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Vegetation communities of western substeppe ilmens of the Volga delta

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with 10 figures and 7 tables

Abstract. A region adjacent to the west of the Volga river delta is known as "western substeppe ilmens" (WSI). Ilmens are elongated water bodies appearing during the spring floods and stretching from east to west. The Volga waters used to reach dozens of kilometres deep into the Precaspian desert, but due to various natural and human-induced impacts, many of them have become isolated from the Volga fresh waters which resulted in their drying-up and salinization. The vegetation cover of the western substeppe ilmens is characterized by a great diversity which can be attributed to extreme variations in moisture content and soil salinization levels. Thus, the moisture gradient ranges from aquatic to desert-like habitats, and the salinization gradient from almost non-saline soils to lakes with salt layer instead of water. Some new halophytic communities which were distinguished during the WSI investigations are discussed in the present paper.

Introduction

This paper continues our previous descriptions of the vegetation in the Lower Volga valley and its adjacent territories (GOLUB & MIRKIN 1986, GOLUB & TCHORBADZE 1989, GOLUB et al. 1991). The current presentation has been accomplished in accordance with the Braun-Blanquet phytosociological approach.

Description of the area under study

A vast (more than 3000 sq.km) and extremely diverse area of western substeppe ilmens (WSI) spreads to the west of the Volga delta (Fig. 1). The main peculiarity of the WSI territory is a combination of Baer mounds (named in honour of the famous researcher of the Caspian Sea region, K.M. BAER) and intermound depressions (ilmens).

The height from the bottom of the intermound depression to the top of the Baer mounds varies from 10 to 15 m. It gradually decreases to 6–8 m westwards. The origin of such an unusual landscape has long been disputed. One of the latest papers (dealing with the genesis of the Baer mounds) suggests that its occurrence could be attributed to the joint effects of tectonics, winds and streamflow erosion (ARISTARKHOVA 1980).

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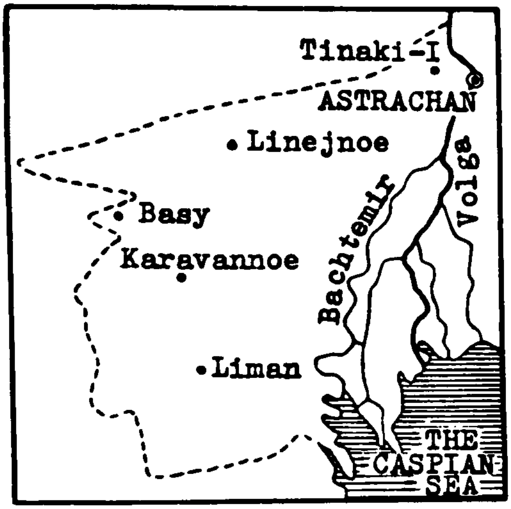

Fig. 1. Sketch map of the WSI area under study (scale is 1:1733000). The northern, western and southern borders are indicated by the broken line. The eastern border goes along the Volga-Bakhtemir rivers.

All the intermound depressions were formerly linked with the Volga waters. Along the depressions the spring-summer flooding waters penetrated for some 50–70 km westward into the desert and then retreated with the resulting wash-out of the soil salts. The regression of the Caspian Sea promoted the isolation and, hence, the salinization of numerous ilmens. The process of salinization of the intermound depressions was further considerably enhanced by the anthropogenic impacts within the last three decades. The salt distribution on the Baer mound slopes have been found to depend primarily on the hydrological regimes of the intermound depressions. This permitted us to distinguish four principal types of the WSI stows (Golub et al. 1986):

1. Dry ilmens-solonchaks (salt-marshes) and ilmens with high saline waters which lost their contact with the fresh Volga waters long ago.
2. Stows with intermound depressions, the salinization of which is gradually increasing, as they are no longer inundated with fresh waters.
3. Freshwater ilmens and streams with almost unchangeable water levels throughout the year.
4. Stows of streams with a flood-plain regime, the valleys of which, are regularly flooded.

Materials and methods

The whole WSI area was subjected to a geobotanical investigation. The abundance of plant species was assessed in the per cent coverage and the results were converted into points according to the slightly modified Mirkin scale (Mirkin et al. 1989). The points correspond to the amount of coverage by the sample species in the respective relevé. Point 5: more than 50 %, point 4: 26 to 50 %, point 3: 16 to 25 %, point 2: 6 to 15 %, point 1: 1 to 5 %, (+): less than 1 %.

The presence degree (Pres. cl.) of species in the relevé tables is indicated in the standard Braun-Blanquet points of presence degree (BRAUN-BLANQUET 1964).

The newly distinguished syntaxa are described according to the "Code of phytosociological nomenclature" (BARKMAN et al. 1986). The Latin names of plant species are given according to TCHEREPANOV (1981).

Special studies were carried out to reveal the respective soil salinization patterns and distribution of vegetation communities along the slopes of the four Baer mounds, representing the four above-mentioned stow types, where five 100 m-spaced transects were arranged. Each transect was given 25 1×3 m plots rising from the bottoms of dry intermound depressions or water tables of the filled depressions to the mound tops. There was a total of 125 plots on the slopes of each type of the WSI stows. With the help of a level the height of each plot above the respective depression bottom or water table was exactly determined. For each plot soil samples from the surface layers of 15 cm depth were taken four times. Each set of samples was thoroughly mixed and the average sample was taken to determine the ion composition of the respective aqueous extract. With the help of bores in some places of the slopes of the Baer mound, some soil samples were also taken from boreholes of up to 90 cm depth at vertical intervals of 15 cm. A relevé was provided for each plot.

The aqueous extracts were examined at a dilution of 1:5 (ARINUSHKINA 1970).

The amount of separate ions (in mg-equivalent per 100 g of soil) and the sum-total of soluble salts (in %) were determined. Apart from that, the integral index ("the sum-total effect of toxic ions") in Cl equivalents (T) based on the BASILEVICH & PANKOVA (1968) algorithm was ascertained. This index takes into account that the soil carbonates are mainly in a solid state. The first to be mentioned are $Ca(HCO_3)_2$ and $CaSO_4$. Further ions can only be encountered in an artificially prepared aqueous solution. The toxicity index of a soil solution also allows for a varying plant-related toxicity of ions ($1\ Cl^- = 3HCO_3^- = 5SO_4^{2-}$).

