Notes on the typification of *Gibberella zeae*

Keith A. Seifert*

Eastern Cereal and Oilseed Research Centre, Agriculture Canada, Research Branch, Ottawa, Ontario K1A 0C6 Canada

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Two isotype specimens of *Gibberella zeae* were examined, and a lectotype at Kew is selected. Illustrations and a description of the lectotype demonstrate that the contemporary usage of the name is accurate. The second isotype in Philadelphia lacks diagnostic fungal structures. There is no specimen in the Fries herbarium at Uppsala.

Keywords: taxonomy, lectotype, *Fusarium graminearum*.

In 1985, a Subcommittee on *Fusarium* Systematics was established by the International Society for Plant Pathology. Part of the terms of reference of this subcommittee is to examine the available type specimens of all described *Fusarium* species and their associated teleomorphs. The intention is to stabilize nomenclature by determining whether the type specimens actually represent the species that are currently designated by the names. There are several challanges inherent in this task. The first is locating the type specimens, a process that is problematic for some *Fusarium* workers who lack classical taxonomic training. The second is interpreting herbarium specimens on natural substrates in the context of a modern taxonomy based almost entirely on *in vitro* characters. There is a certain irony in this latter situation. Much effort has been expended in the history of *Fusarium* taxonomy on essentially duplicating the conditions of nature in a Petri dish, a process given the term *Hochkultur* (Appel & Wollenweber, 1910). The actual morphology and anatomy of the fungi, however, has rarely actually been studied *in vivo*, and the descriptions and illustrations now widely used are based entirely on *in vitro* observations.

Gibberella has never been monographed, and although descriptions of some species are available (eg. Booth, 1971; Nirenberg, 1976), there is uncertainty about whether the type specimens, particularly of the 'classical' species, were considered in constructing

* Email: seifertk@em.agr.ca

the descriptions and designating the names. *Gibberella zeae* (Schw.) Petch (anamorph = *Fusarium graminearum* Schwabe), produces deoxynivalenol (=DON or vomitoxin) and zearalenone, and is one of the most important mycotoxigenic fungi. The diseases caused by this fungus included Fusarium head blight of wheat and Gibberella ear rot of maize (Miller, 1994).

Schweinitz (1822) placed the fungus in the large genus *Sphaeria*, and the original description was characteristically brief:

"234. Zeae. Sz.

S. minuta aggregata conferta conica tuberculosa sulcata atra, intus succo repleta, villo albicante circumdata.

Frequentissime provenit ad Zeae caulium emortuorum nodos vere et eos inquinat. Atra quasi rubescens. Siccata quasi spinulosa redditur."

Few of these details are useful for recognizing the fungus unequivocally and no illustration was provided. The maize substrate and the black, aggregated 'sphaeriae' are all consistent with the fungus now called *G. zeae* and give clues what fungus to look for on the type specimen. This paper reports observations on the original collection of *G. zeae* that was used by Schweinitz in his description of the species.

Materials and methods

To prepare for sectioning, perithecia from herbarium specimens were soaked in distilled water overnight, and then transferred to Microm Freezing Agent (the compound provided for embedding and freezing of specimens by the manufacturers of the microtome) for a further 12-24 hours. The specimens were aligned so that sections would be cut perpendicular to the plane of the substratum. Sections were cut on a Microm HM 500 N Cryostat Freezing Microtome at 10 mm thickness, collected in water, and then mounted in 85% lactic acid.

Herbarium abbreviations are from Holmgren & al. (1990).

Taxonomic part

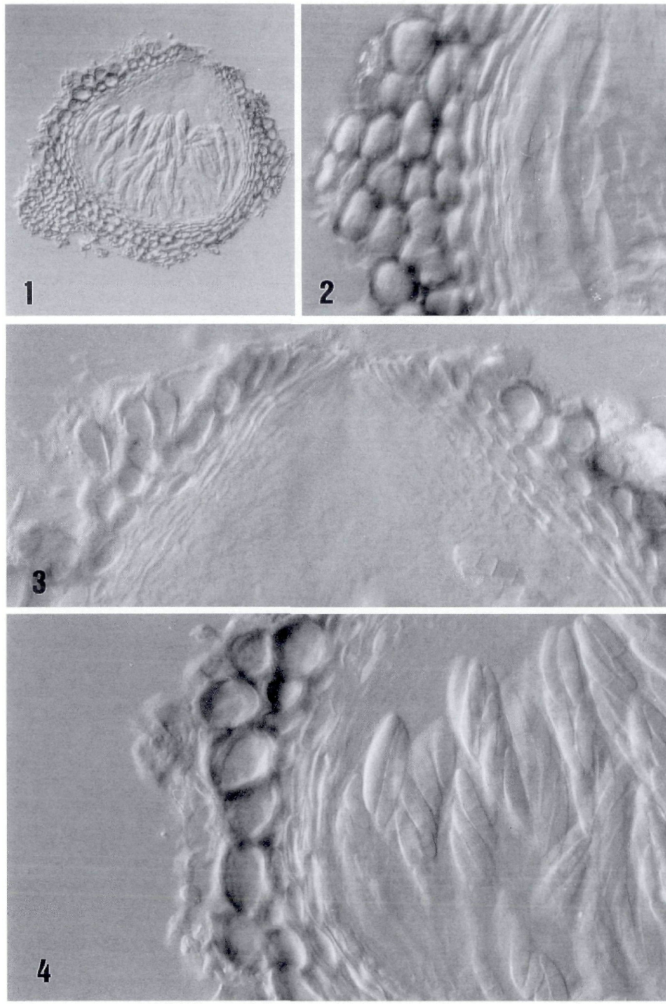
Gibberella zeae (Schweinitz) Petch, Ann. Mycol. 34: 260. 1936.
≡ *Sphaeria zeae* Schweinitz, Synopsis fungorum Carolinae superioris p. 48. 1822.

