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INVESTIGATION OF BIOLOGICAL PRODUCTION AND BIOCLIMATE OF SANDY GRASSLANDS IN BUGAC (GREAT HUNGARIAN PLAIN BETWEEN DANUBE AND TISZA)

L. KÖRMÖCZI, GY. BODROGKÖZY and †I. HORVÁTH

Department of Botany, Attila József University, Szeged
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Summary

A three year period of investigations was performed in the sandy pasture near Bugac in the Kiss kúnság National Park beginning with 1977. On the area covered with sand hills the vegetation show-a mosaic-like distribution according to the various environmental factors determined by differences in the relief. Dynamics of production and bio-cilmate of five plant associations were investigated. The most extreme micro-climate was found in the *Bromus tectorum* stands and in the association *Festucetum vaginatae danubiale* Soó 29 with low degree of cover on the ridges of the sand hills in semiarid years. At this time production of phyto-mass showed a curve with two maxima. A different bio-climate was observed in the more densely covering grasses between the sand hills where vegetation was favourably influenced by better water supply, in the associations *Potentillo-Festucetum pseudovinae danubiale* BODRK. 59 and mainly in the *Lolio-Potentilletum anserinae* (RAPCS. 27) KNAPP 46 and *Molinio-Salicetum rosmarinifoliae* (MAGYAR 33) Soó 57 stands. In these cases dynamics of the production showed a curve with one maximum. The dry mass of the roots is everywhere 85—90 percent of the total dry matter.

Introduction

The biocenological and ecological investigations of the area are going on from 1976.

The mosaic complex of the vegetation enabled us to investigate the bio-climatological role of the vegetation and the relief, and the comparison of the primary production of the different associations and their dynamics. The data of these investigations furnish a reliable basis for the parallel running zoological investigations, concerning in first line the dynamics of the food chains and their energetics. Synthetizing the results a good picture can be obtained about the dynamics of the ecosystems of the sandy sites.

Present paper evaluates the results of the complex investigations of bio-climate and bio-production.

Relatively few data are available about micro-climate of the sandy areas between the Danube and Tisza. There are known the results of MAGYAR (1935) and HARGITAI (1942) about the forests of the area. Latter author compared the micro-climate of the sparsely covered sand hill ridges and that of the densely covered areas. The values obtained are characteristic to the associations. The temperature of air was measured in forests, clearings and pastures and data were published about the stratification of temperature by NAGY (1972). Complex bio-production investigations have been performed in Hungary since the middle of the sixties covering several themes of the International Biological Program (IBP). The papers of KOVÁCS-LÁNG (1971, 1974), KOVÁCS-LÁNG and SZABÓ (1971, 1973), SIMON and KOVÁCS-LÁNG (1972) discuss production-dynamics, its ecological determinants and mathematical problems of the study area Csévharaszt (in the middle of the area between Danube and Tisza). Papers of KOVÁCS-LÁNG and SZABÓ and SIMON and KOVÁCS-LÁNG describe the productivity of the annual and perennial sandy grasses demonstrating the dynamics of the production with two maxima during the vegetative period and connections between productivity relative humidity of air and insolation and temperature.

Materials and Methods

The study area on the eastern part of the Bócsa—Bugac region of the Kiskúnság National Park was fenced to keep off grazing animals. The ridges of the sand hills and the depressions between them have a NW-SE orientation. Differences in level are in general 1.5—2.0 m, the highest and lowest points differ 2.8 m.

On the highest sites occur *Festucetum vaginatae danubiale normale* (MAGYAR 33, KÁRPÁTI I. 54), the degraded *Potentillo-Festucetum pseudovinae danubiale euphorbietosum seguerianae* BODRK. 59 and its *Bromus tectorum* faces, between the hills the *Festuca pseudovina* facies of *Lolio-Potentilletum anserinae* KNAPP 46 while in the deepest sites as remains of extinct marshes the *Festuca pseudovina* facies of *Molinio-Salicetum rosmarinifoliae* (detailed descriptions in BODROGKÖZY and FARKAS 1981).

Plant production was determined by monthly harvesting 30×30 cm squares in three repetition during the vegetative period. The harvested matter was separated in four fractions: living monocotyledonous and living dicotyledonous plants, mosses and lichens, and dead matter. Plant material in the soil was determined by washing out monolithes of 10×10×20 cm. The separated plant materials were dried at 90 °C and the dry matter weight measured.

Bio-climate measurments of the four plant stands (Fig. 1) were performed with the aid of a laboratory-car. Air and soil temperatures were measured with a platinum resistance thermometer (in the air at 10, 180, 350 cm and according to the height of the plants at two more levels, in the soil at 2, 5 and 10 cm deep) through 22—25 hours; nights beeing in the middle of this period. Relative humidity of air was measured by Assmann aspiration psychrometer.

Meteorological data of the three years came from the local station. (Fig. 3.) The climate was characterized by the fifty year means of the meteorological station of Kecskemét, this being the nearest to the study area (Fig. 2). As shown, the climate is continental with hot summers. This distribution of the precipitation is uneven, the falls are generally arid while the summers are variable in this respect.

Results and discussion

The three years of investigation were especially adequate to demonstrate the influence of weather conditions on dynamics of dominancy and of production. 1977 was meagre in rainfall from April, 1978 was rich in precipitation while 1979 had a middle position in this respect showing a rainfall maximum in May-June characteristic to the Hungarian climate.

