

Vegetation and flora in the vicinity of salt and brine extraction sites in the western part of Kuyavia (Poland)

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Appendix

Table A1. List of species, their frequency and abundance in 16 groups of relevés distinguished at the fourth level of TWINSPAN divisive classification.

Species group code in the dendrogram at the sixth level of division / The number of species per group	The group of relevés in the dendrogram at the fourth level of division		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	Σ
	The number of relevés per group		7	93	95	15	39	1	15	1	56	112	77	43	29	6	13	9	611
	The number of groups at further/lower levels of division (up to and including the sixth level)		3	4	4	4	3	1	4	1	4	4	4	4	4	3	4	4	55
	*Elements of technical infrastructure		P,T	P,R,D,M	P,R,D,H,T,M	D,P,R	P,R,D,M,H	P	P,D,R		P,D,R,H,L	P,D,R,M,S	D,R,P	D,R,P	P,R,D		P,D,R	D,P	TWINSPAN species group symbol
	**Type of water reservoir			d	d,c	d,c	p,c,d		p,c,d,l	p,l	d,p,c,h	d,p,c	d,p,c	d,c,p	c,p,d	p,d	p,d,c	c,d,p	
	The number of relevés by land use type:																		
	field		7	72	71	14	11	1	2		5	41	35	10	1				
	grassland			2	3		1				12	27	16	3	22	4	4	4	
	wasteland			15	15		16		6	1	21	36	17	22	5	2	9	4	
	other			4	16	1	11		7		18	8	9	8	1			1	
	Average vegetation cover in a relevé, %		15.71	56.34	71.34	72.69	78.95	1.00	88.20	95.00	86.59	74.33	61.70	83.91	89.24	67.17	90.00	83.89	
	Average number of species per relevé		1.29	5.25	5.43	6.75	6.92	1.00	7.27	8.00	5.45	5.23	3.32	4.30	8.97	9.17	6.46	5.89	
	Species name / **Geographical and historical group of species																		
A/4	<i>Raphanus raphanistrum</i> L.	Ar				^{2,3}						²							000000
	<i>Rorippa palustris</i> (L.) Besser	Sp		¹	²	²											²		000000
	<i>Stellaria media</i> (L.) Vill.	Ap		²	²	²					¹						²		000000
	<i>Triticum aestivum</i> L.	cultiv			^{1,2,3}	³						^{2,3}	^{2,3}						000000
B/2	<i>Senecio vulgaris</i> L.	Ar		^{1,2}	²	^{1,2}							²						000001
	<i>Chenopodium album</i> L.	Ap		^{1,2,3}	^{1,2,3}	^{1,2,3}	^{2,3}				^{1,2}	^{2,3}							000001
C/15	<i>Vicia sepium</i> L.	Sp		^{1,2}															000010
	<i>Echinochloa crus-galli</i> (L.) P.B.	Ar		²	^{1,2,3}	²			²			²							000010
	<i>Capsella bursa-pastoris</i> (L.) Medik.	Ar		²		²													000010
	<i>Atriplex patula</i> L.	Ap		^{2,3}	^{1,2,3}	²	²					^{1,2}	^{1,2}						000010
	<i>Polygonum aviculare</i> L.	Ap		^{2,3}	^{1,2,3}	^{2,3}	^{2,3}				³	^{1,2}	^{1,2}						000010
	<i>Galinsoga parviflora</i> Cav.	Kn		²	^{1,2}														000010
	<i>Secale cereale</i> L.	cultiv		¹	²														000010
	<i>Silene vulgaris</i> (Moench) Garcke	Ap			²	²													000010
	<i>Daucus carota</i> L.	Ap				²													000010
	<i>Agrostis capillaris</i> L.	Ap			²														000010
	<i>Thlaspi arvense</i> L.	Ar			²														000010
	<i>Brassica napus</i> L.	cultiv		³	^{1,2,3}							²							000010
	<i>Papaver rhoeas</i> L.	Ar			^{2,3}														000010
	<i>Amaranthus retroflexus</i> L.	Kn			²														000010
	<i>Pisum sativum</i> L.	cultiv			²														000010
D/7	<i>Anagallis arvensis</i> L.	Ar				²	¹												000011
	<i>Trifolium hybridum</i> L.	Sp								1 ³									000011
	<i>Trifolium dubium</i> Sibdh	Ap								1 ²									000011
	<i>Poa annua</i> L.	Ap			²	²	²												000011
	<i>Convolvullus arvensis</i> L.	Ap			²	²	²		²		²								000011
	<i>Melilotus alba</i> Medik.	Ap			²		²												000011
	<i>Trifolium pratense</i> L.	Ap			²		²												000011
E/2	<i>Lepidium rudera</i> le L.	Ar		^{1,2,3}	^{1,2,3}		^{1,2,3}				^{1,2}	^{1,2}							000100
	<i>Tripleurospermum inodorum</i> (L.) Sch. Bip.	Ar		^{1,2}	^{1,2,3}	^{1,2}	^{1,2}		^{2,3}		²	^{1,2}	²	²	²			²	000100
F/1	<i>Elymus repens</i> (L.) Gould	Ap		^{1,2,3}	√ ^{1,2,3}	^{2,3}	^{2,3}		^{2,3}		^{1,2,3}	^{1,2,3}	^{1,2}	^{1,2,3}	^{2,3}		²		000101
G/1	<i>Phalaris arundinacea</i> L.	Ap		²	^{2,3}				²		³		¹	²	²				00011
H/1	<i>Lolium perenne</i> L.	Ap		²			²		²		¹	²		²					001000
I/1	<i>Lactuca serriola</i> L.	Ar		²	²		²					²			²		^{1,3}		001001

