A REVISION OF SOME GRAMINICOLOUS *HELMINTHOSPORIA**

C. V. SUBRAMANIAN
Centre for Advanced Studies, University Botany Laboratory, Madras
AND
B. L. JAIN
Botany Department, University of Rajasthan, Jaipur

THE taxonomy of graminicolous species of *Helminthosporium* has been the subject of much study and discussion during the past few years (Luttrell[1,2]; Nelson[3]; Shoemaker[4,5]; Hughes[6]; Subramanian[7]; Rapilly[8]). This is a sequel to the discovery that in the type species of *Helminthosporium* Link ex Fries (*H. velutinum* Link ex Fries) the phragmospores are produced apically and laterally on erect conidiophores as in *Spondylocladium atrovirens* Harz [= *Helminthosporium atrovirens* (Harz) Mason and Hughes], whereas in the graminicolous species assigned to this genus the spores are produced on sympodulæ. Although the spores in *H. velutinum* and in the graminicolous species are now considered to be porospores, the differences in conidiophore behaviour between the former and the latter are, in the light of recent trends in the classification of Hyphomycetes based on conidiophore behaviour and spore types, such that both of them cannot be retained in the same genus. In other words, *Helminthosporium* Link can take in only forms producing many-septate porospores which are acropleurogenous on conidiophores showing no sympodial growth. The graminicolous species, many of which cause plant diseases, have to be accommodated elsewhere. The classification of these graminicolous species is the subject of this paper.

One approach to this question is seen in the proposals made by Shoemaker[4] who disposed species belonging to the subgenus *Cylindro-Helminthosporium* (Drechsler,[9] Nisikado[10]) in the genus *Drechslera* Ito[11] and the remaining species belonging to the subgenus *Eu-Helminthosporium* (Drechsler,[9] Nisikado[10]) in the genus *Bipolaris* which he established to accommodate them. Another approach is that of Luttrell[2] who, motivated by the commendable desire of retaining the generic name *Helminthosporium* for these graminicolous species in deference to long-established usage, suggests that *Helminthosporium* "should be redefined with *H. maydis* Nisik. and Miy. as the type and conserved for species in the subgenera *Cylindro-Helminthosporium* and *Eu-Helminthosporium*....*Spondylocladium* with *S. atrovirens* (Harz) Harz ex Sacc. as the type should be conserved for species in *Spondylocladium* auct." and the species congeneric with it.

As far as we are aware, neither of these proposals has been readily accepted, although Luttrell's proposal is quite recent and it is too early to expect comments on it. During the course of our studies on variation and variability of these fungi with special reference to forms collected in India, we have naturally considered the question of their taxonomy carefully. Our conclusions are summarized here.

Luttrell's[2] suggestion involves conservation of two generic names (*Helminthosporium* and *Spondylocladium*), besides the choice of types for both these generic names different from the respective types attached to these names by their authors. Indeed, this also means deliberate rejection of the legitimate types which have been available for study and hence well understood. The type of the genus *Spondylocladium* Mart. is itself stated to be congeneric with the type species of *Stachylidium* Link ex Fries (Hughes[6]). To our mind, Luttrell's suggestion is too complicated and beset with too many difficulties.

Although no such difficulties are posed by the proposals of Shoemaker,[4] doubt has been expressed about the desirability of distributing the graminicolous species in two separate genera, *Drechslera* and *Bipolaris* (Subramanian,[7] Luttrell[2]), as has been done by Shoemaker.[4] That these graminicolous species fall into two major groups corresponding to *Cylindro-Helminthosporium* and *Eu-Helminthosporium* has been known for over forty years and, although Ito segregated the species in *Cylindro-Helminthosporium* and placed them in a separate genus *Drechslera* as early as 1930, this segregation was not accepted by many workers until Hughes[6] and Shoemaker[4] revived this name. For, few workers considered it necessary to

