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NATURAL VALUES OF MARITIME SALT GRASSLANDS AND THE POSSIBILITIES OF THEIR PRESERVATION

Summary

The conducted research included the assessment of natural values of maritime salt grasslands located in Kępa Karsiborska, the determination of threats they are exposed to and, on the basis of the above, defining the possibilities of their preservation. Natural values of communities chosen as a result of the analysis of phytosociological relevés were assessed on the basis of the following: the coefficient of natural valorisation of Oświt (2000), the existence of protected and halophile species (Zarzycki et al. 2000). Whereas threats for the existence of halophile phytocenoses were defined through the analysis of environmental conditions assessed with the phytoindication method with Ellenberg's and Leuschner's (2010) coefficients and utilization. The results show that the highest, unique and remarkable natural values can be assigned to the following syntaxons: Hippuridetum submersae, community from Agrostis stolonifera, Eleocharietum palustris, Puccinellio-Spergularietum salinae, Cladietum marisci. They are conditioned especially by the presence of halophile species (mainly facultative ones) whose existence is strictly connected with strong soil salination, lightly acid soils' reaction and their moderate richness in nitrogen compounds. Some communities present transitional forms with none or only a few halophile species. For the maintenance of salt grasslands flora in Kępa Karsiborska, it is crucial to prevent the displacement of halophile species by extensive utilization (mowing or grazing) and by providing the canals network with salty water.
***Key words**: Kępa Karsiborska, halophile flora, natural values, environmental conditions*

WALORY PRZYRODNICZE SŁONAW NADMORSKICH I MOŻLIWOŚCI ICH ZACHOWANIA

Streszczenie

Prowadzone badania dotyczyły oceny walorów przyrodniczych słonaw nadmorskich zlokalizowanych na Kępie Karsiborskiej, określenia zagrożeń na jakie są narażone i na tej podstawie wskazanie możliwości ich zachowania. Walory przyrodnicze wyróżnionych w wyniku analizy zdjęć fitosocjologicznych zbiorowisk oceniono na podstawie: wskaźnika waloryzacji przyrodniczej Oświta (2000), występowanie gatunków chronionych oraz halofilnych (Zarzycki i in. 2000). Natomiast zagrożenia dla występowania fitocenoz halofilnych określono analizując warunki siedliskowe ocenione metodą fitoindykacji wskaźnikami Ellenberga i Leuschner (2010) oraz prowadzone użytkowanie. Uzyskane wyniki wskazują, że najwyższe walory przyrodnicze, unikalne i wybitne, uzyskują syntaksy: Hippuridetum submersae, zb. z Agrostis stolonifera, Eleocharietum palustris, Puccinellio-Spergularietum salinae, Cladietum marisci. Są one warunkowane szczególnie obecnością gatunków halofilnych (głównie fakultatywnych), których występowanie jest związane z silnym zasoleniem podłoża, słabo kwaśnym odczynem gleb i ich umiarkowaną zasobnością w związki azotowe. Niektóre zbiorowiska przedstawiają formy przejściowe w których jest brak lub niski udział gatunków halofilnych. Dla utrzymania roślinności słonaw nadmorskich na Kępie Karsiborskiej należy zapobiec wypieraniu gatunków halofilnych poprzez ekstensywne użytkowanie (koszenie lub wypas) oraz zapewnienie zasilania sieci kanałów wodami słonymi.
***Słowa kluczowe**: Kępa Karsiborska, roślinność halofilna, walory przyrodnicze, warunki siedliskowe*

1. Introduction and aim of the study

Small areas in Poland, where soils are highly saline as a result of natural environmental factors, are covered with halophytes (Czyż et al. 2010; Piotrowska 1961). Such terrains can be found both at the seaside and in central Poland. Due to their unique character, all such areas are legally protected and recognised as priority habitats within *Nature 2000* network (Pieńkowski et al. 2008, Piernik et al. 2005, 2007). However, the areas systematically shrink and, what follows, numerous halophytes species are endangered (Piotrowska 1976, Czerwiński 1996; Sągin 1999). It is supported by low soil salination and the limitation of intensive agricultural utilization of phytocenoses, which leads to the displacement of halophiles and expansion of species from *Phragmitetea* and *Molinio-Arrhenatheretea* classes (Czyż et al. 2010).

The aim of the conducted research was the assessment of the natural values of salt grasslands located in Kępa Karsiborska and furthermore, the indication of their and on that basis – the determination of possibilities of their maintenance.

2. Materials and methods

The area of *Kępa Karsiborska* located within the regressive delta of Świna river is the terrain of grazing for the farm animals of low livestock density (about 0.3-0.5 LSU/ha) and partly mowed.

