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Morphology of infection structures of Puccinia striiformis var. dactylidis

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Abstract

The yellow rust fungus *Puccinia striiformis* var. *dactylidis* of cocksfoot differs clearly in the morphology of infection structures from both the nominate form, var. *striiformis* of wheat, barley and *Elymus* and var. *striiformis* f.sp. *poae* affecting *Poa pratensis*. The observations are in accordance with the idea that var. *dactylidis* and var. *striiformis* f.sp. *poae* are two distinct not closely related taxa within *P. striiformis*.

The yellow rust fungus (*Puccinia striiformis* Westend.) occurs on a wide range of gramineous genera in most of the cooler regions of the world (Stubbs, 1985). Some authors distinguish a number of formae speciales within the species (Zadoks, 1961; Newton et al., 1985, 1986), others consider the specialization within the species not fixed and prefer to recognize races only (Urban, 1969; Boerema and Verhoeven, 1977). Two forms, however, have been described, that deviate from the most common form, *P. striiformis* var. *striiformis*. In 1960, Manners (1960) described the form infecting cocksfoot (*Dactylis glomerata* L.) as a separate variety, *P. striiformis* var. *dactylidis* Manners. It differs from the yellow rust fungus of other Gramineae by its smaller spores and ability to tolerate higher temperatures. A second deviating form, also tolerating higher tempeatures, is the yellow rust on *Poa pratensis* L. (Tollenaar and Houston, 1967). This form is named *P. striiformis* var. *striiformis* f.sp. *poae*. This form is not considered to differ morphologically from the main variety, var. *striiformis*, e.g. in spore dimensions. Otherwise it would have been raised to the rank of variety as with *P. striiformis* var. *dactylidis*. The form is found on various *Poa* species, but not on *Poa annua* (Ullrich, 1977), and is believed to have reached Europe recently (Ullrich, 1976).

Further evidence for a separate status of *P. striiformis* f.sp. *poae* was found in a study on the morphology of infection structures of various rust species and forms (Niks, 1986). The morphology of the substomatal vesicle and primary infection hyphae of f.sp. *poae* differed clearly from that of isolates of var. *striiformis* obtained from barley, wheat, *Elymus* (Niks, 1986) and *Bromus* (Niks, unpublished data).

In August 1988 there was a mild epidemic of var. *dactylidis* in cocksfoot in the surroundings of Wageningen. The morphology of the infection structures of this taxon was determined and compared with that of f.sp. *poae* and of the other ff.spp. of var. *striiformis*. Also the urediospore dimensions of the forms were determined. Comparison of the forms for these characters could give indications whether or not the var. *dactylidis* and f.sp. *poae* are closely related forms within *P. striiformis*.

Inoculum of var. *dactylidis* was collected from a road side vegetation and applied by a needle to the primary leaf of a seedling of barley line L94. The plant was incubated in a humid greenhouse compartment overnight (16 °C). On the second day after inoculation, at 11.30, the inoculated segment was collected, cleared and stained. All these methods are described in detail in Niks (1986).

Thirty infection units of var. *dactylidis* were screened, using phase contrast microscopy at ×1000. Observations were carried out as described before (Niks, 1986). A representative sporeling was drawn and photographed (Figs. 1A, 2A).

The infection units of var. *dactylidis* lacked an appressorium, as is typical of *P. striiformis* var. *striiformis*. The substomatal vesicle was globular to oval. The diameter of the vesicle was about 20 μm. The vesicle had two to five (average 3.4) primary infection hyphae, arising from various places on the vesicle. The hyphae were club shaped, being narrowest, sometimes constricted, at the basis. The hyphae were running parallel to the plane of the epiderm. The average diameter of the hyphae was 4.2 μm (range 3 to 5 μm). The haustorial mother cells were unlobed, cylindrical with a rounded tip.

Together with var. *dactylidis*, infection structures of var. *striiformis* f.sp. *poae* were examined. The latter from was abundantly present in 1988. The observations on f.sp. *poae* confirmed earlier findings (Niks, 1986), that the substomatal vesicle of this form collapses after the cell contents had been transferred to an irregularly shaped body in deeper mesophyll layers (Figs. 1B, 2B, 2C).

