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17

THE STEPPES OF MONGOLIA

Zoja V. Karamysheva, Vladimir N. Khramtsov

CAMERINO
1995

PUBLICATION DU DEPARTEMENT DE BOTANIQUE ET ÉCOLOGIE DE L'UNIVERSITÉ DE CAMERINO ET DE LA STATION INTERNATIONALE DE PHYTOSOCIOLOGIE DE BAILLEUL SOUS L'ÉGIDE DE L'ASSOCIATION AMICALE DE PHYTOSOCIOLOGIE ET DE L'ASSOCIATION INTERNATIONALE POUR L'ÉTUDE DE LA VÉGÉTATION

BRAUN-BLANQUETIA

Un héritage est enrichissant et ouvre de nouvelles possibilités créatrices. Mais il en découle en contre partie l'obligation de ne pas gaspiller le patrimoine reçu. Ceux qui, aujourd'hui étudient la végétation grâce à la phytosociologie peuvent utiliser des méthodologies bien au point et tirer profit d'un ensemble cohérent de connaisances. C'est le résultat du travail méthodique de nombreux chercheurs de qualité pendant plusieurs décennies. Aujourd'hui, nous nous trouvons face à des problèmes qui ne sont sans doute pas tout à fait nouveaux mais qui paraissent infiniment plus graves que dans le passé: primauté de la technique, spécialisation, pénurie de matières premières, d'énergie et d'espace, crise de l'environnement...
Il se développe ainsi des problèmes spécifiques divers pour lesquels il est nécessaire de trouver des réponses nouvelles. Les chercheurs sont placés devant un véritable défi et il dépend de leur savoir et de leur imagination de montrer si la Science de la végétation est capable d'apporter une contribution appréciable à la solution de ces problèmes.
La tradition phytosociologique dans ce contexte constitue une base essentielle. La conception typologique de la végétation et la clarté du système qui en découle, l'habitude des chercheurs de vivre en contact étroit avec la végétation, les recherches basées sur l'observation condition antithétique de l'expérimentation, sont les traits caractéristiques de la phytosociologie.
Les lignes directrices qui nous ont été transmises par les maîtres de la Science de la végétation, Josias Braun-Blanquet et Reinhold Tüxen avant tout, constituent actuellement une part importante de notre patrimoine d'idées. Notre but est de valoriser cet héritage et d'honorer la mémoire du premier de ces maîtres et fondateur de la phytosociologie moderne par une nouvelle série de publications.
Pourront y trouver place des monographies étudiant concrètement la végétation selon les enseignements de J. Braun-Blanquet et R. Tüxen qui, à travers la créativité des auteurs, produiront de nouveaux fruits.
Disciples nous-mêmes de J. Braun-Blanquet et ayant collaboré à son activité, nous pensons qu'à travers cette série de publications son héritage restera vivant dans l'esprit originel et avec de nouvelles idées.

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J. BRAUN-BLANQUET, 1954
Drawn form a photograph by Françoise M. Dansereau

The authors dedicate the book with love and highest respect to Academician E. M. Lavrenko the best expert on the Eurasian steppes

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INTRODUCTION

Steppes are the most widespread type of plant communities in the Mongolian Republic, that is situated in the easternmost ultracontinental sector of the Eurasian Steppe Region. The territories with the steppes vegetation extend from the western up to the eastern frontiers of the country (from 90° up to 120° E longitude), while in the south they reach 44°20' N latitude that is much more south then in the neighbouring continental sector– Kazakhstan, where the boundary between steppe and desert region nearly coincides with 48°N latitude (KARAMYSHEVA, LAVRENKO, RACHKOVSKAJA, 1969).

E. I. RACHKOVSKAJA (1977, 1986, 1993) draws the border between steppes and deserts in Mongolia considerably further north (approximately along 46° N l.), including the southern types of steppes (desertified steppes and desert ones) into the Afro-Asian Desert Region. V. I. GRUBOV (1990) also interprets the desert steppes of Central Asia as the desert vegetation.

In the east and south-east where under influence of the Greater Khingan Mts. (Da Hinggan Ling) and the Pacific Ocean the inversion in plant communities distribution is observed, and the zonal belts has rather longitudinal position, this boundary extends even more southward. The border between the boreal-forest and steppe botanical-geographic regions, that is northern boundary of Eurasian Steppe Region, has on the territory of Mongolia quite intricate outline. Most of botanists (YUNATOV, 1950, 1954; YUNATOV, DASHNJAM, GERBIKH, 1979; LAVRENKO, 1970a; LAVRENKO, KARAMYSHEVA, NIKULINA, 1991; LAVRENKO, KARAMYSHEVA, 1993) attribute to the boreal region only the territories around the Khubsugul Lake (northern than 50° N l.) and mountain massif Khentei (Hentiyn Nuruu) with the exception of its low mountain forest-steppe regions at the periphery of the basic massif, including the rest of the territory (between 50 and 44°20' N l.) in the Eurasian Steppe Region (fig. 1).

The steppe vegetation occupies also the western and eastern slopes of the Greater Khingan Mountains and the low mountain at the foothills of the Mongolian and Gobi Altai and the middle mountain and high mountain parts of these range. In these mountains the clearly defined altitudinal belt with some sub-belts are characterised. On some ridges the steppes extend up to 3100 m above sea level.

Scientific Russian investigations in Central Asia, in particular in Mongolia, are traditional. They have a long history connected with names of outstanding Russian traveller-naturalists (N. M. PRZHEVALSKII, G. N. POTANIN, M. V. PEVTSOV, P. K. KOZLOV, etc.). Their publications contained the bright descriptions of natural landscapes of the country. These works, continued in the beginning of XX c. by specialist-botanists (I. V. PALIBIN, V. L. KOMAROV, V. V. SAPOZHNIKOV, etc.), give us the more thorough and detailed information about vegetation and flora of the separate regions of Mongolia. After 1921, as Mongolia had not the own specialist-botanists, the botanical investigations were accomplished by Russian scientists (N. V. PAVLOV, I. M. KRASHENINNIKOV, E. G. POBEDIMOVA, V. L. BARANOV, etc.). A great significance in the study of botanical-geographic regularities of the vegetation and flora of Mongolia had the works of 50–60th years by E. M. LAVRENKO, V. I. GRUBOV and especially A. A. YUNATOV, in whose publication the first scientific description of the whole Mongolian vegetation is contained. A. A. YUNATOV has published two monographs (YUNATOV, 1950, 1954), in which the main features and peculiarities of Mongolian vegetation are revealed, including the steppes, and the analysis of their botanical-geographic regularities and the brief description of the main types of steppes, as well as the main fodder plants of the steppe pastures, are given.

A special attention deserves the monograph by YUNATOV (1974) devoted to the analysis of flora and vegetation of the desert steppes in Northern Gobi. These communities specific for floristic composition and structure distributed on the northern part of the Central Asian subdominion of the Ancient Mediterranean dominion (GRUBOV, 1963) are the endemics of Central Asia and have not analogies in other arid districts of Palaearctic region.

The above mentioned three monographs by YUNATOV belong to the classical ones and have not lost their significance up to the present time.

A. A. YUNATOV is the author of first small-scale map of the Mongolian vegetation (YUNATOV, DASHNJAM, GERBIKH, 1979) which contains 77 subdivisions of steppe vegetation (zonal types, geographic and edaphic variations) differed in colours, hatchings and letter indices.

A great contribution into the study of Eurasian steppe vegetation including Mongolian one was done by the outstanding Russian botanist-geographer E. M. LAVRENKO. His publications are devoted to the cardinal problems of the botanical geography of Eurasian Steppe Region that is botanical-geographic division (regionalization), mapping, and peculiarities of the flora and the history of steppe vegetation, etc. They are of a great importance not only for steppe region, but also for understanding of the vegetation origin of the Eurasian continent especially its non-tropical part (LAVRENKO, 1940, 1942, 1948, 1954, 1956, 1968, 1970a,b).

In 50–60th the investigations of Mongolian steppes, their classification and mainly the dynamic of above-ground biomass of natural steppe pastures, were carried out by Mongolian specialists (DAVAZHAMTS, 1954; DASHNJAM, 1966, 1974; BANZRAGCH, 1982). Unfortunately in the majority of case these works were published in Mongolian, and thus is not enough accessible to the broad usage.

A considerable progress in steppe vegetation study was observed in the last decades owing to the works of the Joint Soviet(now Russian)–Mongolian complex biological expedition Ac. Sci. of the USSR (R. Ac. Sci.) and Ac. Sci. of Mongolia (Scientific leaders Acad. E. M. LAVRENKO and Acad. V. E. SOKOLOV).

In addition to special extensive route botanical-geographic and cartographic works in the main natural zones of Mongolia, the biological observations at the field stations during several years were also carried out there. They included the comprehensive examinations of the edificators and dominants – the main environment forming species of steppe communities. The investigations were carried out in zonal types of steppes: meadow steppes (LAVRENKO, BANNIKOVA, 1983, 1986), dry (LAVRENKO, 1984, 1988) and desert ones (LAVRENKO, 1980a, 1981). By late 1980 the field station studies of the Eastern Mongolian steppes were started, but unfortunately they were interrupted.

The fundamental task of field station works was the all-around research of separate species and their ecological-physiologic and biological-morphologic characteristics and also the peculiarities of their adaptation to the specific conditions of the ultracontinental climate of Central Asia. But the results of these treatments are of great importance for the decision of many botanical-geographic problems. The elaboration of the objective criteria for an understanding of distinctions between the steppe vegetation and desert one is of chief interest. It is necessary for the definition of steppe vegetation boundaries in Mongolia more exactly as well as for working up the syntaxonomical classification of steppes.

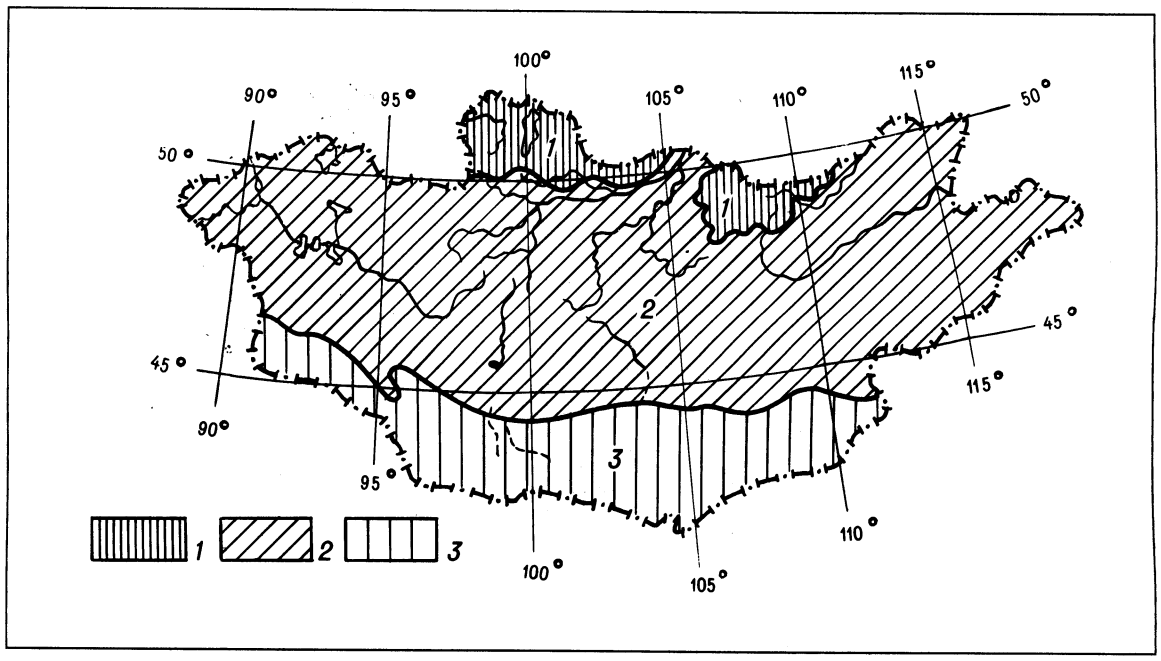

Fig.1. The position of Mongolia in the scheme of the botanical-geographic division of Eurasia: 1. The Eurasian boreal forest zone; 2. The Eurasian steppe zone; 3. The Central Asian desert zone.

The route botanical-geographic and cartographical investigations have been dedicated to the great numbers of problems that is the improvement of the zonal and subzonal borders and the elaboration of the scheme of the provincial and sub-provincial differentiation of the vegetation cover. One of the most important task was the study of the altitudinal regularities and peculiarities of high mountain vegetation, that is of especial importance in Mongolia taking into consideration that nearly half of its territory is occupied by the mountains. These investigations have sufficiently enriched the knowledge about the floristic and typological diversity of the plant communities. They allowed us to make the complete and all-round explanation to the relation between the vegetation and leading factors of nature (peculiarities of the soil cover, relief, distribution of the perma frost, etc.).

Recent researches have been generalised in a lot of publications: in the Transactions of Joint Soviet(Russian)–Mongolian complex biological expedition Ac. Sci. of the USSR (R. Ac.Sci.) and Ac. Sci. of Mongolia (series "Biological resourses and natural conditions of the Mongolian People's Republic"), in other publications (SOKOLOV, KAMELIN, 1986; HILBIG, 1981, 1991; GUBANOV, HILBIG, 1993 a, b), as well as in the new small-scale vegetation map of Mongolia published in the National Atlas of the MPR (LAVRENKO, VOLKOVA, KARAMYSHEVA, *et al.*, 1986, 1988; KARAMYSHEVA, VOLKOVA, RACHKOVSKAJA, *et al.*, 1987; KARAMYSHEVA, DASHNJAM, 1990). As the basis of this map the new botanical-geographic conception was assumed owing to which the diversity of vegetation communities and regularities of their spatial distribution were revealed. The features of vegetation determined by the modern or remote past relations between the Mongolian vegetation and the vegetation of neighbouring territories were found. With respect to the steppe vegetation it is possible to say about the relations with steppes of East Kazakhstan, the Altai and Transbaykal Mts. and with the vegetation of East Asian moderate-continental sector of Palaearctic.

The map has obviously shown, that the penetration to the Mongolian territory of the communities, which are peculiar to the neighbouring regions, resulted in the considerable floristic originality of different parts of Mongolia. It allows us to comment about the existing of some great botanical-geographic boundaries in this region.

While writing this work, we used chiefly the original published and unpublished materials collected by the authors at the time of above mentioned expedition works (70–80^s and 90^s).

For the Latin names of plants, cited in text, the "Key of the Mongolian vascular plants" (GRUBOV, 1982) was used.

The authors express their thanks to the operative management of Joint Russian-Mongolian complex biological expedition, especially to its head Dr. P. D. GUNIN for promoting of this work publication. Also we are thankful to G. D. KATENINA and N. ANISIMOVA for help in drawing the figures.

NATURAL CONDITIONS

Climate. The climate of steppe zone (the position of the meteorological station is given in the fig. 2) possesses a number of specific features, which distinguish it from Kazakhstan, that is situated westward.

In middle winter the prolonged and slightly mobile Asiatic antycyclone takes place on the most part of Mongolia. It prevents the penetration of the wet and relatively warm western masses of air here and provokes the hard cooling of territory. During the cold period (November–April) only 8–12% (10–20 mm) precipitation of their total quantity occurs there. The mean thickness of snow cover is 5–10 cm while in Kazakhstan it reaches 20–30 (40) cm. The dates of steady snow cover in Mongolia and Kazakhstan are approximately the same (2–3nd decade of November), but in Mongolia the snow thaws much earlier 11 February–1 March [20 March–10 April][1]. Thus, in Mongolia the steady snow cover is preserved for 50 (at south)–120 (at north) days [120–160]. Small thickness of snow cover and very low negative temperatures provoke the deep freezing of soil-grounds and the

[1] Here and further in this chapter the climatic characteristics Kazakhstan are given in brackets [ ].

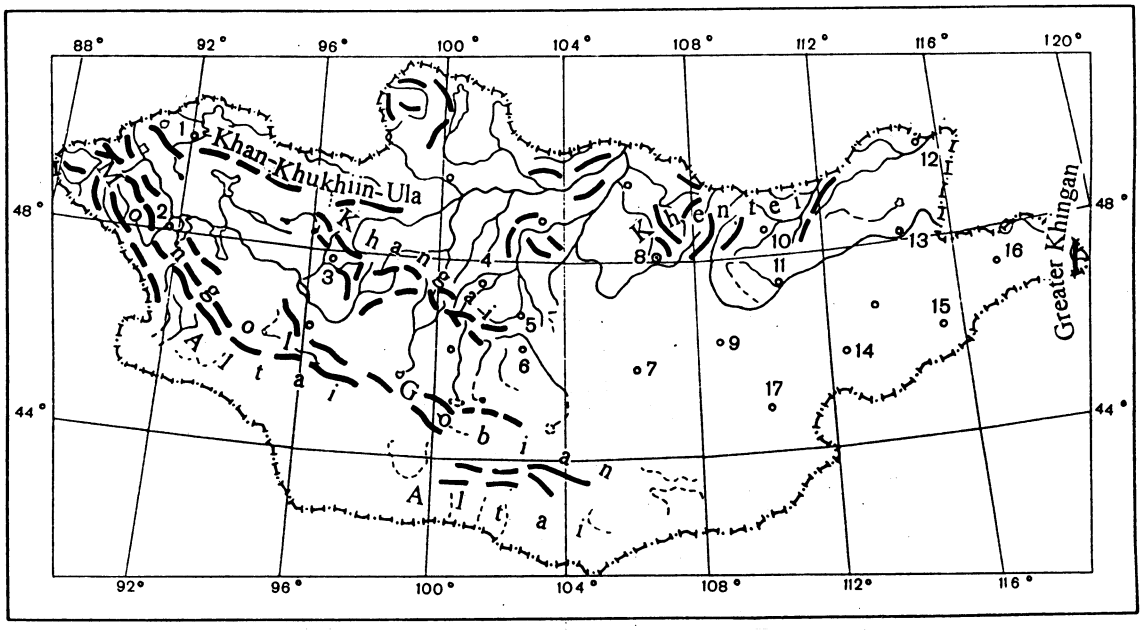

Fig. 2. The main mountain massifs and the position of the meteorological stations in the steppe zone of Mongolia.
1 – Ulaan-Gom, *2* – Khovd, *3* – Uliastai, *4* – Tsetserleg, *5* – Khuzhyrt, *6* – Arvaikhaar, *7* – Mandalgov, *8* – Ulan-Bator, *9* – Kh. Choir, *10* – Binder, *11* – Under-Khan, *12* – Chingesiin Dalan, *13* – Choilbalsan, *14* – Baishint, *15* – Erdenetsagan, *16* – Tamsag-Bulak, *17* – Saishand.

