Morphological adaptation and spore pleomorphism in the form-complex *Dichomera-Camarosporium* and *Fusicoccum-Dothiorella*

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Affinities between morphologically different form-taxa of some Deuteromycetes were demonstrated with the aid of cultural experiments. The conidiomata of *Camarosporium oreades* and *Dichomera saubinetii* differed only in the presence or absence of a pseudoparenchymatous stroma. This was similarly the only difference between *Dothiorella* cf. *aesculi* and *Fusicoccum* cf. *aesculi*. All the form-taxa examined were able to produce two different types of spores, together with intermediate forms.

Keywords: oak-inhabiting fungi, Pleomorphism, *Camarosporium oreades*, *Dichomera saubinetii*.

The existence of more than one distinct morphological state within a single fungal species is a well known phenomenon, and there are many species in which the development of one state or another is known to be influenced by environmental factors. In particular, the nature of the growth substrate can be of paramount importance for morphological features (v. Arx, 1981; Butin, 1981; Klebahn, 1918; Sutton, 1980).

The present study was undertaken to confirm observations of the close association in nature of certain form-species of oak–inhabiting fungi, for which initial indications exist that they might represent modified stages of a single biological species. The taxa concerned belong to the *Dichomera-Camarosporium* form-complex and the *Fusicoccum-Dothiorella* form-complex.

Material and methods

Fresh leaf and twig samples from *Quercus robur* were collected from different sites in the field. Details of the collected material were as follows:

- Sample group **A**: branches of *Quercus robur* of different age with necrotic bark, Wienhausen/Celle, 21. 03. 1979; three-year-old feathered *Q. robur*, Bonn 17. 02. 1992.
- Sample group **B**: leaves of *Q. robur* with necrotic spots, approx. 20 samples, Braunschweig, collection period July–September 1991.

The remaining samples were exsiccata from the Institut für Pflanzenschutz im Forst (BBA).

For microscopic studies, leaf and bark samples were embedded in glycol-methacrylate (GMC) and sections of approx. 4 µm thickness were cut with a microtome. The sections were stained in thionine (0. 1% aqueous solution) and mounted in a proprietary medium (Entelan). For cultural studies, colonies of each fungus were grown from single spores on malt agar (1% malt) and kept at room temperature. Microtome sections of the conidiomata which developed in culture were prepared according to the methods described above and then examined with a microscope. Micrographs were taken with a Leitz-Aristoplan with a Wild MPS camera attachment.

