Studies in Erysiphales anamorphs (III): Conidiophore variability in *Oidium carpini**

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Kurzfassung
Studien an Erysiphales-Anamorphen (III): Variabilität der Konidiophoren bei *Oidium carpini
Die Morphologie des anamorphen Echten Mehltaupilzes *Oidium carpini* auf *Carpinus betulus* (Hainbuchenmehltau) wird mit Hilfe lichtmikroskopischer Methoden untersucht. Sämtliche morphologischen Merkmale werden durch Zeichnungen dokumentiert. Die Länge der Konidiophoren ist sehr variabel und hängt davon ab, auf welcher Blattseite sie gebildet werden. Die Bedeutung der Konidiophorenlänge als morpho-taxonomisches Merkmal und für die Bestimmung von Anamorphen Echter Mehltaupilze (Erysiphales) wird diskutiert. Die Art wurde erstmals für den Iran nachgewiesen.

Abstract
The morphology of the anamorphic hornbeam powdery mildew fungus *Oidium carpini* on *Carpinus betulus* is re-examined using light microscopy. All morphological features were documented by line drawings The conidiophore length is very variable and depends on which side of the leaf the conidiophores are formed. This variability is discussed with respect to the morpho-taxonomic value of conidiophore length and identification of anamorphic Erysiphales species. Furthermore, we report this species for the first time from Iran.

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Introduction

So far, the anamorphic Erysiphales species *Oidium carpini* Foitzik has been recorded in Asia (Armenia) and Europe (Braun 1995) on *Carpinus betulus* L. (Corylaceae). It was discovered for the first time in Germany in 1989 and described as a new species (Foitzik in Braun 1995). Since then, the species has been reported many times, especially in urban habitats on hornbeam hedges where it is apparently very common in Central Europe. Due to the appearance of this previously unknown species in great abundance, Scholler (1996) assumed it might be an introduced species. In the following we provide the results of a detailed re-study of the morphology of *O. carpini*.

Materials and Methods

Methods

Fresh material (which was dried afterwards and deposited in the herbarium KR) and dried herbarium samples were examined in tap water mounts by light microscopy. Pertinent features were measured at a magnification of 400 x or 1000 x and documented by line drawings. For individual specimens, lengths of 50 conidiophores were analysed and evaluated according to Frank (1990): the five values indicating the minimum, lower limit, arithmetic mean, upper limit and maximum value, respectively; lower and upper limits indicate the range of 95% of all values. To induce conidial germination, the method of Schmidt & Scholler (1992) was applied: Fresh conidia were sprinkled on a microscope slide and put in a Petri dish with moist cellulose tissue. The closed Petri dishes were incubated at room temperature and exposed to daylight through a north-sided window for 24 h.

Material examined

Oidium carpini on *Carpinus betulus*, material from Germany (DE) and Iran (IR).
Dried herbarium specimens:
DE, Sachsen-Anhalt, Sangershausen, mittlerer Jüdengrund 1 km SW Stolberg, 24 May 1989, leg. & det. O. Foitzik (JE, holotype); Mecklenburg-Vorpommern, Rügen: Heide-Berge 0.5 km SE Patzig, 6 Sep. 1989, leg. & det. O. Foitzik (JE). – IR, Gilan, 13 km W Asalem, creek, 17 June 2004, leg. M. Scholler & M. Abbasi, det. M. Scholler (KR 14861).

* Dedicated to Prof. Heinrich Rubner, author of „Die Hainbuche in Mittel- und Westeuropa“, on the occasion of his 80th birthday.

