STUDIES ON VENTURIA AND RELATED GENERA

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ABSTRACT

This article discusses the characteristics on which a natural system of classification of the *Pyrenomycetes* must be based and then considers the family *Venturiaceae*, giving a key to the genera. The nomenclature and the synonymy of the genera and their type-species are briefly discussed.

INTRODUCTION

The Ascomycete group known as the *Pyrenomycetes* is arranged by SACCARDO (1882/83) in his Sylloge fungorum according to the colour and the number of cells in the spores. He considered the number of cells in an ascospore as a valid characteristic for separating the families. The number of cells is indeed characteristic for certain groups; but *Ascomycetes* with two-celled spores for example may belong to different groups and an arrangement based only on this characteristic is artificial and can be compared with the arrangement of the higher plants by LINNAEUS, based on the number of stamina in the flowers.

Other authors, such as WINTER (1887) in Rabenhorst's Kryptogamenflora or LINDAU (1897) in Engler et Prantl, tried to establish a system of the *Ascomycetes* in accordance with natural characters. These authors specially considered the vegetative part of the fruiting-body and neglected the structure of the sexual part. They regarded as important, such characters for example, as the colour of the fruiting-bodies – whether dark or light; the position of the perithecia – whether separate or aggregated in a stroma; their situation in the substratum – whether immersed or superficial. This system, also, is of no phylogenetic value; it is as if we were to divide the Phanerogams into trees, shrubs and herbs; or into plants with or without green leaves.

In research on the *Pyrenomycetes* it is very important that we distinguish clearly between the vegetative part (perithecial wall or tissue of the stroma) and the sexual part, the fructifications resulting from a copulation. A natural system has to be based upon the sexual phase, in this case on the structure of the perithecial centrum and the position of the asci in the fruiting-body; also, on the structure of the ascus-membrane and the mechanism by which the ascospores are ejected from asci and perithecia. Structure, colour and number of cells in the spores are also characteristic for many groups of *Ascomycetes*.

The structure of the vegetative part of the fruiting-body and its position in the host tissue should receive only secondary consideration in any systematic arrangement. The characters of the perithecial wall or the stroma have to be considered only in so far as they have some connection with the sexual phase. The form of the fruiting-bodies may be influenced by the nature of the substrate and modifiable characters of this kind are of no phylogenitic value.

In a review of the perithecial fungi it is necessary to consider the whole development and all elements of the structure and other characters of the fruiting-body. There are few researches on ontogenetic development in these fungi, so

our conclusions must usually be based on the morphological characteristics of the ripe perithecia.

THE CHARACTERISTICS OF THE VENTURIACEAE

Some genera of the *Pyrenomycetes*, whose relationships were partly recognized by VON HÖHNEL (1918) and elucidated and worked out by PETRAK (1924, 1947) have been taken together as *Venturiaceae*. The phylogenetic position of these fungi and their assignment to the *Pseudosphaeriales* have been discussed by MÜLLER and VON ARX (1950). The latter authors included in the family some other genera, which had previously been placed in rather widely different groups. The structure of the sexual parts of all members of the family corresponds very well. There is much less agreement between the vegetative stromata or the fruiting-bodies, with their divergent structure and different position in the host tissue.

The following morphological features are characteristic for the *Venturiaceae:*

a. Sexual part.

The ascospores are first hyaline or pale green; later they nearly always become olive-brown or greyish-green, rarely dark-brown, but remain translucent. They are ovoid or ellipsoid and two-celled. In many cases the transverse septum is not in the middle of the spore, but is displaced a little towards the bottom or the top, so that the spore is unequally two-celled.

The asci are elongated-oblong or nearly cylindrical, rounded at the top, sometimes a little broader in the lower third part. They have a rather delicate double membrane, with the same thickness throughout or apically slightly thickened, and contain 8 spores, rarely 4.

