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INTERPOPULATION VARIABILITY OF *LEYMUS ARENARIUS* (L.) HOCHST.

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ABSTRACT. The paper reports results of a biometric study of four features of *Leymus arenarius* (L.) Hochst. caryopses on the basis of 23 samples collected at marine and inland sites. The productivity of caryopses in the spike and the strength of their germination were determined.

Key words: *Leymus arenarius*, variability, caryopses, Poland, dunes

Introduction

The range of occurrence of *Leymus arenarius* (L.) Hochst. covers central and northern Europe, Syberia and North America, it does not occur in the Mediterranean sea basin (**Podbielkowski** 1992). Together with *Ammophila arenaria* (L.) Link, *Leymus arenarius* (L.) Hochst. forms the association *Elymo-Ammophiletum* Br.-Bl. et de Leeuw (1936), growing on white dunes. It has pioneer character because the plants forming this association are the first to colonise the running sand. It develops on dunes of different exposition and slope angle, on the sand of pH close to neutral and with the deep ground water table. The components of this association show full viability only at the sites which are continuously and rather strongly buried with sand. Because of the important role it plays in sea shore strengthening, this association is under full protection (**Piotrowska** and **Celiński** 1965, **Piotrowska** and **Stasiak** 1984 a, 1984 b).

At the border between the beach and the white dune, over the accumulation sections of the coastline, the initial subassembly *Elymo-Ammophiletum honckenyetosum* develops. Its components cover only from 5 to 35% of the area, but make a sufficient barrier for the quick sand thanks to which the first microdunes appear (Piotrowska 1997). In Poland *Leymus arenarius* (L.) Hochst as a native plant grows along the Baltic sea coast, apart from that it has been planted or introduced on inland dunes and borders of pine forests.

The lyme grass is a massive perennial reaching 1.5 m height, of erected bare and unbranched blades. The leaf blades are stiff, prickly, of 1-2 cm in width, flat, rarely a little rounded. From the top they are slightly coarse with clearly protruding nerves, while from the bottom they are smooth (Klimko 1975). The sheath is bare and smooth; the spike erected, of about 30 cm in length and 2.5 cm in width, stiff and somewhat frayed at the bottom, made of spikelets of 2-3 cm in length. The spikelets are usually with three flowers, awnless, arranged in pairs at the opposite sides of the torus. Glumes are with distinct ridge of almost the same length as the spikes, cuspidate and rather stiff. The bottom glumes are cuspidate and hairy. The caryopses with the glumes are longitudinally lanceolate, of up to 10 mm in length, blue-green and whitish or yellowish (Szafer et al. 1969).

The aim of the paper was to analyse the variability of caryopses of *Leymus arenarius* (L.) Hochst on the basis of analysis of selected features in individuals from the marine and inland populations. The results were expected to allow determination of the scale of variability of the features studied, the structure of the surface of glumes and caryopses (SEM observations) and the productivity of the caryopses. Microphotographies were taken at the SEM laboratory at the Adam Mickiewicz University, Poznań.

Material and methods

The material to be studied was collected at 13 marine sites: 1 – Świnoujście, 2 – Międzywodzie, 3 – Dziwnów, 4 – Pogorzelica, 5 – Pogorzelica, 6 – Kołobrzeg, 7 – Kołobrzeg, 8 – Mielno, 9 – Mielno, 10 – Jarosławiec, 11 – Ustka, 12 – Ustka, 13 – Poddębnie, 14 – Rowy, 15 – Rowy, 16 – Rowy, 17 – Łeba, 18 – Białogóra, 19 – Jantar, 20 – Piaski and three inland sites: 21 – Mogilno, 22 – Koziegłowy, 23 – Pyzdry (Fig. 1).

To assess morphological variability of *Leymus arenarius*, 25 randomly chosen spikes were collected at each site and from each of them 30-50 caryopses were characterised. The following four features of the caryopses were analysed: length (1), width (2), length of hair on the glume (3), the ratio of the width to the length (4). The method of measurements is illustrated in Figure 2.

