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FIRST RECORDS OF THE *HYGROPHILA POLYSPERMA* (ROXB.) T. ANDERSON (ACANTHACEAE) IN POLAND

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ABSTRACT. The first locality in Poland and the second in Europe of *Hygrophila polysperma* was found during geobotanical investigation carried out in 2008 in the water reservoirs near Konin (central-western Poland). This locality is situated in a fishpond near the Pątnowskie Lake and Ślesiński Channel, which are incorporated into the cooling system of the "Konin" and "Pątnów" power stations. The habitat parameters and biogeography are described and the possibility of *H. polysperma* dispersion is estimated.

KEY WORDS: *Hygrophila polysperma*, alien plants, distribution, aquatic weed, Konin lakes, Poland

INTRODUCTION

Changes in the thermal conditions of water and increase in their heat capacity (Strub et al. 1985, Bajkiewicz-Grabowska 1994, Anderson et al. 1996, King et al. 1999, Snucins and Gunn 2000) have permitted expansion of neophytic species of high thermal requirements (Van Dijk et al. 1986, Hilbricht-Ilkowska 1998, Hussner and Lösch 2005). The foreign species penetrate especially easily the ecosystems subjected to strong anthropopressure (Hussner and Lösch 2005). In Poland, the area subjected to multidirectional anthropopressure related to excavation mines, fishing, anthropogenic eutrophication and power plants activity, is the series of channel lakes near Konin (Socha 1996, Socha and Zdanowski 2001). In the lakes whose water is polluted with the heated post-cooling water used in power plants, the expansion of neophytic species *Vallisneria spiralis* has been documented (Protasov et al. 1994, Gąbka 2002, Hutorowicz 2006). For over 10 years this macrophyte has been the main component of submerged vegetation in the near Konin lakes (Gąbka 2002, Hutorowicz 2006). From the lakes to which the heated water was released, for the first time in Poland the occurrence of the phytoplancton algae whose presence is characteristic of higher temperatures has been reported (Burchardt 1977). These algae species include e.g. *Cylindrospermopsis raciborski* (Burchardt 1977) presently considered as an invasive species in Europe (Padisák 1997, Briand et al. 2004). Another geographically alien species favouring warm waters noted by the authors in 2008 in the lakes near Konin is *Hygrophila polysperma* (Roxb.) T. Anderson.

This paper reports on the distribution and conditions of occurrence of *H. polysperma* at this newly found locality presented on a background of the available data on the occurrence of this species in Europe.

MATERIAL AND METHODS

In the course of floristic study of charophytes and phytoplancton algae in the lakes of the Konin Valley area (Wielkopolsko-Kujawska Lowland) in one of the fish farm ponds the presence of *H. polysperma* was noted. This pond is localized in a wide peat-containing plain of Lake Pątnowskie, near the complex of post peatland exploitation ponds to the north of Gosławice. The pond is in the neighbourhood of the Ślesiński Channel carrying the heated water released from the power plant "Pątnów". The distribution of new localities is presented in Figure 1.

The study was performed by the traditional hydrobiological methods (Starmach 1963, 1989, Bernatowicz and Wolny 1974, Kawecka and Eloranta 1994).

Taxonomic verification of *H. polysperma* was based on the papers by Anderson (1876), Cuda and Sutton (2000) and Hussner et al. (2007). The phytoplankton identification was made using the keys proposed by Starmach (1966, 1974, 1989).

On the locality with *H. polysperma*, a phytosociological relévе was taken and the water samples were collected for physico-chemical analysis. The samples were poured into three plastic containers. Two of the samples were immediately conserved: one by addition of 1 ml of concentrated sulphuric acid and the other by addition of 1 ml of 95% chloroform, while the third sample

