

## MACROALGA *Ulva intestinalis* (L.) OCCURRENCE IN FRESHWATER ECOSYSTEMS OF POLAND: A NEW LOCALITY IN WIELKOPOLSKA

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**Summary.** A new locality of *Ulva intestinalis* was found near Kraplewo in the River Samica Stęszewska located in the Wielkopolski National Park region (Wielkopolska). On the basis of Carlson's index ranges, waters of the Samica Stęszewska river were qualified as eutrophic. In the river single thalluses of *U. intestinalis* which appeared by its banks were observed. The presence of this *Ulva* species thalluses in the Samica Stęszewska river confirmed the results of trophic examinations of this river. *U. intestinalis* is a species attached to eutrophic waters – both salty, slightly salty and inland. This next found site of this *Ulva* species is the 35th site on the inland area of Poland and the third in the Wielkopolska region. Altogether 59 localities of *Ulva* genera representatives, including *U. intestinalis* and 4 other species (*U. compressa*, *U. flexuosa*, *U. paradoxa*, *U. prolifera*) and one subspecies (*U. flexuosa* subsp. *pilifera*), were noted in limnic waters of Poland. The new locality of *U. intestinalis* in freshwaters of Wielkopolska contributes new and essential information about the distribution of this originally marine species on the inland area of Poland. The authors indicated the lack of studies in the scope of the mass thalluses influence from the *Ulva* genera on inland ecosystems and on water organisms inhabiting them.

**Key words:** *Ulva intestinalis* (*Enteromorpha intestinalis*), Chlorophyta, macroalgae mats, salinity, Wielkopolska region

### INTRODUCTION

*Ulva intestinalis* (L.), syn. *Enteromorpha intestinalis* (L.) Ness, is a macro green alga species, frequently found in the coastal zone of seas and oceans. As a cosmopolitan species, it is settling a majority of habitats connected with salty and slightly salty waters [Lee 1999, Kirchhoff and Pflugmacher 2002, Romano *et al.* 2003]. It is found also in sweetened out habitats connected with estuary waters [Zedler 1980, 1982, Pregall 1983, Pregall and Rudy 1985, Kwak and

Zedler 1997, Bäck *et al.* 2000, Kamer and Fong 2000, McAvoy and Klug 2005]. Sites of *U. intestinalis* in Europe are concentrated in north-western parts of the Baltic Sea. It is the most common species of the *Ulva* in the tidal zone between Finland, Sweden and Denmark coasts [Bonsdorff *et al.* 1997, Bäck *et al.* 2000]. In the Polish part of the Baltic Sea, *U. intestinalis* was found in the littoral zone of water bodies in the surroundings of about 25 towns, among others Władysławowo [Biernacka 1968, Pliński and Józwiak 2004], Świnoujście, Kołobrzeg, Łeba, Mielno or Ustronie [Pliński and Józwiak 2004]. The largest number of sites of this macro green alga species were observed in the Gdańsk Bay [Kornaś and Medwecka-Kornaś 1949, Biernacka 1961, Pliński *et al.* 1982, Pliński and Florczyk 1984, Pliński 1988, Haroon *et al.* 1999] and in the Pucka Bay [Fronczak and Pliński 1982, Pliński *et al.* 1982, Haroon *et al.* 1999, Pliński and Józwiak 2004]. The participation of *U. intestinalis* thalluses is the biggest with respect to other *Ulva* species being found in the Baltic Sea. At the Polish part of the Baltic Sea coast it is the most often registered species [Pliński *et al.* 1982, Pliński and Józwiak 2004].

*U. intestinalis* is a typical euryhalin species [Young *et al.* 1987, Edwards *et al.* 1988,]. Therefore, its tolerance to salting waters [Kornaś 1957] and the ability to adapt rapidly to changeable conditions of the environment [Kadłubowska 1975] has a significant influence on the distribution of this green alga in the basin of the Baltic Sea. *U. intestinalis* is able to persist and to develop in strongly sweetened waters as well as fresh waters [Reed and Russell 1979, Pringle 1986, Kamer and Fong 2000]. This potential enabled *U. intestinalis* settling many freshwater ecosystems in Europe, also such that are located far into the continent [Kirchhoff and Pflugmacher 2002].

There is a lack of analyses concerning the taxonomic classification of representatives of macroalgae from the *Ulva* and *Enteromorpha* genera in freshwaters, which often leads to their being excluded from consideration of the structure of phycoflora species richness of an investigated water body. Until recently, for the Wielkopolska area, two sites of *Ulva intestinalis* occurrence were described [Messyas – in press]. Different oral reports of *Ulva* thalluses appearing in waters of Wielkopolska are required for collecting and determining research material in order to confirm the species affiliation of particular individuals. The aim of this study was to describe the distribution of all known *U. intestinalis* sites in the area of Poland, taking into consideration the new Wielkopolska site at the Samica Stęszewska river.