The assessment of natural values was conducted in the vegetation season 2012-2013 on the basis of a multidimensional analysis of 63 phytosociological releves taken with Braun-Blanquet's method. Phytosociological releves were taken in the areas of 50-100 m^2. Featured syntaxons were analysed in terms of natural values assessed with Oświt's coefficient (2000) and, furthermore, the existence of pro-

tected species and halophiles (Zarzycki et al. 2000). The status of threat to species was defined in accordance with the Polish Red Book of Flora (Kaźmierczakowa et al. 2014), the red list of tracheophytes (Zarzycki, Szeląg 2006) and the list of extinction and endangered species in Western Pomerania (Żukowski, Jackowiak 1995).

Whereas the threat for the existence of halophile phytocenoses were defined upon an analysis of environmental conditions assessed with the phytoindication method with Ellenberg's and Leuschner's (2010) coefficients and the conducted utilization.

3. Results

Communities from 6 phytosociological classes were found in Kępa Karsiborska: Phragmitetea, Molinio-Arrhenatheretea, Scheuchzerio-Caricetea nigrae, Potametea, Asteretea tripolium, Isoëto-Nanojuncetea. The most frequent phytocenoses were the ones from Schoenoplectus tabernaemontani, Phragmitetum australis, from Juncus conglomeratus, from Carex nigra (Tab. 1).

111 floral species were found in the floral composition of the featured communities and the average number of the species in a phytosociological relevé was 11.5. Among all the featured taxons, 57 halophile taxons were observed including 10 obligatory ones. However, the communities differed in terms of the number of the halophile species. The most facultative halophytes were found in the phytocenoses from *Juncus conglomeratus* – 29. Whereas the lowest number of them was observed in *Hippuriedetum submersae* -3, all the species were halophytes, tough. *Potentilla anserina, Carex nigra, Eleocharis palustris, Festuca rubra, Galium palustre, Holcus lanatus, Lychnis flos-cuculi, Phragmites australis, Poa annua, Ranunculus repens, Ranunculus sceleratus, Trifolium pratense* were most numerous and often found among facultative halophytes, whereas among obligatory halophytes *Glaux maritima, Juncus gerardi, Lotus tenuis, Plantago maritima, Schoeneplectus tabernaemontani*.

Featured syntaxons showed high natural values and *Hippuridetum submersae*, community from *Agrostis stolonifera, Eleocharietum palustris, Puccinellio-Spergularietum salinae* – even unique values, *Cladietum marisci* – remarkable, and *Triglochino-Glaucetum maritimae*, community from *Schoenoplectus tabernomontana* - very large. Those great natural values are determined by the presence of as many as 15 protected species which:

- according to the Polish Red Book of Flora are labelled as endangered (*Carex chordorrhiza, Plantago maritima*) or critically endangered (*Carex nigra, Plantago coronopus*);
- according to the Red List of Tracheophytes are of an extinction – critically endangered status (*Plantago coronopus, Aster tripolium*), endangered (*Carex chordorrhiza, Epipactis palustris, Juncus gerardii, Lotus tenuis, Plantago maritima, Spergularia salina*), rare potentially endangered (*Glaux maritima*);
- are listed on the list of extinction and endangered species in Western Pomerania in the following categories: extinct and endangered (*Carex chordorrhiza, Cirsium rivulare, Plantago coronopus*), endangered (*Carex tomentosa, Epipactis palustris, Juncus gerardii, Lotus tenuis, Plantago maritima, Aster tripolium, Glaux maritima, Spergularia salina*), rare potentially endangered (*Cladium mariscus*).

Apart from the presented high natural values of the communities, their species composition is claimed to be transformed, which is connected with their displacement and even atrophy of halophile species characteristic to this areas, especially obligatory ones. It was confirmed by flora's phytosociological analysis which showed that it represents 19 phytosociological classes. Featured species were dominated by taxons from *Molinio-Arrhenatheretea* class (about 37.5% of all the species). The most species from this class were found in the undergrowth of *Triglochino-Glaucetum maritimae* (57.1%). Moreover, 21.5% of *Phragmitetea* class species were found in the area. A still negative halophile character of some communities was confirmed by the appearance of taxons from the communities from *Asteretea tripolium* class in their species composition, especially in the following phytocenoses: *Lolio-Cynosuretum* (36.4%), *Puccinellio-Spergularietum salinae* (27.3%), *Triglochino-Glaucetum maritimae* (21.4%). They cover the most saline habitats (S – more than 2.0), lightly acid soils (R – more than 7.3) and rich in nitrogen compounds (N – almost 7.0). Whereas transformations in the floral composition, which are proved with the lack or very low share of halophile species and species from *Asteretea tripolium* class, are connected with low salination and high moisture of the habitats (F of about 9) as well as with acid reactions of soils (R between 3 and 5) and low content of nitrogen compounds (N between 3 and 5) (Table 2).

