

**TAXONOMIC CHARACTERS
OF THE GENERA ALTERNARIA
AND MACROSPORIUM, PP.
439-476**

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BY

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TAXONOMIC CHARACTERS OF THE GENERA ALTERNARIA AND MACROSPORIUM

JOHN A. ELLIOTT

I. INTRODUCTION

Alternaria and *Macrosporium* are among the most universally distributed and most common forms of the Fungi Imperfecti, embracing, according to the "Sylloge Fungorum" of Saccardo, 41 species and varieties of *Alternaria* and 189 species and varieties of *Macrosporium*, these numbers including some synonyms but not the new species which have been described since the publication of the last volume of Saccardo's work. Some species, such as *Alternaria solani* (E. & M.) J. & G., *A. brassicae* var. *nigrescens* Peglion, and *Macrosporium sarcinaeforme* Cav. are well known and destructive parasites, but the great majority are saprophytes or have been described from non-important hosts. The ascigerous stages of a few species are known, the connection in all such cases being with the genus *Pleospora*.

Even a casual survey of the literature dealing with the genera in question would reveal the fact that the generic names, *Alternaria* and *Macrosporium*, are in many cases used synonymously in dealing with the best known of the parasitic species. This condition could be due either to there being no basis for distinction between the two genera, or to this basis being ill defined. The studies of the writer were undertaken with the hope of adding to the knowledge of these two genera. The work was necessarily limited and the result is in no way of the nature of a monograph.

II. HISTORICAL

The genus *Alternaria* was described and figured by Nees (15), *A. tenuis* being the type and only species described. The description

is incomplete and in some particulars inaccurate, but it is definite and complete enough to leave little doubt that what Nees described was what is now generally recognized as *Alternaria*.

Fries (7) described the genus *Macrosporium*, differentiating it from *Cladosporium*, *Helminthosporium*, and *Sporodesmium*. The muriform spore, now given as one of the characters of the genus, is not mentioned in the generic description, otherwise it fits the present current conception fairly well. Having dropped the genus *Alternaria*, Fries makes no mention of it in his description of *Macrosporium*.

Macrosporium and *Alternaria* are placed by reason of their muriform spores in the section *Dictyosporae* of the family *Dimidiaceae* of the order *Moniliales*, the muriform spores separating them from the genera *Cladosporium* and *Helminthosporium*, which in some species are in many particulars similar. Among the *Dictyosporae* there is little basis, as the genera are described, for separating *Stemphylium*, *Septosporium*, or *Mystrosporium* from *Macrosporium*. The separation of the genera *Alternaria* and *Macrosporium* rests solely on the catenulation of spores in the former genus. The fact that many of the species of *Alternaria* now recognized were first described as *Macrosporium* indicates the uncertainty of this basis for generic distinction. In the specific descriptions in both genera, while mycelium, conidiophores, and spores may all be taken into consideration, spore characters are the most used basis for distinction.

The question of the validity of the separation of the two genera arose over the study of their ascigerous connection with *Pleospora herbarum* Tul. The Tulasne brothers (19) figure *P. herbarum* bearing both *Alternaria* and sarcinaeform spores on the same hyphae. Gibelli and Griffini (8), Mattiolo (13), Bauk (1), and Kohl (12), studying *P. herbarum* in pure culture, concluded that it should be divided into two varieties or species, one having *Alternaria* conidia and the other having sarcinaeform conidia. Miyake (14), studying the life history of *Macrosporium parasiticum* Thum., found no *Alternaria* stage in the life cycle. Halsted (9), in studying the life history of *Pleospora tropaeoli* Hal. in pure culture, found that the cycle included only *Pleospora* and *Alternaria* stages.

As the ascigerous stage of most species of *Alternaria* and *Macrosporium* is unknown or non-existent, the basis for the distinction of genera and species must rest, in general, on the conidia. Jones (10-11), in studying *Macrosporium solani* E. & M. and *M. fasciculatum* C. & E.

on artificial media, found that they formed chains of conidia and placed them in the genus *Alternaria*. Bioletti (3) reported securing pure cultures of *Macrosporium* sp. and *Alternaria* sp. from olives in California. Others have reported isolating species of one or the other genera from various sources and growing them in pure culture under conditions where the morphology of the fungi ought to have been pretty certainly ascertained, but by far the greatest amount of literature on the two genera deals with their pathogenic effects or with the mere description of species.