#### STUDY AREA, MATERIALS AND METHODS

The research area was located near the village Krąplewo (south-west Wielkopolska region) in the Samica Stęszewska river. The studied river is situated in the Wielkopolski National Park area and constitutes one of left-side Warta river tributaries.

Samples of thalluses were taken into plastic containers and next were conserved using 4% concentrated formalin. The species identification was made on the basis of microscope slide observations performed for different parts of thalluses. This macroalga thalluses were examined with a light microscope at  $\times 20$  and  $\times 40$  magnifications, paying special attention to the shape, size and setting of cells in the thallus as well as the number of pirenoids in the cell.

The water samples for chlorophyll *a* analyses were taken at the river centre with current from the surface zone. The trophic condition was calculated using the  $TSI_{SD}$  and  $TSI_{Chl a}$  Carlson Index [Carlson 1977]. Physicochemical parameters (temperature, pH, dissolved oxygen) were determined in the field with the ELMETRON CX-401 Meter. Also, visibility was determined with the use of the Secchi discs.

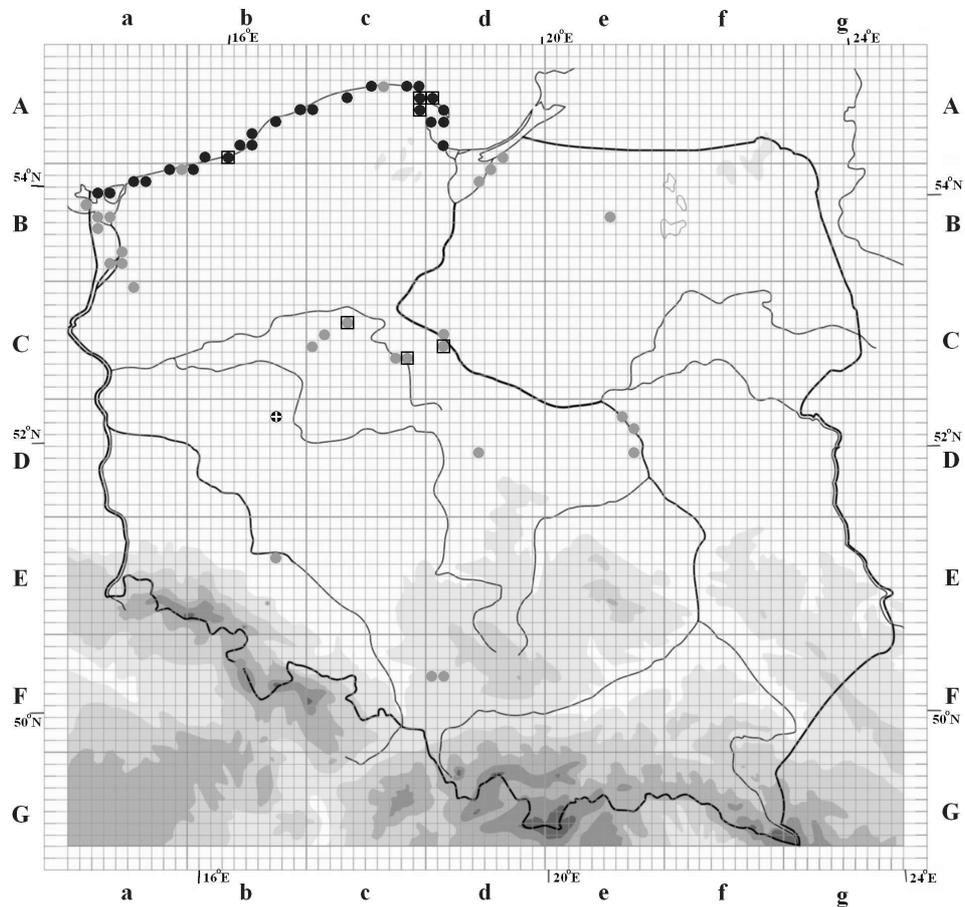


Fig. 1. Distribution of marine and freshwater sites of the green alga *U. intestinalis* in Poland on the map, with the use of the ATPOL grid: ● – known in the literature as sites in the littoral zone of the Baltic Sea, ● – known in the literature as inland sites, ⊕ – a new site in the Wielkopolska region, ■ – a few sites within one ATPOL square

Information about *U. intestinalis* distribution in Poland was based on all available limnological data. The marine and freshwater sites of this green alga were marked on the map of Poland using the ATPOL grid [Zajac and Zajac 2001]. The territory of Poland according to the above division is covered by 3646 squares with lengths of side  $10 \times 10$  km (Fig. 1).

