PRESLIA (PRAHA)
36 : 343—361, 1964

A Contribution to the Ecology of Genus *Stipa*
I. Characteristic Properties of the Substrate

Příspěvek k ekologii kavylů

I. Charakteristické vlastnosti substrátu

Blanka Úlehlová

Botanical Institute, Czechoslovak Academy of Sciences, Brno, Stará 18

Abstract — The soils from different localities of the *Stipa* species found in Czechoslovakia (*Stipa capillata* L., *S. joannis* ČELAK., *S. pulcherrima* C. KOCH, *S. stenophylla* ČERN., and *S. dasyphylla* ČERN.) were analysed. On the basis of the results of soil analyses the ecological demands of the individual *Stipa* species were determined. The most frequently occuring species *Stipa capillata* and *S. joannis* were found to shown a greater range of the values of soil characteristics, their ecological demands being thus wider and less specific than those of the less common species. According to the C/N ratios and the NO_3 contents the mineralization processes were found to be fastest and the soil properties the best balanced on localities of *Stipa stenophylla* and *S. joannis* with a deeper soil profile and a better soil water supply. The mineralization processes are slowest in the shallow skeleton soils of arid localities of *Stipa pulcherrima* and *S. dasyphylla.* With respect to the pH of the soils the *Stipa* species may be devided into a relatively alkaliphilic group of *Stipa pulcherrima*, *S. joannis*, and *S. capillata* and the relatively acidiphilic group of *S. stenophylla* and *S. dasyphylla.*

Introduction

The sturdy perennial grasses of the genus *Stipa* are important representatives of the xerotherm vegetation of steppes and rocky slopes. From all the various species of this genus only five[1]) grow in this country, mostly on the margin of the area of their distribution: *Stipa capillata* L., *S. joannis* ČELAK., *S. pulcherrima* C. KOCH, *S. stenophylla* ČERN., and *S. dasyphylla* ČERN.

MARTINOVSKÝ (1963) gives the lastest key for the determination of the species and their distribution in this country. Numerous works from all parts of the world, written in recent years — WENDELBERGER (1953), KAMYŠEV (1955), KURENCOV (1955), KRYLOVA et NOVOSELTSEV (1953), HANSON et OAKE (1957), WEAVER (1960) — bring a lot of information about the ecology both of the various species of the genus *Stipa* and of the plant communities, whose components these grasses are. In all the cases, however, the species discussed differ from those found in this country and the papers are of descriptive character, without analytical data. BAO-ČŽEN (1959) and ŽATKANBAJEV (1960) study the intensity of transpiration of some species of the genus *Stipa* and the temperature and humidity relations of the habitat. MAHN (1957) gives the values of soil temperatures and the general pedological and partly pedo-chemical characteristics of the site of a plant community including *Stipa capillata* near Halle.

The aim of the present paper is to give analytic values necessary for the characteristics of the soil relations on sites covered with various species of the genus *Stipa* in this country. In addition the present paper aims at giving a picture of differences in the characteristics of the habitat and, starting

[1] The last year was a new species *Stipa rubens* discovered by MARTINOVSKÝ.

from this foundation, to establish the ecological demands of various species of the genus *Stipa.*

Material and Methods

During the vegetational period in the year 1963 we collected and analysed 90 soil samples from about 40 localities of several species of the genus *Stipa* in eight different regions in Czechoslovakia. The sites of *Stipa capillata, S. joannis, S. pulcherrima, S. stenophylla, S. dasyphylla* were studied in the following areas:

a) The vicinity of the Křivoklát Castle and of the town of Beroun:

1. Baba Mountain near Křivoklát — algonkian slates — SW steppe slope — *S. joannis* and *S. capillata.*
2. Herinky near Beroun — carboniferous limestone — the southern foot of the slope — *S. capillata, S. joannis.*
3. The hill of Velká hora above the Kubrycht hut — carboniferous limestone — SW and S slopes — *S. capillata, S. pulcherrima.*

b) České Středohoří (Bohemian Mountains):

4. Pasture lands under Brník Mountain — basalt, weathering products of basalt — SE slope of pasture lands — *S. capillata, S. joannis, S. stenophylla.*
5. Brník Mountain — basalt — a deeper substrate to S and W *S. stenophylla* — shallow skeleton soil to SW *S. pulcherrima, S. joannis.*
6. Abandoned vineyards under Oblík Mountain — weathering products of basalt — SE slope — countinous cover of *S. stenophylla.*
7. Oblík Mountain — S slopes with shallow skeleton soil *S. capillata* — SW and W slopes *S. joannis* and *S. pulcherrima*—top plateau with a deeper profile *S. stenophylla.*
8. The hill of Ránská hora — basalt — the foot of SE slope *S. capillata* — on the slope *S. pulcherrima* — SW and S stone ridge scattered *S. dasyphylla* — SW slope — thick cover of *S. pulcherrima* and *S. joannis* — SE slope *S. pulcherrima.*
9. The hill of Hladový vrch near Černodol — porcelanite area — "bílá stráň" ("white hillside", chalk) with a loes cap — on SW slope of the white hillside *S. pulcherrima* — upper loess part sharply separated continuous thick cover of *S. stenophylla.*

c) The vicinity of Prague:

10. Máslovická rokle (the Máslovice gorge) — spyllite — SSE slopes — *S. capillata, S. pulcherrima,* and *S. stenophylla.*
11. Podbaba hill — loess and algonkian slates-SE slope — *S. capillata.*
12. Kalvárie (Calvary hill) over the Motolské údolí (Motoly Valley) — diabase — S slope — *S. capillata.*
13. Prokopské údolí (Prokop Valley) — Černá skála (Black Rock) near Jinonice — diabase, tuffs — SSE slope — *S. capillata.*
14. Prokopské údolí near Klenkovice — devonian limestone — S slope — *S. capillata.*

d) The neighbourhood of Znojmo and Mikulov:

15. Markův kopec (Mark's Hill) near Miroslav — permian-carboniferous conglomerates covered by loess — SSW slope *S. capillata* — elevation South of Markův kopec near Miroslav — SE slope *S. capillata.*
16. Dvorská hill near Hostěradice — culm conglomerates — SSW slope — *S. capillata.*
17. Popice near Znojmo — aplite — a small hill east of Popice — *S. dasyphylla, S. capillata, S. pulcherrima.*
18. Havraníky — loes on Znojmo granite — SW slope — *S. capillata.*
19. Derflice near Znojmo — Znojmo granite + loess — elevation 215 m. ASL — S steppe slopes — *S. capillata.*
20. Sv. Šebestián (St. Sebastian) near Mikulov — limestone — SW slopes — *S. pulcherrima, S. capillata.*

e) The neighbourhood of Hodonín and Bučovice:

21. Blatnička — calcareous Tertiary sandstones — rendzina — S slopes — Milejové lúky (Milejov Meadows) — *S. stenophylla.*

T a b l e I. List of the analysed Czechoslovak localities of different *Stipa* species

Stipa capillata	*Stipa joannis*	*Stipa pulcherrima*	*Stipa stenophylla*	*Stipa dasyphylla*
1. Baba u Křivoklátu	1. Baba u Křivoklátu	1. Velká hora	1. Brník	1. Brník
2. Baba u Křivoklátu	2. Herinky	2. Velká hora	2. Brník	2. Ránská hora
3. Herinky	3. Brník	3. Brník	3. Brník	3. Větrníky
4. Velká hora	4. Brník	4. Oblík	4. Oblík	4. Mohelno
5. Velká hora	5. Oblík	5. Ránská hora	5. Oblík	5. Popice u Znojma
6. úbočí pod Brníkem	6. Oblík	6. Ránská hora	6. Oblík	6. Čelgar
7. Brník	7. Kobylí	7. Hladový vrch	7. Hladový vrch	
8. Oblík	8. Špidlák	8. Máslovická rokle	8. Máslovická rokle	
9. Oblík	9. Čejč	9. Kobylí	9. Větrníky	
10. Máslovická rokle	10. Obřany	10. Špidlák	10. Blatnička	
11. Podbaba	11. Mohelno	11. Čejč	11. Blatnička	
12. Motol	12. Mor. Krumlov	12. Popice u Znojma	12. Mor. Krumlov	
13. Prokopské údolí	13. Mor. Krumlov	13. Sv. kopeček u Mik.	13. Nová Vieska	
14. Prokopské údolí	14. Nová Vieska	14. Větrníky	14. Kováčovské kopce	
15. Kobylí	15. Nová Vieska	15. Větřníky	15. Šipka	
16. Špidlák	16. Čenkov	16. Tišnov	16. Šipka	
17. Špidlák	17. Salka	17. Mor. Krumlov	17. Sv. Benadík	
18. Čejč	18. Salka	18. Nová Vieska		
19. Markův kopec	19. Čelgar	19. Nová Vieska		
20. Markův kopec	20. Sv. Beňadik	20. Kamenica n. Hr.		
21. Dvorská u Host.		21. Kováčovské kopce		
22. Derflice		22. záp. od Salky		
23. Kraví hora u Derflic		23. Čelgar		
24. Havraníky		24. Sidorovo		
25. Popice u Znojma		25. Košeca		
26. Ševy u Maref				
27. Mohelno				
28. Mor. Krumlov				
29. Kováčovské kopce				
30. Kamenica n. Hr.				