Two isotype specimens of *S. zeae* Schweinitz were located. The Fries herbarium at UPS, where some Schweinitz's specimens are

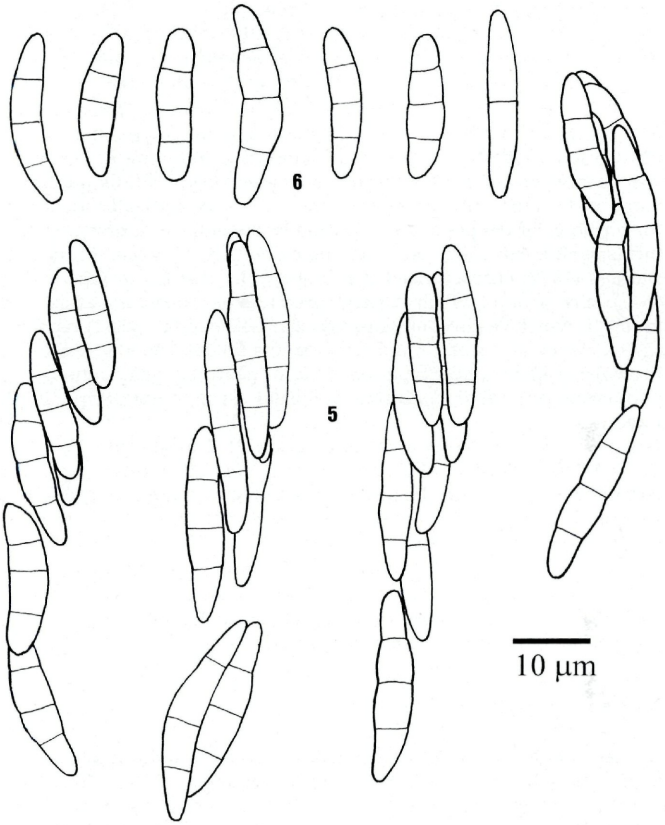
located, has no specimens of *S. zeae* (or any of its synonyms) originating from Schweinitz. Most of Schweinitz's herbarium is maintained in Philadelphia (PH). There is only one specimen labelled *S. zeae* in PH, which is marked "*Sphaeria Zeae* – Schw. Salem-Beth. 1457-3-6-Syn. Fung." There are no perithecia left on the specimen, only black, erumpent stromatal structures on a piece of *Zea* stem. Sections reveal no evidence of subepidermal ascomata or conidiomata. No spores or fertile structures were seen. These structures probably are the remains of the basal stroma from which perithecia have broken off.

Schweinitz sent specimens of many of his species to Berkeley. These specimens are maintained at Kew (K) and are usually considered isotypes of Schweinitz' species. In the Berkeley herbarium is a specimen marked, "*Dothidea Zeae*, L. v. S., Herb. Schwein., Herb. Berk. 1879." A note, presumably by C. L. Shear, is enclosed in the packet and states "This is apparently a part of Schw. type of *Sphaeria zeae* Syn. Fun. Car. no. 234. = *Dothidea zeae* Schw. No. 4 = *Gibberella Saubinetii* Mont. C. L. S. cf *Sph. zeae* spec. with Curry's note. Petch (1936, p. 259) also considered this specimen to represent Schweinitz material, and it can therefore be treated as an isotype. Because this specimen is apparently the only Schweinitz material containing perithecia, it is here designated as lectotype of *S. zeae* Schw.