Sporelings of the isolate of var. *dactylidis* differed from var. *striiformis* (Niks, 1986 and unpublished data) (Fig. 1C, 2D) by the thinner hyphae, and much lower tendency to form swellings in the primary infection hyphae. Only one out of the thirty sporelings

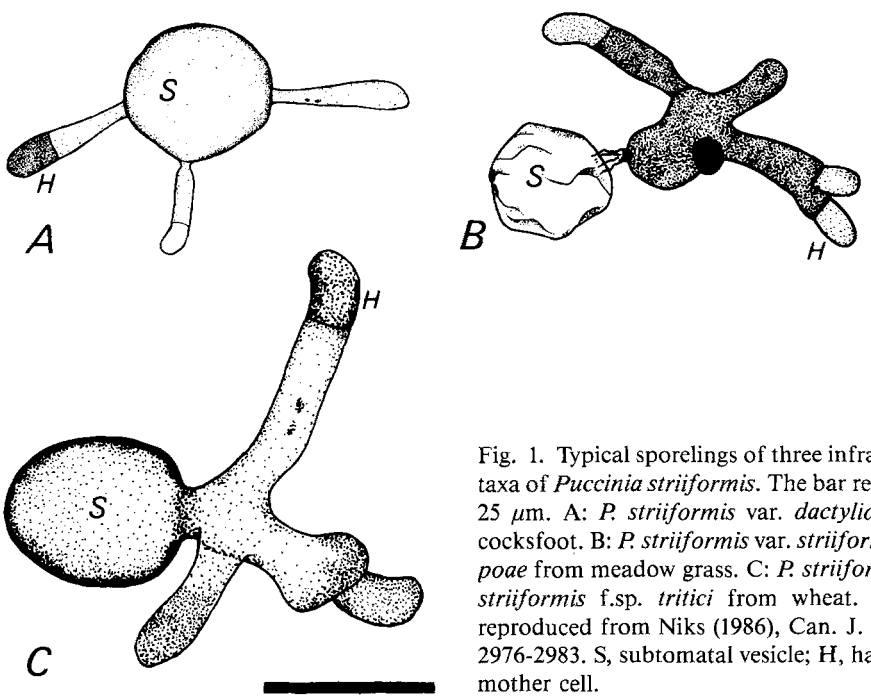

Fig. 1. Typical sporelings of three infraspecific taxa of *Puccinia striiformis*. The bar represents 25 μm. A: *P. striiformis* var. *dactylidis* from cocksfoot. B: *P. striiformis* var. *striiformis* f.sp. *poae* from meadow grass. C: *P. striiformis* var. *striiformis* f.sp. *tritici* from wheat. Fig. 1B reproduced from Niks (1986), Can. J. Bot. 64: 2976-2983. S, subtomatal vesicle; H, haustorial mother cell.