22. Kobylí — elevation 274 m. ASL — loess — SE slopes — *S. capillata, S. joannis, S. pulcherrima.*
23. Čejč — a small ridge from Špidlák hill to the village — loess — W slope — *S. joannis, S. capillata, S. pulcherrima.*
24. Špidlák hill near Čejč — loess — WSW slope — *S. capillata, S. pulcherrima.*
25. Větrníky hills near Bučovice — Tertiary sandstones + loess — SW slope — from the foot upwards *S. capillata, S. joannis, S. dasyphylla, S. pulcherrima* — on the top plateau *S. stenophylla.*
26. The Ševy hillside near Marefy — sandy gravel + loess — SE slope — *S. capillata.*

f) The neighbourhood of Brno:

27. Obřany — Brno eruptive rock — *S. capillata, S. joannis.*
28. Moravský Krumlov — Permian conglomerates — S, SE and SW steppe slopes above the town — *S. capillata, S. joannis, S. stenophylla, S. pulcherrima.*
29. Mohelno — serpentine — S and SW slopes of the Mohelno steppe — *S. capillata, S. joannis, S. dasyphylla.*
30. Tišnov — Květnice hill — limestone — SW slopes — *S. pulcherrima.*
g) Southern Slovakia:
31. Nova Vieska — elevation 226 m. ASL — loess — SW slope — abandoned vineyards *S. stenophylla* — on the slope *S. pulcherrima, S. joannis, S. capillata.*
32. Čenkov — alkaline sands — lowland — *S. joannis.*
33. Kamenice nad Hronom — andesites — S slopes — *S. pulcherrima, S. capillata.*
34. Kováčovské kopce (Kováčov hills) coarse-grained agglomerates of andesite with Sarmatian sediments of limestone and sand — S and SW slopes — *S. pulcherrima, S. capillata, S. stenophylla.*
35. Salka — west of the village — loess — S and SE slopes — *S. pulcherrima, S. joannis, S. capillata.*
36. Šipka hill near Plášťovce — secondary tuff conglomerates — polites with abundant fauna of Mollusca — S slopes continuous cover of *S. stenophylla* — top plateau fully continuous cover of *S. stenophylla.*

f) Central Slovakia:

37. Čelgar hill near Zlaté Moravce — skeleton soil — SSE slope — *S. joannis, S. stenophylla, S. dasyphylla, S. pulcherrima.*
38. Sv. Beňadik — a small hill north of Sv. Beňadik — top plateau *S. stenophylla* — SE slopes *S. joannis, S. stenophylla.*
39. Sidorovo mountain near Ružomberok — limestone — S slopes — a locality denoted as a finding place of *S. pulcherrima*, but we did not find it.
40. Košecká dolina (Košeca Valley) — dolomitic rocks — S slopes — *S. pulcherrima.*

Table I gives the survey of localities in the area under consideration in which the species of *Stipa* were analyzed.

The soil samples were collected once for all in spring without rainfall between April 10th to 22th, 1963, in a period when all the area under study still had a good supply of soil moisture. In places in which more *Stipa* species grew not far from one another (e.g. Větrníky, Brník, Moravský Krumlov) we collected greater number of soil samples from the immediate neighbourhood of each species.

The moisture of all the soil samples was determined gravimetrically (Klika et al. 1954). We also determined the pH-content in water (the ratio of soil to water without CO_2 1 : 2.5)

Table II. The Number of Localities and the Proportion of Various Species of the Genus *Stipa* (expressed in parts per cent)

Species	Number of Localities	Proportion (expressed in parts per cent.)
Stipa capillata	30	30,6
Stipa pulcherrima	25	25,5
Stipa joannis	20	20,4
Stipa stenophylla	17	17,4
Stipa dasyphylla	6	6,1
Total	98	100,0

after 30 minutes and after 25 hours, and the pH content in the solution of KCl. All the pH values were measured by Ionoscope by means of glass + calomel electrode. The pH values of soils in water measured after the period of 30 minutes can be considered as a model of the values corresponding to the relations in soil in a dry period, while the pH values of soils in water measured after 24 hours correspond to the relations in soil after a longer period of humidity.

We established the humus content in all the soil samples oxidimetrically according to Springer and Klee (Thun 1955), the total content of N in soil titrimetrically according to Kjehldal (The Official Methods, reprint), the content of N in nitrates colorimetrically, using the disulphophenolic acid (The Official Methods, reprint), the exchangeable bases complexometrically (Moravec 1960).

All the material obtained from analyses was statistically evaluated by comparing, by means of the t-test, two groups with a different number of cases (Snedecor 1946, p. 80).

The soil used for analyses was sifted through a 2 mm. sieve — soil powder 1, for the determination of humus — soil powder 2.

Results and Analysis of Results

From the analyses of the above-mentioned material and from field experience we may conclude, that the majority of the *Stipa* species in this country grow on warm substrates chiefly on the southern, southeastern and southwestern slopes so that the microclima seems to play a very important role in the life and occurrence of various species of the genus *Stipa*. A more de-

Table III. Soil moisture in habitats of different *Stipa* species studied

Stipa capillata	*Stipa joannis*	*Stipa pulcherrima*	*Stipa stenophylla*	*Stipa dasyphylla*
1. 28.20	1. 28,20	1. 25.75	1. 30.66	1. 21.27
2. 16.68	2. 31.40	2. 27.33	2. 25.63	2. 21.80
3. 31.39	3. 30.70	3. 25.63	3. 21.27	3. 24.85
4. 25.75	4. 25.63	4. 16.65	4. 29.52	4. 23.48
5. 19.15	5. 15.55	5. 22.32	5. 27.97	5. 14.49
6. 30.66	6. 19.70	6. 11.37	6. 13.35	6. 11.53
7. 20.04	7. 15.10	7. 25.71	7. 19.02	
8. 16.65	8. 17.76	8. 12.92	8. 17.83	
9. 16.23	9. 29.30	9. 15.08	9. 20.89	
10. 10.02	10. 24.40	10. 17.76	10. —	
11. 16.69	11. 17.01	11. 29.28	11. —	
12. 17.67	12. 26.90	12. 14.49	12. 20.97	
13. 13.77	13. 21.00	13. 14.03	13. 17.37	
14. 19.15	14. 9.40	14. 24.85	14. 12.50	
15. 15.08	15. 17.40	15. 20.89	15. 24.94	
16. 17.76	16. 6.75	16. 16.00	16. 15.91	
17. 26.25	17. 21.24	17. 18.27	17. 18.00	
18. 29.28	18. 10.92	18. 19.55		
19. 14.67	19. 11.13	19. 17.37		
20. —	20. 17.28	20. 9.81		
21. 16.44	21. —	21. 11.55		
22. 11.77	22. —	22. 21.27		
23. 21.63	23. —	23. 8.28		
24. 28.03	24. —	24. —		
25. 14.49	25. —	25. 11.79		
26. 22.31				
27. 15.33				
28. 28.75				
29. 9.34				
30. 9.81				

T a b l e IV. pH values of the suspensions of soils from the localities of *Stipa* studied: in water immediately after the addition of water (pH im) and after 24 hours (pH 24 h) and in KCl solution (pH KCl)

	Stipa capillata			*Stipa joannis*			*Stipa pulcherrima*			*Stipa stenophylla*			*Stipa desyphylla*		
	pH H_2O im	pH H_2O 24 h	pH KCl	pH H_2O im	pH H_2O 24 h	pH KCl	pH H_2O im	pH H_2O 24 h	pH KCl	pH H_2O im	pH H_2O 24 h	pH KCl	pH H_2O im	pH H_2O 24 h	pH KCl
1.	4.40	6.25	5.70	4.40	6.30	5.75	7.70	9.80	7.25	5.85	7.15	5.20	5.00	6.85	5.15
2.	4.50	6.75	5.50	8.00	8.90	7.40	9.10	6.60	7.20	5.55	7.20	5.65	4.75	6.10	5.10
3.	8.10	9.05	7.40	5.85	7.15	5.20	5.50	7.20	5.70	5.00	6.85	5.15	5.65	7.30	6.75
4.	7.70	9.40	7.25	5.55	7.20	5.60	6.85	7.15	6.20	5.30	6.20	5.45	6.50	—	6.80
5.	8.10	9.10	7.75	6.85	7.15	6.20	6.55	7.20	6.90	5.00	6.90	5.65	5.85	6.70	5.75
6.	5.30	6.70	5.90	4.90	7.70	6.40	6.70	6.70	6.50	6.50	6.65	6.20	5.15	6.75	5.65
7.	6.70	7.25	6.50	9.10	8.00	7.50	8.60	7.45	6.70	6.30	6.15	5.55			
8.	5.85	7.15	5.20	7.90	7.50	7.15	5.80	6.00	5.80	5.85	5.85	5.25			
9.	4.75	6.85	5.65	6.40	7.70	6.90	9.00	8.00	7.50	6.15	8.25	6.75			
10.	5.45	5.85	4.85	—	—	6.75	7.90	7.50	7.15	—	—	5.40			
11.	3.50	5.55	5.00	—	—	5.85	6.45	7.70	6.90	—	—	5.30			
12.	6.15	7.25	5.40	—	—	6.25	5.85	6.70	5.75	—	—	5.55			
13.	7.60	8.25	6.80	—	—	5.35	7.65	7.65	7.35	6.65	7.43	7.27			
14.	7.45	7.70	6.60	8.50	6.75	7.35	5.65	7.30	6.75	4.85	6.45	5.35			
15.	9.20	8.10	7.50	6.65	7.43	7.27	6.15	8.25	6.75	4.90	6.75	5.70			
16.	7.90	7.50	7.15	8.85	9.51	7.75	—	—	7.30	7.75	7.10	6.10			
17.	8.65	9.20	7.20	6.85	7.71	7.00	6.45	—	6.05	6.15	6.95	5.40			
18.	6.45	7.70	6.90	8.40	8.10	6.65	7.55	7.70	7.25						
19.	5.45	7.15	5.90	5.65	7.00	6.30	6.65	7.43	7.27						
20.	5.65	7.10	7.00	6.30	8.85	7.40	5.65	7.95	6.20						
21.	6.30	8.25	7.15				5.70	7.10	6.25						
22.	4.95	6.45	4.65				6.85	7.70	7.00						
23.	5.30	6.85	5.10				5.55	6.75	5.60						
24.	5.65	6.45	5.30				7.40	7.70	7.00						
25.	5.85	6.70	5.75				8.10	7.45	7.20						
26.	6.95	8.60	7.20												
27.	—	—	5.85												
28.	6.06	—	5.60												
29.	5.45	7.15	6.10												
30.	5.65	7.95	6.20												

