ORGANISMS AFFECTING THE HEALTH OF TYPHA SPP. IN THE LITTORAL ZONE OF LAKES IN DRAWA NATIONAL PARK (NW POLAND)

K. Mazurkiewicz-Zapałowicz, D. Ładczuk and M. Wolska

Abstract

Mycological analyses of diseased shoots of lesser bulrush (Typha angustifolia) and common bulrush (T. latifolia) were made in the field and laboratory in 2009 and 2010. The plants occur in the littoral zone of three lakes in Drawa National Park (Czarne, Płociczno, Zdroje) in the Typhaetum angustifoliae and T. latifoliae associations. It was shown that fungi (30 taxa: 28 on T. angustifolia and 10 on T. latifolia) and the beetle (Donacia crassipes) may affect the health of Typha plants. Phaeosphaeria eustoma, Phoma typharum, Pyrenophora typhicola and Scolecosporiella typhae were isolated from necrotic leaf tissues of Typha plants. These are the first records of the mentioned fungi on Typha in Poland. Larvae of D. crassipes were shown to be vectors of Cladosporium cladosporioides, Phoma typharum and Phyllosticta typhina in Typha plants.

Key words: Typha latifolia, T. angustifolia, microscopic fungi, Donacia crassipes

Introduction

Aquatic plants lesser bulrush (Typha angustifolia) and common bulrush (T. latifolia) are a part of the rush and sedge communities, typical of the phytosociological class Phragmitetea R.Tx. et Prsg 1942, and order Phragmitetalia Koch 1926 (Matuszkiewicz 2002). Phytosociologically, T. angustifolia and T. latifolia are typical of Typhaetum angustifoliae and T. latifoliae associations, respectively. They occupy large areas and only rarely occur together. The associations mentioned have similar effect on the landscape architecture. Their ecological significance lies in the increase of plant succession rate, land drainage, and reclamation. Both Typhaetum associations significantly enhance plant diversity, and contribute to the formation
of suitable and convenient sites for reproduction of many species of fishes, molluscs, crustaceans and insects.

The plants of both *T. angustifoliae* and *T. latifoliae* associations have been studied, among others, by Vuille (1991), Raspopov et al. (2002) and Rechylicz (2011). Microscopic fungi accompanying *Typhaetum* associations significantly increase the biodiversity, and also affect plant growth and decomposition.

The microscopic fungal communities of *Typhaetum* associations are insufficiently known, locally or globally, considering their significance, in sustaining the equilibrium of aquatic ecosystems. There is a justification for more extensive studies on the mycology and pathology of the order *Phragmitetalia*.

**Materials and methods**

Lesser bulrush (*T. angustifolia*) and common bulrush (*T. latifolia*), found in the littoral zone along the banks of three lakes, Czarne, Płociczno and Zdroje, in the Drawa National Park, were studied in the field and laboratory in two growing seasons, 2009 and 2010. The rushes were collected from *Typhaetum angustifoliae* and *T. latifoliae* associations at selected locations three times each year, from June until the end of October. Leaves and stems with visible symptoms of disease, i.e. chlorosis or necrosis, or mechanical damage, were used for mycological analyses. They were surface-disinfected in 70% ethanol for 1 min. Pieces 3–5 cm long were incubated in sterile moist chambers at 20 ±2°C for 2–14 days. Fungi growing on the plant tissues (including biotrophs) were identified directly on the basis of their morphology and sporulation *in situ*. Other fungi were identified in axenic culture on potato dextrose agar (PDA), Czapek-Dox agar (CDA) and 2% malt agar (MEA) in Petri dishes after isolation as single spores (Király et al. 1977). Transfers were made according to phytopathological standards (Király et al. 1977, Waller et al. 1998). Mycological literature by Kochman and Majewski (1973), Sutton (1980), Brandenburger (1985), Borowska (1986), Kwaśna et al. (1991), Ellis and Ellis (1997) was used for morphological identification. Taxonomy was based on the classification of fungi by Kirk et al. (2008) and Index Fungorum nomenclature (www.indexfungorum.org.names/Names.asp).

The studied materials are deposited in the form of descriptions and pictures, dried diseased *T. angustifolia* and *T. latifolia* plants, and fungi stored on synthetic nutrient agar (SNA) slants at Department of Hydrobiology, West Pomeranian University of Technology in Szczecin.

The Jaccard index (= Jaccard similarity coefficient) modified by Sörensen (Krebs 1997) was used to measure the similarity and diversity of the fungal communities from different plant species, locations and years.