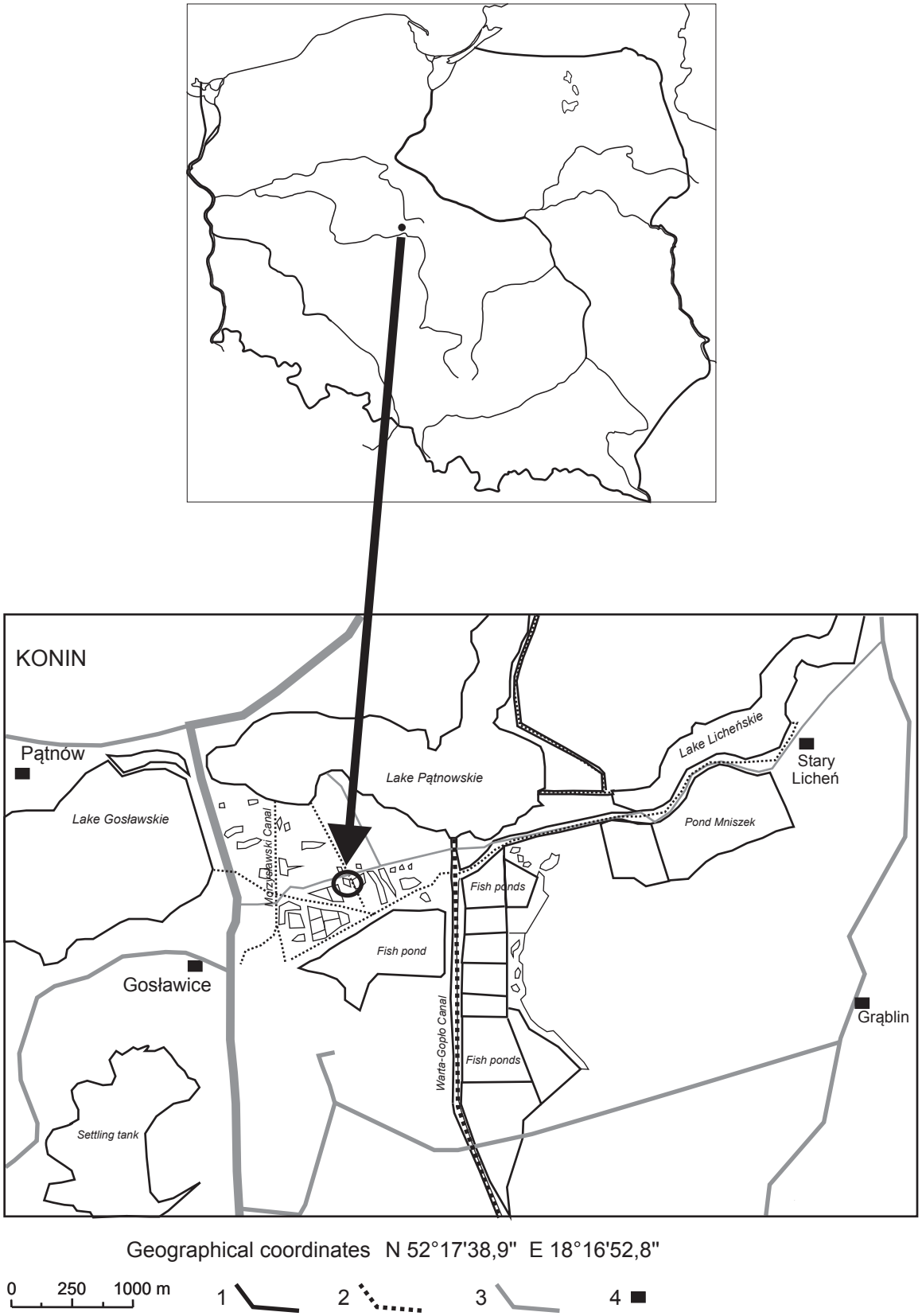

FIG. 1. Locations of site with *Hygrophila polysperma*: 1 – lakes, 2 – watercourse, 3 – roads, 4 – towns

was not conserved. Directly on the spot of collection the pH value, temperature, electrolytic conductivity, oxygen dissolved and water saturation with oxygen were measured. The other parameters were measured at laboratory. Physico-chemical analyses were performed according to the standard methods given by HERMANOWICZ et AL. (1998) and ELBANOWSKA et AL. (1999). Altogether 14 parameters were analysed: colour, pH, electrolytic conductivity, oxygen dissolved in water, water saturation with oxygen, the contents of NH_4^+, NO^{3-}, PO_4^{3-}, Na^+, K^+, Ca^{2+}, Mg^{2+}, SO_4^{2-} and Fe. The species structure of the phytoplankton and concentration of a-chlorophyll were

also determined in the pond with *H. polysperma*. The nomenclature of the vascular plant species is given after Mirek et al. (2002).