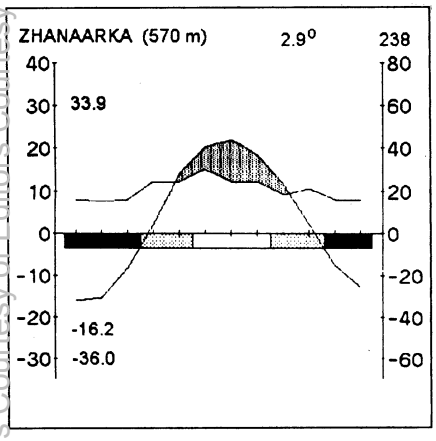

Fig. 3. The climatic diagram for the desertified steppe subzone of Kazakhstan.

formation of seasonally frozen grounds and preservation of perma frost. The absolute minimum of air temperature reaches -40,-45°C [-42,-43°]. January mean temperatures are -24, -20 °C (at north) and -16 °C (at south). In the winter period there is no accumulation of water in the Mongolian steppe's soil, on the contrary – the soil is physically withered. That is why the beginning of the period of the active growth is not connected with positive temperatures, but starts only after the first rains, which usually are observed in the end of May–middle of June (BORISOVA, POPOVA, BUEVICH, 1987). Probably the spring dryness is responsible for the absence of ephemerals and ephemeroids (perennials fruiting in spring and quiescent in summer), which are broadly represented in Kazakhstan and Middle Asia.

The warm period in the territory of whole Mongolia except the extreme west is characterised by prevalence of monsoon type of climate with its specific rhythm of precipitation: with clearly defined summer maximum and autumn–winter–spring minimum. During the period of maximum precipitation (July and August) about 90 % of them usually occur there. As a rule they have the downpour character and deeply soak the soil (more than 1 m), especially when the soils are loamy sand or sandy loam in texture. Annual precipitation varies from 300 mm at the north up to 140 mm at the south. In Kazakhstan steppes the distribution of precipitation is more even with spring-summer and summer-autumn maximum, but during warm period only 60–75% precipitation occur there (annual mean – 250–400 mm). The temperatures mean of July in Mongolia are 15–20 (at north) and 25° (at south), absolute maximum 30–41° [40–42°].

The comparison of the climatic diagrams (fig. 3, 4, 5) compiled by method of WALTER (WALTER, LIETH, 1960) for Mongolia (Climatic manual..., 1971) and Kazakhstan (Agroclimatic reference book ..., 1962) shows, that only at Western Mongolia the summer arid period is sharply defined (fig. 5: *1*, 2). It is the arid type

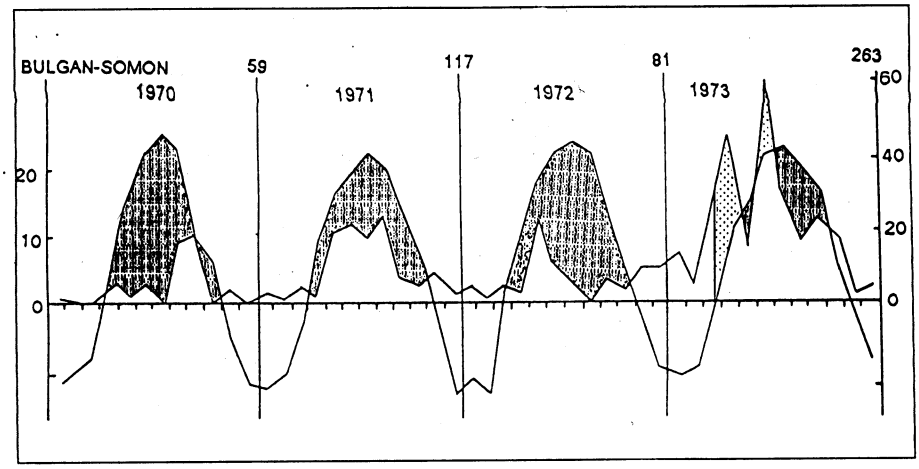

Fig. 4. The climatic diagrams for the desert steppe zone of Mongolia (Bulgan Somon) by the matter of direct observation in every year (by BORISOVA, *et al.*, 1976).

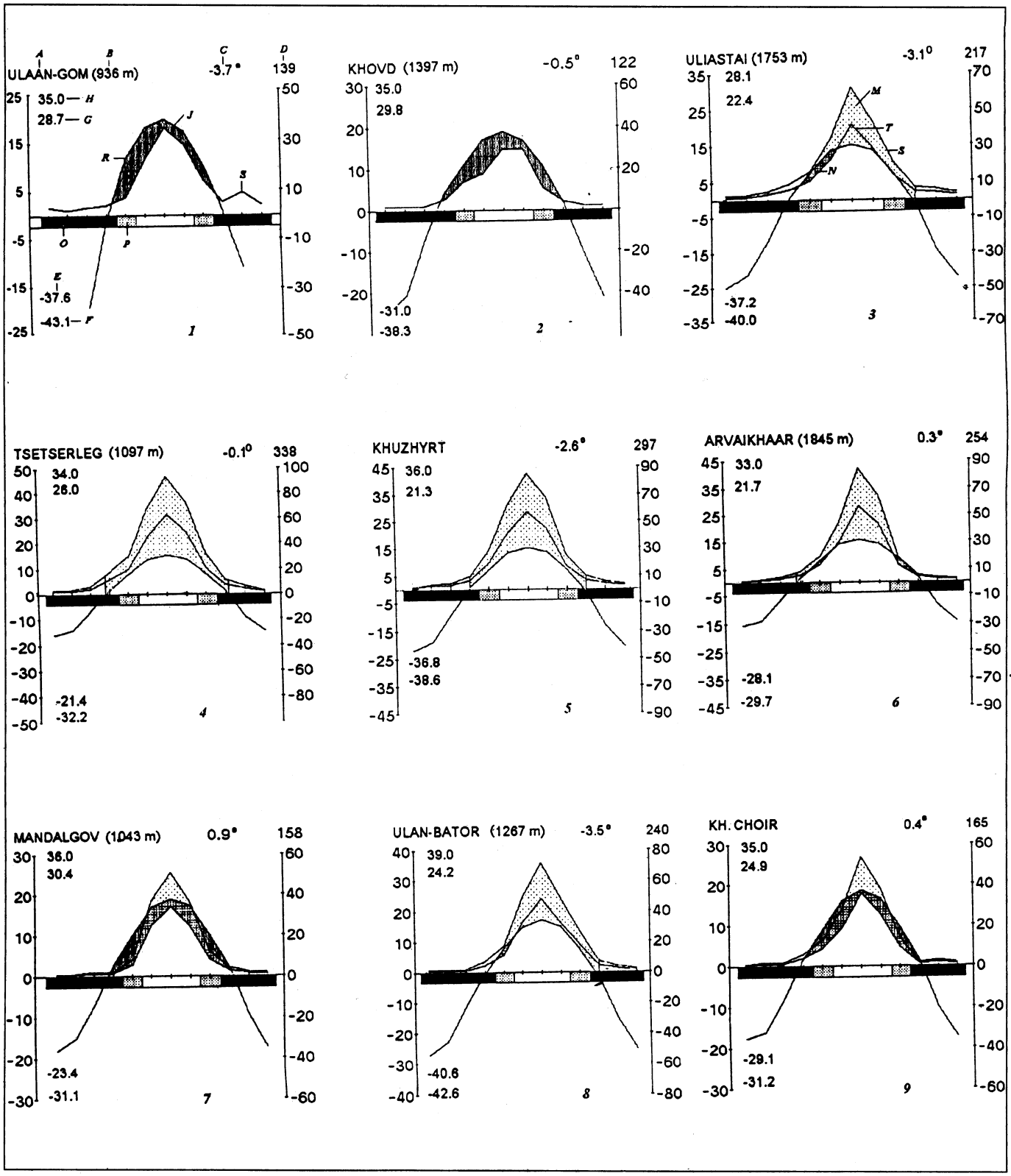

Fig. 5. The climatic diagrams for the steppe zone of Mongolia.
Each of the letters of the alphabet used below stands for a certain meaning: ***A*** – station, ***B*** - altitude, ***C*** – mean annual temperature in degrees centigrade, ***D*** – mean annual sum-total of precipitation in mm, ***E*** – mean daily minimum of the coldest month, ***F*** – absolute minimum, ***G*** – mean daily maximum of the hottest month, ***H*** – absolute maximum, ***J*** – arid period, ***M*** – humid period, ***N*** – subarid period, ***O*** – in case the absolute minimum of a month falls below zero centrigrade, ***P*** – in case the absolute minimum lies below zero, ***R*** – the mouthly means temperature, ***S*** – the mouthly means of precipitation, ***T*** – precipitation curve in scale of 1 : 3 for determine subarid period in summer.

of climate similar to the Kazakhstanian one (fig. 3). In central and eastern parts of Mongolian steppe region the arid period sometimes subarid one can be observed only in spring (fig. 5 : *3, 7, 9, 11, 13, 14,* etc.). The climate of the summer period may be classified as a wet one and according to WALTER (WALTER, LIETH, 1960) is almost similar to boreal types being profoundly different from the arid and subarid climate of Kazakhstanian steppe. At the same time Mongolia is situated in the conditions of insufficient and extremely insufficient moisture (BERESNEVA, 1988) that is connected with its latitudinal position and strong insolation.

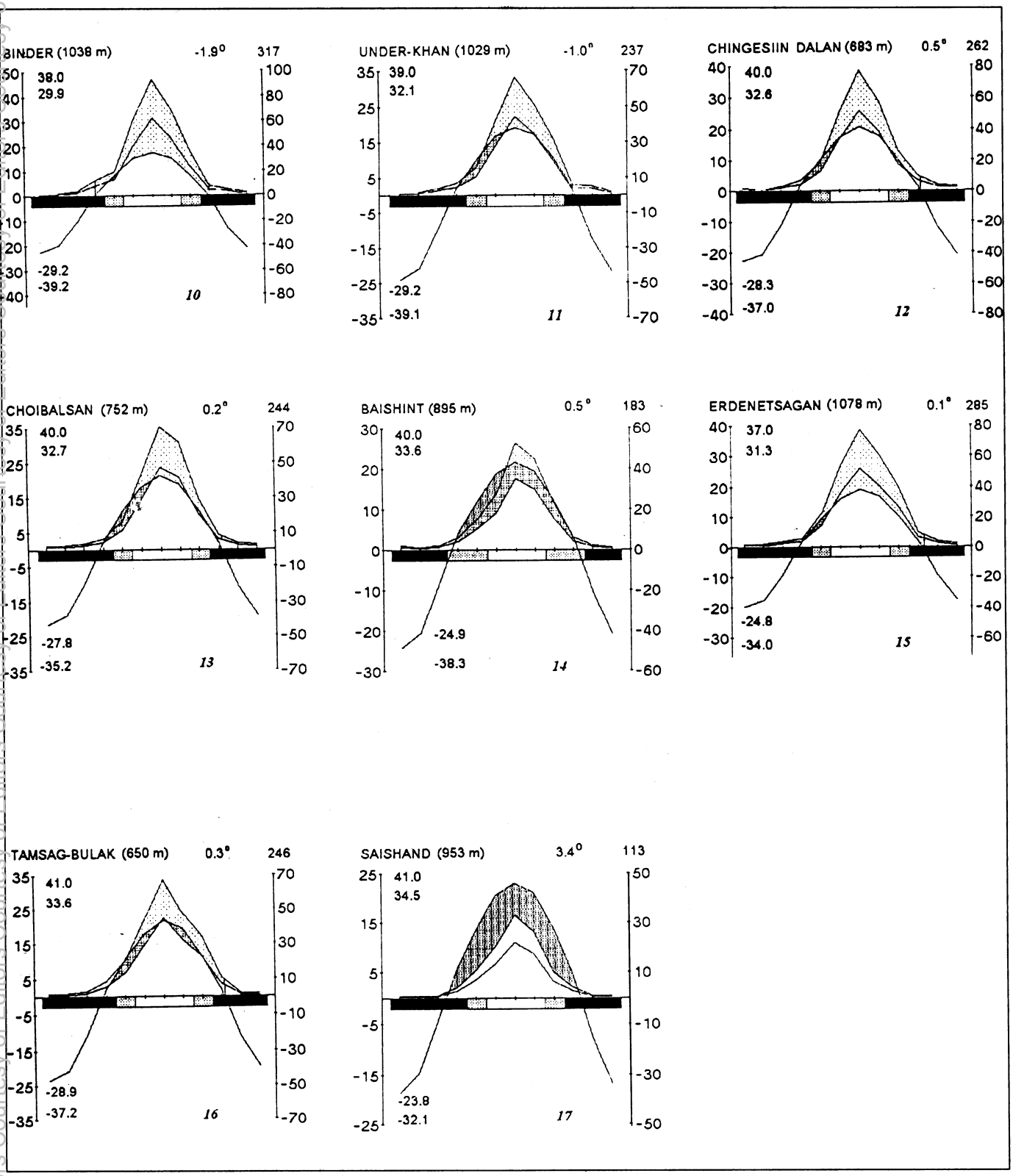

Fig. 5. The climatic diagrams for the steppe zone of Mongolia (continuation).
Each of the letters of the alphabet used below stands for a certain meaning: ***A*** – station, ***B*** - altitude, ***C*** – mean annual temperature in degrees centigrade, ***D*** – mean annual sum-total of precipitation in mm, ***E*** – mean daily minimum of the coldest month, ***F*** – absolute minimum, ***G*** – mean daily maximum of the hottest month, ***H*** – absolute maximum, ***J*** – arid period, ***M*** – humid period, ***N*** – subarid period, ***O*** – in case the absolute minimum of a month falls below zero centrigrade, ***P*** – in case the absolute minimum lies below zero, ***R*** – the mouthly means temperature, ***S*** – the mouthly means of precipitation, ***T*** – precipitation curve in scale of 1 : 3 for determine subarid period in summer.

The climate and weather in Mongolia are characterised by extraordinary lability and, in particular, by the alternation of dry extremely unfavourable for the plant's life (fig. 4; 1970–1972) and wet (often anomalous wet) years (fig. 4; 1973). The biological and morphological observations of the plants in the Central mongolian dry steppe subzone showed that the features of dry and droughty years, especially if they are repeated for several seasons one after the other, exactly determine the vegetation development and existence of steppe phytocoenoses (BORISOVA, BESPALOVA, POPOVA, 1976).

As we have noted above, the neighbourhood of the Pacific ocean deter-

mines the distribution of precipitation (its monsoon type) in Mongolia. Moving from east to west in meridional direction, we can observe that the climate became more continental. It reveals first of all in the increasing of the winter severity. The degree of climate's severity in western part of Mongolia is comparable with outlying districts of Greenland (BERESNEVA, 1988). Influence of ocean intensified by orography (submeridional stretch of the Greater Khingan Mts.) tend to the inversion of zonality from latitudinal to longitudinal one, that is observed at the Far East of the country and has its farther continuation in China. The zonality in the central part of Mongolia has the latitudinal character typical for Eurasia, what is defined by the rise of solar radiation and correspondingly the sum of the temperatures higher +10° which in the north is equal 1000° and in the south of steppe zone is 1800° (VITVITSKII, ZHAMBAAZHAMTS, 1990). In mountain massifs the altitudinal differentiation of vegetation is observed, being determined by mezoclimatic changes. For instance, in the Khangai Mts. the sum of the temperatures higher +10° during the period of active growth ranges from 1800 in the lower belt (1350–1550 m above sea level) up to 1000° (2350–2550 m), while the quantity of annual precipitation rises from 325 up to 500 mm (BERESNEVA, 1988).

Geocryological conditions. The typical feature of the environment in Mongolia is the wide distribution of the perma frost and seasonally frozen grounds. It is often accompanied by well-pronounced cryogenic phenomena: frost mound, thermokarst, icing field (flooding ice), solifluction, etc. Seasonal freezing up to 2–5 m depth can be found all over the steppe zone. On the plains in the central and western parts the permanently frozen grounds are sporadically observed, mainly related with water-soaked loam in the pans around the springs. At foothills and lower parts of mountains (the Khentei Mts., the mountains near the Khubsugul Lake, the Khangai and Mongolian Altai Mts.) there are small and big "islands" of permanently frozen grounds (about 5% of territory) from 5–10 up to 50 m depth, chiefly located on northern slopes with forest, partly with the steppe or meadow steppe vegetation. With the increasing of high above the sea level the area of these "islands" gradually increases and they occupy up to 80% of high mountain's territory where the cryophytic steppes, cushion communities, sedge meadows and *Kobresia* meadows predominate. Boundaries of geocryological belts have different altitudinal position in different massifs and on the slopes of different exposition, being lower on the northern slopes and higher on the southern and eastern ones (MEL'NIKOV, 1974).

Relief. Relief of Mongolia is rather diverse. There are high mountains, middle and low ones, hills, intermountain denudative plains, socle, alluvial-proluvial, lake-alluvial, aeolian ones, volcanic lava plateau (Florensov, Korguev, 1987; Chichagov, Natsag, 1990). The main peculiarity of Mongolia is its high location; the about 80% of its territory is situated higher than 1200 m above sea level.

At the west of country there are elevated mountains of Mongolian Altai stretching from north-west to south-east as long as 600–650 km. They are the narrow, deep-dissected ridges with steep slopes and have the heights exceeding 4000 m. Here inside the massif Tavan-Bogdo-Ula the highest point of Mongolia – the mountain Kuiten Uul (4374 m above sea lev.) is situated. Eastward from the Mongolian Altai Mts. there is a vast hollow – the Big Lakes Pan with the great sandy massifs: Borig-Del-Els, Bor-Khara-Els and Mongol-Els.

The central part of steppe region is occupied with the ancients Khangai elevation including several great ridges (Khan-Khukhiin-Ula, Tarbagatai, Bulnai). The vast watershed plains and deep cut steep canyons are characterised to the Khangai Mts.

Southward and south-east from the Khangai Mts. the vast wavy and hilly denudative plains as well as the peneplains of the Middle Khalkha are stretched.

Eastward from Khangai the Khentei elevation is situated. The latter is represented by small ridges with smoothed summits. Southward and eastward from the Khentei massif the vast flat or waved deluvial-proluvial denudative plains and lake-alluvial ones are spreaded with total extend more than 1200 km. Their heights regularly reduce from west to east. At the extreme north-east near the Khukh-Nur Lake they reach 560 m. It is the lowermost point of Mongolia. The plains alternate with peneplains and separate low mountain massifs.

