Interannual Variation in Productivity of Steppe Pastures As Related to Climatic Changes

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Abstract—The results of long-term stationary research on the assessment of aboveground phytomass and soil moisture dynamics in a steppe pasture are presented. An analysis of annual and interannual variation in meteorological parameters over the study period has been performed, and, on this basis, the dependence of productivity on climatic changes has been determined.

Key words: steppe ecosystems, pastures, climatic changes.

Under conditions of high natural variation in the productivity of steppe communities, data collected during one or even several years are insufficient for correctly estimating the effect of grazing load. Long-term stationary studies have shown that the production and destruction processes in steppe geosystems have distinct rhythms and multiannual cyclicity (Snytko et al., 1983). Hence, to analyze the dependence of ecosystem productivity on climatic rhythms, the period of studies should be sufficient for the manifestation of characteristic periodicity in temporal organization of bioclimatic processes.

MATERIAL AND METHODS

Studies were performed at the Odesskii state farm located in Kominternovskii raion of Odessa oblast, Ukraine, from 1981 to 1995. This region (1500 km^2) is between the Tiligul and Kuyalnik estuaries. In the late 1950s, pastures and hayfields covered 17% of its total area. Today, when agricultural development of the region has reached its limit, this proportion is only 9%, or 11% of all farmlands.

The representative test area chosen for observations on pasture productivity (46.6 ha) is located 5 km northeast of the city of Odessa and 8 km from the Black Sea coast, in the zone of breeze circulation characterized by an arid climate (with a precipitation–evaporation ratio of 0.45–0.48) and considerable variation in bioclimatic parameters. According to long-term data from weather stations, the difference between the total amounts of precipitation in the wettest and driest years is 2.5- to 3-fold in the steppe zone near Odessa and 3.45-fold within the Odessa city limits. Some years may be extremely arid. In 1921, for example, the amount of precipitation was only 192 mm, while evaporation reached 800 mm, with their ratio being 0.24.

The Greater Ajalyk (Dofinovka) estuary located 3.0–3.5 km from the test area has a certain influence on the local climate. It is fed mainly by an input of sea water through a sand pit, and the level of water mineralization in the estuary averages 21‰ (210 mg/l), increasing in summer to 400 mg/l. The chemical composition of precipitation in the zone of land–sea contact is known to have certain specific features, as it is enriched with salts (mainly sodium and magnesium chlorides and sulfates) transferred from the sea and estuaries: the annual amount of these salts falling on land reaches 150–170 kg per hectare. In the subzone of southern chernozems, 77 days per year, on average, are characterized by atmospheric drought with hot winds (Bogdanova, 1967). Regions near estuaries often suffer from strong winds (15–24 m/s), whereas the average wind velocity in the south of Ukraine is only 4–5 m/s. At a low vegetation coverage, this results in litter redistribution over the soil surface in steppe ecosystems, facilitating the spread of fires.

The study region is close to a weather station, which allows a more detailed analysis of the relationship between productivity and climate. The test area is on the western (left) slope of the Glubokaya ravine, one of the two arms of the Greater Ajalyk estuary in its upper reaches. The total length of the slope (from the watershed to the ravine bottom) is 1.1 km. Its upper and middle parts (830 m long, average slope angle 2.5 degrees) are plowed. The lower quarter (270 m, 3.5 degrees), which begins on a gently sloping terrace with an absolute elevation of 19 m, is grassed. Sampling plots were established on this terrace, on weakly eroded low-humus southern chernozem with sand and heavy loam.

Table 1. Relative areas of main categories of farmlands in Kherson province, %

Year	Plowed land	Hayfields	Pastures and virgin land
1850–1852	45.4	38.3	11.2*
1887	53.0	14.7	32.3
1890	58.9	13.4	27.4
1895	61.8	10.5	27.7
1900	68.2	7.1	24.7
1905	72.7	7.3	20.0
1910	83.4	4.5	12.1
1911	85.9	3.8	9.0

* Pastures and roads.

Its parameters are as follows: the depth of horizon A and humus horizon 10 and 33 cm, respectively; a boiling reaction with 10% HCl is observed beginning from 16 cm; total absorbed bases in horizon A 24.9 mg · equiv/100 g soil; humus and carbonate contents in the 0–20 cm layer 2.8 and 4.0%, respectively; C : N ratio 8.9; and $\mathrm{pH_{water}}$ 6.85.