Table V. Humus and total nitrogen content in the soils from the localities of *Stipa* studied

	Stipa capillata		*Stipa joannis*		*Stipa pulcherrima*		*Stipa stenophylla*		*Stipa dasyphylla*	
	C hum. %	N tot. %	C hum. %	N tot. %	C hum. %	N tot. %	C hum. %	N tot. %	C hum. %	N tot. %
1.		0.98	48.45	0.98		0.90	23.20	1.08	15.20	0.55
2.	19.34	1.51	41.48	1.24	25.23	1.88	18.03	1.23	40.45	0.52
3.	41.48	1.24	23.20	1.08	18.03	1.23	11.84	0.68	12.88	0.96
4.	46.70	0.90	18.00	1.23	9.64	0.63	16.25	0.78	5.42	0.52
5.	10.11	0.70	9.64	0.63	10.32	0.46	49.25	1.11	12.63	0.38
6.	23.20	1.08	11.32	0.08	6.43	0.65	2.58	0.06	4.65	0.35
7.	6.18	0.41	4.38	0.34	8.00	0.43	10.35	0.43		
8.	14.42	1.13	1.29	0.15	14.39	0.26	22.45	0.15		
9.	10.00	0.05	4.63	0.60	4.38	0.34	7.74	0.56		
10.	26.08	0.64	7.48	0.48	1.29	0.15	11.35	0.80		
11.	3.35	0.08	10.58	0.96	4.63	0.60	11.87	0.89		
12.	4.90	0.15	5.68	0.12	12.63	0.38	3.10	0.39		
13.	18.54	1.41	3.10	—	15.22	1.06	5.41	0.25		
14.	16.50	0.25	8.26	0.18	7.74	0.55	5.16	0.64		
15.	4.38	0.34	5.41	0.25	12.88	0.96	5.42	0.06		
16.	1.29	0.15	2.82	0.06	8.52	0.41	2.32	0.22		
17.	3.87	0.18	5.43	0.15	7.25	0.39	7.99	0.11		
18.	4.63	0.60	2.83	0.42	5.41	0.25				
19.	6.70	0.53	9.55	0.14	1.54	0.06				
20.	2.57	0.05	7.99	0.37	7.25	0.27				
21.	1.03	0.11			5.43	0.15				
22.	4.64	0.51			29.38	0.25				
23.	12.63	0.21			—	1.72				
24.	9.02	0.13			5.68	0.13				
25.	12.63	0.38								
26.	8.52	0.75								
27.	5.72	0.58								
28.	—	0.61								
29.	2.32	0.14								
30.	1.54	0.06								

Table VI. Content of exchangeable Ca··, Mg·· and NO_3 ions in the soils from the localities of *Stipa* studied

	Stipa capillata			*Stipa joannis*			*Stipa pulcherrima*			*Stipa stenophylla*			*Stipa dasyphylla*		
	Ca··	Mg··	NO_3	Ca··	Mg··	NO_3	Ca..	Mg··	NO_3	Ca··	Mg··	NO_3	Ca··	Mg··	NO_3
1.	749	63	23.40	749	63	23.40	1122	184	1.08	781	104	16.20	397	97	9.70
2.	661	90	10.00	923	96	11.40	1158	68	16.40	448	83	16.20	470	119	8.20
3.	923	96	11.40	757	117	20.40	781	104	16.20	757	117	20.40	625	99	3.40
4.	1122	184	1.08	781	104	16.20	601	92	0.63	489	78	20.40	364	134	1.80
5.	669	104	2.60	601	92	16.20	731	126	3.20	677	115	18.00	258	78	4.00
6.	757	117	20.40	687	61	8.60	629	114	2.10	258	83	1.34	272	56	6.00
7.	747	164	6.40	184	56	0.64	576	93	18.00	266	56	21.40			
8.	733	137	10.60	192	44	2.60	573	85	2.20	323	65	29.60			
9.	116	361	2.40	417	97	3.00	184	56	0.64	805	62	2.60			
10.	529	68	6.40	412	73	0.62	192	44	2.60	597	126	3.00			
11.	210	51	2.00	228	187	15.00	417	97	3.00	613	51	5.80			
12.	473	91	9.00	354	51	2.60	258	78	4.00	236	44	3.00			
13.	860	96	5.60	236	44	3.00	794	38	16.20	172	81	0.12			
14.	681	53	14.00	349	56	6.00	625	99	3.40	365	99	2.00			
15.	184	56	0.64	172	81	0.12	805	62	2.60	124	216	2.40			
16.	192	44	2.60	150	99	1.00	428	123	2.20	342	107	2.40			
17.	395	46	8.80	438	83	14.00	230	64	2.40	200	56	2.60			
18.	417	97	3.00	620	81	6.00	282	66	4.60						
19.	304	92	1.50	353	99	8.60	172	81	0.12						
20.	357	85	5.60	260	81	0.90	588	80	1.50						
21.	352	61	3.00				482	122	10.60						
22.	181	77	8.40				438	83	14.00						
23.	252	63	6.40				88	162	1.40						
24.	212	55	12.00				865	89	—						
25.	258	78	4.00				332	80	8.60						
26.	520	85	12.00												
27.	130	163	6.40												
28.	286	71	5.00												
29.	392	64	7.00												
30.	588	80	1.50												

tailed analysis of this aspect will be given in the following paper by Milena RYCHNOVSKÁ.

We can also say that *Stipa dasyphylla* and *S. pulcherrima* mostly grow on stony and skeleton soils with a shallow soil profile. On the other hand, *Stipa stenophylla* prefers habitats with a deeper soil profile such as top plateaux and foots of hills. *Stipa joannis* grows on sites with a deeper soil profile, but also often on stony soils. *Stipa capillata* can also be found on stony soils and in some cases even on deeper soils.

The number of localities and the proportion of various *Stipa* species expressed in parts per cent, as they are given in Table II, present a rough picture of the distribution of the species in the whole area under study. We can conclude from the table, in agreement with the data reported elswhere (MARTINOVSKÝ 1963, PODPĚRA1925), that the most frequent species found in this country is *Stipa capillata*, less frequent species are *Stipa pulcherrima* and *S. joannis*, and *S. stenophylla* is rarer than the three above-mentioned species, but it is very expansive on its sites and often forms continuous covers. *Stipa dasyphylla* is the rarest of all the *Stipa* species in this country.

The results of the soil sample analyses collected on various sites of the species of the genus *Stipa* are displayed in Tables III—VI.

For the purpose of evaluation we arranged the results of analyses of all the soil characteristics belonging to various species into several classes, expressed the percentage of the occurence of soils relative to the values in those classes and plotted graphs of their distribution (diagrams 1—5). The analysis of the graphs and of the table points to the conclusion that the *Stipa* species which are most frequently found in the area under consideration show greater dispersion in the values of the soil characteristics, their ecological demands being thus wider and less specified than those of the species whose occurrence is less frequent. It can be said that the most frequent species show a wider ecological amplitude than the rarer species. On the contrary, the values of the soil characteristics of the rarer species are not so dispersed, their ecological demands being more specific.

Thus, e.g., *Stipa capillata*, which is the species most freqently found in Czechoslovakia, has the widest distribution of values of all the soil characteristics studied. *Stipa pulcherrima* and *S. joannis* also show a relatively wide range of the values of various soil characteristics.

In comparison with *Stipa capillata*, however, *S. pulcherrima* has a narrower range of the pH values and of soil humidity, and the percentage of soils with higher pH values and lower humidity values is also higher. *Stipa joannis* has a more limited distribution and lower values of N and Ca content in the soil.

The distribution of the values of almost all the soil characteristics of *Stipa stenophylla* is more limited than that of all the preceding species, and *Stipa dasyphylla* shows the narrowest range among all of them. It can be concluded, that the demands — as to the habitat — of these species are the most specified of all.

Another indication of the differences appearing in the characteristics of the habitats of various *Stipa* species are the averages as displayed in Table VII. These values enable us to form ecological sequences of the *Stipa* species corresponding to their demands on certain factors of their environment.

The habitats of *Stipa pulcherrima* are, on the average, most arid of all.