The toxicity index can be calculated as follows:

a) if $HCO_3^- > Ca^{2+}$, then $T = Cl^- + \dfrac{SO_4^{2-}}{5} + \dfrac{HCO_3^- - Ca^{2+}}{3}$

b) if $HCO_3^- < Ca^{2+} < HCO_3^- + SO_4^{2-}$, then $T = Cl^- + \dfrac{SO_4^{2-} - (Ca^{2+} - HCO_3^-)}{5}$

c) if $HCO_3^- + SO_4^{2-} < Ca^{2+}$, then $T = Cl^-$

Since the peculiar patterns of the surface soil salinization as well as the vegetation syntaxonomy of the Baer mound slopes relating to the first type of the WSI stows were discussed in our previous paper (GOLUB & TCHORBADZE 1989), we shall consider only the types 2–4 here.

Regularly patterns of the surface soil salinization of Baer mound slopes

Type 2. Stows with infrequently flooded depressions

The elevation profile is given in Fig. 2. Nowadays, the intermound depressions of the stows (bottoms) are inundated only during high waters, which occur once in 3–5 years. In the year of our investigations (1985), the intermound depressions were not flooded.

The total amount of salts in the upper soil layer has been found to increase downwards the mound slopes and to have two salinization peaks: one at the depression bottom and the other in the lower part of the mound slope (Fig. 3). By the way, judging from the ion composition of the aqueous extract, the second maximum could be attributed to the presence of gypsum in the soil.

Since $CaSO_4$ is low-soluble in the natural conditions, the toxicity index of a soil aqueous solution has only one maximum, i. e. at the depression bottom. The soil salinization is of a chloride-sulfate type. The lower transect, the closer the saline horizon to the soil surface (Fig. 4). The salt content in the upper 15 cm-layer of the depression bottom reaches 4 %, and is thus smaller than that of the lower slopes of ilmens with ancient salinization (stows of type 1) covered with communities of the ord. Halostachyetalia (Golub & Tchorbadze 1989).

Type 3. A fresh-water ilmen with almost unchangeable water level

The respective transect is presented in Fig. 5. Its lower part is typically flooded with fresh water.

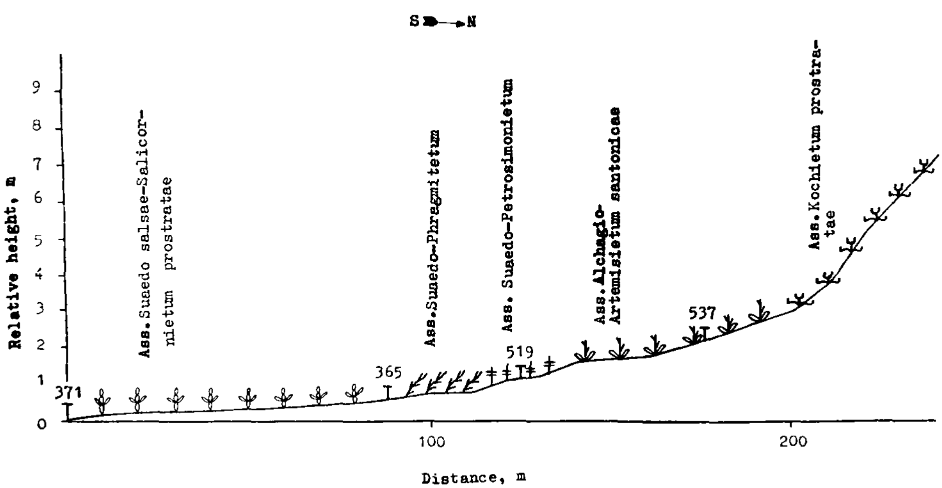

Fig. 2. Vertical profile of a stow slope with an infrequently flooded intermound depression and communities occurrence. (The numbers in Figs. 2, 5 and 8 indicate bore holes).

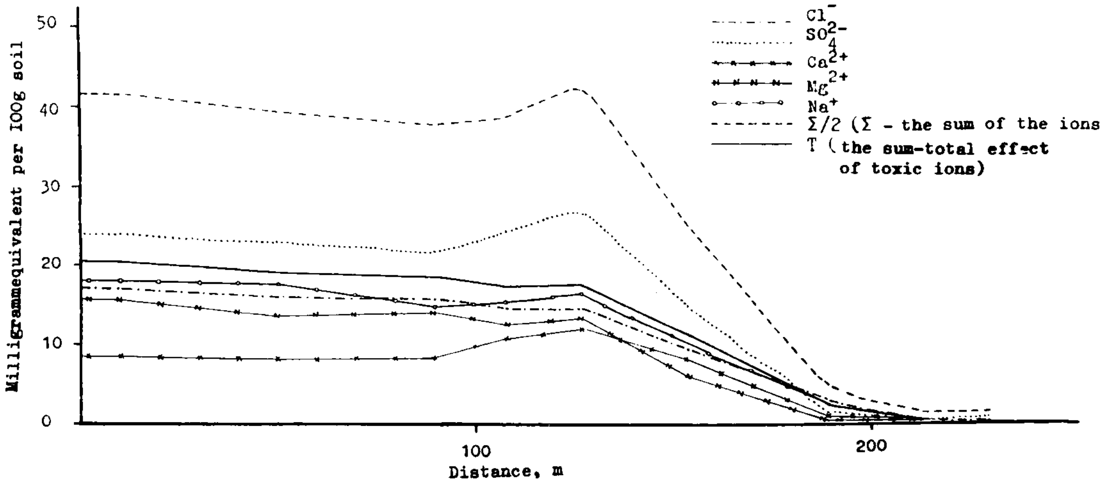

Fig. 3. Variations in the ion composition of aqueous extract of soil samples taken from the layer of 0–15 cm on the slopes of stows with infrequently flooded intermound depressions.

The salinization pattern of the upper soil level is characterized by a well-pronounced maximum in the lower slope and by another, lesser pronounced one, at the water table (Fig. 6). The second maximum can be attributed to the elevated concentration of Ca^{2+} and SO_4^{2-} ions in the aqueous extract. These

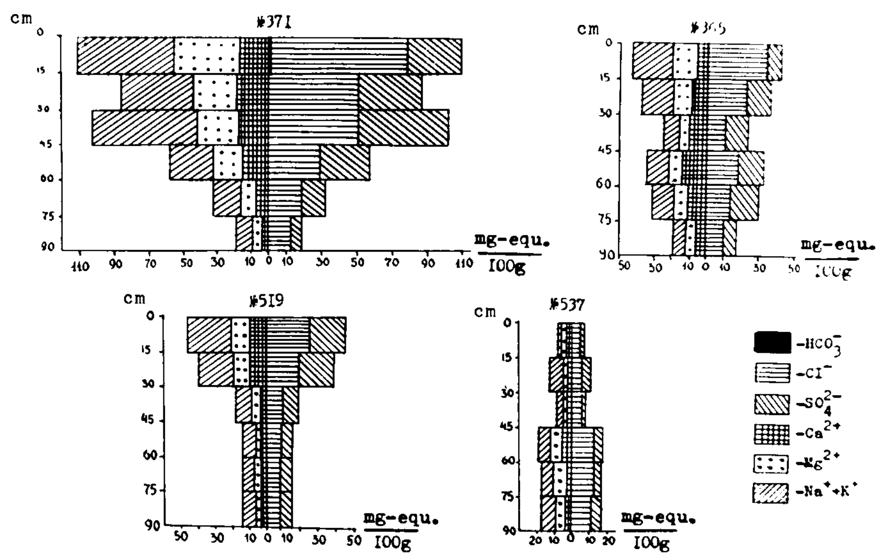

Fig. 4. Variations in salt profiles along the slopes of stow with an infrequently flooded intermound depression. The localization of bore holes is given in Fig. 2.