Taking into consideration the listed dependencies, it can be claimed that the existence of salt grasslands in *Kepa Karsiborska* is endangered by:

- environmental variabilities, especially in terms of low salination, reaction and soil's trophism;
- the appearance of community species from *Phragmitetea* and *Molinio-Arrhenatheretea* classes as a result of none or rare mowing-grazing utilization.

Table 2. Values of coefficients in the assessment of environmental conditions of the featured communities

	Syntaxon															Research area
	Ph.a.	*com. with S.t*	*com. with A.s.*	*E.p.*	*C.m.*	*com. with C.e.*	*com. with H.l.*	*com. with J.c.*	*com. Pp-Fr*	*L-C*	*com. with C.n.*	*H.s.*	*P-S.s*	*T-G*	*com. with J.b.*	
F	8.06	8.95	9.00	8.60	8.88	7.12	6.72	7.21	6.90	6.30	6.80	10.0	6.25	6.67	6.69	7.61
S	0.61	2.46	0.08	0	1.54	0.50	0.62	0.25	0.42	2.30	0.89	2.25	3.79	1.83	1.03	0.99
R	6.35	7.02	5.75	3.0	7.34	5.69	4.98	5.06	5.54	7.13	5.08	8.50	7.34	5.89	6.07	6.05
N	5.21	5.26	4.67	3.25	4.50	5.24	4.89	4.93	4.92	6.75	4.66	6.0	6.97	5.0	6.54	5.25

Source: own work

Table 1. Natural values of salt grasslands in *Kępa Karsiborska*

	Syntaxon															Research area
	Ph.a.	*com. with S.t*	*com. with A.s.*	*E.p.*	*C.m.*	*com. with C.e.*	*com. with H.l.*	*com. with J.c.*	*com. Pp-Fr*	*L-C*	*com. with C.n.*	*H.s.*	*P-S.s*	*T-G*	*com. with J.b.*	
Number of species																
General	42	19	7	5	7	34	41	50	35	11	51	3	11	14	17	111
The average in phytosociological relevé	11.5	6.6	7	5	5	25	14	14.9	18	11	10.9	3	8.5	14	9.5	11.5
Facultative halophytes	13	13	4	4	4	18	21	29	18	4	14	2	4	9	4	47
Obligatory halophytes	4	-	-	-	-	5	3	2	2	4	4	1	5	3	3	10
Protected species	3	1	-	1	1	4	5	2	6	4	8	1	3	4	1	15
Participation of species (%)																
Facultative halophytes	59.5	68.4	57.1	80.0	57.1	52.9	51.2	58.0	42.9	36.4	27.5	66.7	36.4	64.3	23.5	42.3
Halofitów obligatoryjnych	9.5	-	-	-	-	14.7	7.3	4.0	4.8	36.4	7.8	33.3	45.5	21.4	17.7	9.0
Phytosociological structure (%)																
Ch *Phragmitetea*	14.3	42.1	57.2	40.0	42.9	11.8	10.0	16.0	8.6	-	6.0	66.7	-	-	6.3	21.4
Ch *Molinio-Arrhenatheretea*	38.1	31.6	-	20.0	42.8	44.1	47.5	52.0	51.4	54.6	44.0	-	54.6	57.1	25.0	37.5
Ch *Scheuchzerio-Caricetea nigrae*	7.1	10.5	28.6	40.0	14.3	11.8	7.5	8.0	8.6	-	12.0	-	-	-	-	9.9
Ch *Artemisietea vulgaris*	7.1	-	-	-	-	5.9	5.0	4.0	5.7	-	2.0	-	-	-	11.8	2.3
Ch *Bidentetea tripartitii*	7.1	-	11.3	-	-	5.9	-	2.0	-	9.1	2.0	-	18.2	-	17.7	5.1
Ch *Agropyretea intermedio-repentis*	-	-	-	-	-	-	-	4.0	2.9	-	6.0	-	-	-	-	0.9
Ch *Asteretea tripolium*	4.8	5.3				5.9	5.0	2.0	8.6	36.3	6.0	-	27.2	21.4	5.9	8.6
pozostałe	21.5	10.5	2.9	0	0	14.6	25.0	12.0	14.2	0	22.0	33.3	0	21.5	33.3	14.3
Natural valorisation value [Oświt 2000]																
	3.73	3.95	5.14	4.8	4.43	3.79	3.51	3.36	3.66	4.55	3.82	6.67	4.64	4.21	3.76	4.27
Class of values	VII	VIII	X	X	IX	VII	VII	VI	VII	IX	VII	X	X	VIII	VII	IX
Values	large values	very large values	unique	unique	outsta nding	large values	large values	moder ate	large values	large values	large values	unique	unique	very large values	large values	outstanding