Organic matter productivity and bio-climate of the four stands can be summarized as follows:

Festucetum vaginatae danubiale normale (MAGYAR 33, KÁRPÁTI I. 54) has a covering of 40—50 per cent. The plants remain short, even in the early summer less than 30 cm in average. According to the recorders of station number II. here were measured the most extreme temperatures. The fluctuations were the highest (daily 27—32 °C) in the lower and higher air layers, the greatest differences from the other stands being observed at 30 cm due to the uncovered sand surfaces. The highest temperatures were measured at 13—14 hours p.m., the lowest at 5—7 hours a.m., depending on the season. Also in this scanty covered site was measured the lowest relative air humidity: 40—50 per cent.

The little-maximum of formation of dew was striking; independently of the season it occourred between 0 and 2 hours, not only here but in the other stands too (Fig. 4).

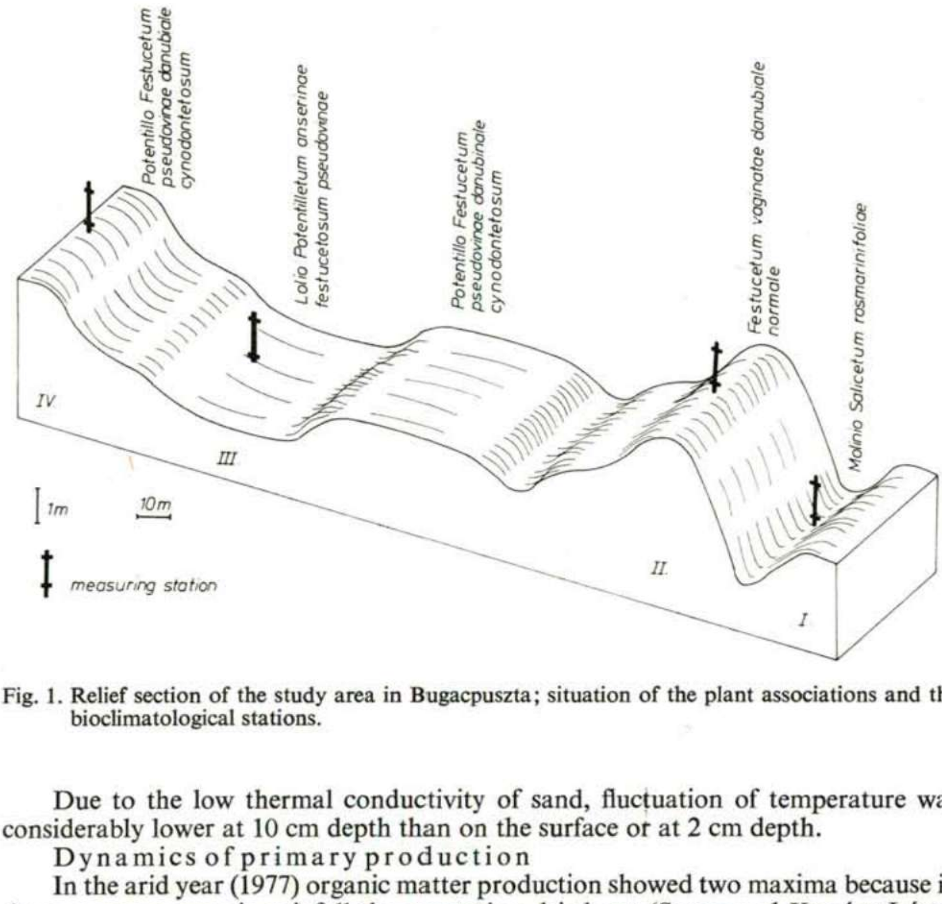

Fig. 1. Relief section of the study area in Bugacpuszta; situation of the plant associations and the bioclimatological stations.

Due to the low thermal conductivity of sand, fluctuation of temperature was considerably lower at 10 cm depth than on the surface or at 2 cm depth.

Dynamics of primary production

In the arid year (1977) organic matter production showed two maxima because in the summer meagre in rainfall the vegetation dried out (Simon and Kovács-Láng, 1972). In 1978 the regress of phytomass (negative production) was not expressed due to the rainfall maximum in June; positiv production, however, was not observed. This latter can be attributed to biogeneous factors. The study area, however exempted of pasturing, was invaded in the early summer by locusts which consumed a considerable part of the Gramineae species. This supposition was supported by the investigations of Kiss (1979) on the seasonal dynamics of orthopterean nymphs. Their number showed a maximum at the end of May and beginning of June, their number in the

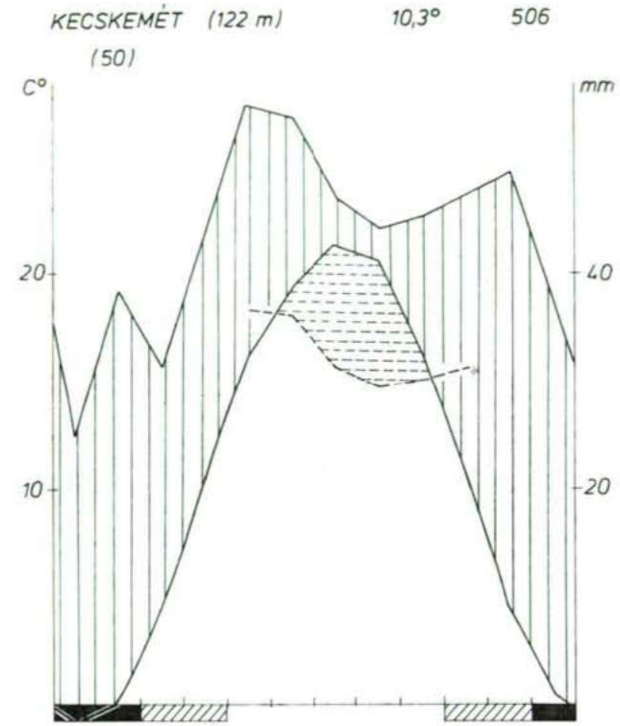

Fig. 2. Walter-Lieth diagram of Kecskemét based on the fifty-yeras mean of temperature and precipitation values.