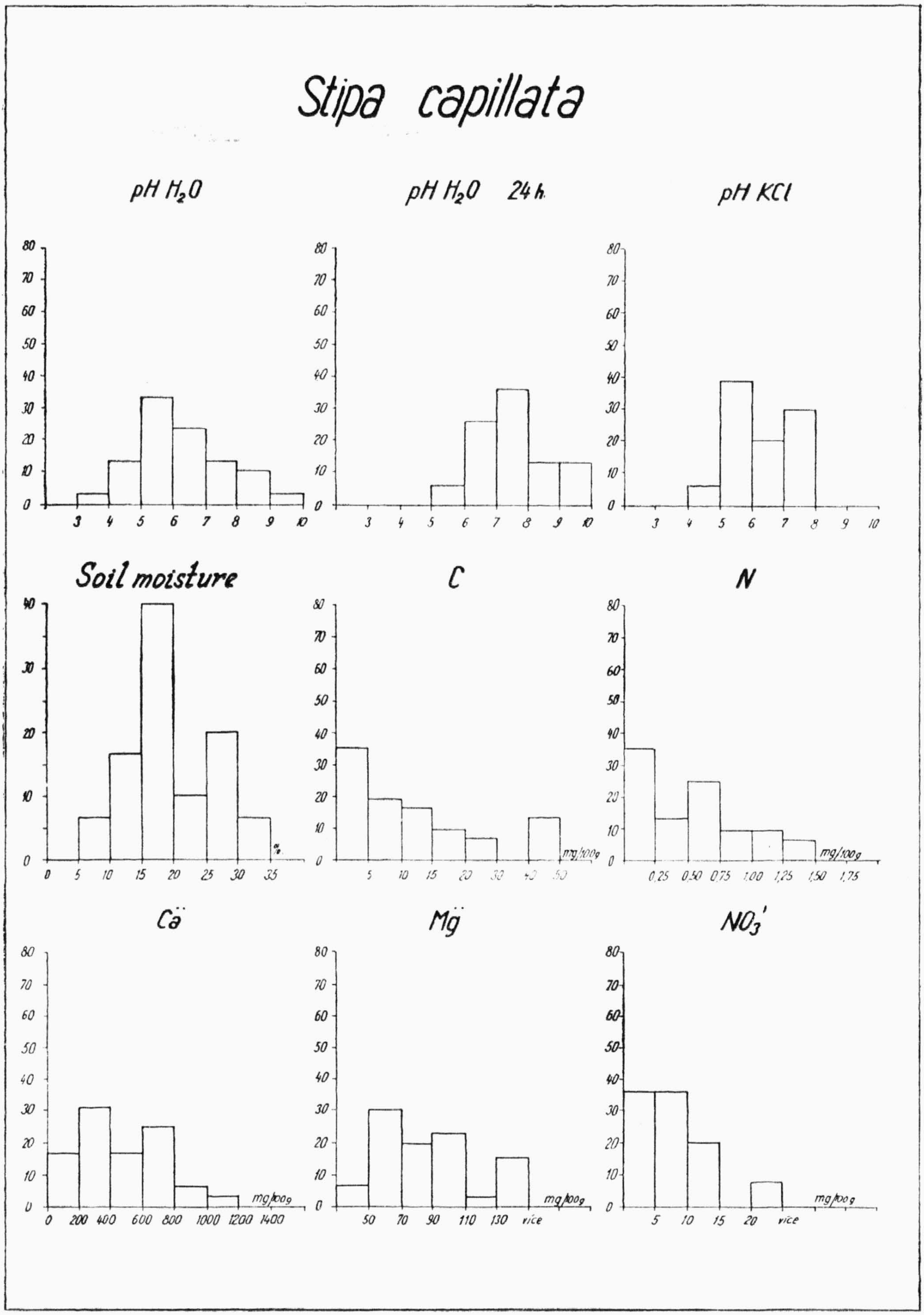


Fig. 1. — The distribution of analytic dates of different soil characteristics in localities of *Stipa capillata*. The x- axis: analytic dates of soil characteristics. The y- axis: occurence of localities in per cent.

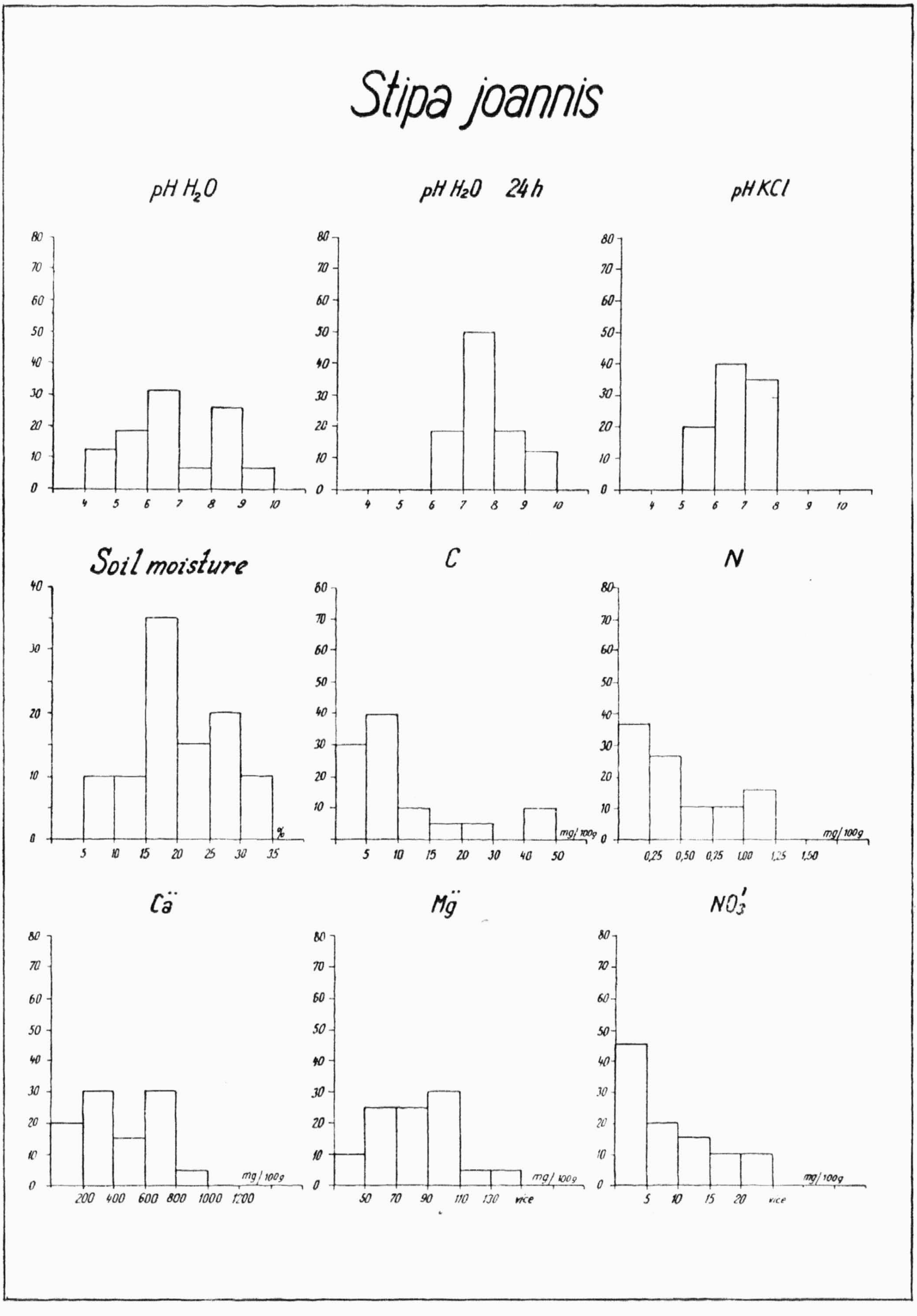


Fig. 2. — The distribution of analytic dates of different soil characteristics in localities of *Stipa joannis*. Explanation as for Fig. 1.

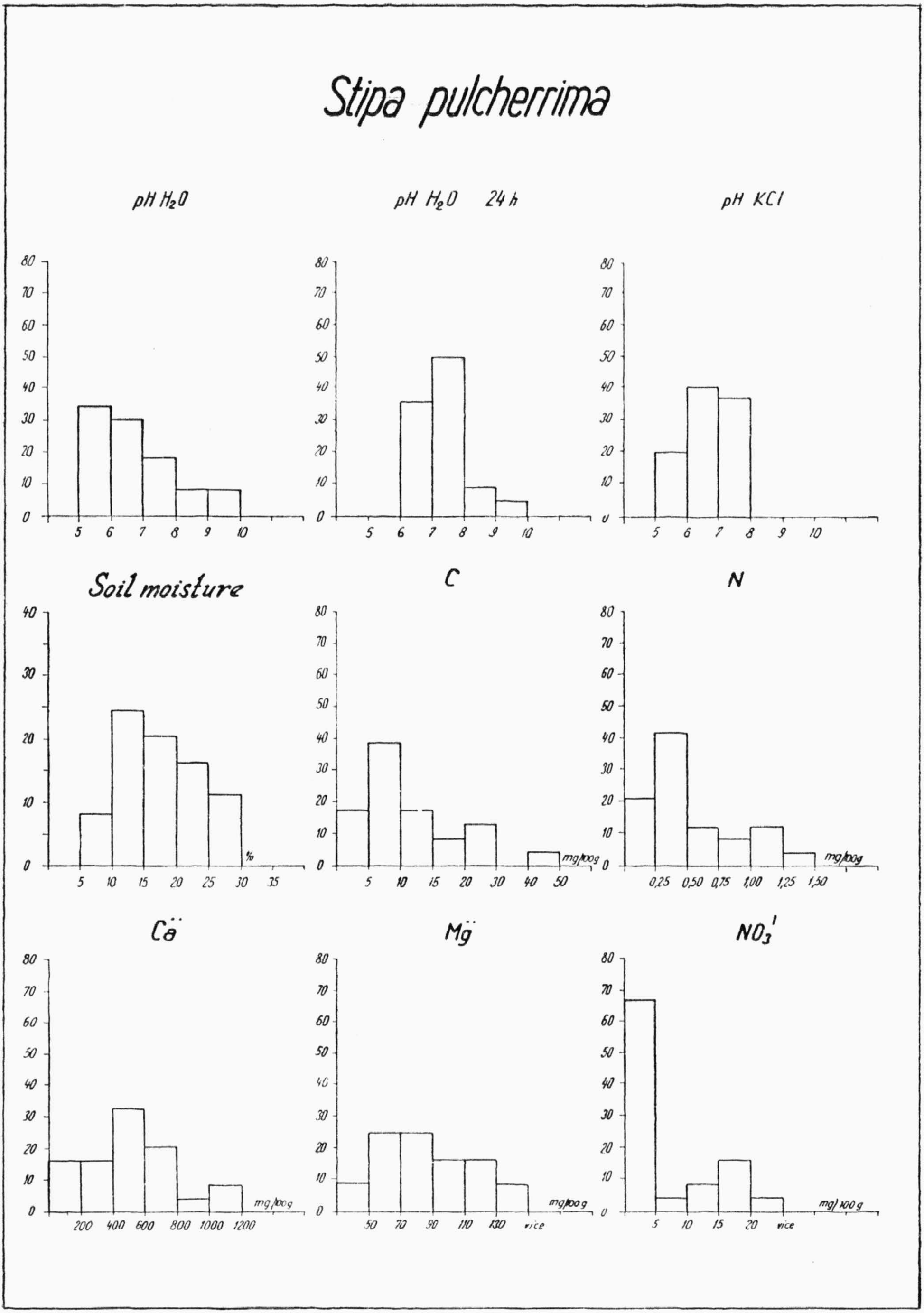


Fig. 3. — The distribution of analytic dates of soil characteristics in localities of *Stipa pulcherrima*. Explanation as for Fig. 1.

