTA, A.A. Microhabitats occupied by myxomycetes in the Brazilian Atlantic forest: *Heliconiaceae* inflorescences. *Brazilian Journal of Biology* **75**(4): 859-867 (2015) [DOI: 10.1590/1519-6984.01714]. CHENG, C.B.T., YU, K.N.T., CAMPOS, M.L., ADORA, J.M.V., PASCUA, G.C.P., PANGILINAN, M.V.B., BUAYA, A.T. & CRUZ, T.E.E. DE LA. Occurrence and diversity of myxomycetes (plasmodial slime molds) along the northern slope of Mt. Makulot, Cuenca, Batangas, Philippines. *Asian Journal of Biodiversity* **4**(1): 65-83 (2013). CHUNG, C.H., LIU, C.H. & TZEAN, S.S. Slime molds in edible mushroom cultivation sites. *Plant Pathology Bulletin* **7**: 141-146 (1998). CLARK, J. & HASKINS, E.F. Reproductive systems in the myxomycetes: a review. *Mycosphere* **1**(4): 337-353 (2010). CLARK, J. & HASKINS, E.F. Sporophore morphology and development in the myxomycetes: a review. *Mycosphere* **5**: 153-170 (2014). CLARK, J., HASKINS, E.F. & STEPHENSON, S.L. Culture and reproductive systems of 11 species of Mycetozoans. *Mycologia* **96**(1): 36-40 (2004). CLARK, J., SCHNITTLER, M. & STEPHENSON, S.L. Biosystematics of *Arcyria cinerea*. In: *Abstracts of 4th International Congress on the Systematics and Ecology of Myxomycetes* (Meise, Belgium: National Botanic Garden of Belgium): 17 (2002). COSTA, A.A.A., BEZERRA, A.C.C., LIMA, V.X. DE & CAVALCANTI, L. DE H. Diversity of myxomycetes in an environmentally protected area of Atlantic forest in northeastern Brazil. *Acta Botanica Brasilica* **28**(3): 445-455 (2014) [DOI: 10.1590/0102-33062014abb3428]. DAI, Q., YAN, S.Z., YAO, H.Q. & CHEN, S.L. [Myxomycete diversity in hilly forests of east China]. *Biodiversity Science* **21**(4): 507-513 (2013) [text in Chinese; DOI: 10.3724/SP.J.1003.2013.07028]. DUDKA, I.O. & ROMANENKO, K.O. Co-existence and interaction between myxomycetes and other organisms in shared niches. *Acta Mycologica* **41**(1): 99-112 (2006). ELLIOTT, E.W. The swarm-cells of myxomycetes. *Mycologia* **41**(2): 141-170 (1949). ERGÜL, C.C. & ERGÜL, H. Myxomycete diversity of Uludağ National Park, Turkey. *Mycotaxon* **116**: 479 (2011). ERSHAD, D. *Fungi of Iran* Edn 3 (Tehran: Iranian Research Institute of Plant Protection): 558 pp. (2009). FEFELOV, K.A. Micromycetes of the Urals. *Микология и Фитопатология* [*Mycology & Phytopathology*] **44**(4): 340-351 (2010). FERREIRA, I.N. & CAVALCANTI, L. DE H. [Availability of microhabitats for myxomycetes in the Atlantic forest: *Bromeliaceae*]. *Biotemas* **23**(3): 1-10 (2010) [text in Portuguese]. GADD, G.M. Geomycology: biogeochemical transformations of rocks, minerals, metals and radionuclides by fungi, bioweathering and bioremediation. *Mycological Research* **111**(1): 3-49 (2007). HARDTKE, H.J., DÄMMRICH, F. & KLENKE, F. *Rote Liste und Artenliste Sachsens-Pilze* (Dresden: Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie): 580 pp. (2015). HÄRKÖNEN, M. Myxomycetes developed on litter of common Finnish trees in moist chamber cultures. *Nordic Journal of Botany* **1**(6): 791-794 (1981). INDIRA, P.U. Swarmer formation from plasmodia of myxomycetes. *Transactions of the British Mycological Society* **47**(4): 531-533 (1964). INDIRA, P.U. On the plasmodium of myxomycetes. *University of Iowa Studies in Natural History* **21**(2): 1-36 (1969). ING, B. *The Myxomycetes of Britain and Ireland* (Slough, UK: Richmond Publishing): iv + 374 pp. (1999). ISHIBASHI, M. Isolation of bioactive natural products from myxomycetes. *Medicinal Chemistry* **1**(6): 575-590 (2005). KAMATA, K., KIYOTA, M., NAOE, A., NAKATANI, S., YAMAMOTO, Y., HAYASHI, M., KOMIYAMA, K., YAMORI, T. &

