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DRAGONFLIES (ODONATA) AND CADDISFLIES (TRICHOPTERA) OF WATER RESERVOIRS IN THE SUBURBAN LANDSCAPE OF ŚWINOUJŚCIE (NORTHWEST POLAND)

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SYNOPSIS

In 2007, ten dragonfly species and eight caddisflies species were recorded in periodical water reservoirs situated at the site where a liquefied natural gas terminal was going to be constructed. The encountered dragonfly and caddisfly fauna was typical of periodical reservoirs. Three communities of these insects were differentiated. Faunistic similarities among the reservoirs only partly corresponded to habitat diversity and reservoir types, which might indicate that species composition depends also on colonization processes, which are well described by the model of ecological islands.

INTRODUCTION

Due to their small sizes, small water bodies are among these water ecosystems found in urbanized areas which are the most vulnerable to anthropogenic reshaping. In cities they are usually filled up and thus liquidated. Furthermore, being small and largely dependent on their surroundings, such water reservoirs are subject to rapid eutrophication and anthropogenic pollution.

Urbanization is a comparatively young process from the point of view of geology. The adjustment of species to environmental changes due to urbanization, i.e. synurbization, is a very interesting and important process. So far, the studies of synurbization have concentrated mainly on plants, mammals, birds and selected groups of terrestrial invertebrates. Few studies have been conducted regarding aquatic insects, including dragonflies and caddisflies inhabiting urbanized areas (Pietrzak, 2004) or agricultural land and the countryside (Szczepański, 2009).

The studies of small invertebrates inhabiting periodical water reservoirs are not very numerous due to little economic significance of such water ecosystems. So far, as far as dragonflies and caddisflies are concerned, in northern Poland, there have been studied only the periodical reservoirs of post-lakeland landscape (Fischer, 1959; Czachorowski & Szczepańska, 1991; Czachorowski & Zawal, 1994; Czachorowski, 1995; Buczyński, 2001; Zawal et al., 2004), urbanized areas (Pietrzak, 2004), and agricultural land (Czachorowski et al., 2000; Szczepański, 2009). A more comprehensive study, including a faunistic typology of small water bodies, has been conducted only with reference to caddisflies (Czachorowski, 1994).

The present study aims to display the results of research conducted on dragonfly and caddisfly larvae found in small water bodies situated in the suburban areas of the city of Świnoujście (northwest Poland) before a liquefied natural gas terminal was constructed in the area. Further studies are planned to take place in the future in order to identify the impact of anthropogenic changes on species composition of insects inhabiting small water bodies which are affected by urbanization processes.

The studied area is situated away from the zones characterized by a high nature value, as these are situated mostly in the southern part of Świnoujście. It is a suburban area, subjected to the pressure exercised both by the nearby seaport and by tourists. It covers ca. 47ha and can be roughly described as a rectangular bordered by the following streets: Barlickiego, Ku morzu and Artyleryjska. It is a non-built-up area, intended for use connected with the seaport and sea economy. The construction of a liquefied natural gas terminal in Świnoujście is planned in this area.

The area in question is diversified with reference to habitats that can be encountered within it. There can be observed a stripe pattern regarding particular habitat types, with various habitat types parallel to the sea coast and including the following: winter beach with initial vegetation; yellow dunes with willows; grey dunes; marshy depression with alders; alder riparian forest and considerably altered forest patches with oaks, birches and willows; raised area with coastal forest; marshy depression with lowland peat bog and osiery; Baltic dune Scots pine woods, mostly cut down but with valuable parts still remaining, and an altered coastal forest. The neighbouring anthropogenic objects, i.e. streets, railways and buildings, are covered with dry grasslands and heaths.

