GLOMOSPORA AND GLOMOPSIS

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A hyphomycetous fungus associated with dying of *Empetrum nigrum* has been collected on several occasions in Scotland during the last few years. Previously, the late Dr. Malcolm Wilson had received three collections of the same fungus from Scotland and had provisionally assigned them to the genus *Glomerularia* Peck. The recent collections stimulated a more complete investigation. As no described genus has been found to accommodate this fungus satisfactorily the following new genus and species are proposed.

Glomospora D. M. Henderson, **gen. nov.**
Fungi imperfecti, Moniliaceae hyalosporae. Mycelium immersum, ex hyphis hyalinis septatis compositum. Conidiophora simplicia, erecta, hyalina, septata; summa cellula in tubulo angustiore abrupte contracta; ramuli breves, paulum ramosi. Conidia acrogena in apice lato ramulorum singulatim orientia globosa, sicca, hyalina, in glomerulis integris apice stipitis fracto dejecta. Species typica *Glomospora empetri.*
Mycelium immersed in the host, hyaline, septate. Conidiophores simple or sparingly branched from the base, erect, septate, the uppermost hyaline cell abruptly contracted medianly into a narrow tube, sparingly branched at the base, with short, sparingly dichotomous branches at the apex. Conidia borne acrogenously and singly on the broad apex of the ultimate branchlets, globose, dry, hyaline, liberated as conidial-bearing heads by the fracture of the uppermost cell of the stipe.

Glomospora empetri D. M. Henderson **sp. nov.**
Mycelium immersum hyalinum septatum 2–3μ latum. Conidiophora in soris pulvinatis erumpentibus aggregata, ex hyphis hyalinis orientia, hyalina, erecta, paulum septata, usque ad 120μ longa, 8–10μ lata, septo supremo stipitis a duobus hyphis e cellula inferiore orientibus cincto, cellula suprema in tubulo 6μ lato abrupte contracta. Apex conidophororum 4–partitim ramosus. Ramuli paulum ramosi septatique 8–14μ longi 5μ lati. Conidia subglobosa, hyalina, 1–cellulata dense echinulata 6–9μ in diametro e conidiophororum ramulis a septis latis divisa, in glomerulis ex 8–14 conidiis compositis, cellula suprema stipitis fracta, dejecta. Habitat in foliis moribundis *Empetri nigri* L. et *E. hermaphroditi* (Lange) Hagerup.

Mycelium immersed in the host intra- and intercellular. Hyphae hyaline, sparingly branched 2–3μ in diameter, without clamp connections. Sori strictly foliicolous usually confined to the under surface of the revolute host leaves, developing from a sparse subcuticular layer of plectenchyme which displaces some of the epidermal cells. Young sori composed of a compact palisade of conidiophores which rupture the cuticle. In surface view young sori pallid grey and tremellaceous in texture. Sori 0·2–0·5 mm. in diameter. Conidiophores hyaline, usually unbranched but occasionally

bearing one (rarely two) branches from the base. Stipe 2–3 septate, up to 120μ long, 8–10μ broad. Ultimate cell abruptly contracted approximately medianly to about 5μ. The septum between the ultimate and penultimate cells of the stipe encircled by two hyphae arising from the upper part of the penultimate cell. Apex of the stipe bearing at first four branches each simple or branched once or twice and each bearing 1–4 spores. All branches short, 8–11μ long, 5μ broad. Conidia one-celled, subglobose, hyaline, dry, densely echinulate, 6–9μ in diameter, produced as the enlarged ends of conidiophore branches and delimited from them by 5μ broad, very indistinct septa. Conidial head pure white composed of 8–14 conidia the whole head shed by the fracture of the ultimate cell of the stipe at the point of contraction.

Habitat: on living and moribund leaves of *Empetrum nigrum* L. and *E. hermaphroditum* (Lange) Hagerup.

Material examined.

On *E. nigrum* s. str.: Gifford, E. Lothian 19 Nov. 1954, *D. M Henderson* 1746 (holotype); Glen Fee, Clova, Angus, 21 Oct. 1953, *D. M. Henderson* 1033; Ardvie, Morayshire, coll. *J. Macdonald* & *M. Anderson* [Herb. M. Wilson].