The content of exchangeable sodium in southern chernozems usually does not exceed 1–3% of total exchangeable bases. However, the enhancement of physical alkalinization (apparent compaction, signs of slitization, and a specific structure of the transitional horizon) is accompanied by a marked increase in the amount of magnesium in the soil absorbing complex (SAC): in southern chernozem tilled on the watershed, the content of exchangeable magnesium in horizon A ranged from 3.2 to 3.6 mg · equiv/100 g soil, or 15.5–18.0% of total exchangeable bases, increasing to 22–23% in horizons B1 and $\mathrm{B2_{Ca}}$. The soil of the pasture (0–20 cm) contained 4.4–4.8 mg · equiv exchangeable magnesium per 100 g (19–20% of total exchangeable bases), while the proportion of exchangeable sodium was insignificant (1.7%).

The aboveground phytomass of herbaceous plants was estimated in sampling plots (25 × 25 cm) in four to six replications, with each sample being dried in a thermostat to determine its absolutely dry weight. The relative error of means for green phytomass ranged from 9 to 13%, increasing to 18% only upon overgrazing; in the case of dead plants and litter, this error varied more widely, increasing to 20–30% at the peak of grazing load.

RESULTS AND DISCUSSION

The study area is in the geobotanical province of xerophytic mixed herb–sheep's fescue–feather grass steppes on dark chestnut soils and southern residually alkaline chernozems. The botanical composition of the herb–grass phytocenosis was fairly diverse: the number of flowering plant species found in a 1-m^2 plot reached 25–34 in May and June, decreasing to 8–19 between July and September. Grasses such as *Festuca valesiaca* Gaud., *Koeleria cristata* (L.) Pers., and *Poa bulbosa* L. were usually dominant. Vegetation on the bottoms of gullies cutting through the slope included a large proportion of mesophytes: *Alopecurus aequalis* Sobol., *Elytrigia repens* (L.) Nevski, *Carex stenophylla* Wahl., and *Poa angustifolia* L., etc. In some years flowering *Stipa capillata* L. in late summer accounted for up to 59% of the total phytomass. Other feather grass species, *S. lessingiana* Trin. et Rupr. and *S. ucrainica* P. Smirn., occurred mainly on the slopes of ravines, with the amount of green phytomass reaching a peak of 2434 kg/ha (with dead plants, 3614 kg/ha) between late April and June.

In spring (April and May), a considerable role in plant communities belonged to *Crinitaria villosa* Cass., *Euphorbia seguieriana* Neck., *Linum perenne* L., *Medicago lupulina* L., *Veronica seppacea* Kotov, and *Jurinea mollissima* Klok., with *Potentilla patula* Walsf., *Astragalus pubiflorus* DC., and *Salvia nutans* L. being less widespread. The contribution of wormwood *Artemisia austriaca* Jacq. to the total aboveground phytomass did not exceed 10%. Beginning from the second half of summer, the proportion of wormwood in areas exposed to different grazing loads increased to 20–90%. The improvement of the phytocenotic role of wormwood is a diagnostic sign of steppe desertification. As shown previously (Lisetskii, 1992), the proportion of wormwood in the total phytomass is insignificant only at the digressive stages at which the number of plant species in a 25 × 25-cm plot is no less than 12 (the ratio of species numbers in 1-m^2 and 25 × 25-cm plots is 2.00–2.67). The phytomass of ground-dwelling lichens reached 48–76 kg/ha (September 1984), and the proportion of animal feces in the litter varied from 12.3 to 23.2% (120–340 kg/ha).

The steppe grass stand, both natural and seminatural (transformed to different degrees under the effects of grazing load and hay harvesting), lost its former economic significance during a short historical period (60 years) from the mid-19th to the early 20th century (Table 1). In 1864, arable lands and hayfields in Kherson province exceeded 5×10^6 ha, accounting for 19% of its total area, and accommodated 23% of the total sheep stock and 33% of the fine-wool sheep stock in southern Russia: there were 10 head of ordinary sheep and 47 head of fine-wool sheep per 100 hectares, compared to 14 and 18 head, respectively, in 1856. However, this agricultural practice radically changed already in the 1860s, especially in small farms: livestock breeding was reduced to a minimum, giving way to extensive grain husbandry (Postnikov, 1891). In 1910, pastures and remaining virgin lands in Odessa district (9341 km^2) accounted for only 10.4% of its area (*Statistiko-ekonomicheskii obzor…*, 1911).