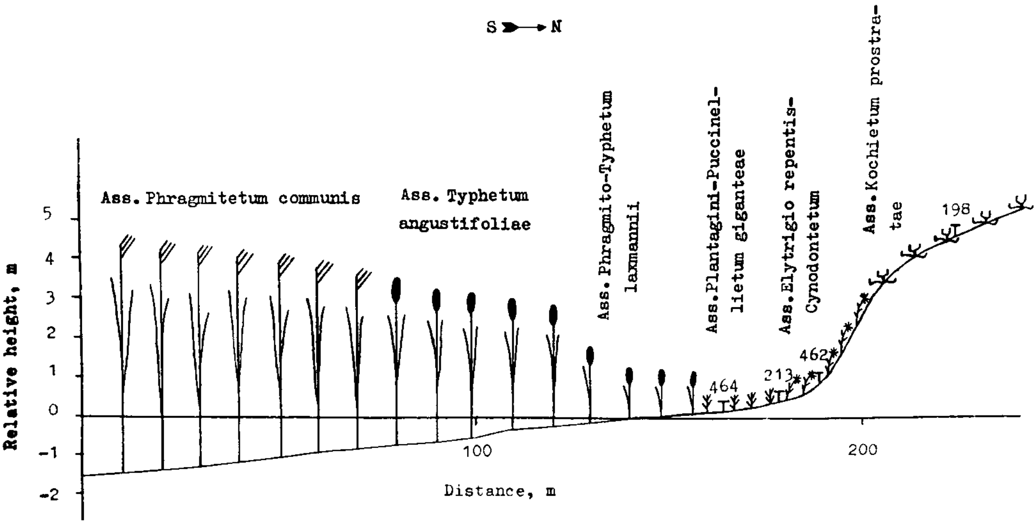

Fig. 5. Vertical profile of a stow slope with almost permanent water table (a freshwater lake) and communities occurrence.

ions were likely to occur in the laboratory solutions after the desalinization of gypsum. Therefore, the toxicity index of the soil solution has only one maximum in the lower slope, where the evaporation from the soil surface is at its most intensive. In this part of the slope as well as in the previous type of

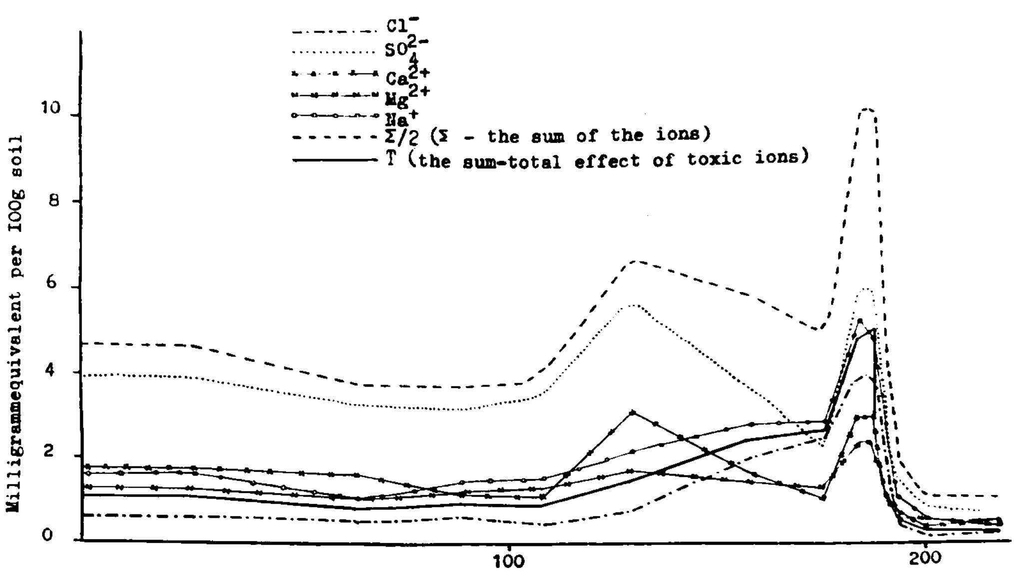

Fig. 6. Variations in the ion composition of aqueous extract of soil samples taken from the layer of 0–15 cm on the slopes with almost permanent water table.

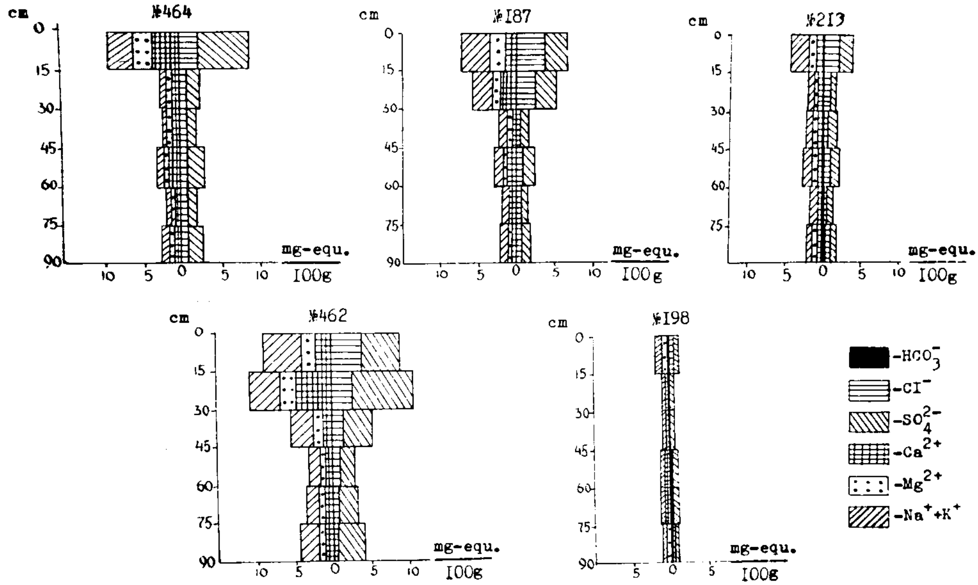

Fig. 7. Soil salt profiles based on the resuls of an aqueous extract of soil samples taken on the slopes of a freshwater ilmen with almost permanent water table. Soil sample points are given in Fig. 5.