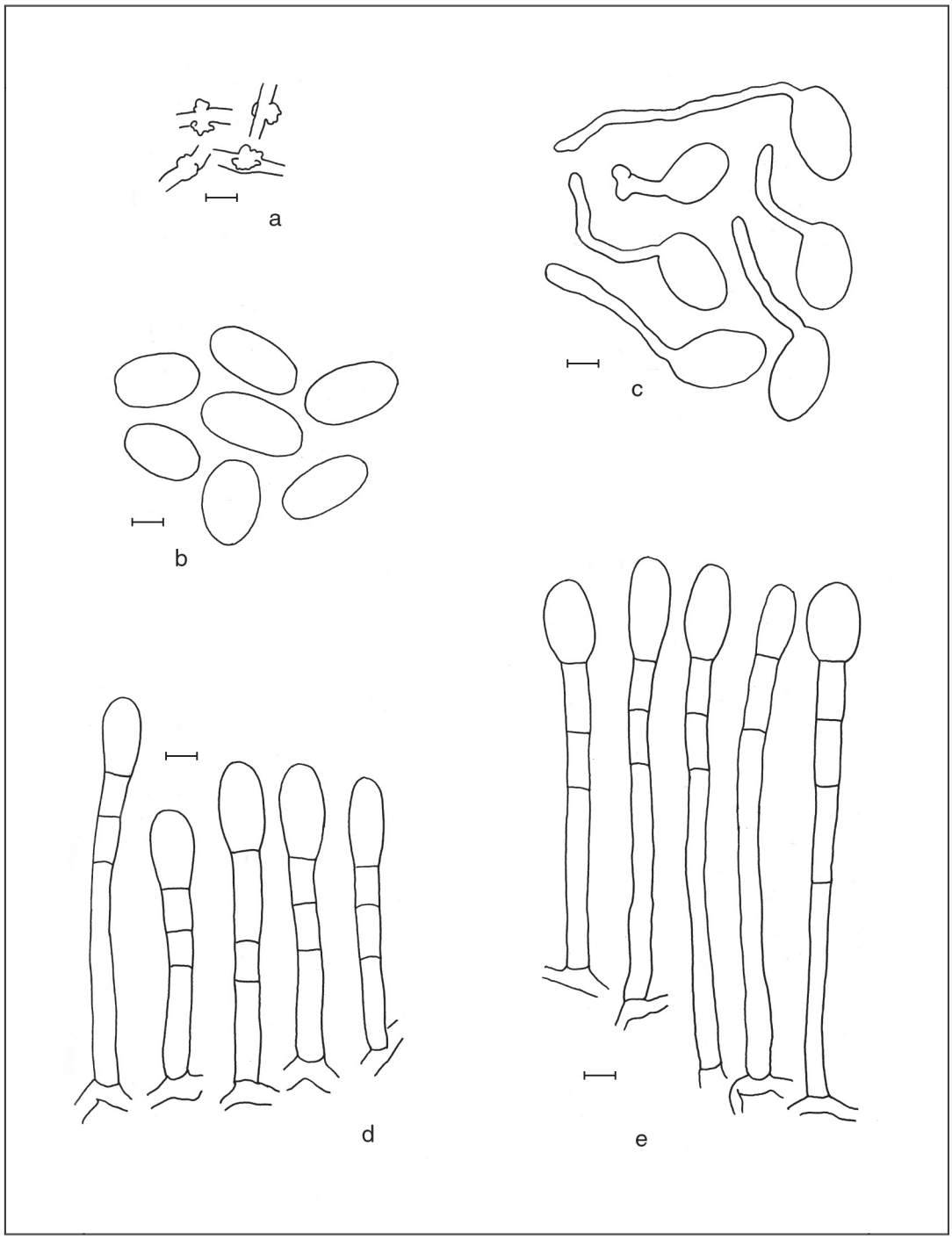

Fig. 1: *Oidium carpini* Foitzik (KR 15088). a. Appressoria, b. Conidia, c. Germinated conidia after 24 h in moist chamber cultures, d. conidiophores (epiphyllous), e. Conidiophores (hypophyllous). Bar:10 µm.

Fresh specimens:
DE, Schleswig-Holstein, Lübeck, Karlshof, Forstmeisterweg 41a, hedge, 29 Aug. 2003, leg. & det. A. SCHMIDT (KR 15088, and herb. A. SCHMIDT no. 179); Scharbeutz, Seestrasse 31/33, hedge, 19 Sep. 2003, leg. & det. A. SCHMIDT (KR 15089 and herb. A. SCHMIDT no. 181); Lübeck, Karlshof, Travemünder Allee 51, hedge at the entrance of Hotel Schweizerhof, 12 Aug. 2005, leg. & det. A. SCHMIDT (KR 15601, herb. A. SCHMIDT no. 209); Baden-Württemberg, Karlsruhe, Grünwinkel, Albsiedlung, Silcherstrasse, hedge, 12 Aug. 2005, leg. & det. M. SCHOLLER (KR 14146).