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have two separate genera for these two groups of species. While Nisikado[10] proposed two subgenera to take in these, Drechsler[9] himself merely recognized two groups within this genus. While it is admitted that the general spore morphology (shape, mode of germination, etc.) on which the separation into the two groups is based can be recognized usually without difficulty, the question to be considered is whether the differences are of the magnitude to justify separation into two genera. In our humble opinion, they are not. In fact, examining more closely the species which are distributed in the genera *Drechslera* and *Bipolaris*, one sees further groups of species here which can be bundled together as having certain other significant features in common. Several species (*Helminthosporium halodes* Drechsler, *H. turcicum* Pass., *H. pedicellatum* Henry, *H. monoceras* Drechsler, *H. micropus* Drechsler, *H. holmii* Luttrell) have spores with a conspicuous protruding hilum and in studies on some of these species we have found this character invariable. Coupled with the presence of this protruding hilum is the fact that germ tube emergence during germination is usually not through the hilum but extra-hilar. If one now stresses relationship to the perfect state as an additional argument for generic separation, as has been done by Shoemaker[4] for *Drechslera* and *Bipolaris* whose perfect states are in *Pyrenophora* and *Cochliobolus* respectively, then the species with protruding hila, as far as known, have perfect states in *Trichometasphæria* and, therefore, following a similar line of thought, may well be re-classified in a separate form-genus. There are also several species usually disposed in *Cylindro-Helminthosporium* (in *Drechslera*, by Shoemaker) which have spores which are not strictly cylindrical but in some cases even distinctly and characteristically obclavate and, therefore, are not easily placed in *Cylindro-Helminthosporium*. A few short- and few-septate-spored species such as *H. triseptatum* Drechsler, *H. dematioideum* Bub. & Wrob. and *H. biforme* Mason & Hughes also exist and according to Ibrahim and Threlfall[12] these deserve segregation into a separate genus *Tetracellularis*. In this way one can see a hierarchy of differences in the graminicolous species as a whole. Nevertheless, what appears to us to be most striking and significant about them are the features that unite all these forms. No doubt, the forms assigned to *Drechslera* appear to be somewhat more specialized in parasitism than those placed in *Bipolaris*, but this again is not a feature of much taxonomic significance at least in so far as these species are concerned.

Considering all these facts, we recognize the unity of all these species and, since they cannot be retained in *Helminthosporium* as now known from a study of its type species, we suggest that they be accommodated in a single genus, *Drechslera* Ito, which is the earliest validly published name available. Accordingly, *Bipolaris* Shoemaker is reduced to synonymy with *Drechslera*. A possible objection to this proposal is that several new combinations in *Drechslera* would be necessary and, although we are reluctant to publish new combinations in view of those that have been made in the genus *Bipolaris* by Shoemaker,[4] there is unfortunately no better alternative. The names in *Bipolaris* proposed by Shoemaker are yet to come into general use. Our proposal underlines the essential unity of all these species recognized by mycologists and plant pathologists for a long time, does not involve conservation of any names or procedures in any way violating the provisions of the Code, and merely brings into general use a generic name proposed many years ago by Ito, in place of the generic name *Helminthosporium* which is unavailable. We hope that this proposal will meet with general approval, particularly from plant pathologists whose sentiments with regard to nomenclatural changes we respect and we offer this proposal as relatively the best among the possibilities all of which pose one difficulty or another.

Drechslera Ito emend.

Ito, 1930, Proc. Imp. Acad. Tokyo 6 : 455.

Hyphomycete typically producing porospores. Conidiophores erect, septate, simple or branched, brown, geniculate. Conidia phragmospores, borne on sympodulæ, acrogenous, brown, variable in shape, with inserted or protruding basal hilum.

Belongs to the *Helminthosporiaceæ* Corda emend. Subram.

So far as known, the perfect states are in *Pyrenophora*, *Cochliobolus* and *Trichometasphæria*.

Lectotpye species: *Drechslera tritici-vulgaris* (Nisikado) Ito, 1930, Proc. imp. Acad. Tokyo 6 : 355. (= *Helminthosporium tritici-vulgaris* Nisikado, 1928, *Ann. phytopath. Soc. Japan* 2: 96).

On the basis of the proposals made here, the following transfers are made.

Drechslera arizonica **(Sprague) comb. nov.**
= *Bipolaris arizonica* Sprague, 1960, *Mycologia*, 52: 358.

Drechslera australiense (Bugnicourt) comb. nov.
= *Helminthosporium australiense* Bugnicourt, 1955. *Rev. gen. Bot.* 62 : 238-43.

Drechslera bicolor (Mitra) comb. nov.
= *Helminthosporium bicolor* Mitra, 1930, *Trans. Brit. mycol. Soc.* 15 : 286.

Drechslera biforme (Mason & Hughes) comb. nov.
= *Helminthosporium biforme* Mason & Hughes in Chesters, 1948, *Trans. Brit. mycol. Soc.* 30 : 114-117.

Drechslera brizae (Nisikado) comb. nov.
= *Helminthosporium brizæ* Nisikado, 1928, *Spec. Rept. Ohara Inst. agric. Res.* 4 : 133.

Drechslera buchloes (Lefebvre & Johnson) comb. nov.
= *Helminthosporium buchloes* Lefebvre & Johnson, 1949, *Mycologia* 41 : 204.

