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Two New Species of Leafblight Fungi on Kalmia Latifolia

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Abstract
The evergreen shrub, Kalmia latifolia L., commonly known as mountain laurel, calico bush, or sheep-kill, grows widely on rocky, acid soils in the eastern United States. Whether growing in its natural habit or in cultivation, mountain laurel appears to be equally subject to attack by fungi. The following account characterizes and discusses two of these fungi. One of them has not been described previously and additional observations have been made regarding the developmental morphology of the other one.

Both pathogens are Pyrenomycetes, one a Physalospora and the other a Diaporthe. Each produces a leafblight disease. Tiny brown discolorations on young leaves characterize the early stages of attack by both organisms. These small lesions gradually enlarge and become irregular brown spots that may encompass the major portion of the leaf surface. The invaded tissues are darkest near the margins of the lesions, but a reddish zone lies between the darker border and the surrounding green tissues. Severely attacked leaves are deformed and shed prematurely.

The reproductive structures of the Physalospora occur on the lower surface and begin to develop before the leaves are shed. The pycnidial stromata of the Diaporthe elevate the epidermis and caticle, and consequently produce grayish spots on the leaf surface. Both fungi continue to develop after the leaves have fallen, and since the mycelia extend beyond the margins of the lesions, perithecia ultimately may occupy most of the leaf surface. [*excerpt*]

Keywords
leafblight, Kalmia latifolia, fungi, mountain laurel

Disciplines
Biology | Horticulture | Plant Sciences

TWO NEW SPECIES OF LEAFBLIGHT FUNGI ON KALMIA LATIFOLIA

F. A. Wolf and A. R. Cavaliere

(with 8 figures)

The evergreen shrub, *Kalmia latifolia* L., commonly known as mountain laurel, calico bush, or sheep-kill, grows widely on rocky, acid soils in the eastern United States. Whether growing in its natural habit or in cultivation, mountain laurel appears to be equally subject to attack by fungi. The following account characterizes and discusses two of these fungi. One of them has not been described previously and additional observations have been made regarding the developmental morphology of the other one.

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The reproductive structures of the *Physalospora* occur on the lower surface and begin to develop before the leaves are shed. The pycnidial stromata of the *Diaporthe* elevate the epidermis and cuticle, and consequently produce grayish spots on the leaf surface. Both fungi continue to develop after the leaves have fallen, and since the mycelia extend beyond the margins of the lesions, perithecia ultimately may occupy most of the leaf surface.

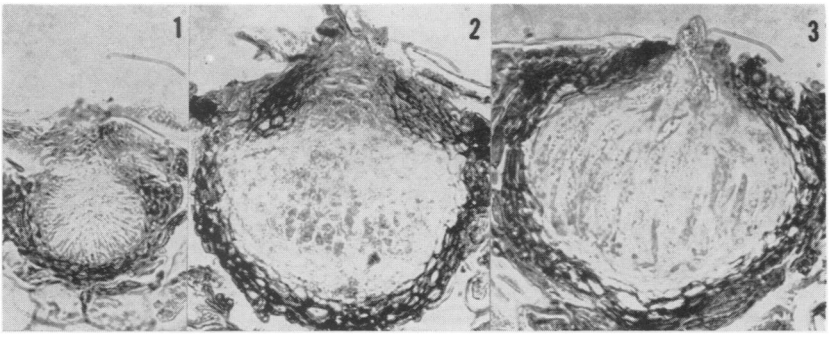
Physalospora

Both recently infected leaves and older fallen ones were collected near Simsbury, Connecticut, during late April and again about a month later, but the reproductive structures were immature. Diseased leaves were placed in a moist chamber. After 8–10 days some of the structures developed into mature perithecia whereas others, still immature, were in various stages of development. To trace perithecial formation, diseased tissues were fixed in formalin-acetic acid-alcohol, dehydrated,

embedded in paraffin, sectioned, and stained with hematoxylin. These stained sections contained spermagonia, young ascocarps and perithecia in various developmental stages. Moreover, these three structures were in such close contact in the leaf tissues that we interpreted them as fructifications of the same species.

The spermagonia are spherical bodies approximately 70 μ in diameter. At maturity they are completely filled with parallel-elements, the spermatiophores. Bacilliform spermatia, 2×4 μ in size, are first formed near the ostiolum. Subsequent spermatial formation proceeds toward the spermagonial base. The spermatia are extruded from the ostiolum and adhere in a mass at the leaf surface (FIGS. 1, 4).

