Acta Phytopathologica et Entomologica Hungarica 37 (4), pp. 353–364 (2002)

Effects of Habitat Characteristics and Climatic Factors on the Fungal Diseases of Reed Stands in Hungary

R. BÁN[1], G. FISCHL[2],
A. I. ENGLONER[3] and F. VIRÁNYI[1]

[1]Department of Plant Protection, Szent István University, Gödöllő, Hungary
[2]Institute of Plant Protection, University of Veszprém, Keszthely, Hungary
[3]Department of Botany and Plant Physiology, Szent István University, Gödöllő, Hungary

Effects of habitat characteristics and climatic factors on the occurrence of reed pathogens were investigated in a four-year survey. While diseases caused by *Puccinia magnusiana, Polythrinciopsis phragmitis* and *Stagonospora* sp. started to increase as early as in August, the other species caused severe infection in September *(Deightoniella arundinacea, Puccinia phragmitis)* or even later in the vegetation period *(Deightoniella roumeguerei).* For the distribution of some fungal pathogens (*Puccinia phragmitis, Deightoniella arundinacea, D. roumeguerei* and *Stagonospora* sp.) weather conditions (especially precipitation) were profound, while the occurrence of others (*Puccinia magnusiana* and *Polythrinciopsis phragmitis*) depended more on the characteristics of reed stands.

Keywords: pathogenic fungi, common reed, habitat characteristics, climatic factors, Balaton.

Reeds have been exploited for a long time. The economic values of the common reed (*Phragmites australis* (Cav.) Trin. ex Steudel) mainly derive from thatching, grazing animals and producing several different products (paper, organic material, etc.). Reed stands also play important role in the purification of water, protection of the shore, etc.

Diseases of reeds caused by pathogenic fungi may considerably affect the above processes. Some of the pathogens can seriously damage the stem (*Ustilago grandis* Fries) or even kill the entire plant [*Deightoniella arundinacea* (Corda) Hughes] making industrial usage impossible (Ruttkay et al., 1964; Durska, 1970). Other fungal species cause leaf spot diseases [*Deightoniella roumeguerei* (Cav.) O. Const., *Polythrinciopsis phragmitis* Walker, *Stagonospora* sp.] or rupture the epidermis by rust pustules [*Puccinia phragmitis* (Schum.) Koernicke, *P. magnusiana* Koernicke] restraining the normal development of reed plants (Constantinescu, 1983; Fischl et al., 1996). However, the extent to which the causal agents of foliar diseases are associated with losses in reed stem quality is still unknown.

Reed decline is an important trait that should be considered in relation to the pathogens, since degradation of reed stands can be observed in many lakes and ponds in the world. There are several factors that may effect on and possibly included in the retreat of the stands (Ostendorp, 1989; Fischl et al., 1998), but the role of diseases in reed decline processes has not yet been thoroughly investigated.

0238–1249/2002/$ 5.00 © 2002 Akadémiai Kiadó, Budapest

Not only reed plants can be affected by various pathogens but the influence of environmental factors on the distribution and intensity of diseases can also be profound. Thus, it has been previously shown that reed stands differing in terms of reed quality, water distance and management were attecked by their pathogens differently (Bán et al., 1996, 1998, 2000; Engloner et al., 2000). It is, therefore, important to determine the factors which contribute to the actual level of diseases thus influencing the extent of damage in reed stands. Most of these results, however, were based on short-term examinations, but only long-term surveys can result in the better understanding of the processes existing in reeds. In addition, beside the characteristics of a field (or a stand), the extent and the progress of many diseases are frequently dependent on climatic factors during the vegetation period and winter.

Therefore, the objectives of our investigations were: (1) to determine a general tendency for the temporal distribution of reed pathogens; (2) to compare disease intensities among different habitats in a four-year survey; (3) to compare disease records in relation to concurrent weather conditions; and (4) to see which of the factors either climatic or habitat will effect dominantly the occurrence of the pathogens examined.

