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Studies on the biology and occurrence of *Ampelomyces quisqualis* in the Drawski Landscape Park (NW Poland)

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In the years 1996–1998, the occurrence of *Ampelomyces quisqualis* parasitizing powdery mildews (*Erysiphales*) affecting plants of 12 permanent plots with nine plant associations, as well as those of 32 agricultural fields and gardens of the Drawsko Landscape Park in north-western Poland was investigated. The plant associations of the 12 permanent plots were *Luzulo pilosae-Fagetum, Stellario-Carpinetum, Querco roboris-Pinetum, Leucobryo-Pinetum, Ribo nigri-Alnetum, Circaeo-Alnetum, Vaccinio ulginosi-Pinetum, Chenopodietea,* and *Artemisietea.* In the laboratory, the morphology of this hyperparasite, its pattern of colonization of powdery mildews, as well as the influence of cultural conditions on its growth and sporulation were determined. Of the 57 species of *Erysiphales* found in Drawsko Landscape Park, *A. quisqualis* parasitized 14 in three genera. Of them, nine species were for the first time found to be fungal hosts of *A. quisqualis* in Poland. This hyperparasite preferred the *Artemisietea* and *Chenopodiatea* plant associations, as well as plants of agricultural and horticultural areas, i. e., plants of warmer sites compared with the others considered in this study. The media favouring the growth and sporulation of *A. quisqualis* were Sabouraud agar and potato dextrose agar. The optimal temperature range for both growth and sporulation of *A. quisqualis* was 20–25°C.

Key words: *Ampelomyces quisqualis*, Drawski Landscape Park, in *in vivo* and *in vitro* development.

INTRODUCTION

Ampelomyces quisqualis Ces. (= *Cicinnobolus cesatii* de Bary) is considered to be a commonly occurring fungal hyperparasite, probably affecting all species of the order *Erysiphales*, the causal agents of powdery mildews of plants (Kiss and Vajna 1995; Madej and Antoszczyszyn 1963; Sundheim 1986). Numerous records in regions of both tropical and temperate climates indicate that this fungus is well adapted to a wide range of environmental conditions

(S u n h e i m 1982). However, in Poland, the incidence and importance of *A. quisqualis* in inhibition of the powdery mildew fungal agents are very poorly recognized. There are only a few records of this hyperparasite made during investigations concentrated mainly on the occurrence of powdery mildews (A d a m s k a et al. 1999; K u ć m i e r z 1976; M a d e j 1963; M a d e j and A n t o s z c z y s z y n 1965; M a j e w s k i 1970, 1972; M i c h a l s k i 1959; M u ł e n k o 1988).

According to K i s s and V a j n a (1995), little is known on the biology of *A. quisqualis* and the literature data show differences in both the morphology and physiology of the hyperparasite. Despite more than 40 species were described in the genus *Ampelomyces*, most taxonomists consider that *A. quisqualis* is the only species of this genus and that the differences observed represent a common variability of a single species. However, no literature data exist on the range of variability of morphological properties of *A. quisqualis* determined in controlled conditions.

According to J e f f r i e s and Y o u n g (1994), *A. quisqualis* is a biotroph in the initial stage of infection of powdery mildews and later a necrotroph. In the biotrophis stage, S u n d h e i m and K r e k l i n g (1982) found that the parasitism of both conidia and hyphae of powdery mildews was preceded by their penetration by appressorium-like structures formed by swollen distal ends of hyphae of the hyperparasite. No toxins excreted by *A. quisqualis* were found in this stage. Ultrastructural investigations of A b o - F o u l et al. (1996) showed that *A. quisqualis* inside the host cells penetrates from cell to cell by constricting its hyphae through the septal pores of the powdery mildew hyphae. The necrotrophic stage of parasitism of *A. quisqualis* begins the degeneration of host ultrastructure, which was suggested to be accompanied by the production of a range of extracellular enzymes found in *in vitro* investigations (P h i l l i p p 1985).

One of the valuable parks of Poland is the Drawski Landscape Park (DLP; F i j a ł k o w s k i et al. 1994). It is situated in the South of the Western-pomerania Voivodeship. Of the 695 species of the flora of DLP, 28 and 14 are entirely and partly protected, respectively. However, C z e r n i a w s k a ' s (2001) investigations suggested that the condition of vegetation of this park is highly affected by fungi of the order *Erysiphales* due to their frequent occurrence and the well known high destructiveness of the powdery mildew diseases caused.

Many literature reports showed that *A. quisqualis* effectively affected both conidial and ascogenous stages of the pathogens in both *in vivo* and *in vitro* conditions (F a l k et al. 1995; S u n d h e i m 1986). This hyperparasite reduced sporulation and production of cleistothecia and even killed the powdery mildew colony. Hence, F a l k et al. (1995) suggested that the wide fungal host range, common occurrence, and tolerance to many fungicides used in the control of powdery mildews (S u n d h e i m 1982) make *A. quisqualis* a highly attractive candidate for biological control of plants against the

important group of pathogens. Therefore, in the years 1996–1998, the colonization of powdery mildew fungi of plants of DLP by the hyperparasite *A. quisqualis* was investigated. Additionally, in laboratory experiments, the development and morphology of *A. quisqualis*, as well as the influence of cultural conditions on its growth and sporulation were determined. Such information will be important in attempts to protect the most threatened plant species of DLP.