A frequency coefficient ($F_i$), based on the occurrence of individual fungal species in a location, and dominating class coefficient ($D_i$), based on frequency of individual species in a community, were calculated after Czachorowski (2006) as follows:
\[ F_i = \frac{s_i}{S} \cdot 100\% \]

\[ D_i = \frac{n_i}{N} \cdot 100\% \]

\( s_i \) – number of locations with \( ‘i’ \) species,
\( S \) – number of all locations,
\( n_i \) – number of \( ‘i’ \) species isolates,
\( N \) – number of all isolates for \( T. \) angustifolia (\( T. \) latifolia).

Fungi were described as eudominants (E), dominants (D), subdominants (SD), recedents (R) or subrecedents (SR) on the basis of their dominance class coefficient (\( D_i \)) values, which were, respectively, >10%, 5.01–10%, 2.01–5%, 1.01–2% and ≤ 1%.

Results

The phyllosphere and caulosphere of two species of rush (\( T. \) angustifolia and \( T. \) latifolia) in the littoral zone of three lakes (Czarne, Płociczno and Zdroje) in the Drawa National Park in 2009 and 2010 were colonized by microscopic fungi of 30 taxa (altogether 350 isolates). Twenty taxa were recorded in 2009 and 21 taxa in 2010 (Table 1). Twenty eight taxa were recorded on \( T. \) angustifolia and 10 taxa on \( T. \) latifolia. The number of species on \( T. \) angustifolia from each of the lakes was similar (9-10) in 2009 and ranged from 2 to 16 in 2010. No disease symptoms were recorded on \( T. \) latifolia in 2009. The same number of species (6) was found on \( T. \) latifolia from two lakes in 2010.

After combining totals from the two plant species and all locations, the largest group of fungi was Hyphomycetes, represented by 50% of isolates in 2009 and 42% in 2010 (Fig. 1). Coelomycetes comprised 27% and 29% of isolates in 2009 and 2010, respectively; Ascomycota comprised 20% and 24%, and Basidiomycota 3% and 5%. Hyphomycetes, Coelomycetes, Ascomycota and Basidiomycota were represented by 15, 8, 6 and 1 species, respectively (Table 1).

After combining totals for individual plant species and two years, \( T. \) angustifolia from each lake was colonized mostly by Hyphomycetes (39–45%), Coelomycetes (25–40%) and Ascomycota (10–24%, Fig. 2). The same order of results was found for \( T. \) latifolia, which was analyzed less frequently because of absence of symptoms in 2009: Hyphomycetes (32–66%), Coelomycetes (32–50%), and Ascomycota (0–18%, Fig. 3).

The diversity of fungal communities measured as the number of species (for all locations or separately for one or two locations) often differed between plant species or years, or among locations. The Jaccard-Sörensen index for fungal communities on \( T. \) angustifolia and \( T. \) latifolia was 42.1%. The group of taxa common for both plant species included Alternaria alternata, Cephalosporium sp., Cladosporium herbarum,
## Table 1

Fungi found on diseased or damaged leaves and shoots of *Typha angustifolia* (TA) and *T. latifolia* (TL) in Czarne, Płociczno and Zdroje lakes in 2009 and 2010

<table>
<thead>
<tr>
<th>No.</th>
<th>Genus of fungi</th>
<th>Year 2009</th>
<th>Year 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CZARNE LAKE</td>
<td>PŁOCICZNO LAKE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TA</td>
<td>TA</td>
</tr>
<tr>
<td>1</td>
<td><em>Alternaria alternata</em></td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td><em>Alternaria tenuissima</em></td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3</td>
<td><em>Cephalosporium</em> sp.</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>4</td>
<td><em>Chaetomium globosum</em></td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>5</td>
<td><em>Cladosporium cladosporioides</em></td>
<td>++</td>
<td>–</td>
</tr>
<tr>
<td>6</td>
<td><em>Cladosporium herbarum</em></td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>7</td>
<td><em>Clonostachys rosea</em> f. <em>catenulata</em></td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>8</td>
<td><em>Didymella proximella</em></td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>9</td>
<td><em>Epicoccum nigrum</em></td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>10</td>
<td><em>Fusarium culmorum</em></td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>11</td>
<td><em>Gibberella avenacea</em></td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>12</td>
<td><em>Gibberella intrincas</em></td>
<td>++</td>
<td>–</td>
</tr>
<tr>
<td>13</td>
<td><em>Gibberella sacchari</em></td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>14</td>
<td><em>Hymenospora typhae</em></td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>15</td>
<td><em>Penicillium 1 sp.</em></td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>16</td>
<td><em>Penicillium 2 sp.</em></td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>17</td>
<td><em>Periconia typhicola</em></td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>18</td>
<td><em>Phaeosphaeria eustoma</em></td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>19</td>
<td><em>Phaeosphaeria typharum</em></td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>4</td>
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</tr>
<tr>
<td>20</td>
<td>Phoma typhae</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>21</td>
<td>Phoma typharum</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>22</td>
<td>Phoma typhicola</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>23</td>
<td>Phytlosticta typhina</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>24</td>
<td>Pyrenophora typhicola</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>25</td>
<td>Scolecosporiella typhae</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>26</td>
<td>Stagonospora sp.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>27</td>
<td>Stagonospora typhoidarum</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>28</td>
<td>Ulocladium chartarum</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>29</td>
<td>Ustilago grandis</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>30</td>
<td>Volutella arundinis</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Total number of species in the lake 10 9 10 16 2 6 7 6 - - -

