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STUDIES IN ASCOSTROMATIC LICHEN-FUNGI—I *

The problem of Ascohymeniales and Ascoloculares

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The hyphal elements in the hymenium of the mature ascocarp do not provide a reliable means of distinguishing an ascohymenial ascocarp from an ascostroma. The nature of these hyphal elements is determined by neither their shape nor their tips but solely by their origin. Furthermore, since it has not yet been proved that there is any relation between the structure of the ascus and the type of development of the ascocarp, the kind of ascus is of relatively little value as a means of determining the developmental type of the ascocarp. Moreover, it is often practically impossible to decide whether an ascus is bitunicate or not.

The author does not know of any other feature that is a reliable indicator of the true nature of the ascocarp. Therefore, he sees no other means of determining the group to which the ascocarp is to be referred except to study its mode of development.

When in 1955 I started a revision of the Cryptotheciaceae I was struck by the peculiar nature of their ascocarps which were neither perithecia nor apothecia. Taxonomically, therefore, they should be referred to a group other than Pyrenolichenes or Discolichenes. Santesson (1952: 54) had already reached the same conclusion, referring the Cryptotheciaceae, along with genera of Arthoniaceae and Opegraphaceae, to a group of lichens with ascolocular (ascostromatic) fruitbodies. However, he added that the Cryptotheciaceae do not produce true ascocarps (p. 59), as the asci occur scattered in ascigerous parts of the thallus and are separated by hyphal tissue. Although at first sight Santesson seemed to be right, I was not satisfied. I had

* Shortly before his death, on the 3rd November 1965, our colleague Pieter Groenhart submitted three manuscripts on ascostromatic lichen-fungi. Although he said that he could very probably improve on them, he must have been aware that this would no longer be possible. It is especially regretted that he has not had the opportunity to evaluate the most recent literature on his subject.

Even though his papers are, therefore, not without shortcomings it was decided to publish two of them without delay. The third will appear shortly.

Groenhart, a dedicated lichenologist, gradually came to realize that to understand the construction of the lichen-fructification it is indispensable to follow its development while no real insight in this process can be gained without knowledge of the steadily growing literature on the development of the apothecium in the Ascomycetes since the time Nannfeldt and Luttrell had published their papers.

Groenhart's great merit lies in his endeavour to make lichenologists familiar with recent developments in mycological literature while at the same time leaving it to the mycologists to find out for themselves that they would do well not to ignore lichen-fungi.

R. A. MAAS GEESTERANUS

often observed that the so-called scattered asci, which are usually surrounded by a hyphal tissue, arise from a cluster of what are apparently to be considered ascogenous cells.[1] In my opinion these structures, consisting of ascogenous cells, asci, and enveloping hyphal tissue, represent some kind of ascocarp. This gave birth to a plan to determine the nature of this particular ascocarp. As a consequence I extended the revision of the Cryptothecia ceae with a comparative study of the development and structure of other ascocarps, especially of those in lichen-fungi. From this investigation it has appeared that various types of ascostromatic ascocarps are represented in lichen-fungi.

It would seem rather natural for closely related fungi to show strong resemblances in the development and structure of their ascocarps, as well as in the shape and structure of their asci and spores. Therefore, I have tried to detect groups of lichen-fungi that are characterized by such resemblances. As these groups are based on purely mycological criteria, taxa of the mycological system, in so far as these are based on the same criteria, should be comparable to them. As a result these groups of lichen-fungi can be inserted in the mycological system more correctly than has thus far been possible. The results of these studies will be reported in subsequent papers.

A special debt of gratitude is due to Prof. Dr. H. J. Lam who showed his interest by giving me the opportunity to carry out my work at the Rijksherbarium. I am also very much indebted to the Netherlands Organization for the Advancement of Pure Research (Z.W.O.) which, at the instigation of Prof. Lam, decided to subsidize my work, in order to enable me to spend all my time on these studies. I would like to express my sincere appreciation to the curators of the following herbaria for the loan of specimens: BM, BR, FH, FI, G, GLAM, H, LISU, M, PC, S, TUR, UPS, US, W, WRSL, WU,[2] and to Prof. Dr. C. W. Dodge and the late Dr. A. H. Magnusson for sending specimens from their private herbaria.

* * *

A review of the definitions of the three main divisions in Nannfeldt's classification of the so-called higher Ascomycetes (1932) shows that they represent three fundamental types of development; these are characterized (i) by the sequence of initiation of the ascogenous system and of the auxiliary tissues of the ascocarp, and (ii) by the number and origin of the auxiliary tissues.[3]

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[1] With this term nothing is implied about the cytology: no particular nuclear condition is postulated.

[2] These standard abbreviations are in accordance with Lanjouw & Stafleu, Index herbariorum, Part I, 5th Ed., 1964 (Regn. veg. 31).

[3] The present author is of the opinion that the ascogenous system represents the true (sexual) reproductive portion of the fungus. The more or less differentiated tissues that clothe and protect this system are considered of secondary importance. The ascogenous system and the auxiliary tissues together constitute the body which is called the ascocarp.

In the Ascohymeniales the ascogenous system initiates unprotected on a hypha.[4] This is followed by the development of two tissues of different origin: (i) a paraphysogenous tissue that arises from the supporting cell of the ascogon to produce true paraphyses; (ii) a tissue that originates from adjacent hyphae to constitute the excipulum.

In the Ascoloculares a stromatous tissue is formed first; within this the ascogenous system later initiates.

The basic criteria determining these two groups are clear-cut and should give no trouble in assigning a fungus to its proper group. However, neither the sequence of initiation and development of the ascogenous system and the auxiliary tissues nor the origin of the latter are usually known. Because of the lack of ascocarps in their earliest stages of development they cannot as a rule be observed in the material to be examined. The only way to obtain the data needed is to culture the fungus. This, however, is not always easy to do and it is often even quite impossible in the case of lichen-fungi. In the practically unique case in which a lichen-fungus was cultivated successfully by Anderson & Ahmadjian (1962), they failed to give particulars about the development of the ascocarps. As a result, mycologists trying to classify the fungi involved used characters of the asci and the auxiliary tissues to determine to what group their fungi belonged. It would seem that hitherto no one had questioned the reliability of the features taken into consideration.

Before Nannfeldt published his new classification, all hyphal elements in ascocarps among which the asci develop were called paraphyses and they were either simple, or branched, or branched and interconnected paraphyses. According to their origin, Nannfeldt distinguished interthecial filaments and true paraphyses. The former were remnants of the original tissue of the ascolocular stroma and were connected with the lower as well as with the upper layer of the stroma; they acquired free tips only in those ascocarps of which the upper layer had crumbled away. True paraphyses were produced by the paraphysogenous tissue in ascochymenial ascocarps; they had free tips from the beginning of their development. It was further pointed out by Nannfeldt that thick-walled asci with a dome-shaped extension of the lumen into the thick top were common in ascolocular ascocarps. Since then hyphal elements with free tips in the hymenium have been considered to be true paraphyses and a proof of the ascohymenial nature of the ascocarp. The origin of these hyphal elements was not even taken into account. The dome-shaped extension of the lumen in the top of thick-walled asci came to be regarded as an inherent attribute of bitunicate asci. Thick-walled asci without this attribute were considered unitunicate. In accordance with these views and ignoring their origin, Nannfeldt

[4] As pointed out by Nannfeldt, the ascogons of ascohymenial ascocarps may also initiate in a stroma like, for instance, in *Xylaria* and *Hypoxylon*. These stromata, however, are bodies which contain complete ascocarps. They are thus not comparable with the ascostromata of the Ascoloculares which contain only asci or groups of asci. For the type of stroma as it is known in *Xylaria* and *Hypoxylon* the present author proposes to use the term c a r p o s t r o m a.

referred the Graphidaceae (sensu stricto) to the Ascohymeniales because of their unbranched hyphal elements with free tips in the hymenium. Nevertheless, the ascocarps of the fungi belonging to this family are truly ascostromatic.

This way of determining the nature of an ascocarp may lead to curious results; this is illustrated in a paper by Mme Letrouit-Galinou (1962), who gave an account of the development of *Lecanora subfuscata* Magn. The development of the ascocarp starts with the formation of a stromatic tissue. Correctly and without exception she called the ascocarp an ascostroma. Moreover, she stated that the "paraphyses" originate not from the base of the ascogon but from the surface of the "réseau paraphysogène." This réseau is the original stromatic tissue within which, after the pseudoparaphyses have started their development, the ascogenous system later originates. All this is perfectly in accordance with an ascostromatic development of an ascocarp but, without motivating her conclusion, the author ends by stating that the ascocarp of *L. subfuscata* is a gymnocarpous ascohymenial apothecium. This unexpected conclusion was obviously induced by the paraphyse-like structures having free tips.

Luttrell (1951) pointed out that the asci in ascostromatic ascocarps are not always enclosed singly in loculi separated by original stromal tissue. Many stromata become differentiated into a hyphal centre and a peripheral part constructed otherwise. The ascogenous system, initiating at the bottom of the central tissue, produces the asci that grow into that tissue, while the peripheral part forms the wall of the stroma. The hyphal elements of the central tissue, which Luttrell called pseudoparaphyses, are either simple or branched. Ascostromata may be divided into two groups according to their development: (i) true ascolocular stromata in which the asci are separated by original stromal tissue (*Myriangium*) and (ii) ascostromata in which the asci are surrounded by pseudoparaphyses (*Pleospora*). In the second group asci and pseudoparaphyses constitute a hymenium similar to the hymenium in an ascohymenial ascocarp. If the pseudoparaphyses grow free tips at an early stage of development, as in Graphidaceae, or if the tips are free from the beginning of their development, as in *Lecanora*, there is no longer a difference between the hymenia of an ascostroma and an ascohymenial ascocarp. The only means, then, of determining the nature of the hyphal elements in the hymenium is to discover their origin.

According to Luttrell (1951) bitunicate asci are correlated with the ascostromatic character of the ascocarp. That bitunicate asci are frequently found in ascostromata may point in that direction but this is nevertheless no absolute proof.

Bitunicate asci are characterized by thick walls, a thick top with a dome-shaped extension of the lumen, and failure to react to iodine. This certainly holds true for the bitunicate asci in *Cryptothecia* Stirt. and related genera. In the bitunicate asci of other genera these characters are often less evident or even absent. If endoascus and exoascus cannot be separated it then becomes very difficult to decide whether the asci are bitunicate or not. In *Aglaothecium saxicola* Groenh. (1962) the ascocarp is an ascostroma. The asci are thin-walled and there is no evidence that the wall is composed of two separable layers. Hence the author called the asci unitunicate.

Because he had at that time not yet studied that type of development he called the ascocarp an apothecium in the conventional sense of the word. Although it now appears that the ascocarp is an ascostroma and the asci show no reaction to iodine he is not as yet prepared to regard the asci as bitunicate. At best a question-mark may be placed after the word unitunicate. If, to the contrary, the asci should really prove to be unitunicate, it would be absurd to call the ascocarp ascohymenial because of that single wall.

As to the iodine reactions in the hymenium, it is questionable whether these have any value other than merely to indicate that the hymenial gelatine and/or the protoplasm of the asci contains a matter that turns wine-red, violet or blue with iodine. It is still more questionable whether these reactions have anything to do with the structure of the ascus wall. The colourable matter is often concentrated close to the inner and the outer sides of the wall of the top of the asci. It is then the question whether the matter is produced by the ascoplasm or in the hymenial gelatine and whether it is transported through the wall from the ascoplasm to the hymenial gelatine or in the opposite direction. As a rule the wall itself is less intensely stained and it is impossible to decide whether it is the wall itself or the matter that is being transported (if any) that is showing the reaction or whether the wall is merely reflecting the colour. To the present author it seems rather hazardous to draw any conclusion about the structure of the ascus wall based on either these vague reactions or an absence of them.

It may be recalled here that according to Nannfeldt's basic characterization the Ascohymeniales possess true paraphyses, that is, paraphyses with free tips. However, while falling definitely within this category certain Ascohymeniales prove also to possess paraphyses without free tips; an example of this is *Ophiobolus graminis* Sacc. The development of that species was described by Jones (1926). The ascocarp initiates with an ascogenous system unprotected on a hypha. This system becomes enclosed by a paraphysogenous and an excipular tissue of differing origins. This is the pattern according to which an ascohymenial ascocarp starts to develop. The mass of paraphysogenous tissue increases by the division and growth of the cells to constitute a core of ovoid cells within the excipular wall. During the course of its further development ascogenous cells come into being in the base of the core to take the place of the desintegrated original ascogenous system. The peripheral cells of the core also desintegrate to form a granular layer close to the inner side of the exciple. The other cells of the core elongate and become arranged into vertical series; these separate in turn to form the paraphyses.

It has been assumed that the characters used as primary ones in the classificatory systems discussed above are fully correlated with others considered secondary. While this may be true in some cases it need not be true in general; in any case the supposition, if not based on specific details, is likely to lead to misinterpretation and confusion. This is exemplified by *Melogramma spiniferum* (Wallr.) De Not. Doguet (1959), describing this species, failed to furnish information about the initiation and

development of the ascocarp. Instead, because of the neatly delimited perithecial wall, the periphyses filling the apical canal, and the paraphyses with free tips, he simply concluded that the fungus was ascohymenial. From this he drew the conclusion that the ascocarp was entirely wrong. According to Luttrell, since the asci are bitunicate, the ascocarp must be ascolocular. To judge from their apical apparatus the asci are nassasceous. Indeed it must be admitted that it seems quite impossible to find more discrepancies combined in a single ascocarp.

Is there any way out of this difficulty to be found? First it should be pointed out that Doguet's conception of the developmental group to which he referred the ascocarp of *M. spiniferum* was based on secondary characters. It has already been shown in the foregoing that without knowledge of their origin it may be impossible to distinguish paraphyses and pseudoparaphyses. It is not known whether a neatly shaped perithecial wall and periphyses are unmistakable indications of an ascohymenial ascocarp. It therefore remains uncertain whether the ascocarp in *Melogramma spiniferum* is ascohymenial or ascostromatic. If it should turn out that the ascocarp develops ascohymenially then it is proved that bitunicate asci are also produced in ascohymenial ascocarps. If the ascocarp should turn out to be an ascostroma then it is certain that hyphal elements with free tips in the hymenium do not provide an infallible means of distinguishing an ascohymenial ascocarp from an ascostroma. The asci in *M. spiniferum*, which are both annellasceous and bitunicate, prove that bitunicate asci, at any rate, may be not only annellasceous but also nassasceous.

From the examples given in this study it appears that (i) the characters considered secondary by the various authors are not always correlated with the primary characters on which they based their systems; (ii) these secondary characters cannot therefore be used to decide correctly to what group a fungus is to be referred; (iii) the use of secondary features as differential characters has led to misinterpretations and confusion.

To avoid these difficulties, the present author sees only one possibility and that is to adhere strictly to the primary characters on which the systems are based, using the secondary characters only in order to distinguish subdivisions.

Nannfeldt's system is based on the sequence of initiation and development of the ascogenous system and the auxiliary tissues of the ascocarp. It would be logical if the main groups of this system were to be subdivided according to the types of development and those structures resulting from this development which may be distinguished within each group. Taxa of lower rank might then be based on the characters of asci and spores.

Luttrell based his system on the structure of the ascus wall. A good basis for the first subdivision of the main groups ought to be the apical structure of the asci, after which taxa of lower rank could be formed according to the types of ascocarps.

In Chadefaud's system the natural sequence logically would be to distinguish the main divisions according to the apical apparatus of the asci, the first subdivisions according to the type of the asci and further subdivisions according to the type of the ascocarp.

Melogramma spiniferum, once a riddle which could not be made to fit into any of the three systems mentioned, could then easily be inserted in each of them in its correct place. In Nannfeldt's system, on account of the development of the ascocarp, the type of the ascus, and the apical apparatus in the top of the ascus, this species would then be an annellasceous, bitunicate ascohymenial (or ascolocular) fungus; in Luttrell's system, an ascohymenial (or ascolocular), annellasceous bitunicate fungus; in Chadefaud's system, an ascohymenial (or ascolocular), bitunicate annellasceous fungus.

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STUDIES IN ASCOSTROMATIC LICHEN-FUNGI—II

Types of ascostromata [1]

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Attention is drawn to the fact that the development of ascostromatic fungi is so diverse that it is possible to recognize a number of differently organized groups. Some of these groups correspond to the developmental types recognized by Luttrell but it is also shown that his *Pleospora*-type is not homogeneous, comprising as it does a number of categories, each of which has its own type of development of the ascocarp.

To designate structures not indicated before, the new terms t i c h u s, c a t a p h y s i s, and t i n o p h y s i s are introduced.

The ascostromatic fungi were recognized by Nannfeldt (1932) as a group of 'higher Ascomycetes' characterized by the development and structure of their ascocarps. According to him the development of the ascocarps starts with the formation of a stromatic tissue. The ascogenous system initiates within this tissue. The asci produced by the ascogenous cells or hyphae push into the stromal tissue to form monascous or pluriacous loculi that remain separated. The remnants of the stromal tissue, which separate the loculi, are known as interthecial filaments or strands. Because of the formation of loculi in the ascocarp Nannfeldt named the group Ascoloculares. Luttrell wanting to give this group definite taxonomic rank therefore proposed to call it Loculoascomycetes, as a new subclass of the Ascomycetes.

More recent studies on ascostromatic ascocarps have revealed that the tissue separating the asci is not always formed by the original stromal tissue. Miller, followed by Luttrell (1951), pointed out that in certain ascostromata the hyphal elements separating the asci are produced before the latter start their development. Consequently, these hyphal elements cannot be regarded as compressed remnants of the original stromal tissue.

In a number of cases, according to Luttrell, after a locule has been formed in the centre of the stroma, it becomes filled with newly formed hyphal elements. The asci arising from the ascogenous tissue at the bottom of the locule push their way between these hyphal elements, which have been called pseudoparaphyses. There are ascostromata in which the pseudoparaphyses, instead of being formed in the centre, result from a differentiation of hyphae in the apical region of the stroma.

However, it has become clear in the meantime that in many ascostromata the

[1] The term ascomata is also in use. It was introduced by Wallroth (1833: 407) as follows: "... stromate ascophoro, i. e. *a s c o m a t e* fibroso-carnoso s. gelatinoso-lubrico ..."

pseudoparaphyses do not fill a pre-existing locule or, at any rate, the locules are somewhat illusory. In these types of ascostroma the pseudoparaphyses are the result of a differentiation of the stromal tissue into a central and a peripheral tissue. The central tissue turns into pseudoparaphyses, while the peripheral tissue forms the stromal wall. Thus the structure gives the impression of a locule filled with pseudoparaphyses and surrounded by a wall but at no time has there ever been a central cavity in the stroma.

On the basis of the characters mentioned above the ascostromatic Ascomycetes may be divided into two groups: (1) 'ascolocular', viz. non-pseudoparaphysate, Ascomycetes and (2) pseudoparaphysate Ascomycetes. The first group comprises (1a) ascolocular Ascomycetes with monascous loculi and (1b) ascolocular Ascomycetes with pluriascous loculi. Where the loculi are pluriascous, there is a bundle or palisade of aparaphysate asci. In the second group there are again two subdivisions, (2a) pseudoparaphysate Ascomycetes with 'internal' pseudoparaphyses, and (2b) pseudoparaphysate Ascomycetes with 'external' pseudoparaphyses.

Luttrell (1951, 1955) accepted the above variations in the structure of the centre of the ascocarp as the basis for a subdivision of the pyrenocarpous Ascomycetes into a number of "developmental types." As far as the ascostromatic Ascomycetes are concerned, he originally distinguished three types: (i) the *Dothiora*-type, (ii) the *Pleospora*-type, and (iii) the *Elsinoe*-type. Judging from the descriptions, the *Dothiora*- and the *Dothidea*-types comprise the ascolocular Ascomycetes with pluriascous loculi (group 1b), the *Pleospora*-type represents the pseudoparaphysate Ascomycetes (group 2a), while the *Elsinoe*-type might be called the 'true' ascolocular Ascomycetes with monascous loculi (group 1a).

From the term "developmental type" one would suppose that the ascocarps of the fungi of a certain type all develop similarly. On the contrary, the ascocarps of several of them develop very differently. An example of this is to be found in the following species which Luttrell regarded as belonging to the *Pleospora*-type.

PLEOSPORA HERBARUM (Fr.) Rabenh.—The first authors to describe details of development of this species are Cavara & Mollica (1907), but from their cursory description it is impossible to acquire an accurate picture of the development of the ascocarp. A better description has, however, been provided by Kerr (1961).

Kerr established that the young stage of the ascocarp consists of a spherical, pseudoparenchymatic body. She did not explain, however, how this body comes into being, so that the initial stage remains unknown. According to her the pseudoparenchymatic body becomes differentiated into a central part composed of vertically aligned hyphal elements and a pseudoparenchymatic stromal wall, to which the hyphal elements are attached by their tips and bases. She concluded that they were attached at both ends from the beginning. It is, therefore, very likely that they come into being by the stretching and intercalary growth of the central cells of the pseudoparenchyma. As the hyphal elements are derived from the original stromal tissue and precede the asci, they are pseudoparaphyses. Kerr's Fig. 4B

(p. 477) shows that in the mature ascocarps the tissue in the top of the stromal wall disintegrates. Hence the pseudoparaphyses, originally connected with that part of the stromal wall, develop free tips.

The peripheral cells of the stromal wall turn compact, hard, and dark-coloured, constituting a distinct protective wall; for this the term t i c h u s is proposed.

Of the development of the asci nothing was stated except that they arise from the bottom of the locule.

VENTURIA RUMICIS (Desm.) Wint.—The ascostroma of this species very probably initiates in the same way as the ascostroma of *Pleospora herbarum*. The initial stage of the stroma of *V. rumicis* is illustrated by Kerr in Fig. 2A (p. 471). It may easily be mistaken for a cell-fusion, which explains Cavara & Mollica's impression about the initiation of the ascostroma. The short bundle of crowded hyphae that sprout from the point of initiation soon constitutes a paraplectenchymatic body that is attached to a single hypha.

SPORORMIA LEPORINA Niessl. — The ascostroma of this fungus initiates as a single cell on a hypha (Arnold, 1928). Subsequent divisions in three directions cause the initial cell to grow out to become a true parenchymatic body. In the course of development the central cells of the body become detached from one another, resulting in the materialization of a central cavity. The original parenchyma continues its growth to constitute the stromal wall, while its peripheral cells turn brown, to form a tichus. In the top of the wall meristematic tissue is formed, from the cells of which pseudoparaphyses arise that grow down into the cavity. The apical cells of the pseudoparaphyses are swollen and are unusual in that on reaching the bottom of the cavity they form a placenta which produces the asci.

Comparison of the way the ascostromata of *Sporormia leporina* and *Pleospora herbarum* develop shows that they are basically different as to their origin and the formation of their structures. The ascostroma in *S. leporina* is parenchymatic, that in *P. herbarum* paraplectenchymatic. In the stroma of *S. leporina* a true cavity is formed, whereas in *P. herbarum* the locule is purely illusory, being only suggested by the different structures of the centre and the wall. The pseudoparaphyses of *S. leporina* grow downward from the roof of the cavity; the paraphyses of this type may be termed c a t a p h y s e s (κατα = downward). The pseudoparaphyses in *Pleospora* are formed by the stretching and intercalary growth of the cells between the top and the bottom of the stromal wall. They remain connected with the top and bottom of the wall as long as possible. For this type of pseudoparaphyses the term t i n o p h y s e s (τείνω = to stretch) is proposed. As shown in the foregoing, the types of development of the two species under discussion have little in common.

OPHIOBOLUS GRAMINIS Sacc.—This species was discussed by the present author in the preceding paper (Groenhart, 1965). He came to the conclusion that the ascocarp is to be considered ascohymenial, so that its development is certainly not of the *Pleospora*-type.

MELANOMMA PULVIS-PYRIUS (Pers. ex Fr.) Fuck.—Chesters' description (1938) of the development of the ascocarp of this species is very incomplete. The young stage of the ascocarp is a more or less spherical, pseudoparenchymatic body with a core of thin-walled cells. This calls to mind the structure of a young ascocarp of *Ophiobolus*, as is also true of the way the branched and connected hyphal elements within the ascocarps are formed. However, nothing is said about the way the ascocarp initiates or about the origin of the cells of the core. Consequently, it is even impossible to decide whether the ascocarp is ascostromatic or ascohymenial.