MATERIALS AND METHODS

General data. The data on the location, vegetation, climatic conditions of DLP, distribution and properties of the study sites, as well as those regarding the methods of collection of diseased plants and identification of fungi are as those earlier presented (Czerniawska 2001). Briefly, DLP is situated in the South of the Westernpomerania Voivodeship of Poland (53°46–53°33'N, 16°6'–16°2'E). The occurrence of *A. quisqualis* was investigated on thalli of powdery mildews affecting plants of 12 permanent plots with natural vegetation and 32 agricultural fields and gardens. The area of each permanent plot was ca. 1 ha. The vegetation of the permanent plots was represented by nine plant associations classified according to Matuszkiewicz (1984). These were *Luzulo pilosae-Fagetum, Stellario-Carpinetum, Querco roboris-Pinetum, Leucobryo-Pinetum, Ribo nigri-Alnetum, Circaeo-Alnetum, Vaccinio ulginosi-Pinetum, Chenopodietea*, and *Artemisietea*. Plant species were recognized after Szafer, Kulczyński and Pawłowski (1969). Plant nomenclature and authorities are those of Mirek et al. (1995). Samples of diseased plants were collected three times in each year, in: July, August, and September.

The powdery mildew fungi were identified according to Braun (1987) and Hanlin (1990). *Ampelomyces quisqualis* was recognized according to Ellis and Ellis (1988) and Sutton (1980). The morphological properties considered were colour, shape, and dimensions of pycnidia and conidia. Colour names are from Kornerup and Wanscher (1983). The diagnostic properties of both powdery mildew fungi and *A. quisqualis* were determined using an OLYMPUS SZX9 dissecting microscope and an OLYMPUS BX50 compound microscope equipped with differential interference optics.

Inoculum source. The basal inoculum used in the experiments characterized below was a culture of *A. quisqualis* developed from a single spore in a Petri dishe containing potato dextrose agar (PDA, Difco Laboratories) with streptomycine (1 g per 1 l of the medium). The conidia came from pycnidia of *A. quisqualis* parasitising *Podosphaera leucotricha* (Ellis et Everh.) Salm affecting *Malus domestica*.

Development and morphological properties of *A. quisqualis*. The development and morphological properties of

A. quisqualis growing in *in vitro* conditions were determined based on cultures of this fungus growing on PDA with streptomycin in 10-cm-diameter Petri dishes. The cultures were maintained in room conditions. The properties selected were determined after one, two, and six weeks of incubation.

The development of *A. quisqualis* in *in vivo* conditions was determined based on infested powdery mildew fungi collected together with their plant hosts in Szczecin and DLP in the years 1996–1998. The species of powdery mildew fungi and their plant hosts considered were *Erysiphe cichoracearum* var. *cichoracearum* from *Tanacetum vulgare, Aster novi-belgii* and *Solidago canadensis; E. artemisiae* from *Artemisia vulgaris*, as well as *P. leucotricha* from *M. domestica.*

In vitro germination of *A. quisqualis* conidia. Conidia coming from abundantly sporulating PDA cultures of *A. quisqualis* were suspended in sterile water. Single droplets of this suspension were subsequently placed onto sterile microscopic slides maintained in humid chambers and the surface of PDA with streptomycin in 10-cm-diameter Petri dishes. The PDA dishes were vigorously shaken to disperse the spores over the surface of the medium. Each of the two treatments was replicated four times. Germination, germ-tube growing rate, and morphological changes of the germinating conidia were determined at 1-h intervals.

Influence of media on growth of *A. quisqualis.* Three basal media were used and compared for their ability to support *A. quisqualis* growth in culture. They were Sabouraud agar medium (SabA) with yeast extract, PDA, malt extract (Difco Laboratories, Detroid), and the medium formulated by Sudheim (1982). Four x four-mm pieces of culture of *A. quisqualis* taken from the actively growing zone of the basal culture were placed at the center on the surface of a tested medium in 10-cm-diameter Petri dishes. Each medium was represented by four dishes (replicates). Inoculated Petri dishes were maintained in room conditions. After 7, 21, and 42 days of culturing of *A. quisqualis*, the shape, structure, colour, diameter of the colonies produced, as well as the number of the pycinida formed were determined.

Influence of temperature on growth and sporulation of *A. quisqualis.* Four x four-mm agar pieces of culture cut from the actively growing zone of *A. quisqualis* cultures in PDA Petri dishes were placed at the center on the surface of PDA with yeast extract and streptomycin in 10-cm-diameter Petri dishes. The dishes were incubated at 5, 10, 15, 20, 25, and 30°C. The experiment was conducted in four replicates (Petri dishes). The growing rate and sporulation of *A. quisqualis* after 4, 7, 15, 22, and 35 days of cultivation were determined.

RESULTS

General data. The results of the occurrence of the causal agents of powdery mildews in 12 permanent plots with nine plant associations of DLP

were presented in a previous paper (C z e r n i a w s k a 2001). Briefly, a total of 1042 plant samples were collected. They represented 157 species in 39 plant families. The plant families most frequently examined were the *Asteraceae* (with 31 plant species), followed by the *Poaceae* (19) and *Rosaceae* (17). The plant species most frequently sampled were *Polygonum aviculare* and *Tanacetum vulgare*. Most genera of *Erysiphales* hosted plants of the *Luzulo pilosae-Fagetum* and *Artemisietea* plant associations (each 7), and least those of *Querco roboris-Pinetum* and *Chenopodietea* (each 4). Most species of *Erysiphales* were found in *Artemisietea* (22), followed by *Chenopodietea*, *Circaeo-Alnetum*, and *Ribo nigri-Alnetum* (each 16 species). The plant association harbouring the lowest number of powdery fungal species was *Querco roboris-Pinetum* (11). The highest number of species came from the genus *Erysiphe* (21), followed by *Sphaerotheca* (11) and *Microsphaera* (14). The genera represented by the lowest number of species were *Uncinula* and *Phyllactinia* (one species each). Most species of the genus *Erysiphe* were revealed in the *Artemisietea* plant association (12), followed by *Ribo nigri-Alnetum* (8) and *Chenopodietea* (7). The lowest species diversity of fungi of this genus was found in *Vaccinio uliginosi-Pinetum* (2).