In the initially fully closed perithecium, the asci penetrate between a tissue of hyaline, parenchymatous cells or vertically arranged threads (pseudoparaphyses), which are connected above as well as below. When ripening, the perithecia or locules open by an apical pore, formed by histolysis of the usually thin-walled cells in the centre of the sometimes beak-like upper part of the perithecial wall. The pseudoparaphyses then loosen at their top, absorb water, elongate and fill the pore as gelatinous threads (Fig. 1). When ripe, the outer membrane of the ascus splits. The inner membrane is elastic and protrudes, and in consequence of this, the apex of the ascus reaches into the pore. As a result of the pressure inside, the spores break through the membrane, are ejected and the empty ascus collapses.

b. Vegetative part.

In the *Venturiaceae*, the stroma may have very different positions in the substratum; its development can take place either subepidermally or subcuticularly. The perithecia can be erumpent, or completely superficial, or innate with only a foot-like hypostroma. Characteristic of the *Venturiaceae* is the formation of a subcuticular flat hypostroma. This is either strongly developed, crustose and parenchymatous, or – especially in forms on leaves – reduced to a simple layer of light coloured cells. In some cases this layer is obliterated when the perithecia are ripening, and the conidia are then abstricted from the surface of a subcuticular stromatic cushion (Fig. 2).

The formation of hairs or setae on the fruiting-bodies or the existence of a superficial dematioid subiculum is characteristic of many *Venturiaceae*. Besides these forms there are also species with glabrous fruiting-bodies. However

characteristic setae or hyphae may be for many species, they are still not fitted for the classification of genera or species. The reason for this is that in one and the same species the fruiting-bodies may be found either glabrous or with appendices; the latter may also be inconspicuous and sometimes disappear at an early stage.

KEY TO THE GENERA

1. Perithecia sunken in the substratum, below the epidermis, mostly separate, communicating with the exterior by means of a papillate, glabrous or setose beak . . . . . *Venturia*

1x. Perithecia or stromata subcuticular or erumpent or superficial 2

2. Perithecia or stromata subcuticular, glabrous, dimidiate or flat . . . 3

2x. Perithecia or stromata erumpent or superficial, immersed with a hypostroma 4

3. Perithecia small, halved, separate . . . . . *Stigmatea*

3x. Stromata flat or dimidiate, dothideaceous, with spherical locules *Atopospora*

4. Perithecia small, glabrous, separate, innate in the stomata with a central foot. On Conifer needles . . . . . *Phaeocryptopus*

4x. Perithecia rarely separate and then not glabrous, not on Conifers . 5

5. Stromata superficial, innate in the substratum with a foot-like hypostroma. Stroma sterile in center, locules immersed in a marginal circle. Marginal hyphae present 6

5x. Perithecia superficial, on a sclerotium-like stroma or on a hypostroma or in a subiculum-like mass of hyphae 7

6. Stroma smaller than 300 μ, innate in the stomata. Spores hyaline *Trichodothella*

6x. Stroma larger than 300 μ, innate in the epidermis. Spores olive-green *Trichodothis*

7. Perithecia marginal in a ring on a sclerotium-like stroma, which communicates with a subcuticular hypostroma. Marginal hyphae present . . . . . *Lasiobotrys*

7x. Perithecia on a subcuticular or deeper, sometimes reduced hypostroma or in a subiculum 8

8. Hypostroma subcuticular, thin, skin-like, consisting of one layer of cells. Perithecia setose or hairy, mostly separated, on Rosaceae and Geraniaceae . . . . . *Coleroa*

8x. Hypostroma consisting of several layers of cells, crustose 9

9. Perithecia separated, as well as the hypostroma glabrous, on Legumes *Parodiella*

9x. Hypostroma with dematioid hyphae or perithecia setose or hairy or glabrous, mostly caespitose, not on Legumes 10

10. Perithecia without a beak, when ripe discomycete-like, opening by crumbling of the lower part of the perithecial wall. Asci standing parallel to the margin, surrounded by numerous pseudoparaphyses *Pseudoparodia*