J/5	<i>Melilotus officinalis</i> (L.) Palla	Ap					²												001010	
	<i>Carum carvi</i> L.	Ap					²												001010	
	<i>Rubus caesius</i> L.	Ap					²												001010	
	<i>Artemisia absinthium</i> L.	Ap			²		^{2,3}												001010	
	<i>Cichorium intybus</i> L.	Ar		¹	²		^{1,2,3}	1 ²											001010	
K/7	<i>Agrostis gigantea</i> Roth	Ap		²			²			1 ²				²					001011	
	<i>Artemisia vulgaris</i> L.	Ap			^{1,2}		^{1,2}		^{2,3}		²	^{1,2}		²	²				001011	
	<i>Rumex acetosa</i> L.	Ap			²		²		²					²			³		001011	
	<i>Matricaria chamomilla</i> L.	Ar			²		^{2,3}					²							001011	
	<i>Taraxacum officinale</i> Weber coll.	Ap		²	^{1,2}		^{V1,2,3}		^{2,3}		²	²			²		²		001011	
	<i>Medicago lupulina</i> L.	Ap			²		²		²						²	²			001011	
	<i>Achillea millefolium</i> L.	Ap		²	^{2,3}	²	^{V1,2,3}		^{2,3}		²	²		²	²	²		²	001011	
L/1	<i>Persicaria lapathifolia</i> (L.) Delarbre	Ap			²				²						²				001100	
M/2	<i>Plantago major</i> L.	Ap		²	²	²	^{2,3}			1 ²			²		²	²	^{2,3}		²	001101
	<i>Sonchus oleraceus</i> L.	Ar		²	^{2,3}	²	²		²			^{1,2}	²	¹	^{2,3}		²			001101
N/1	<i>Sonchus arvensis</i> L.	Ap		²	²		^{1,2,3}		²		^{2,3}	²		²	²		²	²		001110
O/2	<i>Rumex maritimus</i> L.	Ap	³		³		²		³		²						³			001111
	<i>Cirsium arvense</i> (L.) Scop.	Ap		²	²	²	^{2,3}		^{2,3}	1 ²	²	²			²	^{2,3}	^{2,3}	²		001111
P/1	<i>Avena sativa</i> L.	cultiv		²		^{1,2,3}						²	^{1,2}							0100
Q/1	<i>Chenopodium glaucum</i> L.	Ap	^{V2,3}	^{1,2,3}	²	²							^{1,2,3}	¹						0101
R/1	<i>Puccinellia distans</i> (Jacq.) Parl.	Ap	²	^{V2,3}	^{V1,2,3}	^{1,2,3}	^{V1,2,3}		^{1,2}		^{IV2,3}	^{V2,3}	^{IV 1,2,3}	^{V2,3}	^{1,2,3}	^{2,3}	^{2,3}	²		01100
S/1	<i>Erigeron canadensis</i> (L.) Cronq.	Kn			²						²	²					²			01101
T/1	<i>Lotus corniculatus</i> L.	Ap					²					²							²	011100
U/1	<i>Hypericum perforatum</i> L.	Ap					^{1,2}					²								011101
V/1	<i>Plantago lanceolata</i> L.	Ap			²		²									²				01111
a/1	<i>Hordeum vulgare</i> L.	cultiv		²		^{2,3}						²	^{1,2}							10000
b/1	<i>Festuca pratensis</i> Hudson	Ap		²							²									100010
c/1	<i>Atriplex sagittata</i> Borkh.	Kn		^{2,3}	^{1,2}		^{2,3}				^{1,2,3}	^{1,2,3}	²	²				²		100011
d/2	<i>Acorus calamus</i> L.	Kn			²						³					²				100100