To the extreme east the western spurs of the Greater Khingan Mts. composed of granite massifs and plots of basalt plateau are extending. The direction of axial ridge is from north-east to south-west. At foothills of the Greater Khingan Mts. there are plenty of sand massifs.

Soils. The mountain relief and prolonged development of denudation processes were the reason of the vast distribution of the deluvial-proluvial deposits. The soils of sandy-loam and loamy-sand in texture prevail. The relatively monotony of the mechanical texture of different zonal soil types may be attributed to this natural phenomenon. In summer rain period often with showers the deep sometimes even through drench of soil profile occurs. It promotes the leaching and desalinisation of the soil. It is unusual for steppe of the Kazakhstan and Black Sea regions phenomenon.

Most types of the soils have no of any degree of salinization. Thus the halogene-hydrogene complexity of soil (and accordingly vegetation) cover is absent in the steppe zone of Mongolia in contrast to Khazakhstan where complexity is typical and broadly distributed. The soda type of salinity is characteristic. The carbonates are presented by farinaceous forms. There are also the soils with well-pronounced carbonate horizon (obviously relic one) and without it (NOGINA, 1978, 1980; GERASIMOV, NOGINA, 1984; DORZHGOTOV, NOGINA, 1990).

The peculiarities of soils (steppe ones among them) allow to attribute them into the Central Asian bioclimatical facies with two main soil-bioclimatical regions: Khangaian occupying the northern part of country northward from 46° N l. (its southern boundary coincides with north boundary of light chestnut soils subzone) and Gobian, which includes the desert steppe and desert zones (DORZHGOTOV, NOGINA, 1990).

Khangaian soil-bioclimatic region. Out of the mountain part the soil cover is composed by dark chestnut soils and chestnut ones. Chernozems occupy not a great area. The most territories of them are situated at the mountain regions. Dark chestnut soils and chestnut ones are characterised by slight thickness, considerable gravely content, sandy and sandy-loam texture. In mountains there are highmountain-steppe rough-humus soils and high-mountain-meadow ones under cryo-xerophytic steppe vegetation.

On the territory of the East-Mongolian plain the dark chestnut soils are especially widespread. The territories with dark chestnut soils are stretched from northern frontier of Mongolia up to southern one, that is related with the rise of the plain heights from north to

south (from 650–700 to 1100 m above sea lev.), and mainly with the influence of the Pacific ocean. There are comparatively big pans on this plain where the more arid proper chestnut soils are distributed. At the foothills of Greater Khingan the chernozems and meadow-chernozem soils are spread. The chernozems and chestnut soils are characterised by small thickness of humus horizon.

For the Gobian soil-bioclimatic region, which includes the southern and western parts of Mongolia and the Mongolian and Gobi Altai Mts. also, the consecutive replacement of the light chestnut soils up to the brown desert steppe ones and more southward – the grey-brown desert soils are characterised. In Mongolian Altai there is clearly defined altitudinal changing of soil namely the desert and desert steppe soils in foot-hills are replaced by the chestnut ones and then – the mountain-steppe soils and highmountain steppe rough-humus ones.

PLANT GROWTH-FORM PECULIARITIES

Like all steppe communities of Eurasian temperate belt, the Mongolian steppes are formed by perennial long-lived, mainly polycarpic, microtherm xerophilous and often sclerophilous plants, in particular the bunch grasses of genera *Stipa, Festuca, Helictotrichon, Agropyron, Cleistogenes, Koeleria, Poa,* etc. Steppe bunch grasses create the basis part of the vegetation cover. They form the dominating synusia[2] often being edificators[3] and dominants and provide the most of phytomass.

The life form of bunch grasses apparently possesses an advantage over other ecobiomorphs in the unfavourable water supply in summer, low temperatures and insignificant snow cover in winter also permanent trampling down and grazing by cattle and sheep (LAVRENKO, 1941). Its renewal buds are safely covered by numerous dead parts of leaves vaginae; the bases of the tufts sufficiently deepened into soil and all this results in the developing of the thick surface-underground biohorizon. In this biohorizon the accumulation of phytomass takes place, that plays the basic role in substance and energy turnover as opposed to the above-ground biohorizon which is destroyed and removed yearly by grazing (GORDEEVA, 1977). This horizon accumulates snow, water and fine earth, that improves the moisture keeping.

Throughout in the steppe region the definite structural peculiarity of grass stand my be observed. The dominanting synusia of bunch-grasses is usually composed of a combination of the relatively tall bunch-grasses, mostly species of genera *Stipa, Agropyron, Helictotrichon,* and of the shorter ones mainly of genera *Festuca, Cleistogenes, Poa, Koeleria,* etc., or sometimes also the shorter species of *Stipa.*

The structure of Mongolian steppe communities has some specific features. So, their distinctive peculiarity (as well as of steppe in Transbaykal region and neighbouring Inner-Mongolia) is the dominance of small bunch-grasses in contrast to Kazakhstan and Black See region where large bunch-grasses predominate in steppe communities. The loose-bunch-grasses (species of genera *Bromus, Phleum, Poa,* etc.) are appreciably abundant, chiefly in the more northern types of steppes. These regularities are characterised of the all Eurasian steppes. However in the subzone of dry steppes in Mongolia there are large territories covered with the communities of a loose-bunch grass *Cleistogenes squarrosa.* These steppes are distributed on soils with light mechanical texture or on the intensively used pastures. The rhizomatous grasses, as well as loose-bunch ones, in Black Sea region and Kazakhstan can be met chiefly in the northern types of steppes, but never in abundance. In Mongolia, however (at the east especially), the rhizomatous grass *Leymus chinensis* is the dominating or co-dominating species in the various types of steppes (both in northern meadow steppes and in typical dry ones). Steppes of rhizomatous grasses are specific for Mongolia.

The role of dominants in the steppe stands of Mongolia also play the tuft forming sedges and onions. The latter (onion steppes) are endemic for Central Asia (Mongolia). The usual components of steppes are forbs of families *Alliaceae, Liliaceae, Iridaceae, Rosaceae, Fabaceae,* etc. The quantity of forbs (both in abundance of species and in their proportional contribution to biomass) decreases from north to south along the climatic moisture gradients. Simultaneously the composition of the ecological group's changes: xeromesophilous and mezoxerophilous species in northern types of steppes are replaced by xerophilous and even hyperxerophilous ones at the south.

Steppe forbs include diverse life (growth) forms: tap root-plants (species of genera *Astragalus, Oxytropis, Onobrychis, Dianthus, Silene, Peucedanum,* etc.), root sucker plants (*Cymbaria*), rhizomatous plants including short rhizomatous ones (species of genera *Galium, Veronica, Vicia,* etc.). Only for Mongolia and also for Transbaykal region and Inner Mongolia the steppe communities of tufted tap-root plant *Filifolim sibiricum* are typical.

Among the forbs dominating in high mountain steppes of Mongolia, as well as in petrophytic and psammophytic variants of steppes some plants forming the compact or friable cushions occur. Some of the pulvinate plants belong to dwarf semi-shrubs.

The dwarf semi-shrubs synusia dominates in the zonal desert steppes and also in psammophytic and petrophytic variants of different zonal types.

In the steppe communities of Mongolia, as well as in the steppes of the neighbouring Kazakhstan, a great role belongs to the shrubs, which form here a special synusia. In Mongolia it is chiefly the species of g. *Caragana* and also *Spiraea, Cotoneaster, Dasiphora, Amygdalus,* etc.

The distinctive feature of the typical Mongolian steppes is the absence of ephemerals and ephemeroids, which vegetate only during the cool humid period, mainly in spring and early autumn. This is accounted for the specific character of climate namely of cold and dry spring. Ephemeroids are represented only by *Tulipa uniflora* and 2 species of g. *Gagea* (*G. pauciflora* and *G. hiensis*); some ephemeral species have been found only in the western part of Mongolia (GRUBOV, 1982; KAMELIN, GUBANOV, DARIIMA, 1985; GUBANOV, KAMELIN, DARIIMA, 1986, 1987). It has to be noted that in the Black Sea region and in Kazakhstan the short-lived species are very abundant, and they form a clearly defined synusia in spring or autumn there. In the preserve ASKANIA-NOVA, for example, they are numbered as 2–3 thousands of plants per $1m^2$ (SHALYT, 1938).

[2] The term "synusia" is used in the sense of GAMS (1918, also see KORCHAGIN, 1976). Synusia is the structural part of plant community, which includes those species that are similar in biological and ecological sense.

[3] "Edificator" is environment-forming species, that is responsible for the floristic composition and physiognomy of community and the quantity of phytomass produced (BRAUN-BLANQUET and PAVIARD, 1922).

The annual species of g. *Artemisia* (*A. scoparia, A. pectinata, A. palustris,* etc.), and species of g. *Dontostemon, Chamaerhodos, Bassia, Axyris*, and small grasses *Eragrostis minor, Aristida heymannii,* etc. (LAVRENKO, 1973) in desert steppes are more typical. These species grow particularly often on the ground digged out by rodents, on aeolian drift sands around steppe shrubs and tufts of large grass *Achnatherum splendens*. In wet years they are more abundant.

The moss or lichen covers are common only for some types of Mongolian steppes. For example, the moss layer of forest moss *Rhytidium rugosum* is observed often in the meadow steppes, while in high mountain steppes – of *Thuidium abietinum, Aulacomnium palustre* and other forest and tundra mosses. Synusia of lichens is not peculiar to Mongolian steppes unlike the Black Sea region and Kazakhstan, where for instance *Parmelia vagans, P.ryssolea* and other foliate lichen species often constitute the continuous cover.

Thus, the communities of Mongolian steppes are characterised by the definite biomorphic (growth form) composition, which distinguishes them from the steppes of the Black Sea region and Kazakhstan.

PECULIARITIES OF MONGOLIAN STEPPE FLORA

A comparison between the Mongolian steppes and Black Sea–Kazakhstanian ones shows some essential floristic peculiarities. They are differed in quantitative composition of the whole flora and of the inter-genus taxa and the genera's composition in lesser degree, and also in presence of endemic species and in predominance of some specific geoelements, etc. This peculiar character is concerned not only with the flora as a whole, but also with the most active part of it, namely the main environment forming species, determining the set of formations and other syntaxa that are typical for the plakor and nonplakor habitats.

Term "formation" in the Russian coenotic school means a syntaxon, which unites the phytocoenoses with the same edificator. The term "plakor" was introduced by G. N. VYSOTSKII (1915) to signify a flat, well drained plain with loamy soils; the ground water is located too deep to affect plant growth. The vegetation of plakor plains most fully reflects zonal climate conditions.

Most of the species being the dominants and co-dominants are peculiar only to the steppes of Mongolia and also Central Asia, which Mongolia belongs to (Table 1).

Let us briefly characterize the main features of Mongolian steppe's flora.

Table 1

The main edificator, dominant and co-dominant species in the steppe communities of the Transvolga-Kazakhstanian province of the Black See-Kazakstanian steppe subregion and Dahuria-Mongolian (Central Asian) subregion

Transvolga-Kazakhstanian province		"Transition" stripe: West Mongolia (Khan-Khukhiin-Ula, Ubsu-Nur Pan, north-eastern part of Mongolian Altai, the ranges of the frontier Dzhungaria)		Central and Eastern Mongolia
		Schrubs		
Berberis sibirica		*Berberis sibirica*		*Berberis sibirica*
Caragana balchashensis			←	*Amygdalus pedunculata*
Caragana bongardiana				*Armeniaca sibirica*
Caragana frutex		*Caragana bungei*		*Caragana korshinskii*
Caragana leucoploea		*Caragana leucophloea*	→	*Caragana leucophloea*
Caragana pumila		*Caragana pygmaea*		*Caragana microphylla*
Lonicera microphylla		*Lonicera microphylla*		*Caragana pygmaea*
Dasiphora fruticosa		*Dasiphora fruticosa*	→	*Caragana stenophylla*
				Dasiphora fruticosa
Spiraea hypericifolia	→			*Dasiphora parvifolia*
			←	*Spiraea aquilegifolia*
		Dwarf semi-shrubs		
		Artemisia argyrophylla		*Artemisia argyrophylla*
				Artemisia changaica
				Artemisia gmelinii
Artemisia frigida		*Artemisia frigida*		*Artemisia frigida*
Artemisia gracilescens	→			
Artemisia lerchiana		*Artemisia dolosa*	←	*Artemisia dolosa*
Artemisia schrenkiana	→			
Artemisia semiarida		*Artemisia klemenzae*	→	
Artemisia sublessingiana	→		←	*Artemisia monostachya*
Artemisia terrae- albae	→	*Artemisia sphaerocephala*		*Artemisia sphaerocephala*
			←	*Artemisia xanthochroa*
			←	*Artemisia xerophytica*
	←	*Ajania fruticulosa*		*Ajania fruticulosa*
		Ajania achilleoides		*Ajania achilleoides*
				Ajania trifida
		Anabasis brevifolia		*Anabasis brevifolia*
		Asterothamnus heteropappoides		
Eurotia ceratoides		*Eurotia ceratoides*		*Eurotia ceratoides*
Nanophyton erinaceum		*Nanophyton erinaceum*		

Table 1 (continuation)

Transvolga-Kazakhstanian province		"Transition" stripe: West Mongolia (Khan-Khukhiin-Ula, Ubsu-Nur Pan, north-eastern part of Mongolian Altai, the ranges of the frontier Dzhungaria)		Central and Eastern Mongolia
		Perennial grasses and sedges		
		Carex duriuscula		*Carex duriuscula*
Carex pediformis		*Carex pediformis*		*Carex pediformis*
	←	*Kobresia humilis*	→	
		Kobresia smirnovii		
Agropyron cristatum		*Agropyron cristatum*		*Agropyron cristatum*
				Cleistogenes kitagawae
Cleistogenes squarrosa		*Cleistogenes squarrosa*		*Cleistogenes squarrosa*
		Cleistogenes songorica		*Cleistogenes songorica*
Festuca valesiaca	→	*Festuca kryloviana*		*Festuca kryloviana*
		Festuca sibirica		*Festuca sibirica*
	←	*Festuca tschujensis*		
		Festuca lenensis		*Festuca lenensis*
Helictotrichon altaicum		*Helictotrichon altaicum*		
Helictotrichon desertorum				
Helictotrichon schellianum		*Helictotrichon schellianum*		*Helictotrichon schellianum*
Koeleria cristata	→	*Koeleria macrantha*		*Koeleria macrantha*
				Koeleria mukdenensis
Leymus racemosus		*Leymus racemosus*		*Leymus racemosus*
				Leymus chinensis
		Poa attenuata		*Poa attenuata*
		Poa botryoides		*Poa botryoides*
Poa stepposa		*Poa stepposa*	→	
		Psammochloa villosa		*Psammochloa villosa*
Stipa capillata	→			*Stipa baicalensis*
Stipa kirghisorum	→			*Stipa grandis*
Stipa korshinskyi		*Stipa glareosa*		*Stipa glareosa*
			←	*Stipa gobica*
Stipa lessingiana		*Stipa krylovii*		*Stipa krylovii*
Stipa orientalis	→			
Stipa pennata	→		←	*Stipa klemenzii*
Stipa sareptana	→			
Stipa sibirica		*Stipa sibirica*		*Stipa sibirica*
Stipa tirsa				
Stipa zalesskii	→			
		Perennial forbs		
Allium galanthum	→	*Allium altaicum*	←	*Allium polyrrhizum*
		Allium anisopodium		*Allium anisopodium*
		Allium mongolicum		*Allium mongolicum*
		Allium senescens		*Allium senescens*
		Amblynotus rupestris		*Amblynotus rupestris*
				Arctogeron gramineum
				Astragalus melilotoides
		Chamaerhodos altaica	→	*Chamerhodos trifida*
Coluria geoides		*Coluria geoides*	→	
				Filifolium sibiricum
				Leontopodium leontopodioides
		Leontopodium ochroleucum		*Leontopodium ochroleucum*
				Lespedeza dahurica
				Lespedeza hedysaroides
		Oxytropis filiformis		*Oxytropis filiformis*
			←	*Oxytropis myriophylla*
			←	*Oxytropis nitens*
		Polygonum angustifolium		*Polygonum angustifolium*
		Polygonum alpinum		*Polygonum divaricatum*
				Polygonum valerii
				Potentilla tanacetifolia
		Pulsatilla bungeana		*Pulsatilla bungeana*
				Saposhnikovia divaricata
				Stellera chamaejasme

Note: species, which penetrate into the neighbouring territories, are marked by arrows.

A.A. YUNATOV (1950, 1954, 1974) and E. M. LAVRENKO (1956, 1970a, 1978, 1980b) repeatedly noted that the distinctions of the feather grasses dominanting in Black Sea–Kazakhstanian steppes and Mongolian ones are concerned with a Section composition in genus *Stipa*. Species of the Section *Leiostipa* (*Stipa krylovii, S. baicalensis, S. grandis*, at western part – *S. capillata, S. sareptana*) predominate in the Mongolian steppes. *Stipa krylovii* dominates in the true dry steppes both on plains and mountains. The Manchzhuria-Dahuria-Mongolian species (*S. baicalensis* and *S. grandis*) are widespread chiefly in more mesophytic meadow steppes, the latter grows on the soils with light texture. Only three species of the Section *Stipa* (*S. zalesskii, S. kirghisorum* and *S. pennata*), which are the environment-forming species in the Black Sea–Khazakhstanian steppes penetrate to the West Mongolia (TSVELEV, 1968; BANZRAGCH, KARAMYSHEVA, MUNKH-BAJAR, *et al.*, 1975; KARAMYSHEVA, BANZRAGCH, 1976a,b; GRUBOV, 1982). *Stipa orientalis* (petrophilous-steppe sp. of the Section *Barbatae*) grows also only in West Mongolia. In the petrophytic types of steppe and in the shrub thickets the characteristic species is *Stipa sibirica* (of the Section *Achnatheropsis*). Among the small bunch-grasses, that play an important phytocoenotic role, the species of the following genera are to be mentioned.

Cleistogenes: *C. squarrosa* is the most abundant sp. on the plain in the dry steppe subzone throughout the whole territory; *C. songorica* extends only in desertified and desert steppes, rare in West Mongolia; *C. kitagawae* is more mesophilous sp. typical for East Mongolia.

Agropyron: *A. cristatum* ranges on the plains and mountains in the dry and desertified steppe subzones across the whole territory; *A. nevskii* is the petrophilous mountain sp., endemic of Mongolian Altai and western part of the Big Lake Pan; *A. sibiricum* is the psammophilous sp., which occurs in Central and East Mongolia; *A. aegilopoides* is the petrophilous mountain sp., etc.