## RESULTS AND DISCUSSION

The first inland site of *Ulva intestinalis* in Poland was found in 1849 [Göppert and Cohn 1850] in the Lower Silesia province near the towns Miękinia and Duszniki Zdrój. From 1850 till 2007, altogether 35 sites of *U. intestinalis* located in inland ecosystems of Poland were found. The following numbers of sites in particular provinces were recorded: Kuyavian-Pomeranian – 10 [Kozłowski 1890, Torka 1910, Raciborski 1910, Rouppert 1913, Liebetanz 1925, Namysłowski 1927, Wysocka 1952, Wilkoń-Michalska 1963], West Pomeranian – 9 [Piotrowska 1961, Kowalski 1975], Mazovian – 4 [Wysocka 1952, Podbielkowski 1969], Lower Silesia – 2 [Göppert and Cohn 1850], Pomerania – 2 [Preuschoff 1883, Pliński 1973a, b], Warmian-Mazurian – 2 [Nitardy 1904, Endler *et al.* 2006], the Wielkopolska region – 2 [Messyasz – in press], Lublin – 1 [Marczek 1954], Silesia – 1 [Kowalski 1975, basing on information from Jagielski and Zabawski 1954], Łódź – 1 [Pliński 1971]. *Ulva intestinalis* in the majority of freshwater and slightly salty types of inland ecosystems were taken down. It was observed in systems of natural origin (lakes, rivers, saltingses, brines, mineral springs), semi-natural (watercourses and drainage ditches) as well as anthropogenic ones (fish ponds, clay pits, pools) (Fig. 1). Altogether, this macroalga species was found in 8 Polish lakes, 6 small streams and 5 rivers. Isolated sites were concerned ponds, pit holes, navigation canals of brines or clay pits [Messyasz and Rybak – in press].

During phycological examinations led on the Wielkopolski National Park area in 1997 single thalluses of *U. intestinalis* in the small watercourse were observed. A new site of this species was located in the river Samica Stęszewska ( $52^{\circ}17'28,1''\text{N}$ ;  $16^{\circ}41'03,8''\text{N}$ ), flowing through the Wielkopolski National Park (Wielkopolska).

On the basis of water research findings collected from the site with *U. intestinalis* it was noted that the Samica Stęszewska river was characterised by eutrophic waters. Carlson's index value of the Secchi disc designed to the visibility was reached 73, while calculated on the basis of chlorophyll *a* concentration was lower at 44. Concentration of chlorophyll *a* at the site with *U. intestinalis* thalluses amounted to  $3.85 \mu\text{g}\cdot\text{l}^{-1}$ . During summer, pH value in the surface water ranged between 6.66 and 7.34. Moreover, the degree of the river waters saturation with oxygen was high and constituted 61.5%. The temperature of water was on the level of  $12.6^{\circ}\text{C}$ . Thalluses of *U. intestinalis* reached maximally the length of 25 cm and the breadth of 2.4 cm. The dying specimens were shorter than ma-

ture forms but they were marked by a greater breadth, amounting to 4 cm the at the most. Branching of thalluses was noted very rarely. Examined material from the Samica Stęszewska river in 83% contained alga thalluses without branches.

Thalluses of *U. intestinalis* in the Samica Stęszewska appeared singly by the river bank and they did not create thick mats freely floating on the water surface (macroalgae coatings), characteristic for species from *Ulva* genera. The observed new site of *U. intestinalis* in freshwaters is the third in the Wielkopolska region and the 35th site located on the inland area of Poland. Two remaining sites of *U. intestinalis* in the Wielkopolska region were in Lake Laskownickie (near Gołańcz) and in the Nielba river (surroundings of Wągrowiec). Thalluses of this species were found in above sites from May to July in 1993–2006 [Messyasz – in press]. However, on those sites thalluses of this green alga on the water surface formed thick mats exceeding the surface area of 20 m<sup>2</sup>, especially in Lake Laskownickie. In the case of the Nielba river, the surface area of mats of the macroalga was smaller (average of 2 m<sup>2</sup>) on account of the small width of this river. *Ulva intestinalis*, both in the river and in the lake sites, achieved a similar length of the thallus and rarely exceeded the size of 20 cm. In both aquatic ecosystems also rare appearance of thallus branches or their complete lack were a common feature of found *Ulva* thalluses. Filamentous algae, among others: *Cladophora* ssp. and *Oedogonium* ssp., accompanied this macro green alga mats.

*U. intestinalis* development in waters of the Samica Stęszewska is a confirmation of eutrophic state of this river, because this species very often appears in waters with increased trophic state where it finds favourable conditions for its development [Fletcher 1996, Graf *et al.* 2001]. The appearance of thalluses of *U. intestinalis* in the Samica Stęszewska river can result also from poor water quality of this river. The studied site is located near Stęszew, where large amounts of urban and industrial sewage are supplied to the Samica Stęszewska river. Similarly as in the Nielba river, numerous appearance of *U. intestinalis* at the site in the Samica Stęszewska was accompanied by mass development of filamentous algae from *Oedogonium* genera.