ISHIBASHI, M. New bisindole alkaloids isolated from myxomycetes *Arcyria cinerea* and *Lycogala epidendrum*. *Chemical & Pharmaceutical Bulletin* **53**(5): 594-597 (2005). KARPOV, S.A., NOVOZHILOV, Y.K. & CHISTIAKOVA, L.V. A comparative study of zoospore cytoskeleton in *Symphytocarpus impexus*, *Arcyria cinerea* and *Lycogala epidendrum* (*Eumycetozoa*). *Protistology* **3**(1): 15-29 (2003). KELLER, H.W. & EVERHART, S.E. Importance of myxomycetes in biological research and teaching. *Fungi* **3**(1): 13-27 (2010). KELLER, H.W., WHITNEY, K.D. & BUBEN-ZUREY, M.J. Corticolous myxomycetes. IX. Two species of *Arcyria*, one new, one old. *Mycologia* **78**(3): 432-438 (1986). KO KO, T.W., STEPHENSON, S.L., HYDE, K.D. & LUMYONG, S. Influence of seasonality on the occurrence of myxomycetes. *Chiang Mai Journal of Science* **38**(1): 71-84 (2011). KO KO, T.W., STEPHENSON, S.L., HYDE, K.D., ROJAS, C. & LUMYONG, S. Patterns of occurrence of myxomycetes on lianas. *Fungal Ecology* **3**: 302-310 (2010). KRYVOMAZ, T.I. The assessment of heavy metal accumulation by myxomycetes. *Motrol* Lublin **17**(8): 157-164 (2015). KRYVOMAZ, T.I. Assessment [of] environmental safety for mangrove biome. *Підводні Технології* [*Underwater Technology*] **4**: 16-25 (2016). KRYVOMAZ, T.I. [as КРИВОМАЗ, Т.І.]. *Наукові Основи Моніторингу Забруднення Навколишнього Середовища Токсичними Елементами з Використанням Міксоміцетів* [*Scientific Basis for Monitoring Environmental Pollution by Toxic Elements using Myxomycetes*]. Дис. д-ра техн. наук [Thesis (DSc), Technical Science], 21.06.01 (Київ: Київ Національний Університет Будівництва і Архітектури [Kyiv: Kyiv National Construction and Architecture University]): 349 pp. (2017*a*) [text in Ukrainian]. KRYVOMAZ, T.I. Accumulation of toxic metals and other elements by myxomycetes. In: *Abstracts of 9th International Congress on the Systematics and Ecology of Myxomycetes* Tanabe, Japan, 18-23 August 2017: 38 (2017*b*). KRYVOMAZ, T.I. & ANDRUSISHINA, I. Assessment of mangrove environmental safety by analyses of metals transition. *Environmental Safety* **1-2**(21): 55-59 (2016). KRYVOMAZ, T., MICHAUD, A. & STEPHENSON, S.L. Patterns of myxomycetes ecology and distribution on isolated tropical islands. In: *Abstracts of 9th International Congress on the Systematics and Ecology of Myxomycetes* Tanabe, Japan, 18-23 August 2017: 31 (2017*a*). KRYVOMAZ, T.I., MICHAUD, A. & STEPHENSON, S.L. First survey of myxomycetes on Mahé Island in the Seychelles. *Nova Hedwigia* **104**(1-3): 65-84 (2017*b*). KRYVOMAZ, T.I. & STEPHENSON, S.L. Preliminary evaluation of the possible impact of climate change on myxomycetes. *Nova Hedwigia* **104**(1-3): 5-30 (2017). KRYVOMAZ, T.I., VOLOSHKINA, O., MAXIMENKO, D.V. & ZHUKOVA, O.G. [as КРИВОМАЗ, Т.І., ВОЛОШКІНА, О.С., МАКСИМЕНКО, Д.В. & ЖУКОВА, О.Г.]. Регресійні моделі переходу елементів в міксоміцетах в залежності від параметрів навколишнього середовища [Regression models for the transition of elements in myxomycetes depending on the environmental parameters]. *Екологічна Безпека та Збалансоване Ресурсокористування* [*Environmental Safety and Sustainable Resources Management*] **1**(15): 97-104 (2017*c*) [text in Ukrainian]. KYLIN, H., MITCHELL, D.W., SERAOUI, E.