On *E. hermaphroditum*; Meall Odhar, Devils Elbow, Perthshire, c. 750 m., 19 Apr. 1954, *D. M. Henderson* 1311.

The distinctive features of this monotypic genus are the specialised conidiophore stipe, the dispersal of conidial heads entire—'in glomerules' and the monomorphic conidia. With respect to the first two characters it is similar to *Glomerularia* Peck, but in that genus the conidiophore head is more specialised the conidia fewer and dimorphic.

Development of the Conidiophore

The conidiophores arise from a subcuticular palisade of hyaline cells. Following the rupture of the cuticle these cells grow rapidly, producing a row of two to four cells, the apical one with a characteristic constriction (fig. b). The appendages arise most frequently as a pair of outgrowths from below the septum of the ultimate cell (fig. c and h) but occasionally only one develops (figs. b, i and j). The apex of the conidiophore produced four short lobes (fig. b and e) each of which branches (fig. f). By unequal growth of these pairs of branches one assumes a lateral position (fig. g). The terminal branch usually divides once more. The apex of each branch differentiates into a spore so that each conidiophore bears a head of from eight to fourteen conidia (fig. m). In the process of spore formation the branch ends swell and the wall becomes asperate. If a spore mass is squashed severely in mounting it is possible to isolate the conidia from the heads (fig. n.) and the echinulate apex with the short smooth basal portion is more easily examined.

The development of the stipe appendages subsequent to their initial outgrowth is obscure, they always become closely applied to the wall of the cell above that from which they develop and in some cases appear to fuse with it (figs. i and j). Usually they form complex coils and may even fuse with one another (figs. k and l).

The function of these appendages is not clear. In the mature conidiophore the ultimate cell of the stipe and branches are charged with