Poa: *P. attenuata* is the mountain sp.; *P. altaica* is the high mountain sp.; *P. botryoides* ranges widespread on the plains and low hills across the whole territory, etc.

Koeleria: *K. altaica* extends only in high mountain steppes; *K. macrantha* is distributed in mountain and plain steppes; *K. mukdenensis* extends only in the plain steppes at the eastern part of the country.

The peculiarities of floristic composition and phytocoenotic role of genus *Festuca* species could be clearly revealed. Contrary to Black Sea region and Kazakhstan, where the euxerophilous West Palaearctic sp. *Festuca valesiaca* s.l. plays an important role in different zonal types from northern meadow steppes up to desertified ones, in Mongolia the plant communities with dominance *Festuca* species occur only in mountains. The Mongolia–West Siberian sp. *Festuca lenensis*, Tien Shan–Mongolia–East Siberian sp. *F. kryloviana*, the East Altai–Tuva–West Mongolian sp. *F. tschujensis*, the Altai–West Mongolian sp. *F. albiflora* and also *F. sibirica* (*Leucopoa albida*) should be mentioned amongst the *Festuca* species broadly distributed as dominants or co-dominants. *F. valesiaca* is the dominant only in plain and mountain steppes of West Mongolia. On sandy soils of East Mongolia *F. dahurica* is present.

As in the steppes of East Kazakhstan and in the forest-steppes of East Europe and West Siberia, in Mongolia an important role belongs to the species of genus *Helictotrichon*. *Helictotrichon schellianum* is the meadow steppe Palaearctic sp. widespread throughout the whole territory. *Helictotrichon altaicum* is distributed in mountain forb–grass steppes only in the western part of the country.

In the western part of steppe region the species of *Leymus* g. grow only in meadow communities on solonets and solonchak, while in Mongolia there are the steppe (*L. chinensis*) and petrophilous steppe species (*L. secalinus, L. sibiricus, L. schrenkianus*), which are the dominants and co-dominants. *Leymus racemosus* is widespread on sandy soils.

The very rich and specific steppe of *Arundinella anomala* can be found only at the extreme east at the Greater Khingan district and at the north-eastern slope of the Khentei Mts. This species distributes at Far East, Japan, China also.

The Kazakhstan–Siberia–Mongolian sp. *Carex pediformis* often is edificator or dominant in meadow steppes. This species is replaced in the West by *C. humilis*, which is the peculiar component of East European meadow steppes.

The differences in composition of *Artemisia* genus species are essential. It is known that the wormwoods, mainly of the Subgenus *Seriphidium*, form the peculiar synusia in desertified steppes in the Black Sea–Kazakhstanian Subregion. In Mongolia some species of this Subgenus that is *A. gracilescens, A. terrae-albae, A. sublessingiana, A. schrenkiana* can be met. But they have the a significant role only in the West in the Ubsu-Nur Pan and in the Barun Khurai Hollow. Wormwoods of the Subgenus *Artemisia* (*A. frigida, A. argyrophylla. A. xerophytica, A. caespitosa, A. dolosa, A. monostachya, A. sericea, A. rutifolia, A. latifolia, A. santolinifolia*, etc.) and the Subgenus *Dracunculus* (*A. changaica, A. halodendron*, etc.) grow abundantly in the all types of Mongolian steppes from the meadow steppes up to the desert ones.

In the desert steppes of Mongolia there are no wormwood except of psammophytic and petrophytic steppes, as it is typical for North Turanian and Kazakhstanian desertified steppes. But the hyperxerophilous species of g. *Ajania* (*A. achilleoides, A. trifida, A. fruticulosa*) as well as dwarf semi-shrubs of *Chenopodiaceae* (*Anabasis brevifolia, Salsola passerina, Chenopodium frutescens, Nanophyton erinaceum*, etc.) and *Tamaricaceae* (*Reaumuria soongorica*, etc.) are peculiar.

It was mentioned above that the shrub thickets and shrub steppes are common to the whole Eurasian region, especially to the East Kazakhstan and Mongolia, as the soil of light mechanical composition often gravely ones prevail there.

Caragana is the most abundant genera amongst the shrubs in Mongolia. The important phytocoenotical role have the following species: the Dahuria–East Mongolian sp. *Caragana microphylla;* the Dahuria–Mongolian sp. *Caragana pygmaea*; the Sajan–West Mongolian sp. *Caragana bungei*; the Middle Khuan-Kheian (Hwang Ho River) sp. *Caragana korshinskii*; the Upper Yenisei–Dahuria–Mongolian sp. *Caragana stenophylla*; the Middle Asia–Mongolian sp. *Caragana leucophloea.* In the West Mongolia there are shrub thickets and shrub steppes with *Spiraea hypericifolia* and sometimes with *Lonicera microphylla. Armeniaca sibirica* distributes mainly at the Eastern Mongolia in the psammophytic and petrophytic types of steppes. Throughout the whole territory in more mesophytic and often petrophytic types of steppes *Cotoneaster melanocarpa* and *Dasiphora fruticosa* are abundant. *Amygdalus pedunculata* prevails in more southern ones. As we mentioned above, the communities with a specific composition distribute in the mountain steppe belts and on a

stony and gravely soils. The cushion like low semi-shrubs as *Arenaria capillaris* (Mongolia–East Siberian sp.) and *Arctogeron gramineum* (Upper Yenisei–Dahuria–Mongolian sp.) are common to such types of steppes. The small cushion like herbs as *Androsace incana* (Mongolia–East Siberian sp.), *Amblynotus rupestris* (Mongolia–South-Eastern Siberian sp.) and species of genera *Patrinia, Phlojodicarpus,* etc., also grow there. The dwarf semi-shrubs not forming the cushions as *Chamaerhodos trifida, Ch. altaica* (East Dahuria–East Mongolian sp.) should be mentioned.

In Black Sea–Kazakhstanian subregion a great role in the plant communities on the stone soil belongs to the species of *Lamiaceae* especially to the numerous species of *Thymus, Hyssopus,* etc. In Mongolia the species of *Thymus* are not often to be met on the granite outcrops and on the sands, while the only species of *Hyssopus* (*H. cuspidatus*) penetrates to the extreme west of the country. The typical for Central Asia genera *Amblynotus* and *Arctogeron* are connected with the vegetation of outcrops (LAVRENKO, 1972).

After the analysis of Mongolian steppe flora a big number of species and genera especially typical for Mongolia and absent in Black Sea–Kazakhstanian subregion can be mentioned (LAVRENKO, KARAMYSHEVA, NIKULINA, 1991). An example of such genera is *Leontopodium* that is of widespread occurence not only in Mongolia, but also in the Far East, Eastern and Inner Tien-Shan. In the Kopetdag Mts., Asia Minor and Caucasus this genus is absent and the only species (*Leontopodium alpinum*) appears again in the Middle Europaean Mts., including the Carpathians Mts.

The Far East–Central Asian olygotypic g. *Cymbaria* from *Scrophullariaceae,* the Far East–Dahuria–Mongolian monotypic g. *Saposhnikovia* from *Apiaceae,* the South Siberia–Central Asian g. *Sibbaldianthe* from *Rosaceae* are among the genera which are also absent in Black Sea–Kazakhstan subregion.

There are some genera, that are distributed not only in Mongolia and Dahuria, but in the southern part of East Siberia region. An example is *Dontostemon* (Siberia–Dahuria–Mongolian olygotypic genus from *Brassicaceae*), and *Filifolium* (North China–Manchzhuria–Dahuria–Mongolian g. from *Asteraceae*).

Anemarrhena, Stellera, Panzeria, Schizonepeta, Olgae, Lespedeza and many other belong to the genera, which spread only in steppes of Mongolia and in neighbouring China. The absence in Mongolia of such Black Sea–Kazakhstanian genera as *Crambe, Trinia, Verbascum, Sideritis, Salvia* [there is the only doubtful indication on the *Salvia deserta* in Kobdo district (GRUBOV, 1982)], the Section *Phlomis* of genus *Phlomis*, etc. is a fact of great interest.

Some genera, more or less rich in species in Black Sea–Kazakhstanian subregion are rather rare in Mongolia (for example, *Centaurea, Jurinea,* etc.). There are many genera such as *Onosma, Coluria, Eremostachys, Helichrysum, Herniaria, Tetracme, Ziziphora, Ferula, Piptatherum, Nanophyton, Rindera, Cicerbita, Syrenia,* etc., that are penetrate only to the West Mongolia (GRUBOV, 1976; KAMELIN, GUBANOV, DARIIMA, 1985; GUBANOV, KAMELIN, 1988; LAVRENKO, KARAMYSHEVA, NIKULINA, 1991).

Flora of Mongolian steppes is represented by 5 large geographic groups, which are divided into more fractional geoelements:

1. South-Eastern Siberia–North Mongolian;
2. Proper Mongolian;
3. Central Asian;
4. West Palaearctic–West Mongolian (Black Sea–Kazakhstan–West Mongolian; Kazakhstan–West Mongolian; East Kazakhstan–West Mongolian; Middle Asia–West Mongolian);
5. East Asian (Manchzhurian, Dahuria–Mongolian, Dahuria–East Mongolian, etc.). The areas of some species are shown on the Fig. (6–11).

The data that mentioned above show that the close floristic affinities between the Mongolian steppe's flora and the flora of the most eastern part of the Ancient Mediterranean (in the M. G. POPOV's sense, 1915) and the flora of Far East are exist. In the steppe flora of the Black Sea–Kazakhstan subregion the close associaions with flora of more southern regions of western parts of Ancient Mediterranean especially with ancient Pannonia and steppe flora of Caucasus and Asia Minor can be traced.

E. M. LAVRENKO (1956, 1970a, 1980b) singled out the Mongolian steppe region as a separate Dahuria-Mongolian (Central Asian) subregion within the Eurasian Steppe Region taking into account their floristic and phytocoenotic distinctions.

GENERAL BOTANICAL-GEOGRAPHIC REGULARITIES OF STEPPE VEGETATION

The general botanical-geographic regularities of the plant communities in Mongolia are connected first of all with zonality phenomena (latitudinal differentiation), which are well noticeable in central part, and less pronounced in eastern and western parts of the country.

Also the longitudinal regularities are well revealed in the steppe region of Mongolia. This meridional (provincial) division of vegetation has attracted the major attention especially during the last years (LAVRENKO, 1978; LAVRENKO, VOLKOVA, KARAMYSHEVA, *et al.*, 1988; KARAMYSHEVA, VOLKOVA, RACHKOVSKAJA, et al., 1987).

The regularities of the altitudinal division of vegetation are represented very distinctly throughout the whole steppe Mongolian territory, as there are the great areas of mountain ridges and massifs there.

At last the peculiarity of vegetation caused by the edaphic diversity should be mentioned, such as soil texture, degree of its salinity, gravely content, etc.

Some unique features of the steppe vegetation and peculiarities of its spatial structure depend, to a considerable extent, on paleogeographical events, which took place on this territory in the Quanternary period (Pleistocene-Holocene). The main events, that have made a greater impact on the development of Mongolian nature, are:

– the prolonged existence of continental condition;

– the broad development of cryospheric processes, which led to the formation of vast perma frost areas;

– the existence of the peculiar periglacial condition at the north of Mongolia that determined the specific type of zonality, when the periglacial tundra-steppes elements penetrated deeply southward and mixed there with arid elements of flora.

All these events created the conditions favourable for the exchange between boreal and arid flora and fauna (RAVSKII, 1972; MEL'NIKOV, 1974; DEVJATKIN, 1981) and for the formation of peculiar types of plant communities (forests, steppes). For example, there are widely represented steppes, especially in the Mongolian mountains, with cryophilous elements and cryophytic grass communities (*Kobresia*

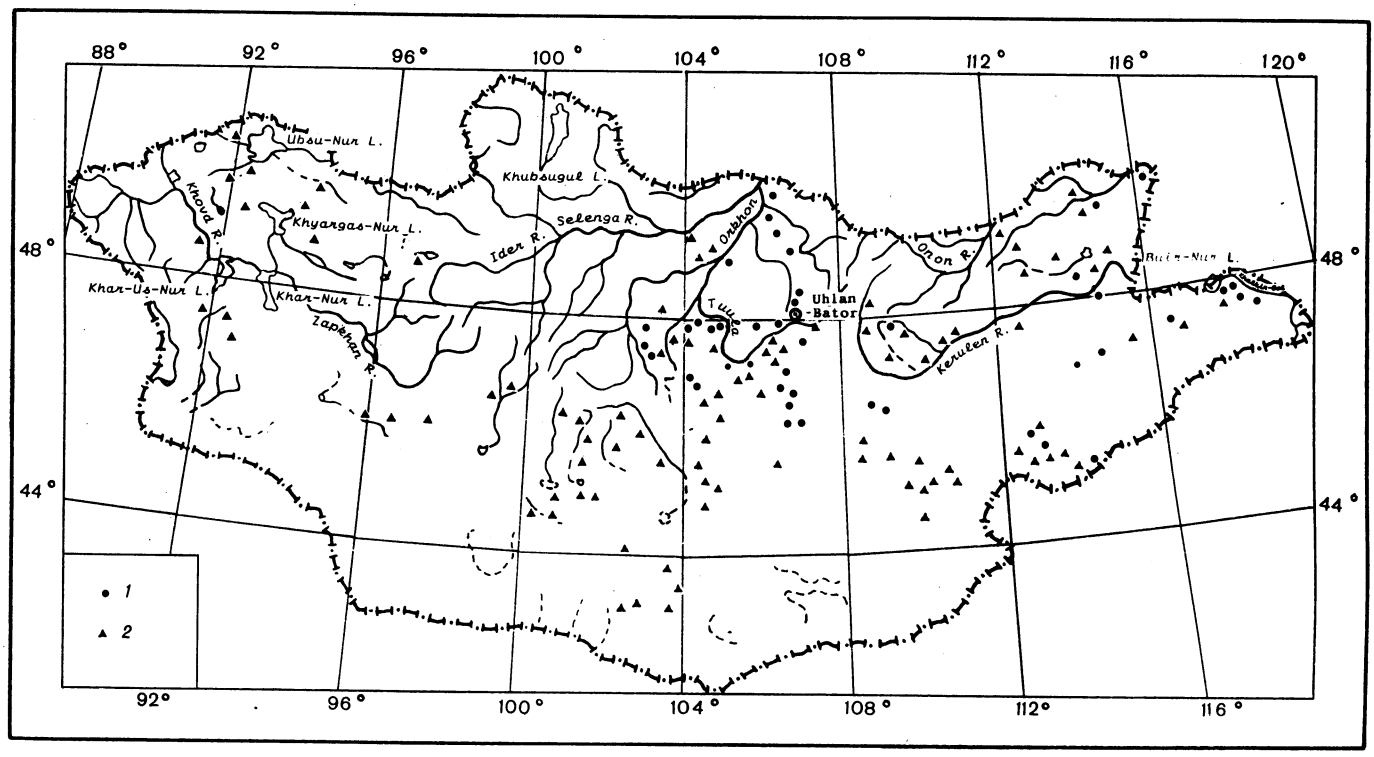

Fig. 6. Distribution ranges of the Mongolian steppe species: 1. *Caragana microphylla* (Pall.) Lam.; 2. *Cleistogenes squarrosa* (Trin.) Keng.

Note: The maps area of species (fig. 6–11) was compiled by Dr. I. YU. SUMERINA.

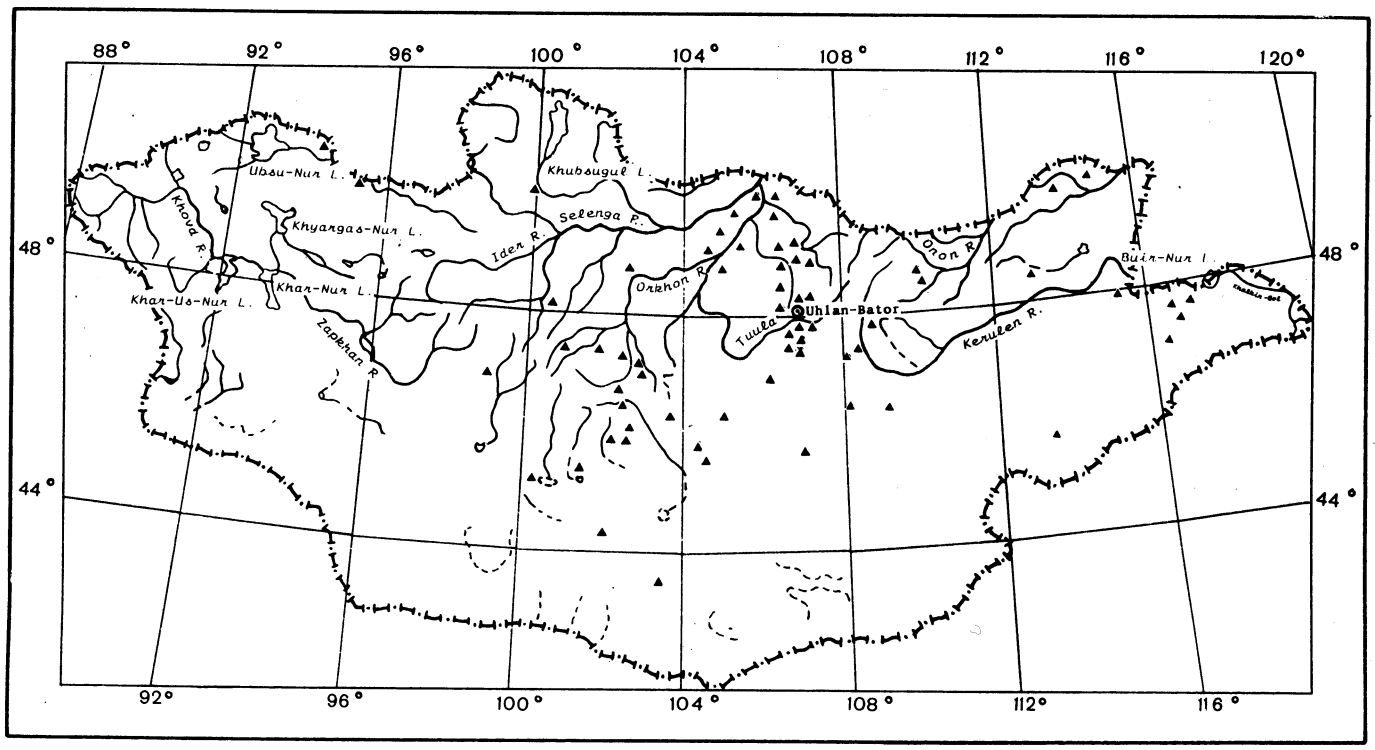

Fig. 7. Distribution range of the Mongolian steppe species *Cymbaria dahurica* L.