Materials and Methods

Investigations were carried out in three and four reed stands (numbered as sites 1, 2, 3 and 4, 5, 6, 7) at Lake Balaton and Lake Velencei, respectively. These stands have different characteristics as shown in *Table 1*. Reed categories I to V (category I: the best quality, category V: the poorest one) are classifying reed stands mostly through visual observations, for example for homogeneity, density, vitality, height and the presence of accompanying species (Kovács et al., 1993). The examined reed stands at Lake Balaton equally belonged to category III, while reeds at Lake Velencei numbered as 4, 5, 6 and 7 belonged to categories II, III, IV and V, respectively. Stands 1, 6 and 7 were far from the

Table 1

Characterization of sampling sites

Location	Site code	Reed quality	Distance from the lake	Reed stand management
Lake Balaton	1	III	far (2 km)	none
	2	III	near (5 m)	none
	3	III	near (20 m)	burnt
Lake Velencei	4	II	near (5 m)	none
	5	III	near (10 m)	cut
	6	IV	far (500 m)	none
	7	V	far (100 m)	none

lakes (0.1–2 km apart), while the others were situated onshore. Only reed stands 3 and 5 were regularly managed (burnt/cut) during the examination period.

Fungal pathogens previously found to attack reed stands in Hungary were: *Puccinia phragmitis* (Schum.) Koern., *Puccinia magnusiana* Koern., *Deightoniella arundinacea* (Corda) Hughes, *Deightoniella roumeguerei* (Cav.) O. Const., *Polythrinciopsis phragmitis* Walker and *Stagonospora* sp. (Fischl et al., 1996; Bán et al., 1998). Disease assessment was performed on ten marked shoots (ramets) of each of the seven locations at monthly intervals from June to October in 1996–97, and on 50 ramets at two sampling sites (site 3: Balatonberény and site 2: Fenékpuszta, at Lake Balaton) in September in the years 1998 and 2000 based on a five-scaled assessment key (Bán et al., 2000). For *Puccinia magnusiana,* reed ramets were assessed until September because symptoms caused by this fungus were difficult to detect as late as by the end of the vegetation period (October). Similarly, since the vegetation period finished earlier in 1997, disease assessment was performed until September for all fungi. The disease assessment records of single leaf blades were the subject of calculating disease indices for the plants examined by using the formula described earlier (Bán et al., 2000). The sampling conditions during the four-year examination period are summarized in *Table 2.*

Table 2

Summary of sampling conditions during the four-year examination period (monthly: June–October, once: in September)

Examination period	Number of ramets (Number of sampling)	Sampling sites
June–October 1996	10 (monthly)	sites 1–7
June–September 1997	10 (monthly)	sites 1–7
September 1998	50 (once)	sites 2, 3
September 2000	50 (once)	sites 2, 3

Meteorological data (mean monthly temperature and monthly precipitation) recorded at Siófok (Lake Balaton) which is the closest town to the sampling sites were provided by the National Meteorological Service.

Experimental data were evaluated by oneway analysis of variance (ANOVA) and by canonical variates analysis (CVA) using the MINITAB 10.2 and SYN-TAX computer program packages (Podani, 1994, 1997).

Results

Temporal distribution of reed pathogens

Since the temporal distribution of reed pathogens showed similar tendency from year to year (i.e. the distribution of each pathogen showed a characteristic disease curve during the vegetation period), only disease records at site 4 (Lake Velencei in 1996) as a

representative are presented here *(Fig. 1).* While diseases caused by *Puccinia magnusiana, Polythrinciopsis phragmitis* and *Stagonospora* sp. started to increase as early as in August, the other species caused severe infection in September *(Deightoniella arundinacea, Puccinia phragmitis)* or even later in the vegetation period *(Deightoniella roumeguerei).*