RESULTS

New localities

The new locality of *H. polysperma* was found in July 2008. Representatives of this species were found in the extensively used pond of the Fishing Farm Gosławice (Fig. 1). The locality is at about 1.5 km from Gosławice (N part of Konin), on the right side of the beaten tract from Gosławice to Stary Licheń. In the ATPOL grid square system (Atlas... 2001) it is localized in the square CD 18.

Hygrophila polysperma grew in an extensively used pond of the area close to 0.5 ha and the depth to 2 m, whose vegetation was dominated by macrophytes. The greatest was the contribution of *Ceratophyllum demersum* and *Nuphar lutea*. The shallow zones of the pond were grown with *Phragmites australis*. *Hygrophila polysperma* grew in a cluster of about 50 m^2, localised in the central part of the pond, together with *Hippuris vulgaris* for. *submersum*, *Ceratophyllum demersum*, *Polygonum amphibium* f. *natans*, *Lemna gibba* and *L. minor*.

The presence of the species was documented by taking a phytosociological relévе; date: 10.07.2008, the area: 16 m^2, cover 'c': 90%, *Hygrophila polysperma* 4.4, *Hippuris vulgaris* for. *submersum* 1.1, *Ceratophyllum demersum* +.

The stand of *H. polysperma* grew at the depth varying from 1 to 1.5 m, on organic support. The water in the pond had eutrophic character of high electrolytic conductivity and basic pH. It was characterised by a high concentration of nutrients. Table 1 presents physicochemical properties of water found in habitats of *H. polysperma*.

Table 1. Physico-chemical properties of water and concentration of chlorophyll *a* in locality with *Hygrophila polysperma*

Properties		
pH		7.94
Colour	mg Pt/l	24
Saturation with O_2	%	31
O_2 dissolved	mg O_2/l	3.1
Conductivity	µS/cm	611.8
NH_4-N	mg N/l	2.46
NO_3-N	mg N/l	0.2
PO_4	mg PO_4/l	0.88
Ca	mg Ca/l	76.4
Mg	mg Mg/l	12.4
Na	mg Na/l	32.1
K	mg K/l	8.2
SO_4	mg SO_4/l	86.4
Cl	mg Cl/l	7
Chlorophyll *a*	µg Cha/l	44.9

The phytoplankton of the pond was dominated by cyanobacteria (Cyanobacteria) from the orders of Nostocales – *Anabaena flos-aquae* (Lyngbye) Brébisson ex Bornet & Flauhault and Oscillatoriales – *Planktolyngbya limnetica* (Lemmermann) J. Komárková-Legnerová & G. Cronberg), along with Chlorophyta from the order of Volvocales – *Chlamydomonas globosa* J. Snow. It was interesting to note the presence of the following taxons typical of warm waters: *Cylindrospermopsis raciborskii* (Wołoszyńska) Seenaya & Subba Raju (Cyanobacteria), *Peridiniopsis berolinense* (Lemmermann) Bourrelly, *P. polonicum* (Wołoszyńska) Bourrelly and *P. cunninghtonii* Lemmermann in the pond.

Distribution and description of Hygrophila polysperma

Hygrophila polysperma (Roxb.) T. Anderson occurs naturally in India and Malaysia (Casper and Krausch 1981, Spencer and Bowes 1985, Cuda and Sutton 2000) and has been anthropogenically spread over the USA (Florida, Texas) and Mexico (Angerstein and Lemke 1994, Cuda and Sutton 2000); in Florida it has been treated as invasive species (Van Dijk et al. 1986, Cuda and Sutton 2000, Sutton and Dingler 2000). In Europe *H. polysperma* has been reported hitherto only from Germany (Hussner 2005, Hussner et al. 2007). For the first time it was reported from two localities in Northern Westphalia (Kaster Mühlenerft) and from River Erft of increased thermal regime in 2005, later it was found in Lake Fülinger near Köln (Hussner 2005, Hussner et al. 2007).