Miyake (14), Prillieux and Delacroix, (17), and others (4) have shown by careful experiments or have suggested that many of the specific names are synonyms. Constantin (4) and Planchon (16) have reported great variations in *Alternaria* due to growth on different media. Planchon (16) expresses the opinion that *Macrosporium* is merely *Alternaria* with dissociated conidia. No extensive comparative work, either between the two genera or between species of the two genera, has yet been undertaken.

III. METHODS IN GENERAL

To aid in the comparison of published descriptions; a tabulation of the species and varieties of *Alternaria* and *Macrosporium* given in the "Sylloge Fungorum" was made on the basis of spore length, the species being arranged according to the maximum length given. Specimens from all available exsiccati were studied and compared. Cultures of the principal types found in the exsiccati were studied under varied conditions in order to learn something of the constancy of the characters which are made the basis of specific distinctions. The original generic descriptions were studied in order to ascertain the basis of generic distinction.

THE VALUE OF WRITTEN DESCRIPTIONS

An examination of the specific descriptions of the two genera in question showed that spore measurements were most constantly used in distinguishing between species; in many cases several species were alike in every character given except that of size of spores. In order to learn something of the variation in measurements which may be due to the personal element and to the use of different micrometers and microscopes in measuring, three slides were prepared and together with cultures of *Phoma destructiva* Pat. were sent to a number of persons

actively engaged in descriptive mycological work. On one slide of *Pleurosigma angulatum* Sm., a single frustule was enclosed in a circle and indicated; on a second slide two spores of *Alternaria fasciculata* were similarly indicated. A third slide of *A. fasciculata* contained several hundred spores. Identical typewritten directions were sent to each one who made the measurements, asking that no more care be used than would ordinarily be taken in measuring for the purpose of describing a new species. A tabulation of results follows:

TABLE A.

Observer No.	Eye-piece Value	Single Frustule of <i>P. angulatum</i>	One Spore of <i>Alternaria</i>	One Spore of <i>Alternaria</i>	Many Spores of <i>Alternaria</i>	Many Spores of <i>Phoma</i>
1	2.4	285.6 × 45.6	48 × 7.2	19.2 × 9.6	12-36 × 6-12	2-5 × 1-2
2	2.4	284.4 × 46.8	49.2 × 6	19.2 × 9.6	14-36 × 9-12	3-4 × 2-3
3	1.8	284.4 × 45.9	50.6 × 7.2	19.8 × 9.9	11-41 × 6-13	
4	3.16	282 × 46.5	48 × 7.5	19.5 × 9.5	10.5-24 × 7.5-13	5-6 × 1.5-2
5	3.4	282 × 46	48 × 7	20 × 10	17-34 × 7-10	
6	3.2	280 × 45	48 × 7	20 × 7	13-29 × 9-11	4-8 × 2-3.5
7	4.	280 × 44	48 × 7	20 × 9	20 × 9	5-6 × 2-2.5
8	3.2	276 × 45	48 × 8	21 × 7	12-35 × 9-12	5-9 × 2-3
9	10.	275 × 50	.....	.....	13-35 × 7-11	.....
10	3.2	275 × 45	47 × 7	20 × 10	12-33 × 6-12	3-8 × 2-3
11	3.	270 × 48	50 × 7.5	21 × 9.5	15-40 × 8-12	5-8 × 3-5
Variation	.....	15.6 × 6	3.6 × 2	1.8 × 3	6.5-17 × 3-3	3-4 × 2-3
Variation %	.....	5 × 12	7 × 25	8.5 × 30	43-41 × 33-23	60-44 × 66-60

The second column gives the value of the smallest division of each eyepiece micrometer in micromillimeters. All the measurements given in the table are in microns. The arrangement is according to the maximum measurement given for *Pleurosigma angulatum*.