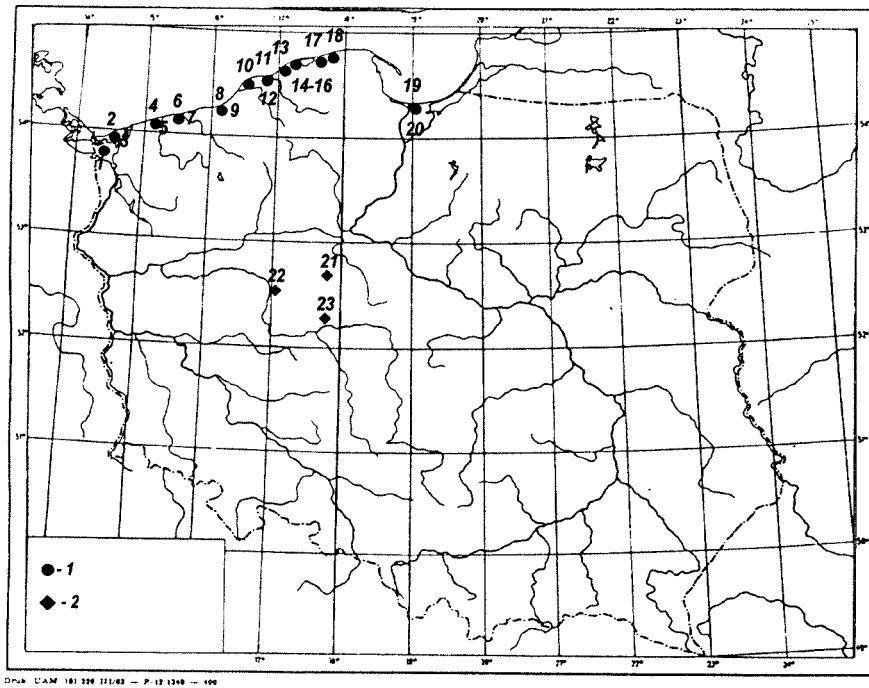


Fig. 1. Localisation of the samples of *Leymus arenarius* (L.) Hochst.: 1 – marine samples, 2 – inland samples
 Ryc. 1. Rozmieszczenie prób *Leymus arenarius* (L.) Hochst.: 1 – próby nadmorskie, 2 – próby śródlądowe

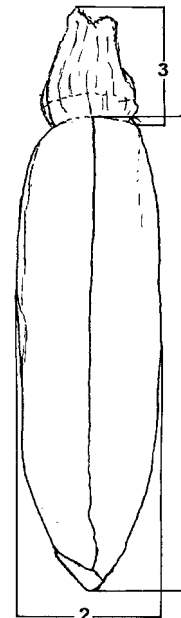


Fig. 2. The manner of measurements of caryopsis of *Leymus arenarius* (L.) Hochst.
 Ryc. 2. Sposób mierzenia cech ziarniaków *Leymus arenarius* (L.) Hochst.

For each of the features the values of arithmetic mean (X), standard deviation (SD) and variability coefficient (V) were determined. The morphological variability of the caryopses was analysed on the basis of the size and shape line (**Jentys-Szaferowa** 1959) and cluster method proposed by StatSoft Inc. (1997).

Results

A comparison of the size and the shapes of the *Leymus arenarius* caryopses is illustrated by the plots in Figure 3. Comparative units (vertical lines) are the arithmetic means of the features for a general sample including all samples from marine sites. A detailed analysis performed by the graphic method of **Jentys-Szaferowa** (1959) allowed identification of a few morphological types. Particularly distinguishing are the samples: 19, 20, 12, 13 and 15. They were distinguished on the basis of three features: the length of the glume hair, the length and width of the caryopses, of the four features analysed. The most variable feature was the length of the glume hair, as indicated by high values of the variability coefficient (see Tab. 1), while the least variable was the width of the caryopses.