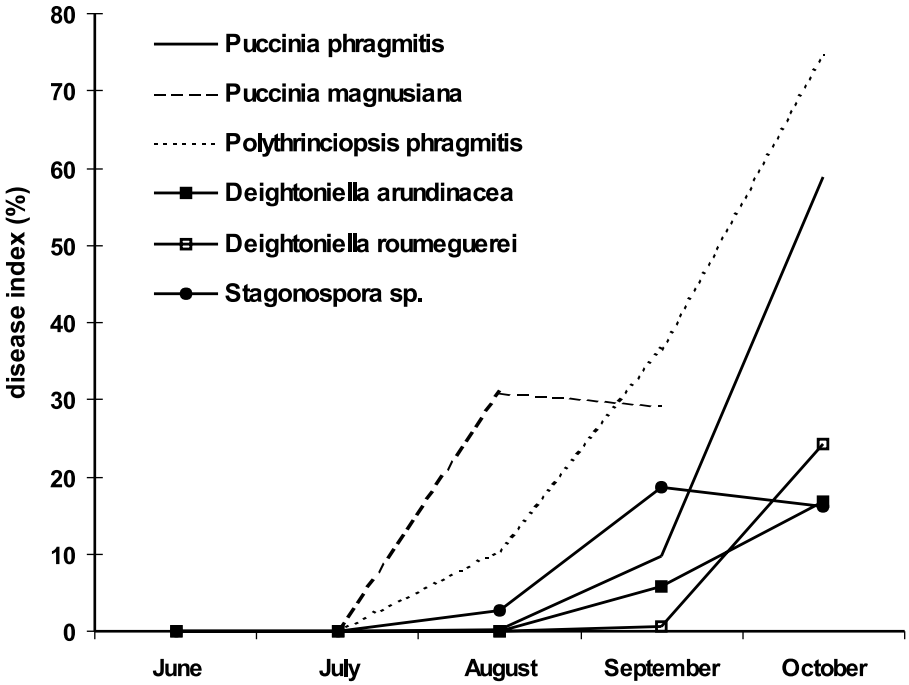

Fig. 1. Temporal distribution of reed pathogens at Lake Velencei (site 4) in 1996

Distribution of pathogens at different sampling sites

Although each disease has a characteristic progress during the vegetation period, it can be highly affected by the habitat conditions where it occurs. The occurrence of fungal diseases in each of the seven sampling sites in September 1996 and 1997 is presented in *Figs 2, 3,* respectively. In general, the most common fungal pathogens to occur were the rust fungi (*Puccinia phragmitis* and *P. magnusiana*) and *Stagonospora* sp., as far as both disease incidence (occurrence or frequency by sampling sites) and disease severity (measured by disease index) were concerned. Furthermore, the majority of the pathogens were common in nearly all sampling sites, whereas *Polythrinciopsis phragmitis* occurred in a few areas (sampling sites 2, 6 and 7) only.