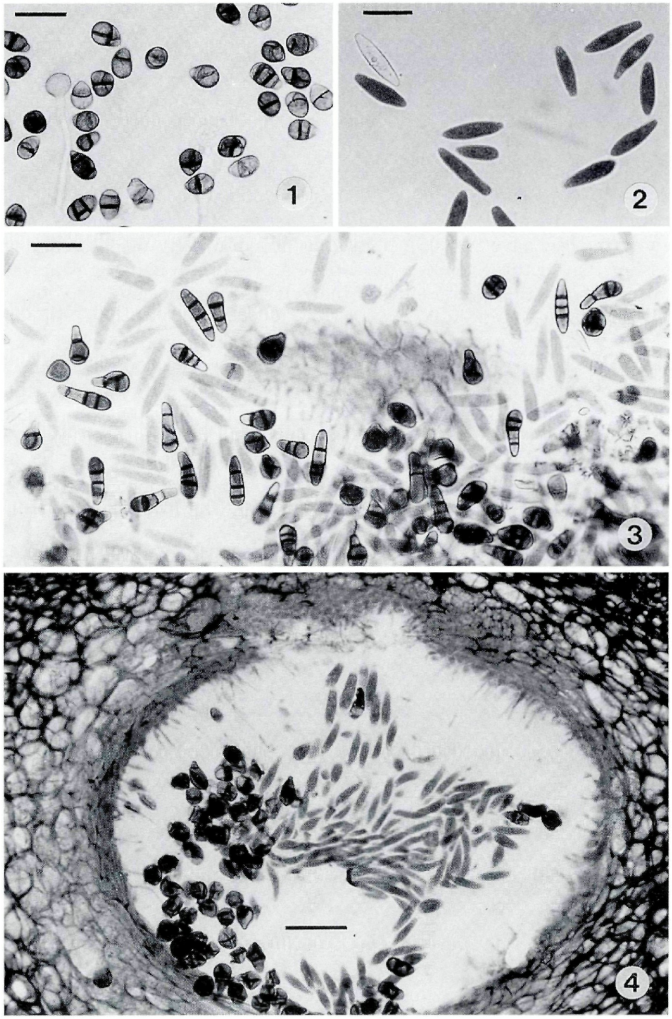
Results

On the bark of the sample group **A** stromatic fruit-bodies were present in which brown, muriform, 10–14 x 6–9 µm large conidia developed in loculi. On the basis of the above character-state combination this form can be placed in *Dichomera saubinetii* (Fig. 1).

The conidiomata of *D. saubinetii* were sometimes accompanied by similar structures immediately adjacent, but with their locules occupied by an entirely different spore-type (Fig. 2). These other spores, which were hyaline, fusiform, one-celled and 16–24 x 4–6 µm in size corresponded to those of *Fusicoccum* cf. *aesculi*. Sometimes it was found that conidiomata of *D. saubinetii,* resp. *F.* cf. *aesculi* contained spores intermediate between the pigmented muriform conidia and the hyaline aseptate conidia. These intermediate spores either resembled those of *Fusicoccum*, except for having a brown colouration and multiple transverse septa, or resembled those of *Dichomera*, but were club-shaped. Photographs of some of the spore-types are shown in Fig. 3.

During the studies of sample group **B** fruit-bodies were observed which could partly be placed in *Camarosporium oreades* and partly in *Dothiorella* cf. *aesculi*.

Whilst comparing the fungal forms present on the bark and leaves it was ascertained that *Dichomera saubinetii* (on bark) possesses the same spores as *Camarosporium oreades* (on leaves), but a pseudoparenchymatous stroma was absent in the latter. Equally a similar connection in the resemblance of spores and the presence or absence



Figs. 1–4. Spores of *Dichomera saubinetii* and *Fusicoccum* cf. *aesculi*. – 1. Spores of *D. saubinetii*. – 2. Spores of *Fusicoccum* cf. *aesculi* (stained in aniline blue). – 3. Spores of the *Dichomera* and *Fusicoccum* types, mixed with intermediate spores in a naturally formed pycnidium. – 4. Cross-section through a locule of a conidioma formed on malt agar. The locule contains spores of *Dichomera saubinetii* as well as those of *Fusicoccum* cf. *aesculi*; origin: monosporous culture of *Dothiorella* cf. *aesculi*. (1–3: scale bar = 20 µm; 4: scale bar = 40 µm).

of a pseudoparenchymatous stroma was observed in *Fusicoccum* cf. *aesculi* (on bark) and *Dothiorella* cf. *aesculi* (on leaves). Due to the resemblance of different spores and fruit-bodies there are reasons for assuming that close relationships among the separate forms must exist.

For final evidence, cultural studies were undertaken using monosporous cultures from the bark-inhabiting *Dichomera saubinetii* and *Fusicoccum* cf. *aesculi*, as well as from the leaf-inhabiting *Camarosporium oreades* and *Dothiorella* cf. *aesculi*. On malt agar, all four spore sources gave rise to a light grey-brown mycelium. All colonies assumed after three weeks a dark-brown colour and had a grey aerial mycelium. On the reverse sides of the Petri-dishes, the cultures appeared dark-blue to black.

The cultures produced stromatic structures after six weeks. These were elevated, irregular in shape, approx. 1 mm across and contained pigmented muriform conidia (*Dichomera* spore-type) or hyaline, aseptate, fusiform conidia (*Fusicoccum* spore-type). The suspicion that the different spores merely represented various stages of maturity was ruled out of the question. A substantial proportion of individual locules contained both spore forms (Fig. 4). Under UV light, some cultures also produced mycelium knots containing microspores 3 x 1. 5 µm in size.

The cultural data confirmed the suspicion that all forms examined belong to the same fungus, although they produced different spores and different fruit-bodies. The entire form-complex is presented in Tab. 1.