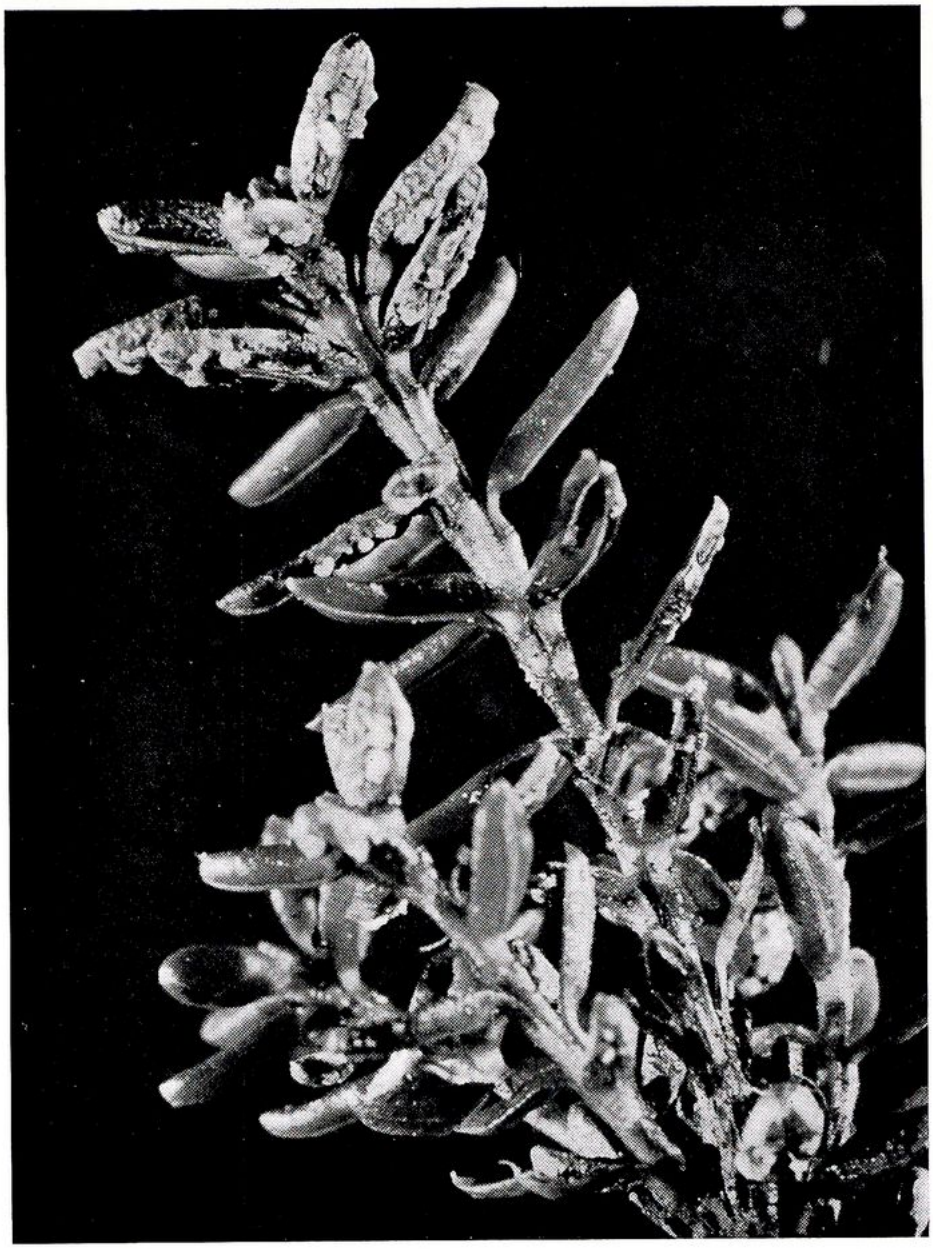


PLATE 17. *Glomospora empetri*. Sori on Empetrum nigrum.

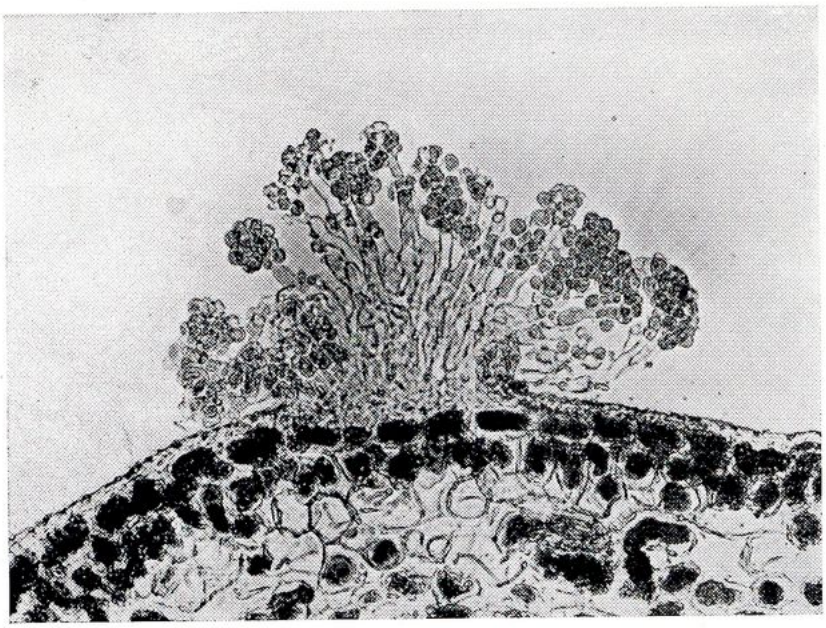
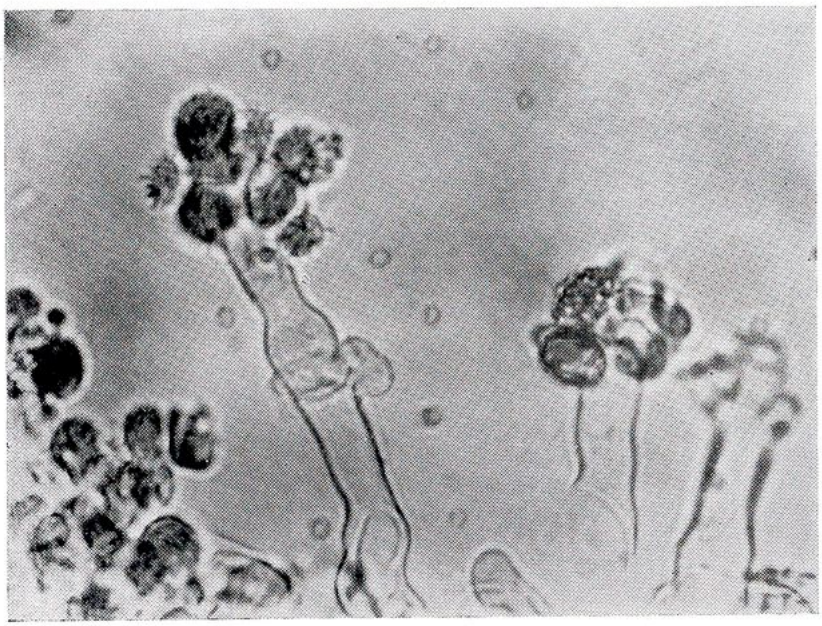