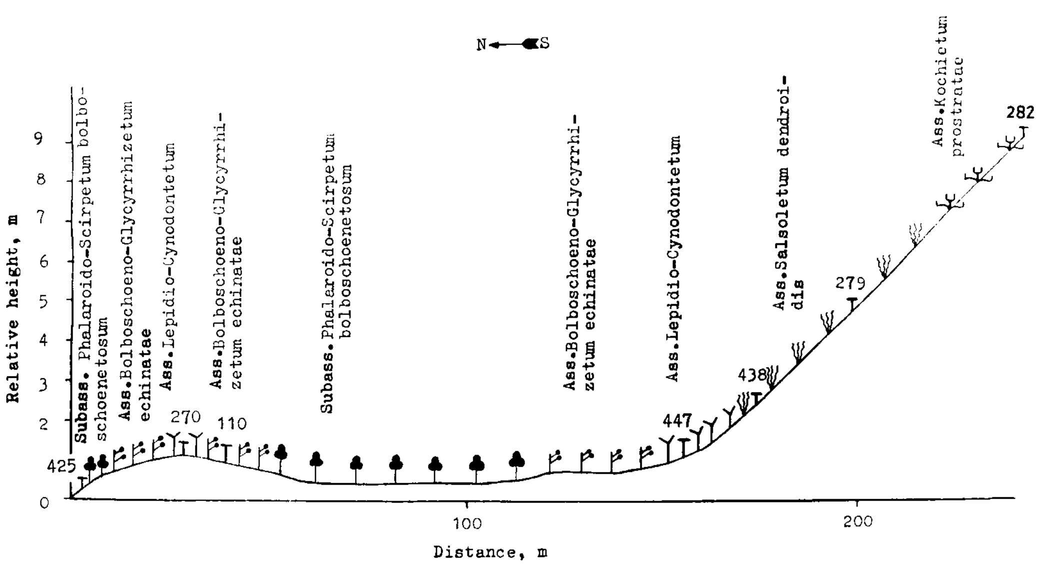

Fig. 8. Vertical profile of a slope with a flood-plain regime and communities occurrence.

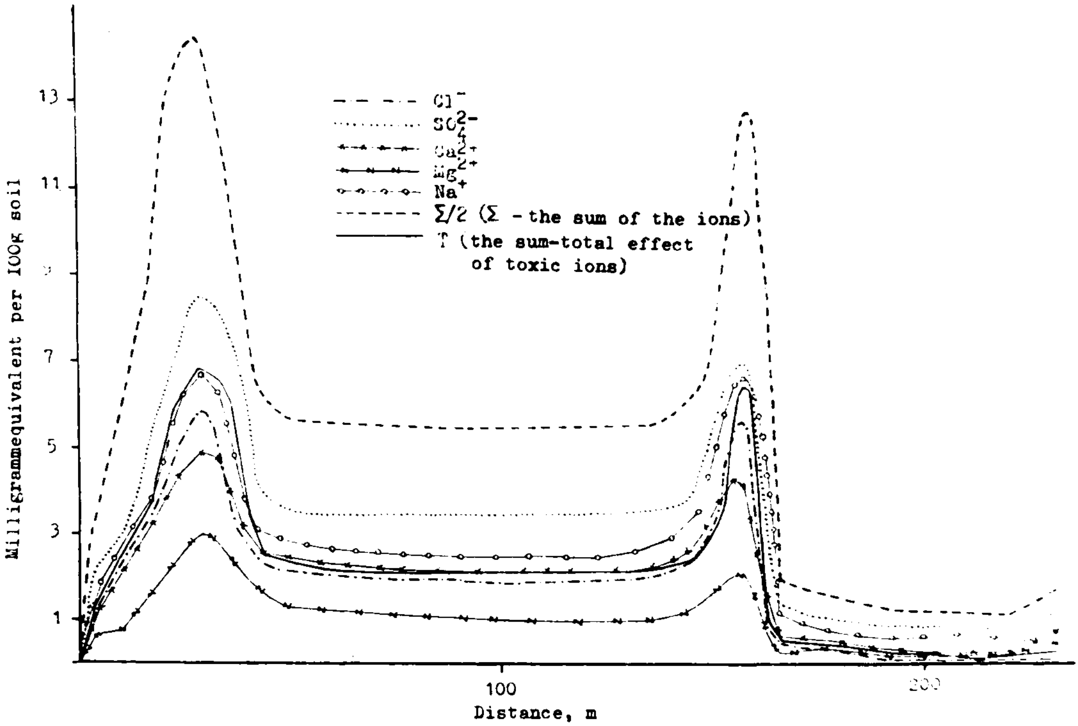

Fig. 9. Variations in the ion composition of aqueous extract of soil samples taken from the layer of 0–15 cm on the slopes of a stow with a flood-plain hydrological regime.

stow the salinization is of the chloride-sulfate type, but the Cl^-/SO_4^{2-} ratio is somewhat higher here.

The vertical saline profiles of boring wells testify to the presence of a salinization maximum in the upper 90 cm-layer on the lower dry slope of ilmens (Fig. 7). The total amount of soil salts in this type of ilmen is essentially lower than in that of type 2. The content of water-soluble salts in the upper 15 cm-layer reaches 1.5 %.

Type 4. Ilmens with a flood-plain regime

The respective vertical transect is given in Fig. 8. The slope of a Baer mound normally transfers into a small valley with low bars typical of a flood-plain landscape.

The salinization pattern in the upper soil layer is characterized by two well-pronounced maxima: on the longshore and on the lower slope of Baer mound (Fig. 9). The salinization is of the chloride-sulfate type.