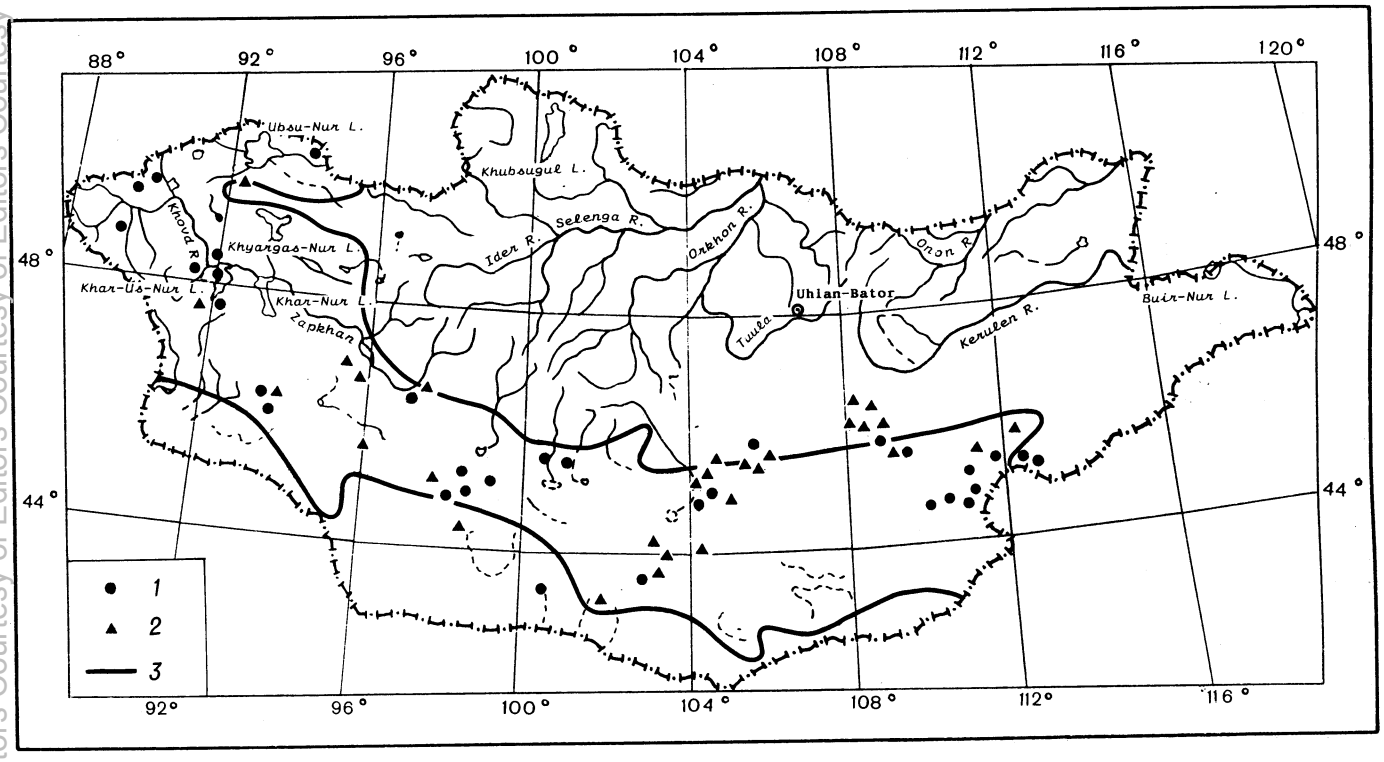

Fig. 8. Distribution area of the North Gobi desert steppe species *Artemisia caespitosa* Ledeb.: *1.* Points are according to the Herbarium Komarov Botanical Institute of RAS; *2.* Points are according to Lavrenko field observations (LAVRENKO, SUMERINA, 1977); *3.* The boundary of the desert steppe subzone (according to YUNATOV, 1974).

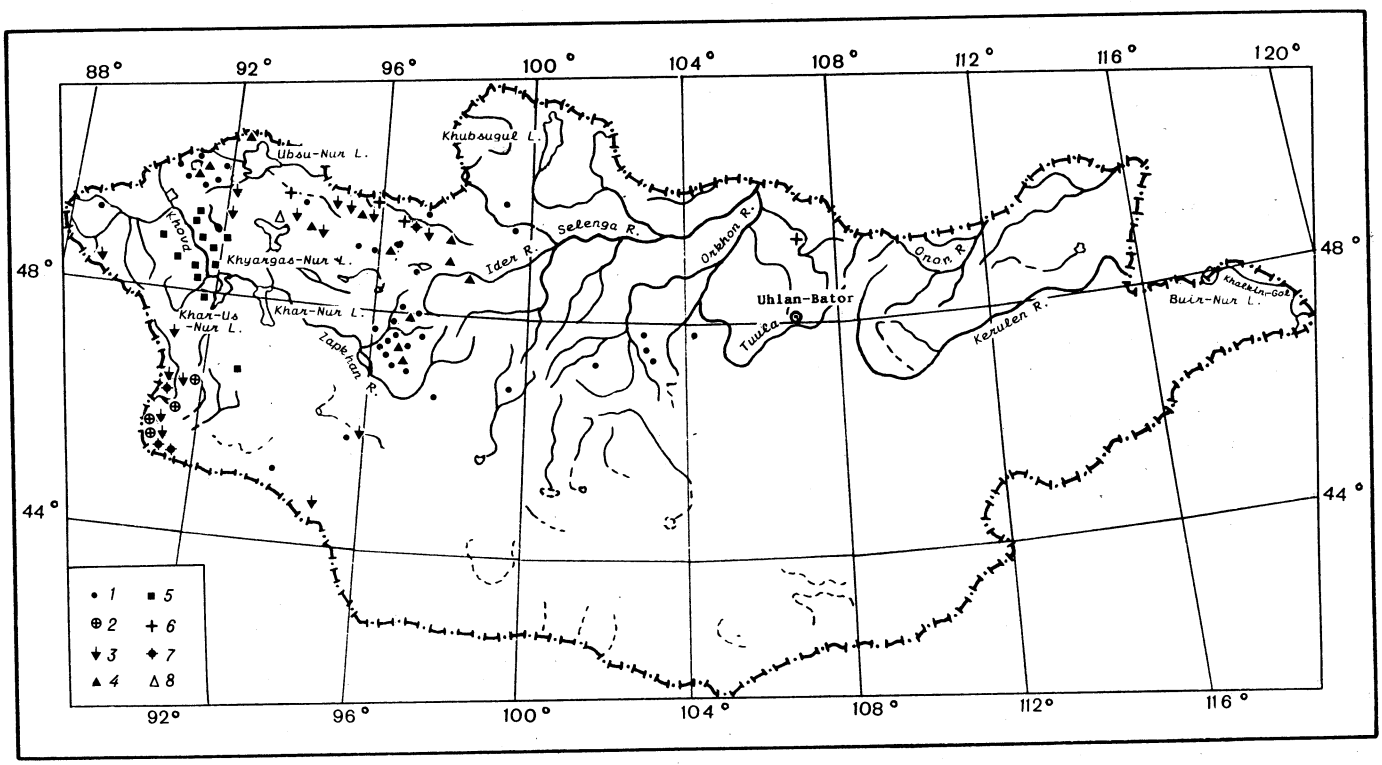

Fig. 9. Distribution ranges of the Kazakhstan – West Mongolian and Middle Asia–West Mongolian steppe and desert steppe species: *1. Veronica pinnata* L.; *2. Allium galanthum* Kar.et Kir. *3. Spiraea hypericifolia* L.; *4. Coluria geoides* (Pall.) Ledeb.; *5. Gueldenstaedtia monophylla* Fisch.; *6. Stipa pennata* L.; *7. Stipa zalesskii* Wilensky; *8. Stipa kirghisorum* P.Smirn.

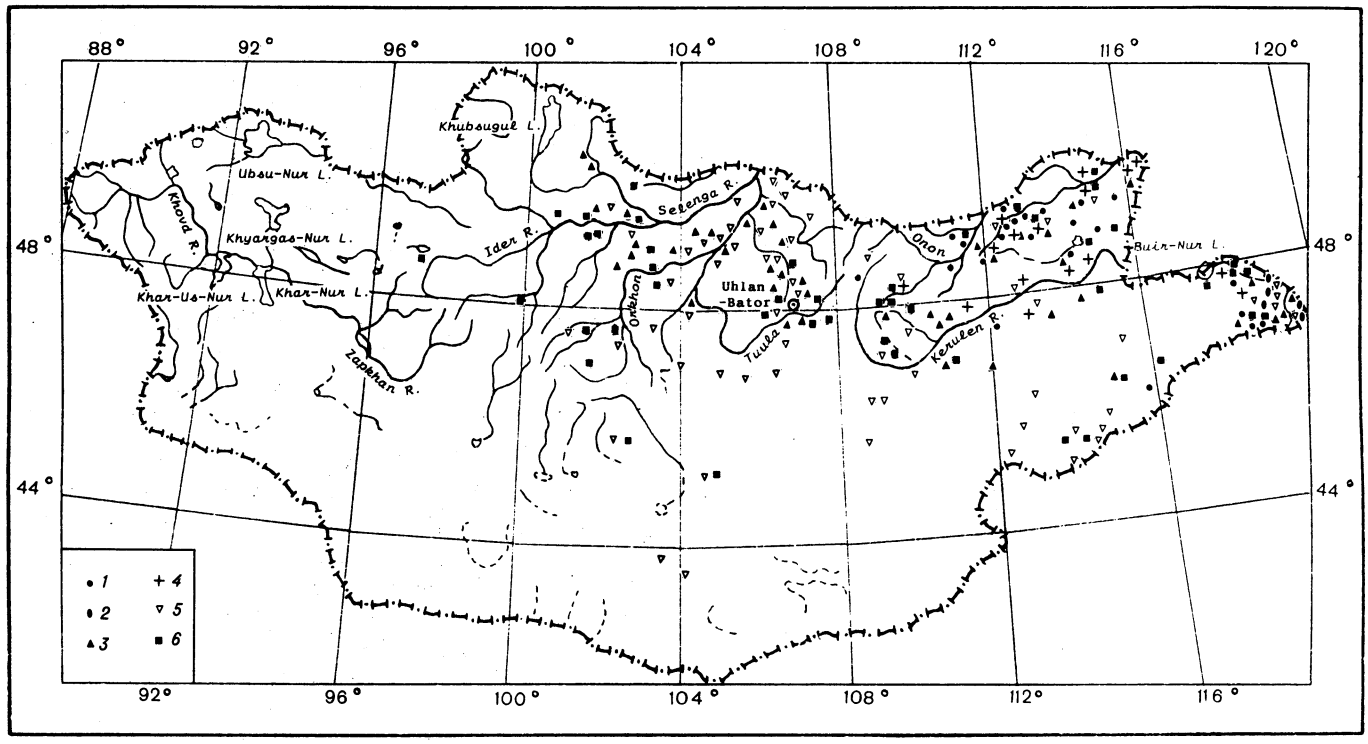

Fig. 10. Distribution ranges of the Dahuria–Mongolian and Manchzhurian meadow steppe and steppe species: *1. Iris dichotoma* Pall.; *2. Paeonia lactiflora* Pall.; *3. Filifolium sibiricum* (L.) Kitam.; *4. Clematis hexapetala* Pall.; *5. Spiraea aquilegifolia* Pall.; *6. Bupleurum scorzonerifolium* Willd.

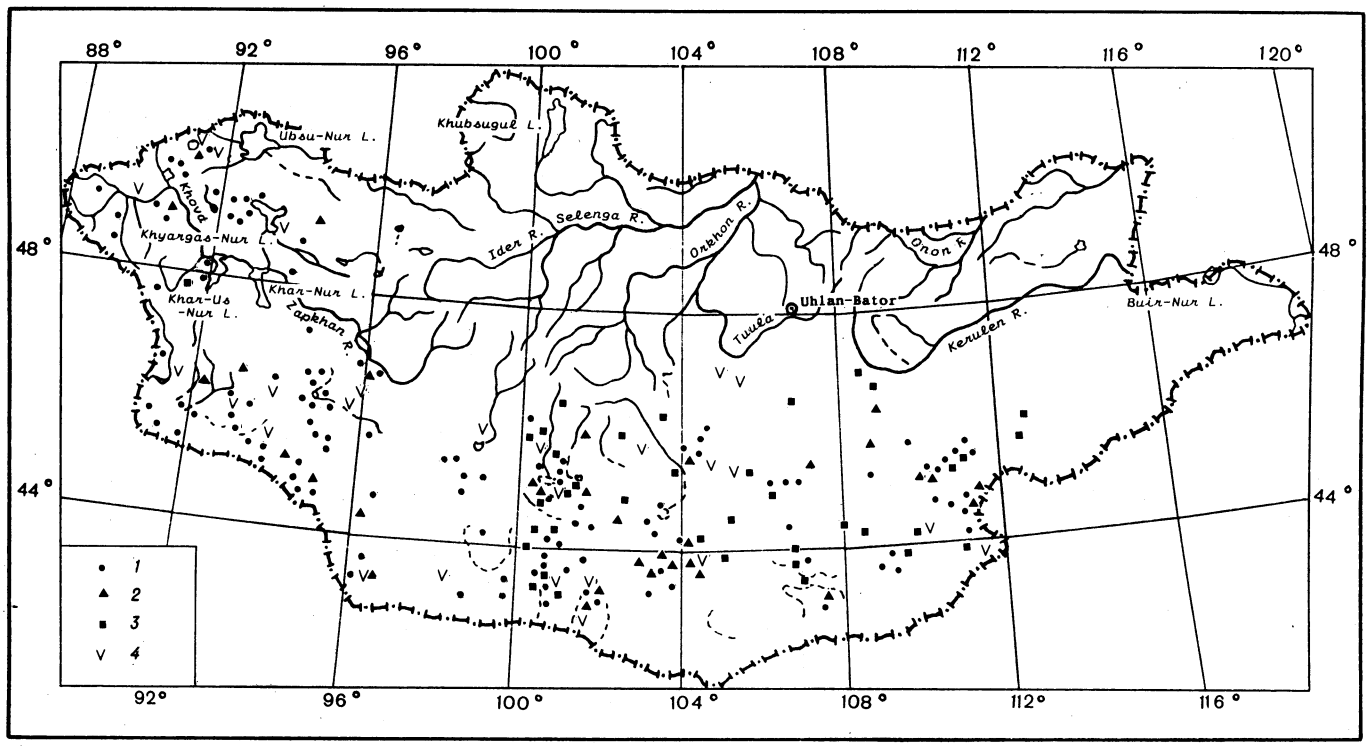

Fig. 11. Distribution ranges of the Gobi (Central Asian) desert steppe and desert species: *1. Anabasis brevifolia* C.A.Mey.; *2. Stipa gobica* Rochev.; *3. Cleistogenes songorica* (Roshev.) Ohwi; *4. Allium mongolicum* Regel.

and sedge meadows) rich in steppe species and mountain-steppe ones (KARAMYSHEVA, 1982, 1986; VOLKOVA, 1992). They all are related with relic and modern plots of perma frost.

LATITUDINAL (ZONAL) DIFFERENTIATION

Russian geobotanists traditionally distinguish the following steppe types, which successively replace one another from north to south with increasing aridity of climate, as demonstrated by decreasing precipitation, increase of temperature summations and lengthening of the frost-free period (LAVRENKO, KARAMYSHEVA, NIKULINA, 1991; LAVRENKO, KARAMYSHEVA, 1993):

1. **Meadow steppe,** in semihumid climate;
2. **True or typical steppes:**
   a) Bunch-grass steppe with many forbs, in semiarid climate,
   b) Bunch-grass steppe with few forbs, in arid climate;
3. **Desertified bunch-grass and dwarf semi-shrub–bunch-grass (semi-desert) steppe,** in very arid climate;
4. **Desert dwarf semi-shrub–bunch-grass steppe,** in hyperarid climate.

The latter two types of steppe can be characterised as very and super dry ones.

According to this division of main zonal types the corresponding latitudinal subzones are distinguished. These subzones have a good correlation with the replacements of zonal and subzonal soil types.

The general altitude of plains is the cause of some peculiarities of steppe vegetation cover, for instance, of the considerable displacement of subzonal and zonal boundaries to the south. This event has been mentioned above and have been noted also in early publications (GRUBOV, 1963).

The picture of zonality within the steppe zone of Mongolia (that is the existence of different zonal stripes and the distinguishing characteristics of their boundaries, etc.) has the following peculiarities: the subzone of meadow forb–grass and grass–forb steppes on chernozems and meadow-chernozem soils (forest-steppe) does not have the latitudinal stretching, as in case with the Black Sea–Kazakhstan subregion. In Mongolia the forest-steppe landscapes are chiefly connected with submountain, lower mountain and mountain territories namely the Khangai Mts., the Khentei Mts. and the Greater Khingan Mts. The so called "expositional" forest-steppe is distinctive. In this case the steppe communities on the southern slopes are combined with the forest ones on the northern slopes. The forest communities are associated with perma frost grounds.

The subzone of true steppes which includes the forb–bunch-grass and the bunch-grass steppes on the chernozems, and on the dark chestnut soils and chestnut ones is clearly defined only in the central and partly in the eastern Mongolia. At the extreme east it has nearly longitudinal direction, while at the west it almost disappears.

The subzone of desertified steppes on light chestnut soils is a narrow stripe extending along the northern part of the desert steppe subzone. This subzone has been marked for the first time on a small scale map of vegetation in the National Atlas of Mongolia (LAVRENKO, VOLKOVA, KARAMYSHEVA, *et al.*, 1986, 1988; KARAMYSHEVA, VOLKOVA, RACHKOVSKAJA, *et al.*, 1987).

Desert steppes are the more xerophytic, that is hyperxerophytic type of steppe vegetation at the extreme south of its distribution. They occupy the vast territories between 44° and 46° N latitude and are connected with brown desert steppe soils.

LONGITUDINAL (MERIDIONAL) DIFFERENTIATION

Almost the whole of Mongolian territory is situated in the East Siberia-Central Asian ultracontinental sector of the non-tropical belt of Eurasia (LAVRENKO, 1978; LAVRENKO, KARAMYSHEVA, 1991). The western border of this sector is in close proximity to Mongolia frontier while the eastern one crosses the extreme eastern part of the country. The western boundary of the East Siberia-Central Asian ultracontinental sector is of considerable importance both for the ecological conditions and for the vegetation. This boundary agrees very closely with the boundaries of two regional blocks within three botanical-geographic regions of Palaearctic, Black Sea–Kazakhstanian and Dahuria–Mongolian (Central Asian) subregions of the Eurasian Steppe Region are amongst them (LAVRENKO, KARAMYSHEVA, NIKULINA, 1991).