Small water reservoirs located in the area are situated in depressions. Three reservoirs are located within the boggy stripe with alders. Reservoir 1, located near a railway (53°54’57” N, 14°17’36” E) is a dystrophic, comparatively shallow one, shaded by trees and osieries. It is covered with sparse emergent plants and less sparse submergent plants (*Lemna trisulca*). In all probability the reservoir dries out during the periods of dry and hot weather. Reservoir 2, situated in the neighbourhood of Reservoir 1 (53°54’61” N, 14°17’35” E), is smaller, deeper, and

less shaded. It is also characterized by better developed emergent vegetation and less lush submergent vegetation. Reservoir 5 is located within the same stripe (53°54'43" N, 14°17'39" E), next to the street Ku morzu. It is the largest of the three and covered with comparatively lush vegetation (*Sparganium* sp., *Lemna trisulca, Riccia fluitans*, *Glyceria* sp.). This reservoir is characterized by a high degree of astaticity. Next two: reservoir 3 ((53°54'43" N, 14°17'47" E) and reservoir 4 (53°54'47" N, 14°18'3" E) are situated in lowland bog and covered with sedges, grasses and osieries.

MATERIAL AND METHODS

Dragonflies and caddisflies were collected with hydrobiological sweep net from March till October 2007, at monthly intervals. In total, five water reservoirs situated at the future building site were studied.

The program "BiodiversityPro" was used to obtain the value of faunistic similarity coefficient calculated by Jaccard's method and Bray-Curtis's method and the value of species co-occurrence coefficient calculated by Bray-Curtis's method.

RESULTS

The dendrite showing similarities among the sites from the qualitative perspective (Fig. 1) allows to clearly differentiating a group of three sites, namely 1, 5 and 2, and a group of two sites, namely 4 and 5. The analysis of similarities from the quantitative perspective (Fig. 2) also allows distinguishing the group including sites 1, 2 and 5, while the other two sites do not form a clearly distinguished group. In the course of the study Reservoirs 2 and 4 were characterized by the absence of dragonflies. Furthermore, the presence of *Grammotaulius nitidus* and *Limnephilus vittatus* was observed only in Reservoir 3. Faunistic similarities partially corresponded to habitat diversity of the studied reservoirs. The faunistic separateness of Reservoir 3 might be connected with its most astatic character in comparison to the other two reservoirs.

In total, 307 specimens of dragonfly larvae were collected, belonging to 10 species (Tab. 1). The most numerously represented species was *Coenagrion puella*, followed by less numerously represented *Lestes sponsa, Sympetrum vulgatum, Coenagrion pulchellum* and *Enallagma cyathigerum*. The presence of dragonflies was not observed in Reservoirs 3 and 4, while in Reservoirs 1 and 5 all dragonfly species encountered in the studied area were observed. The identified dragonfly fauna may be considered typical of small periodical water bodies, including those combined with lowland peat bogs.

Table 1: Odonata in researched reservoirs.

Species	reservoir 1	reservoir 2	reservoir 5	Total
Aeshna cyanea	2		3	5
Coenagrion puella	30	46	33	109
Coenagrion pulchellum	9	9	17	35
Cordulia aenea	7	7	7	21
Enallagma cyathigerum	8	11	17	36
Lestes sponsa	13		24	37
Lestes virens	3		4	7
Libellula quadrimaculata	1	2	1	4
Sympetrum sanguineum	7	7	3	17
Sympetrum vulgatum	12	18	6	36
Total	92	100	115	307

In the studied water reservoirs the total of 264 caddisfly larvae were collected, representing 8 species (Tab. 2). The most numerously represented was *Limnephilus stigma*. Other comparatively numerously represented species included *Trichostegia minor, Holocentropus stagnalis* and *Limnephilus flavicornis*. All of the identified caddisfly species were typical of small periodical water bodies.

The analysis of species co-occurrence (Fig. 3) resulted in differentiating three rather clearly defined communities. The first of these, characterized by the highest level of similarities, included such species as *Limnephilus griseus, Lestes virens* and *Aeschana cyanea*. *Limnephilus griseus* is a species typically encountered in small periodical water bodies, which prefers water reservoirs located in an open landscape. *Aeschna cyanea* is a common species, encountered in all types of waters, including periodical waters. As for *Lestes virens*, it is also a common species, but inhabits stagnant waters, peatbogs and small midfield reservoirs.

Table 2: Cadisflies (Trichoptera) in researched resoivoirs.