PSEUDOTRICHIA AURATA (Rehm) Wehm.—Wehmeyer (1941) gave the following description of the development of *P. aurata*. The primordium of *P. aurata* consists of a mass of intertwined vegetative hyphae. Within the primordium a cavity is formed. The original stromal tissue constitutes the stromal wall which becomes differentiated into a hyphous inner layer and a tichus of brown-walled cells. From a meristematic tissue in the roof of the cavity cataphyses grow downward into the cavity. No written information is given about the tips of the cataphyses, but from Fig. 11 it may be seen that they are not swollen.

The ascocarps of *P. aurata* and of *S. leporina* agree in that in both a central cavity that becomes filled with cataphyses is formed. However, they differ considerably in the initiation and structure of the stromal tissue. The cataphyses are also different; those of *P. aurata* lack the swollen tips which constitute the placenta in *S. leporina*.

The examples discussed above show that what Luttrell thought of as belonging developmentally to his *Pleospora*-type actually comprises various fungi which differ widely in the mode of development of their ascostromata. The only feature they have in common is the formation of pseudoparaphyses in the centre of the ascostromata. These pseudoparaphyses, however, come into being in a number of very different ways that are not at all comparable. Moreover the ascostromata also initiate in quite different ways. Hence the pattern of development of the ascostroma of *Pleospora* is in no way typical of the entire group. The group would, therefore, have been better characterized by a name relating to the internal pseudoparaphyses.

By a "development type" the present author understands the entire sequence of changes during development, starting with the initiation of the ascostroma and ending with its maturity. As far as the ascostroma is concerned, the type of development is considered to be characterized by the mode of initiation, the kind of hyphal elements present in the ascostroma, the presence or absence of a stromal wall, and the way these are formed. In accordance with this view the author proposes to apply the term *Pleospora*-type only to the mode of development revealed by the ascostromata in *Pleospora*. This type is characterized by (i) the paraplectenchymatic initial stage of the stroma, composed of coalescent initial hyphae, (ii) the differentiation of the initial stage into a central and a peripheral tissue, (iii) the transformation of the central tissue into tinophyses, (iv) the formation of a distinct outer wall by the peripheral tissue.

The *Sporormia*-type is quite different, being characterized by (i) a true paren-

chymatic initial stage originating from a single initial cell, (ii) the formation of a central cavity within the initial body, (iii) the production of cataphyses growing downward from a meristematic tissue at the top of the cavity, (iv) the stromal wall which is formed by the undifferentiated tissue of the original body.

Types of development which would otherwise appear to be more or less related can thus be distinguished from one another. On the basis of these relationships it should be possible to establish taxa on which to build up a system in which at least the lichen-fungi may be arranged more naturally than in the current systems, both lichenological and mycological.

It may be pointed out here that in lichen-fungi the ascocarp is not always identical with the ascostroma. In several species the ascocarp is composed of the ascostroma clothed with one or two layers that are not produced by the ascostroma.

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SOME NOTES ON THE DISTRIBUTION OF PLASMODIOPHORA DIPLANTHERAE, A PARASITIC FUNGUS ON SPECIES OF HALODULE

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(With two Text-figures)

Plasmodiophora diplantherae (F. & W.) Iv. Cook is a specific parasite on species of the sea-grass genus *Halodule*. It had been recorded only from its type locality in the West Indies, but from a recent study of extensive herbarium material it has proved to be a widely distributed pantropic species.

Amongst unidentified sea-grasses of the genus *Halodule* from the herbarium of the University of Copenhagen I found a small collection of plants from the Key Islands (Moluccas). These plants seemed to be closely allied to *Halodule pinifolia* (Miki) Hartog, but differed from it in their almost entire leaf-tips and the strongly swollen internodes of the stem which gave the latter the appearance of a string of beads (Fig. 1). As the tips of young leaves of *H. pinifolia* often are almost entire no importance was attached to this character. The remarkable, very conspicuous, swollen internodes, however, distinguished these plants from all material of the genus *Halodule* that I had ever seen before. As a tendency to thicken at the internodes of the stem does not occur in either the genus *Halodule* or in the related genera *Cymodocea* and *Syringodium*, I hesitated long about the status of this material. Fortunately I found that the swellings of the internodes were caused by a parasitic fungus, belonging to the family of the Plasmodiophoraceae, viz. *Plasmodiophora diplantherae*.

PLASMODIOPHORA DIPLANTHERAE (F. & W.) Iv. Cook

Ostenfeldiella diplantherae Ferdinandsen & Winge *in* Ann. Bot. **28**: 648, fs. 1, 4, pl. 45. 1914 — *Plasmodiophora diplantherae* (F. & W.) Iv. Cook *in* Hong Kong Nat. **1** (Suppl.): 34, pl. 13 f. 2. 1932; *in* Arch. Protistenk. **80**: 194, f. 9, pl. 6 fs. 5, 6. 1933.

DESCRIPTIONS & ILLUSTRATIONS.—Johnson & Sparrow, Fungi in oceans and estuaries 60, 319. 1961; Karling, Plasmodiophorales 32, pl. 4 fs. 98–101. 1942.

Resting spores spherical, brown, 4–4.5 μ in diameter, with thin, hyaline, brownish, smooth membranes, producing plasmodia which grow to a large size, 125–200 μ in diameter and contain many nuclei. Plasmodia induce the host cells to increase in size from 35 μ to 200 μ in diameter.

The effect on the host had been already studied by Ferdinandsen & Winge (1914). They found that only the internodes of the stem were infected by the parasite, the cells in the tops of the internodes remaining uninfected. In the meristematic part of

the plant uninucleate myxamoebae are present. Lower down in the internode large plasmodia occur; they cause swelling of the host tissue and tangential stretching instead of radial stretching of the cell. In the lower part of the internodes many of the cells are filled with masses of spores. The parasite is restricted to the inner cortex and does not occur in the outer cortex or in the central cylinder of the host, so the infected plant is able to continue its growth.

The species had been recorded so far only from St Croix (Virgin Islands) in the West Indies (Ferdinandsen & Winge, 1914), where it was a parasite on *Halodule wrightii* Aschers.

Later I discovered on several occasions the fungus also on other members of the genus *Halodule*, and now it is known as a parasite on the following species: *H. uninervis* (Forsk.) Aschers., *H. tridentata* (Steinheil) F. v. M., *H. beaudettei* (Hartog) Hartog, *H. wrightii*, and *H. pinifolia*. I did not succeed in finding it on species of the allied genera *Cymodocea* and *Syringodium*, although I had considerably more material of these. Therefore, it seems that *Plasmodiophora diplantherae* is a specific parasite of the genus *Halodule*.

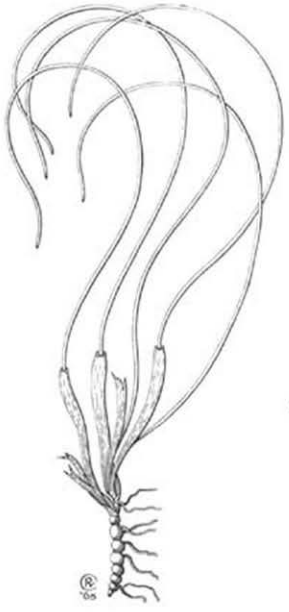

Fig. 1.—*Halodule pinifolia* (Miki) Hartog, heavily infected by *Plasmodiophora diplantherae* (F. & W.) Iv. Cook (*Jensen 247*, × 1).

Heavily diseased plants can be recognized easily in the herbarium (e.g. *Simmonds 15033*, *Jensen 247*). In most cases, however, the symptoms seem to be limited to one or more shoots of the host, while the other parts look healthy and do not seem to be affected by the parasite. Early stages of the disease can, of course, not be detected in the herbarium material. The distribution of *Plasmodiophora diplantherae* is pantropic and covers almost the whole area of distribution of the genus *Halodule* (Fig. 2).

MATERIAL STUDIED:—

UNITED STATES OF AMERICA: Florida, Pinellas County, St Petersburg, Tampa Bay, 24/28 Dec. 1951, on *Halodule beaudettei* from muddy substrate at extreme low-water-mark, *R. F. Thorne 10304* (UC).

CUBA: Province of Oriente, Guantanamo Bay, 17/30 March 1909, on *H. wrightii* in shallow water at Conde beach, *N. L. Britton 2129* (US).

BAHAMA ISLANDS: South Caicos, East Bay, 22 June 1954, on *H. beaudettei* rooting in sand of shallow bay, *G. R. Proctor 8910* (GH).

VIRGIN ISLANDS: St Croix, Krauses Lagoon, 4 Febr. 1906, on *H. wrightii*, *F. Børgesen* (US).

GUADELOUPE: Marie Galante, 27 March 1936, on *H. beaudettei*, *L. Rodriguez 4359* (P).

TRINIDAD: Charachacare, 2 Jan. 1954, on *H. beaudettei* in shallow, sheltered sandy bay; very heavily infected! *N. U. Simmonds 15033* (K).

CURAÇAO: St Joris Baai along the north-eastern coast, 8 July 1958, on *H. beaudettei*, *M. Díaz-Piferrer* (MICH).

MOZAMBIQUE: Bazaruto Island, 28 Oct. 1958, on *H. wrightii* in very shallow water, *A. O. D. Mogg 28670* (PRE); Inhaca Island, intertidal mud-flats opposite the Marine Laboratory, 8 Oct. 1957, on *H. wrightii*, *A. O. D. Mogg 27730* (PRE); idem, 31 Oct. 1962, on *H. uninervis*, *Mauve* and *Verdoorn 65* (PRE); idem, on *H. wrightii*, 1 Nov. 1962, *Mauve* and *Verdoorn 105* (L).

YEMEN: Hodeidah, 23 Dec. 1888, on *H. uninervis*, *Schweinfurth 148* (GH).

PERSIA: Bushire, on *H. wrightii*, *K. H. Rechinger 1731* (C).

INDIA: Tuticorin, 25 Febr. 1928, on *H. tridentata*, *F. Børgesen 281* (C); idem, Hare Island, 28 Febr. 1928, on *H. tridentata*, *F. Børgesen 302* (US).

VIETNAM: Nha Trang, Ile Tré, 6 Nov. 1957, dredged from 5–6 m depth on *H. tridentata*, *J. Feldmann 9753* (Herb. Lab. Biol. vég. marine, Paris).

JAPAN: Ryukyu Islands, Okinawa, Awashi (Awase or Ashi) reef, 7 Oct. 1945, on *H. pinifolia* (US, MICH); Okinawa, on the east side of the island opposite Kadena, 9/11 April 1953, on *H. tridentata* from low-tide level of an exposed shore, *E. Y. Dawson 11618* (UC).

MALAYA: Johore, Pulau Tinggi, 19 June 1915, on *H. tridentata* from a sandy coral beach near low tidal level, *Burkill 899* (SING); Singapore, Pulau Senang, 1 April 1956, on *H. tridentata* from sandy littoral pools of a coral reef, *Burkill 547* (SING, BO, L).

PHILIPPINES: Mindoro, Puerto Galero, Balateros Maliit, 20 May 1924, on *H. pinifolia* from tidal flat behind coral reef, *J. Pascasio 371* (15476) (UC); idem, on *H. uninervis*, *J. Pascasio 376* (15481) (UC); Puerto Galero, 2/4 Dec. 1953, on *H. tridentata*, *M. Doty 10912* (L, Hawaii University); Cavilli Island in the

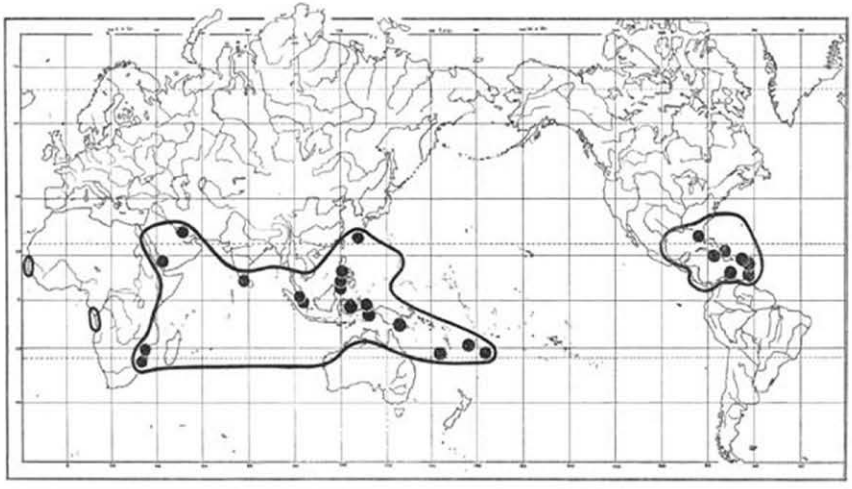

Fig. 2.—Distribution of *Plasmodiophora diplantherae* (F. & W.) Iv. Cook. The area of the genus *Halodule* is surrounded by a thick line.

Sulu Sea, Sept. 1910, on *H. pinifolia*, *E. D. Merrill 7179* (US); Sulu Group, Pearl Bank, June 1923, on *H. pinifolia*, *R. Kienholz* (UC).

INDONESIA: Moluccas, Sula Islands, Samana, 1 Sept. 1954, on *H. pinifolia* from sandy spot, *A. H. G. Alston 17036* (BM); Key Islands, Jamtil, 9 May 1922, on *H. pinifolia* from 1 m depth in the surf, *Jensen 247* (C, BO, US, A, GH); New Guinea, Sorong, 1872, on *H. pinifolia*, *Beccari 11821* (P.P. 132) (FI, L).

AUSTRALIAN NEW GUINEA: Port Moresby, Ela Beach, 17 June 1960, on *H. pinifolia* in shallow water, *R. F. Thorne 12564* (LAE).

FIJI ISLANDS: Suva, Viti Levu, 22/28 May 1926, on *H. pinifolia*, *W. A. Setchell & H. E. Parks 17739* (UC).

NEW CALEDONIA: Balade, 8 Jan. 1961, on *H. tridentata* from muddy bottom, *H. S. McKee 8009* (US).

TONGA ISLANDS: Tongatapu, Nuku'alofa, 15 April 1953, on *H. pinifolia* exposed at low tide, *T. G. Yuncker 15288* (US, GH).

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GEOGLOSSACEAE OF INDIA AND ADJACENT COUNTRIES

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(With 36 Text-figures)

A revision of the genera *Geoglossum*, *Microglossum*, and *Trichoglossum* as represented by collections made in West Pakistan, India, Nepal, Sikkim, and Tibet is given. Several species from this area are recorded for the first time. *Geoglossum glabrum*, albeit not indigenous, is discussed and shown to be a nomen dubium; the name as used in the sense of Nannfeldt is replaced by *G. sphagnophilum*. The name *Geoglossum nigritum* is a misapplication, so that for it *G. umbratile* is re-introduced. *Geoglossum umbratile* var. *heterosporum* is a new combination.

In 1964 two members of the 'Rijksherbarium' collected fungi in the northwestern part of India. This was made possible by a grant from the 'Netherlands Organisation for the Advancement of Pure Research (Z.W.O.).'

The Geoglossaceae, which were found exclusively during the last stage of the trip, comprise comparatively few species, but combined with collections borrowed from various institutes and covering a much wider area they probably give a fair picture of the number of species represented in the lower ranges of the Himalayas.

In the past, collectors did not pay a great deal of attention to Geoglossaceae and records from the Himalayan region were extremely scarce. Berkeley (1854: 209) listed *Geoglossum glabrum* from Yeumtong (Sikkim) and *Geoglossum viride* from Yeumtong and Lachoong (Sikkim). For a long time these were the only data available and they were repeated by Cooke (1875: 7, 9), Saccardo (1889: 44, *G. ophioglossoides*; 38, *Mitrula viridis*), and Butler & Bisby (1931: 11). Gradually the situation improved but not much. Lloyd (1916: 12) recorded *Geoglossum hirsutum* from India and shortly afterwards (1917: 4) mentioned *G. glabrum* in a list for an Indian correspondent. *Geoglossum ophioglossoides* was reported from southeastern Tibet by Mrs. Balfour-Browne (1955: 213). Sultan Ahmad (1956: 37) mentioned *Geoglossum glabrum* and *Trichoglossum velutipes* from West Pakistan. An important contribution was made by Batra & Batra (1963: 149–151) who reported many species distributed over the genera *Geoglossum*, *Gloeoglossum* (which in the present paper is not accepted as a separate taxon), *Microglossum*, and *Trichoglossum*.

A serious defect common to all records mentioned is the lack of descriptions of even passable quality. This is meagre encouragement for a prospective investigator since he cannot know whether his collections match those already reported. Worse still, without access to the material he has no means of verifying whether the species recorded have been correctly identified. As a definite improvement must be regarded

a recently published paper by Thind & Singh (1965) in which the authors deal with a few species only of *Geoglossum* and *Trichoglossum*, but give detailed descriptions. The present paper is offered in the hope that it may incite local mycologists to further interest in this much neglected group.

India and adjacent countries lie in an area that from a plant-geographical point of view cannot fail to yield interesting data. This is borne out by the present paper, however few the collections on which it is based. For example, *Geoglossum affine*, previously known only from the United States, is shown to occur in Nepal and Sikkim; *G. cookeianum*, hitherto known from Europe and the United States, appears in a single collection from India; and so on. More is certainly to be expected from an extended study.

There is also another point that requires comment. In the past several species have been described from a single collection which sometimes consists of a single specimen. It is not at all exceptional to find that collections are being regarded as referable to two independent species if they are found to differ in a single character. While this displays a certain disregard for the variability of the character in question, the distinction tends to be carefully maintained, particularly if the collections have come from places widely remote from one another. However, subsequent finds are likely to bridge the gap between the two 'species' while the Himalayan ranges, because of their enormous and uninterrupted expanse, are a promising place for such finds. The following example serves to illustrate this point. *Geoglossum pumilum*, described from Brazil, and *G. pusillum*, described from China, were once thought to represent two separate species but material collected in India demonstrates that they are the same. It is probable that even *G. pygmaeum* from the United States is another synonym.

Practically nothing is as yet known of the altitudinal distribution of the Geoglossaceae in the Himalayas. It may be expected, however, that at least some species favour a certain altitude and *G. affine* is possibly a case in point.

Attention must be drawn to a few technical points. The descriptions have been made from dried material. This unavoidably affects the size and colour of the fruit-body and, in the case of *Microglossum*, possibly also the spore-measurements. While it is desirable that eventually these parts in the descriptions be replaced by observations of fresh material, neither the size of the fruit-body nor its colour has been used in the key. The key used is basically the same as the one first published by Nannfeldt (1942), but it has been appropriately modified and adapted.

As far as possible duplicates of the material collected by the Dutch party have been deposited in (i) the herbarium of the Botanical Survey of India, Northern Circle, Dehra Dun (BSD), (ii) the Forest Research Institute & Colleges, Dehra Dun (DD), and (iii) the Indian Agricultural Research Institute, Division of Mycology and Plant Pathology, New Delhi (HCIO).

I gratefully acknowledge the loan of valuable collections from The National Fungus Collections, Beltsville (Mycological Herbarium of Lloyd, BPI), Department

of Plant Pathology, Cornell University, Ithaca (CUP), The Herbarium, Royal Botanic Gardens, Kew (K), British Museum (National History), Department of Botany, London (BM), Istituto e Orto Botanico dell'Università, Padova (PAD), and Laboratoire de Cryptogamie, Paris (PC). Thanks are also due to Dr. Sultan Ahmad, Lahore, for generously sending unidentified material, and to Prof. Dr. J. A. Nannfeldt, Uppsala, for the gift of some collections of *Geoglossum starbaeckii*. I am also very much indebted to Mrs. E. van Maanen, Amsterdam, for her advice in linguistical matters; deviations from the English idiom remain my responsibility.

GEOGLOSSACEAE

Fruit-bodies solitary or gregarious to subcespitose, erect, consisting of a fertile portion (clavula) born by a stipe, fleshy to somewhat waxy-fleshy, with or without black setae, dry to viscid. Clavula more or less gradually passing into the stipe, terete or compressed, cylindrical, clavate, ligulate, spathulate, lanceolate, more rarely capitate or flabellate, glabrous to felted or setose, black, black-brown, (when fresh also) purplish brown, olivaceous, green, yellow, orange. Stipe usually well developed, terete, glabrous, pubescent, squamulose, setose, more or less concolorous with the clavula. Asci cylindrical to cylindrical-clavate, inoperculate, (2–)4–8-spored. Spores 1–2-seriate or fasciculate in the ascus, acicular or cylindrical to cylindrical-clavate or ellipsoid to fabiform, straight or curved, 1–16-celled, rarely with more cells, colourless to brown. Paraphyses discrete or agglutinate, septate, more or less branched, straight to variously curved, colourless or brownish above.

Terrestrial or growing on vegetable debris or decaying wood.

Thus far only three genera—*Geoglossum*, *Microglossum*, and *Trichoglossum*—have been found in the area under discussion, which includes West Pakistan, India, Nepal, Sikkim, and Tibet.

Leotia Pers. is considered to belong to the Helotiaceae (Maas Geesteranus, 1964: 81) and is not treated in this paper.

KEY TO THE GENERA

1. Spores turning brown at maturity (in one species long remaining colourless, but then paraphyses apically abruptly enlarged and stipe slippery-viscid).
   2. Hymenium without dark setae . . . . . *Geoglossum*
   2. Hymenium with dark setae . . . . . *Trichoglossum*
1. Spores permanently colourless; paraphyses not abruptly enlarged apically and stipe not viscid . . . . . *Microglossum*

GEOGLOSSUM Pers. ex Fr.

Geoglossum Pers. *in* Neues Mag. Bot. **1**: 116. 1794; *ex* Fr., Syst. mycol. **1**: 487. 1821. — Type species: *G. glabrum* Pers. ex Fr. (Cf. Saccardo, 1884: 214).

Gloeoglossum Dur. *in* Annls mycol. **6**: 418. 1908. — Type species: *Geoglossum peckianum* Cooke (cf. Durand).

Fruit-bodies solitary or gregarious to subcespitose. Clavula gradually passing into the stipe, terete or compressed, cylindrical, clavate, ligulate, spathulate or lanceolate, glabrous or felted, dry or viscid, black to dark brown (also when fresh). Stipe terete, glabrous or pubescent to squamulose, dry or viscid, concolorous with the clavula or

darker. Asci cylindrical to cylindrical-clavate, inoperculate, 4–8-spored, the pore blued with iodine. Spores fasciculate in the ascus, acicular, cylindrical, cylindrical-clavate, straight or curved, 1–16-celled, eventually brownish to brown. Paraphyses discrete or agglutinate, septate, more or less branched, straight to variously curved, colourless or brownish above; in some species not confined to the hymenium, but continuing down the stipe to form a dense palisade.

Batra & Batra (1963: 149) mentioned a species called *Geoglossum alveolatum* from various localities in India, referring to Butler & Bisby's check-list as well as to their own collection. However, it turned out that at Cornell University, Ithaca, only slides had been deposited and these had not been sent on loan. The material which seems to be preserved at Panjab University, Chandigarh, was asked on loan, but had not arrived at the time this paper went to press.

From the Kew Herbarium word was received that no Indian material of *G. alveolatum* was either there or at the Commonwealth Institute. Butler, it was said, normally sent his fungi to Sydow so that the place they were most likely to be found was Stockholm. However, the reply from the Natural History Museum at Stockholm was that no material of *G. alveolatum* had been found there either.

Although it may turn out after all that *G. alveolatum* has actually been collected in India, the species is not dealt with here.

KEY TO THE SPECIES

1. Paraphyses in the upper part agglutinate by brownish amorphous matter.
   2. Paraphyses continuing down the stipe to form a conspicuous palisade.
      3. Paraphyses enveloped in a sheath of brown matter. Asci 18–25 μ wide *G. affine*
      3. Paraphyses without adhering brown matter. Asci up to 15 μ wide *G. glutinosum*
   2. Paraphyses not continuing down the stipe to form a palisade, remotely septate, colourless . . . . . *G. fallax*
1. Paraphyses not agglutinate by brownish matter, discrete.
   4. Spores 8-celled or with fewer cells.
      5. Asci 8-spored.
         6. Paraphyses in the upper part as a rule without side-branches or buds.
            7. Paraphyses closely to moderately septate above.
               8. Paraphyses continuing down the stipe as 'hairs' which form a dense palisade; besides, the paraphyses are characterized by many barrel-shaped pairs of cells . . . . . *G. simile*
               8. Paraphyses not continuing down the stipe to form a dense palisade; barrel-shaped pairs of cells rare or absent.
                  9. Paraphyses straight to somewhat curved, the upper part consisting of a chain of symmetrical cells . . . . . *G. cookeianum*
                  9. Paraphyses variously curved to coiled, most cells of the upper part unequal-sided . . . . . *G. japonicum*
            7. Paraphyses remotely (rarely moderately) septate *G. umbratile* var. *umbratile*
         6. Paraphyses with many side-branches and buds . . . . . *Geoglossum* sp.
      5. Asci 4–8-spored . . . . . *G. umbratile* var. *heterosporum*
   4. Some or all of the spores more than 8-celled.
      10. At least part of the spores 9–12-celled . . . . . *G. japonicum*
      10. Spores normally 16-celled . . . . . *G. pumilum*

GEOGLOSSUM AFFINE (Dur.) Sacc. & Trav.—Figs. 1–4

Geoglossum affine Dur. *in* Annls mycol. **6**: 420, figs. 73, 74, 165–167. 1908. — *Geoglossum affine* (Dur.) Sacc. & Trav. *in* Syll. Fung. **19**: 756. 1910. — *Cibalocoryne affinis* (Dur.) Imai *in* Bot. Mag., Tokyo **56**: 526. 1942.