The specimen consists of a piece of maize stalk glued to the sheet. A small number of globose, black perithecia are visible, 150–175 µm diam. ($\bar{x}$ = 167 µm diam.), either solitary or in groups of up to 6, laterally pinched or not collapsed, with smooth to slightly warty walls. In section (Figs. 1–4), the perithecial wall is 25–50 µm wide and is in three layers. The outer pigmented layer (Figs 2, 4) is 8–35 µm and 1–5 cells thick and is composed of globose, ellipsoidal or angular cells that are red in lactic acid and have walls up to 2.5 µm thick; in surface view, these cells are 14–27.5 x 9–20 µm. The middle layer (Figs. 2, 4) is unpigmented, 6.5–13 µm and 1-3 cells thick and composed of somewhat elongated to ellipsoidal, compressed cells 7–20 x 2–4.5 µm, with a somewhat reduced lumen and cell walls 0.5–2 µm thick. The inner layer, next to the lumen (Figs. 2, 4), is 4–7 µm thick and is composed of collapsed, elongated thin-walled cells. The cells around the ostiole (Fig. 3) are vertically elongated hyphal elements from the middle and outer wall, forming a flattened disk around the ostiole. Since only one perithecium was sectioned, no details of the stroma were observed. Periphyses line the ostiolar canal and are thin-walled, presumably gelatinous, 2–2.5 µm wide, and visible only with phase contrast. Asci (Figs. 4, 5, 6) are 8-spored and produced from the base of the centrum, and are clavate, 56–70 x 8–11.5 µm ($\bar{x}$ = 64.3 x 9.9), with a simple apex, thin walled, completely filled with ascospores. The ascospores are smooth-walled, unpigmented or slightly brown,



Figs. 1–4. – Transverse section of perithecium of *Gibberella zeae*, lectotype specimen in K, differential interference contrast. – 1. Entire perithecium, x 160. – 2. Detail of lateral wall, x 640. – Fig. 3. Detail of cells around ostiole, x 640. – 4. Detail of lateral wall, with asci in centrum, x 640.



Figs. 5, 6. – Camera lucida drawings of ascospores of *Gibberella zeae*, lectotype specimen in K. – 5. – Ascospores in groups of 8. – 6. Loose ascospores.

uniseriate near the base of the ascus, but biseriate in the upper 2/3 of the ascus. The ascospores in the asci (Fig. 5) are fusiform to allantoid, 19.5–29 x 3.5–4.5 µm ($\bar{x}$ = 24.7 x 4.1), L/B 4.7-8.3, mostly 3 but sometimes 1-septate, sometimes slightly constricted at the central septum. No sporodochia or conidia were seen on the specimen.

The fungus represented by the Kew lectotype specimen of *G. zeae* is recognizable as the species now known by that name as described

by Booth (1971). The sizes of the the ascomata, asci and ascospores are consistent with Booth's description, as are the anatomical details. The other species of *Gibberella* likely to occur on maize, *G. fujikuroi sensu lato*, has shorter, generally 1-septate ascospores (Booth, 1971).

The most recent International Code of Botanical Nomenclature (Greuter & al., 1994) allows the designation of an epitype specimen or illustration (Art. 9.7), intended to support a holotype or lectotype specimen when „original material associated with a validly published name is demonstrably ambiguous and cannot be critically identified for purposes of the precise application of the name of a taxon." Some infraspecific variation has been noted within *G. zeae*. Francis & Burgess (1977) characterized two biologically distinct groups within the species, group I which „rarely" produces perithecia in nature, and group II, which readily forms perithecia. Cullen & al. (1982) reported the existence of a small number of strains (about 5%) that exhibit a brownish-yellow phenotype on potato dextrose agar amongst a population of strains exhibiting the usual carmine phenotype. In all likelihood, the lectotype of *G. zeae*, had it been cultured, would represent the carmine phenotype of group II. Despite this, however, there is no evidence at this time that the interpretation of the lectotype of *G. zeae* can be considered ambiguous (even if 'group I' is eventually considered a separate species), and therefore I have chosen not to designate an epitype at this time.

Therefore, despite the depauperate condition of one of the isotypes, and the lack of a recognizable anamorph, *S. zeae* Schw. is well represented by its lectotype specimen in K, and contemporary application of the name is thus confirmed.

Notes on synonyms

No validly published synonyms of *G. zeae* are so far known. Prior to the study by Petch (1936), *Gibberella saubinetii* (Mont.) Sacc. was the name widely employed for the fungus considered here. Petch (1936) demonstrated that the two fungi were different, and *G. saubinetii* is now considered a synonym of either *G. pulicaris* (Fr.) Sacc. (anam. *F. sambucinum* Fuckel), or if *F. sulphureum* Schlecht. is considered distinct from *F. sambucinum*, then *G. cyanogena* (Desm.) Sacc. (Booth, 1971). One putative synonym of *G. zeae* mentioned by Petch (1936), *Dothidea glumarum* Berk. & M. A. Curtis, is apparently a *nomen nudum*; I have found no evidence of valid publication of the name. The specimen with this name in Berkeley's herbarium at Kew consists of three bits of wheat spikelets completely covered with blackish perithecia. Most perithecia are empty, but their size and anatomy are consistent with that reported above from the lectotype of

G. zeae. Loose ascospores associated with the perithecia are identical to those of *G. zeae*. Wollenweber (1917) examined several specimens under other names attributable to *G. zeae*, but none of these were considered type or authentic for those names.

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