On the territory of arid and subarid regions this border-line coincides very closely with the boundary of the eastern longitudinal macroclimatic sector (BERESNEVA, 1988). The interaction between the west air masses and oceanic monsoons takes place here, and the change of precipitation rate occurs. It is mentioned above, that the summer maximum of precipitation is observed throughout of the whole territory of Mongolia, that is why there is no summer semi-dormancy and dormancy period as in case with more western section of Eurasian Steppe Region. There are also some specific functioning features of Mongolian plant (LAVRENKO, KARAMYSHEVA, NIKULINA, 1991; LAVRENKO, KARAMYSHEVA, 1993).

The latest investigations (BANZRAGCH, KARAMYSHEVA, MUNKH-BAJAR, *et al.*, 1975; KARAMYSHEVA, BANZRAGCH, 1976a, b; VOLKOVA, RACHKOVSKAJA, 1980; KARAMYSHEVA, 1981; KARAMYSHEVA, VOLKOVA, RACHKOVSKAJA, *et al.*, 1986, 1987; LAVRENKO, VOLKOVA, KARAMYSHEVA, *et al.*, 1986, 1988) showed, that there is the broad "transition" stripe ("ecoton": WALTER, BOX, 1976; "buffer": SOCHAVA, 1979) along the border between the West Siberia – Kazakhstanian continental sector and East Siberia – Central Asian ultracontinental ones. This "transition" stripe includes the western part of Big Lakes Pan, north-eastern part of the Mongol Altai Mts., eastern lower part of the Eastern Tannu-Ola Mts., the Khan-Khukhiin-Ula Range and Barun-Turun Hollow. In this "transition" stripe the species of West Palaearctic–West Mongolian group of geoelements are broadly spread, and specific "hybrid" communities occur. As to the Central Asian species, their composition becomes poor. Thus, *Allium polyrrhizum, Stipa gobica* and many other communities, which dominate in the desert steppe subzone of central and eastern part of Mongolia are absent here (see Table 1).

The structure of the vegetation cover along the eastern boundary of East Siberia–Central Asian sector did not study well enough, and the position of this boundary need futher consideration. LAVRENKO (1978) drew it outside the Mongolia. There is a reason to believe that V. I. GRUBOV's point of view is more correct. V. I. GRUBOV (1976) proposed to separate the western forest-steppe spurs of the Greater Khingan Mts. from the other Mongolian steppe territory and to include them into Manchzhurian province of the East Asian subregion of Holarctic. The strong influence of the Pacific monsoon is observed here. There is also a well-pronounced "transition"

("fore monsoon") stripe along this boundary, which as all natural boundaries have not a linear character. The steppes on the plains westward from the Khalkhin-Gol River (East Mongolia) and the forest-steppe landscapes and steppe ones of the submountain territories of the eastern Khentei Mts. should be included in this "transition" stripe. The Manchzhurian species and another "eastern" ones are of a great importance for the plant composition there. Some species and communities typical for the East Mongolia spread far westward – in the eastern spurs of the Khangai Mts. (SKVORTSOV, 1983; LAVRENKO, BANNIKOVA, 1986; GOLUBKOVA, KAMELIN, 1989) and along the Orkhon and Selenga River.

ALTITUDINAL REGULARITIES

There are several altitudinal types of steppes, some of them are the analogues of the plain subzonal ones that is meadow mountain steppes, forb–bunch-grass mountain steppes, bunch-grass dry and desertified mountain steppes, dwarf semi-shrub bunch-grass desert mountain ones. The higher (upper) mountain steppes are specific for their floristic and phytocoenotic composition, so they have not any analogues among the plain types.

Taking into account the orographic position of steppe communities, the mountains' types of steppes and the lower mountain ones can be distinguished in addition to the higher mountains ones. Depending on zonal position of mountain's feet these orographic types are represented by the different ecological types. For example, in the eastern and south-eastern part of the Khentei Mts. in the mountains and in the lower mountains the meadow and bunch-grass rich in herbs steppes are usual while in Mongolian Altai on the same height the dry bunch-grass steppes and desertified ones predominate.

It is difficult to distinguish the formations, which are unique only to the certain altitudinal belts or subbelts. Mention may be made of the syntaxa within the formation that is classes or groups of associations, which are connected with some subbelt. These syntaxa are always characterised by the presence of so called "differential" species, which have the sufficiently narrow ecological amplitude and do not come out of the certain sub-belts (KARAMYSHEVA, 1981; KARAMYSHEVA, VOLKOVA, RACHKOVSKAJA, *et al.*, 1987). Widely distributed in Mongolian mountains' formation of fescue (*Festuca lenensis)* is a good illustration for this idea. The communities of *Festuca lenensis* grow everywhere from higher mountains to low ones. The cryophilous or cryoxerophilous species are typical for the higher mountain *Festuca lenensis* steppes. As a rule these species are absent in the mountain and lower mountain steppes.

More narrow ecological diapason is peculiar for such formation as *Festuca kryloviana*; its communities grow chiefly in higher mountain, or *Helictotrichon altaicum*, the basic areas of which are in the middle mountains. The communities of *Agropyron nevskii, Festuca tschujensis* and some others are spread only in lower mountains, submountaines and on low hills (sopki).

The mountains exert influence not only on the altitudinal regularity of vegetation on the slopes. The distribution of vegetation cover on the plains adjoining mountains and on the inner-mountain hollows also is directly related to the mountain's influence. For instance, the effect of the Greater Khingan Mts. is observed on the submountain plains, which are spaced at 100–150 km westward from it. Some subzonal types of steppe, namely dry bunch-grass, forb–bunch-grass and meadow ones successively replace one another in meridional direction from west to east with increasing the altitude from 600 up to 900 m above sea level. The soil scientists (LIVEROVSKII, KORNBLJUM, 1960), who have noticed such regularities for the first time, explained them by indirect influence of mountains and have named them "the submountain-humid zonality".

In the Khangai Mts. the altitudinal vegetation changes have even more complicated manifestation (KARAMYSHEVA, BANZRAGCH, 1977). The replacing of the zonal types on the intermountain plains situated on different altitudes and the replacing of the altitudinal steppes types on the slopes of the separate mountain massifs go together.

The climate inversions, appearing in the pans are also of great influence on the regularities of steppe vegetation. They lead to the penetration of more xerophytic communities to the north. However, the bottoms in more closed and high elevated pans situated in mountains are partly covered with higher mountain cryophytic steppes, which are lower here than usually. Such phenomena are peculiar, for instance, to the intermountain valleys in Khangai, where the perma frost grounds are distributed.

EDAPHIC REGULARITIES

The features of the steppe vegetation depending on the edaphic peculiarities that is the vegetation differentiation of the landscape significant are to be mentioned. In Mongolia the mosaic (complexity) of vegetation cover caused by soil salinity is almost absent, and halophytic steppe communities are rare. They are located mainly in the Ubsu-Nur Pan and the Barun Khurai Hollow. However in true – forb bunch-grass, bunch–grass dry steppes and desertified – dwarf semi-shrub–bunch-grass one the complex of vegetation (mosaic) communities has the broad distribution because of the burrowing rodents activity (LAVRENKO, 1952; GURICHEVA, DMITRIEV, 1983; DMITRIEV, KHRAMTSOV, 1994; KHRAMTSOV, DMITRIEV, 1995). The effect of rodents on steppe is similar in some ways to that caused by grazing of domesticated ungulates.

Rather small areas are also under the psammophytic steppes. They are concentrated around sand massifs especially at the west of Big Lake Pan, where primitive plant aggregations of psammophilous grasses, forbs and dwarf semi-shrubs mainly *Artemisia* grow. The communities of hemipetrophytic and petrophytic steppes are on the rocks with different lithology. There is a great diversity of these communities.

MAIN ZONAL AND ALTITUDINAL TYPES OF STEPPES

The list of the main zonal and altitudinal types of steppes is maked up on the basis of the legend to the vegetation map of MPR (KARAMYSHEVA, DASHNJAM, 1990). The information by E. I. RACHKOVSKAJA and E. A. VOLKOVA is used for the territories of the Gobi Altai, the central and eastern parts of Mongolian Altai Mts. and the desert steppes.

The Latin names of plant communities are composed in the following order: Latin names of the dominants and codominants are transfed in the first place. They are united by symbol "–". Further the groups of the so called "differential" species with the special ecology and (or) geography are adduced.

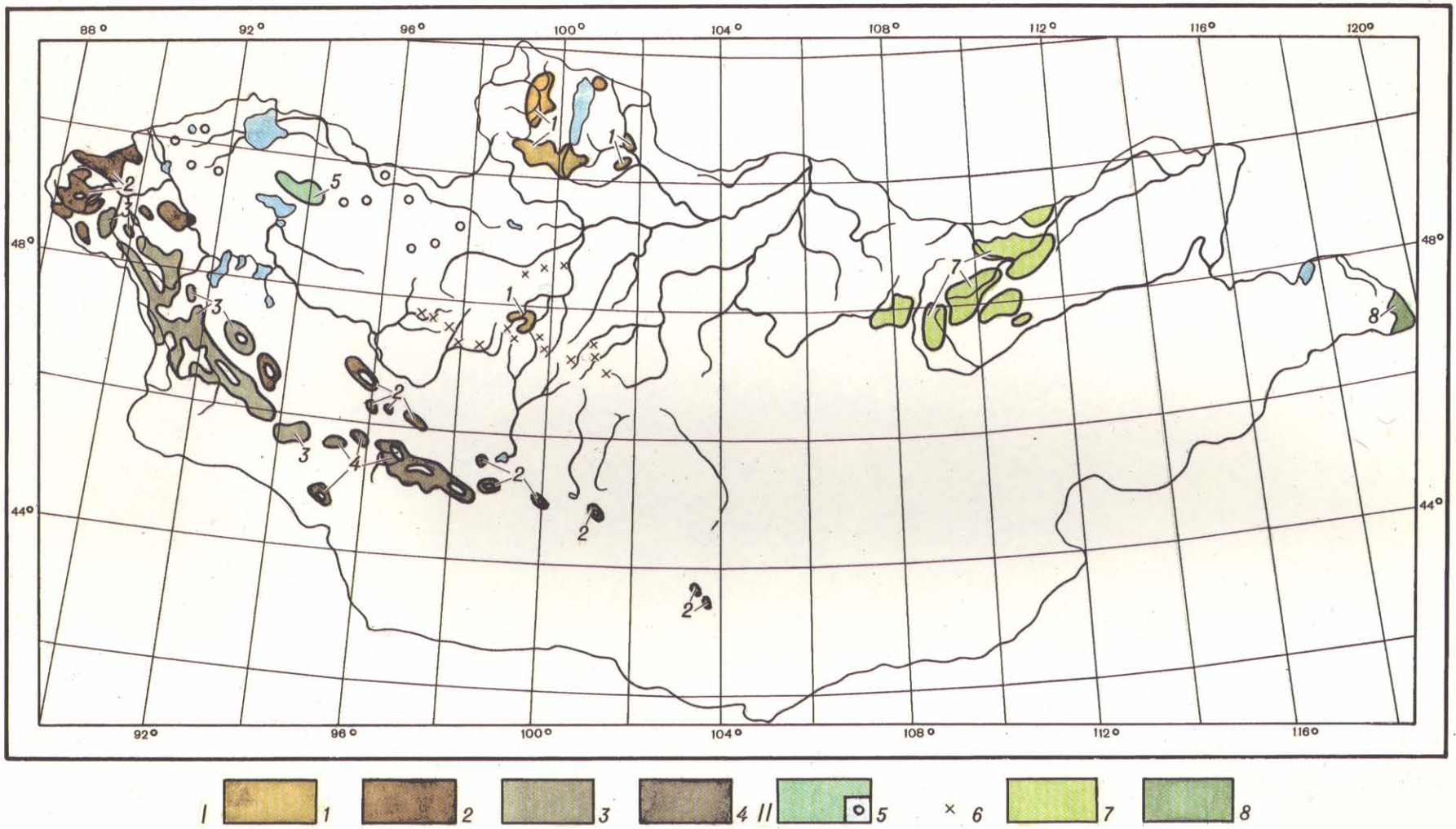

Fig. 12. I. Distribution of the cryoxerophytic forb–bunch-grass and cushion forb–bunch-grass higher mountain steppes: *1.* Darkhan Hollow and Central Khangaian; *2.* Khangaian, Mongol Altaian and Gobi Altaian; *3.* Central Mongol Altaian; *4.* Mongol Altaian and Gobi Altaian; II. Distribution of the forb–grass, grass–forb and forb–sedge meadow steppes: *5.* West Khangaian and North-Eastern Mongol Altaian; *6.* Khangaian; *7.* East Khenteian; *8.* Cis-Khinganian.

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I. CRYOXEROPHYTIC FORB–BUNCH-GRASS AND CUSHION FORB–BUNCH-GRASS STEPPES (fig. 12, I)[4]

HIGHER MOUNTAIN

1. **Festuca lenensis–Kobresia filifolia** communities with cryophilous grasses (*Festuca kryloviana, Helictotrichon mongolicum*), forbs (*Potentilla nivea, Saussurea schanginiana, Thalictrum alpinum, Leontopodium ochroleucum, Saxifraga sibirica*) and sedge (*Carex rupestris*).
2. **Festuca lenensis** or mixed bunch-grass **Festuca lenensis–F. kryloviana–Poa attenuata** communities with *Kobresia myosuroides* and cryophilous forbs (*Oxytropis oligantha, O. chionophyla. Saussurea leucophylla. S. saichanensis, Potentilla nivea*).
3. **Festuca lenensis** or mixed bunch-grass **Festuca lenensis–Poa attenuata–Agropyron cristatum** communities with cushion (*Stellaria pulvinata*) and cryophilous forbs (*Draba pygmaea, Potentilla nivea*).
4. **Festuca lenensis–Agropyron cristatum** communities with *Kobresia humilis, Artemisia argyrophylla*, cryophilous sedges (*Carex rupestris, C. pseudofoetida*) and forbs (*Oxytropis chionophyla*).

II. FORB–GRASS, GRASS–FORB AND FORB–SEDGE MEADOW STEPPES (fig. 12, II)

MOUNTAIN

5. **Helictotrichon altaicum–Carex pediformis** communities rich in xeromesophylous forbs (*Trifolium lupinaster, Scabiosa ochroleuca, Coluria geoides*) and shrubs (*Spiraea hypericifolia, Dasiphora fruticosa*); **Festuca valesiaca–Helictotrichon altaicum–Stipa sibirica** communities rich in petrophilous forbs (*Sedum hybridum, Gypsophila patrinii*) and shrubs (*Dasiphora fruticosa, Spiraea hypericifolia*); **Stipa zalesskii–Carex pediformis** communities rich in forbs (*Coluria geoides, Schizonepeta multifida, Polygonum angustifolium, Thalictrum petaloideum*).
6. **Stipa baicalensis** communities rich in mesoxerophilous and xeromesophilous forbs (*Scabiosa comosa, Chrysanthemum zawadskii, Oxytropis nitens*) and grasses (*Helictotrichon schellianum, Festuca sibirica, F. kryloviana*).

MOUNTAIN AND LOWMOUNTAIN

7. **Filifolium sibiricum** communities, **Carex pediformis** communities, **Stipa baicalensis** communities rich in xeromesophilous forbs (*Polygonum divaricatum, Stellera chamaejasme, Iris dichotoma, Hemerocallis minor, Scutellaria baicalensis, Saposhnikovia divaricata, Clematis hexapetala*) and shrubs (*Armeniaca sibirica*).

SUBMOUNTAIN

8. **Helictotrichon schellianum–Stipa baicalensis– S. sibirica** and **Filifolium sibiricum** communities rich in xeromesophilous forbs (*Sanguisorba officinalis, Adenophora stenanthina, Chrysanthemum chalchingolicum, Polygonum valerii, Euphorbia pallasii, Paeonia lactiflora*) and shrubs (*Armeniaca sibirica*).

III. FORB–BUNCH-GRASS AND CAESPITOSE FORB STEPPES (fig. 13)

MOUNTAIN

9. **Helictotrichon altaicum** communities rich in mesoxerophilous forbs (*Scabiosa ochroleuca, Phlomis tuberosa, Schizonepeta multifida, Coluria geoides, Onosma transrhymnense*) and shrubs (*Spiraea hypericifolia*).
10. Mixed bunch-grass **Festuca lenensis–Poa attenuata–Koeleria macrantha–Agropyron cristatum** communities with *Artemisia monostachya*, mesoxerophilous and petrophilous forbs (*Silene repens, Clausia aprica, Arenaria capillaris, Amblynotus rupestris, Alyssum lenense*).
11. Mixed bunch-grass **Helictotrichon altaicum–Festuca valesiaca–Stipa sibirica** communities with *Artemisia dolosa*, mesoxerophilous and petrophilous forbs (*Aster alpinus, Coluria geoides*).
12. **Koeleria macrantha** communities with *Artemisia frigida*, mesoxerophilous and petrophilous forbs (*Aster alpinus, Oxytropis filiformis*).
13. **Festuca lenensis** or mixed bunch-grass **Festuca lenensis–Poa attenuata–Koeleria macrantha–Agropyron cristatum** communities with *Artemisia commutata*, mesoxerophilous and petrophilous forbs (*Potentilla sericea, Oxytropis nitens, O. filiformis*, on the east – *Stellera chamaejasme*).
14. **Poa attenuata** or mixed bunch-grass **Poa attenuata–Festuca lenensis–F. sibirica–Helictotrichon schellianum** communities with *Carex pediformis*, rich in forbs (*Scabiosa comosa, Gypsophila dahurica, Polygonum angustifolium*, on the east – *Filifolium sibiricum*).

SUBMOUNTAIN, COLLINE AND LOWLAND

15. **Filifolium sibiricum** or **Filifolium sibiricum**–mixed bunch-grass **Stipa baicalensis–Koeleria mukdenensis–Cleistogenes kitagawae** communities rich in mesoxerophilous and xeromesophylous forbs (*Polygonum divaricatum, Lespedeza dahurica, Hemerocallis minor, Clematis hexapetala, Iris dichotoma*) and shrub (*Armeniaca sibirica*):

    a. psammophytic forb (*Euphorbia mandshurica, E. pallasii, Pimpinella thellungiana*) communities alternating with shrub (*Armeniaca sibirica, Ulmus japonica, Salix gordejevii, S. microstachya*) communities; **Artemisia halodendron** communities and psammophilous forb (*Oxytropis gracillima, Vincetoxicum sibiricum, Clematis aethusifolia*) communities;

    b. petrophytic **Festuca lenensis** communities and **Stipa baicalensis–S. sibirica** communities with mesoxerophilous and petrophilous forbs (*Cerastium arvense, Clausia aprica, Artemisia latifolia, Filifolium sibiricum*).
16. **Stipa krylovii–S. baicalensis** communities and **Stipa krylovii–Leymus chinensis** communities with mesoxerophilous forbs (*Bupleurum scorzonerifolium, Galium verum, Astragalus melilotoides, Allium* sp.div.).