Species	reservoir 1	reservoir 2	reservoir 3	reservoir 4	reservoir 5	Total
Analolia brevipennis					2	2
Grammotaulius nitidus			2		13	15
Holocentropus stagnalis	27	6				33
Limnephilus flavicornis	10	7	1	2	14	34
Limnephilus griseus	4	2	2	1	4	13
Limnephilus stigma	23	3	3	35	55	119
Limnephilus vittatus			1			1
Trichostegia minor	6	12	4	5	17	44
Total	72	30	13	43	106	264

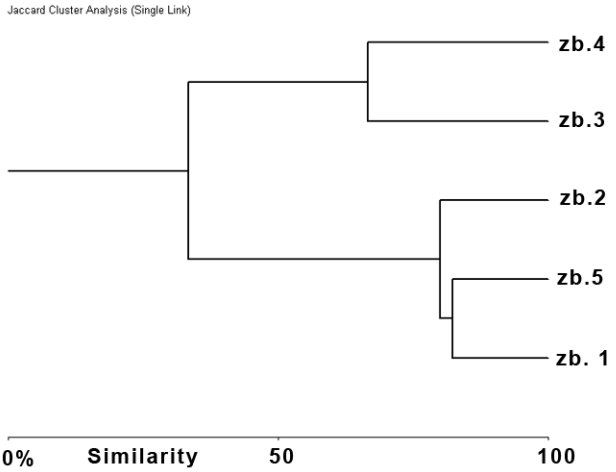

Figure 1: Dendrite of similarities among the studied water reservoirs according to the qualitative formula.

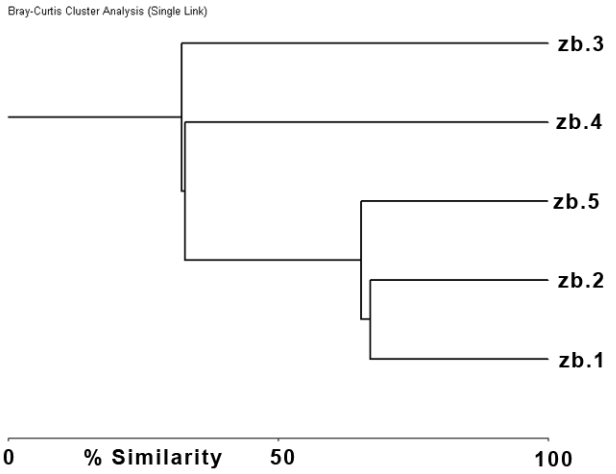

Figure 2: Dendrite of similarities among the studied water reservoirs according to the quantitative formula.

The second community included 8 species: *Limnephilus flavicornis* (eurytopic species typical of small periodical water bodies and comparatively small reservoirs with stagnant water), *Trichosteria minor* (typical species of periodical reservoirs situated in a forest), *Enallagma cyathigerum* (common species inhabiting stagnant waters, including acidic and peatbog waters), *Coenagrion pulchellum* (common species inhabiting stagnant waters), *Cordulia aenea* (eurytopic species), *Sympetrum sanguineum* (common species preferring small water bodies), *Lestes sponsa* (eurytopic species, inhabiting small water bodies) and *Sympetrum vulgatum* (common, eurytopic species). The third community included two species: *Limnephilus stigma* (typical of small periodical reservoirs with sedges) and *Coenagrion puella* (common, eurytopic species). The caddisfly species *Limnephilus*

vittatus was characterized by the lowest level of co-occurrence with the other studied species (Fig. 3).