O c c u r r e n c e o f *A m p e l o m y c e s q u i s q u a l i s*. Of the 57 species of *Erysiphales* found in DLP, *A. quisqualis* parazitized 14 in three genera of the order *Erysiphales* affecting 20 and 3 uncultivated and cultivated plant species, respectively. Of them, eight species were for the first time recognized to be fungal hosts of *A. quisqualis* in Poland. Most species of powdery mildews colonized by this hyperparasite came from the genus *Erysiphe* (9), whose members most frequently occurred in DLP (C z e r n i a w s k a 2001). This supports the conclusions of, e. g., F a l k et al. (1995) and S u n d h e i m (1986), that this hyperparasite is a widely distributed fungus with no host specificity.

Both the number of fungal hosts of *A. quisqualis* and the density of pycnidia produced by this hyperparasite were highest in 1997, and lowest in 1996. This did not correspond with the total number of species of *Erysiphales* found in DLP in the 3-year study (C z e r n i a w s k a 2001). Most species of the powdery mildew fungi were found in 1998, in which the mean annual temperature and the sum of rainfalls were higher by 0.6°C and 43.3%, respectively, compared with those of the years 1951 – 1980. Compared with the years 1951 – 1980, the year 1997 also was warmer (by 0.3°C), but much less humid; its sum of rainfalls was higher only by 13.4%. Thus, despite *A. quisqualis* is a stenothermal fungal species (P u z a n o w a 1984), the high rainfalls in 1998 may have washed down its spores from the thalli of the powdery mildews and, thereby, decreased the incidence of this hyperparasite. *Ampelomyces quisqualis* most frequently occurred in the synantrophic plant associations *Artemisietea* and *Chenopodietea*, as well as on powdery mildews of plants of agricultural and horticultural areas, i. e., warm and illuminated sites. Of the forestry sites considered, this hyperparasite was most frequently

encountered in the *Circaeo-Alnetum* and *Querco roboris-Pinetum* plant associations. *Ampelomyces quisqualis* was not found on powdery mildews of plants of the relatively cold and shaded *Stellario-Carpinetum* and *Vaccinio uliginosi-Pinetum* plant associations. This corresponds with the finding of, e. g., P u z a n o w a (1984) that *A. quisqualis* prefers warm sites.

The fungal hosts of *A. quisqualis*, their plant hosts, as well as the sites of their occurrence in DLP and other regions of Poland are presented below. The lack of information of an earlier record of *A. quisqualis* from a given powdery mildew fungus and its plant host indicates this paper to be the first report of the occurrence of such association in Poland. The data given after a plant host of a powdery mildew fungus are the year of study and the density of *A. quisqualis* pycnidia on its fungal host, where: +, ++, and +++ indicate 1–10, 11–20, and 21–30 pycnidia present on 1 mm^2 of the thalli of powdery mildews, respectively.

Erysiphe aquilegiae var. *ranunculi* on: *Consolida ajacis*, 1996 +, 1997 –, 1998 –, in a garden in Stare Drawsko.

Erysiphe artemisiae on: *Artemisia vulgaris*, 1996 ++, 1997 +++, 1998 ++, *Artemisietea.*

Ampelomyces quisqualis has earlier been found to parasitize *Erysiphe artemisiae* affecting *A. vulgaris* growing in Szczecin (M a d e j and A n t o s z c z y s z y n 1965), in the Łęczyńsko-Włodawskie Lake District (M u ł e n k o 1988), and the Słowiński National Park (A d a m s k a et al. 1999).

Erysiphe buhrii on: *Melandrium album*, 1996 –, 1997 –, 1998 +, *Artemisietea.*

M a d e j and A n t o s z c z y s z y n (1965) encountered *A. quisqualis* on the *E. buhrii* x *M. album* association in Szczecin.

Erysiphe cichoracearum var. *cichoracearum* on: *Achillea millefolium*, 1996 –, 1997 +, 1998 –, *Leucobryo-Pinetum; Aster tradescantii*, 1996 ++, 1997 –, 1998 –, *Artemisietea; Aster novi-belgii*, 1996 –, 1997 –, 1998 ++, gardens in Stare Drawsko, Złocieniec, and Połczyn Zdrój; *Cichorium intybus*, 1996 –, 1997 –, 1998 ++, *Luzulo pilosae-Fagetum; Solidago canadensis*, 1996 +++, 1997 ++, 1998 –, *Chenopodietea; Tanacetum vulgare*, 1996 –, 1997 ++, 1998 +, *Artemisietea.*

M u ł e n k o (1988) found *A. quisqualis* on *Erysiphe cichoracearum* var. *cichoracearum* associated with *T. vulgare* growing in the Łęczyńsko-Włodawskie Lake District.

Tragopogon pratensis, 1996 –, 1997 ++, 1998 –, *Chenopodietea.*

Erysiphe heraclei on: *Heracleum sphondylium*, 1996 –, 1997 –, 1998 ++, *Ribo nigri-Alnetum.*

M u ł e n k o (1988) recorded *A. quisqualis* associated with *E. heraclei* on *H. sphondylium* growing in the Łęczyńsko-Włodawskie Lake District.