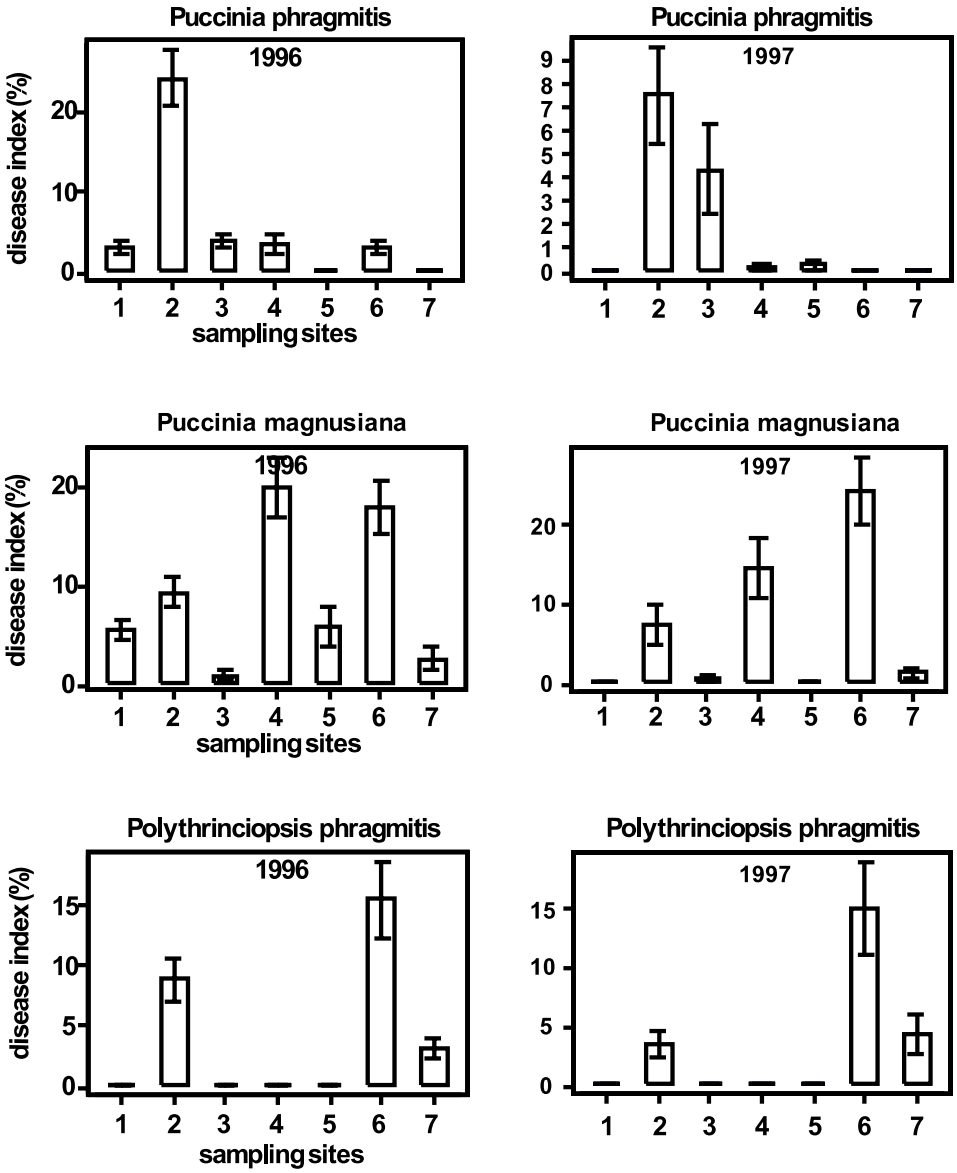

Fig. 2. Occurrence of *Puccinia phragmitis, P. magnusiana* and *Polythrinciopsis phragmitis* by sampling sites in September 1996 and 1997 (I means standard deviaton)