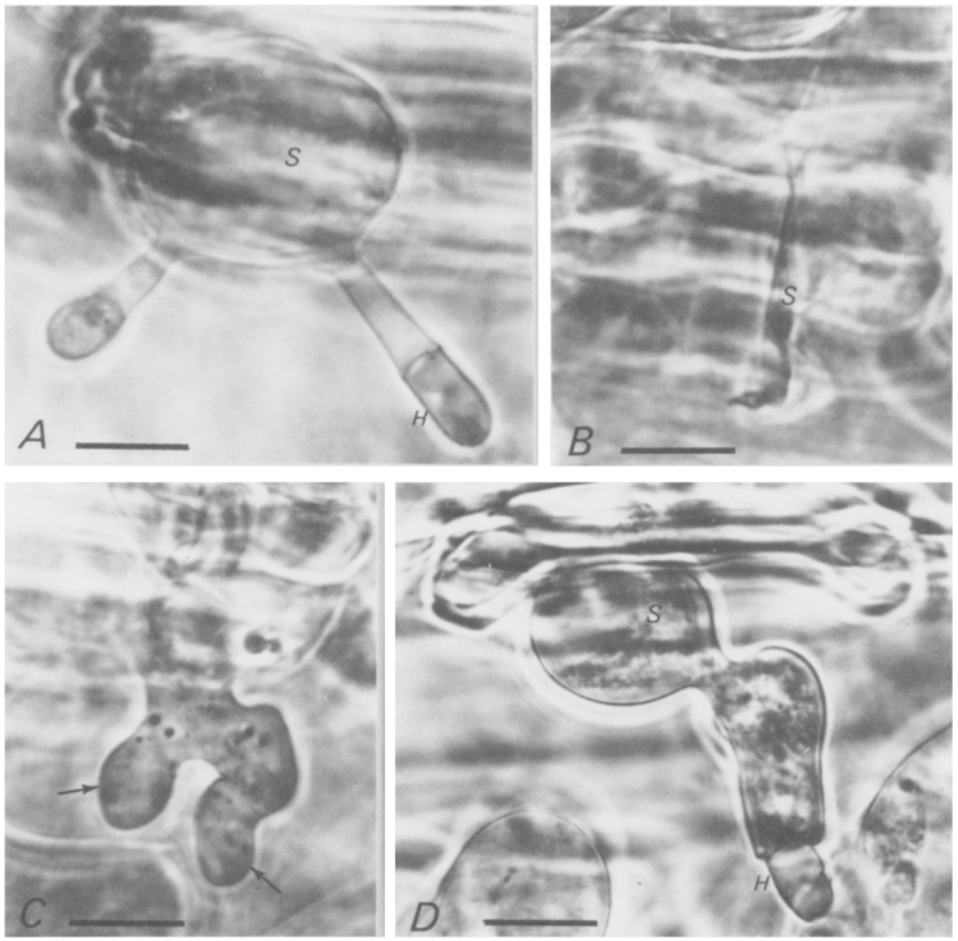

Fig. 2. Micrographs of mycelial structures of three infraspecific taxa of *Puccinia striiformis*. The bar represents 10 μm. A: *P. striiformis* var. *dactylidis* from cocksfoot. B and C: *P. striiformis* var. *striiformis* f.sp. *poae* from meadow grass. Completely collapsed substomatal vesicle (Fig. B) and primary infection hyphae (arrows) (Fig. C). D: *P. striiformis* var. *striiformis* f.sp. *tritici* from wheat.

Fig. 2D reproduced from Niks (1986), Can.J.Bot. 64: 2976-2983. S, substomatal vesicle; H, haustorial mother cell.

of var. *dactylidis* had swollen hyphae at the basis of the haustorial mother cells. Var. *dactylidis* differed from both forms by the production of at least two infection hyphae from different sides of the substomatal vesicle. Both other forms are unipolar.

Dimensions of thirty urediospores of freshly collected samples of var. *dactylidis* and f.sp. *poae* and of stored samples of three isolates of var. *striiformis* obtained from wheat, barley and couch-grass (*Elymus repens* (L.) Gould, syn. *Agropyron repens* (L.) Beauv.) were determined. The latter three isolates, 60113, 62021 and 60097, were kindly provided by Dr R.W. Stubbs and co-workers, Research Institute for Plant Protection, Wagen-

Table 1. Average length and width of thirty urediospores of five isolates of *Puccinia striiformis*.

Taxonomic status of the isolate	Urediospore dimensions (μm)[1]	
	length	width
P. striiformis var. *striiformis* f.sp. *tritici*	27.1a	23.6a
P. striiformis var. *striiformis* f.sp. *agropyri*	25.5b	21.9b
P. striiformis var. *striiformis* f.sp. *hordei*	24.0c	19.6c
P. striiformis var. *striiformis* f.sp. *poae*	23.8c	19.8c
P. striiformis var. *dactylidis*[2]	23.4c	19.8c

[1] Per column different letters indicate a significant difference ($P \leqslant 0.05$) according to Duncan's multiple-range test.
[2] IVP32 in the Rijksherbarium, Leiden, the Netherlands.

ingen. All five isolates were hydrated in Petri dishes provided with moist filter paper for 24 h. At night the lids were removed to prevent germination.

The data (Table 1) confirm Manners' (1960) observation that var. *dactylidis* has smaller spores than var. *striiformis* from wheat. the dimensions of the samples in our study, however, are about 10 to 20% greater than those given by Manners. Within var. *striiformis* there are significant differences in average spore size (Table 1). Var. *dactylidis* did not differ significantly from var. *striiformis* f.sp. *hordei* and f.sp. *poae* in spore size.

The data on the morphology of the infection structures and on the spore dimensions of var. *dactylidis* are based on observations on one isolate only. In order to determine the possible variation between isolates of var. *dactylidis* it is necessary to study isolates from various locations and years.

The morphology of the infection structures of the isolate of var. *dactylidis* is in accordance with its distinct taxonomic status within *Puccinia striiformis* as proposed by Manners (1960). Despite their similar tolerance for higher temperatures (Manners, 1960; Tollenaar and Houston, 1967) and similar urediospore dimensions (Table 1), var. *dactylidis* and var. *striiformis* f.sp. *poae* do not appear to be particularly closely related forms within *P. striiformis*, since they differ clearly in morphology of the infection structures (Figs. 1A, 1B). Due to its unique mycelial morphology it may be justified to give f.sp. *poae* the rank of variety.

Samenvatting

Morfologie van infectiestructuren van Puccinia striiformis var. dactylidis

In de morfologie van de infectiestructuren verschilt de gele-roestschimmel *Puccinia striiformis* var. *dactylidis* van kropaar duidelijk van zowel de nominaatvorm, var. *striiformis* van tarwe, gerst en kweekgras, als van var. *striiformis* f.sp. *poae* die beemdgrassen aantast. De waarnemingen steunen de opvatting dat var. *dactylidis* en var. *striiformis* f.sp. *poae* twee onderscheiden en niet nauwverwante taxa zijn binnen *P. striiformis*.

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