Drechslera coicis (Nisikado) comb. nov.
= *Helminthosporium coicis* Nisikado, 1928, *Spec. Rept. Ohara Inst. agric. Res.* 4 : 136.

Drechslera cookei (Sacc.) comb. nov.
= *Helminthosporium cookei* Sacc., 1886, *Syll. Fung.* 4 : 420.

Drechslera cynodontis (Marig.) comb. nov.
= *Helminthosporium cynodontis* Marig., 1909, *Micromiceti di Schio, Schio*, p. 27.

Drechslera dematioideum **(Bub. & Wrob.) comb. nov.**
= *Helminthosporium dematioideum* Bub. & Wrob. in Bub., 1916. *Hedwigia* 57 : 337.

Drechslera eragrostidis **(P. Henn.) comb. nov.**
= *Helminthosporium eragrostidis* P. Henn., 1908, *Annal. Musée du Congo, Terveren, Belg., Bot.* serie 5, 2 : 231.

Drechslera euchlaenae **(Zimm.) comb. nov.**
= *Helminthosporium euchlænæ* Zimm., 1904, *Ber. Land.-u. Forstw. Kaiserl. Gouv. Deutsch-Ostafrika* 2 : 18.

Drechslera halodes **(Drechsler) comb. nov.**
= *Helminthosporium halodes* Drechsler, 1923, *J. agric. Res.* 24 : 709.

Drechslera hawaiiense **(Bugnicourt) comb. nov.**
= *Helminthosporium hawaiiense* Bugnicourt, 1955, *Rev. gen. Bot.* 62 : 238-43.

Drechslera holmii **(Luttrell) comb. nov.**
= *Helminthosporium holmii* Luttrell, 1963, *Phytopathology* 53 : 285.

Drechslera kusanoi **(Nisikado) comb. nov.**
= *Helminthosporium kusanoi* Nisikado, 1928, *Spec. Rept. Ohara Inst. agric. Res.* 4 : 150.

Drechslera leersiae **(Atk.) comb. nov.**
= *Helminthosporium leersiæ* Atk., 1897, *Cornell Univ. Bull. (Sci.)* 3 (1): 47.

Drechslera leucostyla **(Drechsler) comb. nov.**
= *Helminthosporium leucostylum* Drechsler, 1923, *J. agric. Res.* 24 : 711.

Drechslera maydis **(Nisikado) comb. nov.**
= *Helminthosporium maydis* Nisikado, 1926, *Sci. Res. Alumni Assoc. Morioka agric. Coll. Japan* 3 : 46 (Japanese diagnosis), 52 (English diagnosis).

Drechslera mediocre **(Putterill) comb. nov.**
= *Helminthosporium mediocre* Putterill, 1954, *Bothalia* 6 : 354.

Drechslera micropa **(Drechsler) comb. nov.**
= *Helminthosporium micropus* Drechsler, 1923, *J. agric. Res.* 24 : 722.

Drechslera miyakei **(Nisikado) comb. nov.**
= *Helminthosporium miyakei* Nisikado, 1928, *Spec. Rept. Ohara Inst. agric. Res.* 4 : 145.

Drechslera monoceras **(Drechsler) comb. nov.**
= *Helminthosporium monoceras* Drechsler, 1923, *J. agric. Res.* 24 : 706.

Drechslera nodulosa **(Berk. & Curt.) comb. nov.**
= *Helminthosporium nodulosum* Berk. & Curt. in Sacc., 1886, *Syll. Fung.* 4 : 421.

Drechslera ocella **(Faris) comb. nov.**
= *Helminthosporium ocellum* Faris, 1928, *Phytopathology* 18 : 136.

Drechslera olyrae **(Viegas) comb. nov.**
= *Helminthosporium olyræ* Viegas, 1946, *Bragantia* 6 : 381.

Drechslera oryzae **(Breda de Haan) comb. nov.**
= *Helminthosporium oryzæ* Breda de Haan, 1900, *Bull. Inst. Bot. Buitenz.* 6 : 11.

Drechslera panici-miliacei **(Nisikado) comb. nov.**
= *Helminthosporium panici-miliacei* Nisikado, 1928, *Spec. Rept. Ohara Inst. agric. Res.* 4 : 42.

Drechslera pedicellata **(Henry) comb. nov.**
= *Helminthosporium pedicellatum* Henry, 1924, *Univ. Minn. agric. Exp. Sta. Tech. Bull.* 22 : 42.