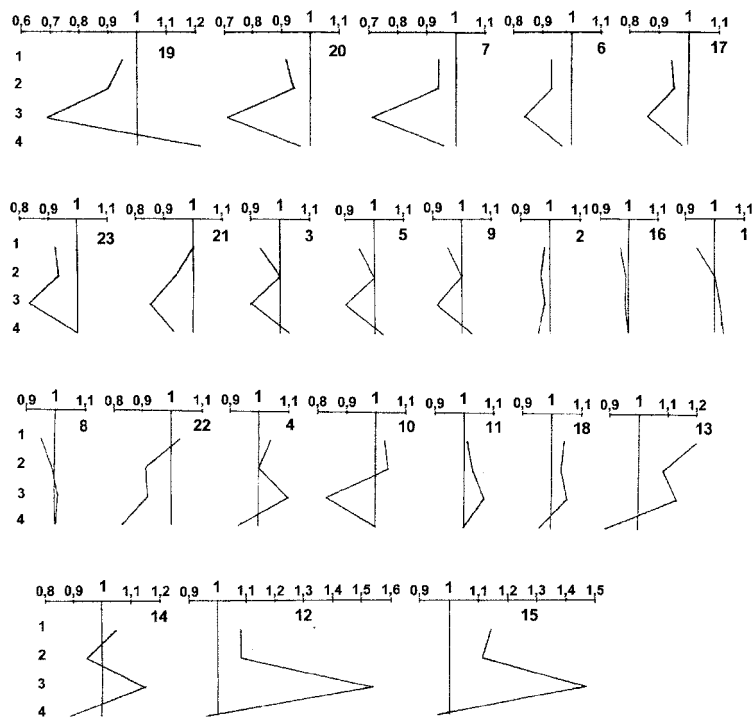


Fig. 3. A comparison of the size and shape of caryopses of *Leymus arenarius* (L.) Hochst. obtained for local samples (broken lines) to the corresponding values for the general sample (vertical lines)

Ryc. 3. Porównanie linii wielkości i kształtu ziarniaków prób lokalnych (linie łamane) *Leymus arenarius* (L.) Hochst. z próbą ogólną (linia prosta)

Table 1

Arithmetic means (X), standard deviation (SD) and variability coefficient (V)
 local samples and general sample of *Leymus arenarius* (L.) Hochst.
 Średnie arytmetyczne (X), odchylenie standardowe (SD) i współczynnik zmienności (V)
 populacji lokalnych i nadmorskiej próby ogólnej *Leymus arenarius* (L.) Hochst.