The young ascocarps are globular or subspherical bodies, 57–104 μ high and 65–120 μ in diameter. The wall is made up of several cell layers, the individual elements of which are dark brown, thick-walled,



FIGS. 1–3. Photomicrographs of longitudinal sections of *Physalospora kalmiae*. 1. Spermagonium. × 100. 2. Young ascocarp. × 100. 3. Perithecium. × 100.

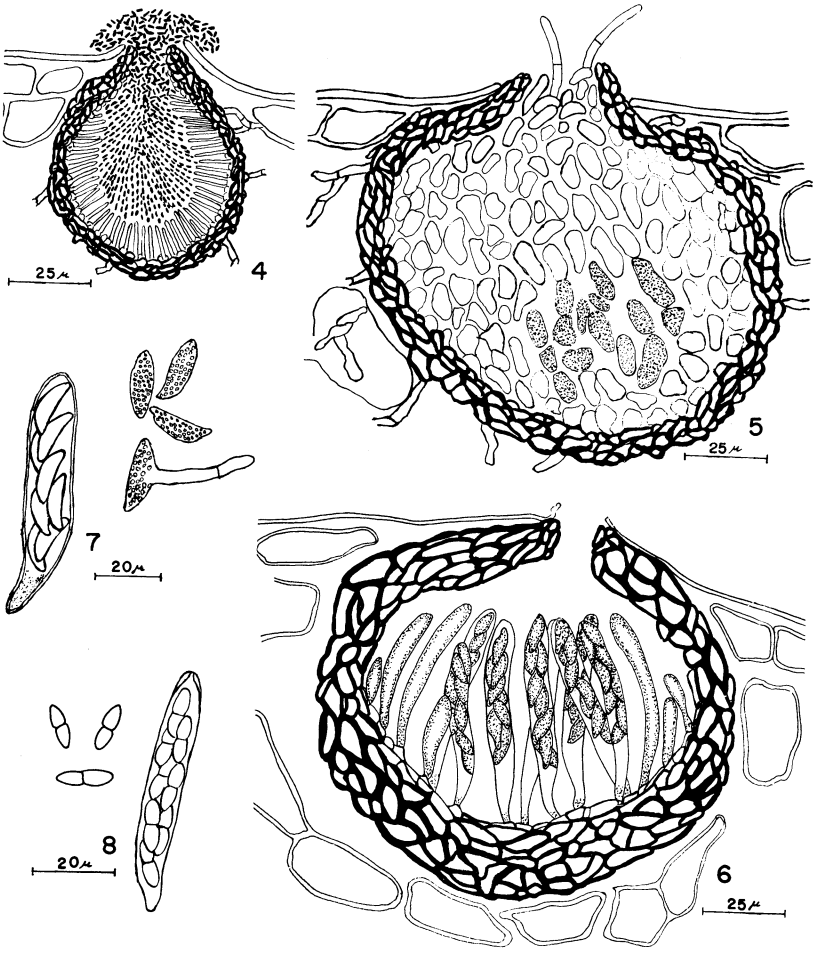
and more or less spherical or broadly ellipsoidal. The centrum in early development is completely filled with thin-walled, loosely-arranged polygonal cells. Groups of more deeply staining cells occupy the basal portion (FIGS. 2, 5). These deeply stained structures are interpreted as parts of the ascogones although it was not possible to distinguish croziers or ascogenous hyphae. However, structures identified as trichogynes extend from the ostiolar region (FIG. 5).

The young ascocarps (FIGS. 2, 5) gradually become transformed into mature perithecia (FIGS. 3, 6). During this process, the pseudoparenchymatous cells in the centrum are dissolved and utilized by the developing asci. Young asci are densely filled with minute granules.

Neither standard checklists of fungi (Seymour, **1929**; Weiss, **1950–53**), nor current mycological literature refer to *Physalospora* on *Kalmia*

latifolia. Several species of this genus, however, are known to attack other members of the Ericaceae. Therefore, essential features of the organism on mountain laurel were compared with species on other Ericaceae (TABLE I).

These data (TABLE I) show the fungus on mountain laurel to have smaller spores than those occurring on other species of Ericaceae. Moreover, spore shape is different. Consequently we regard the *Kalmia*



FIGS. 4–8. 4–7. *Physalospora kalmiae* (camera lucida drawings). 8. *Diaporthe kalmiae*. 4. Spermagonium. 5. Young ascocarp. 6. Perithecium. 7. Ascus and ascospores. 8. *Diaporthe kalmiae* ascus and ascospores.