	<i>Beta vulgaris</i> L.	cultiv			²						^{2,3}									100100
e/2	<i>Chelidonium majus</i> L.	Ap			^{1,2}								²	²						100101
	<i>Chenopodium rubrum</i> L.	Ap		²		²					^{1,2}	^{2,3}				²				100101
f/1	<i>Spergularia marina</i> (L.) Besser (= <i>Spergularia salina</i> J. Presl & C. Presl)	Ap		^{1,2,3}	^{1,2,3}	^{2,3}	^{1,2,3}				^{2,3}	^{V1,2,3}	^{2,3}	^{1,2}	²					100110
g/2	<i>Rumex obtusifolius</i> L.	Ap										²								100111
	<i>Epilobium palustre</i> L.	Sp										²								100111
h/5	<i>Iris pseudacorus</i> L.	Sp									²									101000
	<i>Althaea officinalis</i> L.	Ap									²									101000
	<i>Cerastium fontanum</i> subsp. <i>Vulgare</i> (Hartm.) Greuter & Burdet	Ap									³									101000
	<i>Armoracia rusticana</i> P. Gaertn., B. Mey. et Scherb.	Ar									²									101000
	<i>Urtica dioica</i> L.	Ap									^{2,3}	²						¹		101000
i/2	<i>Atriplex prostrata</i> Boucher ex DC.	Ap		^{1,2,3}	^{2,3}	^{2,3}	^{2,3}				^{V2,3}	^{IV1,2,3}	^{1,2,3}	^{1,2,3}	^{1,2}	²	^{2,3}	²		101001
	<i>Dactylis glomerata</i> L.	Ap										²								101001
j/1	<i>Salicornia europaea</i> L. (= <i>Salicornia herbacea</i> (L.) L.)	Ap									²	^{1,2,3}	^{V1,2,3}	^{1,2,3}	¹					101010
k/2	<i>Tripolium pannonicum</i> (Jacq.) Dobrocz. (= <i>Aster tripolium</i> L.)	Ap							³		^{1,2,3}	²	^{2,3}	^{IV1,2,3}	^{2,3}			^{V2,3}		101011
	<i>Epilobium angustifolium</i> L.	Ap												²			¹			101011
l/2	<i>Poa angustifolia</i> L.	Ap									²		²		²					101100
	<i>Alopecurus geniculatus</i> L.	Ap									³			³		²		²		101100
m/2	<i>Bolboschoenus maritimus</i> (L.) Palla (= <i>Scirpus maritimus</i> L.)	Sp		³	^{2,3}	²	^{1,3}		^{2,3}		^{1,3}	^{1,2}			^{2,3}	²	^{IV2,3}	^{2,3}		101101
	<i>Phragmites australis</i> (Cav.) Trin. ex Steudel	Sp							^{1,2,3}		^{1,2,3}	^{1,2}	^{1,2}	^{2,3}	^{2,3}		^{2,3}	^{2,3}		101101
n/6	<i>Festuca arundinacea</i> Schreb.	Ap			²				³		²	²	²	²	^{2,3}	³	²	²		101110
	<i>Juncus compressus</i> Jacq.	Ap			²		²			1 ²	^{1,2,3}	²	²	^{1,2}	^{2,3}	²	³			101110
	<i>Odontites verna</i> (Bell.) Dumort.	Ar							²					²		³		³		101110
	<i>Mentha arvensis</i> L.	Ap							¹					²		²	²	²		101110
	<i>Eleocharis palustris</i> (L.) Roem. et Sch.	Sp										²		^{1,2}	^{1,2}	^{1,2}	^{1,3}	²		101110