No samples Nr próby		Feature – Cecha			
		1	2	3	4
1	x±SD	7,10±0,71	2,13±0,23	2,20±0,47	0,30±0,02
	V%	10,00	10,79	18,80	6,66
2	x±SD	7,38±0,58	2,06±0,11	2,43±0,38	0,23±0,02
	V%	7,85	5,33	15,63	7,14
3	x±SD	7,02±0,68	2,13±0,16	2,22±0,41	0,30±0,03
	V%	9,68	7,51	18,46	10,00
4	x±SD	7,78±0,49	2,14±0,17	2,72±0,34	0,27±0,02
	V%	6,29	7,94	12,50	7,40
5	x±SD	7,14±0,69	2,13±0,18	2,22±0,31	0,30±0,03
	V%	9,66	8,45	13,96	10,00
6	x±SD	6,98±0,71	1,97±0,23	2,09±0,39	0,28±0,03
	V%	10,17	11,67	18,66	10,71
7	x±SD	7,08±0,55	2,00±0,24	1,92±0,35	0,28±0,04
	V%	7,76	12,00	18,22	14,28
8	x±SD	7,15±0,67	2,11±0,17	2,49±0,51	0,29±0,04
	V%	9,37	8,05	20,48	13,79
9	x±SD	7,15±0,68	2,12±0,18	2,25±0,51	0,30±0,04
	V%	9,51	8,49	22,66	13,33
10	x±SD	7,70±0,68	2,21±0,20	2,06±0,43	0,29±0,06
	V%	8,83	9,04	20,38	20,68
11	x±SD	7,58±0,34	2,18±0,11	2,63±0,53	0,29±0,01
	V%	4,48	5,04	20,15	3,44
12	x±SD	8,12±0,40	2,29±0,12	3,80±0,92	0,28±0,02
	V%	4,92	5,24	24,21	7,14
13	x±SD	9,01±0,70	2,32±0,17	2,78±0,48	0,26±0,03
	V%	7,76	7,32	17,26	11,53
14	x±SD	7,84±0,60	2,02±0,11	2,83±0,62	0,26±0,03
	V%	7,65	5,44	21,90	11,53
15	x±SD	8,22±0,64	2,36±0,11	3,63±0,80	0,28±0,02
	V%	7,48	4,66	22,03	7,14
16	x±SD	7,28±0,72	2,11±0,18	2,45±0,46	0,29±0,03
	V%	9,89	8,53	18,77	10,34
17	x±SD	7,05±0,91	2,02±0,22	2,13±0,31	0,28±0,03
	V%	12,90	10,89	14,55	10,71
18	x±SD	7,78±0,64	2,18±0,17	2,63±0,49	0,28±0,02
	V%	8,22	7,79	18,63	7,14
19	x±SD	7,15±0,54	1,92±0,19	1,68±0,31	0,35±0,04
	V%	7,55	9,89	18,45	11,42
20	x±SD	6,86±0,49	1,99±0,21	1,75±0,28	0,28±0,03
	V%	7,14	10,55	16,00	10,71
21	x±SD	7,50±0,60	1,99±0,15	2,10±0,36	0,27±0,03
	V%	8,00	7,53	17,41	11,11
22	x±SD	7,74±0,49	1,93±0,18	2,26±0,36	0,24±0,02
	V%	6,33	7,25	10,17	8,33
23	x±SD	6,95±0,47	1,99±0,14	2,05±0,23	0,29±0,02
	V%	6,76	7,03	11,22	6,89
General sample Próba ogólna	x±SD	7,49±0,76	2,12±0,21	2,46±0,49	0,29±0,03
	V%	10,10	9,90	19,90	10,34

Figure 3 presents a comparison of the features studied, measured for three local inland samples with their correspondents obtained for the general marine sample. The length of the caryopses in these three local samples does not differ significantly from that obtained for the general sample. The values characterising the other three features are much smaller than those determined for the general sample. The exception is the shape of the caryopses in sample 23 from Pyzdry, most resembling the shape of those collected in the marine samples from Kołobrzeg 6, 7 and 17 (Łeba). The caryopses from the other inland samples, no. 21 and 22, are characterised by smaller values of features 2, 3 and 4 than those obtained for the general sample, but their length (feature 1) is greater (Fig. 4).