The third, fourth and fifth columns show the variations in measurements when all, without any doubt, were measuring the same things. The variation is least in the longest measurements, being a little over 5 percent in the greatest length given, and greatest in one of the two shortest measurements, amounting to 30 percent in the width of the spore indicated in the fifth column. That this variation is not due to the eyepiece used is shown by the fact that observer No. 10 who returned the lowest measurement for the long spore, column 4, also returned the highest measurement for the width of the spore given in column 5. The variations given for the *Phoma* spores are the greatest, being 66 percent for the shortest measurement and 44 percent for the longest measurement. In this case each mycologist made his own microscopic preparation.

The most instructive results appear in the sixth column of the table where the maximum and minimum lengths and breadths of the spores are given under conditions such as would obtain in describing a new species. Here there was a variation of over 41 percent of the highest maximum measurement returned for the length of the spores. The variation for the minimum lengths was greater. Assuming variation equal to that shown in column 6 of Table A, 34 species of Macrosporium and 5 species of Alternaria in the "Sylloge Fungorum" are inseparable by measurements of both length and breadth.

Applying to all the species of Alternaria and Macrosporium in the "Sylloge Fungorum" the variability shown in column 6 of Table A, they can be combined into thirteen groups, taking into consideration the measurements for both length and breadth of spores. In other words, if other characters are disregarded, in so far as actual spore measurements are dependable, there are only thirteen species of Macrosporium and Alternaria adequately described in the "Sylloge Fungorum."

STUDY OF EXSICCATI

Following the study of descriptions in the "Sylloge Fungorum," examination was made of the specimens of Macrosporium and Alternaria in the exsiccati immediately available. One hundred and thirty-four specimens labeled as 85 species, were found. Of this number 17 were marked "sp. n." *i. e.*, of or nearly of the value of type material. Eighteen other species not marked "sp. n." were found in the exsiccati of the authors or one of the joint authors of the species. This gave a total of 35 species, the material of which can be regarded as reasonably authentic.

Mounts were made from each of the specimens, from which spore and conidiophore measurements, and the character of each, were recorded. The nature of the growth, whether apparently parasitic or saprophytic, was also recorded and the descriptions so made were compared. There was no doubt that in the collection, many specimens morphologically indistinguishable appeared under different names, and that in some instances the same name was given to specimens which were in no way similar or which could readily be distinguished from each other.

In the following summary of the study of the exsiccati the names are given as they appeared on the specimen, followed by the title of

the collection and the specimen number in the collection. Two asterisks (**) following the species name indicates that the specimen was marked "sp. n."; a single asterisk (*) indicates that the specimen was found in the exsiccati of the author of the species.

Group 1

The following species had only globular or packet-shaped spores and were essentially alike:

- Macrosporium sarcinaeforme** Cavara, Fungi Par., Bri. & Cav., 116.
M. cladosporioides Desm., Fungi Sel. Ex., Roum., 5596.
M. stilbosporoideum Bri. & Cav., N. Amer. Fungi, Ellis, 2080.

Group 2

A second group was made of those having globular or packet-shaped spores like those of the first group, but having in addition some ovate or pointed spores which might be due to variation in the shape of spore or to a mixture of two forms:

- M. parasiticum*** Thum., Myc. Univ. Thum., 667; Fungi Par., Bri. & Cav., 152.
*M. consortiale*** Thum., Myc. Univ. Thum., 1373.
M. sarcinula Berk., Fungi Columb., 3032.
M. chartarum Pk., N. Amer. Fungi, Ellis, 648; Fungi Sel. Ex., Roum., 6560.
M. heteronemum (Desm.) Sacc. Fungi Sel. Ex., Roum., 6647, 6562, 6358.

The following were possibly the same as the above but they either showed minor differences or else the material was not sufficient to afford positive judgment:

- M. chartarum* Pk., Fungi Columb., 396.
M. zimmermanii Thum., Fungi Sel. Ex., Roum., 396.
M. polytrichum Cke. & Rav., Fungi Par., Bri. & Cav., 191.
M. puccinioides E. & And., N. Amer. Fungi, Ellis, 2876.

Group 3

A third group was made of species having long, narrow, regular, tapering spores with few longitudinal septa. All were apparently parasitic:

- M. euphorbiae*** Bart., Fungi Columb., 2633.
*M. carotae** E. & E., N. Amer. Fungi, Ellis, 3289; Fungi Columb., 2632.