Total number of species in the year 20 21

Damage caused by *Donacia crassipes* ++ ++ ++ ++ ++ + + - - - -

There were no symptoms of disease or damage on TL at any locations in 2009 or on TL at Czarne in 2010.

"+-", "++" - number of research stations on TA and TL lakes populated by given fungi species.

"-" - absent species.
Hymenopsis typhae, Phaeosphaeria typharum, Phoma typharum, Phoma typhicola and Stagonospora typhoidearum (Table 1).

The Jaccard-Sörensen index for fungal communities on T. angustifolia in the three lakes was 53.8%, 57.9% and 56.2% respectively for Zdroje–Płociczno, Zdroje–Czarne and Czarne–Płociczno lake associations. The group of taxa common to all three lakes included A. alternata, Cephalosporium sp., Chaetomium globosum, H. typhae, Phoma typharum, P. typhicola, Scolecosporiella typhae and Volutella arundinis (Table 1).

The frequency coefficient showed that H. typhae (75%) and A. alternata (58.3%) were the most common fungi at all three lakes. The frequency coefficients for Cephalosporium sp., Gibberella intricans, Phoma typharum, P. typhicola, S. typhae and Stagonospora sp. were > 30% (Table 1).

The numbers of fungal species on T. angustifolia and T. latifolia in the different dominance classes, eudominants, dominants, subdominants and recedents, differed greatly (Fig. 4). Typha angustifolia was colonized by only one eudominant species (H. typhae), four dominant species (A. alternata, G. intricans, Phoma typharum and S. typhae), 13 subdominants and 10 recedents. Typha latifolia was colonized by

Fig. 1. Diversity of mycobiota on Typha angustifolia and T. latifolia in three lakes in 2009 and 2010

Fig. 2. Diversity of mycobiota on Typha angustifolia in three lakes in 2009 and 2010
two taxa of eudominants (A. alternata and Cephalosporium sp.) but mostly by dominants (eight species).

Damage to Typha leaf tissues was caused not only by microscopic fungi but also by insects, i.e. larvae and imago stage of the amphibiotic (= aquatic) beetle Donacia crassipes. Circular holes, 1–2 mm diameter, and elongated feeding canals surrounded by chlorotic-necrotic tissue were recorded on leaves of T. angustifolia. Only three species of fungi, C. cladosporioides, Phoma typharum and Phyllosticta typhina, grew on PDA following isolation from Donacia larvae that were extracted from holes in leaves.

Discussion

The present results supplement to the list of fungal species known to occur on diseased T. angustifolia and T. latifolia in Poland. This study of mycobiota on Typha in the Drawa National Park followed investigations by Adamczewski (2007). Thirty species of fungi were recorded in the phyllosphere and caulosphere of T. angustifolia and T. latifolia. The results also confirmed the occurrence of 11 species found in two other lakes (Marta and Sitno) in the Park (Adamczewski 2007, Adamczewski and Mazurkiewicz-Zapałowicz unpublished data). Common fungi included H. typhae and Phoma typhicola (earlier found to cause brownish-black discoloration on Typha leaves), Didymella proximella, Phaeosphaeria typharum (syn. Leptosphaeria typharum) and Pyrenophora typhicola (isolated earlier from necrotic areas on T. angustifolia leaves), Gibberella avenacea (isolated earlier from T. latifolia leaves with discoloration symptoms) and Stagonospora typhoidearum (syn. Ascochyta typhoidearum), Fusarium incarnatum (= F. semitectum) and Gliomastix luzulae, found
previously in the phyllosphere of *T. latifolia* with discoloration symptoms (Adamczewski 2007), were not recorded.

Only three species of fungi, *Phoma typharum*, *Phylosticta typhina* and *Leptosphaeria culmifraga*, were found on *T. angustifolia* and *T. latifolia* in other lakes in Northern Poland (Durska 1974, Adamska 2001, Czerniawska et al. 2010).