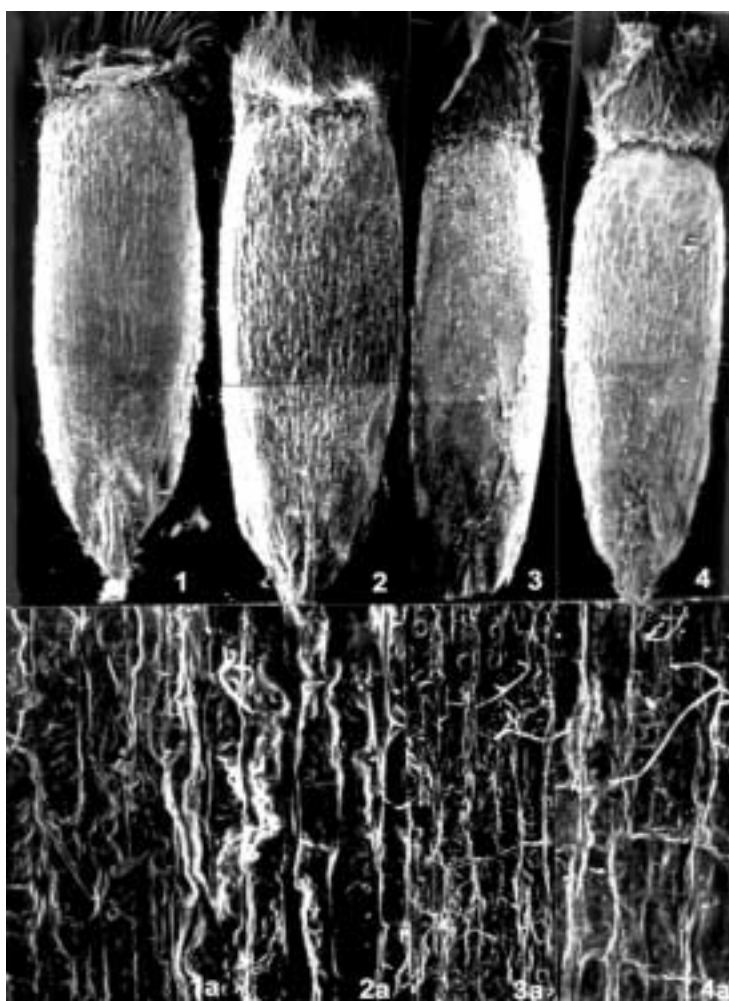


Fig. 4. Sculpture of the surface of caryopses and glumes in SEM: 1 – Ustka (37.5 x), 2 – Piaski (20 x), 3 – Mogilno (37.5 x), 4 – Koziegłowy (37.5 x), a – 600 x
 Ryc. 4. Skulptura powierzchni ziarniaków i plew w świetle SEM: 1 – Ustka (37,5 x), 2 – Piaski (20 x), 3 – Mogilno (37,5 x), 4 – Koziegłowy (37,5 x), a – 600 x

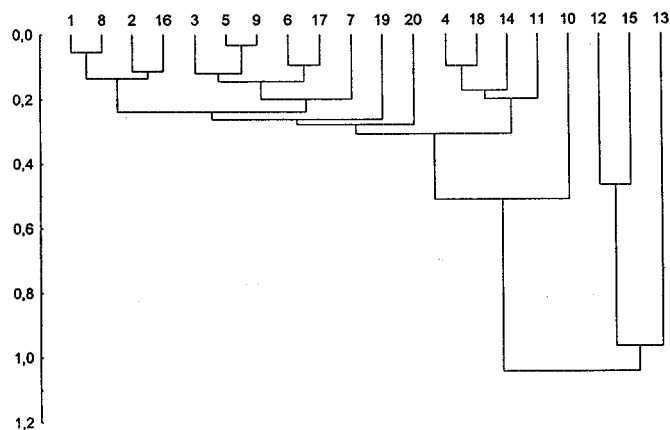


Fig. 5. Dendrogram of the Euclidean distances of *Leymus arenarius* (L.) Hochst. of marine samples
Ryc. 5. Dendrogram odległości Euklidesa nadmorskich prób *Leymus arenarius* (L.) Hochst.

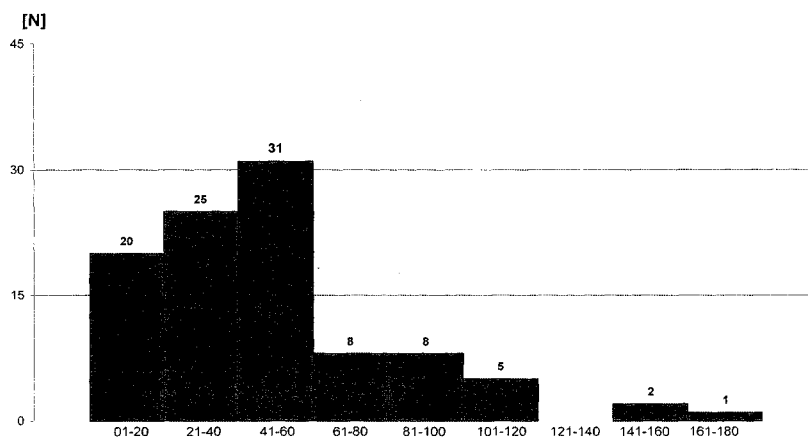


Fig. 6. Distribution of the number of caryopses in the spike
Ryc. 6. Rozkład liczby ziarniaków w kłosie