Legend: *Ph.a. – Phragmitetum australis; com. with S.t.- Schoenoplectus tabernomontana*; *com. with* A.s. *– com. with Agrostis stolonifera; E.p. – Equisteum palustre; C.m. – Cladietum amrisci; com. with C.e. – com. with Calamagrostis epigejos; com. with H.l. - zb. with com. with Holcus lanatus; com. with J.c. – com. with Juncus conglomeratus; com. Pop-Fr – com. Poa pratensis-Festuca rubra; L-C – Lolium-Cynosuretum; com. with C.n. – com. with Carex nigra; H.s.- Hippuridetum submersae; P-S.s.- Puccinellio-Spergularietum salinae; T-G- Triglochino-Glaucetum maritimae; com. with J.b. - com. with Juncus bufonius*

Source: own work

4. Discussion

The transformations of halophyte flora in Kępa Karsiborska are observed since the 70s of the 20th century. The conducted research has confirmed the existence of only 10 obligatory halophytes, whereas according to Sągin (1999) – there are 21 taxons and to Piotrowska (1976) – 24 ones. Species such as *Plantago maritima, Glaux maritima, Juncus gerardi, Spergularia salina, Aster tripolium, Plantago coronopus, Atriplex prostrata,- Festuca arundinacea, Lotus tenuis, Schoenopletus tabernaemontani* still exist in *Kępa Karsiborska*, yet in such positions which are characterized by high salination as well as lightly acid and rich in nitrogen compounds soils (N – almost 7.0). The importance of such conditioning for the maintenance of halophile communities is emphasized by Niedźwiecki et al. (2006). Yet, they also claim that they are especially endangered by acid soil's reaction, significant content of organic matter and low salination. Czyż's et al. (2006) research has proved that stable salination of ground waters is the factor which determines the existence of halophytes in *Kępa Karsiborska* , whereas systematic shallow backwater of changeable salination is a less-meaningful factor.

The obtained results show that excessive moisturization does not support the existence of phytocenoses with halophytes. Having taken into consideration that the most of maritime communities of salt grasslands are of secondary character, their permeability and maintenance depends on the extensive mowing-grazing utilization. However, long-term excessive moisturization often impedes the utilization of undergrowth which may be one of the reasons for the lower share of halophytes as a result of displacement by taxons from *Phragmitetea* and *Molinio-Arrhenatheretea* classes. Under such conditions and by low soil salination, excessive growth of *Phragmites australis* and *Agrostis stolonifera* was observed. Simultaneously, drainage of the communities may also result in the displacement of halophytes. The dependency between the moisturization of habitats and utilization, and botanical composition of phytocenoses of salt grasslands is emphasized by Bockholt et al. (2002), Czyż et al. (2005), Kitczak and Czyż (2010).

Therefore, taking into consideration the results of our own research and the ones presented in the literature (Sągin 1999, Wikoń-Michalska 1986, Zander 2002, Czyż et al. 2003, 2010, Musielak, Rogalski 2006), the possibility of maintenance of salt grasslands in *Kepa Karsiborska* can be found in:

- mowing *Phragmitetum australis*, especially in June and July which would prevent the displacement of halophile species,
- extensive grazing with e.g. Polish primitive horses,
- partial renovation of amelioration system in order to control water management and enable the supply of salty water to the net of canals.

5. Conclusions

1. The highest natural, unique and remarkable values of the following syntaxons: *Hippuridetum submersae*, community from *Agrostis stolonifera*, *Eleocharietum palustris, Puccinellio-Spergularietum salinae, Cladietum marisci*, are conditioned especially by the presence of halophyle species (mainly facultative ones) whose existence is connected with strong salination of soils, their lightly acid reaction and moderate richness in nitrogen compounds.
2. Visible transformations in the floral composition of selected communities, which often represent transitional forms, with none or only a few halophile species and which represent *Asteretea tripolium* class, are strongly connected with low soil salination, high moisturization of habitats, acid reaction of soils and low content of nitrogen compounds.
3. What is crucial for the maintenance of halophile grassland – pasture areas in *Kępa Karsiborska*, is the prevention of the displacement of halophile species through extensive utilization (mowing or grazing) as well as the supply of salty water to the net of canals.

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