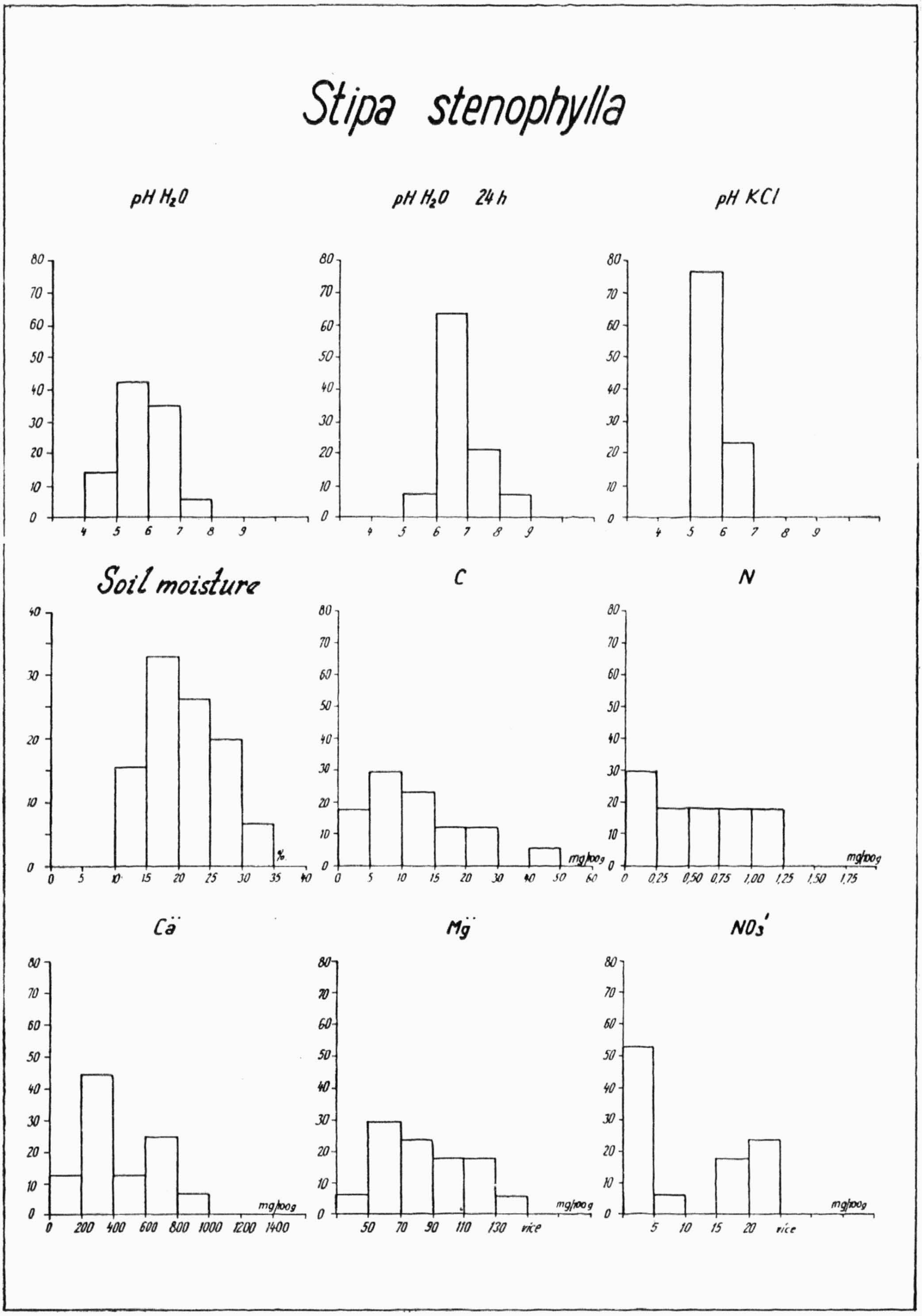


Fig. 4. — The distribution of analytic dates of different soil characteristics in localities of *Stipa stenophylla*. Explanation as for Fig. 1.

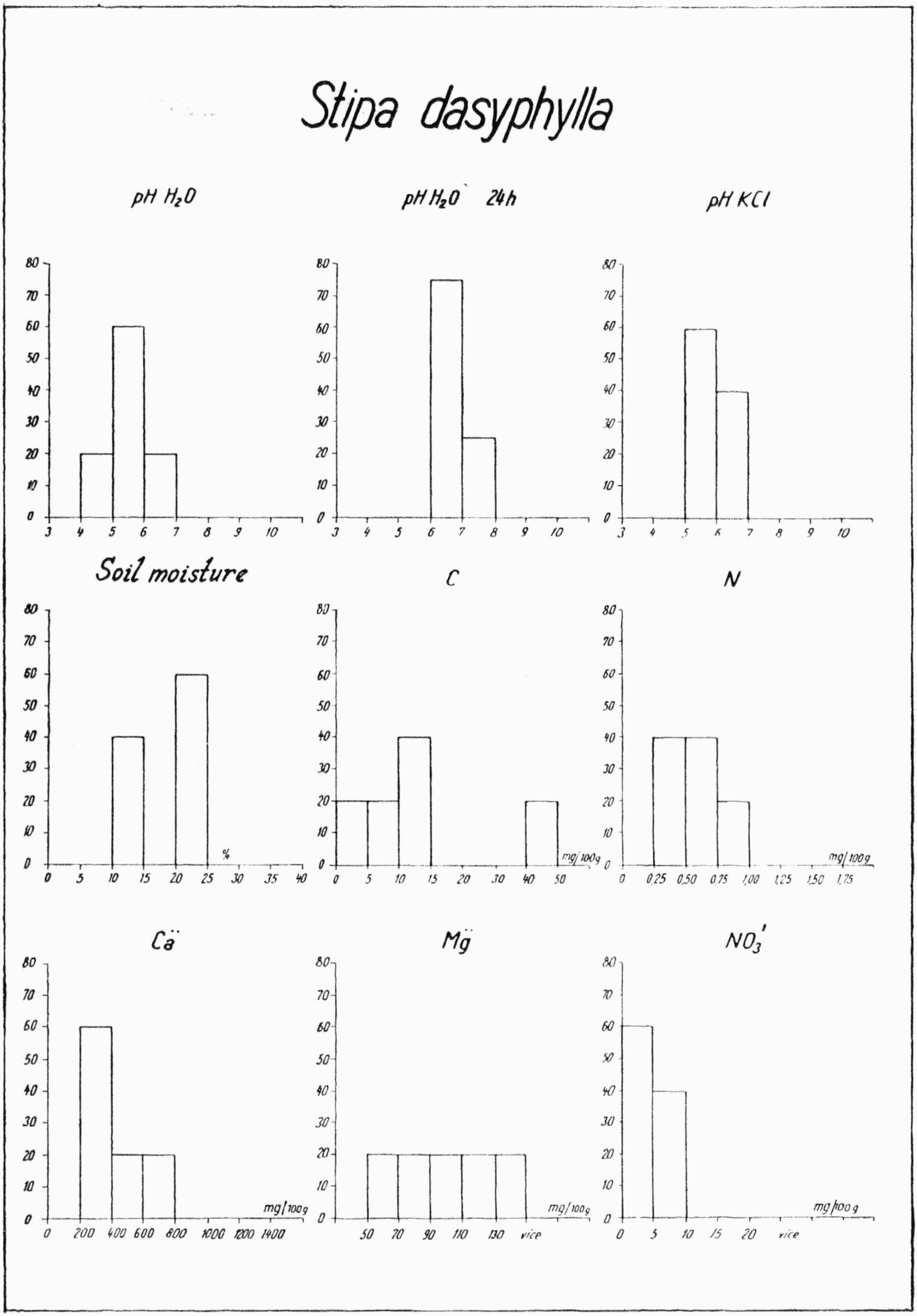
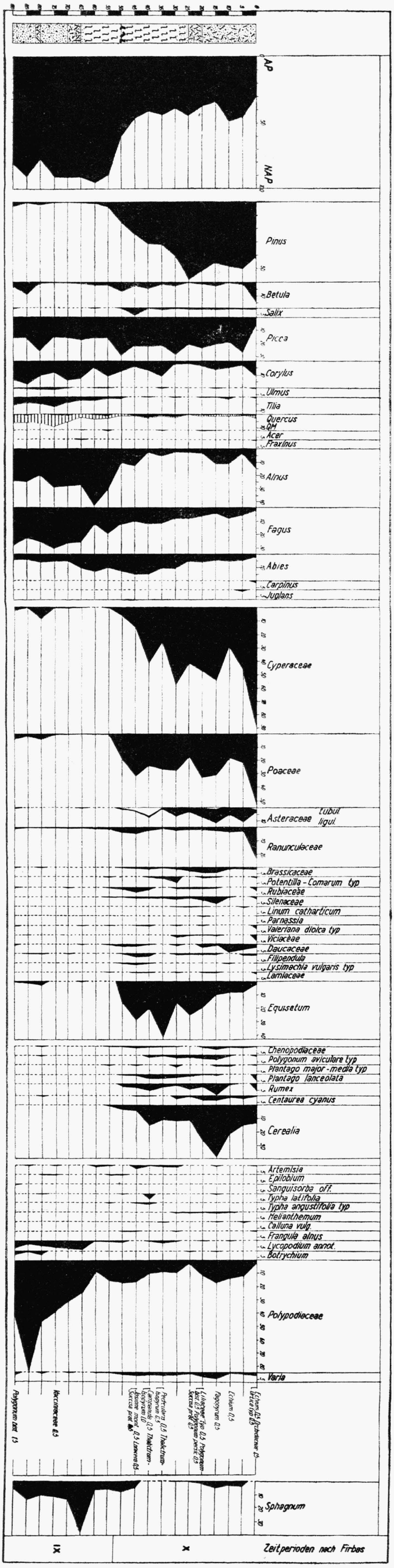
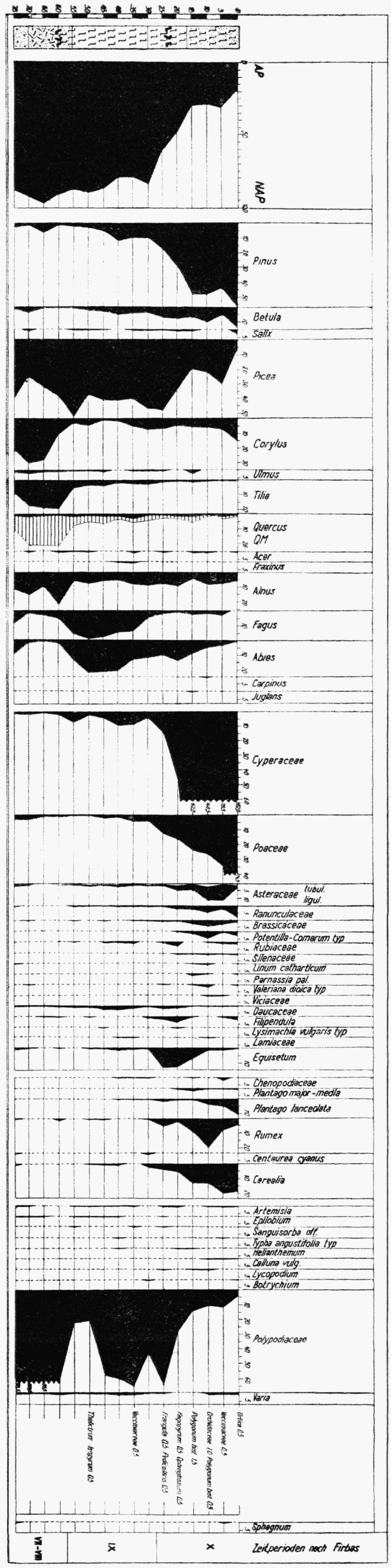