Fruit-body 16–50 mm high. Clavula 10–21 × 1–2 mm, lanceolate or ligulate, with median groove and obtuse apex, dull, black-brown. Stipe 9–31 × 0.5–1.5 mm, terete, apparently smooth and viscid when fresh, dried somewhat shiny, covered with dirt, black-brown. Asci (154–)158–190(–210) × (18–)20–25.5 μ, 8-spored. Spores 52–65(–71) × 6.5–7.5(–10) μ (but sometimes longer, e.g. 73–95 × 5.5–7 μ), cylindrical-clavate to somewhat fusiform, 8-celled, brown. Paraphyses agglutinate by brown amorphous matter (which also partly or wholly envelops the upper cells), 2–5 μ wide and colourless below, 8–12 μ wide and pale brown above, moderately to remotely septate in the upper parts and curved to coiled, rarely straight; continuing down the stipe to form a conspicuous palisade that is viscid when fresh.

HABITAT.—This seems to be a species of somewhat higher altitudes, having been collected among dwarf *Rhododendron* and *Vaccinium* between 3600 and 4000 m.

DISTRIBUTION.—Thus far the species does not seem to have been reported outside the United States (Durand, Mains).

COLLECTIONS EXAMINED.—

N e p a l: S. of Gurjakhani, 17 Aug. 1954, *Stainton, Sykes, & Williams 3879a 3879b* (BM); Annapurna Himal, Leti Khola, 28 July 1954, *Stainton, Sykes, & Williams 6540* (BM).

S i k k i m: Yeumtong, 5 Sept. 1849, *Dr. Hooker* (K); [6 Sept. 1849, *Dr. Hooker*] (K).

T i b e t: Mira La, Nyang chu, 17 Aug. 1938, *Ludlow, Sherriff, & Taylor 6095* (BM).

Generally, but erroneously, Lloyd (1916: 9) is being regarded as the first author to have transferred the present species to the genus *Geoglossum*.

Durand (l.c.) gave the measurements of the spores of the type only, omitting those of the second collection he cited. The latter was examined by Mains (1954: 594) who found the spores (55–)60–80(–85) μ long. It is clear that the length of the spores has a wider range of variability than can be deduced from Durand's data. The spores in *Stainton, Sykes, & Williams 3879a* were even longer still, measuring 73–95 × 5.5–7 μ.

Mains (1954: 593), comparing the present species with *G. glutinosum*, found the status of *G. affine* very uncertain. This sounds strange, considering that there are enough features to make it possible to tell the species apart. In dried condition the hymenium is dull and black-brown in *G. affine*, shiny and black in *G. glutinosum*. The asci are much stouter in *G. affine* than in *G. glutinosum*. The spores in *G. glutinosum* apparently take their time maturing, hence in the same slide they vary from colourless to brownish and from one-celled to eight-celled, whereas in *G. affine* a large proportion mature at the same time. In their heavy incrustation and the shape of the upper cells, the paraphyses of *G. affine* differ considerably from those of *G. glutinosum*.

Berkeley (1945: 209) reported two species from Yeumtong in Sikkim, *G. viride*

and *G. glabrum*, both collected by Hooker. The former turns out to be *G. affine*, while the latter is partly *G. affine*, partly *G. fallax*.

Part of the collection of *Stainton, Sykes, & Williams* from Nepal (No. *3879c*) deviates from Nos. *3879a* and *3879b* in that the paraphyses are discrete and not encrusted with brown matter. It is not known what significance should be attributed to this phenomenon.

GEOGLOSSUM COOKEIANUM Nannf.—Fig. 5

Geoglossum cookeianum Nannf. *in* Ark. Bot. (A) **30** (4): 22 figs. 2d, 3. 1940.

The collection consists of a single specimen which is incomplete, as it lacks the upper half of the clavula. Clavula 1–1.5 mm wide, dull, black-brown. Stipe 18 × 1 mm, somewhat flattened, smooth, somewhat shiny, black. Asci 170–177 × 20–22 μ, 8-spored. Spores 75–83 × 5.5–7 μ, cylindrical-clavate, 8-celled, brown. Paraphyses somewhat adhering in clusters in the upper part, not really agglutinate by brown amorphous matter, 2–3 μ wide and brownish below, up to 8–10 μ wide and brownish to darkish brown above, closely septate in the upper parts, straight to somewhat curved.

HABITAT.—No information.

DISTRIBUTION.—Europe (Nannfeldt), India, U.S.A. (Durand, Mains).

COLLECTION EXAMINED.—

India: Uttar Pradesh, Mussoorie, Camel's Back Road, Cemetery, 9 Sept. 1960, *L. R. Batra* (CUP-I. 133).

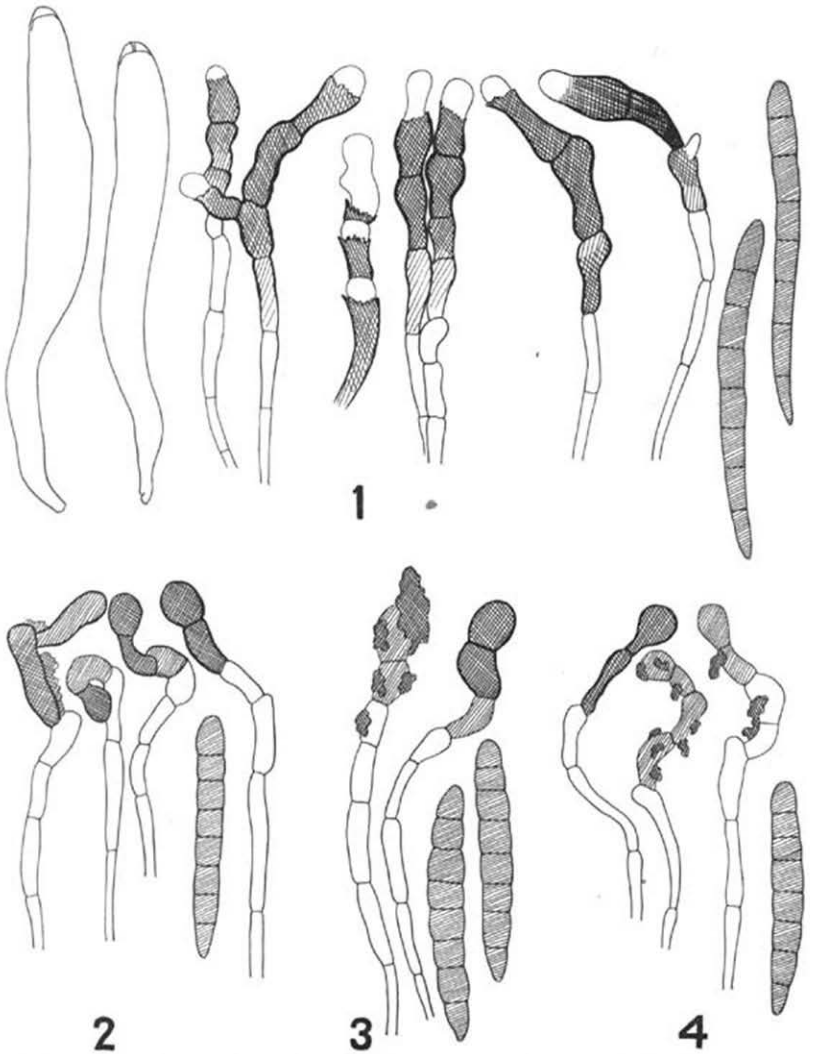
Thind & Singh (1965: pl. 2 fig. 1) published a photograph of *Geoglossum cookeianum*, but failed to give a description and did not indicate whether the material had been collected in India.

Even though much has already been said on the subject, it is unavoidable to discuss *G. glabrum* once again in connection with the present species.

Mains (1954: 601) once said that "there is considerable disagreement concerning the specific limitations of *Geoglossum glabrum*." The situation is worse than that for it is not known what the original *Geoglossum glabrum* looks like. There is, however, some knowledge of (and disagreement about) *G. glabrum* sensu Nannfeldt, a species for which a good epithet is available.

The specific epithet glabrum goes back to Persoon (1794: 116) who introduced it as a new name for *Clavaria ophioglossoides* L. Later (1799: 61), having become disgusted with all the different conceptions of what various authors called *C. ophioglossoides*, Persoon supplied a description for what he called "this my fungus," adding that the species occurs among grass in the hills ("in colliculis graminosis"). Unfortunately, this macroscopical description, however detailed, is altogether inadequate for identification of the species. Microscopical examination of the type could have furnished the clue, but the whole point is that there is no type.

The cover in Persoon's herbarium labelled *Geoglossum glabrum* contains the five following sheets. Of none of these can it be proved that it possibly served for the description of the species. In the case of the last sheet there is even definite proof that Persoon did not come into possession of the material until after he had published his *G. glabrum*.



Figs. 1–4. *Geoglossum affine*: asci (× 400), paraphyses and spores (× 600). — 1. Nepal, *Stainton, Sykes, & Williams 3879a* (BM). — 2. Nepal, *Stainton, Sykes, & Williams 3879b* (BM). — 3. Sikkim, 6 Sept. 1849, *Hooker* (K). — 4. Tibet, *Ludlow, Sherriff, & Taylor 6095* (BM).

No. 910.261–768: nine specimens glued to a piece of paper and the name written in Persoon's handwriting. Seven specimens belong to *G. fallax*, two to *G. cookeianum*.

No. 910.261–769: two specimens glued to a piece of paper and the name in Persoon's handwriting. Both specimens belong to *Trichoglossum hirsutum*.

No. 910.261–770: one specimen, about which Persoon was in doubt whether it represented a young stage or possibly a small variety of *G. glabrum*. Instead, it is an immature specimen of some species of *Xylosphaera*.

No. 910.261–773: two specimens glued to a piece of paper along with a message which Mougeot had sent to Persoon. Both specimens represent *G. fallax*.

No. 910.262–109: two specimens glued to a piece of paper, to the bottom of which two smaller slips are attached, both written in Mougeot's handwriting. One bears the name *Geoglossum glabrum*, the other a remark to the effect that the specimens were found to be perfectly glabrous and not viscid. These specimens appear to be *Geoglossum glabrum* as understood by Nannfeldt.

It was from this last sheet that fragments of both specimens were sent to Durand who naturally assumed that he had received parts of the type. It is quite certain, however, that these specimens do not represent the type. First, Persoon received Mougeot's material after he had already settled in Paris, that is, long after the publication of the name *G. glabrum*. Secondly, Mougeot's material came from a habitat entirely different from that which Persoon had indicated for his species. The two specimens forwarded by Mougeot have the bases of their stipes attached to tufts of *Sphagnum*. There is no doubt but that these specimens form part of a larger collection distributed by Mougeot & Nestler in their Stirpes cryptogamae vogeso-rhenanae under No. 684 as *Geoglossum sphagnorum* Pers. (which is a nomen nudum). At any rate, the specimens in the copy at Leiden are also fastened to tufts of *Sphagnum*. The label of this exsiccatum reads: "Inter *Sphagna* in torfaceis circa Gerardmer. Autumno."

As there is no sense in speculating on the identity of *G. glabrum* and as it would be undesirable to choose a neotype from among the specimens discussed above, the specific epithet is here formally rejected.

Nannfeldt (1942: 29) accepted Durand's choice of the type and very likely during his visit to Leiden he had himself noticed the identity of the alleged type and Mougeot & Nestler's exsiccatum. This, in all probability, is the source from which his conviction grew that *G. glabrum* must be a species of *Sphagnum* bogs. Nannfeldt is perfectly right in maintaining that the species is well characterized and distinct from all others, but its name must be replaced by *Geoglossum sphagnophilum* Ehrenb. ex Wallr. [1]

Notwithstanding the fact that Nannfeldt had clearly demonstrated the difference

[1] *Geoglossum sphagnophilum* Ehrenb., Sylv. mycol. berol. 30. 1818; *ex* Wallr., Fl. cryptog. Germ. **2**: 532. 1833. — *Geoglossum ophioglossoides* var. *sphagnophilum* (Ehrenb. ex Wallr.) Rehm *in* KryptogFl. Deutschl., Ed. 2, **1** (3): 1156. 1896. — *Geoglossum glabrum* f. *sphagnophilum* (Ehrenb. ex Wallr.) J. Favre *in* Matér. Fl. cryptog. suisse **10** (3) : 21. 1948. — *Geoglossum glabrum* var. *sphagnophilum* (Ehrenb. ex Wallr.) Imai *in* Trans. mycol. Soc. Japan **3**: 52. 1962 ("Fr."). — Lectotype: *Geoglossum sphagnophilum* Ehbg. in Herb. Pers. (L 910.261–786).

Misapplication: *Geoglossum glabrum* Pers. ex Fr. sensu Nannf. *in* Ark. Bot. (A) **30** (4): 29. 1942.

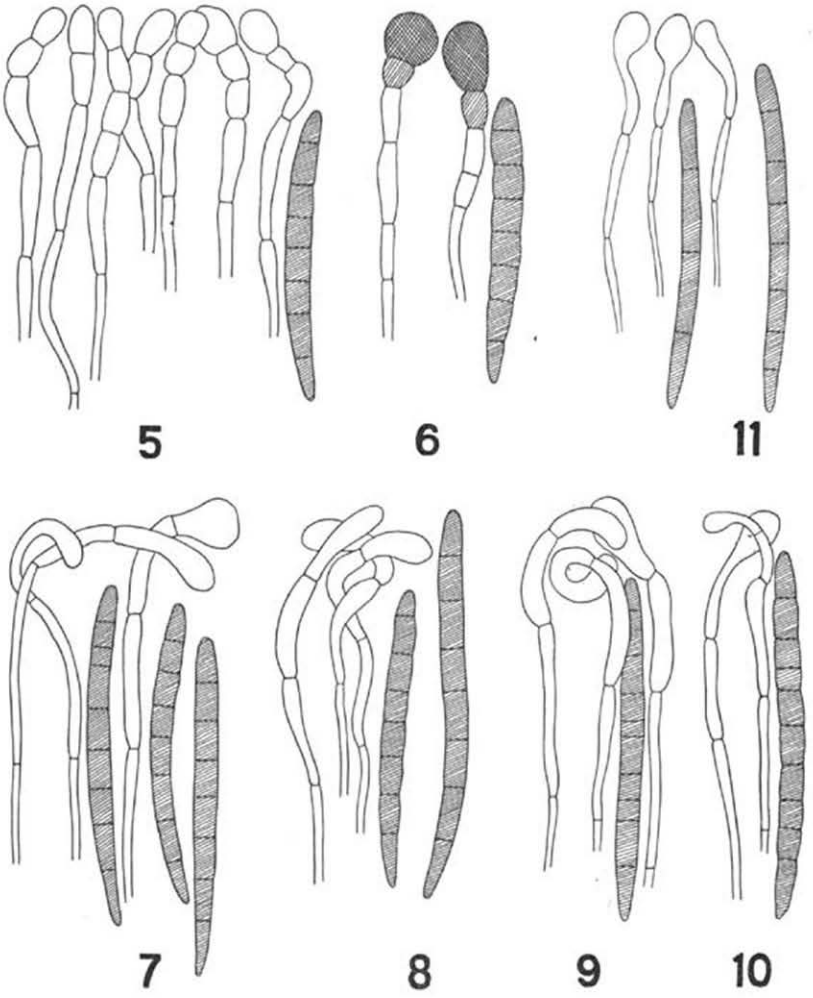


Fig. 5. *Geoglossum cookeianum:* paraphyses and spore (× 600); India, *Batra* (CUP-I. 133).
Fig. 6. *Geoglossum sphagnophilum:* paraphyses and spore (× 600); Germany, *Ehrenberg* (lectotype, L).
Figs. 7–10. *Geoglossum fallax:* paraphyses and spores (× 600). — 7. India, *Maas Geesteranus 14507* (L). — 8. India, *Maas Geesteranus 14550* (L). — 9. India, *Maas Geesteranus 14559* (L). — 10. Sikkim, *Hooker* (K).
Fig. 11. *Geoglossum glutinosum:* paraphyses and spores (× 600); India, *Thind 202b* (K).

between *G. cookeianum* and *G. sphagnophilum*, Durand's description and figures of what he considered to be *G. glabrum* continued to determine the opinion of later authors, the main trouble being the distinction between the two species so admirably unravelled by Nannfeldt. Mains (1954: 602) said that "usually there is considerable variation in the types of paraphyses within collections and distinctions are based on the predominance of types . . .. It seems best to recognize these variants as varieties of *G. glabrum*." To judge from Mains' descriptions and, above all, his photographs, it seems that he never saw a good sample of the true *G. sphagnophilum*. It certainly is by no means superfluous to quote Nannfeldt's observation: "The apical cells [of the paraphyses] are almost invariably globose, very large (often reaching a diameter of 15 μ), adhere almost indissolubly to each other and form a continuous dark, almost opaque layer above the asci, which layer is very conspicuous under the microscope, and renders *G. glabrum* recognizable already at first sight."

The Geoglossums in Persoon's herbarium are none too easy to examine microscopically and Durand may not have known that to enable the terminal cells of the paraphyses to resume their original shape the material has to be boiled in a fairly strong solution of KOH. From Durand's drawings it is obvious that he has altogether missed the typical paraphyses. Figures 5 and 6 in this paper show the difference between *G. cookeianum* and *G. sphagnophilum*.

GEOGLOSSUM FALLAX Dur.—Figs. 7–10

Geoglossum fallax Dur. *in* Annls mycol. **6**: 428, figs. 61–64, 133–137. 1908.

Fruit-body 12–47 mm high. Clavula 3–11 × 1–3.5 mm, clavate to ligulate, with median groove and obtuse apex, dull, dark brown to black-brown. Stipe 5–35 × 0.5–1 mm, minutely squamulose, dark brown to black. Asci 132–177 × 16–20 μ, 8-spored. Spores 76–102 × (4–)5–6 μ, cylindrical-clavate to acicular, slowly maturing, finally 8–13-celled and brown. Paraphyses agglutinate by brownish matter and sometimes firmly coherent, 2–4 μ wide and colourless below, (5–)6–12 μ wide and colourless to brownish above, remotely septate, not or little constricted at the septa, curved to coiled, the apical cell clavate to abruptly pyriform or hooked.

HABITAT.—On earth or among mosses covering rocks, sometimes in deep shade, but also in exposed positions, up to an altitude of about 4000 m.

DISTRIBUTION.—China (Tai, Teng), Europe (Nannfeldt), India, Japan (Imai), Sikkim, U.S.A. (Durand, Mains).

COLLECTIONS EXAMINED.—

India: Uttar Pradesh, Mussoorie, Jabber Keth, 10 Sept. 1960, *L. R. Batra* (CUP-I. 145); Mussoorie, 15 Sept. 1964, *R. A. Maas Geesteranus 14538* (L); 17 Sept. 1964, *R. A. Maas Geesteranus 14559* (L); Mussoorie, Camel's Back Road, 12 Sept. 1964, *R. A. Maas Geesteranus 14501* (BSD, DD, HCIO, L); Mussoorie, near Charleville, 13 Sept. 1964, *R. A. Maas Geesteranus 14507* (L); Mussoorie, Oakvilla, 16 Sept. 1964, *R. A. Maas Geesteranus 14550* (L).

Sikkim: Yeumtong, 6 Sept. 1849, *Dr. Hooker* (K).

Bille-Hansen (1954: 12) observed that in the colour of the apical part of the paraphyses and the amount of brown, amorphous matter in which they are embedded *Geoglossum fallax* is markedly variable. The difference between the extremes proved

so great that were it not for the intermediate forms he would have found it difficult to believe that the specimens belonged to the same species. A similar variability is seen in the Indian collections.

The collection from Sikkim was identified by Berkeley (1854: 212) as *G. glabrum*.

GEOGLOSSUM GLUTINOSUM Pers. ex Fr.—Fig. 11

Geoglossum glutinosum Pers., Obs. mycol. **1**: 11. 1796; *ex* Fr., Syst. mycol. **1**: 489. 1821. — *Geoglossum glutinosum* (Pers. ex Fr.) Dur. *in* Annls mycol. **6**: 419, figs. 70–72, 149–155. 1908. — *Cibalocoryne glutinosa* (Pers. ex Fr.) Imai *in* Bot. Mag., Tokyo **56**: 525. 1942.

Fruit-body 22–50 mm high. Clavula 8–18 × 1–2(–4) mm, clavate to ligulate, with median groove and obtuse apex, somewhat shiny (viscid when fresh), black-brown to black. Stipe 10–36 × 1–1.5 mm, glabrous, shiny (viscid when fresh), dark brown to black. Asci 207–265 × 12–16 μ, very slender, 8-spored. Spores 73–95.5 × 4–5.5 μ, acicular-cylindrical, maturing slowly and tardily becoming septate, ultimately 8-celled and brown, but many with fewer cells and brownish or colourless. Paraphyses agglutinate by brownish matter, 2–4 μ wide and colourless below, 4–10 μ wide and brownish above, remotely septate, straight to curved, the terminal cell clavate to pyriform; continuing down the stipe to form a conspicuous palisade.

HABITAT.—On soil in oak forest or among mosses on stony slopes, at an altitude of about 2000 m.

DISTRIBUTION.—China (Tai, Teng), Europe (Nannfeldt), India (Batra & Batra, Thind & Singh), Japan (Imai), U.S.A. (Durand, Mains).

COLLECTIONS EXAMINED.—

India: Himachal Pradesh, Dalhousie, 22 Sept. 1955, *L. R. Batra* (CUP-I. 54). Uttar Pradesh, Mussoorie, Jabber Khet, 8 Sept. 1960, *L. R. Batra* (CUP-I. 127); Mussoorie, Camel's Back Road, 9 Sept. 1960, *L. R. Batra* (CUP-I. 126); Mussoorie, Jabber Kher Khad, 18 Aug. 1961, *K. S. Thind 215* (K); 9 Sept. 1961, *K. S. Thind 202b* (K); Mussoorie, 17 Sept. 1964, *R. A. Maas Geesteranus 14560* (BSD, DD, HCIO, L).

GEOGLOSSUM JAPONICUM Imai—Figs. 12–14

Geoglossum japonicum Imai *in* J. Fac. Agric. Hokkaido imp. Univ. **45**: 210, pl. 8 fig. 5. 1941. — *Geoglossum glabrum* var. *japonicum* (Imai) Imai *in* Trans. mycol. Soc. Japan **3**: 52. 1952 ("Mains").

Fruit-body 25–42 mm high. Clavula 6–20 × 2–4 mm, ligulate, with median groove and obtuse apex, dull, dark brown to black. Stipe 15–17 × 1–1.5 mm, terete to flattened, minutely squamulose or glabrescent below, dull, black-brown to black. Asci 144–197 × (16-)20–25 μ, 8-spored. Spores 66–89 × 6–7 μ, cylindrical-clavate to somewhat fusiform, 8–12-celled, brown. Paraphyses discrete, 2–4 μ wide and colourless below, 5–9 μ wide and pale to fairly dark brown above, moderately to closely septate in the upper part, usually much constricted at the septa, straight or, more often, variously curved to circinate, the terminal cell generally clavata to pyriform.

HABITAT.—Among moss on stony slopes outside the forest, at an approximate altitude of 2000 m.

DISTRIBUTION.—India, Japan (Imai).

COLLECTIONS EXAMINED.—

India: Uttar Pradesh, Mussoorie, 17 Sept. 1964, *R. A. Maas Geesteranus 14557* (BSD, DD, HCIO, L), *14646* (L); Mussoorie, Oakvilla, 16 Sept. 1964, *R. A Maas Geesteranus 14549* (L).

Mains (1954: 602) expressed it as his opinion that "*G. japonicum* should also probably be considered a variety of *G. glabrum*." This led Imai to think that Mains had actually made the transfer. Even if it is borne in mind that Mains' conception of the type variety of *G. glabrum* covers *G. cookeianum*, it is by no means certain that *G. japonicum* is related with *G. cookeianum*, let alone that it should be subordinate to that species at all; too many of the paraphyses of both species are completely dissimilar in appearance.