TABLE I

SPECIES OF PHYSALOSPORA ON ERICACEAE

SUSCEPTS	PATHOGEN	ASCOSPORE SIZE (μ)	ASCOSPORE SHAPE
Vaccinium	*P. corticia* Dem. & Wilcox	29×11	Ellipsoidal, fusoidal
Chamaedaphne *Lyonia* *Oxydendrum* *Rhododendron* *Vaccinium*	*P. obtusa* (Schw.) Cke.	35–40×9	lanceolate
Lyonia	*P. entoxia* (C. & E.) Sacc.	30–32×10	lanceolate
Rhododendron	*P. rhododendri* (De Not.) Rehm	20×8	oblate
Azalea *Clethra*	*P. viscosa* (C. & E.) Sacc.	35×10	naviculate
Kalmia	*P. kalmiae* Wolf & Cavaliere	15–16×5–6	inaequilateral and apiculate

pathogen as an undescribed species. Accordingly, it is given the name *Physalospora kalmiae* and characterized as follows:

Physalospora kalmiae Wolf & Cavaliere, sp. nov.

Maculae magnae, irregulares, brunnae, cum marginae rubicunde. Peritheciis hypophyllis, ab margine maculae vel dispersis, innatis deinde erumpentibus, globosis, atris, papillatis, 56–150 alt. × 78–170 μ lat., muro 3–5-cellula, crasso, aparaphysatis. Ascis octosporis bitunicatis, elongato-clavatis, 90–110 × 12–15 μ; ascosporis apiculatis, inaequalaeralibus, dense guttulatis, hyalinis, 15–16 × 5–7 μ. Spermagoniis et carpogoniis in consortio cum peritheciis. Spermatiis bacilliformibus.

Hab.: in foliis vivis atque emortuis Kalmiae latifoliae, Simsbury, Connecticut.

Necrotic leafspots large, irregular, brown with a reddish marginal zone. Perithecia borne on the lower leaf surface, either in a line near the margin between necrotic and green tissues or widely dispersed, innate but with erumpent necks; perithecia 56–150 × 78–170 μ, globular, or slightly flattened, venter wall 3–5 cells thick. Aparaphysate. Asci 8-spored, bitunicate, elongate to clavate, 90–110 × 12–15 μ. Ascospores blunt-apiculate, inequilateral, densely filled with minute guttules, hyaline, 15–16 × 5–7 μ (FIG. 7).

Type: On leaves of *Kalmia latifolia,* Simsbury, Connecticut, F. A. Wolf, April, 1964 (HOLOTYPE, BPI; ISOTYPE, DUKE).

The genus *Physalospora,* as presently delimited, contains well over 100 species, many of which are pathogenic on such cultivated plants as apples, pears, oranges, avocados, sugar cane, corn, and cocoa. Most of them are not known to possess a conidial stage, but in a few instances, conidial stages belonging either to *Sphaeropsis, Diplodia, Macrophoma,* or to *Colletotrichum* are known to be connected with the developmental cycle of certain species. Some species of *Physalospora* are paraphysate, while others lack paraphyses. Certain species, *P. obtusa* (Schw.) Cooks, for example, have a wide suscept range, whereas others are restricted to a single genus.

The foregoing facts indicate that monographic studies of the genus *Physalospora* should be made based in part on results of cross inoculation experiments and in part on the possible taxonomic significance of conidial stages. It would appear that *Physalospora,* as presently understood, consists of several genera.

DIAPORTHE

Enlows (**1918**) first directed attention to the presence, in the District of Columbia, of a leafblight on *Kalmia latifolia,* and identified the causal agent as *Phomopsis kalmiae* Enlows. Since this organism had not been described previously, she made a detailed study of its morphology, pathogenicity, and cultural characteristics. In addition, she compared it with certain other pathogenic species of *Phomopsis,* including *P. citri* Fawcett, *P. vexans* (Sacc. & Syd.) Harter, and *P. mali* Roberts. None of them was found to be capable of infecting *Kalmia.* All of her attempts to find an ascigerous stage were unsuccessful.

It has long been known that the causal agent of leafblight of mountain laurel growing in the vicinity of Durham, North Carolina, is identical with the organism described by Enlows, but its perithecial stage had not been demonstrated. Accordingly, infected leaves of *Kalmia* were placed in a moist chamber. After a period of two weeks mature perithecia of *Diaporthe* had developed. Subsequently, poured plates of corn meal agar were inverted above the perithecia-bearing leaves to trap ejected ascospores. The isolates obtained by this procedure consisted of loose-spreading white mycelia. Ultimately, sparse clusters of pycnidia developed containing conidia and scolecospores (also called stylospores and beta spores) identifiable with those of *Phomopsis kalmiae.* The occurrence of a conidial and an ascigerous stage in the developmental pattern of the mountain laurel leafblight fungus accords with that of the known pattern of several other species of pathogenic *Diaporthe,* such as *D. sojae*

Lehman, *D. phaseolarum* Harter, *D. citri* Wolf, *D. batatatis* Harter & Field, and *D. arctii* Nitschke.