Studies on the mycobiota on *Typha* have rarely been made. Only a few reports have been published on fungi affecting the health of *Typha* in various geographical locations and different climatic conditions. The diversity of fungi in the phyllosphere and caulosphere of *T. angustifolia* and *T. latifolia* presented here is similar to that reported for *T. latifolia* in Japan (Tokumasu 1993), but less than reported for *T. latifolia* in Canada (45 taxa; Schulz and Thormann 2005). In Europe (Belgium), it was shown that damage to *Typha* tissues could be caused by 50 species of fungi and five species of Myxomycetes (Meulder 2003). Only few species, including *A. alternata*, *Cladosporium cladosporioides*, *C. herbarum* and *Phoma typhicola*, have been recorded in different locations and climates, identifying them as cosmopolitan. Most other species occur locally in specific habitats and climatic conditions.

The available literature on the microscopic mycobiota of *Typha* currently lists 120 fungal taxa. The list is being extended continually by taxa newly described or new for *Typha*, including *Berkleasmium typhae* sp.nov., found on *T. angustifolia* in Thailand (Somrithipol and Jones 2003). *Phaeosphaeria eustoma*, *Phoma typharum*, *Pyrenophora typhica* and *S. typhae* are new species for *Typha* in Poland.

The occurrence of small, circular spots, 2–5 mm diameter, on *T. angustifolia* was associated with colonization by *Stagonospora* spp., while the occurrence of brownish, elongated spots, 5–35 mm long and 3–8 mm wide, with blunt and uneven edges was associated with colonization by a few species, i.e. *D. proximella*, *Phaeosphaeria typharum*, *Phoma typhae*, *P. typharum*, *P. typhica* and *Phylosticta typhina*. Where spots similar to the latter occurred on *T. latifolia* they were colonized only by *Phoma typhica* and *P. typharum*.

Fungi in different reproductive states, anamorph or teleomorph, were recorded. *Phylosticta typhina* (anamorph: *Phoma typhina*), for example, occurred only in its sexual stage and produced perithecia during the whole growing season. The absence of the anamorph stage suggests active participation of ascospores in both primary and secondary infections.

The observations on (i) specific relationships between symptoms and colonization by individual fungi, and (ii) production of characteristic reproductive stages, contribute to our knowledge of the aetiology and epidemiology of leaf spot diseases of *Typha*.

The observations suggest participation of insects as vectors of *Typha* pathogens. This suggestion is based mainly on the presence of *D. crassipes*, which commonly colonized and fed on *T. angustifolia*. The biology of *D. crassipes* helps it to spread fungal pathogens. Oviposition takes place below the water surface, and the females deposit their eggs one by one in the *Typha* leaf tissue, in holes made earlier by the insect (Krzemiński 1966). Larvae migrate first to rhizomes and later to the undersides of leaves located above the water surface, where they feed as imago form (Aleksandrowicz and Marczak 2004). Mechanical damage in the form of
holes in leaf tissues was recorded very often on *T. angustifolia*. Holes were accompanied by necrotic lesions.

All 19 species of *Donacia* occurring in Poland have similar behaviour. *Cladosporium cladosporioides*, *Phoma typharum* and *Phyllosticta typhina* may not be the only species of fungi transmitted in *Typha* under water by *Donacia*. It seems that various species of Donacinae can transmit different fungi, including air-borne as well as plant-borne species, and also *A. alternata*, for example, which has been recorded in the underwater parts of *Typha*.

*Alternaria alternata*, together with *C. cladosporioides* and *C. herbarum*, are polyphagous, secondary plant pathogens. On *Typha*, however, they infected mostly young leaves (Tokumasu 1993), so they may be primary invaders of the under- and above-water parts of plants, so increasing the plants’ predisposition to other pathogens.

The results of this study indicate a need of further interdisciplinary studies concerning the interactions and effects of biota from various groups on plant health.

**Acknowledgements**

The authors thanks the Management and the Staff of the Drawa National Park for help in collecting research materials.

**Streszczenie**

ORGANIZMY WPŁYWAJĄCE NA ZDROWOTNOŚĆ TYPHA SPP. W LITORALU JEZIOR DRAWIŃSKIEGO PARKU NARODOWEGO (NW POLAND)

26

K. Mazurkiewicz-Zapałowicz, D. Ładczuk and M. Wolska

Literature


Tokumasu S., 1993: Trophodynamic structure of a swampy bog at the climax stage of limnological succession III. Filamentous fungi associated with the standing leaves of Typha latifolia. Water Air Soil Pollut. 76: 491–499.


Organisms affecting the health of Typha spp. in the littoral zone of lakes... 27

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Accepted for publication: 27.07.2011