The septation of the spores appears to be unequal. Imai described the spores of his species as 8-celled; so are most of the spores in *Maas Geesteranus 14557*. Many other spores, however, have fewer cells, although, to judge from their brown colour, they seem mature. In *Maas Geesteranus 14549* some of the spores are 9-celled, in *Maas Geesteranus 14646* even 8–12-celled. The steps are so gradual and the paraphyses so similar that it would seem arbitrary to draw any line. The situation is somewhat reminiscent of that in *G. starbaeckii* Nannf., a species that is characterized by slowly maturing, 1–10(–14)-celled spores and discrete, fairly dark, remotely septate, and variously curved paraphyses. There seems, in fact, to be no objection to placing *G. japonicum* (or what is here taken to be that species) proximate to *G. starbaeckii*. To facilitate comparison, Figure 15 is added.

Batra & Batra (1963: 149) mentioned *Geoglossum japonicum* in their publication, but their collection is here referred to *G. simile*.

GEOGLOSSUM PUMILUM Wint.—Figs. 16, 17

Geoglossum pumilum Wint. *in* Grevillea **15**: 91. 1887.
Geoglossum pusillum Tai *in* Lloydia **7**: 150, fig. 23. 1944.

Fruit-body 5–28 mm high. Clavula 2–10 × 1–3.5 mm, lanceolate to ligulate or spathulate, with median groove and obtuse apex, sometimes deformed and globose, dull, dark brown. Stipe 3–19 × 0.3–0.5 mm, terete, minutely squamulose or smooth below, somewhat shiny, black. Asci 175–225 × 20–24 μ, 8-spored. Spores 77–148 × 5–6.5 μ, acicular, (14–)16-celled at maturity, brown. Paraphyses discrete, 2–4 μ wide and colourless below, 5–10(–11.5) μ wide and pale brown above, (moderately to) remotely septate in the upper part, constricted at the septa, straight to curved or coiled, the terminal cell cylindrical to clavate or pyriform.

HABITAT.—On damp soil in forest of *Quercus* and *Rhododendron* or among mosses on exposed stony slopes, at an altitude of about 2000 m.

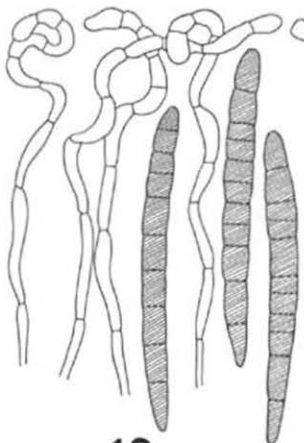
DISTRIBUTION.—Brazil (type locality), Bermuda (Durand), China (as *G. pusillum*, Tai), India (as *G. pygmaeum*, Batra & Batra; Thind & Singh), Japan (Imai), U.S.A. (Durand, Mains).

EXPLANATION OF FIGURES 12–17

Figs. 12–14. *Geoglossum japonicum:* paraphyses and spores (× 600). — 12. India, *Maas Geesteranus 14646* (L). — 13. India, *Maas Geesteranus 14549* (L). — 14. India, *Maas Geesteranus 14557* (L).

Fig. 15. *Geoglossum starbaeckii:* paraphyses and spores (× 600); Sweden, *Donk, Lundell, & Nannfeldt 4447* (L).

Figs. 16, 17. *Geoglossum pumilum:* paraphyses and spores (× 600). — 16. India, *Batra* (CUP-I. 131). 17. India, *Maas Geesteranus 14558* (L).



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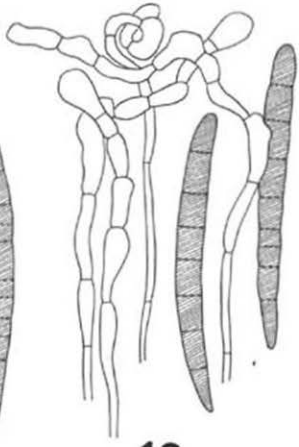

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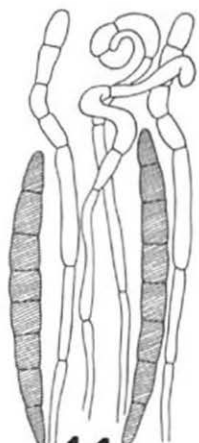

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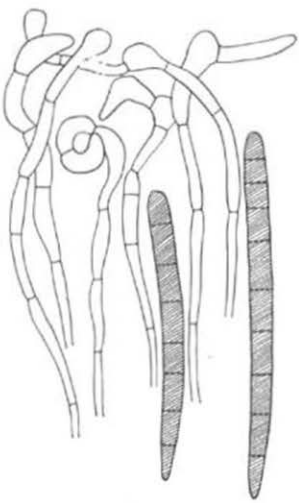

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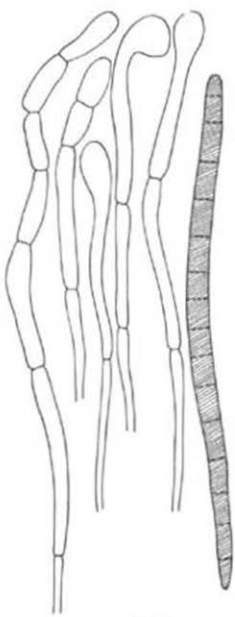

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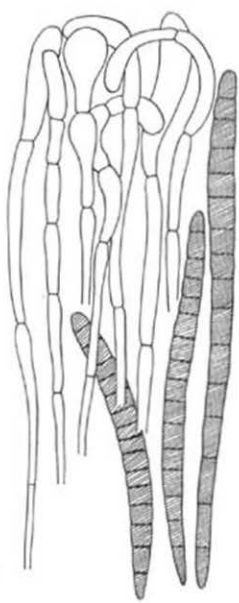

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Figs. 12–17

COLLECTIONS EXAMINED.—
India: Himachal Pradesh, Simla, Summer Hill Chakkar, 7 Sept. 1962, *K. S. Thind 207* (K). Uttar Pradesh, Mussoorie, Camel's Back Road, Cemetery, 9 Sept. 1960, *L. R. Batra* (CUP-I. 131); Mussoorie, Jabber Khet, 10 Sept. 1960, *L. R. Batra* (CUP-I. 130); Mussoorie, Camel's Back Road, 19 Aug. 1961, *K. S. Thind 206* (K); Mussoorie, 17 Sept. 1964, *R. A. Maas Geesteranus 14558* (L).

The paraphyses in Winter's description are said to be straight but the Indian material proves that in the same collection they vary from straight to curved or coiled. Similarly, Durand (1921: 184) found the paraphyses in his material "usually nearly straight but sometimes strongly curved. . .," while Mains (1954: fig. 26) published a photograph of *G. pumilum* which also shows the paraphyses both straight and curved. Compare also Thind & Singh (1965: fig. 4).

A closely similar species is *Geoglossum pygmaeum* Gerard ex Dur. (1908: 429, figs. 60, 140, 141), described from a single collection. Durand (1921: 185) thought that *G. pumilum* would be different from *G. pygmaeum* "in its shorter spores, and especially in its more robust, longer, remotely septate paraphyses." With regard to the paraphyses it should be noted that, while the original description of *G. pumilum* gives no information on either the robustness and length or on the septation of the paraphyses, Durand admitted that he had not seen the type. Regarding the length of the spores, a third species, *Geoglossum pusillum*, must now be introduced, since it helps to illustrate that spore-length alone is an unreliable feature for the distinction of species in a genus like *Geoglossum*. The data available are tabulated as follows:—

TABLE I. SPORE-LENGTHS IN THREE SPECIES OF *Geoglossum*

Authors	*G. pumilum*	*G. pusillum*	*G. pygmaeum*
Winter (1887: 91)	95–110 μ		
Ger. ex Dur. (1908: 429)			122–140 μ
Patouillard (1910: 132)			150 μ
Durand (1921: 184)	(104–)110–115(–125) μ		
Imai (1941: 217)	100–137 μ		
Tai (1944: 150)		111–144 μ	
Mains (1954: 606)	(85–)90–130(–145) μ		(120–)125–160(–180) μ
Thind & Singh (1965: 535)	100–140 μ		

From this table it is obvious that with each successive record the spore-length of *G. pumilum* was found to have greater variability, overlapping that of *G. pygmaeum* to an increasing degree. On the other hand, the spores in *G. pygmaeum* seem to reach greater maximum lengths. If there is any value to be attributed to this difference, then all Indian collections are referable to *G. pumilum*. If the distinction depends on the paraphyses they are equally referable to *G. pumilum*. Since it has not been proved

that the paraphyses of *G. pygmaeum* are in any way different from those of *G. pumilum* there is as yet no reason to use the younger epithet.

If, as is assumed here, the spores with fewer than 16 cells are taken to be deformed or immature, then *Geoglossum pusillum* falls entirely within the limits of variability of *G. pumilum*.

A far more awkward problem is where to draw the line between *G. pumilum* and *G. fallax*. This statement may seem unfounded as the spores are 16-celled in the former, 8-celled in the latter. But there seems to be a gradated transition from one species to the other through *G. pusillum* and *G. fallax* var. *subpumilum* Imai (1941:215). At present no solution can be offered.

GEOGLOSSUM SIMILE PECK—Figs. 18—20

Geoglossum simile Peck *in* Bull. Buffalo Soc. nat. Sci. **1**: 70. 1873 (not seen).

Fruit-body 25–60 mm high. Clavula 9–23 × 1–2 mm, cylindrical to ligulate with narrow median groove and obtuse to subacute apex, dull, brown to black-brown. Stipe 15–48 × 0.5–1.5 mm, terete, minutely pubescent or smooth and seemingly glabrous (in that case usually somewhat shiny and covered with dirt), black. Asci (144–)158–226 × (12–)16–20 μ, 8-spored. Spores 63–87(–97) × (3.5–)4–6 μ, cylindrical-clavate, 8-celled, brown. Paraphyses discrete, 2–4(–5) μ wide and colourless below, (4–)6–10(–12) μ wide and pale, rarely darkish, brown above, moderately to closely septate in the upper part, much constricted at the septa to form barrel-shaped (or clavate) cells or 2-celled segments; continuing down the stipe to form a dense, colourless to dark palisade which under certain circumstances may become gelatinized.

HABITAT.—On soil in *Cedrus* or *Quercus* forest or among mosses on exposed slopes, at an altitude of about 2000 m.

DISTRIBUTION.—India (Batra & Batra), Japan (Imai), U.S.A. (Nannfeldt, Mains).

COLLECTIONS EXAMINED.—

India: Uttar Pradesh, Mussoorie, Camel's Back Road, 9 Sept. 1960, *L. R. Batra* (CUP-I. 128); Mussoorie, Camel's Back Road, Cemetery, 9 Sept. 1960, *L. R. Batra* (CUP-I. 129); Mussoorie, Chakrata Road, 12 Sept, 1960, *L. R. Batra* (CUP-I. 134); Mussoorie, Jabber Kher Khad, 19 Aug. 1961. *K. S. Thind 210* (K); Mussoorie, Dhnaulti, 2 Sept. 1961, *K. S Thind 211b* (K); Mussoorie, 17 Sept. 1964, *R. A. Maas Geesteranus 14648* (L).

As the stipes of each may be equally slippery, in the field *G. simile* can prove indistinguishable from *G. glutinosum*, in close proximity to which it sometimes grows. When dried, however, the macroscopical difference is clear. The clavula in *G. simile* is dull and dark brown, while owing to shrinkage of the hymenium it looks porous; in *G. glutinosum* it is somewhat shiny, black, and continuous. The anatomical explanation is that the hymenial paraphyses are discrete in the former, agglutinate in the latter.

Batra & Batra (1963: 149) mentioned one of the collections (CUP-I. 129) as *G. japonicum*, another (CUP-I. 134) as *G. nigritum*.

GEOGLOSSUM UMBRATILE Sacc.

Geoglossum umbratile Sacc. *in* Michelia **1**: 444. 1878; Fungi ital. fig. 1323. 1882. — *Geoglossum peckianum* f. *umbratile* (Sacc.) Massee *in* Ann. Bot. **11**: 251. 1897. — Holotype: *Geoglossum umbratile* S. / Bizz [ozero] / [18] 78. 10 [= October] / [follows an illegible part, the first letters of which appear to be HPa, possibly the abbreviation of Hortus Patavinus] (PAD).

? *Microglossum partitum* Pat. *in* Revue mycol. **12**: 135, pl. 107 bis fig. 2. 1890. — *Mitrula partita* (Pat.) Massee *in* Ann. Bot. **11**: 283. 1897.

MISAPPLICATION: *Geoglossum nigritum* (Pers. ex Fr.) Cooke, Mycogr. 205, pl. 96 fig. 345. 1878.

Clavula lanceolate to ligulate or cylindrical, with or without median groove and with obtuse to subacute apex, dull, dark brown to black-brown. Stipe terete to somewhat flattened, squamulose to glabrous (in which case somewhat viscid when fresh, shiny when dried), black-brown to black. Asci cylindrical-clavate, consistently 8-spored or 2–8-spored. Spores cylindrical-clavate to acicular, 8-celled, curved, brown. Paraphyses discrete, remotely to moderately septate in the upper part, usually little or not constricted at the septa (but deep constrictions do occur), straight to curved or coiled, colourless or pale brown above, the terminal cell cylindrical, clavate or pyriform, and sometimes much enlarged.

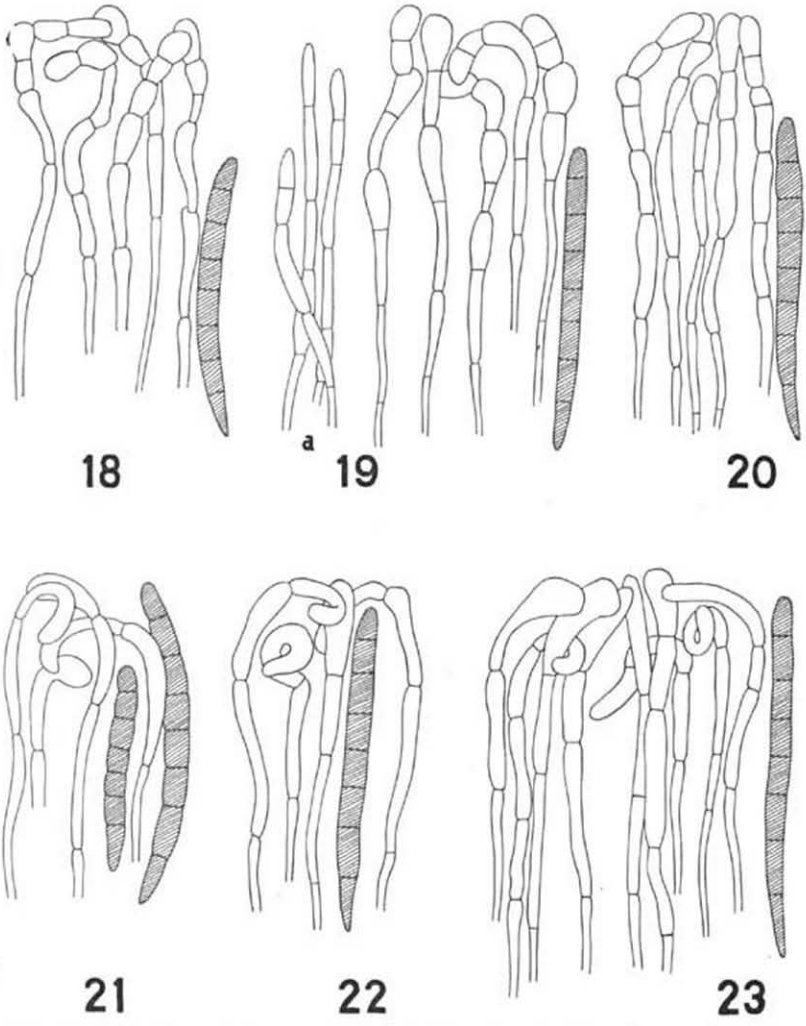
The type variety is the one most commonly encountered; it is characterized by consistently eight-spored asci. Variety *heterosporum* possesses asci which in the same fruit-body may be two- to eight-spored.

The name currently in use for this species is *Geoglossum nigritum*. Some mycologists (Durand, 1908: 427; Nannfeldt, 1942: 35) were of the opinion that Cooke was the author of the species, while others (Imai, 1941: 211; Mains, 1954: 595) used the citation (Fr.) Cooke. Both citations are erroneous, as is the use of the specific epithet. Only Mains expressed his doubts as to the correctness of the application of the name. A review of the history of the epithet would not seem out of place.

Persoon (1797: 78) introduced a *Clavaria nigrita*, characterized among other things by its "clavulis . . . fistulosis"; in the description this was repeated with the words "Clavulae . . . intus cavae." The species was taken up again a few years later (1801: 604) with the circumscription unchanged. It may be stated at the outset that it is precisely on account of this character that *Clavaria nigrita* is not a *Geoglossum*.

Fries (1821: 483), faithfully repeating the word "fistulosa," referred to Persoon's Synopsis, from which it is obvious that *Clavaria nigrita* Pers. ex Fr. is still not a *Geoglossum*. Much later (1874: 676), however, Fries added the sentence "Species insignis, habitu *Geoglossi*, nuperius ad Halmbyboda prope Upsaliam lecta. (v.v.)." This Swedish material turned out to be a true *Geoglossum*. Part of the collection was sent to Berkeley and from this Cooke prepared his figure. Both Durand and Nannfeldt mistakenly concluded that the material in Berkeley's herbarium represented the type of what they thought to be *Clavaria nigrita* Fr., not realizing (i) that Persoon, not Fries, was the first author of that species, (ii) that if a type were in existence (which it is not), it would necessarily be the type of *Clavaria nigrita* Pers., and (iii) that Fries had misidentified his specimens, for a *Geoglossum* is not hollow.

It is not possible, by leaving *Clavaria nigrita* out of consideration, to attribute the name *Geoglossum nigritum* to Cooke alone, since Cooke, too, referred unambiguously



Figs. 18–20. *Geoglossum simile:* paraphyses, hairs from the stipe (a), and spores (× 600). — 18. India, *Batra* (CUP-I. 129). — 19. India, *Batra* (CUP-I. 128). — 20. India, *Thind 210* (K).
Figs. 21–23. *Geoglossum umbratile* var. *umbratile:* paraphyses and spores (× 600). — 21. Italy, *Bizzozero* (holotype; PAD). — 22. India, *Batra* (CUP-I. 139). — 23. India, *Thind 208* (K).

to *Clavaria nigrita* Pers. and even went so far as to describe the species as "fistulosum." Clearly *Geoglossum nigritum* (Pers. ex Fr.) Cooke is a misapplication.

Bourdot & Galzin (1928: 119) and Bresadola (1884: pl. 67 fig. 4; 1932: pl. 1105 fig. 2) are among the few authors who have recognized the true nature of *Clavaria nigrita*.

GEOGLOSSUM UMBRATILE Sacc. var. UMBRATILE—Figs. 21–23

? *Microglossum partitum* Pat., l.c.

Fruit-body 14–31 mm high. Clavula 2–10 × 1–3 mm, lanceolate to ligulate, with narrow median groove and obtuse to subacute apex, dull, dark brown to black-brown. Stipe 9–23 × 0.2–0.6 mm, terete, minulety squamulose to glabrous (in which case somewhat shiny), dark brown to black-brown. Asci 148–197 × (14–) 16–20 μ, 8-spored. Spores 59.5–100 × 4.5–6 μ, acicular to somewhat fusiform, 8-celled, brown. Paraphyses discrete, 1–4 μ wide and colourless below, 3–10 μ wide and colourless to pale brown above, remotely to moderately septate in the upper part, more or less constricted at the septa, straight to curved or coiled to hooked, the terminal cell sometimes abruptly enlarged.

HABITAT.—On soil or among mosses in *Cedrus* or *Quercus* forest, at altitudes between 2000 and 2100 m.

DISTRIBUTION.—China (Tai, Teng), Europe (Nannfeldt), India (Batra & Batra), Japan (Imai), U.S.A. (Durand, Mains), West Pakistan.

COLLECTIONS EXAMINED.—

India: ? Uttar Pradesh, Mussoorie, 23 Sept 1955, *L. R. Batra* (CUP-I. 53; locality not indicated); Uttar Pradesh, Mussoorie, Sept. 1960, *L. R. Batra* (CUP-I. 146); Mussoorie, Landour, 8 Sept. 1960, *L. R. Batra* (CUP-I. 139–141); Mussoorie, Camel's Back Road, Cemetery, 9 Sept. 1960. *L. R. Batra* (CUP-I. 136, 137, 142, 143); Mussoorie, The Park, 11 Sept. 1960, *L. R. Batra* (CUP-I. 138); Mussoorie, Chakrata Road, 11 Sept. 1960, *L. R. Batra* (CUP.-I. 135); Mussoorie, Chakrata Road, 12 Sept. 1960, *L. R. Batra* (CUP.-I. 144); Mussoorie, road Subakholi-Maghra, 31 Aug. 1961, *K. S. Thind 208* (K); Mussoorie, road Maghra-Dhnaulti, 1 Sept. 1961, *K. S. Thind 214* (K); Mussoorie, Dhnaulti, 2 Sept. 1961, *K. S. Thind 211a* (K).

West Pakistan: Lahore, no date, *S. R. Kashyap* (Lloyd 30240 in BPI); Murree, 20 Aug. 1948, *S. Ahmad 2709b* (L); Aug. 1949, *S. Ahmad 4050* (L).

Lloyd (1917: 4), replying to a correspondent who had sent in a collection from Lahore, referred the material to *Geoglossum glabrum* but the note accompanying the packet in his herbarium reads thus: "The paraphyses rather tend toward *nigritum*, but I feel that it is really same as *glabrum*."

Tai (1944: 149, 150), in his enumeration of Chinese Geoglossaceae, mentioned *G. nigritum* and *G. umbratile*. A description is given of the latter only and from this ("spores . . . 3–9–, mostly 7-septate") it is rather uncertain to which of the two species he was referring.

Ahmad (1956: 37) placed the collections from Murree under *G. glabrum*.

Batra & Batra (1963: 149) identified one of the collections from Mussoorie (CUP-I. 142) as *G. cohaerens*, and another (CUP-I. 53) as *G. glabrum*.

It has been customary to regard *Microglossum partitum* as a synonym of *Thuemenidium* (or *Corynetes*) *atropurpureum*, no doubt because Patouillard himself compared

his species with one that later turned out to be identical with *T. atropurpureum*. To judge from the description there is nothing to be said against this assumption. However, the material borrowed from the cryptogamic herbarium in Paris, which in Patouillard's handwriting bears the annotation "*Microglossum partitum* / Yunnan / Leg. Delavay," belongs to a different species. Macroscopically it agrees with the original description in that the apical portion of the clavula is split downwards for some length. From this the conclusion seems permissible that the material actually represents the type, for splitting of the clavula is a most unusual phenomenon. From the following description it is evident that this material, at any rate, belongs to *Geoglossum umbratile* var. *umbratile*:—

The material consists of two specimens. The large specimen is young and in bad condition, with practically all asci and paraphyses collapsed and agglutinated, while the very few mature spores trapped in mucilaginous masses are difficult to discern. Very immature spores—1-celled, often as short as 40 μ, colourless—are unexpectedly numerous, having doubtless been squeezed out by tapping on the cover-glass. The smaller specimen is in excellent condition but even younger than the preceding one. Asci c. 160 × 14–16 μ, 8-spored. Spores 63–87 × 4.5–6 μ, cylindrical-clavate, 8-celled, somewhat curved, finally brown. Paraphyses discrete, colourless or pale brown above, moderately to remotely septate, not or little constricted at the septa, straight to curved or coiled, the terminal cell cylindrical to clavate.

G. UMBRATILE var. **heterosporum** (Mains) Maas G., *comb. nov.*—Fig. 24

Geoglossum nigritum var. *heterosporum* Mains *in* Mycologia **46**: 596, figs. 16–19. 1954 (basionym).

The following description is based on two collections which are referred to the present variety, though not without some doubt.

Fruit-body 14–22 mm high. Clavula 4–9 × 1–1.5 mm, cylindrical to ligulate, dull, black-brown. Stipe 10–12.5 × 0.2–0.5 mm, terete, squamulose, black-brown. Asci 132–165 × 17–20 μ, (5–)6–8-spored in *Thind 212*, consistently 4-spored in one of the specimens of *Thind 213*. Spores (69–)77–89(–102) × 5–6 μ, cylindrical-clavate to acicular, 8-celled, brown. Paraphyses discrete, 2–4 μ wide and colourless below, 6–14 μ wide and colourless to pale brown above, remotely to moderately septate in the upper part, little constricted at the septa, straight to curved, the terminal cell clavate to pyriform and sometimes sharply hooked.