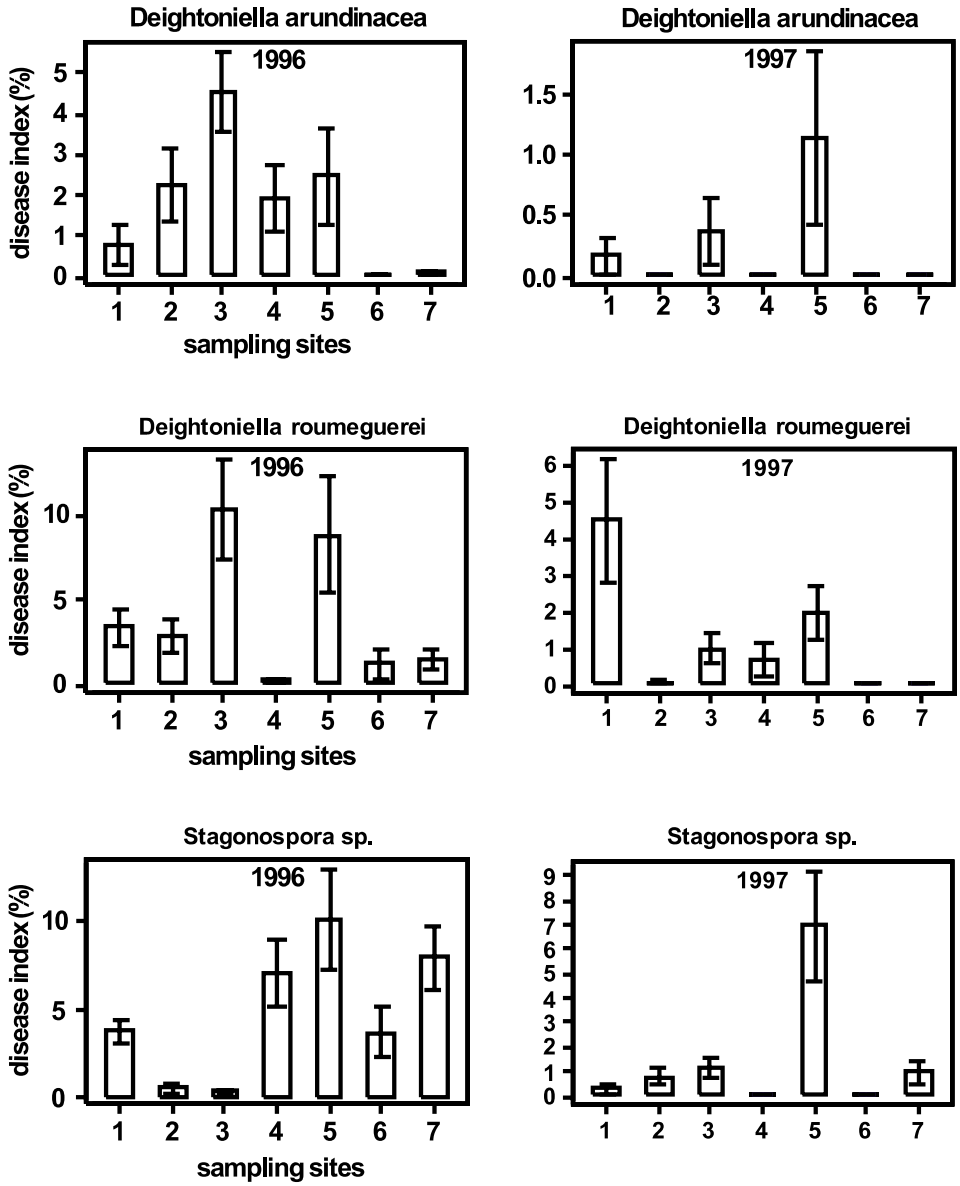

Fig. 3. Occurrence of *Deightoniella arundinacea, D. roumeguerei* and *Stagonospora* sp.by sampling sites in September 1996 and 1997 (I means standard deviaton)

Infection data obtained from different sampling sites in 1996 and 1997 were compaired by variance analysis to reveal correlations between habitat characteristics and the occurrence of each fungal species. Based on ANOVA our results corroborated with those previously found by Bán et al. (1998): *Puccinia phragmitis, Deightoniella arundinacea* and *Deightoniella roumeguerei* were all predominant in good and medium quality reeds (categories II and III) situated near the lakes, but *Puccinia magnusiana* inhabited poor (category IV) or good quality stands either far from or near the lakes *(Table 3).* In contrast, *Polythrinciopsis phragmitis* mainly infected reed stands that were of poor quality and situated far from the water. Furthermore, with the exception of *Deightoniella* species, the pathogens mentioned above caused more severe infections in those areas where reeds had not been treated in the last few years. Reed management (burning, cutting or harvesting), therefore, appeared to be a significant factor in decreasing the disease occurrence in reed stands. Interestingly, the occurrence of *Stagonospora* sp. was found to be independent from any of the factor in the 1996–1997 examination period.

Table 3

Habitat characteristics preferred by the reed pathogens examined

Pathogen	Reed quality	Distance from the lake	Reed stand management
Puccinia phragmitis	II, III	near	none
Puccinia magnusiana	II, IV	far/near	none
Deightoniella arundinacea	II, III	near	treated
Deightoniella roumeguerei	III	near	treated
Polythrinciopsis phragmitis	IV	far	none
Stagonospora sp.	II, V	far/near	treated/none

In 1998, relatively high infection rates were recorded for *Puccinia phragmitis* at sites 2 and 3, and for *Stagonospora* sp. at site 2 as compared to other pathogens *(Fig. 4).* The greater amount of sampling (50 ramets per sampling sites) in the years 1998 and 2000 allowed us to perform canonical variates analysis (CVA) in order to see whether or not sampling sites 2 and 3 differed in the occurrence of fungal diseases. The result of CVA is presented in *Fig. 5.* Variables (fungal species) are shown as vectors and objects (sampling sites) are presented by isodensity circles around centroids. These two reed stands were more different in 1998 than in 2000 as far as infections by *Puccinia phragmitis* and *Stagonospora* sp. were concerned. In 2000 reeds were similar based on their diseases as the overlapping circles show *(Fig. 5).* The other fungi (*Puccinia magnusiana* and the *Deightoniella* species) represented by shorter vectors seemed not to contribute to the differences between the two stands.