	<i>Agrostis stolonifera</i> L.	Ap		I ²				I ²		I ²				I ²	I ^{2,3}	II ^{1,3}	II ²	II ²	II ²	101110
	<i>Bidens tripartita</i> L.	Ap									I ²					I ¹	III ^{2,3}	II ^{1,2}		101111
	<i>Deschampsia cespitosa</i> (L.) P.B.	Sp						I ²			I ²	I ²	I ²	I ²		II ^{2,3}		II ^{2,3}		101111
	<i>Lysimachia maritima</i> (L.) Galasso, Banfi & Soldano (= <i>Glaux maritima</i> L.)	Sp									I ²	I ^{2,3}	I ²	I ²		II ^{2,3}	II ³	I ²	I ³	101111
	<i>Triglochin maritima</i> L.	Sp						I ²				I ^{2,3}	I ²	I ²		II ^{2,3}		I ³	II ³	101111
	<i>Carex cuprina</i> (Sándor ex Heuff.) Nendtv. ex A.Kern.	Sp												I ²		I ^{2,3}		III ²		101111
	<i>Lotus tenuis</i> Waldst. & Kit. (= <i>Lotus tenuifolius</i> C. Presl)	Sp										I ^{1,2}				I ^{2,3}			II ²	101111
	<i>Lotus maritimus</i> L. (= <i>Lotus siliquosus</i> L.)	Sp														I ²				101111
	<i>Melilotus dentatus</i> (Waldst. & Kit.) Desf.	Sp										I ²				I ²			II ²	101111
	<i>Calamagrostis epigejos</i> (L.) Roth	Ap														I ^{1,2}				101111
	<i>Carex hirta</i> L.	Ap														I ²				101111
	<i>Thymus pulegioides</i> L.	Sp														I ¹				101111
	<i>Trifolium repens</i> L.	Ap											I ¹			I ^{2,3}	IV ^{2,3}			101111
	<i>Erodium cicutarium</i> (L.) L'Hér.	Ap														I ¹				101111
	<i>Carex distans</i> L.	Sp														I ²				101111
	<i>Carex vulpina</i> L.	Ap															I ²			101111
	<i>Bromus hordeaceus</i> L.	Ap														I ²				101111
	<i>Ranunculus sceleratus</i> L.	Ap															I ²			101111
	<i>Holcus lanatus</i> L.	Ap														I ²				101111
	<i>Veronica agrestis</i> L.	Ar																I ²		101111
	<i>Ranunculus repens</i> L.	Ap														I ²		I ^{1,2}		101111
	<i>Galium aparine</i> L.	Ap																I ²		101111
	<i>Euphorbia lucida</i> W. et K.	Sp																	II ^{1,2}	101111
	<i>Schoenoplectus tabernaemontani</i> (C. C. Gmel.) Palla	Sp			I ²			I ²				I ³				I ^{2,3}		III ^{2,3}		101111
p/1	<i>Tanacetum vulgare</i> L.	Ap						I ²				I ²								110000
q/1	<i>Senecio vernalis</i> Waldst. & Kit.	Kn						I ²					I ²							110001
r/1	<i>Blysmus compressus</i> (L.) Panzer ex Link	Sp							I ^{1,2}			I ^{1,2}								11001
	<i>Rumex crispus</i> L.	Ap							I ²								I ²			110100
	<i>Geranium pratense</i> L.	Ap						I ²								I ^{2,3}				110100
t/1	<i>Trifolium fragiferum</i> L.	Sp						I ²		IV ³	1 ³	I ²	I ^{1,2,3}			III ^{2,3}	II ³	I ¹		110101
u/1	<i>Plantago major</i> subsp. <i>intermedia</i> (DC.) Arcang.	Ap		I ²	I ^{2,3}	I ²		I ²		III ^{1,2,3}		I ²	I ²			IV ^{2,3}	III ²			110110
v/1	<i>Inula britannica</i> L.	Ap						I ²						I ²		I ^{1,2}	I ¹			110111
w/1	<i>Poa pratensis</i> L.	Ap							I ²							I ^{2,3}	I ²	I ²		111000
x/1	<i>Potentilla anserina</i> L.	Ap			I ³			I ²		II ^{2,3}		I ²	I ^{2,3}		I ^{1,2}	IV ^{2,3}	V ^{1,2,3}		II ^{1,2}	111001
y/1	<i>Scorzoneroides autumnalis</i> L.	Ap		I ²	I ²											I ²	III ²			11101
z/1	<i>Juncus articulatus</i> L.	Sp							I ²	1 ²						I ²		I ²		1111
	TWINSPAN species group symbol		0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	
			0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	1	
			0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	1	
			0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	1	