In the upper part of the Baer mound slope, the surface soil layers and bed-rocks are desalinized (Fig. 10). The salinization occurs in the zones where the

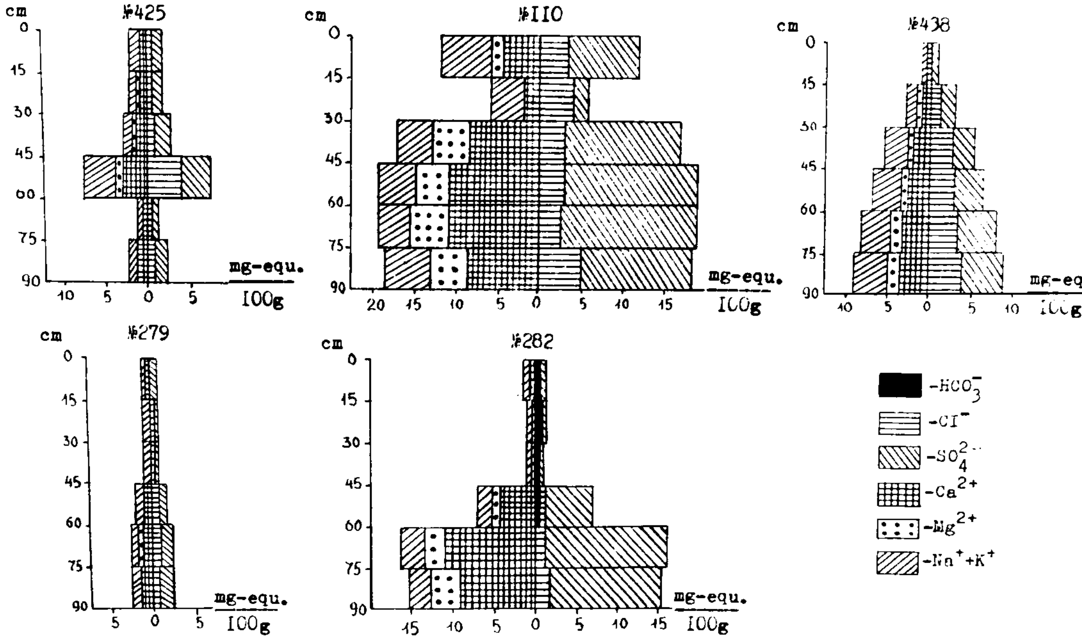

Fig. 10. Variation in the soil salt profiles along the slopes of stow with a flood-plain hydrological regime.

evaporation from the soil surface predominates. The salt content in the upper 15 cm-layer of the soil on the slopes of the ilmens with a flood-plain regime is about the same as in the ilmens of type 3.

Thus, as it is evident from the above, all the landscapes discussed are distinguished by the desalinization of the surface soil layers occurring in the upper parts of Baer mound slopes. The salts usually accumulate on the lower slopes, but their localization depends upon a given hydrological regime of the ilmen.

Syntaxonomy

In the following part of the paper we present some characterizations of new syntaxa of the cl. Thero-Salicornietea Pignatti 1953 em. R.Tx. in R.Tx. et Oberd. 1958 and the cl. Asteretea tripoli Westhoff et Beeftink in Beeftink 1962, which have recently been distinguished for the WSI territory. Also, we give descriptions of the ass. Suaedo-Phragmitetum and Alhagio-Artemisietum santonicae which in the appendix of the recently appeared summarizing article (Golub 1994) were documented only by one relevé – nomenclature-type. A review of higher syntaxa of these classes (orders, suborders, alliances and suballiances) validly promulgated earlier for the territory of the former USSR is given in others of our papers (Golub & Solomakha 1988, Golub 1994). We point out regional diagnostic species (d.s.) as diagnostic for the vegetation types. Their diagnostic value may get lost when halophytic communities of WSI are compared to those of other regions.

A diagnostic scheme of communities of the cl. Thero-Salicornietea for the WSI region is presented below:

Thero-Salicornietea Pignatti 1953 em. R. Tx. in R. Tx. et Oberd. 1958
Thero-Salicornietalia Pignatti 1953 em. R. Tx. in R. Tx. et Oberd. 1958
D.s.: *Salicornia europaea* s.l., *Suaeda maritima* s.l.

Suaedion salsae V. Golub et Tchorbadze all. nova
D.s.: *Suaeda salsa, S. confusa, S. prostrata, Salicornia prostrata*

Suaedo salsae-Salicornietum prostratae V. Golub et Tchorbadze ass. nova	Suaedetum salsae V. Golub et Tchorbadze ass. nova	Suaedetum confusae V. Golub et Tchorbadze ass. nova
D.s.: *Salicornia prostrata, Suaeda salsa*	D.s.: *Suaeda salsa*	D.s.: *Suaeda confusa*

Due to the low species diversity of the communities of the class, we had to use the same diagnostic species for distinguishing syntaxa of different ranks.

A similar scheme for communities of the cl. Asteretea tripolium is given below (see p. 459).

Thero-Salicornietea
Thero-Salicornietalia
Suaedion salsae

The diagnostic species of the Suaedion salsae are *Salicornia prostrata, Suaeda salsa, S. prostrata, S. confusa.*

The alliance comprises phytocoenoses which consist of annual species of the genus *Salicornia* and non-nitrophilous taxa of the genus *Suaeda*. The communities in this alliance are vicarious in relation to the West-European Thero-Salicornion Br.-Bl. 1933 em. R.Tx. 1950.

- Asteretea tripolii Westhoff et Beeftink in Beeftink 1962
D. s.: *Juncus gerardii*
  - Artemisio santonicae-Limonietalia gmelinii V. Golub et V. Slkh. 1988
Artemisienalia santonicae V. Golub 1994
D. s.: *Limonium gmelinii, Artemisia santonica*
    - Alhagion V. Golub et Tchorbadze in V. Golub 1994
D. s.: *Suaeda salsa, Atriplex tatarica, Phragmites australis, Petrosimonia oppositifolia*
      - Tripolio-Phragmitenion V. Golub 1994
D. s.: *Salicornia prostrata, Tripolium pannonicum*
        - Suaedo-Phragmitetum V. Golub et Tchorbadze in V. Golub 1994
D. s.: association = d. s. suballiance
        - Plantagini-Puccinellietum giganteae V. Golub et Tchorbadze in V. Golub et Tchorbadze ass. nova
D. s.: *Puccinellia gigantea, Plantago major, Atriplex rosea*
      - Alhagienion V. Golub 1994
D. s.: *Alhagi pseudalhagi, Galium humifusum, Eremopyrum triticeum*
        - Alhagio-Artemisietum santonicae V. Golub et Tchorbadze in V. Golub 1994
D. s.: association = d. s. suballiance
        - Elytrigio repentis-Cynodontetum V. Golub et Tchorbadze in V. Golub et Tchorbadze ass. nova
D. s.: *Cynodon dactylon, Lactuca tatarica, Elytrigia repens*

One of the three species *Salicornia prostrata, Suaeda salsa* or *S. confusa* has been found to be dominant in the WSI alliance communities. In the years in which the weather conditions are unfavourable for these species, no reproduction of their phytocoenoses may occur. Associations of the Suaedion salsae are often pioneer groupings occupying the bottoms of dry ilmens and adjacent Baer mound slopes. The above WSI alliance contains three associations. The nomenclatural type of the alliance is the Suaedetum salsae.