PLATE 18. *Glomospora empetri.*
Above, section of sorus on Empetrum leaf.
Below, immature conidiophore bearing stipe appendages.



dense protoplasm whilst the penultimate cell is highly vacuolate. The appendages may thus act as channels for rapid transport of the contents of the stipe cells to the developing spores. On the other hand their similarity to clamp connections is striking, except that the outgrowths grow from the penultimate cells, whereas with few exceptions clamps grow from ultimate to penultimate cells. The fact that the nearest relative of *Glomospora* has one species, *Glomopsis lonicerae* (see below), known to be the imperfect stage of a basidiomycete, lends strength to the suggestion that these are homologous with basidiomycetous clamps; but it must be admitted that no clamps are known in either *Glomopsis lonicerae* or its perfect state *Herpobasidium deformans*.

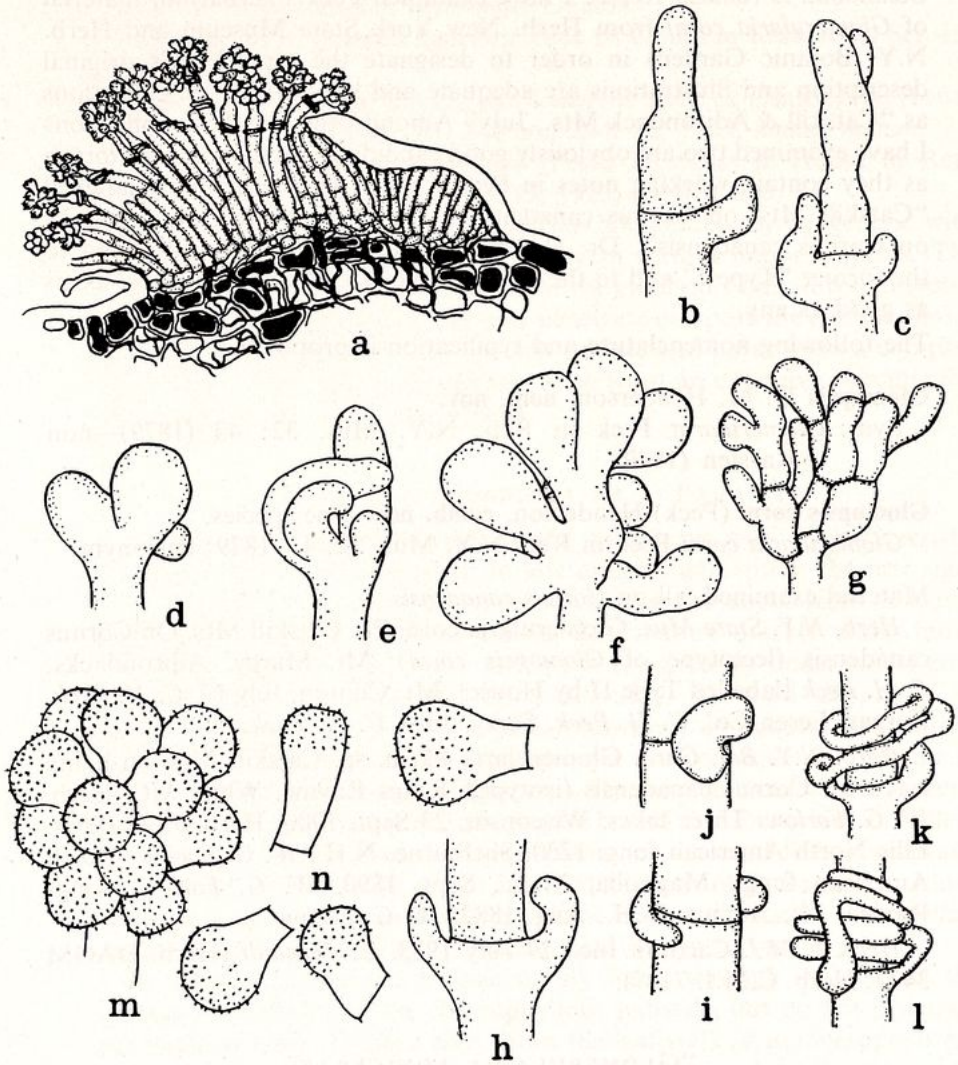


FIG. 1. *Glomospora empetri*. a. Erumpent subcuticular sorus. b & c. Development of young conidiophore. d-g. Stages in branching of conidiophore apex. h-l. Development of conidiophore stipe appendages. m. Mature head of conidia. n. Mature artificially detached conidia. a × 150; b-n × 1500.

GLOMERULARIA PECK

While attempting to find a genus to accommodate the *Empetrum* fungus Peck's genus *Glomerularia* was considered. Peck described the genus in 1879 [Rep. N.Y. Mus. 32: 43, 1879] for a fungus which he called *Glomerularia corni* causing leaf spot of *Cornus canadensis*. It should be noted that Saccardo's reference in Sylloge Fungorum iv, 10, to *Glomerularia* Peck in litt. & Farlow in Appallachia iii (1884) is misleading as Farlow did not give any description other than, "it forms white spots on the leaves" and in any case it had been well described and figured by Peck five years earlier. However Peck was apparently unaware that *Glomerularia* Peck was a later homonym of *Glomerularia* Karsten