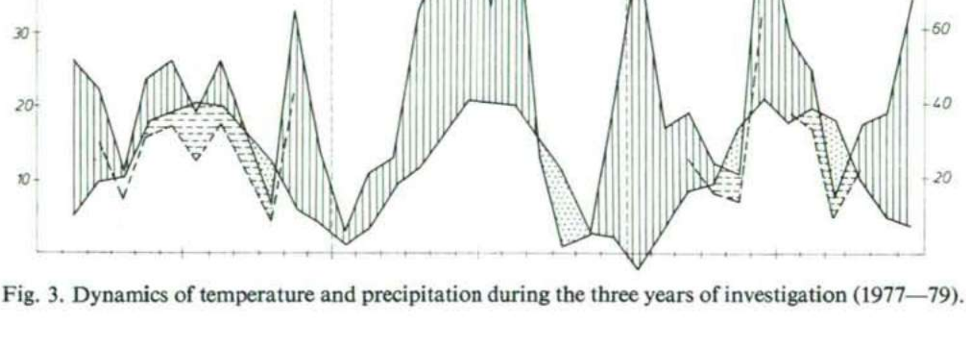

Fig. 3. Dynamics of temperature and precipitation during the three years of investigation (1977—79).

Festuca vaginata stands was 2.5 times more than that of counted in the stands of lower sites.

Potentillo-Festucetum pseudovinae Soó 39/50 *euphorbietusom seguerianae* Bodrk. 59 *Bromus tectorum* facies.

It can be considered as a fase in the succession after Festucetum vaginatae which was degraded by intensive pasturing (Bodrogközy and Farkas, 1981). Its dominancy conditions are more favourable than those of *Festucetum vaginatae*. Its phytomass production was higher than in the *Festucetum vaginatae* especially in the early summer.

Potentillo-Festucetum pseudovinae Soó 39/50 *cynodontetosum*

It occurs at more favourable levels than the former (Fig. 1). From the composing species predominates *Cynodon dactylon* which endure grazing and trodding, having wide ecological adaptability. *Cynodon* can be considered as a differentiating species. Being the dominant species it produces the greater part of organic matter. In the neighborhood of the study area this is the most frequent association. Therefore production biology data obtained may be used in practice too.

Its bio-climate is better than that of the former association; it may be considered as a different type. Due to the more closed growth warming up and cooling down is not so extreme as in the former association. The dynamics of temperature as regarded time of maximum minimum and little-maximum are similar but daily fluctuation is only 20—24 °C. The realtive humidity of air is higher. Dynamics oftemperature in *Potentillo-Festucetum pseudovinae* is shown in Figure 5.

Overground phytomass production

From the enviromental factors precipitation was the first the changes of which showed a close correlation to seasonal dynamics of living matter production.

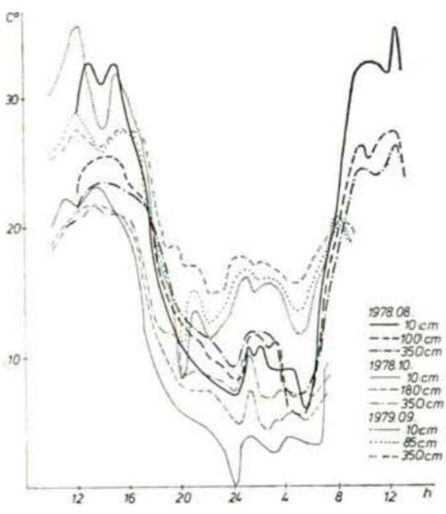

Fig. 4

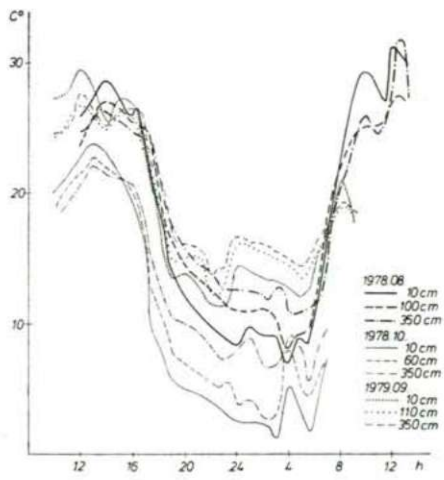

Fig. 5

Fig. 4. Dynamics of temperature in *Festucetum vaginatae* danubiale at different hights and dates.

Fig. 5. Dynamics of temperature in *Potentillo-Festucetum pseudovinae danubiale*.