Drechslera ravenelii **(Curt.) comb. nov.**
= *Helminthosporium ravenelii* Curt., 1848, *Amer. J. Sci.*, ser. 2, 6 (18): 352.

Drechslera sacchari **(Butl.) comb. nov.**
= *Helminthosporium sacchari* Butl. in Butl. and Hafiz, 1913, *Mem. Dept. Agr. India*, Pusa, Bot. ser., 6 : 207.

Drechslera setariae **(Saw.) comb. nov.**
= *Helminthosporium setariae* Saw., 1912, *Formosa Dept. Agr. Bull.* 64 : 19.

Drechslera siliculosa **(Crouan) comb. nov.**
= *Helminthosporium siliculosum* Crouan in Crouan and H. M. Crouan, 1867, *Florule du Finestere*, p. 11.

Drechslera sorokiniana **(Sacc.) comb. nov.**
= *Helminthosporium sorokinianum* Sacc. in Sorok., 1890, Proc. biol. Soc. imp. *Univ. Kazan* 22 (3): 15.

Drechslera stenospila **(Drechsler) comb. nov.**
= *Helminthosporium stenospilum* Drechsler, 1928, *Phytopathology* 18 : 136.

Drechslera tetramera **(McKinney) comb. nov.**
= *Helminthosporium tetramera* McKinney, 1925, *U.S. Dept. Agr. Bull.* 1347 : 33.

Drechslera triseptata **(Drechsler) comb. nov.**
= *Helminthosporium triseptatum* Drechsler, 1923, *J. agric. Res.* 24 : 686.

Drechslera turcica **(Pass.) comb. nov.**
= *Helminthosporium turcicum* Pass., 1876, *Boll. Comiz. Agr. Parmense* 10 : 3.

Drechslera urochloae **(Putterill) comb. nov.**
= *Helminthosporium urochloæ* Putterill, 1954, *Bothalia* 6 : 365.

Drechslera victoriae **(Meehan & Murphy) comb. nov.**
= *Helminthosporium victoriæ* Meehan & Murphy, 1946, *Science* 104 : 413.

Drechslera yamadai **(Nisikado) comb. nov.**
= *Helminthosporium yamadai* Nisikado, 1928, *Spec. Rept. Ohara Inst. agric. Res.* 4 : 117.

Drechslera zeicola **(Stout) comb. nov.**
= *Helminthosporium zeicola* Stout, 1930, *Mycologia* 22 : 273.

Drechslera zizaniae **(Nisikado) comb. nov.**
= *Helminthosporium zizaniæ* Nisikado, 1928, *Spec. Rept. Ohara Inst. agric. Res.* 4 : 173.

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DEVELOPMENT OF DWARF STRAINS OF PEARL MILLET AND AN ASSESSMENT OF THEIR YIELD POTENTIAL

J. S. BAKSHI
Assistant Professor, Botany Division, I.A.R.I., New Delhi

AND

K. O. RACHIE AND AMARJIT SINGH
Geneticist and Research Associate respectively, The Rockefeller Foundation, New Delhi

THE introduction of dwarfing genes in wheat, rice and sorghum has revolutionized the concept of yield potentials attainable in these crops. These dwarfing genes reduce plant height without affecting reproductive or any other useful plant processes and thus permit the application of fertilizer and irrigation practices conducive to maximization of grain yield.

In the bajra (*Pennisetum typhoides* S. & H.) breeding program at the I.A.R.I., major portion of efforts was devoted to the development of dwarfs. For this purpose, a large number of Indian lines were crossed with four different dwarf stocks kindly supplied by Dr. G. W. Burton of Georgia, U.S.A. Progenies from these crosses were grown at Coimbatore and Delhi over different seasons to select the lines possessing desirable morphological characters as well as a wide range of adaptability. Several hundred stabilized dwarf inbreds ranging in height from 60 to 140 cm., having erect growth habit, upright leaves and large compact heads are now available. The most promising among these are being tested for their potentialities as breeding stocks and as commercial varieties. One of these stabilized inbreds, D. 174, was found to be particularly promising in Summer 1965 at Delhi and is now in the advanced stages of testing.

This inbred—D. 174—was developed from the cross D 2 × IP 81 and was sufficiently uniform for bulking in the F. 6 generation. In *Kharif* season at Delhi, it grows about 1 metre tall, with 5–7 synchronous tillers per plant. Its growth habit is erect and leaves are upright. Its maturity is comparable to other varieties like Pusa Moti and HB-1. During *Kharif* 1965, it was grown in a demonstration plot at the I.A.R.I. in rows 75 cm. apart with 15 cm.