10x. Perithecia with a short beak or papillate or opening with a pore . . . 11

11. Spores light coloured, greyish or olive-green, perithecia brown to dark, setose, hairy or glabrous, sometimes with a subiculum, on Ericaceae,

Caprifoliaceae, Rosaceae etc. . . . . *Gibbera*

11x. Spores dark, sometimes black-brown, perithecia blue-black, mostly glabrous, hypostroma mostly covered with seta-like, dark hyphae; on Fagaceae . . . . . *Neogibbera*

SYNONYMY AND TYPE-SPECIES OF THE GENERA

1. *Venturia* de Not. – Atti Sci. Ital. 6, 484 (1844) sensu SACCARDO (1882) et SHEAR (1948).

Syn.: *Phaeosphaerella* Karsten – Medd. Soc. Fenn. **16,** 28 (1880) (teste PETRAK 1940)
Sphaerellopsis Klebahn – Haupt- und Nebenfruchtformen der Ascomyceten p. 168 (1918)
Spilosticta Sydow. – Ann. Mycol. **21,** 173 (1923) (by PETRAK 1947 used)
Endostigme Sydow. – Ann. Mycol. **21,** 173 (1923) (teste PETRAK 1924, 1947)
Lectotype: *V. inaequalis* (Cke.) Winter (vide SHEAR 1948, MÜLLER et VON ARX 1950)

The genus Venturia includes most species in the family and among them are some very important plant pathogenic fungi. The conidial stages of the apple scab fungus *V. inaequalis* (Cke.) Winter and the pear scab fungus *V. pirina* Aderh. (Fig. 1) belong to *Fusicladium* (Fig. 2). A synonym is *Megacladosporium* Viennot-Bourgin. The conidial stage of *V. tremulae* Aderh. must be named *Pollaccia radiosa* (Lib.) Baldacci et Cif.

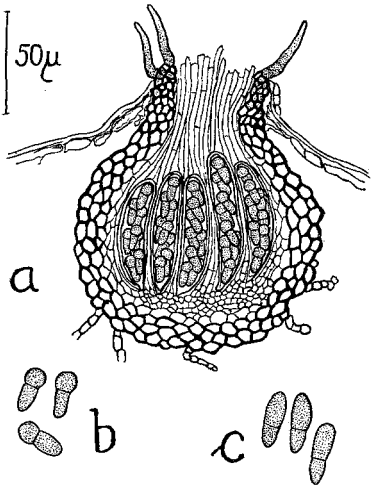

FIG. 1. *Venturia inaequalis*, showing (a) a perithecium in median section, (b) ascospores, (c) ascospores of *Venturia pirina*.

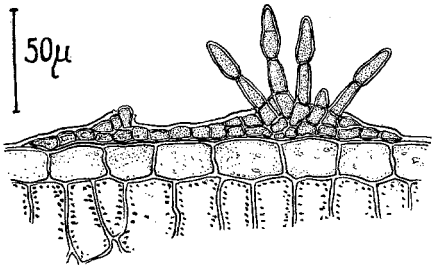

FIG. 2. The conidial stage of *Venturia inaequalis* commonly known as *Fusicladium dendriticum* (Wallr.) Fuck., showing a subcuticular layer of stromatic cells, conidiophores and conidia.

V. macularis (Fries) Müller et v. Arx must be considered the type species of the genus *Phaeosphaerella* Karst. In this species, the perithecial beaks are glabrous as well as setose. *Stigmatea confertissima* Fuck., the type species of the genus *Sphaerellopsis* Klebahn is, according to an original specimen, also a glabrous *Venturia* and is identical with *V. geranii* (Fries) Winter.

2. *Stigmatea* Fries – Summa Veget. Scandinav. p. 421 (1849).

This genus should be maintained, in accordance with the views of THEISSEN (1916), with *S. robertiani* Fr. as the type species. In this case, *Hormotheca* Bonorden is a typonym.

3. *Atopospora* Petrak – Ann. Mycol. 23, 100 (1925).