Table 1. Dynamics of phytomass production of the stand

Overground phytomass g/m²

Date	Monocotyl.	Dicotyl.	Phanerogam. total	Moss-lichen	Living total	Dead	Total
07.04.77..	23.3	29.6	52.9	31.7	84.6	67.1	151.6
05.05.	58.0	31.1	89.3	12.3	101.6	73.0	174.7
28.07.	7.7	29.2	36.9	7.8	44.7	232.3	277.0
23.09.	18.6	26.8	45.4	12.8	58.2	218.3	276.5
27.10.	21.1	15.6	36.7	15.2	51.9	124.8	176.7
21.11.	17.8	3.7	21.5	51.5	73.0	137.0	210.0
21.04.78.	36.7	6.9	43.6	23.7	67.3	58.1	125.4
17.05.	41.9	65.2	107.1	37.4	144.5	154.1	298.6
10.07.	34.8	51.7	86.5	209.8	296.3	75.2	371.5
13.10.	35.2	19.8	55.0	5.7	60.7	102.2	162.9
15.11.	13.7	5.9	19.6	—	19.6	99.3	118.9
16.02.79	16.7	16.3	33.0	110.0	133.0	298.5	431.5
23.03.	38.9	10.0	48.9	16.7	65.6	255.6	321.2
27.04.	35.1	8.7	43.8	100.4	144.2	167.4	311.6
18.05.	84.1	2.1	86.2	8.0	94.2	209.6	303.8
26.06.	26.0	—	26.0	39.6	65.6	164.1	229.7
15.09.	128.5	19.6	148.1	82.2	230.3	296.7	527.0
18.10.	118.2	14.5	132.7	330.3	452.0	190.8	642.8

Underground phytomass g/m²

Date	0—5 cm	5—10 cm	10—20 cm	Total
07.04.77.	490	250	40	780
05.05.	1190	330	250	1770
23.09.	1530	310	370	2210
27.10.	1990	250	360	2600
21.11.	1400	500	250	2150
23.03.79.	1960	300	360	2620
27.04.	1150	160	90	1400
18.05.	700	310	290	1300
26.06.	1320	360	370	2050
18.10.	960	220	190	1370

Table 2. Productivity of the stand g/m² day

Date						
77.		07.04-05.05. 1.30	05.05-28.07. -0.63	28.07-23.09. 0.15	23.09-27.10. -0.26	27.10-21.11. -0.61
78.			21.04-17.05. 2.44	17.05-10.07. -0.38	10.07-13.10. -0.33	13.10-15.11. -1.07
79.	16.02-23.03. 0.45	23.03-27.04. -0.15	27.04-18.05. 2.02	18.05-26.06. -1.52	26.06-15.09. 1.50	15.09-18.10. -0.45

Table 3. Seasonal dynamics of the overground phytomass (g/m²) during the three years of investigation

Date	Monocotyl.	Dicotyl.	Phanerogam. total	Moss-lichen	Living total	Dead	Total
05.05.77.	90.1	72.4	162.5	10.6	173.1	108.6	281.7
28.07.	34.8	15.6	50.4	15.0	65.4	171.1	236.5
23.09.	21.5	12.2	33.7	18.9	52.6	98.9	151.5
27.10.	39.3	6.3	45.6	29.3	74.9	166.7	241.6
21.11.	30.8	7.8	37.8	22.6	60.4	180.0	240.4
21.04.78.	72.6	5.6	78.2	18.9	97.1	145.5	242.6
17.05.	115.6	31.1	146.7	36.1	182.8	138.1	320.9
10.07.	98.9	33.5	132.4	34.8	167.2	323.5	490.5
13.10.	33.7	—	33.7	23.3	57.0	250.0	307.0
15.11.	25.2	6.7	31.9	19.6	51.5	243.7	295.2
16.02.79.	27.0	—	27.0	78.5	10.5	197.0	302.5
23.03.	46.7	5.6	52.3	—	52.3	255.6	307.9
27.04.	178.2	4.1	182.3	37.0	219.3	343.7	563.0
18.05.	220.0	4.1	224.1	35.6	259.7	177.4	437.1
26.06.	25.9	3.7	29.6	21.5	51.1	245.5	296.6
15.09.	127.0	—	127.0	45.2	172.2	797.8	970 0
18.10.	68.1	3.0	71.1	47.8	118.9	340.4	459.3

Dynamics of the underground phytomass (g/m²)

Date	depth cm			Total
	0—5	5—10	10—20	
05.05.77.	1120	490	440	2050
23.09.	970	310	110	1390
27.10.	1780	320	540	2640
21.11.	750	530	270	1550
27.04.79.	1250	80	120	1450
18.05.	790	390	410	1590
26.06.	590	290	170	1050
18.10.	1660	170	230	1960

Table 4. Dynamics of productivity (g/m² day) in the Bromus tectorum facies

Date					
77.	07.04-	05.05-	28.07-	23.09-	27.10-
	05.05.	28.07.	23.09.	27.10.	21.11.
	—	-1.34	-0.29	0.35	-0.31
78.		21.04-	17.05-	10.07-	13.10-
		17.05.	10.07.	13.10.	14.11.
		2.63	-0.27	-1.40	-0.06
79.	23.03-	27.04-	18.05-	26.06-	15.09-
	27.04.	18.05.	26.06.	15.09.	18.10.
	2.22	1.99	-4.99	1.20	-1.69

In 1977 the vegetative period was meagre in rainfall. The rather low maximum in the late spring-early summer was followed in the rainy fall by a second maximum, as in the *Bromus tectorum* facies. The dead matter fraction evenly increasing attained a maximum in October.