Suaedo salsae-Salicornietum prostratae (Table 1)

The usually form the lowest layer of vegetation in the recently dried-up salinized intermound depressions as well as the water table of salinized ilmens.

The salt content in the soil samples taken at the depths of 0–15 cm in the community habitats variets from 1.5 to 4.0 %.

Salicornia prostrata is dominant in the grass stand. The height of the *Salicornia prostrata* shoots amounts to 10–20 cm.

Throughout the vegetation period the association aspect changes from green in summer to red in autumn.

The nomenclatural type of the association is relevé 3, Table 1. The localization of the relevé is near v. Bakhtemir, Ikryaninski distr., Astrakhan region, 02.08.85. E bank of ilmen Vlasov.

As it is obvious from Table 1, Suaedo salsae-Salicornietum prostratae may include only one species, i. e. *Salicornia prostrata*. According to the formal criteria, such stands should be related to the Salicornietum prostratae (Soó 1927 n. n.) in R. Tx. et Oberd. 1958. But as soon as we admit the occurrence of the ass. Salicornietum prostratae in the WSI communities, we shall have to do the same in relation to the communities of two alliances: Suaedion salsae and Thero-Salicornion, which would be quite unreasonable for pragmatical reasons.

Suaedetum salsae (Table 2)

The stands are usually found on the lower slopes of the Baer mounds surrounding the increasingly salinized depressions. Downward the slopes they are frequently superseded by the communities of the Suaedo salsae-Salicornietum prostratae. There are also the intermound depressions with increasing salinization where the lowest vegetation levels are formed by the Suaedetum salsae. The stands at the bottoms of highly salinized intermound depressions tend to microelevations. The amount of water-soluble salts in the soil layer of 0–15 cm is 1.5–4 %.

The total cover of the associations is on an average 50–60 %, the height amounts to 15–30 cm. Similar to the previous association, the communities under discussion substantially change their aspect from summer to autumn.

The nomenclatural type of the association is relevé 6, Table 2 (2 km S of v. Ozernoye, Ikryaninski distr., Astrakhan reg., 27.07.85. The lower part of Baer mound, S. exp. 5°).

Suaedetum confusae (Table 3)

The localization is similar to that of the previous associations; the difference consists in greater fluctuations in moisture and salinity level.

Table 1. Suaedo salsae-Salicornietum prostratae.

Relevé	1	2	3	4	5	6	7	8	Pres. cl.
Area analysed (sq.m)	25	25	25	4	25	4	25	25	
Total cover (%)	60	50	80	35	60	55	90	95	
Number of species	1	1	2	3	3	1	2	1	
Salicornia prostrata Pall.	5	4	5	4	5	5	5	5	V
Suaeda salsa (L.) Pall.	.	.	+	.	1	.	.	.	II
Suaeda confusa Iljin	.	.	.	.	1	.	.	.	I
Tripolium pannonicum (Jacq.) Dobrocz.	.	.	.	1	.	.	+	.	II
Tamarix ramosissima Ledeb.	.	.	.	1	.	.	.	.	I

Table 2. Suaedetum salsae.

Relevé	1	2	3	4	5	6	Pres. cl.
Area analysed (sq.m)	4	25	25	9	25	25	
Total cover (%)	100	60	55	80	35	50	
Number of species	3	2	4	4	3	4	
Suaeda salsa (L.) Pall.	5	4	4	5	4	5	V
Salicornia prostrata Pall.	+	.	.	+	.	+	III
Suaeda confusa Iljin	.	.	.	.	.	1	I
Suaeda altissima (L.) Pall.	+	.	.	1	.	.	II
Limonium gmelinii (Willd.) O. Kuntze	.	.	.	+	.	+	II
Climacoptera crassa (Bieb.) Botsch.	.	.	1	.	+	.	II
Petrosimonia oppositifolia (Pall.) Litv.	.	.	1	.	+	.	II
Atriplex tatarica L.	.	2	.	.	.	.	I
Petrosimonia brachiata (Pall.) Bunge	.	.	2	.	.	.	I

Table 3. Suaedetum confusae.

Relevé	1	2	3	4	5	Pres. cl.
Area analysed (sq.m)	4	8	2	4	100	
Total cover (%)	40	15	20	8	2	
Number of species	3	2	1	1	1	
Suaeda confusa Iljin.	4	2	3	2	1	V
Salicornia prostrata Pall.	.	1	.	.	.	I
Petrosimonia oppositifolia (Pall.) Litv.	2	.	.	.	.	I
Limonium gmelinii (Willd.) O. Kuntze	+	.	.	.	.	I

The total cover greatly varies, being on an average 20 %, the height of the grass stand is 15–20 cm.

The nomenclatural type of the association is relevé 3, Table 3 (2 km SE of v. Karavannoye, Limanski distr., Astrakhan reg., 05.08.85. N bank of ilmen).

Asteretea tripolii
Artemisio-Limonietalia gmelinii
Artemisienalia santonicae
Alhagion[1]
Tripolio-Phragmitenion

Suaedo-Phragmitetum (Table 4)

The stands occupy the wet parts of slopes of salinized intermound depressions. The amount of water-soluble salts in the upper 15 cm soil layer is 1.0–2.5 %.

Table 4. Suaedo-Phragmitetum.

Relevé	1	2	3	4	5	6	7	8	Pres. cl.
Area analysed (sq.m)	10	8	9	12	8	9	9	9	
Total cover (%)	50	75	70	80	35	40	60	65	
Number of species	5	9	9	5	6	7	7	8	
Salicornia prostrata Pall.	1	.	4	1	1	1	1	4	V
Tripolium pannonicum (Jacq.) Dobrocz.	4	+	.	.	.	3	4	1	IV
Phragmites australis (Cav.) Trin. ex Steud.	1	1	1	1	1	+	1	+	V
Suaeda salsa (L.) Pall.	.	4	+	4	2	1	.	.	IV
Atriplex tatarica L.	.	+	.	.	.	.	1	.	II
Petrosimonia oppositifolia (Pall.) Litv.	.	1	.	.	.	.	.	.	I
Limonium gmelinii (Willd.) O. Kuntze	.	.	.	2	2	.	.	.	II
Suaeda confusa Iljin	1	3	.	.	.	.	1	1	III
Suaeda altissima (L.) Pall.	.	1	.	1	5	.	1	.	III
Puccinellia gigantea (Grossh.) Grossh.	.	1	.	.	.	.	.	1	II
Suaeda corniculata (C. A. Mey) Bunge	.	.	2	.	1	.	.	.	II
Chenopodium rubrum L.	.	.	.	.	.	.	1	1	II
Polygonum neglectum Bess.	+	.	+	.	.	.	.	.	II

Besides, the following species with a presence degree of 20 % and less were noted: Aeluropus pungens (Bieb.) C. Koch in 6 (+), Atriplex laevis C. A. Mey in 3 (1), A. prostrata Boucher in 3 (1), Bassia sedoides (Bieb.) C. Koch in 3 (1), Bolboschoenus maritimus (L.) Pall in 6 (+), Lactuca tatarica (L.) C. A. Mey in 7 (2), Limonium caspium (Willd.) Gams in 8 (+), Polygonum pulchellum Loisel. in 2 (1), Tamarix ramosissima Ledeb. in 3 (1), Xanthium albinum (Widd.) H. Scholz in 8 (+).