The type species *A. betulina* (Fr.) Petr. has been placed in *Dothidella* by WINTER (1887) and in *Euryachora* by THEISSEN et SYDOW (1915).

4. *Phaeocryptopus* Naoumov. – Bull. Soc. Oural d'Amis de Sci. Nat. **35**, 20 (1915).

Syn.: *Adelopus* Theiss. – Ann. Mycol. **15**, 482 (1917) (teste PETRAK 1938)

PETRAK (1938) re-introduced this genus with the type-species *P. nudus* (Peck) Petr. for the fungi mostly known as *Adelopus*. Figure 3 gives a diagram of *P. Gaeumanni* (Rohde) Petr., a parasite on needles of *Pseudotsuga taxifolia*. In this species, the spores remain hyaline.

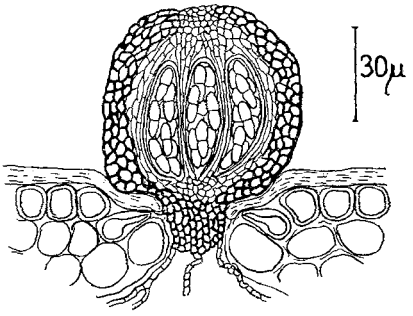

FIG. 3. *Phaeocryptopus Gaeumanni*, showing a perithecium in section, with asci- and ascospores.

5. *Trichodothis* Theiss. et Syd. – Ann. Mycol. **12,** 176 (1914).

The type species *T. comata* (Berk. et Rav.) Theiss. et Syd. and a new species have been described in detail by PETRAK (1947).

6. *Trichodothella* Petr. ap. Blumer – Ergebn. wissensch. Untersuch. Schweizer. Nationalparkes, Neue Folge **2**, 36 (1946).

The type species *T. Blumeri* Petr. is a parasite on leaves of Globularia in the Alps; mostly found unripe or only poorly developed.

7. *Lasiobotrys* Kze. – Mykol. Hefte **2**, 88 (1823).

All species later described seem to be identical with *L. lonicerae* Kze. Figure 4 gives a drawing of this fungus, parasitizing the leaves of *Lonicera*. Before ripening, the sclerotial body is loosened from the hypostroma by the pressure of the marginal hyphae and shot away. The small perithecia, situated in a ring, are closed at first and open, when ripe, by an apical pore.

8. *Coleroa* Rabenh. – Herb. Myc. no 1456 (1850) et Botan. Ztg. 9, 180 (1851).

The type-species *C. chaetomium* (Kze.) Rbh. is very variable. The summer form on living leaves has rounded superficial perithecia on a thin, subcuticular, skin-like hypostroma. The winter form has its perithecia subepidermal on the margin of a thick crust (see VON HÖHNEL 1918).

9. *Parodiella* Speg. – Fungi Argentini **1**, 178 (1880).

The genus has been revised by THEISSEN AND SYDOW (1917) and by PETRAK (1947). A diagram of the type-species *P. perisporioides* (Berk. et Curt.) Speg. is given by HANSFORD (1946). All species grow on leaves of papilionaceous plants

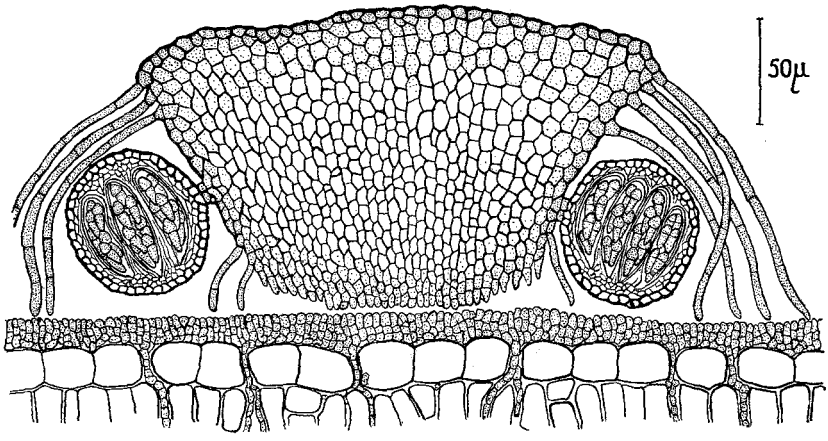

FIG. 4. *Lasiobotrys lonicerae*, showing hypostroma and sclerotium with two perithecia.