A close correlation was established between the summer precipitation maximum and phytomass production of *Cynodon* stands. The living matter maximum was in July while in the *Bromus* stands in May. In the fall meagre in precipitation productivity decreased to the fifth. The dead matter maximum was in November (in the *Bromus* facies in July) (Table 5).

Table 5. Seasonal dynamics of phytomass production in the stand with *Cynodon*
Overground phytomass g/m²

Date	Monocotyl.	Dicotyl.	Phanerogam. total	Moss-lichen	Living total	Dead	Total
07.04.77.	24.0	20.4	44.4	8.0	52.4	50.8	103.2
05.05.	39.7	33.2	72.9	2.1	75.0	65.9	140.9
28.07.	90.9	41.6	132.5	12.2	144.7	100.8	245.5
23.09.	31.9	31.1	63.0	1.9	64.9	126.3	191.2
27.10.	22.6	11.5	34.1	5.9	40.0	153.3	193.3
21.11	25.2	15.6	40.8	—	40.8	106.3	147.1
21.04.78.	41.2	3.0	44.2	8.3	52.5	136.5	189.0
17.05.	85.9	75.9	161.8	—	161.8	115.6	277.4
10.07.	110.0	71.3	181.3	30.3	211.7	159.1	370.8
13.10.	26.3	—	26.3	10.5	36.8	188.7	225.5
15.11.	11.1	0.5	11.6	4.0	15.6	190.9	206.5
16.02.79.	16.3	4.8	21.1	49.6	70.7	193.7	264.4
23.03.	47.8	6.7	54.5	26.7	81.2	262.2	343.4
27.04.	51.1	18.9	70.0	14.4	84.4	241.8	326.2
18.05.	120.4	15.2	135.6	0.7	136.3	164.8	301.1
26.06.	122.6	23.3	145.9	10.0	155.9	72.6	228.5
15.09.	204.8	23.7	228.5	6.3	234.8	187.0	421.8
18.10.	31.1	8.9	40.0	8.5	48.5	183.0	231.5

Underground phytomass g/m²

Date	0—5 cm	5—10 cm	10—20 cm	Total
07.04.77.	1240	160	170	1570
05.05.	1640	300	270	2210
23.09.	720	260	210	1190
27.10.	1120	660	430	2210
21.11.	1110	690	850	2650
23.03.79.	2720	730	560	4010
27.04.	3820	730	630	5180
18.05.	3060	750	570	4380
26.06.	930	590	470	1990
18.10.	410	210	200	820

To registrate the effect of the abundant precipitation of the following winter in February 1979 investigations were performed. According to these, from November 1978 till February 1979 the organic matter of the *Cynodon* stand became fourfold without any growth in the quantity of dead matter. In the vegetation period this surplus in precipitation was evenly used by the grass; the precipitation maximum in May being a favourable supply. Through these seasonal dynamics of organic matter production showed an evenly rising tendency. The fraction of living matter showed a maximum in September.

In the dry year the underground phytomass of *Cynodon* stand showed a dynamism of two maxima similar to that of the *Bromus* facies. The maximum of the underground parts follows that of the overground parts with a months delay due to regeneration of the roots of *Cynodon*.

In the more humide year of 1979 the roots of *Cynodon* were more respondent to the fluctuation of the precipitation than the overground parts. In the drier summer period following the May rich in precipitation in the 0—5 cm soil layer the root-mass decreased to one third. Negativ repoductivity was here more expressed than in the *Bromus* stand.

Table 6. Seasonal dynamics of productivity (g/m² day) in Potentillo-Festucetum pseudovinae cynodontetosum

Date						
77.		07.04- 05.05. 1.02	05.05- 28.07. 0.70	28.07- 23.09. -1.22	23.09- 27.10. -0.85	27.10- 21.11. 0.26
78.			21.04- 17.05. 4.52	17.05- 10.07. 0.36	10.07- 13.10. -1.63	13.10- 15.11. -0.44
79.	16.02- 23.03. 0.95	23.03- 27.04. 0.44	27.04- 18.05. 3.12	18.05- 26.06. 0.27	26.06- 15.09. 1.02	15.09- 18.10. -5.71

Lolio-Potentilletum anserinae Knapp 46 *festucetosum pseudovinae* (n.n.)

This is the vegetation of the shallow sites between the hills. The soil is a humid sand covered by the vegetation till 100 per cent. Progressive desiccation leads to dominancy of *Festuca pseudovina* and this association is pastured in the region.

Its bio-climate is characterized by a lower temperature as compared with the former stands, espcially at nights. The difference is 3—4 °C. The depressions between the hills function as cold-traps: the air turned cold over the hills flows down and stagnates. So at the surface this sites became colder. On the other hand, irradiation reaches these sites later, warming up can be delayed 0.5—1 hour than on the ridges (Fig. 6). Seasonal dynamics of organic matter prodution was correlated with the dynamics of precipitation. In the dry 1977 production of the overground parts was similar to that of the *Cynodon* stands living higher: maximum of living matter was observed in the early summer, that of dead matter in the fall. This latter determined also the total production. Underground phytomass production showed two maxima in all soil layers and it was more than twentyfold (179—4140 g per m^2) of the overground mass.