Erysiphe magnicellulata var. *magnicellulata* on: *Phlox paniculata*, 1996 ++, 1997 –, 1998 –, *Chenopodietea.*

Erysiphe pisi var. *pisi* on: *Lathyrus montanus*, 1996 −, 1997 −, 1998 ++, *Circaeo-Alnetum.*

Erysiphe polygoni on: *Polygonum aviculare*, 1996 +, 1997 −, 1998 −, *Chenopodietea.*

In Poland, the *A. quisqualis* x *E. polygoni* x *P. aviculare* fungal x plant association has earlier been encountered in Bielinek near the Odra river (Majewski 1970) and in the Łęczyńsko-Włodawskie Lake District (Mułenko 1988).

Erysiphe sordida on: *Plantago maior*, 1996 −, 1997 ++, 1998 −, *Artemisietea.* Madej (1963) and Madej and Antoszczyszyn (1965) also revealed *A. quisqualis* on *E. sordida* from *P. maior* growing near Szczecin.

Oidium chrysanthemi on: *Chrysanthemum* sp., 1996 −, 1997 ++, 1998 −, *Artemisietea.*

The only earlier Polish record of *A. quisqualis* on *O. chrysanthemi* affecting *Chrysanthemum* sp. is that from Białowieża given by Majewski (1972).

Podosphaera leucotricha on: *Malus domestica*, 1996 ++, 1997 +++, 1998 ++, gardens in Czaplinek and Złocieniec.

Madej and Antoszczyszyn (1965) and Kućmierz (1976) found this fungal x plant association in Szczecin and the Pieniny mountains, respectively.

Malus sylvestris, 1996 −, 1997 ++, 1998 −, *Circaeo-Alnetum.*

Sphaerotheca epilobii on: *Epilobium roseum*, 1996 −, 1997 −, 1998 ++, *Querco roboris-Pinetum.*

Sphaerotheca fusca on: *Clinopodium vulgare*, 1996 −, 1997 +, 1998 −, *Artemisietea; Taraxacum officinale*, 1996 −, 1997 ++, 1998 −, *Chenopodietea.*

Ampelomyces quisqualis has earlier been encountered on *S. fusca* from *T. officinale* in Żegiestów Zdrój (Michalski 1959), near Szczecin (Madej 1963), and in the Pojezierze Łęczyńsko-Włodawskie (Mułenko 1988).

Sphaerotheca pannosa on: *Rosa agrestis*, 1996 −, 1997 −, 1998 +++, *Chenopodietea; Rosa canina*, 1996 +, 1997 −, 1998 −, *Querco roboris-Pinetum.*

Although not recorded previously on the two species of the genus *Rosa* listed above, Madej and Antoszczyszyn (1965) revealed *A. quisqualis* on *S. pannosa* parasitizing an unrecognized *Rosa* sp.

Morphological properties of *Ampelomyces quisqualis*. The morphological properties of *A. quisqualis* coming from DLP generally fitted those earlier given by, e.g., Madej and Antoszczyszyn (1965), Hino and Kato (1929), and Sutton (1980). In *in vivo* conditions compared with those of *in vitro*, *A. quisqualis* produced less branched and lighter-coloured mycelium, more variable in shape pycnidia with somewhat smaller conidia of a narrower length : width ratio (Table 1; Figs 1−3,

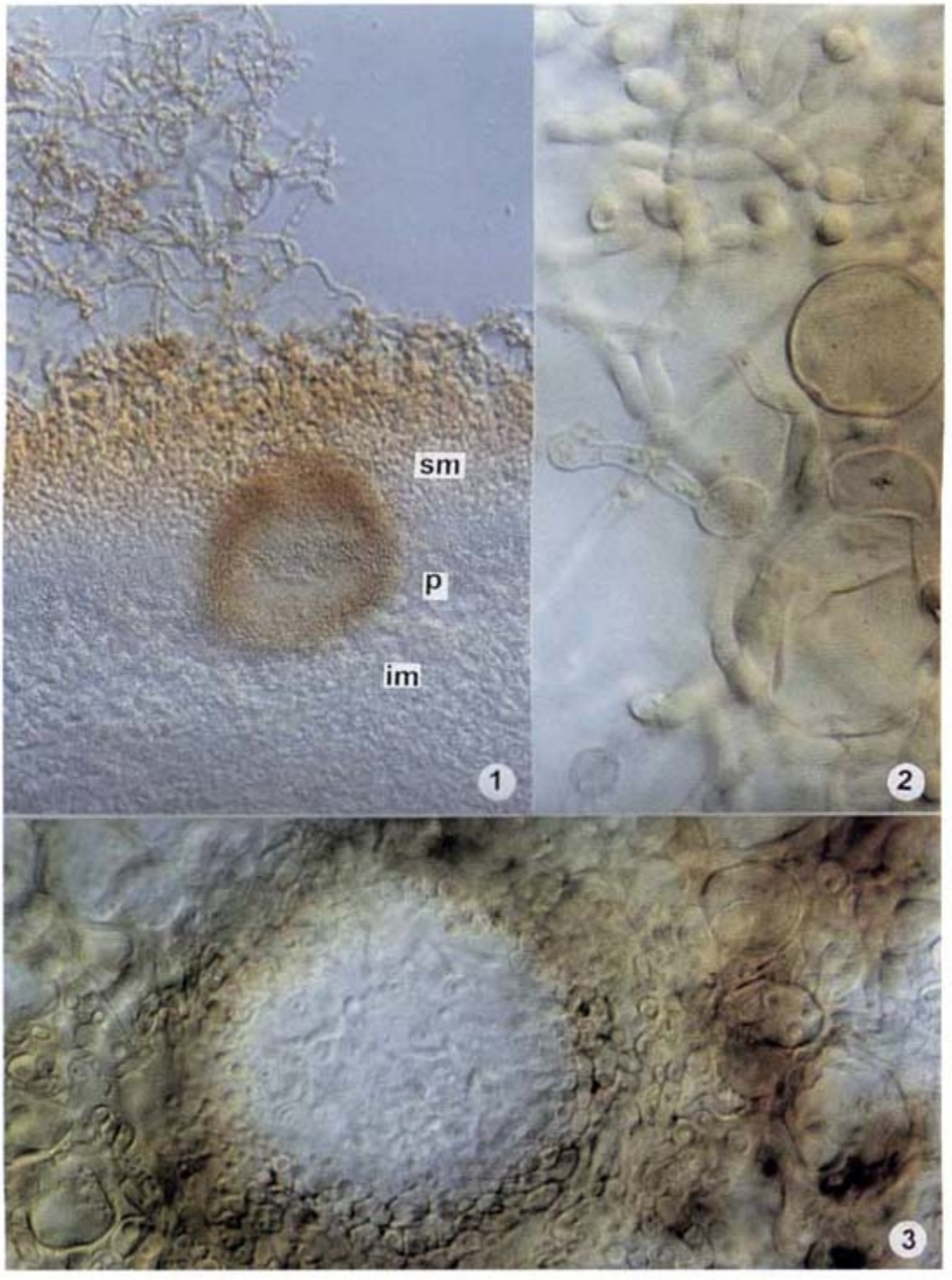
7–11). Morphological variability of fungal structures produced in nature usually is higher than that of those formed in *in vitro* conditions (M o r i c c a et al. 2000). Cultural and ontogenetic studies of *A. quisqualis* in both *in vivo* and *in vitro* conditions should further elucidate and understand the biology of this important fungus.