Fig. 5. — The distribution of analytic dates of different soil characteristics in localities of *Stipa dasyphylla*. Explanation as for Fig. 1.





Erklärungen zum Pollendiagramm

1 — Braunmoostorf, 2 — Moorerde, 3 — Ton, 4 — Sand, 5 — Holzkohle, AP — Baumpollen (Arbor-Pollen), NAP — Nichtbaumpollen (Non-Arbor-Pollen), VII — jüngerer Zeitabschnitt des Atlantikums, VIII — Subboreal, IX — älterer Zeitabschnitt des Subatlantikums, X — jüngerer Zeitabschnitt des Subatlantikums.

Tabelle 1.

Valeriano dioicae-Caricetum davallianae (KUHN 1937) MORAVEC asoc. nova

Subassoziation		*typicum*			*caricetosum pulicaris*					
Aufnahme Nr.		1	2	3	4	5	6	7	8	Stetigkeit
Seehöhe in m		545	600	595	710	775	840	700	605	
Exposition		(NW)	O	N	N	S	S	NW	O	
Neigung in °		2	12	4	4	6	3	9	4	
pH (H_2O) der Rhizosphäre (10 cm tief)		5,8	6,5	6,7	5,4	6,3	5,5	5,0	5.0	
Flächengrösse in qm		15	15	20	16	9	15	20	18	
E_1										
Deckungsgrad %		60	75	70	85	80	80	60	90	
Artenzahl		38	44	41	53	46	57	59	57	
Carex davalliana SM.	Cd	3	3	3	3	4	4	3	3	V
Eriophorum latifolium HOPPE	Cd	2	1	2	+	1	1	1	+	V
Triglochin palustre L.	Cd	+	+	r	.	.	.	+	.	III
Rhinanthus serotinus (SCHÖNH.) OBORNY	dT	.	.	.	.	1	.	1	.	II
Equisetum palustre L.	dT	1	1	1	.	.	.	.	.	II
Carex pulicaris L.	T-Cf	.	.	.	+	+	1	+	1	IV
Carex stellulata GOOD.	Cf	.	.	.	+	1	1	1	1	IV
Scorzonera humilis L.	Nl-CF	.	.	.	.	+	+	r	2	III
Avenochloa pubescens (HUDS.) HOLUB		.	.	.	+	r	.	r	+	III
Valeriana dioica L.	T-CF	1	2	2	2	2	2	1	2	V
Parnassia palustris L.	T-CF	.	.	.	.	1	+	1	1	III
Molinia coerulea (L.) MOENCH		1	1	1	2	1	1	+	1	V
Linum catharticum L.	T-Mn	.	.	.	+	1	1	+	.	III
Briza media L.		.	1	+	1	+	1	1	1	V
Potentilla erecta (L.) RAEUSCH.		+	+	1	2	2	2	2	2	V
Succisa pratensis MOENCH	Ml-T	+	+	+	+	+	.	r	+	V
Hieracium auricula L.	T-CF	+	.	+	1	r	1	.	2	IV
Carex flava L. s. str.	T	r	.	.	+	.	.	+	.	II
Carex dioica L.	T (CF)	.	.	.	.	.	+	+	.	II
Pinguicula vulgaris L.	T (CF)	.	.	.	.	.	+	1	.	II
Carex vulgaris FRIES	CF	1	+	+	2	.	+	1	+	V
Orchis majalis RCHB.	CF	.	1	1	.	1	+	1	+	IV
Eriophorum angustifolium HONCK.	SC	1	1	.	1	2	+	.	+	IV
Cirsium palustre (L.) SCOP.	Ml-CF	+	.	.	.	1	1	.	+	III
Galium uliginosum L.	CF-Ml	r	+	1	1	1	1	1	1	V
Carex panicea L.	CF-Mn	1	2	2	1	2	2	+	2	V
Willemetia stipitata (JACQ.) CASS.	CF	.	.	.	+	r	1	.	.	II
Carex rostrata STOKES	CF	+	.	.	.	r	.	1	r	III
Juncus articulatus L.	CF	+	.	.	.	.	+	+	.	II
Equisetum silvaticum L.	dCF	.	.	.	.	.	+	+	.	II
Agrostis canina L.	Cf	.	.	.	.	.	+	+	+	II
Viola palustris L.	Cf	.	.	.	+	.	1	+	.	II
Senecio rivularis (WALDST., KIT.) DC.	Cf	.	.	+	+	+	1	r	+	IV
Caltha palustris L.	dCn	.	1	+	1	1	1	1	+	V
Crepis paludosa (L.) MOENCH	dCn	.	1	1	1	1	.	2	1	IV
Crepis succisifolia (ALL.) TAUSCH		.	.	1	+	+	r	.	1	IV
Scirpus silvaticus L.	Cn	.	+	1	+	r	.	1	.	IV
Angelica silvestris L.	Ml	+	.	1	1	.	.	.	2	III
Geum rivale L.		.	+	1	r	.	.	.	r	III
Filipendula ulmaria (L.) MAXIM.	Ml	.	1	1	.	.	.	1	.	II
Equisetum arvense L.		r	+	1	+	1	1	+	.	V
Cardamine pratensis L.	MA	1	+	+	1	+	1	+	1	V
Ranunculus auricomus L.		+	+	1	1	1	1	1	2	V
Anemone nemorosa L.		.	+	2	1	2	+	2	+	V
Lychnis flos-cuculi L.	Ml	.	+	+	1	.	+	+	1	IV
Prunella vulgaris L.	MA	+	+	.	.	+	1	+	+	IV
Ajuga reptans L.		.	+	.	1	1	.	+	+	IV
Poa trivialis L.	Ml	+	.	.	r	.	.	r	r	III
Myosotis nemorosa BESS.	Ml	.	.	.	1	+	+	+	.	III
Deschampsia caespitosa (L.) P. BEAUV.	dMl	+	+	.	.	.	.	.	r	II
Sanguisorba officinalis L.	Ml	.	+	+	.	.	.	.	.	II
Trifolium pratense L.	MA	+	+	+	1	+	1	r	1	V
Rumex acetosa L.	MA	.	r	.	1	r	+	r	1	IV
Chrysanthemum leucanthemum L.	MA	.	.	1	.	r	r	+	+	IV
Alchemilla acutiloba OPIZ	MA	.	(+)*	(r)	1	(+)	r	1	+	V
Cerastium caespitosum GILIB	MA	+	r	+	.	.	+	.	.	III
Trifolium repens L.	MA	+	.	.	.	.	r	.	+	II
Achillea millefolium L. s. str.	MA	.	.	+	.	.	r	.	.	II
Lathyrus pratensis L.	MA	+	.	.	.	.	.	.	1	II
Cynosurus cristatus L.	MA	.	.	.	+	.	+	.	.	II
Ranunculus acer L.		1	1	1	2	+	2	1	1	V
Anthoxanthum odoratum L.		+	+	+	1	1	1	1	1	V
Holcus lanatus L.		1	+	r	1	r	+	+	+	V
Leontodon hispidus L.		.	+	+	1	+	1	+	+	V
Plantago lanceolata L.		.	1	r	+	1	+	+	r	V
Luzula campestris (L.) DC.		.	.	.	1	.	.	1	1	II
Festuca rubra L.		+	.	.	1	.	.	.	+	II
Carex umbrosa HOST		+	.	+	r	.	.	.	1	III
Lotus corniculatus L.		.	.	.	.	+	+	r	r	III
Nardus stricta L.	Nl	.	.	.	.	.	+	+	1	II
Phyteuma nigrum SCHM.		.	.	.	+	.	.	r	.	II
Polygala vulgaris L. s. str.	Ng	.	.	.	.	.	r	.	r	II
Viola canina L. s. str.	Ng	.	.	.	.	.	.	r	+	II
Juncus effusus L.		.	.	+	.	.	+	.	+	II
Chaerophyllum hirsutum L.		.	.	.	r	.	.	r	.	II
Rhinanthus minor L.		.	1	.	1	.	.	.	.	II
Epilobium palustre L.		.	.	.	r	.	.	.	r	II
Mentha palustris MOENCH		.	+	.	.	.	r	.	.	II
E_0										
Deckungsgrad %		80	70	50	60	60	85	80	60	
Artenzahl		12	12	16	18	12	18	22	9	
Fissidens adianthoides HEDW.	T	3	+	1	+	3	1	1	.	V
Campylium stellatum (HEDW.) LANG. et C. J.	T	+	2	r	r	r	+	2	.	V
Tomenthypnum nitens (HEDW.) LOESKE	T	1	+	2	1	1	2	1	2	V
Hypnum pratense KOCH	T	1	2	3	2	1	+	2	.	V