In the following humid year production dynamics of *Lolio-Potentilletum anserinae* was different. In contrast to the favourable water supply the maximum of the living matter fraction was hardly 30 per cent higher, while the dead matter having its maximum at the same time (early summer) was the fourfold of the previous year. This can be contributed to preclusion of grazing. It is stiking that humid weather accelerated decomposition of dead matter.

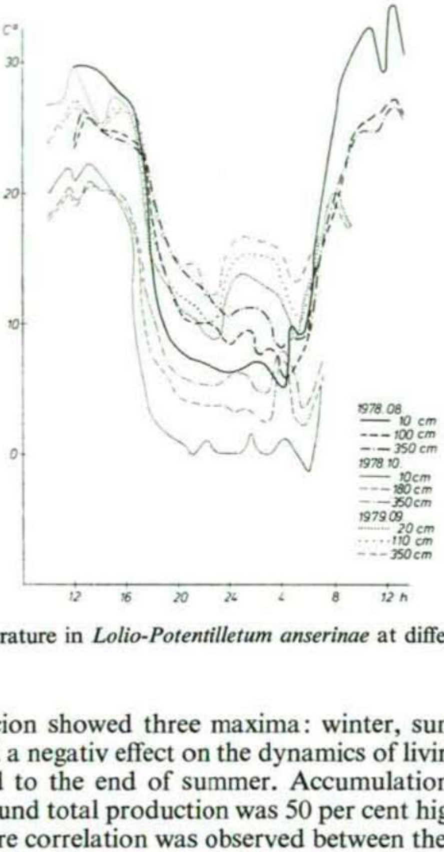

Fig. 6. Dynamics of temperature in *Lolio-Potentilletum anserinae* at different hights.

In 1979 precipitacion showed three maxima: winter, summer and fall. In this year the dry spring had a negativ effect on the dynamics of living fraction. So the maximum was transferred to the end of summer. Accumulation of the dead fraction went on so the overground total production was 50 per cent higher than in the former year (Table 7). Also here correlation was observed between the maxima of the underground organic matter (0—20 cm) and maxima of precipitation (Fig. 2., Table 7).

Molinio-Salicetum rosmarinifoliae Soó 33/57

On the Bugac pasture, as in the sandy grassland between the Danube and Tisza in general, this association occurs on the lowest sites between the hills. Formerly on these sandy meadow soils lived the association *Schoenetum nigricantis* (ALL. 22) W. KOCH 26. Due to inland drainage water table dropped the soil dried out and the vegetation in consequence of pasturing and trodding became a *Molinio-Salicetum rosmarinifoliae* consisting only few species. The analysis of three years bio-climate measurements could not detect differences (either in daylight or at night) great enough

Table 7. Seasonal dynamics of phytomass production in *Lolio-Potentilletum anserinae festucetosum pseudovinae*
Overground phytomass g/m²

Date	Monocotyl.	Dicotyl.	Phanerogam. total	Moss-lichen	Living total	dead	Total
07.04.77.	20.1	12.0	32.1	1.1	33.2	59.4	92.6
05.05.	42.7	29.9	72.6	—	72.6	23.9	96.5
28.07.	59.5	48.9	108.4	—	108.4	61.9	170.3
23.09.	45.2	54.1	99.3	0.4	99.7	97.4	197.1
27.10.	33.3	25.6	58.9	—	58.9	128.5	187.5
21.11.	28.9	5.2	34.1	—	34.1	102.2	136.3
21.04.78.	28.1	14.1	42.2	—	42.2	164.1	206.3
17.05.	80.7	21.1	101.8	0.4	102.2	187.1	289.3
10.07.	82.6	58.9	141.5	6.3	147.8	252.2	400.0
13.10.	23.9	37.9	61.8	—	61.8	176.3	238.1
15.11.	27.0	8.9	35.9	—	35.9	172.6	208.5
16.02.79.	38.1	6.3	44.4	0.4	44.8	237.4	282.2
23.03.	46.7	5.6	52.3	—	52.3	255.6	307.9
27.04.	43.7	14.8	58.5	—	58.5	174.8	233.3
18.05.	95.2	33.7	128.9	1.9	130.8	81.4	214.9
26.06.	191.9	72.2	264.1	—	264.1	181.5	445.6
15.09.	183.4	96.3	279.7	8.1	287.8	355.6	643.4
18.10.	91.8	22.9	121.0	—	121.0	153.0	274.0

Underground phytomass g/m²

Date	0—5 cm	5—10 cm	10—20 cm	Total
07.04.77.	830	560	106	1550
05.05.	1980	540	350	2870
23.09.	1080	340	150	1570
27.10.	3560	420	160	4140
21.11.	1900	470	420	2790
23.03.79.	2690	230	190	3110
27.04.	1450	460	250	2160
18.05.	2680	340	340	3360
26.06.	1950	490	280	2720
18.10.	1580	700	640	2920

Table 8. Dynamics of productivity the stand g/m² day

Date						
77.		07.04-05.05.	05.05-28.07.	28.07-23.09.	23.09-27.10.	27.10-21.11
		1.45	0.43	-0.16	-1.19	-1.00
78.			21.04-17.05.	17.05-10.07.	10.07-13.10.	13.10-15.11.
			2.29	0.74	-0.84	-0.79
79.	16.02-23.03.	23.03-27.04.	27.04-18.05.	18.05-26.06.	26.06-15.09.	15.09-18.10.
	0.23	0.17	3.35	3.47	0.20	-4.80