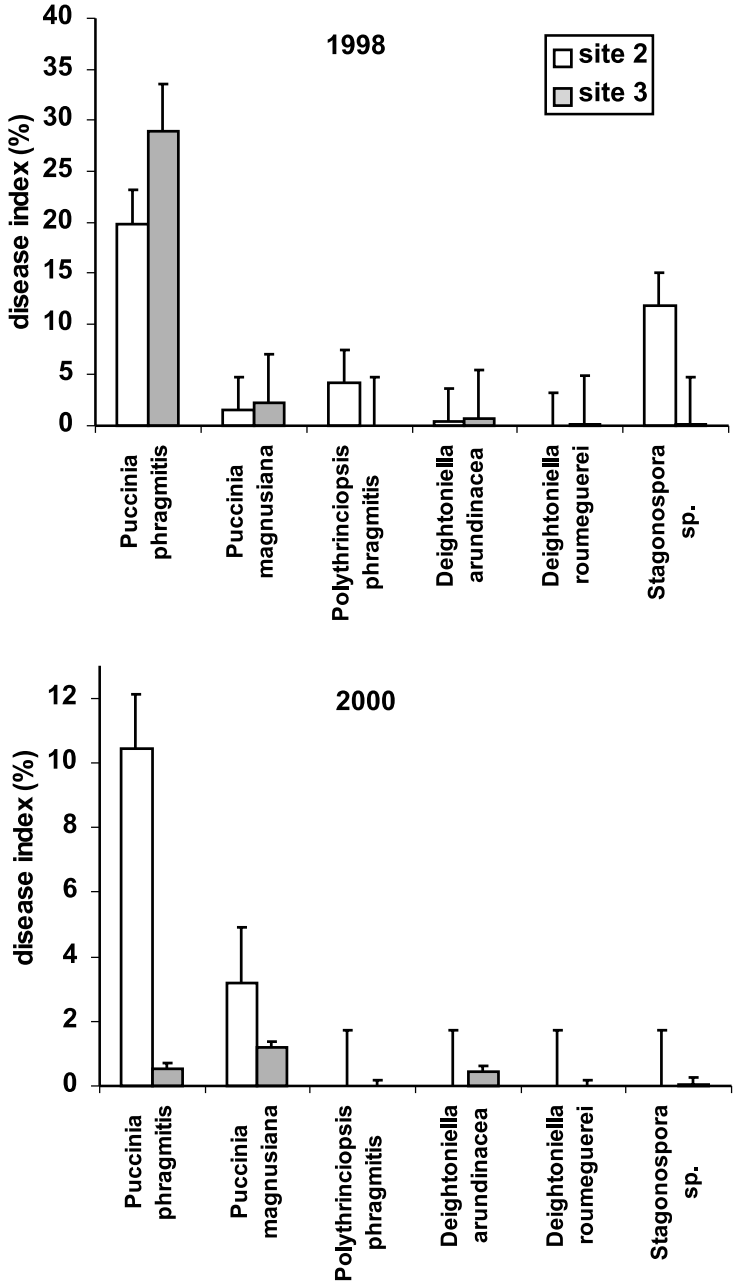

Fig. 4. Occurrence of reed pathogens at Lake Balaton (sites 2 and 3) in September 1998 and 2000 (I means standard deviaton)

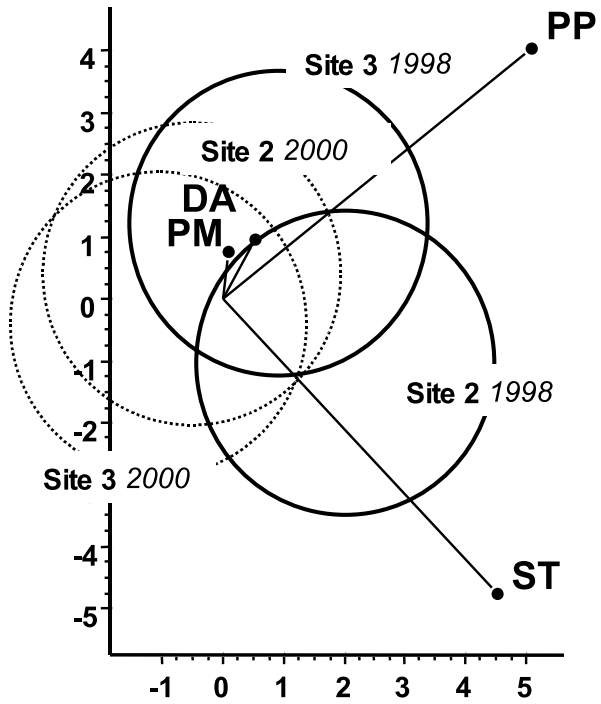

Fig. 5. CVA biplot of infection data of reed pathogens for two sampling sites at Lake Balaton in 1998 and 2000. 95% isodensity circles are shown around centroids. Centroids: 1: site 2 in 1998, 2: site 3 in 1998, 3: site 2 in 2000, 4: site 3 in 2000. Vectors (pathogens): PP: *Puccinia phragmitis,* PM: *Puccinia magnusiana,* DA: *Deightoniella arundinacea,* ST: *Stagonospora* sp.