Depending on weather conditions, virgin lands were used either as hayfields or as pastures. The yielding capacity of hayfields on virgin lands varied from 450 to 3750 kg/ha. In general, farmers obtained 360 kg of hay per hectare from virgin lands, 520–730 kg/ha from fallows (depending on their age), and 1120 kg/ha from meadows (*Khozyaistvenno-statisticheskii obzor…*, 1891). In 1896, hay yield from virgin lands in some districts of Kherson province reached 560–880 kg/ha (*Statistiko-ekonomicheskii obzor…*, 1897). In Odessa district, hay yield from three- to eight-year-old fallows averaged 600 kg/ha in unfavorable years, 1200 kg/ha in ordinary years, and 1800 kg/ha in favorable years (*Materialy…*, 1883); between 1888 and 1890, hayfields yielded 410–600 kg/ha; in 1896, fallows yielded 360–450 kg/ha.

Thus, natural and seminatural grass stands under soil-climatic conditions of the steppe zone yielded up to 900–1200 kg of hay (760–1010 kg of dry phytomass) per hectare without any agrotechnical measures. However, statistical data obtained in the 19th and early 20th centuries can only provide a vague idea of long-term average productivity of greenlands.

Let us consider specific features of the production process in a pasture according to the results of studies in the stationary test area. In the period of more or less regular observations (1981–1990) and, for comparison, in subsequent years with different socioeconomic conditions (1991, 1992, and 1995), 437 measurements of phytomass were made (Table 2). Its values in the pregrazing period varied markedly over 13 years, with the coefficient of variation in the maximum value (over 12 years) reaching 39.7%.

Under increasing grazing load, feather grass was the first to lose its position in the phytocenosis, and then followed sheep's fescue. A considerable proportion of feather grass in the pasture was recorded in only a few years. In such cases, the maximum yield of green phytomass reached 1800 kg/ha, whereas under usual conditions (when sheep's fescue was dominant) this parameter averaged 1500 kg/ha over 12 years.

By the onset of the grazing period, the herbaceous layer on the pasture consisted of grasses (79%), mixed herbage (15%, including 3% of *Euphorbia seguieriana*), and legumes (6%). An assessment of grazing load over the observation period showed that the pasture area per head of cattle averaged 0.9–1.0 ha, corresponding to medium values of the norm for pastures of the steppe zone.

Long-term green phytomass removal under conditions of moderately intensive grazing, accompanied by fires in some years, resulted in apparent adaptation of the grass stand to this kind of anthropogenic impact. For example, data on the period between the autumn of 1989 to the autumn of 1990 characterize the conditions of postfire recovery of the steppe phytocenosis.

To estimate real productivity of the pasture in different years, the values presented in Table 2 should be

Table 2. Dynamics of aboveground phytomass, 100 kg/ha

Year	Date	Aboveground phytomass		Litter
		green parts	dead parts	
1981	June 26	14.34		14.92
	August 10	7.71	–	8.00
1982	May 14	–	4.94	–
	June 16	12.48	–	–
	July 20	10.77	–	–
	August 8	7.51 (+10.91)*	5.73	–
	September 3	21.59		7.56
	November 8	2.44	7.18	6.86
1983	February 2	0.66	3.32	17.58
	March 22	1.42	9.68	14.21
	May 18	7.71	2.54	8.14
	June 8	11.48	1.36	8.41
	August 12	5.18	1.45	17.82
	November 10	–	5.27	12.90
1984	September 23	3.47	7.28	12.79
1985	September 28	12.18		8.20
1986	August 11	5.65	3.33	8.22
	September 27	3.25	4.60	15.16
1987	April 3	1.16	5.63	11.27
	June 7	16.44	3.64	17.90
	August 15	1.81	4.63	7.94
	September 26	1.82	4.34	8.76
1988	June 5	19.88	2.96	12.37
	August 27	14.20	10.66	5.70
1989	April 29	11.41	8.66	7.43
	May 27	16.37	12.72	8.41
	July 8	11.31	11.89	7.60
	August 28	6.41	9.54	14.62
	October 29**	2.73	0	5.38
	December 17	4.40	1.78	6.09
1990	March 11	2.77	1.71	5.83
	April 28	9.08	1.57	7.23
	May 26	10.87	2.33	3.60
	July 11	5.52	3.43	5.92
	August 13	7.53	4.56	8.50
	September 29	9.34	2.99	8.60
	November 17	5.34	7.09	11.03
1991	June 20	30.72	3.38	2.75
1992	May 29	17.35	8.92	13.28
1995	July 3	31.39	1.91	8.27