HABITAT.—On damp, mossy soil in *Quercus* forest.

COLLECTIONS EXAMINED:—

India: Uttar Pradesh, Mussoorie, Jabber Kher Khad, 19 Aug. 1961, *K. S. Thind 212, 213* (K).

Mains described one variety only but it is probable that *G. umbratile* is far more variable than is generally assumed. Nannfeldt (1942: 36) stressed the variability in the spore length but great differences are also to be seen in the general appearance of the paraphyses and the shape of the terminal cell. The usual form of the terminal cell is a more or less strongly curved cylinder or slender club, as can be seen in the paraphyses of the type (Fig. 21). Sometimes, however, the terminal cell is apically abruptly enlarged (Fig. 23), or else deformed (not shown). Or again, it is short and

inflated, separated from the penultimate cell by a deep constriction (not shown). It is only a gradual step to such paraphyses as occur in *Thind 213* (not shown) and *212* (Fig. 24). If these collections are acceptable as forms or varieties of *G. umbratile*, there seems to be no really adequate reason for preventing *G. barlae* Boud. (1888: 76, pl. 16 fig. 1) and *G. montanum* Nannf. (1942: 34, fig. 1 d-e, pl. 3 fig. 6) from being included in the sphere of *G. umbratile*. The paraphyses of *G. barlae* have been depicted by Boudier, Nannfeldt (1942: fig. 1c), and Maas Geesteranus (1955: fig. 1). Their diversity acquires a new significance in the light of a possible relationship between this species and *G. umbratile*. The same is true of the paraphyses in *G. montanum*, a 'species' which closely approaches variety *heterosporum* on account of its 3–6-spored asci (2–7-spored according to Eckblad, 1963: 148).

GEOGLOSSUM sp.—Fig. 25

There is only a fragment, representing the central portion of a clavula, 1.5 mm wide, surface conspicuously felted, somewhat shiny, black. Asci 158–217 × 20–22 μ, 8-spored. Spores 75–95 × 6–7.5 μ, cylindrical-clavate, 8-celled, brown. Paraphyses discrete, 2–3 μ wide and colourless below, 6–8 μ wide and pale brown above, moderately to closely septate in the upper part, little or not constricted at the septa, terminal cell clavate to pyriform.

HABITAT.—No information.

COLLECTION EXAMINED:—

India: Uttar Pradesh, Mussoorie, Camel's Back Road, Cemetery, 9 Sept. 1960, *L. R. Batra* (CUP-I. 132).

Batra & Batra (1963: 149) listed this collection under *Geoglossum glabrum* but it is neither that nor *G. cookeianum*. Were it not for the numerous side-branches and buds of the paraphyses the collection could be referred to *G. japonicum*. Occasional side-branches of the paraphyses do occur in other species of *Geoglossum* but in the present case they are probably too frequent to be dismissed as a mere freak.

MICROGLOSSUM Gill.

Microglossum Gill., Champ. France, Discomyc. 25. 1879. — Type species: *Geoglossum viride* Pers. ex Fr. (cf. Durand).

Fruit-bodies solitary or gregarious to cespitose. Clavula gradually passing into the stipe, terete or compressed, cylindrical, clavate, ligulate, spathulate or lanceolate, glabrous, drab to blackish when dried (brownish green, blue-green, green or yellow

EXPLANATION OF FIGURES 24-28

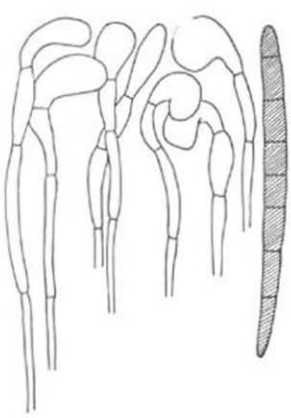
Fig. 24. *Geoglossum umbratile* var. *heterosporum:* paraphyses and spore (× 600); India, *Thind 212* (K).

Fig. 25. *Geoglossum* sp.: paraphyses and spore (× 600); India, *Batra* (CUP-I. 132).

Fig. 26. *Microglossum olivaceum:* asci and paraphysis (× 600), spores (× 1400); India, *Thind 217* (K).

Fig. 27. *Microglossum rufum:* ascus and paraphyses (× 600), spore (× 1400); India, *Thind 216* (K).

Fig. 28. *Microglossum viride:* ascus, paraphyses and spore (× 600); Sikkim, *Hooker* (K).



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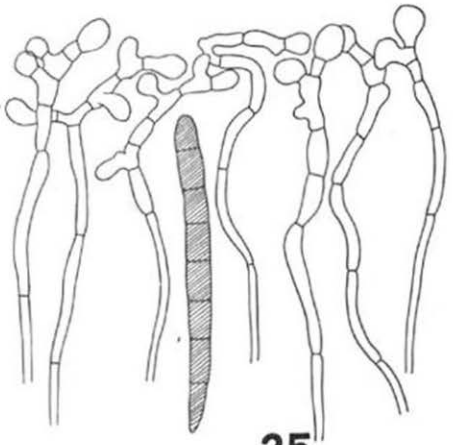

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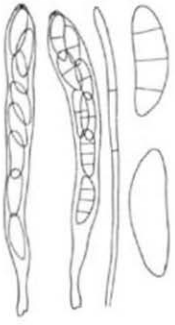

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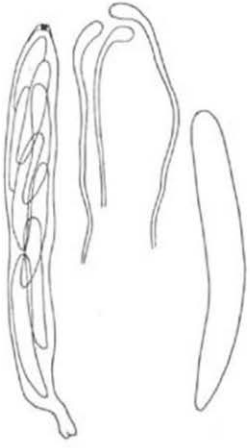

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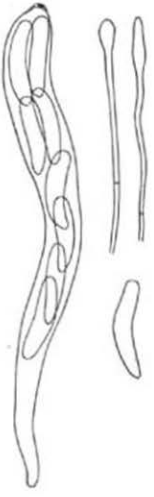


28

Figs. 24–28

when fresh). Stipe terete or somewhat flattened, glabrous or squamulose, dry or somewhat viscid, more or less concolorous with the clavula. Asci cylindrical-clavate, inoperculate, 8-spored, the pore blued with iodine. Spores 1-seriate, then 2-seriate, ellipsoid, fabiform or cylindrical to fusiform, straight to curved, 1–16-celled, colourless. Paraphyses discrete, septate, simple or branched, straight to strongly curved, colourless or apically somewhat coloured.

The spores in all species of *Microglossum* become septate at maturity but in some they seem to take a long time maturing. In general, the septation is not used for the distinction of species.

KEY TO THE SPECIES

1. Paraphyses straight or slightly curved to flexuous, apically not or little enlarged.
   2. Stipe smooth. . . . . *M. olivaceum*
   2. Stipe squamulose. . . . . *M. viride*
1. Paraphyses more or less strongly curved, distinctly enlarged at the apices *M. rufum*

MICROGLOSSUM OLIVACEUM (Pers. ex Fr.) Gill.—Fig. 26

Geoglossum olivaceum Pers., Obs. mycol. **1**: 40, pl. 5 fig. 7. 1796; *ex* Fr., Syst. mycol. **1**: 489. 1821. — *Microglossum olivaceum* (Pers. ex Fr.) Gill., Champ. France, Discomyc. 25. 1879.

Fruit-body 31–33 mm high. Clavula 10–14 × 1–2 mm, ligulate, with median groove and obtuse apex, dull, black-brown. Stipe 10–23 × 0.5–1.5 mm, terete, glabrous, somewhat shiny, black-brown. Asci 67–102 × 7–8.5 μ. Spores 12–14 × 4–5 μ, ellipsoid-fusiform to fabiform, 1-celled, multiguttulate, becoming 4-celled, colourless. Paraphyses 1–1.5 μ wide below, gradually widened to 1.5–2.5 μ above, colourless, straight or slightly curved.

HABITAT.—On damp soil amongst decaying leaves in *Quercus* forest, at an approximate altitude of 2000 m.

DISTRIBUTION.—China (Tai), Europe (Nannfeldt), India (Batra & Batra), Japan (Imai), U.S.A. (Durand, Mains).

COLLECTIONS EXAMINED:—

India: Uttar Pradesh, Mussoorie, Municipal Gardens, 5 Aug. 1960, *L. R. Batra* (CUP-I. 114); Mussoorie, Mossy Fall, 6 Sept. 1961, *K. S. Thind 217* (K).

MICROGLOSSUM RUFUM (Schw.) Underw.—Fig. 27

Geoglossum rufum Schw. *in* Trans. Amer. phil. Soc. **4**: 181. 1834. — *Microglossum rufum* (Schw.) Underw. *in* Minn. bot. Stud. **1**: 496. 1896.

Fruit-body 10–12 mm high. Clavula 4–6 × 1–1.5 mm, cylindrical to ligulate, with narrow median groove and subacute to obtuse apex, orange-brownish. Stipe 6–16 × 0.4–0.8 mm, terete, floccose-squamulose, brownish. Asci 100–114 × 12–14 μ. Spores 22.5–40 × 4–4.5 μ, cylindrical-clavate, 1-celled, colourless. Paraphyses 1.5–2 μ wide below, 4–4.5 μ wide above, colourless, curved apically.

HABITAT.—On damp soil under ferns in forest of *Quercus*, *Rhododendron*, *Pinus*, at c. 2100 m altitude.

DISTRIBUTION.—China (Teng), India, Japan (Imai), U.S.A. (Durand, Mains).

COLLECTION EXAMINED.—

India: Himachal Pradesh, Simla, The Glen, 25 Sept. 1962, *K. S. Thind 216* (K).

MICROGLOSSUM VIRIDE (Pers. ex Fr.) Gill.—Fig. 28

[? *Clavaria viridis* Schrad. *apud* Gmel., Syst. Veget. **2**: 1443. 1791. —] *Geoglossum viride* Pers. *in* Neues Mag. Bot. **1**: 117. 1794; *ex* Fr., Syst. mycol. **1**: 489. 1821. — *Leotia viridis* (Pers. ex Fr.) Fuck. *in* Jb. nassau. Ver. Naturk. **23–24**: 284. 1870. — *Mitrula viridis* (Pers. ex Fr.) P. Karst. *in* Bidr. Känn. Finl. Nat. Folk **19**: 29. 1871. — *Microglossum viride* (Pers. ex Fr.) Gill., Champ. France, Discomyc. 25. 1879. — *Leptoglossum viride* (Pers. ex Fr.) Phill., Brit. Discomyc. 32, pl. 2 fig. 8. 1887.

Fruit-body 24–37 mm high. Clavula 12–15 × 3 mm, ligulate, with obtuse apex, black. Stipe 12–22 × 1.5–2 mm, terete, squamulose, blackened. Asci 124–138 × 10 μ. Spores 18–23.5 × 5–6 μ, clavate to subfusiform, 1-celled, colourless. Paraphyses 1–2 μ wide below, not or gradually widened upwards, clavate, up to 4 μ, the apices somewhat agglutinated to form a greenish epithecium.

HABITAT.—No information except that the two localities mentioned below are situated at altitudes of 2400 and 4000 m.

DISTRIBUTION.—Europe (Nannfeldt), India (Batra & Batra), Japan (Imai), Sikkim (Berkeley), U.S.A. (Durand, Mains).

COLLECTIONS EXAMINED:—

Sikkim: Lachoong, date ?, *Dr. Hooker* (K); Yeumtong, 5 Sept. 1849, *Dr. Hooker* (K).

TRICHOGLOSSUM Boud.

Trichoglossum Boud. *in* Bull. Soc. mycol. France **1**: 110. 1885. — Type species: *Geoglossum hirsutum* Pers. ex Fr. (cf. Boudier).

Fruit-bodies solitary or gregarious to cespitose. Clavula gradually or abruptly passing into the stipe, compressed or not, subglobose, clavate, lanceolate, ligulate or spathulate, black-brown to black, beset with thick-walled, black setae. Stipe terete to somewhat flattened, black, densely setose from black setae. Asci cylindrical-clavate, inoperculate, 4–8-spored, the pore blued with iodine. Spores fasciculate in the ascus, acicular to subfusiform, straight to curved, up to 16-celled (irregularities excepted), brown. Paraphyses discrete, straight or, more often, curved to coiled or circinate, moderately to remotely septate, colourless below, brownish above.

KEY TO THE SPECIES

1. Asci normally 8-spored.
   2. Mature spores 16-celled. . . . . *T. hirsutum*
   2. Mature spores with fewer cells.
      3. Spores 8–12-celled.
         4. Spores 8–12-celled, acicular. . . . . *T. variabile*
         4. Spores 8–10-celled, more fusiform . . . . . *T. rasum*
      3. Spores 1–8-celled.
         5. Spores 80–140 μ long, fusiform-acicular . . . . . *T. octopartitum*
         5. Spores (50–)75–108 μ long, acicular. . . . . *T. walteri*
1. Asci consistently 4-spored . . . . . *T. velutipes*

TRICHOGLOSSUM HIRSUTUM (Pers. ex Fr.) Boud.—Fig. 29

Geoglossum hirsutum Pers. *in* Neues Mag. Bot. **1**: 117. 1794; *ex* Fr., Syst. mycol. **1**: 488. 1821. — *Trichoglossum hirsutum* (Pers. ex Fr.) Boud. *in* Bull. Soc. mycol. France **1**: 110. 1885.

Fruit-body 10–48 mm high. Clavula 2–11 × 2–4.5 mm, ligulate to lanceolate or cordate, with or without median groove, with obtuse to subacute apex, densely setose,

dull, black-brown. Stipe 10–41 × 0.6–1.5 mm, terete or flattened, densely setose, black. Asci 190–217 × 20–26 μ, 8-spored. Spores 112–167 × (4.5–)5–6.5 μ, acicular, 16-celled, brown. Paraphyses 2–3 μ wide and colourless below, 4–6 μ wide and colourless or pale brown above, straight or coiled to circinate, remotely septate. Hymenial setae 50–315 × 4–14 μ, thick-walled, black-brown.

HABITAT.—On earth or among leaf litter in forests of *Quercus incana* and *Rhododendron arborea* or among mosses on stony slopes outside the forest, 1800–2100 m.

DISTRIBUTION.—China (Tai, Teng), Europe (Nannfeldt), India (Batra & Batra, Thind & Singh), Japan (Imai), Java (Rifai), U.S.A. (Durand, Mains).

COLLECTIONS EXAMINED:—

India: Uttar Pradesh, Mussoorie, Cemetery, 9 Sept. 1960, *L. R. Batra* (CUP-I. 117–119, 121, and possibly also 120); Mussoorie, Jabber Khet, 11 Sept. 1960, *L. R. Batra* (CUP-I. 122); Mussoorie, road Maghra-Dhnaulti, 1 Sept. 1961, *K. S. Thind 200* (K); Mussoorie, near Charleville, 13 Sept. 1964, *R. A. Maas Geesteranus 14508* (L); Mussoorie, 15 Sept. 1964, *R. A. Maas Geesteranus 14537* (BSD, DD, HCIO, L); Mussoorie, Oakvilla, 16 Sept. 1964, *R. A. Maas Geesteranus 14551* (L); Mussoorie, Balansar, 18 Sept. 1964, *R. A. Maas Geesteranus 14578* (L); Mussoorie, near Charleville, 20 Sept. 1964, *R. A. Maas Geesteranus 14603* (L); Naini Tal, Lands End, 3 Sept. 1961, *K. S. Thind 209b* (K); Saharanpur, date ?, *W. Gollan* (Lloyd 25422 in BPI).

TRICHOGLOSSUM OCTOPARTITUM Mains—Figs. 30–32

Trichoglossum octopartitum Mains *in* Am. J. Bot. **27**: 325, fig. 10. 1940.

Fruit-body 10–45 mm high. Clavula 2–13 × 1–6 mm, lanceolate to ligulate, with median groove and obtuse apex, densely setose, dull, black. Stipe 5–34 × 0.5–1.5 mm, terete or flattened, densely setose, black. Asci 177–225 × 18–24 μ, 8-spored. Spores (83–)91–140 × 6–7 μ, fusiform-acicular, usually 8-celled (but often with fewer cells and sometimes up to 10-celled), brown. Paraphyses 2–3 μ wide and colourless below, up to 4 μ wide and pale brown above, curved to coiled, remotely septate. Hymenial setae 75–256 × 5–10 μ, thick-walled, black.

HABITAT.—Growing at widely varying altitudes, the Indian material having been collected at an approximate altitude of 2000 m, the collection from West Pakistan coming "from the plains, about 500 ft. above sea level. The climate is extreme, very hot during summer and very cold during winter" (Ahmad, in litt.).

DISTRIBUTION.—British Honduras (type locality), India (Batra & Batra, Thind & Singh), U.S.A. (Mains), West Pakistan.

COLLECTIONS EXAMINED.—

India: Uttar Pradesh, Mussoorie, Cemetery, 9 Sept. 1960, *L. R. Batra* (CUP-I. 123, 124); Mussoorie, Chakrata road, 12 Sept. 1960, *L. R. Batra* (CUP-I. 125).

West Pakistan: Sheikhupura Distr., Ladhar, 27 Dec. 1952, *S. Ahmad 7980* (L).

EXPLANATION OF FIGURES 29–36

Fig. 29. *Trichoglossum hirsutum:* paraphyses and spore (× 600); India, *Maas Geesteranus 14578* (L).

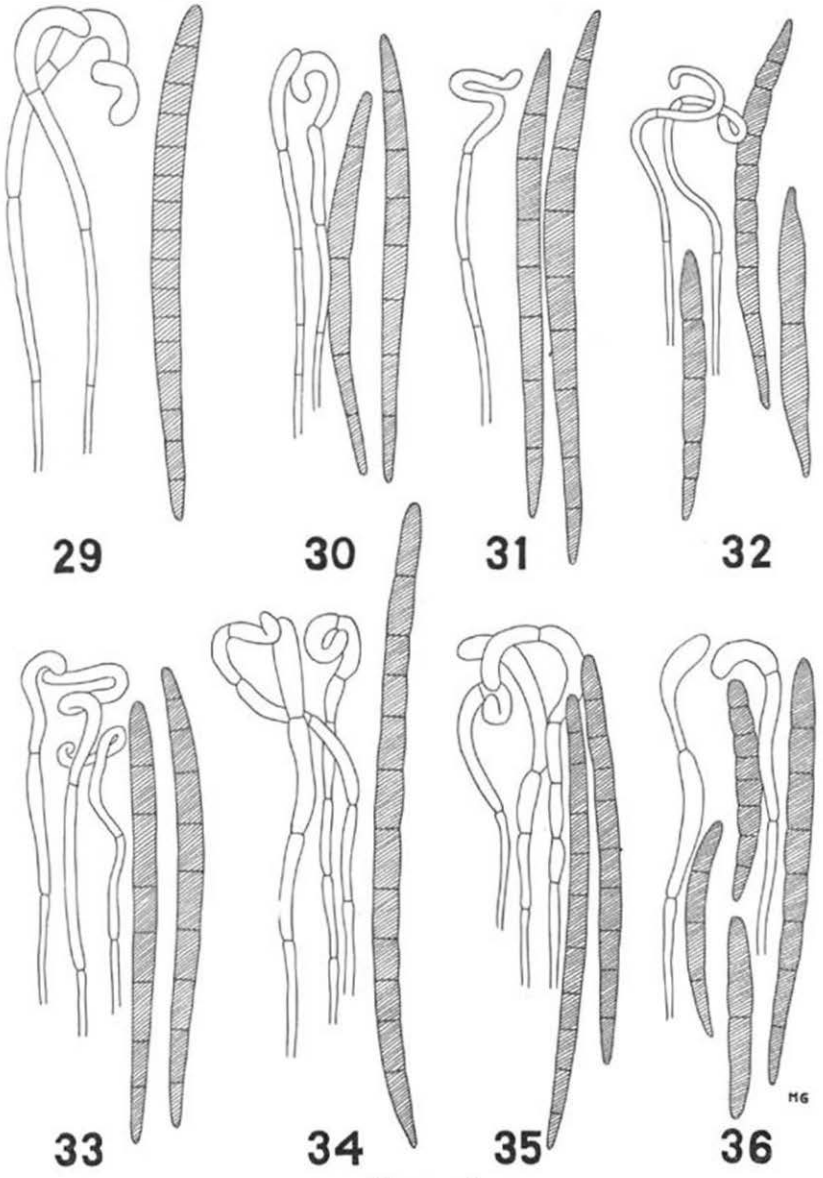
Figs. 30–32. *Trichoglossum octopartitum:* paraphyses and spores (× 600). — 30. India, *Batra* (CUP-I, 123). — 31. India, *Batra* (CUP-I. 125). — West Pakistan, *Ahmad 7980* (L).

Fig. 33. *Trichoglossum rasum:* paraphyses and spores (× 600); India, *Thind 205b* (K).

Fig. 34. *Trichoglossum velutipes:* paraphyses and spore (× 600); West Pakistan, *Ahmad 2709a* (L).

Fig. 35. *Trichoglossum variabile:* paraphyses and spores (× 600); India, *Thind 201* (K).

Fig. 36. *Trichoglossum walteri:* paraphyses and spores (× 600); India, *Thind 204* (K).



Figs. 29–36

Ahmad (1956: 37) listed the collection from Ladhar under *T. velutipes*.

Perhaps the collections enumerated here could better have been placed under *T. rasum*. Considering the great variability even in a single specimen, it must seriously be questioned whether with so few characteristics available more distinctions have not already been made in *Trichoglossum* than there are species.

TRICHOGLOSSUM RASUM Pat.—Fig. 33

Trichoglossum rasum Pat. *in* Bull. Soc. mycol. France **25**: 130. 1909.

Trichoglossum hirsutum f. *wrightii* Dur. *in* Annls mycol. **6**: 438, figs. 83, 174. 1908. — *Trichoglossum wrightii* (Dur.) Dur. *in* Mycologia **13**: 187. 1921.

One small specimen only, 8 mm high. Clavula 4 × 1 mm, ligulate, with obtuse apex, finely setose, dull, black. Stipe 4 × 0.8 mm, terete, setose, black. Asci 20–22 μ broad, 8-spored. Spores 101–114 × 5–6 μ, acicular-fusiform, 8–10-celled, brown. Paraphyses 2–3 μ wide and colourless below, 3–4 μ wide and fairly dark brown above, curved to coiled, remotely septate. Hymenial setae circa 180 × 6–8 μ, thick-walled, black-brown.

HABITAT.—On damp, mossy soil in *Quercus* forest, at c. 2000 m altitude.

DISTRIBUTION.—Bermuda (Durand), China (Teng), Cuba (type locality of *T. hirsutum* f. *wrightii*), India, Java (Rifai), New Caledonia (type locality of *T. rasum*), Panama (Nannfeldt).

COLLECTION EXAMINED.—

India: Uttar Pradesh, Mussoorie, Subakholi-Maghra road, 31 Aug. 1961, *K. S. Thind 205b* (K).

Batra & Batra (1963: 151) indicated the present species (as *T. wrightii*) as common around Mussoorie, but except for a collection apparently preserved in the Herbarium of the Panjab University, Chandigarh (not seen), there is no material to corroborate their statement.

TRICHOGLOSSUM VARIABILE (Dur.) Nannf.—Fig. 35

Trichoglossum hirsutum f. *variabile* Dur. *in* Annls mycol. **6**: 437, figs. 84, 85, 182–184. 1908. — *Trichoglossum variabile* (Dur.) Nannf. *in* Ark. Bot. (A) **30** (4): 64, fig. 6a. 1942.

Fruit-body 15–32 mm high. Clavula 3–7 × 1.5–7 mm, ellipsoid to cordate, with obtuse apex, conspicuously setose to nearly glabrous, dull, black-brown. Stipe 11–24 × 0.5–1 mm, terete, densely setose, black. Asci 161–226 × 20–24 μ, 8-spored. Spores 74–124 × 5.5–6 μ, acicular, 8–12-celled, brown. Paraphyses 2–4 μ wide and colourless below, 6–8 μ wide and colourless to fairly dark brown above, curved to coiled, remotely septate. Hymenial setae 73–177 × 5–8 μ, thick-walled, black brown.

HABITAT.—On soil or among mosses in forest of *Quercus* and *Rhododendron* at c. 2000 m altitude.

DISTRIBUTION.—China (Tai), Europe (Nannfeldt), India, Japan (Imai), U.S.A. (Durand, Mains).