Results

Morphological description of the anamorph (based on fresh material).

Mycelium on leaves whitish to greyish white, amphigenous, but more often epiphyllous, subevanescent or persistent, covering the entire leaf surface, dense, especially around the leaf veins; hyphae branched, septate, 2–7 µm wide, colourless, thin-walled, smooth; appressoria numerous, lobed, mostly in pairs, 7–11 µm diam. (Fig. 1 a). Conidiophores one- to three-septate, (45–)50–170(–205) x (5–)6–10 µm, basal cell 12–80(–100) µm long, the longest of the conidiophore cells, the basal cell and the uppermost cells cylindrical or wider toward the base and the tip, respectively (Figs. 1 d, e). Conidia formed singly, ellipsoid, partly ovoid to doliiform, (25–)29.5–38(–40) x (13–)16–20.5 µm, length/width ratio (1.4–)1.6–2.0(–2.3), forming one non-septate or very rarely a one-septate, subapically inserted germ tube, measuring 20–100 x 3.5–6.5 µm, terminating in a simple, club-shaped or, particularly in short germ tubes, a lobed appressorium in moist-chamber cultures (Fig. 1 b, c).

Variability in conidiophore length

Differences in the length of conidiophores formed in epiphyllous and hypophyllous position are significant and could be confirmed for all specimens studied except for herbarium material KR 14861 (from Iran). In the holotype (from Germany), in which no conidiophores were available on the under side of the leaves.
Conidiophore lengths, epiphyllous versus hypophyllous, in two specimens from different localities: KR 14146: (49.0)46.7–61.9–77.1(82.5) µm (standard deviation s = 7.5) versus (87.5)85.1–144.1–203.1(205.0) µm (s = 29.4) KR 15088: (44.0)39.0–63.9–88.8(106.0) µm (s = 12.4) versus (82.0)84.4–134.5–184.5(186.0) µm (s = 24.9) (Fig. 1 d, e).
No major differences were found in other conidiophore features studied (shape, width, number of septa).

Discussion

Oidium carpini is recorded for the first time from Iran (see ERSHAD 1995) indicating that the species has a much wider geographic distribution and is probably of Asian origin. Our description fits well with the information provided in the protologue and provides further information on the germ tubes and the conidiophore length in particular.

We found minimum and maximum conidiophore length values varying between 44 µm (lower limit 39 µm) and 205 µm (upper limit 203 µm), respectively. In the protologue, the conidiophore length was given as 20–37(–50) µm. We found the conidiophores to be significantly longer in hypophyllous position.

We do not regard the difference in conidiophore length as a dimorphism, but rather a species-specific morphological variability. According to YARWOOD & GARDNER (1970), who studied North American species and made similar observations, the function of longer conidiophores on the under side may be a consequence of some physiologic or nutritive difference between the two leaf surfaces. It may also be part of an ecological strategy, and we speculate that this might facilitate a better wind dispersal of the conidia. The study of YARWOOD & GARDNER (1970) and our study with *Oidium carpini* indicate that such a variability may occur in numerous other species and future anamorph descriptions of new Erysiphales species and re-studies of known species should always be made for both sides when the mycelium is formed amphigenously. Possibly, conidiophore length in the Erysiphales is of less morpho-taxonomic importance than assumed by taxonomists so far.

There is a great difference between our measurements of the conidiophore length and the one provided in the protologue of *Oidium carpini*. FOITZIK (in BRAUN 1995) mentioned the formation

of amphigenous mycelium, but his description of rather short conidiophores indicates that the author probably measured conidiophores only from the upper leaf surface. This was confirmed by examining the holotype, on which we could not find lower surface mycelium.

Acknowledgements
For providing a loan of the holotype and further specimens of *Oidium carpini* we wish to thank the curator of herbarium JE (Jena).

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