[1] For the first time communities of the all. Alhagion were described in an unpublished Golub & Tchorbadze manuscript (1988) submitted to the All-Union Institute of Scientific and Technical Information (VINITI).

Table 5. Plantagini-Puccinellietum giganteae.

Relevé	1	2	3	4	5	Pres. cl.
Area analysed (sq.m)	5	5	5	5	5	
Total cover (%)	55	50	35	35	40	
Number of species	12	12	12	12	13	
Puccinellia gigantea (Grossh.) Grossh.	2	2	2	2	2	V
Plantago major L.	1	1	+	+	+	V
Atriplex rosea L.	2	1	+	1	.	IV
Salicornia prostrata Pall.	1	3	1	1	1	V
Tripolium pannonicum (Jacq.) Dobrocz.	2	2	1	2	1	V
Suaeda salsa Iljin	1	1	+	1	+	V
Phragmites australis (Cav.) Trin. ex Steud.	1	1	1	.	1	V
Limonium gmelinii (Willd.) O. Kuntze	.	.	.	+	+	III
Juncus gerardi Loisel.	2	2	3	3	3	V
Spergularia maritima (All.) Chiov.	+	1	1	1	1	V
Lotus tenuis Waldst. et Kit. ex Willd.	+	+	+	.	+	IV
Cynodon dactylon (L.) Pers.	.	.	1	.	+	III
Bolboschoenus maritimus (L.) Pall.	.	.	.	1	+	II
Taraxacum officinale Wigg.	.	.	+	.	+	II

Besides, the following species with a presence degree of 20 % and less were noted: Butomus umbellatus L. in 3 (+), Crypsis schoenoides (L.) Lam. in 5 (+), Eleocharis palustris (L.) Roem. et Schult. in 2 (+), Inula britannica L. in 2 (+), Lactuca tatarica (L.) C. A. Mey. in 3 (+), Ranunculus sceleratus L. in 3 (+), Scirpus lacustris L. in 5 (+).

As to the standing stock, dominant in the grass stand are: sparse small-size *Phragmites australis* (not higher than 0.5 m), *Tripolium pannonicum, Salicornia prostrata* or *Suaeda salsa.*

The total cover is 35–80 %, the height of the grass stand is 15–50 cm.

The association is transitional from the communities of the cl. Asteretea tripolii to those of the cl. Thero-Salicornietea.

Plantagini-Puccinellietum giganteae (Table 5)

The association spreads along the banks of freshwater and low-saline ilmens (see Fig. 5). The association is floristically richer than the previous one, which can be attributed to a lower salinization of the soil.

The amount of water-soluble salts in the upper 15 cm soil layer is 0.3–0.6 %.

Species, such as *Puccinellia gigantea, Juncus gerardi*, and *Tripolium pannonicum* are most dominant in this association. The total cover in the stands amounts to 35–55 %, the height of the grass stand is 10–20 cm.

The nomenclatural type of the association is relevé 3, Table 5 (6 km W of v. Protochonye, Limanski distr., Astrakhan reg., 05.08.85. The lower flat bank of ilmen Yaman-Arsok).

Table 6. Alhagio-Artemisietum santonicae.

Relevé	1	2	3	4	5	6	Pres. cl.
Area analysed (sq.m)	4	4	4	25	4	10	
Total cover (%)	10	15	20	20	25	65	
Number of species	9	8	6	9	5	6	
Alhagi pseudalhagi (Bieb.) Fisch.	1	1	1	1	1	2	V
Eremopyrum triticeum (Gaert.) Nevski	+	+	2	.	+	+	V
Galium humifusum Bieb.	+	+	.	.	.	.	II
Petrosimonia oppositifolia (Pall.) Litv.	1	1	1	.	1	.	IV
Atriplex tatarica L.	.	.	.	+	.	3	II
Artemisia santonica L.	1	2	2	2	3	2	V
Limonium gmelinii (Willd.) O. Kuntze	2	2	2	.	1	+	IV
Petrosimonia brachiata (Pall.) Bunge	+	+	1	.	.	.	III
Salsola australis R. Br.	.	.	.	1	+	.	II

Besides, the following species with a presence degree of 20 % and less were noted: Aleuropus pungens (Eib.) C. Koch in 1 (1), Asparagus officinalis L. in 1 (+), Chenopodium album L. in 4 (+), Camphorosma monspeliaca L. in 4 (+), Consolida divaricata (Ledeb.) Schroding. in 4 (+), Cynodon dactylon (L.) Pers. in 2 (+), Leymus racemosus (Lam.) Tzvel. in 4 (+), Nonea caspica (Willd.) G. Don fil. in 4 (+), Suaeda altissima (L.) Pall. in 6 (3), Tanacetum achilleifolium (Bieb.) Sch. Bip. in 4 (+).

Alhagienion

Alhagio-Artemisietum santonicae (Table 6)

The association is encountered on the slopes of Baer mounds. Examinations of aqueous extracts have shown that there are 1.5–3.0 % of water-soluble salts in the upper 15 cm-layer of the soil underlying the communities of the association.

Dominant species are *Artemisia santonica* and *Limonium gmelinii.* The height is 30–40 cm.

Elytrigio repentis-Cynodontetum (Table 7)

The stands occur on the slopes and trains of Baer mounds. The amount of water-soluble salts in the upper 15 cm-layer of soil varies from 0.3 to 1.5 %. Since the salinization level is lower than that of the previous association, a greater floristic diversity can be found.

Cynodon dactylon and *Artemisia santonica* are most dominant in the community. The total cover ranges between 30 and 80 %, the height is 20–30 cm.

The nomenclatural type of the association is relevé 4, Table 7 (1.5 km N of v. Yar-Bazzar, Limanski dist., Astrakhan reg., 05.08.85. The train of Baer mound, N exp. 6°, near ilmen Bolshoi Kara-Bulak).

The vegetation of the WSI stows with a flood-plain hydrological regime are the same as in the Volga delta. As the description of the communities has been published (Golub & Mirkin 1986), we omit it here.