COLLECTIONS EXAMINED.—

India: Uttar Pradesh, Mussoorie, 15 Sept. 1965, *R. A. Maas Geesteranus 14647* (L); Naini Tal, Cheena Peak, 30 Sept. 1961, *K. S. Thind 201* (K).

TRICHOGLOSSUM VELUTIPES (Peck) Dur.—Fig. 34

Geoglossum velutipes Peck *in* Rep. N.Y. State Mus. **28**: 65. 1876. — *Trichoglossum velutipes* (Peck) Dur. *in* Annls mycol. **6**: 434, figs. 86–88, 169–173. 1908.

Fruit-body 29–57 mm high. Clavula 4–14 × 1.5–6 mm, lanceolate to ligulate, with median groove and obtuse apex, densely setose, dull, black-brown. Stipe 19–43 × 1–2 mm, terete or flattened in places, densely setose, black. Asci 158–225 × (18–)20–26 μ, 4-spored. Spores 130–163 × 6–8 μ, acicular, (8–)11–13-celled, brown. Paraphyses 2–6 μ wide and colourless below, 4.5–8 μ wide and pale brown above, straight or curved to coiled, remotely septate. Hymenial setae 79–276 × 6–8 μ. thick-walled, black-brown.

HABITAT.—On damp soil in *Quercus* forest at an approximate altitude of 2000 m.

DISTRIBUTION.—China (Tai), India (Thind & Singh), U.S.A. (Durand, Mains), West Pakistan (Ahmad).

COLLECTIONS EXAMINED.—

India: Uttar Pradesh, Mussoorie, Maghra-Dhnaulti road, 1 Sept. 1961, *K. S. Thind 203* (K); Mussoorie, Jabber Kher Khad, 9 Sept. 1961, *K. S. Thind 202a* (K).

West Pakistan: Murree, 20 Aug. 1948, *S. Ahmad 2709a* (L).

TRICHOGLOSSUM WALTERI (Berk.) Dur.—Fig. 36

Geoglossum walteri Berk. *apud* Cooke *in* Hedwigia **14**: 39. 1875. — *Trichoglossum walteri* (Berk.) Dur. *in* Annls mycol. **6**: 440, figs. 94–97, 190–193. 1908.

Fruit-body up to 34 mm high. Clavula about 10 × 2.5 mm, ligulate, with median groove and obtuse apex, densely setose, dull, black-brown. Stipe 24 × 1 mm, terete, setose, black. Asci 120–217 × 18–24 μ, 8-spored. Spores 49–108 × 5–8 μ, cylindrical-clavate to acicular, 1–8-celled, brown. Paraphyses 2–3 μ wide and colourless below, 4–6 μ wide and fairly dark brown above, curved to coiled, remotely septate. Hymenial setae 78–200 × 6–10 μ, thick-walled, black-brown.

HABITAT.—On damp, mossy soil in *Quercus* forest or in mixed forest of *Quercus*, *Rhododendron*, and *Pinus*, at about 2000 m altitude.

DISTRIBUTION.—Australia (type locality), Brazil (Nannfeldt), Europe (Nannfeldt), India, Japan (Imai), U.S.A. (Durand, Mains).

COLLECTIONS EXAMINED.—

India: Himachal Pradesh, Simla, The Glen, 25 June 1962, *K. S. Thind 204* (K); Uttar Pradesh, Mussoorie, Subakholi-Maghra road, 31 Aug. 1961, *K. S. Thind 205a* (K).

Judging from the spores (73–104 × 6–8 μ, 4–8-celled), there is no doubt but that the collection from Mussoorie belongs to the present species. The position is less clear in the case of the collection from Simla. The over all dimensions of the spores (1–8-celled) were found to be 49–108 × 5–5.5 μ, but spores longer than 80 μ proved rare. That would bring the collection very near *T. confusum* Dur., of which Mains (1954: 618) reported the spores as (45–)55–66(–75) × 5–6 μ. This raises the question whether specific distinction in *Trichoglossum*, if based on spore-length alone, is sound.

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REMARKS ON SPECIES OF PHOMA REFERRED TO PEYRONELLAEA

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(With four Plates and four Text-figures)

The authors conclude that the separation of the form-genus *Peyronellaea* Goid. ex Togliani from *Phoma* Sacc. is both undesirable and unpracticable. A comparative study of the data in the literature, of original cultures, and of herbarium material of the fungi ascribed to *Peyronellaea*, leads to the distinction of three species: *Phoma glomerata* (Cda.) Wr. & Hochapf., *Phoma prunicola* (Opiz) Wr. & Hochapf., and *Phoma musae* (Joly) comb. nov. The synonymy and characteristics of these species are discussed and a key is given.

In 1946 Goidànich proposed a new form-genus *Peyronellaea* (Goidànich, 1946a) for *Phoma*-like fungi which *in vitro* are characterized by the production of multicellular chlamydosporal structures resembling the dictyospores found in such Dematiaceae as *Alternaria*, *Stemphylium*, and *Coniothecium*. Luedemann (1959) termed these structures d i c t y o c h l a m y d o s p o r e s. Togliani (1952) validly published the name *Peyronellaea* by furnishing a formal Latin diagnosis and designating *Coniothyrium glomeratum* Cda. sensu Wollenweber & Hochapfel (1936), the basionym of *Peyronellaea glomerata* (Cda.) Goid., as type species.

Disregarding synonymy, Goidànich (1946a) listed twenty-two species and transferred them to the genus *Peyronellaea*. Dictyochlamydospore-like structures are mentioned in the original diagnoses of only seven of these species. Various authors have ascribed similar structures to the other species on the basis of specimens so identified (e.g. Wollenweber & Hochapfel, l.c.). An extensive review of the literature of all the species mentioned by Goidànich (l.c.) is given by Luedemann (1957) in a thesis on the genus *Peyronellaea*. He concluded (see also Luedemann, 1959) that probably only two well-defined morphological species exist: *Peyr. glomerata* and *Peyr. prunicola* (Opiz) Goid. (the last name still not validly published) as defined by Wollenweber & Hochapfel (l.c.). In France (cf. Joly, 1961) a third 'old' species is differentiated, viz. *Peyr. fumaginoides* (Peyron.) Goid. ex Leduc (1958). Luedemann (1959) included this species in the synonymy of *Peyr. glomerata*.

Since the genus was established, further species have been described, such as *Peyr. stipae* Lacoste (1957), which, according to Joly (l.c.), is only a "*Peyr. glomerata* juvénile," *Peyr. nicotiae* Leduc (1958), *Peyr. musae* Joly (1961), and *Peyr. nainensis* Tandon & Bilgrami (1961).

Our own study of the pertinent literature and original cultures has led to the identification of six more species (*Phoma* and *Ascochyta* spp.) that can be considered to be *Peyronellaea*-like fungi.

The present paper gives the results of a comparative study of all these species in co-ordination with the study of Luedemann in the genus *Peyronellaea* (1957).

Names of authors mentioned in this paper are abbreviated as recommended in the 'Index of Plant Diseases in the United States' (Agric. Handb. U.S. Dep. Agric. 165. 1960).

Herbaria and culture collections are coded according to Lanjouw & Stafleu (1959) and the list of abbreviations in the catalogue of the American Type Culture Collection (Ed. 7, 1964), respectively.

The status of Peyronellaea

In the course of this study the question as to why *Peyronellaea* should be separated from *Phoma* proved to be of current interest. In this connection it should first be noted that the pycnidia of the type-species of both form-genera, respectively *Peyr. glomerata* and *Phoma herbarum* West. (see Boerema, 1964), resemble each other so much that they can be distinguished only by small differences in the size and colour of their pycnidiospores. In both cases the pycnidiospores arise through a monopolar repetitive budding process (Boerema, 1965). The only difference between both genera, therefore, is the occurrence of dictyochlamydospores in *Peyronellaea*. However, the production of dictyochlamydospores is a character of questionable value, as appears in the following.

Peyronellaea strains in culture may lose their ability to form dictyochlamydospores (Chodat, 1926, strains of *Phoma alternariaceum*, a synonym of *Peyr. glomerata*; Luedemann, 1957: 62, 65, 67, culture of *Peyr. prunicola* sensu Goidànich) and thus merge into *Phoma!*

In culture *Peyronellaea prunicola*, respectively *Peyr. nicotiae* at first produces only chains of single chlamydospores (Boerema & Dorenbosch, 1965; Leduc, 1958), such as are known in many typical *Phoma* species. In the course of time dictyochlamydospores usually develop as well, but this depends not only on the 'age' of the strain and the composition of the medium but also on strain qualities. Frequently in the cultures of some strains there are scarcely any dictyochlamydospores to be found.

There are many *Phoma*-like fungi which, besides single chlamydospores, incidentally produce complexes of chlamydospores. The difference between these complex chlamydosporal structures and dictyochlamydospores is relative. An example is *Ascochyta gossypii* Syd. Some strains of this fungus apparently produce typical dictyochlamydospores, as in *Peyr. glomerata* (Chippindale, 1929), but in the cultures of the four strains of this fungus that we studied [1] only such irregular compound chlamydosporal structures develop as can be found in many *Phoma*-like fungi that produce chlamydospores.

[1] Culture ATCC (American Type Culture Collection) No. 12786 and three cultures (A, B, C) obtained from Dr. L. S. Bird, A. & M. Coll. of Texas, College Station; see Phytopathology **53**: 621, 622. 1963.

It should also be noted that the pycnidia and the dictyochlamydospores of *Peyronellaea* occur as two different forms, adapted to the conditions of growth of these fungi. In both, the carbon-nitrogen ratio of the medium appears to be a determining factor (Chodat, 1926; Lacoste, 1955; Luedemann, 1957); at low values (6–35) there is greater production of pycnidia, at higher values (40–70) the development of dictyochlamydospores usually increases.

The chief purpose of the artificial system of Deuteromycetes is to provide a practicable method for identifying and naming the asexual forms of fungal appearance, viz. conidial fructifications and characteristic mycelial stages. From this point of view it is, in our opinion, unpractical and undesirable to use for the characterization of a form-genus an unstable criterium that cannot be sharply defined and which largely depends on the conditions of growth. As stated above, this is the case with the dictyochlamydospores of the genus *Peyronellaea*. It is also in conflict with the principle of the nomenclature of the Deuteromycetes to base a form-genus on two different asexual forms that are not indisputably related. This is even more true of *Peyronellaea*, where the relation between pycnidia and dictyochlamydospores can be established only *in vitro*, depending on the medium. In nature dictyochlamydospores are much more variable (i.e. not characteristic) in shape; consequently they cannot be identified as belonging to a pycnidial stage.

Therefore we have concluded that separation of the genus *Peyronellaea* from the genus *Phoma* is undesirable.

Of course in the complete diagnoses of the fungi in question it is always necessary to record that *in vitro*, apart from *Phoma* pycnidia, dictyochlamydospores can also develop. The same is true of single chlamydospores, sclerotia, pigment production, forming of crystals, etc. These alternative characters (*in vitro*) are even indispensable to a key to fungi that produce *Phoma* pycnidia!

The species concept

When considering the problem of the species concept our starting point was again that the system of Deuteromycetes is artificial and should be used for identification purposes only. Therefore in our opinion a form-species must be a taxon that a taxonomist can readily identify. This means that the delimitation of a form-species must be based on clear, stable characteristics. As a result, such a form-species concept is rather broad. In our opinion, however, it is the only one that is practicable. Chaos is bound to arise if form-species are based on minor differences only. This emerged, for example, in comparing the specimens of *Phoma* that produce dictyochlamydospores (*Peyronellaea*) in official (type) culture collections in the United States (ATCC), England (CMI), France (PC), the Netherlands (CBS), and Italy (PAV). The cultures labelled *P. glomerata* in these collections, including cultures originating from Goidànich (Togliani, 1952) and Wollenweber (Wollenweber & Hochapfel, 1936), show more correlative differences than exist, for example, between cultures of *P. prunicola* sensu Goidànich (Pupillo, 1952),

P. glomerata sensu Wollenweber (Wollenweber & Hochapfel, 1936), and *P. fumaginoides* sensu Leduc (1958). Here a narrow species concept would lead to a chaotic confusion of names.

The study of Chodat (1926) has shown that in this type of fungi single spore isolates and saltants from one and the same strain can produce cultures that show many small differences. In this case, therefore, a broad concept of a form-species is in agreement with the variability of the natural species. If, moreover, it is for any reason desirable, there is always the possibility of giving variants that have been detected a separate position (variety, form, etc.) within the form-species.

The pycnidia of all the species of *Phoma* studied that produce dictyochlamydospores show only few differences. This applies equally to many *Phoma* species. Therefore, as pointed out in the former chapter, the substitute characters in culture are essential for differentiating this kind of form-species. For the species discussed in this paper (i) the manner in which the dictyochlamydospores are produced and (ii) the occurrence of single chlamydospores appear to be practicable criteria for distinguishing species.

KEY TO THE SPECIES

1. Dictyochlamydospores generally in chains of 2–20 elements that resemble the conidia-chains of *Alternaria* spp. (compare Fig. 2, Pl. 1) . . . . . *Phoma glomerata*
1a. Dictyochlamydospores generally single, usually resembling the conidia of *Stemphylium* spp. 2
2. Dictyochlamydospores usually terminal on hyphal branches; abundant production of single chlamydospores in long chains (compare Fig. 3, Pl. 3) . . . . *Phoma prunicola*
2a. Dictyochlamydospores seem to be produced laterally from hyphal strands; single chlamydospores do occur but are inconspicuous (compare Fig. 4, Pl. 4) . . *Phoma musae*

The above key is based on the characters of the chlamydospores from fresh cultures on maltagar (recipe Ainsworth, 1961: 241).

For the characters of the pycnidia and pycnidiospores of the three *Phoma* species, see Figure 1 and Table I.

For comparison of the general habitus *in vitro*, see Plates 2, 3, and 4.

TABLE I

PYCNIDIA AND PYCNIDIOSPORES IN PHOMA SPECIES UNDER DISCUSSION

Species	Pycnidia	Pycnidiospores
Phoma glomerata	usually 30—180 × 60—200 μ	usually 6—7.5 × 3—3.5 μ, av. 6.6 × 3.1 μ
Phoma prunicola	usually 80—200 × 100—220 μ, often 'furcate'	usually 5—7 × 2—3 μ, av. 6.1 × 2.8 μ
Phoma musae	usually 50—180 × 60—200 μ	usually 6—7 × 3—4 μ, av. 6.6 × 3.7 μ

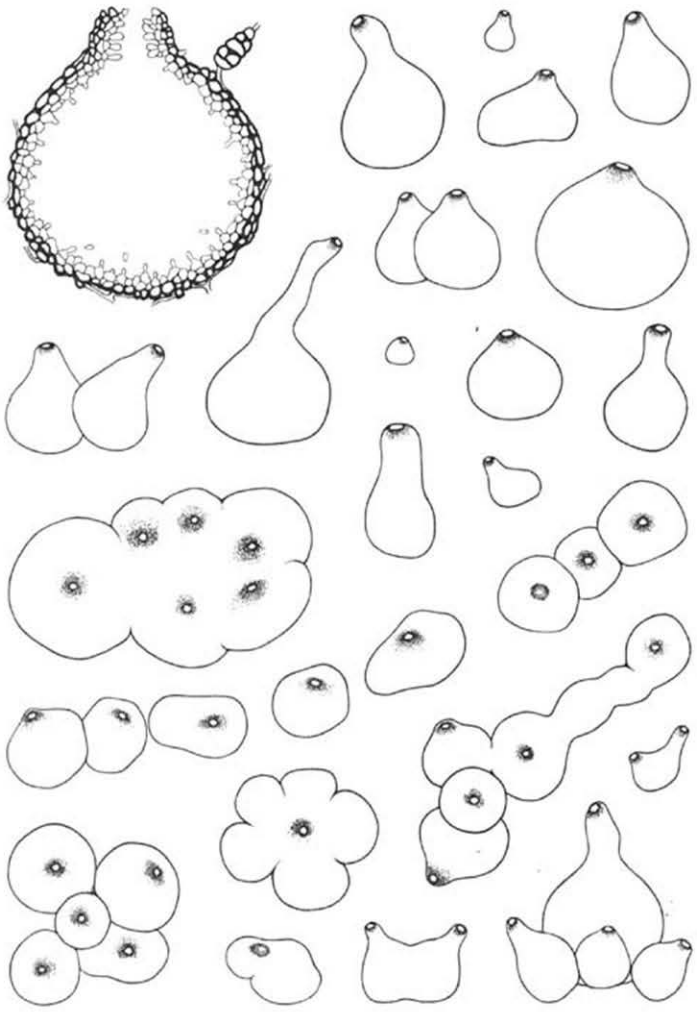

Fig. 1. Pycnidia in the three *Phoma* species under discussion; structure and variation in size and shape.

PHOMA GLOMERATA (Cda.) Wr. & Hochapf.[2] —Fig. 2, Pls. 1, 2

A

Coniothyrium glomeratum Cda., Ic. Fung. **4**: 39. 1840. — *Aposphaeria glomerata* (Cda.) Sacc., Syll. Fung. **3**: 175. 1884. — *Phoma glomerata* (Cda.) Wr. & Hochapf. *in* Z. ParasitKde **8**: 592. 1936. — *Peyronellaea glomerata* (Cda.) Goid. *in* Rc. Accad. Lincei **1**: 455, 658. 1946; [3] *ex* Togliani *in* Annali Sper. agr. **6**: 93. 1952.

Phoma fibricola Berk. *in* Hook. J. Bot. **5**: 41. 1853. — *Aposphaeria fibricola* (Berk.) Sacc., Syll. Fung. **3**: 176. 1884. — *Peyronellaea fibricola* (Berk.) Goid. *in* Rc. Accad. Lincei **1**: 455. 1946. [4]

Aposphaeria consors Schulz. & Sacc. *in* Hedwigia **23**: 109. 1884. — *Peyronellaea consors* (Schulz. & Sacc.) Goid. *in* Rc. Accad. Lincei **1**: 455. 1946. [4]

Phoma herbarum West. f. *chrysanthemi-corymbosi* Allesch. *in* KryptFl. Deutschl. **1** (6): 330. 1901. — *Peyronellaea herbarum* f. *chrysanthemi-corymbosi* (Allesch.) Goid. *in* Rc. Accad. Lincei **1**: 455. 1946. [4]

B

Alternaria polymorpha Planchon *in* Annls Sci. nat. (Bot.), sér. 8, **11**: 48–89. 1900. — *Peyronellaea polymorpha* (Planchon) Goid. *in* Rc. Accad. Lincei **1**: 455. 1946. [4]

Phoma radicis-andromedae Ternetz *in* Jb. wiss. Bot. **46**: 365–366. 1907.

Phoma radicis-vaccinii Ternetz *in* Jb. wiss. Bot. **46**: 366–367. 1907.

Ascochyta trachelospermi Fabricatore *in* Annali Sper. agr., ser. 2, **5**: 1445. 1951.

C

Phoma richardiae Mercer *in* Mykol. Zentbl. **2**: 244, 297, 326. 1913. — *Peyronellaea richardiae* (Mercer) Goid. *in* Rc. Accad. Lincei **1**: 454–455. 1964. [3] — *Coniothecium richardiae* (Mercer) Jauch. *in* An. Soc. cient. argent. **144**: 456. 1947.

Phoma conidiogena Schnegg *in* Zentbl. Bakt. ParasitKde (Abt. 2) **43**: 326–364. 1915. — *Peyronellaea conidiogena* (Schnegg) Goid. *in* Rc. Accad. Lincei **1**: 455. 1946. [4]

Phoma alternariaceum Brooks & Searle *in* Trans. Brit. mycol. Soc. **7**: 193. 1921. — *Peyronellaea alternariaceum* (Brooks & Searle) Goid. *in* Rc. Accad. Lincei **1**: 455. 1946. [4]

Phoma fumaginoides Peyron. = *Alternaria fumaginoides* Peyron., *apud* Filippopulos *in* Boll. Staz. Patol. veg. Roma, ser. 2, **7**: 332–336. 1927. — *Peyronellaea fumaginoides* (Peyron.) Goid. *in* Rc. Accad. Lincei **1**: 452, 455. 1946; [3] *ex* Leduc *in* Revue gén. Bot. **65**: 542, 543. 1958.

Phoma hominis Agostini & Tredici *apud* Pollacci *in* Atti Ist. bot. Univ. Lab. crittog. Pavia, ser. 4, **6**: 154. 1935; [5] *ex* Agostini & Tredici *in* Atti Ist. bot. Univ. Lab. crittog. Pavia, ser. 4a, **9**: 187. 1937 = *Alternaria hominis* Agostini & Tredici *in* Atti Ist. bot. Univ. Lab. crittog. Pavia, ser. 4a, **9**: 187–188. 1937. — *Peyronellaea hominis* (Agostini & Tredici) Goid. *in* Rc. Accad. Lincei **1**: 455. 1946. [4]

Peyronellaea stipae Lacoste *in* C. r. hebd. Séanc. Acad. Sci., Paris **241**: 818–819. 1955; [5] *ex* Lacoste *in* Rev. Mycol. **22** (suppl. colon. 1): 14. 1957.

Phoma saprophytica Eveleigh *in* Trans. Brit. mycol. Soc. **44**: 582–583. 1961.

Peyronellaea veronensis Goid. *in* Rc. Accad. Lincei **1**: 451, 455, 658. 1946. [6]

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[2] The synonyms are divided into three groups, A, B, and C, which will be discussed separately.

[3] Not validly published according to Art. 43 of the International Code of Botanical Nomenclature (Utrecht, 1961).

[4] Not validly published according to Arts. 32 and 43 of the International Code of Botanical Nomenclature (Utrecht, 1961).

[5] Not validly published according to Art. 36 of the International Code of Botanical Nomenclature (Utrecht, 1961).

[6] Not validly published according to Arts. 36 and 43 of the International Code of Botanical Nomenclature (Utrecht, 1961).

MISAPPLICATIONS.—*Phoma cincta* Berk. & Curt., *Phyllosticta destructiva* Desm., *Phyllosticta asteris* Bres., and *Sphaeronaema glomerata* Berk. & Br. *sensu* Wr. & Hochapf. *in* Z. ParasitKde **8**: 592. 1936, pro syn. and *Phoma cincta* Berk. & Curt. and *Phyllosticta destructiva* Desm. *sensu* Togliani *in* Annali Sper. agr., ser. 2, **6**: 93. 1952, pro syn. [see the discussion; all names transferred to *Peyronellaea* by Goidànich (*in* Rc. Accad. Lincei **1**: 455. 1946), but not validly published].

Togliani (*in* Annali Sper. agr., ser. 2, **6**: 93. 1952) mentions further as a synonym of *Peyronellaea glomerata*: *Phyllosticta glomerata* Berk. & Br. This name, however, does not exist. See the discussion.

A cultural variant of *Peyronellaea glomerata*, described by Pupillo (*in* Annali Sper. agr., ser. 2, **6**: 60–65. 1952), has been misidentified by Goidanich as *Peyronellaea prunicola* (Opiz) Goid. The latter, *Phoma prunicola* (Opiz) Wr. & Hochapf., will be discussed hereafter.

DESCRIPTIONS & ILLUSTRATIONS.—Planchon *in* Annls Sci. nat. (Bot.), sér. 8, **11**: 48–92, figs. 7–9, pl. 1, figs. 1–15. 1900 (*Alternaria polymorpha*); Mercer *in* Mykol. Zentbl. **2**: 245–253, figs. 1, 2; 297–305, figs. 3–5; 326–331, fig. 6. 1913 (*Phoma richardiae*); Schnegg *in* Zentbl. Bakt. ParasitKde (Abt. 2) **43**: 326–363, figs. 1–7. 1915 (*Phoma conidiogena*); Brooks & Searle *in* Trans. Brit. mycol. Soc. **7**: 173–197. 1921 (*Phoma alternariaceum*); Chodat *in* Bull. Soc. bot. Genève, sér. 2, **18**: 66–144, figs. 9–18. 1926 [*Phoma alternariaceum* ("*alternariacearum*")]; Filippopulos *in* Boll. Staz. Patol. veg. Roma, ser. 2, **7**: 332–336, figs. 1–4. 1927 (*Alternaria fumaginoides*); Benham *in* Bull. Torrey bot. Club **58**: 203–214, figs. 12–19, pls. 14–16. 1931 (*Phoma conidiogena*); Wollenweber & Hochapfel *in* Z. ParasitKde **8**: 592–594, fig. 15a, b. 1936 (*Phoma glomerata*); Agostini & Tredici *in* Atti Ist. bot. Univ. Lab. crittog. Pavia, ser. 4a, **9**: 180–186, figs. 3–5. 1937 (*Phoma hominis*); Dennis *in* Trans. Brit. mycol. Soc. **29**: 38–39. 1946 [*Phoma alternariaceum* ("*alternariacearum*")]; Pupillo *in* Annali Sper. agr., ser. 2, **6**: 60–65, figs. 9–11. 1952 (as *Peyronellaea prunicola*, misapplied); Togliani *in* Annali Sper. agr., ser. 2, **6**: 82–93, figs. 3–7. 1952 (*Peyronellaea glomerata*); Lacoste *in* C. r. hebd. Séanc. Acad. Sci., Paris **241**: 818–819. 1955 and *in* Rev. Mycol. **22** (suppl. colon. 1): 14, fig. 7. 1957 (*Peyronellaea stipae*); Luedemann *in* Doct. Diss. Ser., Publ. 21, 920, Univ. Michigan: 36–41, pls. 1–6. 1957; Leduc *in* Revue gén. Bot. **65**: 543, figs. 1, 2. 1958 (*Peyronellaea fumaginoides*); Joly *in* Rev. Mycol., **26**: 94–96, figs. 2e, f. 1961 (*Peyronellaea glomerata*).