in the tropics, are very closely related, and perhaps should be reduced to synonymy with the type-species.

10. *Pseudoparodia* Theiss. et Syd. – Ann. Mycol. **15**, 138 (1917), vide PETRAK (1947).

The genus, with the monotypic species *P. pseudopeziza* (Pat.) Theiss. et Syd., has been placed in the *Discomycetes* by the authors. PETRAK (1947) recognized that this genus is related to the *Venturiaceae*.

11. *Gibbera* Fr. – Summa Veget. Scand. p. 402 (1849) emend. PETRAK (1947).

Syn.: *Antennularia* Reichenb. – Consp. Reg. Veg. Tent. **1,** 5 (1828) (teste PETRAK 1947)
Dimeriosporopsis P. Henn. – Hedwigia **40,** 173 (1901) (teste PETRAK 1947)
Dothidotthia v. Höhn. – Ber. deut. bot. Ges. **36,** 312 (1918) (vide PETRAK 1924)
Metacoleroa Petr. – Ann. Mycol. **25,** 332 (1927)
Montagnina v. Höhn. – Fragm. zur Mykologie no 488 (1910)
Pseudotthia P. Henn. – Monsunia **1,** 167 (1899)
Pyrenobotrys Theiss. et Syd. – Ann. Mycol. **13,** 628 (1915) (teste PETRAK 1947)
Xenomeris Sydow. – Ann. Mycol. **22,** 185 (1924)
Typespecies: *G. vaccinii* Fries

Many species of the genus are described in detail by PETRAK (1947). According to him, the genera *Dimerosporiopsis* P. Henn., *Antennularia* Reichenb. and *Pyrenobotrys* Theiss. et Syd. are synonymous and he characterized the genus in such a way that it should contain only species growing on *Ericaceae*. The typespecies of *Pseudotthia* P. Henn., also on an *Ericaceae*, has been transferred to *Gibbera* by MÜLLER AND VON ARX (1950). Fungi with similar structure grow also on other families of the Phanerogams and the genera *Metacoleroa* Petr., *Montagnina* v. Höhn., *Dothidotthia* v. Höhn. and *Xenomeris* Syd. must be reduced to synonymy with *Gibbera*.

Metacoleroa Dickiei (Berk. et Br.) Petr. (= *Venturia Dickiei* Sacc. = *Coleroa linneae* (Dickie) Schröter) on *Linnaea borealis* is closely related to *Gibbera Engleriana* (P. Henn.) van der Byl or to *G. salisburgensis* Niessl and must be named *G. Dickiei* (B. et B.) comb. nov. PETRAK (1927) has given a detailed description of this fungus.

Montagnina examinans (Berk. et Curt.) v. Höhn. (= *Asterina examinans* B. et

C.) is an *Eu-Gibbera* (sensu PETRAK 1947) and must be named *D. examinans* (B. et C.) comb. nov.

The species of the genera *Pseudotthia* P. Henn., *Dothidotthia* v. Höhn. and *Xenomeris* Syd. are closely related and must be placed in *Gibbera* in a new subgenus. In these species, the perithecia are glabrous and a subiculum or free hyphae are lacking. On these characteristics, it would not be possible to base a full genus within the *Venturiaceae*.

12. *Neogibbera* Petrak – Sydowia **1**, 191 (1947).
Type: *N. hamata* (Penz. et Sacc.) Petr.

No specimens of the four species, described by PETRAK (1947) have been seen.

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