Notes: * In the period with prevalence of subdominant *Stipa capillata*, its productivity is shown as its phytomass added to that of the dominant species.

** The results of censuses taken after a recent fire.

Table 3. Soil moisture dynamics in the 0–20-cm layer

Year	Date	Relative soil moisture, %	Stored soil moisture, mm
1982	May 14	20.59	47.02
	June 15	12.59	27.42
	July 20	19.46	46.16
	August 20	13.89	31.12
	September 3	24.61	58.58
	September 5	23.68	57.06
	October 8	12.39	27.96
	October 20	17.26	36.14
	November 8	17.26	36.44
	December 8	15.33	34.58
1983	February 2	23.66	55.84
	March 8	24.08	56.54
	March 22	24.38	60.26
	April 8	22.22	57.79
	May 8	21.48	52.84
	May 18	12.90	31.74
	June 4	11.54	30.00
	June 8	11.60	26.68
	June 14	23.15	60.46
	June 23	15.24	34.14
	July 1	11.93	22.66
	July 13	9.95	22.48
	July 30	21.59	51.82
	August 8	23.89	57.81
	August 20	18.34	42.33
	September 5	10.94	23.94

reduced by 24–35%, subtracting the phytomass of the lower 5-cm plant parts (which are not removed by gazing livestock). In this case, average productivity over the observation period would be 900–1000 kg dry phytomass per hectare or, at standard 16% humidity, 1100–1200 kg/ha. These values are almost identical to those reported in the 19th and early 20th centuries, which is evidence that our observation period was sufficiently representative.

Continuous grazing leads to increasing xerophytization of steppe cenoses, which is manifested in the reduced proportion of feather grass and increasing dominance of sheep's fescue and eventually leads to a general decrease in the productivity of steppes. Consequently, the input of organic matter to the soil with plant residues and the rate of humus reproduction decrease drastically, and prerequisites for soil alkalinization and deflation are created.

The annual amount of aboveground necromass in the pasture proved to be lower than in virgin lands: 1390 vs. 2100 kg/ha, respectively. The annual average amount of dead plants and litter was estimated at 700 kg/ha, whereas the amount of root necromass in the 0–20 cm soil layer reached 5300 kg/ha.

In late summer and autumn, soil moisture in the 0–20 cm soil layer may decrease to 10–11% (Table 3). Under such conditions, cracks 1–2.6 cm wide and 4.3 ± 0.5 cm deep appear on the soil surface, which receive a certain amount of organic matter brought by wind and occasional surface runoff.

An experiment with samples decomposing in nylon bags (1982–1983) showed that the weight of dead plants and litter decreased over the period from autumn to summer (six months) by 32.3 and 25.7%, respectively. Soil moisture in the warm period was higher in the pasture than in the virgin site, with the difference being 6% in 1982 and 7.5% in 1983. This is apparently explained by a heavier soil texture in the pasture.

The dependence of productivity on meteorological parameters (Table 4) was analyzed using a continuous time series (1981–1992). Over this period, the annual amount of precipitation averaged 407.5 mm, varying in different years from 246 mm (1983) to 664 mm (1988); the annual average air temperature was 10.2°C. According to long-term data from the Odessa–Observatory weather station (absolute elevation 42 m) generalized in 1990, the annual average air temperature was 9.9°C and the total amount of precipitation was 446 mm, including 295 mm in the warm period (April–October). Until the past 20 years, normal annual precipitation was estimated at 374 mm. On the whole, it may be concluded that the ten-year period of our field studies adequately reflected characteristic climatic features of the study region.