-H. & BUYCK, B. Myxomycetes from Papua New Guinea and New Caledonia. *Fungal Diversity* **59**: 33-44 (2013). LADO, C., ESTRADA-TORRES, A., STEPHENSON, S.L., WRIGLEY DE BASANTA, D. & SCHNITTLER, M. Biodiversity assessment of myxomycetes from two tropical forest reserves in Mexico. *Fungal Diversity* **12**: 67-110 (2003). LEMOS, D.B.N., AGRA, L. DE A.N.N., IANNUZZI, L., BEZERRA, M. DE F. DE A. & CAVALCANTI, L. DE H. Co-existence of myxomycetes and beetles in an Atlantic Rainforest remnant of Pernambuco, Brazil, with emphasis on staphylinids (*Coleoptera*: *Staphylinidae*). *Journal of Natural History* **44**(21-24): 1365-1376 (2010) [DOI: 10.1080/00222931003632724]. LIERL, M.B. Myxomycete (slime mold) spores: unrecognized aeroallergens? *Annals of Allergy, Asthma & Immunology* **111**(6): 537-541 (2013) [DOI: 10.1016/j.anai.2013.08.007]. LIU, Q.S., YAN, S.Z., DAI, J.Y. & CHEN, S.L. Species diversity of corticolous myxomycetes in Tianmu Mountain National Nature Reserve, China. *Canadian Journal of Microbiology* **59**(12): 803-813 (2013) [DOI: 10.1139/cjm-2013-0360]. LIZÁRRAGA, M., ILLANA, C. & MORENO, G. SEM studies of the myxomycetes from the peninsula of Baja California (Mexico), I. *Arcyria* to *Fuligo*. *Annales Botanici Fennici* **35**(4): 287-306 (1998). LIZARRAGA, M., MORENO, G., ESQUEDA, M., SALAZAR-MARQUEZ, C. & CORONADO, M.L. Myxomycetes of Chihuahua (Mexico) 4. Central plains of the Chihuahuan desert. *Mycotaxon* **130**(4): 1073-1101 (2015). MADELIN, M.F. Myxomycete data of ecological significance. *Transactions of the British Mycological Society* **83**(1): 1-19 (1984). MAIMONI-RODELLA, R.C.S. & CAVALCANTI, L. DE H. Myxomycetes on living inflorescences and leaves of ginger lily (*Hedychium coronarium* Koenig, *Zingiberaceae*): a new substrate register. *Revista Brasileira de Botânica* **29**(2): 331-333 (2006) [DOI: 10.1590/S0100-84042006000200014]. MARTIN, G.W. &

ALEXOPOULOS, C.J. *The Myxomycetes* (Iowa City: University of Iowa Press): ix + 561 pp. (1969). MATVEEV, A.V., LEBEDEV, A.N. & GMOSHINSKIY, V.I. [as МАТВЕЕВ, А.В., ЛЕБЕДЕВ, А.Н. & ГМОШИНСКИЙ, В.И.]. Результаты много летнего изучения биоты миксомицетов Ботанического Сада Тверского Государственного Университета [Results of long-term research of myxomycetes biota in the Tver State University Botanical Garden]. *Микология и Фитопатология* [*Mycology & Phytopathology*] **52**(2): 112-119 (2018) [text in Russian]. MCHUGH, R. Moist chamber culture and field collections of myxomycetes from Ecuador. *Mycotaxon* **92**: 107-118 (2005). MEL'NIK, V.A., HEFTBERGER, M. & SCHEUER, C. Some noteworthy deuteromycetes from Steiermark (Austria). *Микология и Фитопатология* [*Mycology & Phytopathology*] **35**(5): 25-35 (2001). MIMS, C.W. Capillitial formation in *Arcyria cinerea*. *Mycologia* **61**(4): 784-798 (1969). MIMS, C.W. An ultrastructural study of spore germination in the myxomycete *Arcyria cinerea*. *Mycologia* **63**(3): 586-601 (1971). MIMS, C.W. Spore-wall formation in the myxomycete *Arcyria cinerea*. *Transactions of the British Mycological Society* **59**(3): 477-481 + 4 plates (1972*a*). MIMS, C.W. An ultrastructural study of precleavage mitosis in the myxomycete *Arcyria cinerea*. *Journal of General Microbiology* **71**(1): 53-62 (1972*b*). MIMS, C.W. & ROGERS, M.A. A light and electron microscopic study of stalk formation in the myxomycete *Arcyria cinerea*. *Mycologia* **67**(3): 638-649 (1975). NANNENGA-BREMEKAMP, N.E. *A Guide to Temperate Myxomycetes* (Bristol, UK: Biopress Ltd): 409 pp. (1991). NDIRITU, G.G., WINSETT, K.E., SPIEGEL, F.W. & STEPHENSON, S.L. A checklist of African