Note:

*Elements of technical infrastructure: P – brine pipeline; T – graduation tower, R – railway track; D – soda waste heap; M – salt mine; H – highway, L – salty lime slurry ponds; S – sewage pipeline.

**Type of water reservoir: c – the Noteć Canal; d – drainage ditch; h – wet topographic depression; l – lake; p – pond.

***Names of halophyte species are in bold; the names of obligate halophytes are underlined.

****Geographical and historical group of species: Ar – archaeophyte; Ap – apophyte; Kn – kenophyte; Sp – spontaneophyte; cultiv – cultivated plant.

I–V – constancy in each group of relevés: I – 1–20%; II – 21–40%; III – 41–60%; IV – 61–80%; V – 81–100%.

^{1, 2, 3} – species cover classes according to cut levels; the most common class is marked in bold.

Table A2. Percentage of geographical and historical groups of species in the 11 compared floras.

Group of species	Site										
	K-s1-N	K-s2	K-s3	K-s4	K-s5	PL-s6	K-ns1	K-ns2	G-ns1	G-ns2	G-ns3
Sp	18.80	32.86	26.92	28.57	0.00	33.33	45.86	35.00	16.89	12.54	27.89
Ap	62.39	48.76	67.31	62.14	73.90	49.52	50.38	55.71	58.86	62.70	56.41
Ar	13.68	11.66	4.81	7.14	17.27	8.10	3.01	6.43	11.44	9.97	8.33
Kn	5.13	3.54	0.96	1.43	8.03	5.24	0.75	2.14	9.81	10.29	6.41
DF	0.00	3.18	0.00	0.72	0.80	3.81	0.00	0.72	3.00	4.50	0.96
Source of data for calculations	Karasińska (2004)	Pisarek (1995)	Wilkoń-Michalska (1963, 1970)	Wilkoń-Michalska (1963)	Wilkoń-Michalska & Sokół (1969)	Piernik (2012)	Kucharski (1993)	Wilkoń-Michalska & Dmitrenko (1974)	Ratyńska (2003)	Ratyńska (2003)	Ratyńska (2003)

Symbols of the compared sites:

K-s1-N – Western Kuyavia, salt marsh vegetation on the banks of the Noteć River and the Noteć Canal, the study area N;

K-s2 – Eastern Kuyavia, Zgłowiączka River valley;

K-s3 – Ciechocinek nature reserve of halophytes in 1954-1965;

K-s4 – Kuyavia, halophytic plant communities of Kuyavia;

K-s5 – Western Kuyavia, Mątwy and Janikowo localities, limestone heaps and deposits of saline lime sludge;

PL-s6 – Poland, inland salt marshes;

K-ns1 – Southern Kuyavia, vegetation of hydrogenic soils, anthropogenic origin;

K-ns2 – Kuyavia, Gniewkowo terrain depression, shores of periodic floodplains in agricultural landscape;

G-ns1 – Greater Poland, Główna River catchment, biotopes with herbaceous, meadow, grassland and ruderal vegetation;

G-ns2 – Greater Poland, Główna River catchment, mesophilous meadows and grasslands (Ratyńska, 2003);

G-ns3 – Greater Poland, Główna River catchment, flora of wet grasslands.

Symbols of species group: Sp – spontaneophytes; Ap – apophytes; Ar – archaeophytes; Kn – kenophytes; Df – Diaphytes.