DIAGNOSTIC CHARACTERISTICS IN VITRO.—Pycnidia superficial on and immersed in agar (small ones occasionally also in aerial mycelium), sometimes developing from an element in a dictyochlamydospore chain, light-coloured to black and carbonaceous, mostly globose-ampulliform to obpyriform, sometimes irregularly ovoid-ellipsoid to oblong, usually with one ostiole, occasionally 2–3 ostioles; 20–300 × 40–600 μ, mostly 30–180 × 60–200 μ. Often pycnidia coalesce to form irregular large fructifications with many ostioles.

Pycnidiospores hyaline to dark-coloured, with 2 or more guttules; mostly ovoid to ellipsoid, sometimes globose or irregular in shape, usually continuous, occasionally 1-septate, 3–16 × 1.5–6 μ, mostly 6–7.5 × 3–3.5 (av. 6.6 × 3.1) μ.

Dictyochlamydospores (Fig. 2, Pl. 1) dark brown to black, arising in unbranched or branched chains of 2–20 or more elements from older pycnidia, in clumps from the medium and in aerial mycelium, sometimes connected by dark-celled mycelial

elements or else with single chlamydospores and intermediate stages alternating between chlamydospores and dictyochlamydospores, generally obclavate-ovoid to obpyriform, sometimes fusiform-ellipsoid to ovoid or oblong, with 3–9 transverse walls and usually some longitudinal or oblique walls, 18–80 × 12–30 μ.

HABITAT.—This ubiquitous fungus commonly occurs in all kinds of plant material (Wollenweber & Hochapfel, 1936; Togliani, 1952; and personal observations). It occurs with special frequency on dead seed coats, glumes and dead leaf sheaths (Crosier & Weimer, 1940; Reeder & Vanterpool, 1953; Lacoste, 1955, 1957; Leduc, 1958; and personal observations). As a soil fungus (Warcup, 1951) it occurs on the living underground parts of plants (Ternetz, 1907; Wollenwever & Hochapfel, 1936; and personal observations), sometimes having a stimulating effect on the growth of the plants (nitrogen fixation?; Ternetz, 1907; ten Houten, 1939).

The fungus as a secondary invader is often associated with distinct disease symptoms of plants. It occurs on diseased and prematurely fallen leaves of all kinds of plants (Mercer, 1913; Swift, 1932; Andrus, 1933; Wollenweber & Hochapfel, 1936; Togliani, 1952; and personal observations). It is also found on dying shoots and in association with diebacks, cankers, papery bark, tuber lenticel-rot and galls caused by insects (Petri, 1934; Togliani, 1952; Porreye, 1961; Boerema & van Kesteren, 1962; Luedemann, 1957). Inoculation experiments are always negative (Mercer, 1913, on leaf spots of calla lily; Foschi, 1956, on papery bark of apple; Boerema & van Kesteren, 1962, on lenticel-rot of potato tubers). In these cases the role of the fungus is generally considered to be that of a secondary, rather than a primary, invader.

The fungus attacks different fruits; it is known as the cause of rot in tomatoes (Brooks & Searle, 1921; and personal observations), pitting in apples (Wollenweber & Hochapfel, 1936; Goidànich, 1946b; Ghillini, 1952; Ghillini & Mezzini, 1954; Mezzetti, 1956) and pulprot in lemon fruits (Pupillo, 1952). On the vine the fungus has been reported as the cause of a blight of shoots, leaves, and young grapes during the flowering period (Šarić-Sabadoš, Milatović, & Masten, 1960; Milatović, Masten & Kadić, 1960; Picco, 1962). It has been described from a tip blight (silver gray tip) of boxwood (Swift, 1932; Andrus, 1933). Further it is known as a harmful sooty mold on the leaves and branches of olive trees (Filippopulos, 1927).

This fungus has several times been recorded in association with special disease symptoms in man, namely granuloma of the foot, dermatomycosis of the hand (Pollacci, 1935; Agostini & Tredici, 1937), otomycosis, subacute and vasomotor rhinitis and ozaena (Motta, 1929), and mycosis of the genital tract of a woman (Perazzi, 1925). Further it has been reported as inciting asthma attacks in a man (Benham, 1931; Hopkins, Benham & Kesten, 1930). Apparently the fungus is also able to cause tooth-caries (Goidànich, 1946b). In none of these cases could the symptoms be reproduced in animals by artificial infection. With human mycosis the fungus seems to be not a causal but an aggravating factor (Pollacci, 1935).

The fungus can also grow on several purely chemical products (Planchon, 1900; Schnegg, 1915). Further it is known from paint (Eveleigh, 1961; and personal

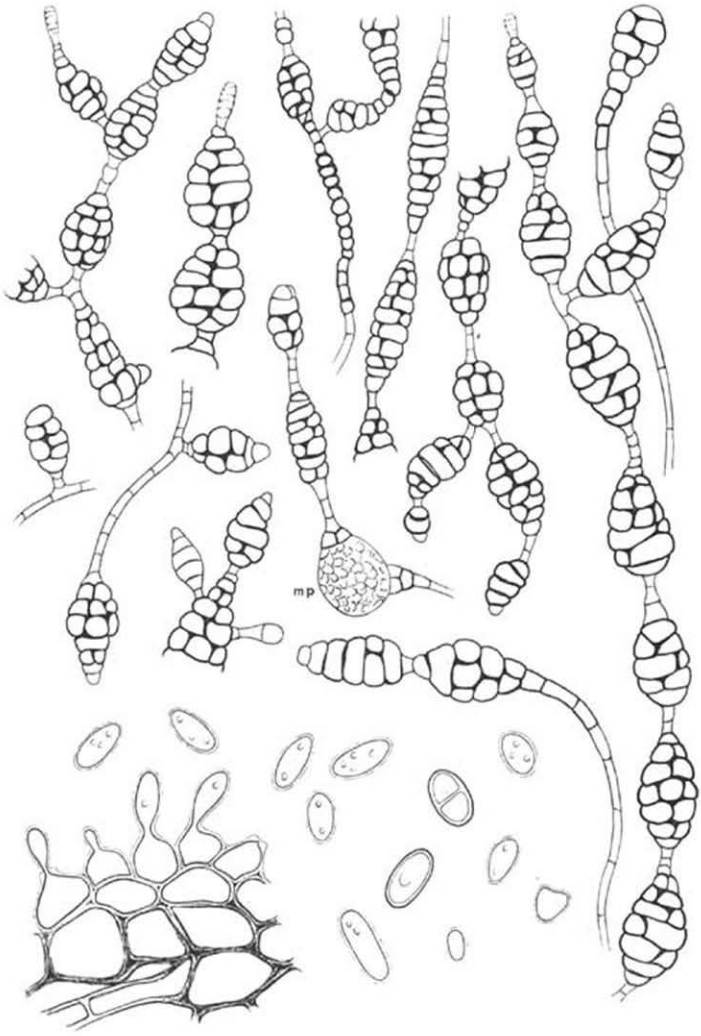

Fig. 2. *Phoma glomerata*; pycnidiospores and dictyochlamydospores. Note the variable shape and size of the latter, depending on the C/N ratio of the medium, age of the culture, and race qualities.

mp = micropycnidium developing from a dictyochlamydospore.

observations), wool fibers (Mulcock, 1959), wood (Vernon, 1935; Harris, 1932) and butter (Vernon, 1935).

SPECIMENS EXAMINED.—

Cultures: *Peyronellaea stipae*, culture of type (PC-1567); "*Peyronellaea prunicola*" (misapplied), isolate from lemon, see Pupillo, 1952, identification Goidànich (CBS, PAV-803); *Phoma alternariaceum*, culture of type, see Brooks & Searle, 1921 (CMI-17.361, under *Peyronellaea glomerata*, catalogue 1960); *Phoma conidiogena*, isolation and identification Benham, 1931 (CBS, under *Peyronellaea*, catalogue 1961); *Phoma* (*Alternaria*) *fumaginoides*, culture Prof. Sibilia, Rome, type culture? (CBS, under *Peyronellaea*, catalogue 1961), isolate made by Mrs. M. Moreau from diseased carnations, France, 1954, identification Mrs. J. Nicot (PC-1521), isolate made by Mrs. J. Nicot, from desert soil in S. Oran (PC-1522); *Phoma glomerata*, isolate made by J. E. Machacek, Canada Dept. Agric., Winnipeg 1938 (ATCC-6735), isolate made by Wollenweber, see Wollenweber & Hochapfel, 1936 (CBS, under *Peyronellaea*, catalogue 1961), isolate from tomato roots (CBS, under *Peyronellaea*, catalogue 1961), isolate made by Mulcock, 1959 (CMI-74.752, under *Peyronellaea*, catalogue 1960), isolate from *Eucalyptus* in S. Africa (CMI-46.259, under *Peyronellaea*, catalogue 1960), isolate made by Goidànich from apple, see Togliani, 1952 (PAV-884, under *Peyronellaea*), isolate made by Goidànich from pear (PAV-804, under *Peyronellaea*), isolate made by Luedemann from walnut petiole galls, strain B and C, see Luedemann, 1957 (under *Peyronellaea*), isolate made by R. Taylor, Australia, from grape, via Luedemann; *Phoma* (*Alternaria*) *hominis*, culture of type, see Pollacci, 1935 (CBS, under *Peyronellaea*, catalogue 1961); *Phoma saprophytica*, culture of type and two other cultures, see Eveleigh, 1961 (CMI-85.470, 85.471, 85.472).

DISCUSSION.—The variability of this fungus *in vitro* is illustrated by the differences between the cultures of this species in various collections. Our first impression was that nearly all these cultures belonged to different species. Our own isolates of *Phoma glomerata* on different agar media, however, so frequently showed sector mutants (saltants) that we have had to accept considerable variability in this species. Aside from this, it appeared that the production of pycnidia, aerial mycelium, and dictyochlamydospores, as well as the size and pigmentation of pycnidia, pycnidiospores, and dictyochlamydospores are strongly influenced by the age of the isolates and the C/N ratio of the artificial media (compare Luedemann, 1957). There is no doubt but that it is the use of different media at the various institutes that has been principally responsible for the increase in variability noted among the old cultures [cf. Chodat (1926) on *Phoma alternariaceum* and Lacoste (1955) on *Peyronellaea stipae*].

Notwithstanding the large variability *in vitro*, *Phoma glomerata* can always be easily recognized (see the Key).

Synonyms of Group A: The synonymy of this group is based on the study of Wollenweber & Hochapfel (1936).

In the paper of Togliani (1952) on *P. glomerata* many old species names are listed as synonyms. It appears that this list was copied from the study by Wollenweber & Hochapfel (l.c.). The original descriptions of these old species were all made from observations *in vivo*, consequently dictyochlamydospores were not mentioned. Wollenweber & Hochapfel based the synonymy on the pycnidial characteristics and on the substrata mentioned as matrices in the various diagnoses. However, they gave their interpretation without studying the existing original exsiccata of the old species. Therefore we rechecked their conclusions.

No original material of the basionym *Coniothyrium glomeratum* exists. The description and figures of this fungus given by Corda agree with the characters of *Phoma glomerata in vivo*. In our opinion, therefore, there is no reason to disagree with Wollenweber & Hochapfel's interpretation of *C. glomeratum*.

The same holds good for *Phoma fibricola*, *Aposphaeria consors*, and *Phoma herbarum* f. *chrysanthemi-corymbosi*, of which, so far as is known, no original herbarium material exists.

Other old species names, however, listed as synonyms by Wollenweber & Hochapfel (l.c.) and Togliani (l.c.), appear to represent other fungi (compare "misapplications" above). Investigation of an original collection of *Phoma cincta* Berk. & Curt. ["*Peyronellaea cincta* (Berk. & Curt.) Goid.", not validly published] nr. 3791 in the herbarium of Berkeley (K, Sphaeropsidales nr. 590679) showed that the wall structure of the pycnidia of this fungus is totally different from the wall structure of *Phoma glomerata*. The shape of the spores is also different, viz. acerose, fusiform, averaging 7.6 × 1.9 μ. Examination of two original collections of *Phyllosticta destructiva* Desm. ["*Peyronellaea destructiva* (Desm.) Goid.," not validly published] occurring on *Lycium europeum* and *Malva sylvestris* (PC, Coll. Desm. 147; 1863 Nr. 8) also showed that this species does not agree with *P. glomerata* [compare the description of *Ascochyta destructiva* (Desm.) Kabat & Bubak (*in* Sber. K. böhm. Ges. Wiss. **II**: 4. 1904)]. Of *Phyllosticta asteris* Bres. and *Sphaeronaema glomerata* Berk. & Br. ["*Peyronellaea asteris* (Bres.) Goid." and "*Peyronellaea glomerata* (Berk. & Br.) Goid.," both not validly published] it was not possible to obtain the original material; from the diagnoses, however, it is obvious that these species are not identical with *Phoma glomerata*. The non-existing name "*Phyllosticta glomerata* Berk. & Br.," inserted in the synonymy by Togliani (l.c.), is apparently a telescoping of the above-mentioned *Phyllosticta asteris* and *Sphaeronaema glomerata*.

Synonyms of Group B: The synonymy of this group is based on original descriptions of the growth *in vitro*.

In the original description of *Alternaria polymorpha*, *Phoma radicis-andromedae*, *Phoma radicis-vaccinii*, and *Assochyta trachelospermi* the occurrence of dictyochlamydospores has been mentioned ("formes *Macrosporium*, *Alternaria* irréguliers etc. etc.," "mauerförmige Conidien," "strutture ipnocistische simili a conidi di Ifali Dema-

ziacee"). Comparison of the descriptions and figures with the characteristics of the three species producing dictyochlamydospores that we studied *in vitro* showed that they all agreed with *Phoma glomerata*.

The small differences in the size of pycnidia and pycnidiospores mentioned by Ternetz in her description of *Phoma radicis-andromedae* and *Phoma radicis-vaccinii* on *Rhododendron* agar are within the normal range of variability of *P. glomerata* on this medium. Ternetz supposed that both species of *Phoma* and three others described from Ericaceae are mycorrhizal fungi but this has never been proved (cf. Harley, 1959). The recorded stimulating effect of *Phoma radicis-andromedae* and *Phoma radicis-vaccinii* on the growth of the plants is in accordance with observations on *P. glomerata* (ten Houten, 1939: 87). Further it must be noted that Fabricatore (1951), in her paper on *Ascochyta trachelospermi*, emphasized the occurrence of some 1-septate pycnidiospores, a character not reported by Goidànich (1946a) for *Peyronellaea*. However, Wollenweber & Hochapfel (l.c.) had already mentioned the incidental occurrence of two-celled spores in *Phoma glomerata*.

Synonymy of Group C: The synonymy of this group is based on original descriptions of the growth *in vitro* and the study of living cultures.

The identifications of the remaining species with *P. glomerata* have been partly based on the observations by Wollenweber & Hochapfel (l.c.). They studied the type culture of *Phoma richardiae*, obtained from the CBS, and found it identical with their isolates of *Phoma glomerata*. The culture of *Phoma richardiae* is no longer present in the CBS.

We studied a culture from the CBS of *Phoma conidiogena*, isolated and determined by Benham (1931). This proved to be *P. glomerata*, mentioned earlier by Luedemann (1957) and Joly (1961). The original description of *Phoma conidiogena* is also in accordance with the characteristics of *P. glomerata*.

The type culture of *Phoma alternariaceum*, preserved in the CMI, was studied extensively by Chodat (1926). Culturally it apparently behaved like *P. glomerata*. Some of the mutants which Chodat obtained from this type culture agree with mutants derived from our own cultures of *P. glomerata*.

The identification of *Alternaria* (*Phoma*) *fumaginoides* with *P. glomerata* is based on a study of two cultures received respectively from the CBS and the Cryptogamic Laboratory in Paris (PC). The CBS culture, possibly a subculture of the type material, was at first sterile. After inoculation in tomato we obtained a culture which sporulated fairly well and which did not differ from *P. glomerata*. Luedemann (l.c.) came to the same conclusion. The culture from Paris also showed the characteristics of *P. glomerata*. Leduc (1958) stated that in *Peyronellaea fumaginoides* (from Paris) the dictyochlamydospores are always connected by mycelial elements, which would not be true of *P. glomerata* (cf. Joly, 1961). We observed both possibilities, however, in various isolates of *P. glomerata*.

The type culture of *Phoma hominis* (CBS) was characterized by chains of relatively small dictyochlamydospores. In our cultures of *P. glomerata*, however, some sections

were observed to possess the same type of dictyochlamydospores. Hence there is no reason to separate *Phoma hominis* from *P. glomerata*. Joly (l.c.), studying an original culture of *Phoma hominis* in Paris (PC), also identified it as *P. glomerata*. A *Peyronellaea* isolate from lemon fruits (Pupillo, 1952), identified by Goidànich as *Peyronellaea prunicola* and received from both Baarn (CBS) and Pavia (PAV) had the same type of dictyochlamydospores as *Phoma hominis* and is therefore also considered to be *P. glomerata* (see under "misapplications"). As can be seen from comparison of the descriptions of both fungi, the true *P. prunicola* is quite different from *P. glomerata*.

As had already been stated by Joly (l.c.), the original culture of *Peyronellaea stipae* (PC), also proved to be identical with *P. glomerata*. The observations by Lacoste (1955) about the influence of a different C/N composition of the growing media on *Peyronellaea stipae* coincide with our observations on isolates of *P. glomerata*.

The original cultures of *Phoma saprophytica*, isolated from paint by Eveleigh (1961) and obtained from the CMI, represent typical isolates of *P. glomerata*. We ourselves have also isolated *P. glomerata* from paint on several occasions. Before describing the paint-fungus as a new species, Eveleigh compared it with cultures of various *Phoma*-like fungi, among others a culture of *P. glomerata* from the CMI. He evidently failed to realize that the CMI strain of *P. glomerata* represents only one cultural type of this variable fungus.

Finally, it should be noted that Goidànich in his study of the genus *Peyronellaea* gave this fungus the provisional name *Peyronellaea veronensis*, so that this name is also mentioned in the synonymy of *P. glomerata*.

PHOMA PRUNICOLA (Opiz) Wr. & Hochapf.[7] —Fig. 3, Pl. 3

A

Depazea prunicola Opiz *in* Malá Encyclop. Nauk. Náklad. česk. Mus. **10**: 120. 1852. — *Phyllosticta prunicola* (Opiz) Sacc. *in* Michelia **1**: 157. 1878. — *Phoma prunicola* (Opiz) Wr. & Hochapf. *in* Z. ParasitKde **8**: 595. 1936. — *Peyronellaea prunicola* (Opiz) Goid. *in* Rc. Accad. Lincei **1**: 455. 1946 (misapplied).[8]

Phyllosticta pruni-avium Allesch. *in* Ber. bot. Ver. Landshut **12**: 15. 1892.

Phyllosticta pirina Sacc. *in* Michelia **1**: 134. 1878. — *Coniothyrium pirinum* (Sacc.) Sheldon *in* Torreya **7**: 142–143. 1907 (misapplied).

Phoma pomorum Thüm., Fungi pomicoli 105. 1879.

Phyllosticta cydoniicola Allesch. *in* Hedwigia **36**: 158. 1897; not *Phyllosticta cydoniicola* P. Henn. *in* Hedwigia **41**: 114. 1902.

Phoma pruni-japonicae Syd. *in* Hedwigia **38**: 136. 1899.

Phyllosticta tirolensis Bubak *apud* Bubak & Kabat *in* Öst. bot. Z. **54**: 181. 1904.

B

Phoma fictilis Del. *in* Bull. Soc. mycol. Fr. **9**: 186. 1893. — *Peyronellaea fictilis* (Del.) Goid. *in* Rc. Accad. Lincei **1**: 455. 1946.[8]

Peyronellaea nicotiae Leduc *in* Revue gén. Bot. **65**: 545. 1958.

[7] The synonyms are divided into two groups, A and B, which will be discussed separately.

[8] Not validly published according to Arts. 32 and 43 of the International Code of Botanical Nomenclature (Utrecht, 1961).

MISAPPLICATIONS.—*Peyronellaea prunicola* (Opiz) Goid. *sensu* Pupillo *in* Annali Sper. agr., ser. 2, **6**: 60–62. 1952 = cultural variant of *Phoma glomerata*, which see, also the discussion below.

Phyllosticta pirina Sacc. *sensu* Sheldon *in* Torreya **7**: 142–143. 1907 [*Coniothyrium pirinum* (Sacc.) Sheldon] = *Coniothyrium* spec.

Coniothyrium tirolense Bubak and *Coniothyrium piricola* Poteb. *sensu* Dennis & Wakefield *in* Trans. Brit. mycol. Soc. **29**: 157. 1946, pro syn. of *Phyllosticta pirina*; both names refer to a true *Coniothyrium* spec., fide Petrak & Sydow (1927) and Wollenweber & Hochapfel (1937).

DESCRIPTIONS & ILLUSTRATIONS.—Crabill *in* Rep. Va agric. Exp. Stn. **1911–1912**: 99–109, figs. 20–26. 1913 (*Phyllosticta pirina*); Bolle *in* Meded. phytopath. Lab. Willie Commelin Scholten **7**: 59, pl. 3, figs. 14–17. 1924 (*Phyllosticta pirina*); Wollenweber & Hochapfel *in* Z. ParasitKde **8**: 595–597, fig. 16. 1936 (*Phoma prunicola*); Leduc *in* Revue gén. Bot. **65**: 544–545, figs. 3–5. 1958 (*Peyronellaea nicotiae*); Boerema & Dorenbosch *in* Versl. Meded. plziektenk. Dienst Wageningen 142 (Jaarb. 1964): 144–149, figs. 7, 8. 1965.

DIAGNOSTIC CHARACTERISTICS IN VITRO.—Pycnidia superficial on and immersed in agar, small pycnidia occasionally also in aerial mycelium, sometimes developing from dictyochlamydospores; light-coloured to black and carbonaceous, globose-ampulliform to obpyriform, generally with a ridged or furrowed surface, usually with one ostiole; size variable, as a rule 80–200 × 100–220 μ. Often pycnidia coalesce to form irregular, large fructifications with many ostioles.

Pycnidiospores hyaline to dark-coloured, usually with some guttules; generally ovoid to ellipsoid; usually continuous, occasionally 1-septate, 3–13 × 1.5–6 μ, as a rule 5–7 × 2–3 (av. 6.1 × 2.8) μ.

Single chlamydospores (Fig. 3, Pl. 3) dark brown to black, produced on agar surface chains of 2–25 or more elements, 8–10 μ diam.

Dictyochlamydospores (Fig. 3, Pl. 3) dark brown to black, usually arising as single terminal spores on mycelial branches, occasionally intercalary in the mycelium in connection with single chlamydospores, and intermediate stages between chlamydospores and dictyochlamydospores; as a rule ovoid to ellipsoid, sometimes obovoid-clavate to oblong; with 3–9 transverse walls and usually some longitudinal or oblique walls, 18–60 × 12–30 μ.

HABITAT.—A ubiquitous fungus, occurring on all kinds of dead and diseased plant material. It is often associated with leaf spots on apple, pear, and species of *Prunus* among others (Crabill, 1913; Wollenweber & Hochapfel, 1936; Boerema & Dorenbosch, 1965). In these cases it seems to be a secondary invader (Crabill, 1913). As a soil fungus it has also been found many times on roots and other underground parts of plants (personal observations). Frequently it occurs on the dead seed coats of all kinds of plants (Leduc, 1958 and personal observations). Further isolations have indicated that it has a rather wide range of substrate upon which it can grow (e.g. earthenware, isolation of Saito, CBS Baarn).