The differentiation of marine samples in two groups is clearly apparent in the dendrogram, Figure 5. The first group including the majority of samples – 16 is much differentiated. The second group combines samples no 12 (Ustka), 15 (Rowy) and 13 (Pogorzelica). Sample no 10 takes an isolated position. Differences in the features studied between these groups are statistically significant. The samples from the second group have been collected from the *Elymo-Ammophiletum* Br.-B1 et de Leeuw 1936 association, with *Leymus arenarius* as the dominant species.

Analysis of the dendrogram shows that the samples collected at the same site may occupy a different position, e.g. samples no. 4 and 5 (probably planted), 8 and 9, 11 and 12, 14, 15 and 16, or may take close positions e.g. samples no. 19, 20 and 6, 7, which

testifies to their high resemblance. The biometric measurements have not suggested any directional geographic variability.

In order to determine individual fecundity 100 spikes from the site in Łeba were analysed. Only two shoots were fertile. A distribution of the number of caryopses in the spikes is presented in Figure 6. The largest number of spikes 31 – produced from 40 to 60 caryopses, while 25 spikes produced from 21 to 40 caryopses.

Leymus arenarius (L.) Hochst. reproduces mainly in the vegetative manner and consequently it grows in masses or agglomerations. At the sites from which the samples were collected no seedlings coming from seeds were observed, therefore the strength of the seed germination was checked in laboratory conditions. The study has shown that the seeds from the inland populations of *Leymus arenarius* (L.) Hochst. germinate in 40% after six days, whereas those from the marine populations – in 20% after 14 or even more days.

Conclusion

Analysis of 23 samples of caryopses collected at 13 marine and three inland sites has shown that they can be divided into a few groups characterised by specific features. There is one particularly distinguished group of small caryopses with short hair and long caryopses with long hair of glumes. No geographical variability has been indicated – the samples collected at distant sites may occupy close positions in the dendrogram, while those from the same site may take much distant positions. No significant differences in the sculpture of the surface of the glumes and caryopses have been noted. Significant differences have been observed in the strength of germination: the caryopses from the inland sites germinate in a much shorter time and in a greater number than those from the marine sites. Moreover, the caryopses from the inland populations are smaller than those from the marine sites and are similar to those from marine phytocenoses with *Ammophila arenaria* (L.) Link as the dominant species.

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MIĘDZYPOPULACYJNA ZMIENNOŚĆ *LEYMUS ARENARIUS* (L.) HOCHST.

S t r e s z c z e n i e

W Polsce *Leymus arenarius* (L.) Hochst. jako gatunek rodzimy występuje na wybrzeżach Bałtyku, poza tym jest sadzony lub zawleczony na wydmach i piaszczyskach śródlądowych. Badania dotyczyły zmienności ziarniaków na podstawie czterech wybranych cech ilościowych z populacji nadmorskich i śródlądowych, cech jakościowych – struktury powierzchni plew i ziarniaków w SE Mikroskop oraz oceny produktywności ziarniaków i siły ich kiełkowania. Stwierdzono, że wydmuchrzyca piaszkowa nie wykazuje zmienności geograficznej, a wyodrębnione grupy populacji charakteryzują się określonymi cechami dotyczącymi wielkości ziarniaków i długości włosków plew. Nie zaobserwowano zróżnicowania w skulpturze powierzchni plew i ziarniaków siedlisk nadmorskich i śródlądowych. Najistotniejsze różnice dotyczą czasu kiełkowania, który dla prób śródlądowych jest zdecydowanie krótszy niż dla prób nadmorskich. Ziarniaki z populacji śródlądowych są nieco mniejsze od ziarniaków nadmorskich i nawiązują do fitocenoz, w których gatunkiem dominującym była *Ammophila arenaria* (L.) Link.