T a b l e 1

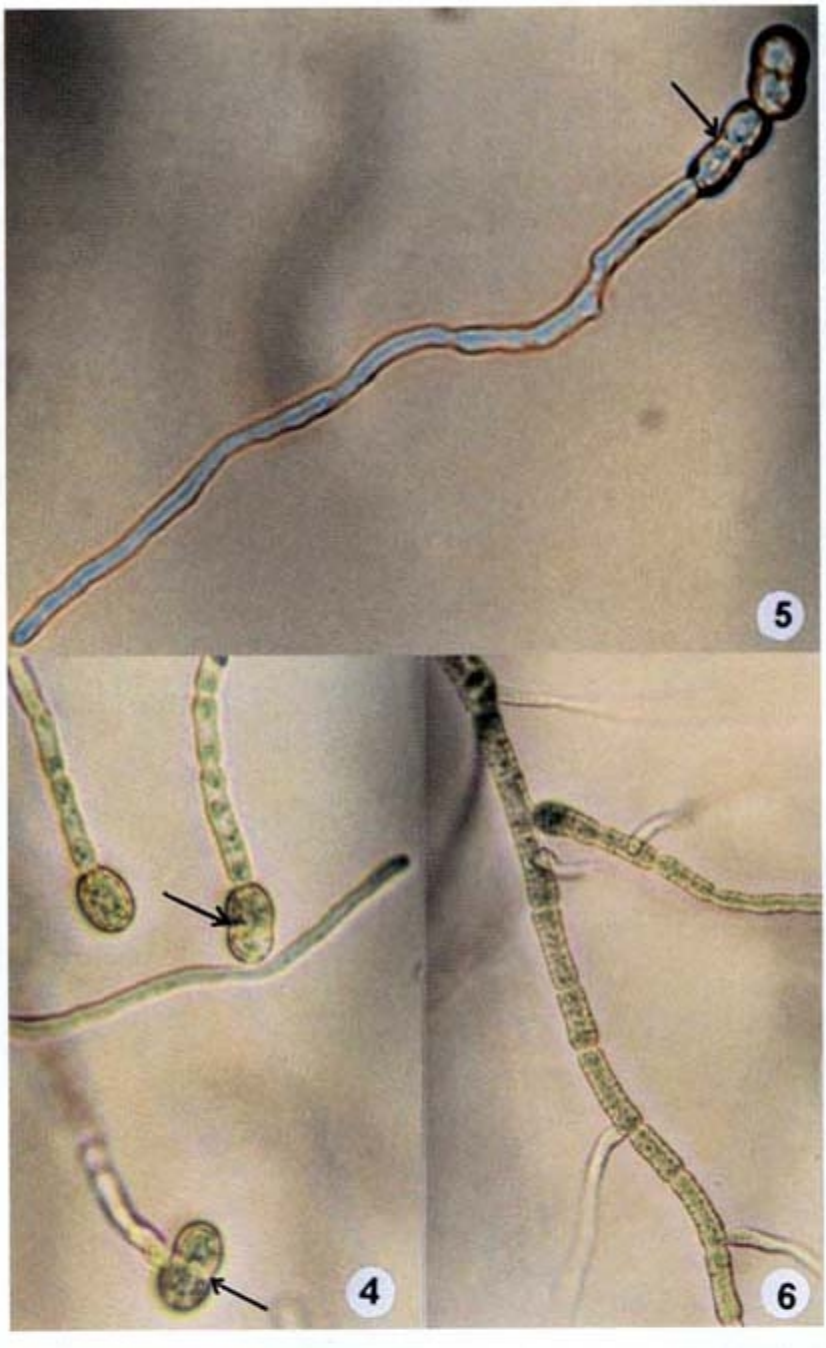
The morphology of *Ampelomyces quisqualis* developed in *in vitro* and *in vivo* conditions