Differences in the distribution of reed pathogens in the investigated years

Disease indices of the examined pathogens varied not only by sampling sites, but also between years. Except for *Polythrinciopsis phragmitis* and *Puccinia magnusiana,* both disease incidence and severity of the reed pathogens markedly decreased in 1997 as compared to 1996 *(Figs 2, 3).* A similar tendency was recorded in the years 1998 and 2000 in two sampling sites (2 and 3) at Lake Balaton, where disease indices, in general, decreased by 2000, but infections caused by *Puccinia magnusiana* were similar in the sampling areas during this period *(Fig. 4).*

Effects of weather conditions and habitat characteristics on the occurrence of fungi

During the examination period the mean monthly temperature was similar, while precipitation showed prominent differences *(Fig. 6).* In the years 1996 and 1998 the weather was relatively rainy in August and in September, but it was especially dry from August to October in 1997 and 2000.

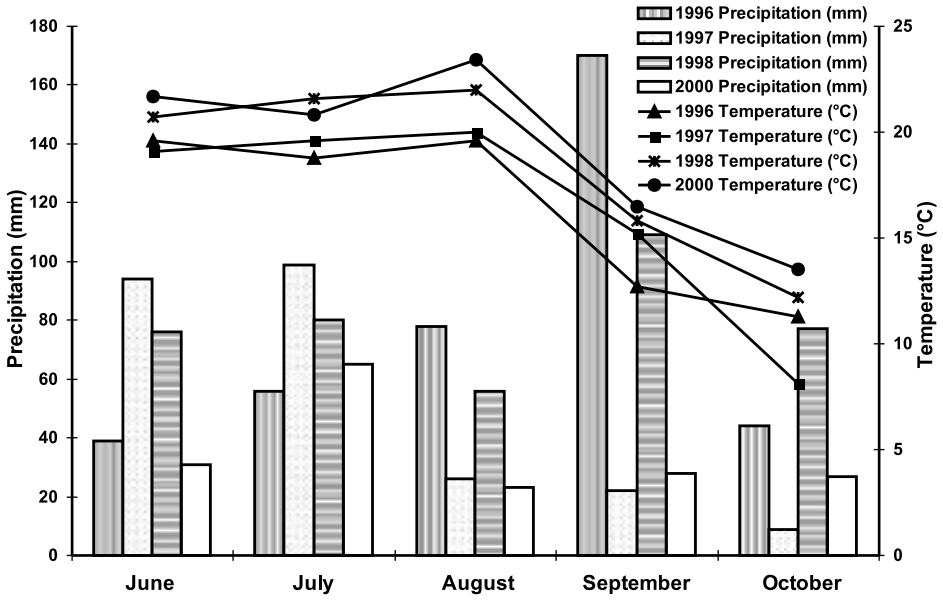

Fig. 6. Precipitation and mean temperature during the examination period at Lake Balaton (Siófok) (Data kindly provided by the National Meteorological Service)

Since the weather in August–September 1996 and 1998 were considerably rainy and *Puccinia phragmitis, Deightoniella arundinacea, D. roumeguerei* and *Stagonospora* sp. caused equally severe infections during this period, it seems that rainy periods are more favourable for the occurrence of these species. Although characteristics of the habitat (reed quality, distance from water and management), found to contribute to disease occurrence and to species diversity together with summer mean temperatures, were constant during the examination period (1996–2000), it was the precipitation that fluctuated with years significantly influencing the distribution of these fungi.

In contrast, there were no differences found in the diseases caused by *Puccinia magnusiana* and *Polythrinciopsis phragmitis* between rainy and dry years and these species frequently infected reeds growing far from the lake. In addition, *Puccinia magnusiana* was often observed and mostly being the only fungus on reed plants along railway embankments and roads. It seems, therefore, that habitat characteristics play a more significant role in the occurrence of the latter fungal species than do climatic factors.