A little more humid habitats are those of *Stipa dasyphylla* and *S. capillata*, while the habitats of *Stipa joannis* have higher average values of humidity than the three species just mentioned. On the average, the habitats of *Stipa stenophylla* are most humid of all. This data correspond to the physical conditions of the habitats of the individual species as given at the beginning of this section.

In the analysis of the mean pH values all the *Stipa species* formed two groups: the more alkaliphilic group with *Stipa pulcherrima*, *S. joannis*, and *S. capillata* and the more acidophilic one with *Stipa dasyphylla* and *S. stenophylla*. This clear differentiation can be seen in all the characteristics of

Table VII. Average values of the soil characteristics studied in the habitats of different Species of *Stipa*

Species	pH H_2O im	pH H_2O 24 h	pH KCl	O hum. %	N tot. %	C : N	Ca.. mg./100 g.	Mg.. mg./100 g.	Ca : Mg	NO mg./600 g.	moisture %
Stipa capillata	6.30	7.40	6.20	12.67	0.53	22.86	479	96	4.90	6.87	19.24
Stipa joannis	6.90	7.69	6.63	11.68	0.49	20.45	451	88	5.10	8.01	20.13
Stipa pulcherrima	6.82	7.38	6.66	12.21	0.54	26.22	519	90	5.76	6.56	18.26
Stipa stenophylla	5.84	6.85	5.67	12.60	0.55	20.13	438	91	4.77	9.84	21.05
Stipa dasyphylla	5.60	6.77	6.00	15.20	0.55	27.03	397	97	4.10	4.68	19.23

the pH values. Certain coincidences may be found between the values of the exchangeable pH and the Ca : Mg ratio in the soil. The wider the Ca : Mg ratio for various species, the higher the exchangeable pH of the soil; with the narrowing of Ca : Mg ratio the exchangeable pH values decrease. The soils of the sites on which *Stipa stenophylla* and *S. dasyphylla* are found have the narrowest Ca : Mg ratio and the lowest pH values in the solution of KCl, while the soils of the sites of *Stipa pulcherrima* have the widest Ca : Mg ratio and the highest pH value in the solution of KCl.

The contents of Mg, of the total N, and of C in humus in the soils of the sites of all the *Stipa* species which we studied are very similar. Only the soils on the sites of *Stipa joannis* have, on the average, a smaller content of the total humus and N.

The species with the highest demands on the exchangeable Ca in the soil is *Stipa pulcherrima* (the mean Ca content in soils 519 mg./100 g. of soil), followed by *Stipa capillata* (479 mg./100 g. of soil), and *Stipa joannis* (451 mg./100 g. of soil). The lowest mean values of exchangeable Ca were found in the soils of the sites of *Stipa stenophylla* (438 mg./100 g. of soil) and *Stipa dasyphylla* (397 mg./100 g. of soil).

The two species of the genus *Stipa* growing on skeleton soils (*Stipa pulcherrima* and *S. dasyphylla*) have a very wide C : N ratio in the soils (*Stipa pulcherrima* 26.22, and *S. dasyphylla* 27.03), the soils of the sites of *Stipa capillata* and *S. joannis* have a narrower C : N ratio, and the narrowest mean C : N ratio is found in the soils of *Stipa stenophylla*. The sequence of these values corresponds to the habitat conditions and is even characteristic of a state of readiness which is found in the substrate of the sites of various species; we can even find wider connections between these values and humidity and N content in the soils. If the mineralization of soil substances containing nitrogen reaches its final phase, nitrates — the products of nitrification — accumulate in the soil and their content may be regarded as an evidence of the satisfactory course of the process of mineralization. The more nitrates are there in the soil, the more intensive is the mineralization. When we compare the mean humidity with the nitrate content and the C : N ratio

Table VIII. A Survey of the t-Values fo All the Soil Characteristics Under Consideration Computed for the Combinations of All the *Stipa* Species

	Humidity	pH H_2O immed.	pH H_2O 24 hrs	pH KCl	C	N	Ca	Mg	NO_3
S. cap. joa.	0.411	1.57	*0·93*	1.53	0.281	0.332	0.39	0.58	0.50
S. cap. pul.	0.567	1.51	0.28	1.93	1.143	0.084	0.52	0.46	0.32
S. cap. ste.	*0·883*	1.18	2.15	1.93	0.018	0.161	0.53	0.27	1.26
S. cap. das.	0.001	*1·13*	3.40	0.45	0.414	0.102	*0·68*	0.027	*0·97*
S. joa. pul.	*0.929*	0.18	1.55	0.24	0.14	0.383	*0·82*	0.22	0.69
S. joa. ste.	0.512	2.27	5.59	3.82	0.236	0.460	0.60	0.34	0.66
S. joa. das.	0.254	1.78	6.96	1.57	0.54	0.335	0.47	0.58	*0·99*
S. pul. ste.	1.389	2.95	2.30	4.63	0.110	0.074	*0·85*	0.15	1.31
S. pul. das.	0.328	2.45	1.61	1.99	0.53	0.048	*0·94*	0.13	0.62
S. ste. das.	0.598	0.59	0.30	*1·00*	0.418	—	0.37	0.26	*1·13*

in the soil of various *Stipa* species (in Table VII), we can see that those species which grow on sites with a higher water content in the soil also have a higher nitrate content and a narrower C : N ratio in the soil. The highest humidity and nitrate values and the narrowest C : N ratio are found in the soils of *Stipa stenophylla*, while lower humidity and nitrate values and a wider C : N ratio are characteristic of *Stipa joannis*, followed by *Stipa capillata*. The lowest humidity and nitrate values and the widest C : N ratio in the soil are found on the sites of *Stipa pulcherrima* and *S. dasyphylla*.

We may summarize this discussion as follows: the most intensive mineralizing processes and the most balanced conditions can be found on the sites of *Stipa stenophylla* and *S. joannis*, while the slowest processes are those found on the sites of *Stipa pulcherrima* nad *S. dasyphylla*.

Some authors in the past, such as Ascherson and Graebner (Podpěra 1925), considered *Stipa dasyphylla* to be but a form of *Stipa pulcherrima*. Our results, point to the fact that the ecological demands of the two *Stipa* species are similar only as to the humidity of the habitat. The pH value and the sorption complex of the habitats of both species are quite different. *Stipa pulcherrima* is alkaliphilic, can be found on soils with a high Ca content in the sorption complex, while *Stipa dasyphylla* prefers more acidic habitats with a lower Ca content and a narrower Ca : Mg ratio.

The entire analytic material was statistically evaluated by the method of comparing two groups of the statistical complex containing a different number of cases by means of the t-test. The t-tests were made for all the soil characteristics and for the combination of each of the *Stipa* species with all the others. A survey of the t-test is given in Table VIII, the values in frames being statistically significant for $P = 10\%$.