Tab. 1. – Morphological characteristics of the form-complex *Dichomera saubinetii/Fusicoccum* cf. *aesculi–Dothiorella* cf. *aesculi/Camarosporium oreades*.

	Dichomera saubinetii	*Fusicoccum* cf. *aesculi*	*Dothiorella* cf. *aesculi*	*Camarosporium oreades*
Conidioma	stromatic, multilocular	stromatic, multilocular	pycnidial, unilocular	pycnidial, unilocular
Conidia	muriform, brown, 10–14 x 6–9 µm	aseptate, hyaline, 16–24 x 4–6 µm	aseptate, hyaline, 16–24 x 4–6 µm	muriform, brown, 10–14 x 6–9 µm
Substratum	bark	bark	leaves	leaves

Discussion

The present study demonstrates that the form-complexes *Dichomera–Camarosporium* and *Fusicoccum–Dothiorella* include phenotypic variants of a single biological species, and that expression of the features separating apparently different form-species within this complex is strongly determined by the growth substrate. This applies

especially to the presence or absence of a pseudoparenchymatous stroma.

Dichomera saubinetii and *Fusicoccum* cf. *aesculi*, which are the forms producing conspicuous stromata, are both bark-inhabiting form-species (Sutton, 1980; Butin, 1981; Ellis & Ellis, 1985). These fungi, however, have apparently adapted to colonize also leaves. In the leaf-inhabiting forms, represented by *Camarosporium oreades* and *Dothiorella* cf. *aesculi*, the stroma has become reduced, eventually becoming absent so that the fungus is able to form simple pycnidia. Although the leaf-inhabiting forms do not form a pseudoparenchymatous stroma in the leaf tissue, they can do so on a suitable substrate, as evidenced by the production of identical locular stromata and spore type mixtures by all four form-taxa in culture.

The capacity of the form-genus *Dichomera* to show marked modification of its stroma-forming ability has previously been noted by Sutton (1980) who, in considering the different species described in *Dichomera*, stated that it . . . "has usually been interpreted as the stromatic analogue of *Camarosporium* Schulz". As an example he mentions *Dichomera gemmicola* Funk & Sutton, which is very frequently stromatic and only occasionally pycnidial. Sutton (1980) also noted that „If *Sclerotheca strobilinum* proves to behave in the same manner, it can be placed in *Dichomera* but if it is more consistently pycnidial, *Camarosporium* would appear to be a preferable genus". The same arguments may apply to the oak-inhabiting forms of *Dichomera* and *Camarosporium* examined in the present study. With regard to the factors that control morphological switching, Funk & Sutton (1972) state . . . "that the nature of the substrate in *Dichomera gemmicola* and *Sclerotheca strobilinum* must influence the development of pycnidia and stromatic conidiomata". We are inclined to take the same view in the case of *D. saubinetii* and *Camarosporium oreades* as well as in the case of *Fusicoccum* cf. *aesculi* and *Dothiorella* cf. *aesculi*.

Since no perfect fruiting state was found in association with the fungi examined in this study, it is not a simple matter to assign a teleomorph to these form-taxa or rather to the entire form-complex. On the grounds of analogous cases one is tempted to look for the teleomorph in the genus *Botryosphaeria*. For example, within *B. dothidea* anamorph stages have been described which are very similiar to *Fusicoccum* cf. *aesculi* and *Dothiorella* cf. *aesculi* (Spiers, 1977; English & al., 1975; Maas & Uecker, 1984; Sivanesan, 1984). However, in the literature no details of any possible connection with *Dichomera saubinetii* or *Camarosporium oreades* are mentioned. An assignment of the examined fungal forms to *B. dothidea* seems therefore, until a comparison of monospore cultures of the suspected teleomorph stage has been undertaken, not justifiable.

Apart from the above systematic questions, our morphological findings in the form-complex *Dichomera/Camarosporium–Fusicoccum/Dothiorella* demonstrate that some characters that have been used to separate taxa may be subjected to morphological adaptation to the host tissue. These include not only the nature of the conidiomata in this form-complex, but also a formerly unrecognized spore pleomorphism.

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