Properties considered	Conditions of development	
	Potato dextrose agar	*Erysiphe cichoracearum* var. *cichoracearum* associated with *Tanacetum vulgare*
Mycelium	Multicelled, branched; 2–3 μm wide; white to orange (6E8); with arthrospore-like, balloon-shaped, thin-walled, ellipsoidal to globose, 25–45 × 23–39 μm outgrowths when older; ingrowing into the medium.	Multicelled, infrequently branched; 2–3 μm wide; dark orange (5B8) to yellowish brown (5D8); developing inside the hyphae and conidia.
Conidia	Cylindrical; hyaline; (7–)9.2 (–11.5) x (3–)3.5(–4) μm.	Widely ellipsoidal to cylindrical; hyaline; (4.5–)6.8(–10.5) × (3–) 4.1(–6) μm.
Length width ratio	2.8 : 1	1.7 : 1
Pycnidia	Ovoid to globose; (45–) 65 (–90) x 60–70 μm; without ostiolum; orange white (5A2) to apricot yellow (5B8) when young, yellowish brown (5D8) to raw umber (5F8) in maturity; immersed in the mycelium.	Ovoid, ellipsoidal, cylindrical to irregular; 40–90 (–105) x (10–) 20–50 (–65) μm; without ostiolum; pale yellow (4A3) to golden yellow (5B8) when young, golden yellow (5B7) to yellowish brown (6E8) in maturity; developing inside the hyphae of the fungal host.

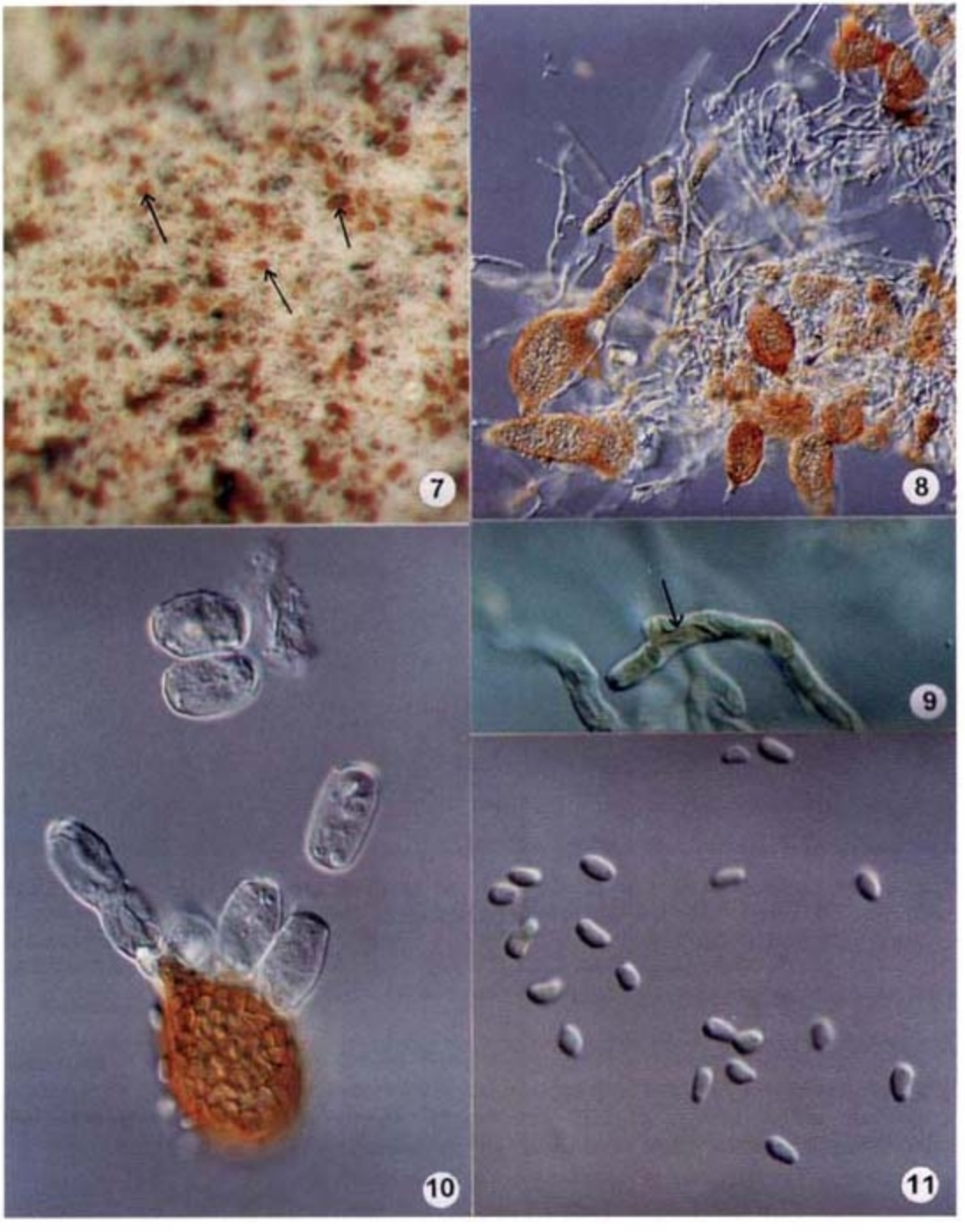
I n v i t r o g e r m i n a t i o n o f *A m p e l o m y c e s q u i s q u a l i s* c o n i d i a. Both on the PDA medium and in water, conidia of *A. quisqualis* began germination after 20-h incubation (Figs 4–6). In *in vitro* S u n d h e i m ' s (1982) investigations, only a small fraction of conidia of this fungus developed very short and abnormal germ tubes, although their germination needed saturated atmosphere when observed on the *A. quisqualis* powdery mildew host (S u n d h e i m 1978). The germination preceded swelling of conidia and formation of a central narrowing. Two hours later, germination tubes appeared. They developed bipolarly in spores incubated in water and monopolarly when incubated on PDA. S u n d h e i m and K r e k l i n g (1982) found most *A. quisqualis* conidia to develop only one germ tube, although two were occasionally observed. The germination tubes were hyaline, lacked septa and appressoria. Their growing rate was 3.5–5 μm per 1 h. After