IV. BUNCH-GRASS AND RHIZOMATOUS GRASS DRY STEPPES (fig. 14)

MOUNTAIN

17. **Festuca lenensis -Agropyron cristatum** communities with xerophilous and petrophilous forbs (*Krylovia eremophila, Peucedanum hystrix, Dracocephalum origanoides*).
18. **Agropyron cristatum** communities with xerophilous and petrophilous forbs (*Arenaria meyeri, Allium eduardii, Potentilla sericea*).

[4] The colour figures 12–16 are in the end of paper.

LOWMOUNTAIN, SUBMOUNTAIN AND LOWLAND

19. Mixed bunch-grass **Stipa krylovii–Cleistogenes squarrosa–Koeleria macrantha** communities with xerophilous forbs (*Sibbaldianthe adpressa, Haplophyllum dauricum, Astragalus galactites, Convolvulus ammanii*) and shrubs (*Caragana microphylla, C. stenophylla*):

a. hemipsammophytic **Cleistogenes squarrosa–Poa botryoides–Leymus chinensis** communities; **Stipa krylovii–S. grandis** communities with shrubs (*Caragana microphylla*) and wormwoods (*Artemisia scoparia, A. frigida*);

b. petrophytic **Stipa krylovii–Agropyron cristatum** communities partly **Festuca lenensis** communities with petrophilous forbs (*Arenaria capillaris, Arctogeron gramineum, Thymus gobicus, Caryopteris mongholica*) and shrubs (*Caragana microphylla, C. pygmaea*).

20. Mixed bunch-grass **Stipa capillata–Festuca valesiaca** communities partly in complex with **Artemisia schrenkiana, Potentilla acaulis** communities:

a. petrophytic **Stipa kirghisorum–S. orientalis–Psathyrostachys juncea** communities with petrophilous forbs (*Melandrium viscosum, Alyssum lenense*) and shrubs (*Spiraea hypericifolia*).

21. Mixed bunch-grass **Stipa krylovii–Koeleria macrantha–Poa botryoides** communities with wormwoods (*Artemisia frigida, A. changaica*), xerophilous forbs (*Cymbaria dahurica, Potentilla acaulis*) and shrubs (*Caragana bungei*):

a. hemipsammophytic and psammophytic **Cleistogenes squarrosa–Stipa krylovii** communities with psammophilous forbs (*Vincetoxicum sibiricum, Iris tenuifolia*) and shrubs (*Caragana bungei*);

b. petrophytic **Festuca valesiaca** communities; **F. tschujensis** communities; **Agropyron nevskii** communities with wormwoods (*Artemisia obtusiloba, A. dolosa*), petrophilous forbs (*Arenaria capillaris, Saussurea pricei, Allium eduardii*) and shrubs (*Caragana bungei, Berberis sibirica*).

22. Mixed grass **Stipa krylovii–Leymus chinensis–Koeleria macrantha–Cleistogenes squarrosa–Poa botryoides** communities with xerophilous forbs (*Heteropappus altaicus, Sibbaldianthe adpressa*) and shrubs (*Caragana microphylla, C. stenophylla*).

V. BUNCH-GRASS AND DWARF SEMI-SHRUB–BUNCH-GRASS DESERTIFIED STEPPES (fig. 15)

MOUNTAIN

23. **Agropyron cristatum–Festuca valesiaca** communities with **Artemisia gracilescens** and xerophilous forbs (*Gypsophila dshungarica*, etc.).

24. **Agropyron nevskii–Stipa glareosa–Artemisia frigida** or **Stipa glareosa** communities with shrub (*Caragana bungei*) partly with *Eurotia ceratoides.*

25. **Stipa gobica–Agropyron cristatum–Artemisia frigida** communities with petrophilous forbs and dwarf semi-shrubs (*Arenaria capillaris, Saussurea pricei, Ajania fruticulosa*).

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26. **Stipa glareosa–S. sareptana–Cleistogenes squarrosa–Nanophyton erinaceum** communities partly in complex with **Artemisia schrenkiana** communities.

27. **Stipa glareosa–S. krylovii–Agropyron cristatum** communities with *Asterothamnus heteropappoides* partly with *Eurotia ceratoides*:

a. hemipsammophytic **Cleistogenes squarrosa–Stipa glareosa** communities with hemipsammophilous forbs (*Serratula centauroides, Astragalus brevifolius, Ephedra sinica*) and shrubs (*Caragana bungei*);

b. psammophytic forb (*Vicia costata, Hedysarum fruticosum, Iris tenuifolia, Allium mongolicum*) communities; wormwood (*Artemisia klementzae*) communities; bunch-grass **Stipa glareosa–Cleistogenes squarrosa** communities with *Caragana bungei*;

c. petrophytic mixed bunch-grass **Stipa glareosa–S. sibirica–S. krylovii–Agropyron nevskii** communities with wormwoods (*Artemisia rutifolia, A. santolinifolia*), petrophilous forbs (*Allium eduardii, Lophanthus chinensis*) and shrubs (*Caragana bungei, Berberis sibirica, Amygdalus pedunculata*).

29. **Stipa krylovii–S. klemenzii–Cleistogenes squarrosa** communities

30. **Stipa klemenzii–S. gobica–Cleistogenes squarrosa–Artemisia frigida** communities.

31. **Stipa gobica–S. glareosa–Cleistogenes songorica–Artemisia frigida** communities with shrubs (*Caragana leucophloea*):

a. petrophytic mixed bunch-grass **Stipa klemenzii–S. gobica–S. krylovii–Agropyron cristatum** communities; dwarf semi-shrub and wormwood (*Artemisia rutifolia. A. santolinifolia, Thymus gobicus, Dracocephalum foetidum*) communities with shrubs (*Caragana leucophloea*).

VI. DWARF SEMI-SHRUB–BUNCH-GRASS DESERT STEPPES (fig. 16)

LOWMOUNTAIN

32. **Agropyron nevskii–Stipa glareosa–Eurotia ceratoides** communities with shrubs (*Caragana leucophloea*).

33. **Stipa glareosa–Eurotia ceratoides** communities with *Ajania achilleoides* and *A. fruticulosa.*

SUBMOUNTAIN, COLLINE, LOWLAND AND HOLLOW

34. **Stipa glareosa–Artemisia gracilescens** communities in complex with **Stipa glareosa–Nanophyton erinaceum** communities.

35. **Stipa glareosa–Anabasis brevifolia** communities:

a. hemipsammophytic **Stipa glareosa–Artemisia xerophytica–A. xanthochroa–Eurotia ceratoides** communities with *Asterothamnus heteropappoides* and shrubs (*Caragana bungei*);

b. psammophytic **Psammochloa villosa** communities; **Leymus racemosus** communities; **Cleistogenes squarrosa** communities with psammophilous wormwoods (*Artemisia sphaerocephala, A. xanthochroa*), forbs (*Echinops gmelinii, Chamaerhodos sabulosa*), dwarf semi-shrubs (*Hedysarum fruticosum*) and shrubs (*Caragana bungei*);

c. petrophytic **Stipa glareosa–Anabasis brevifolia–Chenopodium frutescens** communities; **Agropyron nevskii–Eurotia ceratoides** communities with petrophilous forbs (*Lagochilus ilicifolius, Zygophyllum pterocarpum*) and shrubs (*Caragana bungei, C. leucophloea, Amygdalus pedunculata*).

36. **Stipa glareosa–Stipa gobica–Anabasis brevifolia** communities partly with *Allium polyrrhizum*:

a. hemipsammophytic **Stipa gobica–S. glareosa–Artemisia xerophytica communities**;

b. petrophytic **Stipa gobica–S. glareosa–Anabasis brevifolia** communities with *Ajania fruticulosa* and *Zygophyllum pterocarpum.*

37. **Stipa gobica–S. glareosa–Ajania fruticulosa** communities;

a. petrophytic **Stipa gobica–S. glareosa–Ajania fruticulosa–A. achilleoides** communities with petrophilous forbs (*Lagochilus ilicifolius, Scorzonera capito*).

38. **Stipa gobica–Stipa glareosa–Salsola passerina** communities;

a. hemipsammophytic and psammophytic **Stipa gobica–Stipa glareosa–Caragana korshinskii** communities; **Psammochloa villosa** communities.

I. CRYOXEROPHYTIC FORB–BUNCH-GRASS AND CUSHION FORB–BUNCH-GRASS HIGHER MOUNTAIN STEPPES (fig. 12: *1–4*)

These steppes are the peculiar communities dominated by higher mountain and mountain steppe grasses. Some species of cryoxerophilous forbs and dwarf semi-shrubs, that often have the form of dense low cushion are typical of such communities.

B. B. POLYNOV and I. M. KRASHENINNIKOV (1926) were the first scientists, who briefly described the "alpine" steppes in the Mongolian mountains. A. A. YUNATOV although had used this term for such communities nevertheless made a reservation, that the Mongolian "droughty climate makes the full expression of alpine and subalpine vegetation there impossible" and therefore "the above mentioned analogy may be assumed to a certain degree" (YUNATOV, 1950:76). B. A. YURTSEV (1974, 1978, 1981, etc.) has investigated in detail the cryoxerophytic tundra-steppe communities in boreal and tundra regions of north-eastern Asia and has given the proofs of intimate connections between these communities and the Mongolian higher mountain steppes.

The large areas of these steppes are distributed on the highest ranges of Mongolian Altai (KARAMYSHEVA, 1982, 1986, 1988; KARAMYSHEVA, VOLKOVA, RACHKOVSKAYA *et al.*, 1987; VOLKOVA, 1994) and Gobi Altai (VOLKOVA, 1994) and also on the massifs of Southern Khangai (KARAMYSHEVA, BANZRAGCH, 1976b, 1977). In intermountain pans for instance, in the Darkhan one the cryoxerophytic steppes grow on the lower hypsometric level (2200-2550 m). They are related with mountain steppe rough-humus soils.

The higher mountain *Festuca lenensis – Kobresia filifolia* steppes in the Darkhan hollow and on the intermountain plains on the northern macroslope of the Khangai Mts. (fig. 12: *1*) are characterised by poorness of the cryoxerophilous and xerophilous forbs, but always rich in *Kobresia filifolia* and *K. myosuroides* (Table II: *1*). In such communities the cryogenic forms of micro- and nanorelief are well defined.

In Khangai, in Mongolian and Gobi Altai the higher mountain steppes are distributed at 2500–3200 m above sea l. (fig. 12: *2*). They represent by the communities of *Poa attenuata, Festuca lenensis, F. kryloviana* formations, but more often by the mixed bunch-grass communities. Such cryophilous species and cryoxerophilous ones as *Oxytropis oligantha, O. chionophyla, Arenaria capillaris, Smelovskia alba, Potentilla nivea, Saussurea saichanensis, S. schanginiana, S. leucophylla, Trifolium alpinum, T. eximium, Clausia aprica*, etc. are especially typical for these steppes (Table II: 2, *3*).

The higher mountain steppes of Mongolian Altai are characterised by abundance of *Artemisia argyrophylla.* Cushion forb–bunch-grass steppes are typical for the Mongolian Altai also (fig. 12: *3*). *Stellaria pulvinata* (Gobi endemic, GRUBOV, 1972), that cushions are often 17–20 and over sm. prevail in these communities (Table II: *4*).. The arcto-alpine species *Carex rupestris* or *Carex macrogyna* also could be met in the higher mountain steppes. Physiognomically such steppes are similar to the higher mountain steppes of the Pamirs and Tian Shan. Cushion forb–bunch-grass steppes are related with the highest parts of central massifs of Mongolian Altai, but they are also distributed in the isolated range Dzhargalant-Ula on 2650 m ab. s. l. and higher (KARAMYSHEVA, BUJANORSHYKH, BEKET *et al.*, 1984). Higher mountain steppes are usually combined with *Kobresia myosuroides* or *K. smirnovii* communities (the latter only in Mongolian Altai), with *Carex stenocarpa, C. melanocarpa* and shrub thickets (*Dasiphora fruticosa, Salix glauca, Lonicera altaica*, etc.).

Festuca lenensis–Agropyron cristatum communities with *Artemisia argyrophylla, Oxytropis chionophyla, Carex rupestris, C. pseudofoetida* or *Kobresia humilis* are rather broadly presented in the granit massifs in Mongolian Altai (fig. 12: *4*).

II. FORBS–GRASS, GRASS–FORB AND FORB–SEDGE MEADOW STEPPES (fig. 12: *5–8*)

The ultracontinental climate and comparatively short period of active growth do not favour to the broad distribution of meadow steppes in East Siberia-Central Asian sector. They occur mainly in the east and the west of Mongolia: in Western Khangai and on the north-eastern macroslope of Mongolian Altai. In the south-western part of Mongolian Altai they distribute in the Yelt-Gol and Songint-Gol rivenes, situated in the Black Irtysh basin. They are also found in the south-eastern and eastern Khentei Mts. especially on the Eren-Daba Range and in the western submountain of the Greater Khingan Mts. The meadow steppe are not rare in Central Khangai, where they grow more often on the inner warmest southern slopes and sometimes on the northern slopes.

Meadow steppes are the least xerophytic amongst the all zonal and altitudinal steppe types. They are characterised by the euryxerophilous, mesoxerophilous, xeromesophilous, and mesophilous species of grasses, sedges and forbs. They have the richest floristical composition. Species diversity is the maximum among the steppes (up to 70 and more species on 1 are). The grass canopy of the meadow steppes is the thickest (up to 50–60 and upward) and the foliage cover is very dense (with moss cover 95 % and upward).

The meadow steppes belong to the following formations: *Stipa baicalensis. S. zalesskii, Festuca kryloviana, F. lenensis, Helictotrichon altaicum, H. schellianum, Carex pediformis, Filifolium sibiricum* and mixed forb–grass and grass–forb communities. They are represented both by the plain types and the mountain ones and are related with meadow chernozem and chernozem soils.

West Khangaian and North Eastern Mongolian Altai meadow steppes (fig. 12: *5*) are described in some detail in the Khan-Khukhiin-Ula Range (KARAMYSHEVA, BANZRAGCH, 1976b), in the Tsagan-Shibetu, Turgen and Kharkhira massifs (Mongolian Altai). Meadow steppes in Khan-Khukhiin-Ula

are represented mainly by the communities of three formations – *Helictotrichon altaicum, Festuca kryloviana* and *Carex pediformis*, which both are rich in forbs (Table III: *1–3,5,7*). They are found at 1450–1550 m. The mesophilous meadow species (*Sanguisorba officinalis*), xeromesophilous meadow-steppe species and steppe (*Trifolium lupinaster, Scabiosa ochroleuca, Polygala hybrida, Polygonum alpinum, Schizonepeta multifida*, etc.) ones prevail in these communities; there are many petrophilous species (*Veronica incana, Orostachys spinosa, Sedum hybridum, Cerastium arvense, Gypsophila patrinii*, etc.) among them. These steppes are distinguished by the presence and often prevalence of *Coluria geoides* (East Kazakhstan–South Siberia–West Mongolian sp.) among the forbs. Besides Khan-Khukhiin-Ula this species grows in the north-eastern part of Mongolian Altai and penetrates eastward up to the western part of the Tarbagatai Range. The considerable role among the grasses belongs to the loose tuft plant *Helictotrichon schellianum* and *Hierochloë odorata*, as well as to *Carex pediformis*, which sometimes predominates in the grass stand.

On the southern slopes of Khan-Khukhiin-Ula the petrophytic meadow steppes are distributed. In addition to the usual meadow steppe grasses (*Helictotrichon altaicum, Festuca valesiaca* etc.) the petrophilous grasses (*Leymus gmelinii*) and numerous petrophilous forbs (*Silene repens, Dianthus versicolor, Sedum hybridum, Orostachys spinosa*, etc.) are widely spread there. As a rule these steppes are combined with shrub thickets (*Dasiphora fruticosa, Cotoneaster melanocarpa, Lonicera microphylla, Berberis sibirica*) and petrophytic communities with *Leymus gmelinii, L. sibiricus* and other grasses.

The meadow *Stipa zalesskii* steppes, which are very rare in Mongolia, are found in Khan-Khukhiin-Ula (BANZRAGCH, KARAMYSHEVA, MUNKH-BAJAR, *et al.*, 1975) (Table III: *6*). The large bunch-grasses (*Stipa zalesskii, S. capillata, Festuca valesiaca, Helictotrichon altaicum*) combine with the rhizomatous and loose tuft ones (*Helictotrichon schellianum, Phleum phleoides, Hierochloë odorata*). The forbs are numerous (more than 40 species on 1 are) and ecologically diverse. Xeromesophilous meadow steppe species and steppe ones (*Trifolium lupinaster, Scabiosa ochroleuca, Thalictrum petaloideum, Senecio campester, Polygala hybrida, Polygonum angustifolium*, etc.) prevail. There is a small amount of mesophilous plants (*Rumex acetosella*, etc.).

For the Central- and Eastern Khangaian meadow steppes the communities of *Stipa baicalensis* formation (Table IV: *1–4*), *Festuca lenensis* (Table III: *8, 9*), *Festuca kryloviana* (Table III: *4*), *F. sibirica, Carex pediformis* ones are the most typical. The detail description of the East Khangaian steppe was made by I. A. BANNIKOVA (LAVRENKO, BANNIKOVA, 1983, 1986). These steppes as well as West Khangaian and North Eastern Mongolian Altaian ones are very rich in their floristic composition. In addition to the bunch grasses mentioned above there are also loose-bunch grasses (*Helictotrichon schellianum, Koeleria macrantha, Leymus gmelinii*, etc.) and rhizomatous grasses (*Bromus inermis*, etc.). The xeromesophilous forbs that is the tap root plants (*Bupleurum scorzonerifolium, Leuzea uniflora, Scabiosa comosa, Polygonum angustifolium, Oxytropis myriophylla*, etc.) and rhizomatous ones (*Galium verum, Scutellaria scordiifolia*, etc.) are also typical. The annual forbs: *Gentiana acuta* (*G. amarella*), *Halenia corniculata*, etc. are particularly abundant. *Chrysanthemum zawadskii, Oxytropis nitens* often predominate over the forbs.