Discussion

Effects of habitat characteristics and climatic factors on the occurrence of reed pathogens were investigated in this study in a four-year survey. Diseases caused by *Puccinia magnusiana, Polythrinciopsis phragmitis* and *Stagonospora* sp. started to increase as early

as in August, while the other species caused severe infection in September *(Deightoniella arundinacea, Puccinia phragmitis)* or even later in the vegetation period *(Deightoniella roumeguerei).*

According to the occurrence of fungi under different climatic and habitat conditions, the investigated reed pathogens can be divided into two groups. On one hand, *Puccinia phragmitis, Deightoniella arundinacea, D. roumeguerei* and *Stagonospora* sp. caused severe infections in rainy years (in 1996 and 1998) as well as in rainy periods, e.g. at the end of the vegetation period (September–October). On the other hand, *Puccinia magnusiana* and *Polythrinciopsis phragmitis* infected reed plants even in mid-summer, i.e. in the drier seasons and fluctuation in the weather conditions had no effect on their distribution: the level of infection caused by these fungi was similar either in rainy or in dry periods. Furthermore, these two pathogens were the most characteristic elements of reeds growing either far from the lakes or bordering railway embankments and roads, indicating that habitat characteristics play a more singnificant role in the occurrence of these species than do climatic factors. Differences in the ecological requirements of the two rust fungi (*Puccinia magnusiana* and *P. phragmitis*), belonging to the same fungal genus, are remarkable.

While some of the investigated factors (reed quality, distance from water) exist independently from human activity, reed management is the only one through which health condition of reeds can be effected. Since infection level caused by the majority of the pathogens was significantly lower in reeds where management (burning or cutting) was perfomed *(Table 3),* human activity with a proper reed management program can highly improve the health condition of reed stands. Beside the investigated factors, however, other effects such as water quality, water depth, etc. also have to be considered (Engloner, 2001).

In conclusion, a wide variety of factors may effect on the diseases in reeds. The distribution of some pathogens (*Puccinia phragmitis, Deightoniella arundinacea, D. roumeguerei* and *Stagonospora* sp.) is primarily weather-dependent (especially precipitation), while others (*Puccinia magnusiana* and *Polythrinciopsis phragmitis*) are mainly associated with the investigated characteristics of the reed habitat. The background of these differences is not yet known and would require further investigations.

Acknowledgement

This work was funded by the Balaton Research Grant.

Literature

Bán, R., Engloner, A. and Virányi, F. (2000): Occurrence of fungal pathogens in relation to reed quality. Journal of Plant Diseases and Protection 107, 258–266.

Bán, R., Fischl, G. and Virányi, F. (1996): A spatio-temporal analysis of fungal pathogens on reed in natural habitats. Acta Phytopathologica et Entomologica Hungarica 31, 219–227.

Bán, R., Virányi, F. and Obádovics, Cs. (1998): Különböző típusú nádállományok gomba okozta betegségei. [Survey of pathogenic fungi in different reed stands]. Növénytermelés 47, 407–416.

Constantinescu, O. (1983): Deightoniella on Phragmites. Mycology, Proceedings C 86, 137–141.

Durska, B. (1970): Changes in the reed (*Phragmites communis* Trin.) condition caused by diseases of fungal and animal origin. Polsk. Arch. Hydrobiol. 17, 373–396.

Engloner, A. (2001): A nádpusztulást elősegítő antropogén hatások [Human effects on reed decline]. Természetvédelmi Közlemények 9, 51–58.

Engloner, A. I., Bán, R., Sugár, E. and Virányi, F. (2000): Effects of fungal pathogens on the element content of reed leaf blades. Journal of Plant Diseases and Protection 107, 627–636.

Fischl, G., Bán, R., Szeglet, P. and Szabó, I. (1996): Pathogenic fungi on uliginal plants of Kis-Balaton Conservation Area. Proceedings of "Research, Conservation, Management" Conference, Aggtelek. pp. 179–183.

Fischl, G., Bürgés, Gy. and Szeglet, P. (1998): Plant hygiene conditions of the reed in Lake Balaton with special view of fungal diseases. Proceedings 50th Int. Symp. of Crop Protection. Gent. III. pp. 869–871.

Kovács, M., Gorzó, Gy. and Busics, I. (1993): A Balaton nádas állományának felmérése és minősítése [Qualifying reed stands at Lake Balaton]. ERDA Bt, Budapest, p. 74.

Ostendorp, W. (1989): "Die-back" of reeds in Europe – A critical review of literature. Aquatic Botany 35, 5–26.

Podani, J. (1994): Multivariate data analysis in ecology and systematics. SPB Publishing, The Hague.

Podani, J. (1997): SYN-TAX 5.1: A new version for PC and Macintosh computers. Coenoses 12, 149–152.

Ruttkay, A., Tilesch, S. and Veszprémi, B. (1964): Nádgazdálkodás [Reed management]. Mezőgazdasági Kiadó, Budapest.