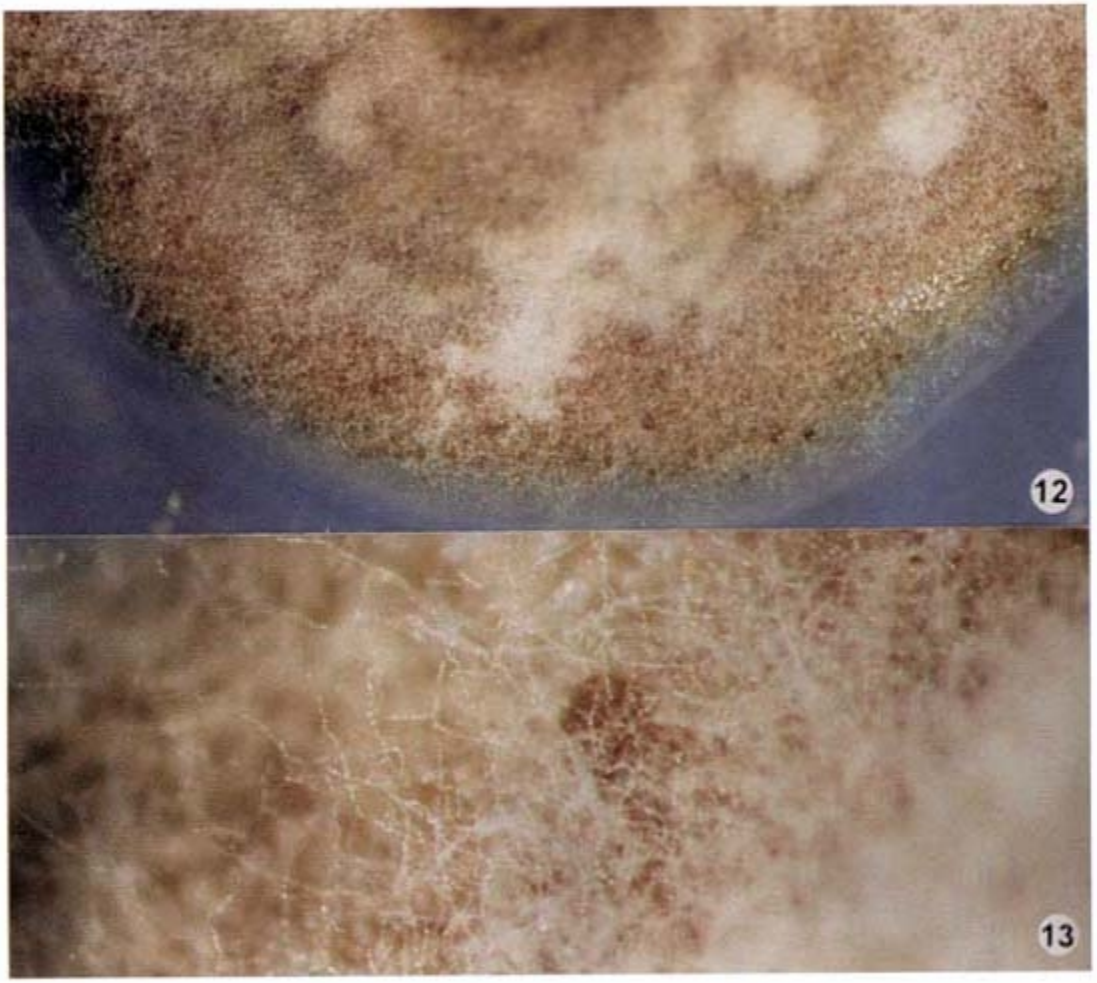
Figs 1 – 3. *Ampelomyces quisqualis* from potato dextrose agar (PDA). Fig. 1. Surface mycelium (sm), pycnidium (p), and mycelium immersed (im) in PDA. Fig. 2. Arthrospore-like structures. Fig. 3. Cross-section of pycnidium. All differential interference contrast (DIC), × 370, × 600, and × 1500, respectively.



Figs 4–6. Conidia and mycelium of *A. quisqualis* on PDA medium. Figs 4 and 5. Germinated conidia; note the narrowed centrum of conidia (arrows). Fig. 6. Branched, septate mycelium. All light microscopy (LM), ×1050, ×1260, and ×1330, respectively.



Figs 7–11. *Ampelomyces quisqualis* developed in *in vivo* conditions. Fig. 7. Numerous pycnidia (arrows) in the thallus of *Microsphaera symphoricarpi*. Fig. 8. Differently shaped pycnidia. Fig. 9. Hyphae of *M. symphoricarpi* inside hyphae of *A. quisqualis* (arrow). Fig. 10. Pycnidium developed from parasitized oidium of *Podosphaera leucotricha*. Fig. 11. Conidia. Fig. 7 – LM, Figs 8–11 – DIC; ×4, ×170, ×800, ×340, and ×800, respectively.