myxomycetes. *Mycotaxon* **107**: 353-356 (2009). NEUBERT, H., NOWOTNY, W. & BAUMANN, K. *Die Myxomyceten Deutschlands und des angrenzenden Alpenraumes unter besonderer Berücksichtigung Österreichs* **1**: *Ceratiomyxales*, *Echinosteliales*, *Liceales*, *Trichiales* (Gomaringen, Germany: Karlheinz Baumann Verlag): 344 pp. (1993). NOVOZHILOV, Y.K., ERASTOVA, D.A., SHCHEPIN, O.N., SCHNITTLER, M., ALEXANDROVA, A.V., POPOV, E.S. & KUZNETOV, A.N. Myxomycetes associated with monsoon lowland tropical forests in southern Vietnam. *Nova Hedwigia* **104**(1): 143-182 (2017). NOVOZHILOV, Y.K., SCHNITTLER, M. & STEPHENSON, S.L. The myxomycetes of Russian subarctic and arctic areas. *Микология и Фитопатология* [*Mycology & Phytopathology*] **32**(1): 18-29 (1998). NOVOZHILOV, Y.K., ZEMLIANSKAIA, I.V., SCHNITTLER, M. & STEPHENSON, S.L. Myxomycete diversity and ecology in the arid regions of the Lower Volga River Basin (Russia). *Fungal Diversity* **23**: 193-241 (2006). OGATA, N., RICO-GRAY, V. & NESTEL, D. Abundance, richness, and diversity of myxomycetes in a neotropical forest ravine. *Biotropica* **28**(4): 627-635 (1996). POULAIN, M., MEYER, M. & BOZONNET, J. *Les Myxomycètes* (Sevrier, France: Fédération Mycologique et Botanique Dauphiné-Savoie): **2** vols, 568 pp. + 544 plates (2011). REA-MAMINTA, M.A.D., DAGAMAC, N.H.A., HUYOP, F.Z., WAHAB, R.A. & CRUZ, T.E.E. DE LA. Comparative diversity and heavy metal biosorption of myxomycetes from forest patches on ultramafic and volcanic soils. *Chemistry and Ecology* **31**(8): 741-753 (2015) [DOI: 10.1080/02757540.2015.1091884]. ŘEZANKA, T. Glycosides of polyenoic branched fatty acids from myxomycetes. *Phytochemistry* **60**(6): 639-646 (2002). ROGERSON, C.T. & STEPHENSON, S.L. Myxomyceticolous fungi. *Mycologia* **85**(3): 456-469 (1993). ROJAS, C. & STEPHENSON, S.L. (eds) *Myxomycetes* Biology, Systematics, Biogeography and Ecology (London, UK & Cambridge, MA, USA: Academic Press): 474 pp. (2017). ROSTAFIŃSKI, J.T. Śluzowce (*Mycetozoa*) Monografia. *Pamiętnik Towarzystwa Nauk Ścisłych w Paryżu* **6**(1): 217-432 + plates 6-13, figs 92-242 (1875) [text in Polish]. SCHNITTLER, M. Foliicolous liverworts as a microhabitat for neotropical myxomycetes. *Nova Hedwigia* **72**(1-2): 259-270 (2001). SCHNITTLER, M. & STEPHENSON, S.L. Inflorescences of neotropical herbs as a newly discovered microhabitat for myxomycetes. *Mycologia* **94**(1): 6-20 (2002). SCHNITTLER, M., UNTERSEHER, M. & TESMER, J. Species richness and ecological characterization of myxomycetes and myxomycete-like organisms in the canopy of a temperate deciduous forest. *Mycologia* **98**(2): 223-232 (2006). SHCHEPIN, O.N., SCHNITTLER, M., ERASTOVA, D.A., PRIKHODKO, I.S., DAHL, M.B., AZAROV, D.V., CHERNYAEVA, E.N. & NOVOZHILOV, Y.K. Community of dark-spored myxomycetes in ground litter and soil of taiga forest (Nizhne-Svirskiy Reserve, Russia) revealed by DNA metabarcoding. *Fungal Ecology* **39**(1): 80-93 (2019). SHI, L.P. & LI, Y. Life cycle of *Arcyria cinerea*. *Journal of Northeast Normal University* Natural Science Edition 2012(1): 25 (2012). SHINTANI, A., TOUME, K., RIFAI, Y., ARAI, M.A. & ISHIBASHI, M. A bisindole alkaloid with Hedgehog Signal Inhibitory Activity from the myxomycete *Perichaena chrysosperma*. *Journal of Natural Products* **73**(10): 1711-1713 (2010) [DOI: 10.1021/np1002687]. SONG, T.P. & CHEN, S.L. [Species diversity of myxomycetes in Huanglian