The underlined t-values are significant only for $P = 25\%$. Even these differences are considered to be of ecological importance, especially as the analytic results concern most of the localities of the *Stipa* species in Czechoslovakia. Differences in the soil moisture of the habitats of *Stipa stenophylla* and *S. pulcherrima* seem to be statistically significant for $P = 10\%$. Other statistically significant soil moisture differences for $P = 25\%$ are those between the habitats of *Stipa capillata* + *S. stenophylla* and *S. joannis* + *S. pulcherrima.*

The differences in the pH values of the soil in water (measured immediately) among all the sites of the *Stipa* species (with the exception of the combinations *Stipa stenophylla* + *S. dasyphylla* and *S. joannis* + *S. pulcherrima*) were statistically significant for $P = 10\%$. The combination *Stipa capillata* + *S. dasyphylla* is just on the verge of statistical significance.

All the *Stipa* species show significant differences in the pH values of the soil in water (measured after 24 hours). Only the combinations *Stipa capillata* + *S. pulcherrima*, *S. capillata* + *S. joannis*, and *S. stenophylla* + *S. dasyphylla* have no statistically significant pH values of the soil in water (measured after 24 hours). The t-values for pH in water (measured after 24 hours) are highy significant almost in all the combinations. This may suggest that it is the humid conditions in which various *Stipa* species behave so differently.

None of the combinations show any significant differences for $P = 10\%$ in the other soil characteristics studied, such as the humus content, total N, exchangeable $Ca^{\cdot\cdot}$ and $Mg^{\cdot\cdot}$ in the soil. Higher t-values than the tabular ones for $P = 25\%$ are in the content of the exchangeable $Ca^{\cdot\cdot}$ in the soils of the sites of *Stipa pulcherrima* + *S. dasyphylla*, *S. pulcherrima* + *S. stenophylla*, and *S. pulcherrima* + *S. joannis*.

As to the nitrate content, statistically significant differences are found among the soils of the sites of *Stipa capillata* + *S. stenophylla* and *S. pulcherrima* + *S. stenophylla*. Differences in the nitrate content among the soils of the sites of *Stipa stenophylla* + *S. dasyphylla* are on the verge of statistical significance. Differences in the nitrate content in the soils of the sites of *Stipa capillata* + *S. dasyphylla* and *S. joannis* + *S. dasyphylla* are also relatively significant and they again have a higher t-value for $P = 25\%$ than the tabular one.

Conclusion

Finally, we should like to characterize the ecological demands of various *Stipa* species which were studied.

All the *Stipa* species are found on substrates rich in minerals, especially in the exchangeable $Ca^{\cdot\cdot}$ and $Mg^{\cdot\cdot}$. Although the parent rocks are not too rich in minerals — they are either covered with loess (some localities in southern Moravia) or with calcareous and sandy sediments and pelitic sediments, frequently with abundant fauna of Mollusca (some Slovakian localities such as Šipka, Kováčovské kopce) and thus enriched by Ca.. and Mg...

Of great importance for all the *Stipa* species are the microclimatic factors. Different *Stipa* species have different demands on their habitats: *Stipa stenophylla* and *S. joannis* prefer deep substrates with more soil moisture and with a favourable course of the minaralizing processes, while *Stipa pulcherrima* and *S. dasyphylla* grow mostly on stony, skeleton soils on dry substrates with relatively unfavourable mineralizing processes. As for their demands on the pH values of the soil of the site, the *Stipa* species are divided in to the relatively alkaliphilic group (*Stipa pulcherrima, S. joannis*, and *S. capillata*) and the relatively acidiphilic group (*Stipa stenophylla* and *S. dasyphylla*). The mutual relations between various species of the genus *Stipa* found in this country are displayed in Table VIII.

The smallest number of differences can be found between the habitats of *Stipa pulcherrima* + *S. capillata* (in two aspects: pH H_2O measured immediately and pH in the solution of KCl) and the habitats of *Stipa stenophylla* + *S. dasyphylla* (in pH in the solution of KCl and in the NO_3 content).

The habitats of *Stipa joannis* + *S. stenophylla* and *S. joannis* + *S. capillata* differ in three aspects: in pH H_2O measured immediately, pH H_2O after 24 hours and pH in the solution of KCl.

The habitats of the following species differ in four apects: *Stipa dasyphylla* + *S. pulcherrima* in pH H_2O measured immediately, pH H_2O after 24 hours, pH in the solution of KCl and the exchangeable Ca··; *Stipa dasyphylla* + *S. joannis* in pH H_2O measured immediately, pH H_2O after 24 hours, pH in the solution of KCl and NO_3, *Stipa dasyphylla* + *S. capillata* in pH H_2O measured immediately, pH H_2O after 24 hours, the exchangeable Ca.. and NO_3, and *Stipa pulcherrima* + *S. joannis* in humidity, pH H_2O after 24 hours, exchangeable Ca·· and NO^3.

The habitats of *Stipa stenophylla* + *S. capillata* differ in five aspects: in humidity, pH H_2O measured immediately, pH H_2O after 24 hours, pH in the solution of KCl and NO_3.

A fundamental difference exists between the habitats of *Stipa stenophylla* + *S. pulcherrima*; they differ in six aspects: in humidity, pH H_2O measured immediately, pH H_2O after 24 hours, pH at the solution of KCl, exchangeable Ca·· and NO_3.

Souhrn

1. Analysovali jsme 98 vzorků půd z různých stanovišť na území ČSSR se vyskytujících druhů rodu *Stipa capillata* L., *S. joannis* Čelak., *S. pulcherrima* C. Koch, *S. stenophylla* Čerň. a *S. dasyphylla* Čerň. Stanovili jsme vlhkost půdy, pH ve vodě, pH v roztoku N—KCl, humus, celkový dusík, dusičnany, výměnný vápník a hořčík.

2. Na základě výsledků půdních rozborů charakterisovali jsme nároky jednotlivých druhů kavylů na vlastnosti stanoviště. Rozdíly mezi jednotlivými druhy hodnotili jsme statisticky pomocí t-testu.

3. Nejrozšířenější druhy, *Stipa capillata* a *S. joannis*, mají větší rozptyl v hodnotách půdních charakteristik a tedy i jejich ekologické nároky jsou širší, méně vyhraněné než u druhů vzácnějších.

4. Poznatky o poměru C/N a o obsahu dusičnanů ukazují, že mineralisační pochody probíhají nejrychleji a půdní poměry jsou nejvyrovnanější na stanovištích druhů *Stipa stenophylla* a *S. joannis*, jež se obvykle vyznačují hlubším půdním profilem a lepší zásobeností vodou. Mineralisační pochody probíhají nejpomaleji v mělkých skeletosních půdách na stanovištích druhů *Stipa pulcherrima* a *S. dasyphylla*.

5. Pomocí údajů o půdním pH je možno rozlišit kavyly na druhy relativně alkalifilní, k nimž patří *Stipa pulcherrima*, *S. joannis* a *S. capillata*, a na druhy relativně acidifilní, *Stipa stenophylla* a *S. dasyphylla*.

References

Bao-Čeň J. (1959): Intensivnosť transpiracii někotorych vidov grudnicevo-tipčakovo-kovylkovogo soobščestva suchich stepej central'nogo Kazachstana. — Bot. Žurnal SSSR 44/12 : 1671—1680.

Dostál J. (1958): Klíč k úplné květeně ČSR. — ČSAV, Praha.

Hanson H. C. et Dahl E. (1957): Some Grassland Communities in the Mountain-Front Zone in Northern Colorado. — Vegetatio 7/4 : 249—270.

Kamyšev G. E. (1955): On the Ecology of Stipa L. — Bot. Žurnal SSSR 40/2 : 200—205.

Klika J., Novák V. et Gregor A. (1954): Praktikum fytocenologie, ekologie, klimatologie a půdoznalství. — Praha.

Krylova I. L. et Novosel'ceva I. F. (1959): Očerk rastitel'nosti Kerčenskogo poluostrova. — Bot. Žurnal SSSR 44/11 : 1616—1624.

Kurencova G. E. (1955): K proischoždeniju rastitel'nosti Prichankajskoj ravniny Primorskogo kraja. — Bot. Žurnal SSSR 40/2 : 148—187.

Mahn E. G. (1957): Über die Vegetations- und Standortsverhältnisse einiger Porphyrkuppen bei Halle. — Wiss. Zeitschr., Univ. Halle, math.-nat. UI/I, p. 177—208.

Martinovský J. O. (1963): Naše kavyly. — Ochrana Přírody 18 : 45—48.

Moravec J. (1960): Komplexometrické stanovení výměnných kationtů Ca··, Mg··, Al··, H v karbonátových půdách. — Sborn. čs. Akad. zeměd. Věd · Rostl. Výroba 6 : 1015—1024.

Official Methods of Analysis of the Association of Official Agriculture Chemists. — 8. vydání, 1955.

Podpěra J. (1925): Květena Moravy ve vztazích systematických a geobotanických. — Pr. mor. přírod. Společ. 2.

Snedecor W. G. (1946): Statistical Methods. — New York.

Thun R., Herrmann R. et Knickmann E. (1955): Die Untersuchung von Böden. — Handbuch der landwirtschaftlichen Versuchs- und Untersuchungsmethodik (Methodenbuch) I.

Weaver J. E. (1960): Extent of Communities and Abundance of the Most Common Grasses in Prairies. — Bot. Gazette 122 1 : 25—33.

Wendelberger G. (1953): Die Trockenrasen im Naturschutzgebiet auf der Peroktoldsdorfen Heide bei Wien. Eine soziologische Studie. — Angewandte Pflanzensoziologie, Wien, 1953 (9) : 1—51.

Žatkanbajev Ž. Ž. (1960): Ekologo-fiziologičeskoje izučenije nekotorych vidov rastenij v uslovijak popupustynnogo klimata Kazachstana. — Bot. Žurnal SSSR 45/11 : 1677—1681.