In light of these new findings, and since the *Kalmia* pathogen was not known previously to possess a perfect stage, it is deemed best to give it the new name, *Diaporthe kalmiae*. It is characterized as follows:

Diaporthe kalmiae Wolf & Cavaliere, sp. nov. (= *Phomopsis kalmiae* Enlows)

Laesiones foliorum magni, brunnei; Peritheciis singulis vel paucis, in folii parenchymate immersis, globulosis, nigris, 75–125 μ in diam; rostro conoideo, epidermidem vix excedente. Ascis unitunicatis clavatis, aparaphysatis, 50–60 × 8–9 μ; sporidiis laxe distichis, ellipticis, medio uniseptatis, leniter constrictis, rectis hyalinis, 10–12 × 3–4 μ.

Status conidicus: Pycnidiis subglobosis, epidermide tectis, sparsis, sine stromate, carbonaceis, ostiolatis, plerumque unilocularibus. Conidiis ovatis, ellipsoideis vel subfusoideis, hyalinis, typice guttulatis, 5.5–8.8 × 1.8–3.6 μ; conidiophoris filiformibus, plerumque continuis, hyalinis, 9–20 × 0.5–2.0 μ; scolecosporis filiformibus, rectis, curvulis, vel hamatis, raro sigmoideis, 14–33.6 × 1.6–2.4 μ.

Hab.: in foliis et caulibus, Kalmiae latifoliae in Regione Columbia, atque Carolina boreale.

Large brown leaf lesions; perithecia solitary or subgregarious, innate, spherical, black, 75–125 μ in diameter, with short conical necks that scarcely protrude above the leaf surface. Asci clavate, unitunicate 50–60 × 8–9 μ. Aparaphysate. Ascospores loosely distichate, ellipsoidal, slightly constricted, medianly septate, straight, hyaline, 10–12 × 3–4 μ (FIG. 8).

Conidial state: Pycindia scattered, subglobose to spherical, nonstromatic, carbonaceous, ostiolate, usually unilocular. Conidia ovate, ellipsoidal or subfusoidal, hyaline, typically guttulate, 5.5–8.8 × 1.8–3.6 μ; conidiophores filiform, usually continuous, hyaline, 9–20 × 0.5–2.0 μ; scolecospores filiform, straight, curved or hamate, rarely sigmoid, 14–33.6 × 1.6–2.4 μ.

Type: On leaves of *Kalmia latifolia,* Durham, North Carolina, F. A. Wolf, March, 1964 (HOLOTYPE, BPI; ISOTYPE, DUKE).

The assignment of an acceptable species name for this fungus on *Kalmia* has been difficult for several reasons. First, over 650 species of *Diaporthe* have been described. Second, perithecial features are of little value in such a large assemblage of species and the ascospores of many of the species, presently recognized as valid, are identical in shape and size. Third, certain species, such as *D. arctii* Nitschke, the generic type, and *D. eres* Nitschke are ubiquitous, occurring on twigs of a very wide variety of hosts while others have a very limited range. Thus, the host is of questionable value in delimiting species. Fourth, at least three

species of *Diaporthe* are known to occur (Wehmeyer, **1933**) on Ericaceae: *D. vaccinii* Shear, on *Vaccinium macrocarpon* Ait., *D. tuberculosa* (Ell.) Sacc. [Syn. = *D. tuberculosa* var. *corymbosa* (C. & E.) Wehmeyer], on *Vaccinium corymbosa* L., and *D. eres* Nitschke [Syn. = *D. ligustrina* C. & E. on *Lyonia* spp.]. Fifth, few of the species have been studied in pure culture; those that have been studied occur in nature in the conidial stage only, but produce the ascigerous stage on artificial substrates.

SUMMARY

This account deals with two leafblight fungi occurring on mountain laurel, *Kalmia latifolia* L. The diseases caused by both these fungi are quite alike in gross appearance. Ascigerous stages of the pathogens develop on fallen leaves. One causal fungus, a *Physalospora,* differs from the five other species known to occur on Ericaceae, and is consequently described as *P. kalmiae.* The second pathogen has been known only in its conidial state from the District of Columbia. It is believed to be distinct from three other species of *Diaporthe* infecting Ericaceous plants, and is described as *D. kalmiae.* Its conidial stage is *Phomopsis kalmiae* Enlows. Material upon which the two taxa were based has been sent to the National Fungus Collection, Washington, D. C.

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