Many varieties of this species have been grown in aquaria since the 1840s when they were brought to Europe (Casper and Krausch 1981, Kamiński 1986). *H. polysperma* occurs naturally in slow-current warm rivers and lakes, rich in nutrients. It is a amphibian perennial of the stem length reaching even over 2 m (Hussner 2009). At the new locality in the pond near Konin the plants height did not exceed 30 cm (Fig. 2). *Hygrophila polysperma* has delicate stem, rarely branching from which at the same node two lanceolate leaves grow in the opposite pattern. The leaves are opposite, can have different shape, usually of the length of 3-5 cm and width of 1-2 cm (Hussner 2009). The tip is rounded and the base converging with no distinct petiole. At the base of the leaf blade, at the stem node, there is a ring of hair of up to 1.5 mm in length. The leaves are green, when exposed to strong illumination can get yellowish-pale green or pink. The colour is the most intense at the back of the leaf blade.

In shallow waters this species can create emerging forms (Spencer and Bowes 1985, Cuda and Sutton 2000). The above-water leaves are smaller and dark green. The invasive character of this species is related to its vegetative mode of reproduction, which has been noted in many countries. In the locality near Konin no blooming plants were observed (Cuda and Sutton 2000).

FIG. 2. Macroscopic habitus of *Hygrophila polysperma* (drawn by P.M. Owsianny)

DISCUSSION

The lakes from the vicinity of Konin, with warmed water, are an important site of invasion of alien water plants and animals (eg. BURCHARDT 1977, SOCHA 1996, SOCHA and ZDANOWSKI 2001, AFANASJEV et al. 2001, GĄBKA 2002, KRASZEWSKI 2006, HUTOROWICZ 2006). *Hygrophila polysperma* is a new alien species in the Polish flora found in this area. The response of water plants to pollution with post-cooling waters of higher temperature has been presented in details by many authors, e.g. DĄMBSKA (1976), BURCHARDT (1977), KRASKA (1988), SOCHA (1994), HUTOROWICZ (2006), HUTOROWICZ and HUTOROWICZ (2007) and HUTOROWICZ et al. (2007). As follows from the database on "Alien Species in Poland", in water reservoirs in Poland until the present, six geographically alien species of macroscopic submerged plants have been noted: *Chara connivens*, *Azolla filiculoides*, *Elodea canadensis*, *Lemna turionifera*, *L. minuta* and *Vallisneria spiralis* (SOLORZ, INTERNET a, BANASZEK and MUSIAŁ 2009). In neighbouring countries the number of neophytic macrophytes is different; from 24 species in Germany (VAN DE WEYER and HUSSNER 2008, HUSSNER 2008), through four in Lithuania, three in Slovakia and Czech Republic, while eight in the European part of Russia (NOBANIS 2009, DAISIE 2009, INTERNET b). The alien water plants are assumed to have spread through their use in aquaria or artificial pools (KAY et al. 2001, HUSSNER 2005) or to have been brought with ballast water (APPELGREN et al. 2004 and literature there cited). In the monograph of CASPER and KRAUSCH (1981), *H. polysperma* is treated as aquarium species that can potentially colonize water reservoirs on the Europa.

Dwarf hygrophil is presently treated as the invasive species whose abundant development can restrict biodiversity of water ecosystems, especially slow-current rivers (CUDA and SUTTON 2000). At the localities in Germany and the USA the species developed to cover substantial areas of the watercourses. As follows from the hitherto collected habitat data, *H. polysperma* prefers highly nutrient waters of basic pH, which has been confirmed by analysis of water from the site of its occurrence near Konin. The water from this fish pond was characterised by particularly high concentration of biogenes PO_4 and NH_4 and high content of *a* chlorophyll, suggesting a considerable biomass of phytoplankton. The parameters were characteristic of waters of high trophy.

An interesting problem is the response of *H. polysperma* to elevated temperature of water. According to the studies performed in Germany, this species colonizes water of relatively high temperature (HUSSNER et al. 2007), however, it is difficult to predict whether it will spread in the lakes near Konin. It should be emphasised that the locality at which it was found has water of lower temperature than the neighbouring lakes with post-cooling water. It cannot be excluded that the presence of abundant population of *H. polysperma* at this newly found locality is related to the anomalies in the air and water temperatures, being higher than the mean values over the last decades.

The newly found population of *H. polysperma* at the locality near Konin should be closely monitored to determine the dynamical tendencies of this population and the prospects of its spread over the near Konin situated warmed waters reservoirs.

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