The centennial dynamics of precipitation are characterized by alternation of dry and moist periods. For example, the annual amount of precipitation in Odessa between 1894 and 1974 averaged 386 mm, whereas that between 1965 and 1974 reached 471 mm (Zakharzhevskii, 1979). After the especially moist 1960s, the amount of precipitation slightly decreased and stabilized between 1970 and 1992. However, significant deviations from this trend were recorded. For example, monthly precipitation in June 1984 and July 1988 reached 128 and 142 mm, with the norm being 56 and 39 mm, respectively.

According to long-term average data from the Odessa–Observatory weather station, parameters of precipitation within the year are as follows: 32 mm in January, 23 mm in February, 22 mm in March, 29 mm in April, 36 mm in May, 56 mm in June, 39 mm in July, 35 mm in August, 30 mm in September, 39 mm in October, 30 mm in November, and 30 mm in December; 85 mm in winter, 87 mm in spring, 130 mm in summer, and 99 mm in autumn; with the annual value being 401 mm.

By 1991 (i.e., over 109 years), only seven warm winters were recorded in the study region, including those of 1982/1983, 1988/1989, and 1989/1990. In the same period, several winters were unusually warm. A southward displacement of the trajectories of Atlantic cyclones resulted in unusual phenomena such as the rise of daily average air temperature to 10–12°C above the norm in December 1989; the midday temperature reaching 15°C on December 18, 1989 (the highest value over the past 45 years); the average December temperature of 4.6°C (vs. 0.2°C in the norm) in 1982; the average February temperature 4.3°C (vs. –2.0°C in the norm) in 1990; and 18.2°C recorded in Odessa on February 24, 1990 (the highest temperature over the century).

Climatologists analyzing the data obtained at the Odessa weather station from 1894 to 1990 revealed no definite dependence between the annual average air temperature and annual precipitation. To integrate conditions of heat and moisture supply in a given year, it appears expedient to use the bioenergetic approach proposed by Volobuev (1959). Developing the concept of this author, we estimated the dependence of annual average plant production in the main zonal biomes on energy expenditures for soil formation (*Q*) (Lisetskii, 1997). In this context, it would be interesting to use this approach for estimating the climatic dependence of the rhythm (time course) of the production process within one natural zone (in particular, the steppe zone).

An analysis of the relationship between the aboveground biomass stock (green phytomass and necromass) in the pregrazing period (1981–1992) and the annual expenditures of radiation energy for soil formation (*Q*) revealed a negative correlation between these parameters.

It would be incorrect to consider that the problem is in finding a direct relationship between pasture productivity and climatic conditions, since specificity of the growing period in a given year manifested itself not only in the total yield of phytomass but also in distinctive features of its regrowth after periodic removal by grazing livestock during the year. Hence, years were arranged in series by the criterion of favorability, depending on their production potential, on the basis of data on the maximum values of aboveground green phytomass and necromass in a feather grass–mixed herb association in the absence of grazing load in the 1980s (Lisetskii, 1992, updated). In the observation period (1981–1989), a correlation was revealed between the *Q* value in the current year and the amount of phytomass in the next year (Spearman's rank correlation coefficient $R_S = 0.50$). Similar calculations for the pasture (1981–1992) showed that the aboveground phytomass (including necromass) in the pregrazing period of the next year correlated with annual radiation energy expenditures for soil formation (*Q*) in the current year ($R_S = 0.58$, $p < 0.001$).

A correction was made only for 1989, which was one of the worst years with respect to bioclimatic conditions: total precipitation was only 310 mm, with 94% falling from March to December. However, the previous year was favorable, with the most abundant moisture supply over the observation period. This combination of factors apparently accounted for the fact that productivity of phytocenoses in 1989 was high both in the virgin plot and in the pasture.

Table 4. Meteorological conditions during the study period (data from the Odessa–Observatory weather station)

Year	Annual precipitation, mm	Precipitation in March–November, mm	Annual average temperature, °C	Average temperature in March–November, °C	Q, MJ(m^2 per year)
1980	616.4	501.9	9.2	12.4	1214.7
1981	558.5	393.8	10.7	14.0	1208.7
1982	327.7	260.4	10.3	13.7	780.4
1983	246.5	188.9	10.9	14.1	556.0
1984	484.2	358.8	9.9	13.4	1076.0
1985	446.6	317.5	8.2	12.2	966.3
1986	405.6	237.7	10.1	13.9	946.6
1987	348.6	257.7	8.5	12.2	801.8
1988	663.6	513.6	9.8	13.2	1290.0
1989	310.0	292.4	11.5	14.4	745.3
1990	404.0	371.0	11.6	14.6	973.4
1991	344.0	–	10.2	–	818.1
1992	350.0	–	10.3	–	833.2
Norm	374*	290	9.8	13.5	892

* With corrections, total precipitation at the Odessa–Agro weather station is 475 mm, with evaporation reaching 996 mm (Gushlya and Mezentseva, 1982).