which is based on *Glomerularia ramosa* Karst. [in Bot. Zeit. vi, 368, 1849= *Gonatobotrys ramosa* Reiss]. I have examined Peck's herbarium material of *Glomerularia corni* from Herb. New York State Museum and Herb. N.Y. Botanic Gardens in order to designate the type. Peck's original description and illustrations are adequate and he localises the collections as "Catskill & Adirondack Mts., July" Amongst the nine Peck collections I have examined two are obviously good candidates for choice as lectotype as they contain working notes in Peck's hand. They are simply labelled "Catskill Mts. on Cornus canadensis", and "Mt. Marcy, Adirondacks on Cornus canadensis". Dr. House labelled the capsules and added to the former "Type I" and to the latter "Type II". House's selection seems as good as any.

The following nomenclature and typification is proposed.

Glomopsis D. M. Henderson, **nom. nov.**

Syn.: *Glomerularia* Peck in Rep. N.Y. Mus. 32: 43 (1879)—non Karsten (1849).

Glomopsis corni (Peck) Henderson, **comb. nov.** type species.

Glomerularia corni Peck in Rep. N.Y. Mus. 32: 43, 1879; basionym.

Material examined, all on *Cornus canadensis*

Herb. N.Y. State Mus. Glomerularia corni Pk. Catskill Mts. On Cornus canadensis (lectotype of *Glomopsis corni*); Mt. Marcy, Adirondacks, *C. H. Peck* [labelled Type II by House]. Mt. Clinton, July 19, *C. H. Peck*. Borgas, Ecsen Co., *C. H. Peck*. Serzy, July, *C. H. Peck*.

Herb. N.Y. Bot. Gard. Glomerularia Pk. n. sp. Catskill Mts. on living leaves of Cornus canadensis (isotype). Kings Ravine, White Mt., Herb. *W. G. Farlow*. Three lakes, Wisconsin, 23 Sept. 1900, Herb. *J. J. Davis*. Ellis North American fungi 1230, Shelburne, N.H., *W. G. Farlow*. North American fungi, Magnolia, Mass., Sept. 1890, *W. G. Farlow*. Kings Ravine, Mt. Adams, N.H., Aug. 1882, *W. G. Farlow*.

Herb. C.M.I. Cacoura Inc., 27 July 1933, *C. Bernault* (Herb. DAOM 3432; Herb. C.M.I. 7147).