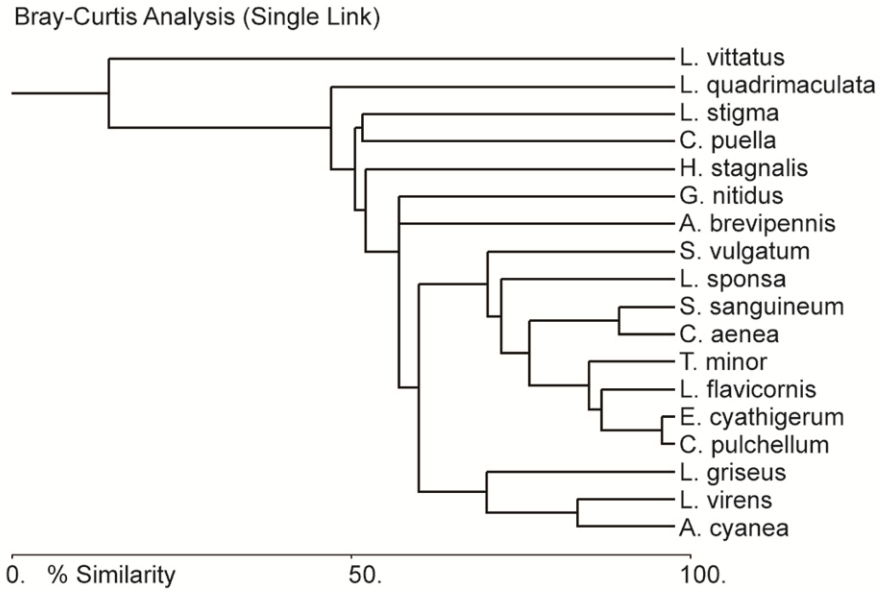

Figure 3: Dendrite of co-occurrence between dragonfly species and caddisfly species.

DISCUSSION

The fauna of dragonflies and caddisflies encountered in the studied periodical water reservoirs of the suburban landscape was typical of this type of reservoirs. It included species typical of small water bodies, eurytopic species and common species. A comparatively small number of encountered dragonfly species (10 species) and caddisfly species (8) resulted from the small number of studied reservoirs and their rather uniform character. Thus, it may be concluded that dragonfly and caddisfly fauna of the studied reservoirs is comparatively well preserved and has not been negatively influenced by human activity.

Two groups of sites were distinguished, but differences between the two were not large. Considerable variability of invertebrate fauna is typical for small water bodies (Czachorowski, 1994). Significant individuality and probably strong fluctuations of particular species abundance are well described by the model of ecological islands (Czachorowski, 1994; Czachorowski & Szczepańska, 1991), which also accounts for changes in the number of species, species composition and species abundance in particular years.

In small water reservoirs located in various landscapes of Poland the changes of caddisfly fauna inhabiting various types of waters have a continuous, gradiental

character (Czachorowski, 1994). Water reservoirs and caddisfly communities inhabiting them follow specific patterns determined by such major factors as stability – instability, eutrophy – dystrophy, and the temperature – oxygen factor (Czachorowski, 1994). The results of the present study remain in accord with results obtained by earlier studies.

The study on caddisflies inhabiting water reservoirs of two towns located in northern Poland, namely Złocieniec and Olsztyn (Pietrzak, 2004), showed that urbanization affected various species and groups of species in various ways. The reaction of these species to the urbanization processes depended not only on environmental factors, but also on individual features of particular species. There was observed a comparatively strong, positive interdependency between the growing urbanization and the abundance and number of *Hydropsychidae* species, as well as the diversity and specificity of *Hydropsychidae* larvae (caddisflies encountered in running waters). At the same time there was observed a weak, negative influence of urbanization and alteration of the reservoir shore zone on the abundance and number of species belonging to the genus *Limnephilus*, as well as the diversity and specificity of larvae representing the genus *Limnephilus* (Pietrzak, 2004). Advancing urbanization probably resulted in a drop in the number and diversity of typical stream species and changes in their habitat distribution.

Habitats within urbanized areas of northern Poland, which are the most vulnerable and endangered with destruction, include peatbogs, dystrophic reservoirs and small reservoirs (i.e. small water bodies, streams) (Pietrzak, 2004). On the other hand, studies on caddisflies encountered in the agricultural landscape showed that small water bodies were less sensitive to landscape changes than streams and small rivers (Szczepański, 2009). Thus, it might be expected that the construction of a gas terminal will not negatively influence the dragonfly and caddisfly fauna of small water bodies located in the area.

Dragonflies are aquatic insects which are easy to observe and have been studied comparatively extensively. Since the beginning of the 1990s in Poland there have been observed changes in the range of some species, as well as the appearance of species representing the southern distribution range (Bernard et al. 2009). These changes may be associated with climate warming. Simultaneously, it has been observed that southern species expanding towards the north very often inhabit water reservoirs characterized by a strong sunshine intensity, especially anthropogenic and post-excavation ones (Buczyński, 1999; Barnard et al., 2009). Therefore, it is an interesting question whether the anthropogenic changes resulting from urbanization processes contribute to the appearance of the species in question in Świnoujście.

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