Monitoring of the appearance of species from the *Ulva* genera is very essential in inland waters of Poland. The importance of the control of *Ulva* thalluses distribution results above all from the bioindicator function performed by these species for polluted waters [Hernandez *et al.* 1997, Reed and Moffat 2003, Skwarzec *et al.* 2003, Żbikowski *et al.* 2005, Messyasz and Rybak 2008] as well as from potential disturbances which the development of thalluses may cause in water ecosystems [Sfriso *et al.* 1987, Valiela *et al.* 1992]. Large-scale appearance of thalluses of *U. intestinalis* in the littoral zone in the form of thick mats caused local disorders of habitat conditions [Sundbäck *et al.* 1990, Sfriso *et al.* 1992, Mäkinen *et al.* 1994, Narkko and Bonsdorff 1996, Bonsdorff 1997]. Mats of macroalgae often cause redevelopment of species composition in zoobenthic community and of fish living under mats, among others: creating anaerobic con-

ditions, limiting the nutrients availability and increased production of hydrogen sulphide from decaying thalluses [Raffaelli *et al.* 1991, Sfriso *et al.* 1992, Ahern *et al.* 1995, Romano *et al.* 2003]. So it is possible that these originally marine green algae, appearing on a large scale in inland waters of Poland can limit the development of freshwater zoobenthos and, in consequence, also that of their predators.

We receive numerous information that thalluses of species from the *Ulva* genera have often been met in a few lakes in the whole area of Wielkopolska [dr Piotrowicz and dr Gąbka – unpublished information]. However, we suppose that largely observed parts of these concentrations were thalluses of *U. intestinalis* – one of the most common *Ulva* species which is attached to average- and highly polluted limnic waters.

#### CONCLUSIONS

- *Ulva intestinalis* (*Enteromorpha intestinalis*) is the most common *Ulva* species in Poland.
- In Poland 35 inland sites of *U. intestinalis* were found in limnic waters since the year 1849.
- The sites of *Ulva intestinalis* are grouped in the north-western area in surroundings of the Oder mouth and in central Poland.
- Few and dispersed sites of *U. intestinalis* were found in the south of the country.
- Migration of this marine species into inland waters of the country took place mainly with river ways (river Vistula and river Oder) and probably through different unknown vectors.
- In the Wielkopolska region 3 sites of *U. intestinalis* appearance were described. Numerous notifications of *Ulva* thalluses development in water ecosystems of Wielkopolska require further and precise examinations for the purpose of taxonomic species identification.

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WYSTĘPOWANIE MAKROZIELENICY *Ulva intestinalis* (L.) W EKOSYSTEMACH  
SŁODKOWODNYCH POLSKI: NOWE STANOWISKO W WIELKOPOLSCE

**Streszczenie.** Nowe stanowisko *U. intestinalis* zostało odnalezione niedaleko Krąplewa w rzece Samica Stęszewska, zlokalizowanej na terenie Wielkopolskiego Parku Narodowego (Wielkopolska). Na podstawie zakresów indeksu Carlsona zakwalifikowano wody Samicy Stęszewskiej do eutroficznych. W rzece odnaleziono pojedyncze plechy *U. intestinalis*, które występowały przy jej brzegach. Obecność plech taśmy kiszkiwatej w Samicy Stęszewskiej potwierdza uzyskane wyniki badań nad trofią tej rzeki. *U. intestinalis* jest bowiem gatunkiem przywiązany do wód eutroficznych zarówno słonych, słonawych jak i słodkich. Kolejne odnalezione stanowisko taśmy kiszkiwatej jest 35. na terenie śródlądowym Polski oraz trzecim w Wielkopolsce. Wraz z *U. intestinalis* w wodach limnicznych Polski zanotowano łącznie 59 stanowisk 4 innych gatunków (*U. compressa*, *U. flexuosa*, *U. paradoxa*, *U. prolifera*) i jednego podgatunku (*U. flexuosa* subsp. *pilifera*) z rodzaju *Ulva*. Nowe stanowisko *U. intestinalis* w wodach słodkich Wielkopolski wnosi kolejne istotne informacje o rozmieszczeniu tego pierwotnie morskiego gatunku na terenie śródlądowym. Wskazano na brak studiów w zakresie wpływu masowego pojawu plech z rodzaju *Ulva* na ekosystemy limniczne i zamieszkujące je organizmy wodne.

**Słowa kluczowe:** *Ulva intestinalis* (*Enteromorpha intestinalis*), Chlorophyta, maty makroglonów, zasolenie, Wielkopolska