"GLOMERULARIA LONICERAE"

A second species of *Glomerularia* has been generally recognised in North America on species of *Lonicera*. Peck however never published the name *Glomerularia corni* var. *lonicerae* which has frequently been ascribed

to him; the name is thus a *nomen nudum*. Peck (1885, p. 111) reported *G. corni* on *Lonicera* as follows "Hitherto found only on Cornus canadensis but now on Lonicera ciliata also. Adirondack Mts. June". In Herb. N.Y. State Museum the corresponding specimen is labelled by Peck "Aiden Lair, Adirondack Mts. Charles H. Peck, June, form lonicerae ciliatae".

Gould (1944) has recently shown that the *Glomerularia* on *Lonicera* is the imperfect stage of *Herpobasidium deformans* Gould and has included a description of it in his diagnosis of that species.

If a name is required for conidial *Herpobasidium deformans* the following is proposed.

Glomopsis lonicerae (Peck ex Gould) Henderson, **comb. nov.** [Imperfect state of *Herpobasidium deformans* Gould].

Basionym. *Glomerularia lonicerae* Peck ex Gould in Iowa Jour. Sci. 19, 301-331, 1944.

Synonym. *Glomerularia corni* var. *lonicerae* Peck ex Dearness & House in Rep. N.Y. Mus. No. 243 and 244, 85, 1923, *nomen nudum*.

Glomerularia lonicerae (Peck) Dearness & House in Rep. N.Y. Mus. No. 243 and 244, 85, 1923, *comb. illegit.*

The conidial stage *Glomopsis lonicerae* is undoubtedly congeneric with *Glomopsis corni* and the two differ only in certain minor respects. The conidiophores of *G. lonicerae* penetrate the epidermis only through stoma pores and although two or more may penetrate one pore the conidiophores are dispersed at intervals over the leaf surface and never form a compact sorus. In *G. corni* the conidiophores arise from an extensive subcuticular mycelium and form discrete groups.

GLOMOSPORA EMPETRI AS A PARASITE

This fungus has always been found associated with a characteristic dying out of *Empetrum nigrum*. In late autumn and spring the first signs of attack appear as isolated brown patches on the under sides of leaves produced during the previous season. Sori mature quickly under moist conditions and are pure white and quite conspicuous under moist conditions (Plate 17)—they are easily mistaken for bird droppings in casual observation. In dry weather, however, immature sori shrivel rapidly and retract almost completely and are consequently difficult to detect even with the aid of a hand lens. By the time conidia are mature, infected leaves are usually entirely greyish brown and somewhat shrivelled; they are not usually shed. The grey colour of the dead foliage contrasts with foliage of *Empetrum* which has died through other causes, in which case it is usually brown and turgid, at least in the early stages. *Phaengellina empetri* is a frequent fungus on such dead brown leaves.

In infected foliage the hyphae ramify freely through the cells of the spongy mesophyll and the chlorophyllous palisade, but do not penetrate the vascular trace. Hyphae pass down the leaf stalk in the mesophyll but do not penetrate the stem. Several attempts to reproduce the disease by inoculating *Empetrum* plants with conidia have so far failed. This is probably due to failure to reproduce conditions favourable to infection. Both the scattered distribution of initial infection spots and the failure

to find hyphae in the stem suggest annual infection rather than the existence of a perennating mycelium.

The spores of Glomospora and Glomopsis

The most interesting character of the genera *Glomospora* and *Glomopsis* is the dispersal of spores in groups or "in glomerules", as Peck so acutely noted in his original description of *G. corni*. He interpreted the head as a collection of conidia liberated as a group. According to this interpretation the ultimate differentiated cells are indehiscent thallospores. The alternative interpretation is that the entire head is a complex spore comparable perhaps to the isthmospore of *Trichothyrium* (Hughes, 1953) or the digitately branched conidia of *Tetracladium* (Ingold, 1941). However, in *Trichothyrium* the spore secedes from spore mother cells at the basal septum; similarly the spores of *Tetracladium* secede at their points of origin. There is no comparable point of origin and secession on the stipe of *Glomopsis* or *Glomospora* but rather an indeterminate zone of fracture in the region of contraction, somewhat similar to the zone of fracture in the teleutospore stipes, although there, as Savile (1955) has pointed out, the zone of fracture is determined by the thinning of stipe wall and the resultant juxtaposition of thick and thin walls.

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