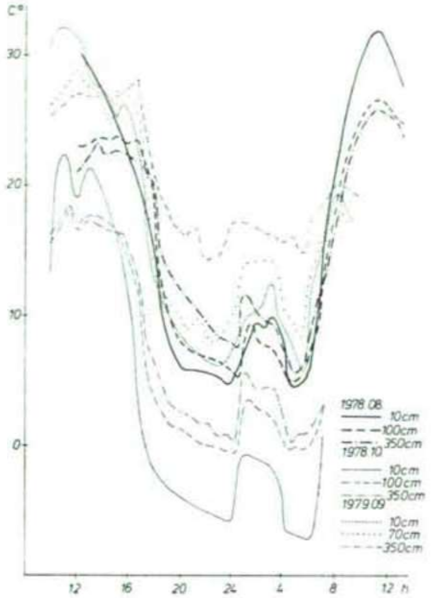

Fig. 7. Dynamics of temperature in *Molinio-Salicetum rosmarinifoliae.*

Table 9. Dynamics of productivity of phytomass (g/m²) in *Molinio-Salicetum rosmarinifoliae*

Date	Mono-cotyl.	Dicotyl.	Phanero-gam. total	Moss-lichen	Living total	Dead	Total
07.04.77.	57.1	15.3	72.4	—	72.4	163.7	236.1
05.05.	71.5	22.9	94.4	2.7	97.1	159.7	256.8
28.07.	37.4	33.1	70.5	11.4	81.9	256.3	338.2
23.09.	61.6	13.6	75.2	1.4	76.6	240.7	317.3
27.10.	52.6	15.2	67.8	5.6	73.4	313.3	386.7
21.11.	14.5	6.3	20.8	11.5	32.3	197.8	230.1
21.04.78.	35.9	7.0	42.9	0.4	43.3	168.1	211.4
17.05.	93.6	79.4	173.0	—	173.0	345.8	518.8
10.07.	142.2	88.7	230.9	10.6	241.5	318.7	560.2
13.10.	67.8	15.2	83.0	4.8	87.8	307.0	394.8
15.11.	29.3	2.6	31.9	0.7	32.6	267.0	299.6
16.02.79.	20.0	2.6	22.6	1.3	23.9	459.6	483.5
23.03.	23.3	5.6	28.9	2.2	31.1	408.9	440.0
27.04.	58.5	29.2	88.7	1.5	89.2	558.1	647.3
18.05.	74.8	41.5	116.3	4.1	120.4	264.4	384.8
26.06.	166.3	44.1	210.4	—	210.4	342.2	552.6
15.09.	221.5	58.9	280.4	3.1	283.5	511.6	795.1
18.10.	102.6	11.1	113.7	—	113.7	662.2	775.9

Underground phytomass g/m²

Date	0—5 cm	5—10 cm	10—20 cm	Total
07.04.77.	2790	300	190	3280
05.05.	2480	410	350	3240
23.09.	2720	820	220	3760
27.10.	2630	590	920	4140
21.11.	2510	900	560	3970
23.03.79.	1320	400	190	1910
27.04.	2970	440	380	3790
18.05.	3250	530	360	4140
26.06.	2260	970	500	3730
18.10.	2050	420	230	2700

to be able to determinate the differences in species composition comparing with the most extereme ecological conditions of *Festucetum vaginatae*. In the *Molinio-Salicetum* stand stood the bio-klimate station number 1. The dynamics of its temperature is shown in Figure 7. Generally it corresponds to that of the former stand. From sunset to sunrise temperature was also here lower with several grades as on the ridges. Fluctuation of temperature at the soil surface was even lower than in the short grass associations, probably in consequence of the height of the plants. Also higher humidity of the soil and nearness of the water table has a similar effect. Relative humidity of air was also 5—8 per cent higher in these lower sites.

Here was registered the highest phytomass production. In the dry year the maximum of the living matter was in May while dead matter production showed a maximum in summer and an other one in fall (Table 9). In 1978 due to the precipitation maximum in June both fractions culminated in July while in 1979, similarly to the stands with *Cynodon* and *Lolium*, maximum was attained in fall. Underground organic matter production is shown in Figure 8.

Table 10. Dynamics of productivity of the stand g/m² day

Date						
77.		07.04- 05.05. 0.78	05.05- 28.07. -0.28	28.07- 23.09. 0.08	23.09- 27.10. -0.21	27.10- 21.11. -1.38
78.			21.04- 17.05. 5.00	17.05- 10.07. 1.07	10.07- 13.10. -1.55	13.10- 15.11. -1.55
79.	16.02- 23.03. 0.18	23.03- 27.04. 1.68	27.04- 18.05. 1.37	18.05- 26.06. 2.42	26.06- 15.09. 0.86	15.09- 18.10. -4.60