The most favorable conditions for plant growth in 1988 were also accounted for by relatively low summer temperatures, in addition to abundant moistening: the average air temperature between May and September (18.2°C) had the minimum value over those years. The years 1982 and 1983, least favorable in terms of climate, were logically characterized by low productivity. However, correlation analysis revealed no connection between the maximum phytomass value and the annual amount of precipitation during the observation period. A probable explanation for this fact is that a major role belongs to the conditions of moisture accumulation in the autumn–winter period of the previous year. It is also important to take into account the amount of precipitation falling before July: after this hottest month, further increase in the amount of phytomass is observed rarely.

Data on the distribution of precipitation within the year between 1980 and 1990 were used for calculating the sums of precipitation in different periods of two subsequent years: from December to April, from June to May, from July to June, and from August to July. The closest correlation between the maximum phytomass value and the amount of precipitation was revealed for the period from July of the previous year to June of the current year.

Thus, the long-term average productivity (over the past 150 years) of pastural ecosystems adapted to climatic changes in the steppe zone equals 1100–1200 kg/ha, being subject to considerable variation. The parameter more strongly correlating with annual radiation energy expenditures for soil formation (according to Volobuev) is the amount of phytomass in the pregrazing period of the next (rather than current) year. The period in which the amount of phytomass correlates with climatic parameters most closely is the period from July of the previous year to June of the current year.

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REFERENCES

Bogdanova, E.S., On Crop Yield Stability in Some Soil Regions of Right-Bank Ukraine, in *Puti povysheniya plodorodiya pochv* (Means for Improving Soil Fertility), Kiev: Urozhai, 1967, pp. 240–244.

Gushlya, A.V. and Mezentseva, O.V., Water Balance and Hydrotechnical Amelioration Standards of Nikolaev Oblast, *Meteorol. Klimatol. Gidrol.*, 1982, no. 18, pp. 132–138.

Khozyaistvenno-statisticheskii obzor Khersonskoi gubernii za 1890 god (Economic–Statistical Review of Kherson Province, 1890), Kherson, 1891.

Lisetskii, F.N., Periodization of the Anthropogenically Conditioned Evolution of Steppe Ecosystems, *Ekologiya*, 1992, no. 5, pp. 17–25.

Lisetskii, F.N., Spatiotemporal Assessment of Plant Production As a Factor of Soil Formation, *Pochvovedenie,* 1997, no. 9, pp. 1055–1057.

Materialy dlya otsenki zemel' Khersonskoi gubernii (Materials for Kherson Province Land Evaluation), vol. 1: *Odesskii uezd* (Odessa Region), Kherson, 1883.

Postnikov, V.E., *Yuzhno-russkoe krest'yanskoe khozyaistvo* (Individual Farming in Southern Russia), Moscow, 1891.

Snytko, V.A., Nefed'eva, L.G., and Dubynina, N.A., Experience in Comparative Studies on Protected and Exploitable Steppe Geosystems, *Geogr. Prir. Resur.,* 1983, no. 1, pp. 61–68.

Statistiko-ekonomicheskii obzor Khersonskoi gubernii za 1896 god (Statistical–Economic Review of Kherson Province, 1896), Kherson, 1897.

Statistiko-ekonomicheskii obzor Khersonskoi gubernii za 1910 god (Statistical–Economic Review of Kherson Province, 1910), Kherson, 1911.

Volobuev, V.R., Energetics of Soil Formation, *Izv. Akad. Nauk SSSR, Ser. Biol.*, 1959, no. 1, pp. 45–54.

Zakharzhevskii, Ya.V., Climate, in *Priroda Odesskoi oblasti* (Nature of Odessa Oblast), Kiev: Vissha Shkola, 1979, pp. 30–37.