Table 7. Elytrigio repentis-Cynodontetum.

Relevé	1	2	3	4	5	Pres. cl.
Area analysed (sq.m)	4	8	8	10	9	
Total cover (%)	30	85	90	45	80	
Number of species	9	21	17	14	8	
Cynodon dactylon (L.) Pers.	1	5	5	+	5	V
Lactuca tatarica (L.) C. A. Mey.	.	+	2	+	+	V
Elytrigia repens (L.) Nevski	+	1	1	+	.	IV
Alhagi pseudalhagi (Bieb.) Fisch.	+	.	+	1	+	IV
Galium humifusum Bieb.	+	+	.	1	+	IV
Eremopyrum triticeum (Gaertn.) Nevski	1	.	.	+	.	II
Phragmites australis (Cav.) Trin. ex Steud.	.	+	+	+	.	III
Atriplex tatarica L.	.	+	.	+	.	II
Petrosimonia oppositifolia (Pall.) Litv.	1	+	.	.	.	II
Artemisia santonica L.	2	1	1	4	.	IV
Limonium gmelinii (Willd.) O. Kuntze	2	.	.	1	.	II
Juncus gerardi Loisel.	.	1	1	.	.	II
Lotus tenuis Waldst. et Kit. ex Willd.	.	1	1	.	+	III
Spergularia maritima (All.) Chiov.	.	1	1	.	1	III
Puccinellia gigantea (Grossh.) Grossh.	.	1	2	.	.	II
Xanthium albinum (Widd.) H. Scholz	.	1	1	.	.	II
Suaeda confusa Iljin	.	1	+	.	.	II
Medicago caerulea Less. ex Ledeb.	.	.	.	+	+	II
Polygonum neglectum Bess.	.	+	1	.	.	II
Tripolium pannonicum (Jacq.) Dobrocz.	.	+	+	.	.	II
Plantago major L.	.	1	1	.	.	II
Trifolium fragiferum L.	.	1	1	.	.	II

Besides, the following species with a presence degree of 20 % and less were noted: Bassia hyssopifolia (Pall.) O. Kuntze in 2 (1), Carex melanostachya Bieb. ex Willd. in 3 (+), Chenopodium polyspermum L. in 2 (+), Consolida divaricata (Ledeb.) Schroding. in 4 (+), Convolvulus arvensis L. in 4 (+), Prangos odontalgica (Pall.) Herrnst. et Heyn in 4 (1), Petrosimonia brachiata (Pall.) Bunge in 1 (1), Suaeda altissima (L.) Pall. in 2 (1), Taraxacum officinale Wigg. in 5 (+).

Summary

The present and the previous papers dealing with the Lower Volga valley and its adjacent territories have given detailed descriptions of the plant communities therein. These have been found to belong to the following classes: Charetea (Fukarek 1961) Krausch 1964, Lemnetea R.Tx. 1955, Ruppietea J.Tx. 1960, Potametea R.Tx. et Preising 1942, Phragmitetea R.Tx. et Preising 1942, Bolboschoenetea maritimi Vicherek et R.Tx. ex R.Tx. et Hülb. 1971, Crypsietea aculeatae Vicherek 1973, Thero-Salicornietea Pignatti 1953 em. R.Tx. in R.Tx. et Oberd. 1958, Asteretea tripolii Westhoff et Beeftink in Beeftink 1962, Molinio-Arrhenatheretea R.Tx. 1937, Glycyrrhizetea glabrae V. Golub

in V. Golub et Savtchenko 1986. Ruderal and segetal communities of the Lower Volga valley are presently being described and respective forest communities (Salicetea purpurea Moor 1958, Querco-Fagetea Br.-Bl. et Vlieger 1937, Nerio-Tamaricetea Br.-Bl. et Bolòs 1957) are going to be studied.

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References

Arinushkina, E.V. (1970): Handbook for chemical analyses of soils. – Moscow Univ. publ., 487 pp. Moscow. (In Russian)

Aristarkhova, L.B. (1980): Once again about origin and description principles of the Baer mounds. – Izv. Akad. nauk USSR ser. geogr. **4**: 67–73. (In Russian with English summary)

Basilevitch, N.I. & Pankova, J.I. (1968): Experience on soil classification by salinization level. – Pochvovedeniye **11**: 3–15. (In Russian)

Barkman, J.J., Moravec, J. & Rauschert, S. (1986): Code of phytosociological nomenclature. – Vegetatio **32**: 131–185.

Braun-Blanquet, J. (1964): Pflanzensoziologie. – Grundzüge der Vegetationskunde. – 3. Ed. Wien, New York, 865 pp.

Golub, V.B. (1994): Class Asteretea tripolium on the territory of the former USSR and Mongolia. – Folia Geobot. Phytotax. **29**: 16–64.

Golub, V.B., Losev, G.A. & Mirkin, B.M. (1991): Aquatic and hydrophytic vegetation of the Lower Volga Valley. – Phytocoenologia **20**: 1–63.

Golub, V.B. & Mirkin, B.M. (1986): Grasslands of the Lower Volga Valley. – Folia Geobot. Phytotax. **21**: 337–395.

Golub, V.B., Novikova, N.M. & Tchorbadze, N.B. (1986): The vegetation dynamics of the west part of near-steppe ilmens of the Volga delta, affected by the regulation of the water flow. – Vodnie resursi N 1: 110–116. (In Russian with English summary)

Golub, V.B. & Savtchenko, I.V. (1986): The floristical classification of the desert pasture communities of the Volga delta. – In: Mirkin, B.M. (ed.): Syntaxonomy and dynamics of anthropogeneous vegetation, 17–26; Bashkirian Univ. Publ. (In Russian)

Golub, V.B. & Solomakha, V.A. (1988): The higher units of the salt vegetation classification of the European part of the USSR. – Bull. M.O.I.P., sect. biol., **93** (6): 80–92. (In Russian with English summary)

Golub, V.B. & Tchorbadze, N.B. (1988): On syntaxonomic characteristic of the plant communities of the Volga delta western substeppe ilmens. – Manuscript, VINITI, Moskva, 08.09.88, N 6909–B88: 57 pp. (In Russian)

— — (1989): The communities of the order Halostachyetalia Topa 1939 in the area of Western Substeppe Ilmens of the Volga Delta. – Folia Geobot. Phytotax. **24**: 111–130.

Mirkin, B.M., Rozenberg, G.S. & Naumova, L.G. (1989): The glossary of the concept and terms of modern phytocoenology. – Nauka, Moskow, 162 pp. (In Russian)

Tcherepanov, S.K. (1981): The vascular plants of the USSR. – Nauka, Leningrad, 509 pp. (In Latin)

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