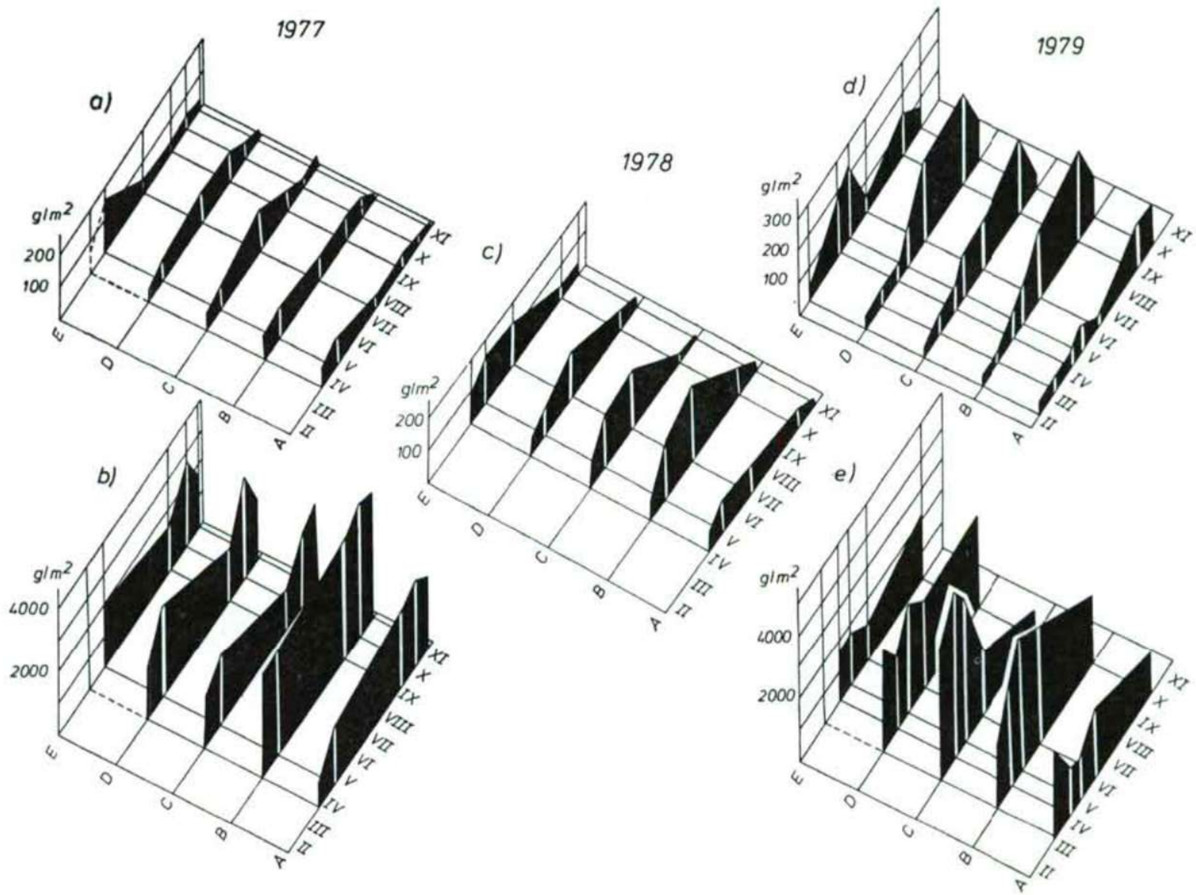

Fig. 8. Seasonal dynamics of overground (a, c, d) and underground (b, e) phytomass in *Festucetum vaginatae* (A), *Molinio-Salicetum rosmarinifoliae* (B), *Potentillo-Festucetum pseudovinae cynodontetosum* (C), *Lilio-Potentilletum anserinae* (D), and *Potentillo-Festucetum pseudovinae brometosum* (E) in the years 1977—79.

References

BODROGKÖZY, GY. and FARKAS, GYÖNGYI (1981): Correlations between vegetation and hydroecology in the sandy grasslands of Kiskúnság National Park — Acta Biol. Szeged. *17.* 33—35

HARGITAI, Z. (1942): Mikroklíma vizsgálatok a nagykőrösi Nagyaerdőben (Microclimate investigations in the Nagyerdő of Nagykőrös). — Acta Geobot. Hung.

KISS, G. (1979): Orthoptera vizsgálatok a Kiskúnsági Nemzeti Parkban pszammofil gyep-ökoszisztémában (Investigations fo Orthopteras in psammophilous grass-ecosystems of Kiskúnság National Park). — Szeged (Thesis).

KOVÁCS-LÁNG, EDIT (1971): Fractional humus investigation of soil under sward communities *(Festucetum vaginatae danubiale, Festucetum wagneri)* growing on sandy sites — Annal. Univ. Sci. Budapest. Sect. Biol. *13,* 163—170.

KOVÁCS-LÁNG, EDIT (1974): A fitomassza produkció és feltételeinek vizsgálata a csévharaszti IBP mintaterületen (Investigation of phytomass production and its conditions in the study area of Csévharaszt). — Budapest (Thesis).

KOVÁCS-LÁNG, EDIT and SZABÓ, MÁRIA (1971): Change of soil humidity and its correlation to phytomass production in sandy meadow association. — Annal. Univ. Sci. Budapest, Sect. Biol. *13,* 115—126.

NAGY, L. (1972): Sugárzás és hőmérsékleti vizsgálatok az újszentmargitai erdőben (Investigation of insolation and temperature in the forest of Újszentmargita). — MTA Biol. Oszt. Közlem. *15,* 51—60.

SIMON, T. és KOVÁCS-LÁNG, EDIT (1972): Produkcióbiológiai vizsgálatok a csévharaszti IBP mintaterületen (Production-biological investigations in the IBP study area at Csévharaszt). — MTA Biol. Oszt. Közlem. *15,* 61—69.

Address of the authors:
L. KÖRMÖCZI
Dr. GY. BODROGKÖZY
Department of Botany, A. J. University,
H-6701 Szeged, P. O. Box 428.
Hungary