Figs 12 and 13. Colonies of *A. quisqualis* developed on PDA. Fig. 12. Fragment of 6-week-old colony, LM, ×9. Fig. 13. Branched aerial mycelium, LM, ×20.

ca. 36 next hours, the tubes developed into mycelium with hyphae divided by septa distributed 4–7 μm from each other (Fig. 6). After 43 hours, the percent of germinated conidia was much higher when inoculated on PDA.

In vivo development of *Ampelomyces quisqualis.* In *in vivo* conditions, conidia of *A. quisqualis* produced germ tubes with appressoria, whose infection hyphae penetrated only the hyphae and oidia of all the fungal host investigated (Figs 7–10). No colonization of cleistothecia by *A. quisqualis* was found, despite F a l k et al. (1995) and S u n d h e i m (1986) did it. Inside the hyphae of the fungal host, *A. quisqualis* colonized their subsequent cells throught pores in their transverse septa. The colonized cells were frequently completely filled with prosenhyma to pseudoparenchyma hyphal tissue. Consequently, the hyphae of the powdery mildew fungal host gradually deteriorated to become highly decomposed in advanced stages of the parasitism. E m m o n s (1930) and S u n d h e i m and K r e k l i n g (1982) found a similar pattern of penetration of the powdery mildew host *Sphaerotheca fuliginea* (Schlecht. ex Fr.) Poll. by *A. quisqualis.*

I n f l u e n c e o f m e d i a o n t h e d e v e l o p m e n t o f *A m p e l o m y c e s q u i s q u a l i s. Ampelomyces quisqualis* grew fastest and most abundantly sporulated on SabA with yeast extract and PDA (Table 2; Figs 12, 13). Although the fungus relatively intensively developed on malt extract agar as well, no sporulation was found. The unfavourable medium for both the growth and sporulation of *A. quisqualis* was that given by S u n d h e i m (1982).

T a b l e 2

The influence of growing media on the development of *Ampelomyces quisqualis*

Medium	Time of incubation		
	1st week	2nd week	6th week
Sabourad with yeast extract	Beginning of growth, hyphae slowly colonize the medium.	Colony fast-growing; aurantiacus 5–8; with an irregular margin; 15–18 mm diam, 5 mm high; pycnidia dark brown (6F8); globose; no sporulation.	Colony fast-growing; aurantiacus 5–9; with an irregular margin; 21–43 mm diam; pycnidia yellowish brown (5D8) to raw umber (5F8); sporulation abundant.
PDA	As above.	Colony fast-growing, with concentric zones; golden yellow (5B7) to yellowish brown (6E8); 12–15 mm diam.	Colony fast-growing, with an irregular margin; golden yellow (5B7) to raw umber (5F8); 12–23 mm diam; pycnidia very numerous, black; sporulation abundant.
Malt Extract Agar	Lack of growth.	Colony raised over the medium surface, with an irregular margin and concentric zones; cloddy; greyish brown (6E3); 11–12 mm diam.	Colony as at 3 week; 12–18 mm diam.

Influence of temperature on the development of *Ampelomyces quisqualis*. The optimal temperature range for both the growth and sporulation of *A. quisqualis* was 20–25°C. Kiss and Vajna (1995) found the highest growth rate of this fungus at 20–28°C. *Ampelomyces quisqualis* started to sporulate after 22 and 35 days when incubated at 20–25°C and 15°C, respectively. No sporulation occurred at 5, 10, and 30°C.

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Badania nad biologią i występowaniem *Ampelomyces quisqualis* w Drawskim Parku Krajobrazowym

S t r e s z c z e n i e

W latach 1996–1998 badano występowanie *Ampelomyces quisqualis* pasożytującego na sprawcach mączniaka prawdziwego (*Erysiphales*) roślin Drawskiego Parku Krajobrazowego (DPK) położonego w północno-zachodniej Polsce. Rośliny te reprezentowały 12 stałych powierzchni badawczych z dziewięcioma zbiorowiskami roślinnymi i 32 ogrody oraz pola użytkowane rolniczo. Zbiorowiskami roślinnymi 12 stałych powierzchni były: *Luzulo pilosae-Fagetum, Stellario-Carpinetum, Querco roboris-Pinetum, Leucobryo-Pinetum, Ribo nigri-Alnetum, Circaeo-Alnetum, Vaccinio ulginosi-Pinetum, Chenopodietea* i *Artemisietea*. W laboratorium określono morfologię *A. quisqualis*, jego sposób wnikania do sprawców mączniaka prawdziwego, jak również wpływ warunków hodowli na wzrost i zarodnikowanie tego nadpasożyta. Spośród 57 gatunków z rzędu *Erysiphales* znalezionych w Drawskim Parku Krajobrazowym, *A. quisqualis* pasożytowało na 12 należących do trzech rodzajów. Dziewięć z nich było gospodarzami *A. quisqualis* po raz pierwszy ujawnionymi w Polsce. Zbiorowiskami roślinnymi preferowanymi przez *A. quisqualis* były *Artemisietea* i *Chenopodietea* oraz zbiorowiska użytkowane rolniczo i ogrodniczo, które rosły w stanowiskach cieplejszych w porównaniu z pozostałymi stanowiskami uwzględnionymi w omawianych badaniach. Podłożami sprzyjającymi wzrostowi i zarodnikowaniu *A. quisqualis* były agar Sabouraud i agar dekstrozowo-ziemniaczany. *Ampelomyces quisqualis* najlepiej rosło i zarodnikowało w temperaturze 20–25°C.