Mountain National Nature Reserve of Yunnan province, China]. *Journal of Ecology and Rural Environment* **30**(4): 458-463 (2014) [text in Chinese]. STEPHENSON, S.L. & MCQUATTIE, C.J. Assessing the potential use of myxomycetes as biomonitors of heavy metals in the environment. *Proceedings of the West Virginia Academy of Science* **72**: 32-33 (2000). STEPHENSON, S.L., WHEELER, Q.D., MCHUGH, J.V. & FRAISSINET, P.R. New North American associations of *Coleoptera* with myxomycetes. *Journal of Natural History* **28**(4): 921–936 (1994) [DOI: 10.1080/00222939400770491]. TAKAHASHI, K. Distribution of myxomycetes on different decay states of deciduous broadleaf and coniferous wood in a natural temperate forest in the southwest of Japan. *Systematics and Geography of Plants* **74**: 133-142 (2004). TESMER, J. & SCHNITTLER, M. Sedimentation velocity of myxomycete spores. *Mycological Progress* **6**(4): 229-234 (2007). TIFFANY, L.H. Myxomycetes of Big Bend National Park, Texas. *Journal of the Iowa Academy of Science* **108**(3): 98-102 (2001). TRAN, H.T.M., STEPHENSON, S.L., HYDE, K.D. & MONGKOLPORN, O. Distribution and occurrence of myxomycetes in tropical forests of northern Thailand. *Fungal Diversity* **22**: 227-242 (2006). TURNER, P.D. Microorganisms Associated with Oil Palm (*Elaeis guineensis* Jacq.). *Phytopathological Papers* **14**: 58 pp. (1971). WRIGLEY DE BASANTA, D. The effect of simulated acid rain on corticolous myxomycetes. *Systematics and Geography of Plants* **74**(1): 175-181 (2004). WRIGLEY DE BASANTA, D., LADO, C., ESTRADA-TORRES, A. & STEPHENSON, S.L. Biodiversity of myxomycetes in subantarctic forests of Patagonia and Tierra del Fuego, Argentina. *Nova Hedwigia* **90**(1-2): 45-79 (2010). WRIGLEY DE BASANTA, D., STEPHENSON, S.L., LADO, C., ESTRADA-TORRES, A. & NIEVES-RIVERA, A.M. Lianas as a microhabitat for myxomycetes in tropical forests. *Fungal Diversity* **28**: 109-125 (2008). YAĞIZ, D. & AFYON, A. The ecology and chorology of myxomycetes in Turkey. *Mycotaxon* **101**: 279-282 (2007). YANG, T.X., LI, C., LI, Y.S., WANG, X.L. & LI, Y. [Changes in cell shape during locomotion of four *Myxamoebae* of myxomycetes]. *Journal of Jilin Agricultural University* **40**(2): 178-184 (2018) [text in Chinese].

Sources additional to those already cited from literature and the internet.

- *Biodiversity Heritage Library* [*www.biodiversitylibrary.org*].
- *Checklist of Fungi of the British Isles* [*https://basidiochecklist.science.kew.org/BritishFungi/FRDBI/FRDBI.asp*].
- *Cybertruffle* [*www.cybertruffle.org.uk*].
- *Discover Life (myxomycete pages)* [*www.discoverlife.org/mp/20q?guide=Myxomycetes*].
- *Fungal Records Database of Britain and Ireland* [*www.frdbi.info*]
- *Fungus Conservation Trust CATE2 Database* [*www.abfg.org*].
- *GBIF* [*www.gbif.org*].
- *Google* [*www.google.co.uk*].
- *Landcare Research New Zealand* [*http://nzfungi2.landcareresearch.co.nz*].
- *Mycoportal* [*www.mycoportal.org*].
- *Mycotaxon Regional Checklists in Downloadable Format* [*www.mycotaxon.com/mycobiota*].
- *National Center for Biotechnology Information* [*www.ncbi.nlm.nih.gov*].
- *Nomen.mycetozoa.com - an online nomenclatural information system of Eumycetozoa* [*http://eumycetozoa.com*].
- *USDA Fungal Databases* [*https://nt.ars-grin.gov/fungaldatabases*].

T.I. Kryvomaz[1], **A. Michaud**[2] & **D.W. Minter**[3]
[1]*Kyiv National University of Construction and Architecture, Kyiv, Ukraine*
[2]*93 Route de La Croizette, F-38360 Engins, France*
[3]*CABI Europe, Egham, UK*

Issued by CABI, Bakeham Lane, Egham, Surrey, TW20 9TY, UK