SPECIMENS EXAMINED.—

Exsiccata: *Depazea* (*Phyllosticta*) *prunicola*, Opiz herb., type (PR-185704), Sydow, Mycoth. germ. 175 in Saccardo herb. (PAD, under *Phyllosticta*); *Phyllosticta*

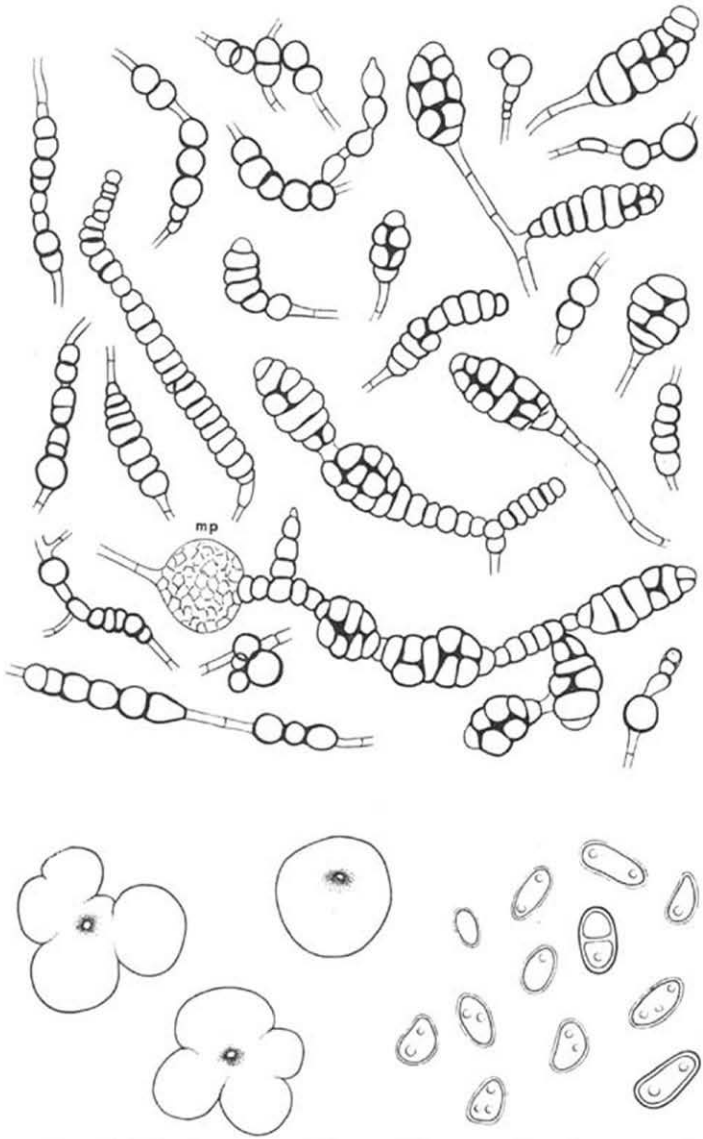

Fig. 3. *Phoma prunicola*; furcate pycnidia, pycnidiospores, chlamydospores, and dictyochlamydospores. Note the complex structures of chlamydospores and dictyochlamydospores. mp = micropycnidium developing from a dictyochlamydospore.

pirina, Saccardo herb., type and exs. coll. Ellis & Martin (PAD); *Phyllosticta tirolensis*, Bubak herb., type (BKL).

Cultures: *Phoma fictilis*, isolate made by Saito from earthen pots in Japan, 1916 (CBS, under *Peyronellaea*, catalogue 1961), *Peyronellaea nicotiae*, culture of type, see Leduc, 1958 (PC-1552).

DISCUSSION.—This fungus is fairly uniform in cultural appearance and characterized by the abundant production of chains of single chlamydospores in combination with dictyochlamydospores. However the production of dictyochlamydospores varies in accordance with the age of the culture and isolate and with the C/N ratio of the medium. The same holds good for the pigmentation and size of the pycnidia and pycnidiospores.

The fungus is fairly easy to distinguish from *Phoma glomerata*. However, Goidànich created confusion by his identification of a cultural variant of *Phoma glomerata* from lemon (Pupillo, 1952) with *Phoma prunicola* as described by Wollenweber & Hochapfel (1936). This implies that the description of *Peyronellaea prunicola* in Pupillo (l.c.) and the cultures labelled *Peyronellaea prunicola* in CBS, PAV, and PC actually relate to *Phoma glomerata*! The detailed characters of *Phoma prunicola* given above have been described from our own isolates of the fungus in comparison with the description given by Wollenweber & Hochapfel (l.c.). Besides this, we had access to data on the cultural characters of two specimens which Wollenweber & Hochapfel (l.c.) considered to be *Phoma prunicola*, viz. *Phyllosticta pirina* as described by Crabill (1913: strain 1, 2; see also Bolle, 1924: 59) and *Phoma fictilis* (sensu Saito, see below under B).

Synonyms of Group A: The synonymy of this group is based on the study of Wollenweber & Hochapfel (1936).

Most of the old species names listed as synonyms of *Phoma prunicola* were described from material in leaf spots on trees. Wollenweber & Hochapfel (l.c.), in their study of this fungus, pointed out that these species, except *Phyllosticta tirolensis*, are identical with *P. prunicola*; with this we agree. It is true that in the original diagnoses of those species dictyochlamydospores are not mentioned, but is should be kept in mind that the descriptions were based on observations *in vivo* (compare the discussion under *P. glomerata*). Because a study of the original diagnoses and an examination of the herbarium material available failed to give any concrete contra-indications, we accept the interpretation by Wollenweber & Hochapfel (l.c.).

The pycnidia in the type material of *Phyllosticta tirolensis* are similar to the pycnidia of *P. prunicola* on leaf spots, so that we have added that species described from leaf spots to the synonymy of *P. prunicola*.

Synonyms of Group B: The synonymy of this group is based on the study of living cultures.

Wollenweber & Hochapfel (l.c.) established that a CBS culture of *Phoma fictilis* isolated from earthen pots and determined by Saito in Japan in 1916 belongs to

Phoma prunicola. This culture was still present in the CBS in 1960 under the name *Peyronellaea fictilis*. It was sterile but after repeated culturing in tomatoes it produced pycnidia and dictyochlamydospores. This agrees with our isolates of *Peyronellaea prunicola*. The vague original French description of *Phoma fictilis* is not in contradistinction to this synonymy. Furthermore it is now known that *Peyronellaea prunicola* occurs on all kinds of substrata.

In France an isolation of *P. prunicola* from flax seed has been described as a new species, *Peyronellaea nicotiae*. From a comparative study of the type culture of this species and *P. prunicola* we came to the conclusion that they are identical.

Phoma musae (Joly) Boerema, Dorenb., & Kest., *comb. nov.*—Fig. 4, Pl. 4.

Peyronellaea musae Joly *in* Rev. Mycol. **26**: 97. July 1961.
Peyronellaea nainensis Tandon & Bilgrami *in* Curr. Sci. **30**: 344. Sept. 1961.

DESCRIPTIONS & ILLUSTRATIONS.—Joly *in* Rev. Mycol. **26**: 96–97, figs. 2a–d. 1961 (*Peyronellaea musae*); Tandon & Bilgrami *in* Curr. Sci. **30**: 343–344, fig. 1. 1961 (*Peyronellaea nainensis*).

DIAGNOSTIC CHARACTERISTICS IN VITRO.—Pycnidia superficial on and immersed in agar, small pycnidia often in aerial mycelium and then as a rule developing from dictyochlamydospores; globose-ampulliform to obpyriform, usually with one ostiole; size variable, generally 50–180 × 60–200 μ. Occasionally pycnidia coalesce to form irregular fructifications with several ostioles.

Pycnidiospores hyaline or yellow-coloured, usually without guttules; as a rule ovoid to ellipsoid, sometimes globose or irregular in shape; continuous; 3–10 × 1.5–6.5 μ, mostly 6–7.5 × 3–4 (av. 6.6 × 3.7) μ.

Dictyochlamydospores (Fig. 4, Pl. 4) tan to dark brown, arising terminally and through continued growth of the hyphae becoming lateral, or of intercalary origin and usually developing laterally; mostly clavate to obovoid, sometimes ovoid; with 1–8 transverse walls and usually some longitudinal or oblique walls; size variable, 13–50 × 7–25 μ. Single chlamydospores and intermediate stages between chlamydospores and dictyochlamydospores occur occasionally.

HABITAT.—This species has been observed only on plant material of tropical origin. In France it is found on stems, peduncles, and the fruit of *Musa* sp. In India it is described as the cause of a leaf spot disease on *Eriobotrya japonica*.

SPECIMENS EXAMINED.—

Exsiccatum: *Peyronellaea nainensis*, dried culture of type isolate made by Dr. Tandon (CMI).

Cultures: *Peyronellaea musae*, culture of type (PC); *Peyronellaea nainensis*, culture of type from Dr. Tandon, Allahabad University, India.

DISCUSSION.—The characters of this species are also highly influenced by the age of the cultures and isolates, and by the C/N ratio of the artificial medium.

This applies especially to the size and pigmentation of pycnidia and pycnidiospores, the size of chlamydospores and the extent of the hyphal elements and hyphal branches between these dictyochlamydospores. It is the background of the differences between the original diagnoses of *P. musae* and *P. nainensis*. Comparative study of the type cultures of both species proved that they are identical in every detail!

Excluded species

Coniothecium chomatosporum Cda., Ic. Fung. **1**: 2. 1837. — *Peyronellaea chomatospora* (Cda.) Goid. *in* Rc. Accad. Lincei **1**: 455. 1946 ("*cromatospora*"). [9]

This species, originally described from dried pine wood, was transferred by Goidànich to the genus *Peyronellaea* apparently on account of Australian data about the fungus (Goidànich 1946: 455). However, in the original diagnosis of *Coniothecium chomatosporum* no pycnidia are mentioned, whereas the complex structures of globose, thick-walled cells described and figured cannot be related to the dictyochlamydospores of the *Phoma* species discussed in this paper.

Coniothecium scabrum McAlp., Fung. dis. Citr. Austr., Melbourne 80. 1899. — *Peyronellaea scabra* (McAlp.) Goid. *in* Rc. Accad. Lincei **1**: 455. 1946. [9]

Goidànich placed this species, which was described from *Citrus*, in his genus *Peyronellaea*. For this he relied on a paper by Mason (1933), who discussed a fungus referred to *Coniothecium scabrum* by S. P. Wiltshire. The figures in Mason's paper actually prove Wiltshire's fungus to be a *Phoma* species that produces dictyochlamydospores, possibly *P. glomerata*. However, in our opinion the original data about *Coniothecium scabrum* do not justify Wiltshire's interpretation. Neither pycnidia nor characteristic dictyochlamydospores are mentioned or figured in the original diagnosis of *Coniothecium scabrum*.

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[9] Not validly published according to Arts. 32 and 43 of the International Code of Botanical Nomenclature (Utrecht, 1961).

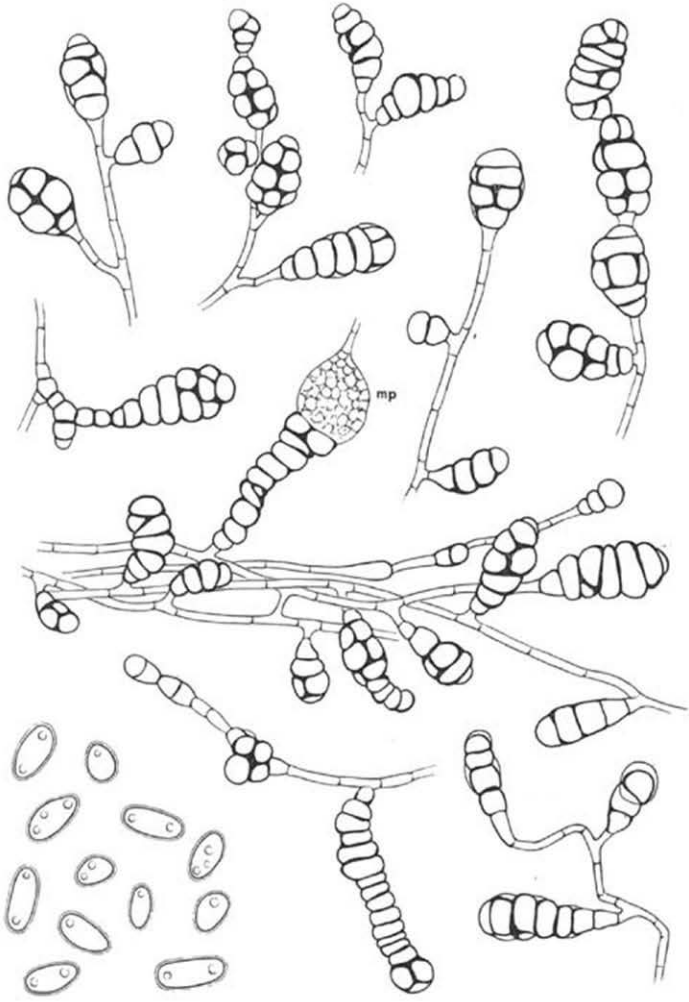

Fig. 4. *Phoma musae*; pycnidiospores and dictyochlamydospores. Note the alternating arrangement of the latter.
mp = micropycnidium developing from a dictyochlamydospore.

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EXPLANATION OF PLATES 1–4

PLATE 1

Figs. 1–8. *Phoma glomerata*; various types of dictyochlamydospores produced in culture. — Figs. 1. 2, 7, 8 from Luedemann (1957). — Figs. 1–6, c. × 60. — Figs. 7–8, c. × 125.
mp = micropycnidia; ps = pycnidiospores.

PLATE 2

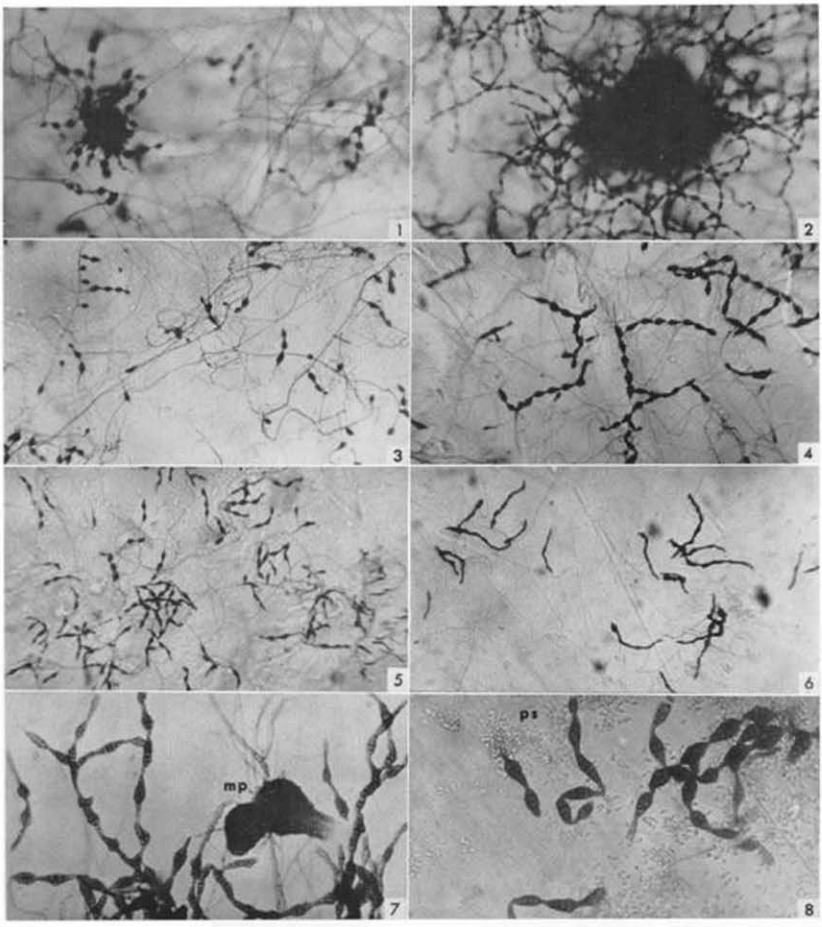
Figs. 9–12. *Phoma glomerata*; cultures of different strains. — Figs. 9 and 10, on cherry agar. — Figs. 11 and 12, on oat agar.

PLATE 3

Figs. 13–19. *Phoma prunicola*; various types of chlamydospores and dictyochlamydospores in culture. — Figs. 13 and 14, c, × 60. — Figs. 15–19, c. × 125.
Figs. 20, 21. *Phoma prunicola*; cultures of different strains. — Fig. 20, on cherry agar. — Fig. 21, on oat agar.

PLATE 4

Figs. 22–25. *Phoma musae*; various types of dictyochlamydospores in culture. — Fig. 22, c. × 60. — Figs. 23–25, c. × 125.
Figs. 26, 27. *Phoma musae*; cultures of different strains. — Fig. 26, on cherry agar. — Fig. 27, on oat agar.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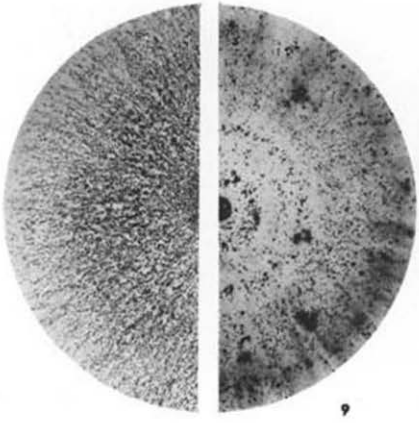

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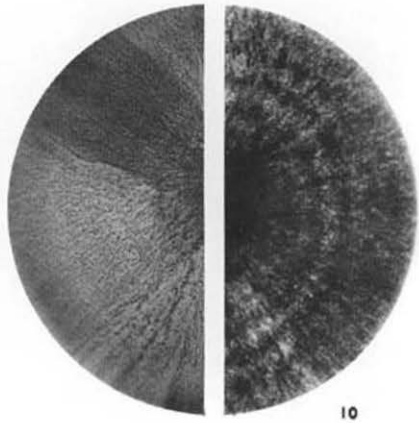

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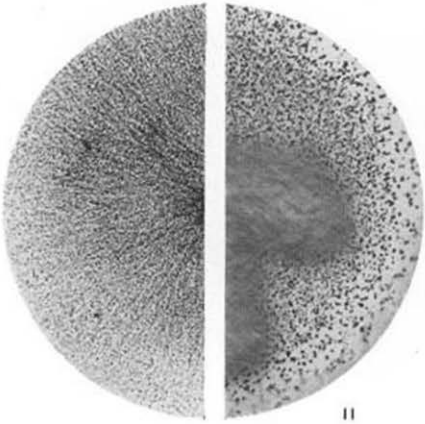

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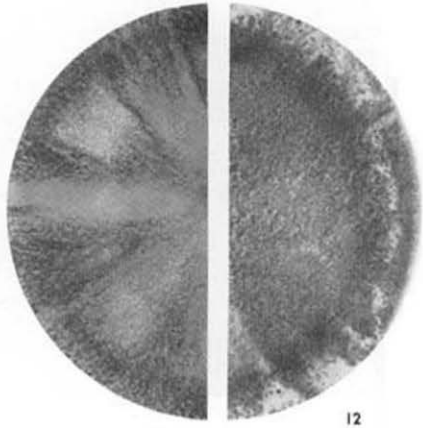

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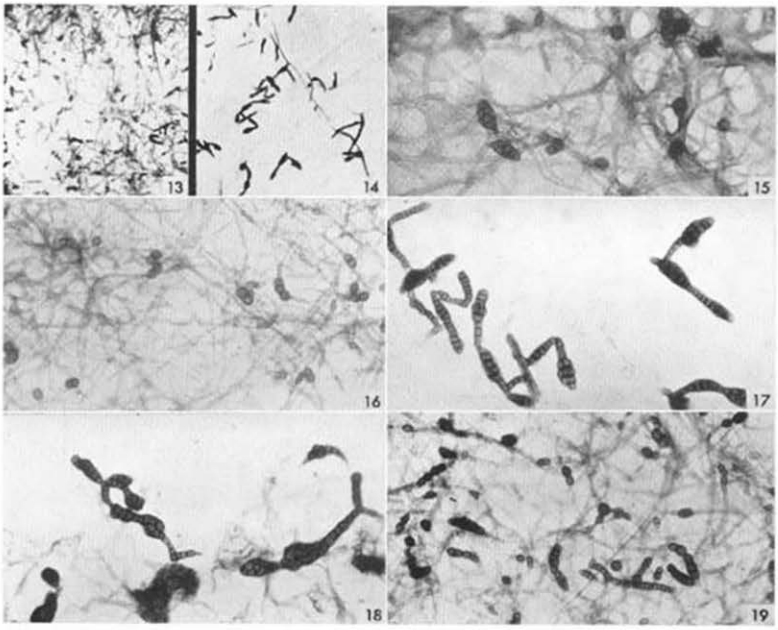
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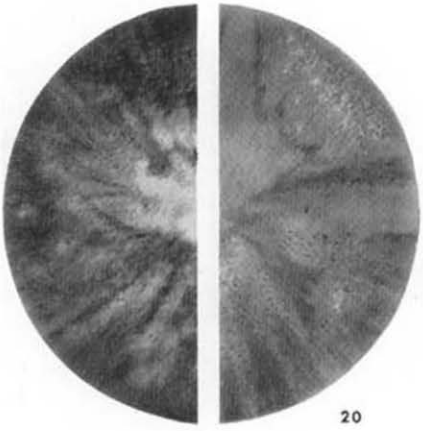
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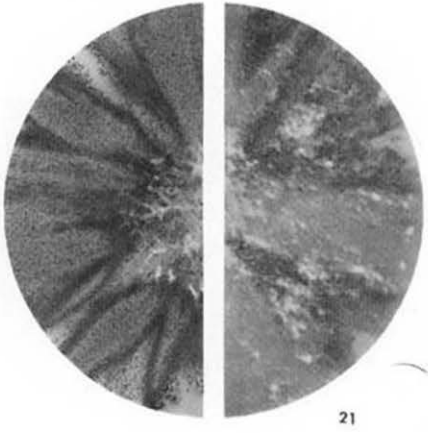
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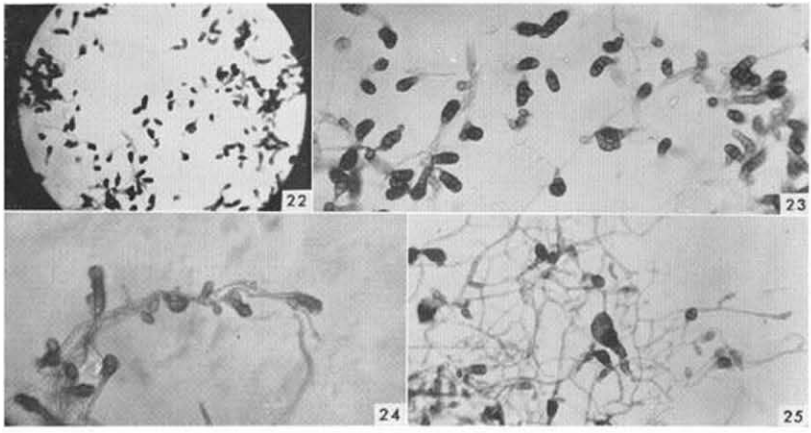
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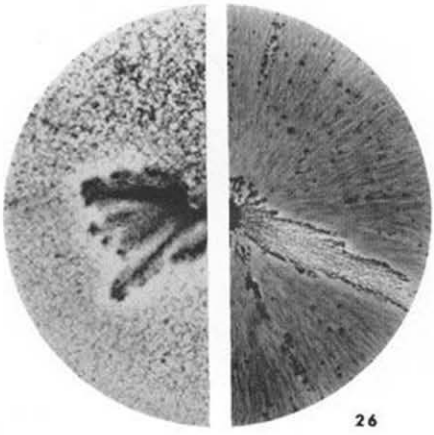
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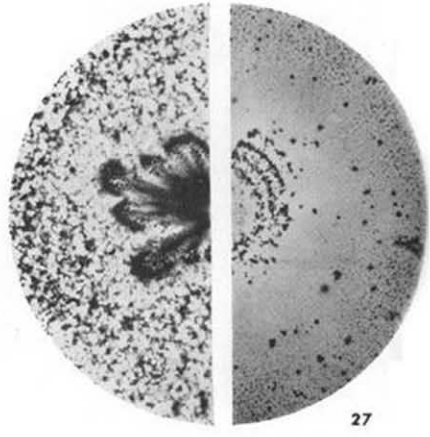
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