The petrophytic types of Khangaian steppes are characterised by prevalence of *Festuca lenensis* (Table III: *8, 9*).

The meadow steppes in Eastern Khentei represent mainly the communities of *Festuca lenensis* formation, *Helictotrichon schellianum, Carex pediformis* (Table III: *10*), *Stipa baicalensis* and especially *Filifolium sibiricum* ones (Table IV: *5–8*). The steppes with similar composition occur also in western submountains of the Greater Khingan Mts. and in the low mountains of Eastern Mongolia. *Sanguisorba officinalis, Trifolium lupinaster, Valeriana officinalis*, and other species which are widely distributed in meadow steppe of Western Siberia, play a considerable phytocoenotic role in the vegetation composition. But such Dahuria-Mongolian, Siberia-Mongolian, East Siberia–Far Eastern species as *Hemerocallis minor, Clematis hexapetala, Thalictrum squarrosum, T. petaloideum, Lilium pumilum, Bupleurum scorzonerifolium, Polygonum angustifolium, Stellera chamaejasme, Lespedeza dahurica, L. hedysaroides*, etc. prevail. The shrubs *Dasiphora fruticosa, Armeniaca sibirica, Spiraea aquilegifolia*, etc. are also typical.

On the foothills of Greater Khingan (fig. 12: *8*) besides of *Filifolium sibiricum* meadow steppes (Table IV: *7*), the forb–grass and grass–forb steppes (*Helictotrichon schellianum, Stipa baicalensis, S. sibirica, Carex pediformis, Adenophora stenanthina, Filifolium sibiricum, Sanguisorba officinalis, Polygonum valerii, P. divaricatum*) with abundance of Manchzhurian elements prevail there. The Manchzurian species are *Euphorbia pallasii, Iris dichotoma, Paeonia lactiflora, Chrysanthemum chalchingolicum*, etc. They are combined with *Armeniaca sibirica* thickets. The steppes with similar composition occur on the submountain of Eastern Khentei (Table IV: *6–8*).

III. FORB–BUNCH-GRASS AND CAESPITOSE FORB STEPPES (fig. 13)

These steppes belong to the typical or true steppes. They are distinguished by dominance of the grasses more xerophilous (euxerophilous and mesoxerophilous) and by lower abundance of forbs, which are of a more xerophilous character then those in the meadow steppes. The species diversity becomes poor: the amounts of plants on 1 are does not exceed 40–50; the total projective cover degree (foliage cover) is 50-60 %. These steppes are related with southern type of chernozems and with the dark chestnut soils.

Forbs–bunch-grass steppes are broadly distributed in the Central Asian subregion. They occur in the mountain massifs of Mongolian Altai, in Khangai, in the plains of Eastern Mongolia and in the submountain parts of Greater Khingan. In the mountains they constitute the well-pronounced sub-belt in the steppe altitudinal belt. Forbs–bunch-grass steppes belong to the following formations: *Helictotrichon altaicum, Festuca lenensis, Koeleria macrantha, Poa attenuata, Filifolium sibiricum, Stipa krylovii.* The mountain types are usually represented by the mixed bunch-grass communities.

East Kazakhstan–West Mongolian forb–bunch-grass steppes (fig. 13: *9*), as well as the meadow ones of the corresponding geographical type, contain many species, which basic areas stretch in the more western territories of the Eurasian Steppe Region. Some of them, for example *Helictotrichon altaicum* (North Tian-Shan–East Kazakhstan–Altaian sp.), *Festuca valesiaca* (West Palaearctic sp.), *Stipa capillata* (West-Palaearctic sp.) are among the dominants. These steppes are located in the West Mongolian mountains, namely, in the Tsagan-Shibetu, Turgen massifs (Mongolian Altai) and western Khangai (the Khan-Khukhiin-Ula Range). In these montains they are located at 1350–1500 m on the northern slope and at the

2100–2500 m on the southern one (Table V:*1*).

In Mongolian Altai (fig. 13: *10*) there is a special sub-belt (2500–2700 m ab. s. l.) with the forb–bunch-grass steppes. The communities of *Festuca lenensis* formations and *Poa attenuata* one prevail but mainly mixed bunch-grass *Festuca lenensis–Poa attenuata–Koeleria macrantha–Agropyron cristatum* communities predominant. The mesopetrophilous and xerophilous forbs and dwarf semi-shrubs (*Arenaria capillaris, Krylovia eremophila, Orostachys spinosa, Potentilla sericea, Clausia aprica, Astragalus brevifolius, Saussurea pricei, Silene repens, Leontopodium ochroleucum, Veronica pinnata, Amblynotus rupestris, Smelovskia alba,* etc.) are abundant in these communities (Table VI: *1*). *Artemisia monostachya* is also typical.

Forb–bunch-grass steppes in the Western and Central Khangai (fig. 13: *11–13*) occur at 1500–1700 m ab. s. l. Typical Khangaian steppes (fig. 13: *13;* Table VI: *2, 3*) are physiognomically similar to the Mongolian Altai ones, but they differ in the forbs composition. *Oxytropis nitens, O. filiformis, Scabiosa comosa, Arctogeron gramineum, Bupleurum scorzonerifolium, Artemisia dolosa, Peucedanum histrix, Stellera chamaejasme,* etc. are abundant. The latter species is in the Eastern Khangaian steppes only. The communities of *Festuca lenensis* with *Artemisia frigida, Thymus gobicus, Arctogeron gramineum, Androsace villosa, Arenaria capillaris, Chamaerhodos altaica, Pulsatilla turczaninovii* and other petrophilous species occur on the gravelly deposits on the southern slopes (Table VI: *4*). I. A. BANNIKOVA (LAVRENKO, BANNIKOVA, 1983, 1986) has described these Eastern Khangaian communities in details.

In Western Khangai (fig. 13: *12*) the *Koeleria macrantha* steppes with *Artemisia frigida, Aster alpinus, Oxytropis filiformis* and other mesoxerophilous and petrophilous species are distributed (Table VI: *5*).

Some West Khangaian steppes (fig. 13: *11*; Table V: 2) are notable for their floristic composition as they are "transitional" between East Kazakhstan–West Mongolian and the proper Khangaian ones. A number of "western" species plays the considerable phytocoenotic role in these steppes.

In South-Western Khentei (fig. 13: *14*) bunch-grass steppes rich in forbs make a special sub-belt on the northern slopes at 1500–1700 m ab. s. l. Their floristic composition is diverse (more than 40 sp. on 1 are). The grass stand is constituted mainly by *Poa attenuata* (Table VI: *6*), but there are also such species, as *Koeleria macrantha, Festuca lenensis, F. sibirica, Helictotrichon schellianum, Carex pediformis, Artemisia frigida, A. commutata,* etc. (Table V: *3;* Table VI: *7*). Among forbs *Scabiosa comosa, Aster alpinus, Arctogeron gramineum, Polygonum angustifolium, Medicago ruthenica, Thalictrum petaloideum, Rheum undulatum, Arenaria capillaris, Bupleurum scorzonerifolium, Gypsophila dahurica,* at east – *Filifolium sibiricum,* etc. prevail.

The vegetation of low mountains in Middle Khalkha is characterised by dominance of *Festuca lenensis* communities (Table VII: *1–6*) and *Stipa baicalensis* communities with forbs and shrubs (Table VIII: *1, 2, 4*).

In East Mongolia (south-eastern submountain of Khentei and western submountain of Greater Khingan) the steppes of the Dahuria-Mongolian and East Mongolian geographical types are distributed (fig. 13: *15, 16*). The communities of *Filifolium sibiricum* formation (Table V: *4–6*) and also communities of *Stipa baicalensis* formation (Table VIII: *3*) are typical for this territory. Dahuria-Mongolian and Manchzhurian species such as *Polygonum divaricatum, Iris dichotoma, Hemerocallis minor, Clematis hexapetala, Scutellaria baicalensis, Saposhnikovia divaricata, Lespedeza dahurica, Stellera chamaejasme* predominate among the forbs.

The vegetation of sandy massifs in the western submountain of Greater Khingan (fig. 13: *15a*) is very interesting. The psammophilous forb (*Euphorbia mandshurica, E. pallasii, Pimpinella thellungiana,* etc.) communities are combined with the shrub thickets (*Armeniaca sibirica, Ulmus japonica, Salix gordejevii, S. microstachya*) and even with open woodlands (*Pinus sylvestris*). The *Festuca dahurica* communities are distributed on the Cis-Khinganian sand plains (Table V: *7*).

On the low hills near Greater Khingan the petrophytic *Festuca lenensis, Stipa baicalensis, S. sibirica* communities are combined with *Armeniaca sibirica* thickets. These steppes are characterised by the abundance of *Thalictrum petaloideum, Filifolium sibiricum, Cerastium arvense, Clausia aprica* and many other petrophilous plants (fig. 13: *15b*).

In East Mongolian steppes (fig. 13: *16*) *Stipa krylovii, S. grandis, S. baicalensis, Leymus chinensis* are as dominants and co-dominants. *Bupleurum scorzonerifolium, Astragalus melilotoides, Galium verum, Allium anisopodium, A. senescens* are particularly abundant among the forbs (Table VIII: *1, 2, 4–7*).

IV. BUNCH-GRASS AND RHIZOMATOUS GRASS DRY STEPPES (fig. 14)

The dry steppes are distinguished by the domination of xerophilous species of bunch grasses and sedges. A low abundance of forbs which are of a more xerophytic character, then those in the communities of the forb–bunch-grass steppes is common to these communities. There is a slight amount of steppe dwarf semi-shrubs (*Artemisia frigida, A. adamsii*; the latter predominantly on the plot with burrowing activity of the soil-inhabiting rodents). Summer-autumn annuals and biennials (*Chenopodium strictum, Dontostemon integrifolius, Chamaerhodos erecta, Artemisia palustris, A. scoparia*) are abundant in these steppes especially during moist years. The shrubs (*Caragana microphylla, C. pygmaea, C. bungei*, etc.) are usual.

Dry steppes are characterised by considerably poor floristic composition, the species diversity does not exceed 30–40 on 1 are; the total cover degree is almost 35–40 %. The communities of the dry steppe are related with dark chestnut soils and chestnut ones.

Mongolian dry steppes represent chiefly by the communities of the following formations: *Stipa krylovii, S. capillata* (the latter only in the west), *Agropyron cristatum, Cleistogenes squarrosa, Leymus chinensis, Festuca lenensis.* The latter is specific to the mountain steppes of Mongolian and Gobi Altai and to the higher hills (*sopki*) of Middle Khalkha. The distribution ranges of dominants and typical species of Mongolian dry steppe, as a rule, do not cross at the west the boundary of the Dahuria–Mongolian subregion of the Eurasian Seppe Region. *Stipa krylovii, Agropyron cristatum* (East Siberia–Mongolian sp.), *Stipa grandis, Caragana stenophylla* (Upper Yenisei–Dahuria–Mongolian sp.), *Allium anisopodium, A. bidentatum, A tenuissimum, Caragana microphylla, C. pygmaea* (Dahuria–Mongolian sp.) prevail in the steppe communities. The numbers of species common with Black Sea–Kazakhstanian steppes are not numerous. *Cleistogenes squarrosa* (the Eurasian steppe sp.) is to be mention amongst them. It illustrates the considerable floristic speciality of the Mongolian dry steppes.

The bunch-grass and rhizomatous grass dry steppes (subzone) occupy the large areas. They distribute on the plains of the Central and East Mongolia from

the Ongiin-Gol River in the west and up to the submountain of Greater Khingan in the east. In the extreme west this stripe is almost absent, while in the east becomes broad and stretches in meridional direction rather deep through the territory of Inner Mongolia (China). There are dry steppe communities in Mongolian and Gobi Altai also where the altitudinal sub-belt of dry steppes is clearly pronounced.

The floristic composition and the structure of vegetation cover change considerably from the south to the north within dry steppe subzone.

Stipa krylovii, Poa attenuata, Cleistogenes squarrosa, Agropyron cristatum, Koeleria macrantha, Leymus chinensis are as the dominants and co-dominants in the northern types of dry steppes. There is rather numerous amount of *Stipa baicalensis* and some species (*Potentilla tanacetifolia, Astragalus melilotoides, Bupleurum scorzonerifolum*, etc.), that are peculiar to the more northern forb–bunch-grass communities. *Stipa grandis* is distributed on the sand soil, *Cleistogenes squarrosa* – on the sandy loam. *Leymus chinensis* dominates on the slightly saline soil.

The typical dry steppes are characterised by the dominance of *Stipa krylovii* and *Cleistogenes squarrosa* amongst the bunch grasses. The forbs are represented by the typical xerophilous species (*Heteropappus altaicus, Cymbaria dahurica, Haplophyllum dauricum, Convolvulus ammanii, Astragalus galactites*, species of onions – *Allium anisopodium, A. bidentatum*).

In the southern types of dry steppes the floristic composition becomes more poor. Only a few species of forbs (*Cymbaria dahurica, Heteropappus altaicus*, etc.) grow there. The most common species are also *Ptilotrichum canescens, Dontostemon integrifolius* and annual species of wormwoods. Some species, which are typical for more southern desertified steppes, penetrate to the gravelly carbonate soils (*Stipa klemenzii*, for example).

The floristic composition of steppes changes also from west to east. In the east the steppes with co-dominance of rhizomatous species *Leymus chinensis* are distributed. In the west some West-Palaearctic species, Black Sea–Kazakhstanian, Middle Asia–Kazakhstan–West Mongolian, Transvolga-Kazakhstan–West Mongolian ones appear as edificators and dominants.

There are rather detail description of plain Mongolian dry steppes in the monograph by A. A. YUNATOV (1950), B. DASHNJAM (1974) and the articles by E. M. LAVRENKO (1978), E. M. LAVRENKO and R. I. NIKULINA (1984). The two volume (LAVRENKO, 1984, 1988) are dedicated to the complex biogeocoenotic analysis of dry steppes.

Let us briefly characterise the main types of dry steppe. The Khanganian, Mongol Altaian and Gobi Altaian dry mountain steppe communities (fig. 14: *17, 18*), which are distributed at 2100 (2300)–2500 m, form a well-pronounced sub-belt in the altitudinal steppe belt. These steppes are distinguished by the dominance of the communities of *Festuca lenensis* formation (Table IX: *1, 2*), *Agropyron cristatum* ones (Table IX: *3*), and *Stipa krylovii* (Table IX: *4, 5*). The second species constitutes the communities that occupy the large areas on the basic ranges of Khangai, Mongolian and Gobi Altai. The presence of xerophilous and xeropetrophilous species (*Krylovia eremophila, Thalictrum foetidum, Peucedanum hystrix*, etc.) is typical for them. On the gravelly soils the phytocoenotic role of petrophilous dwarf semi-shrubs (*Oxytropis tragacanthoides, Ptilotrichum canescens*, etc.) increases. The petrophytic *Festuca lenensis* steppes are rather similar to *Agropyron cristatum* ones. *Stipa krylovii* communities are distributed as a rule in lower mountains. Its areas are not so large as *Agropyron* communities. They belong to the petrophytic types and characterised by abundance of xeropetrophilous forbs and dwarf semi-shrubs (*Thalictrum foetidum, Dracocephalum fruticosum, Allium altaicum, A. eduardii*, etc.) and shrubs (*Caragana bungei, C. pygmaea*).

The mixed small bunch-grass communities with the dominance of *Stipa krylovii, Cleistogenes squarrosa, Koeleria macrantha, Agropyron cristatum, Leymus chinensis* are chiefly typical for Central Mongolia (fig. 14: *19*). The xerophyllous perennial forbs (*Astragalus halactites, Haplophyllum dauricum, Heteropappus altaicus, Sibbaldianthe adpressa*, species of *Allium*) are characteristic for these communities (Table X: *1–3*). On sandy-loam soils *Cleistogenes squarrosa* steppes are widely distributed (fig. 14: *19a*; Table X: *9*) and on the sandy deposits the *Stipa grandis, Stipa krylovii* steppes with xeropsammophilous forbs occur (fig. 14: *19a*. Table X: *4–8*). On the gravelly deposits (fig. 14: *19b*) the petrophilous forbs and dwarf semi-shrubs play an important role in the composition of the steppe communities.

The dry steppes of western Mongolia (fig. 14: *20, 21*) are very peculiar. So, *Stipa capillata, Festuca valesiaca* steppes (Table XI: *1*) and *Stipa kirghisorum* (Table XI:*3*), *Stipa orientalis* steppes with some "western" species occupy the large areas in the Ubsu-Nur Pan and on the foothills of Khan-Khukhiin-Ula west slope. These steppes are distinguished also by the presence of the Sajan–West Mongolian sp. *Caragana bungei*, West Palaearctic sp. *Spiraea hypericifolia* and West Mongolian endemic *Asterothamnus heteropappoides* (KARAMYSHEVA, BANZRAGCH, 1976b).

The sandy steppes in the Borig-Del-Els sand massif (fig. 14: *21a*) are also very specific floristically. The "western" psammophilous species *Stipa pennata*, which is very rare for Mongolia, has been found there. In the petrophytic types (Fig 14, *21b*) the *Artemisia* species (*A. obtusiloba*, etc.) and some species of petrophilous forbs and dwarf semi-shrubs (*Arenaria capillaris, Alyssum lenense, Saussurea pricei*) have the significant role. The shrubs (*Caragana bungei, Spiraea hypericifolia, Berberis sibirica*) are of importance.

The petrophytic phytocoenoses distinguish by the dominance of *Agropyron nevskii* (the endemic sp. of Mongolian Altai and the west part of the Big Lake Pan; Table IX: *2*) and *Festuca tschujensis* (East Altai–Tuva–West Mongolian sp.).

Communities with rhizomatous grass *Leymus chinensis* and with dominance of small bunch-grasses (*Cleistogenes squarrosa, Koeleria macrantha, Agropyron cristatum, Stipa krylovii*) occupy the large areas on the East Mongolian plains (fig. 14: *22*). The similar statement is true for *Stipa krylovii* and *Cleistogenes squarrosa* steppes (Table XI: *4*). The steppe communities with dominance of *Stipa klemenzii* are distributed along southern boundary of the dry steppe subzone (Table XI: *5–7*).

V. BUNCH-GRASS AND DWARF SEMI-SHRUB–BUNCH-GRASS DESERTIFIED STEPPES (fig. 15)

The desertified steppes of Mongolia are the analogues of the desertified steppes, which are traditionally distinguished in the Black Sea-Kazakhstan Steppe Subregion. They have been depicted as a specific subzonal type for the first time only on the vegetation map in the "National Atlas of Mongolia" (LAVRENKO, VOLKOVA, KARAMYSHEVA, *et al.*, 1986, 1988; KARAMYSHEVA, VOLKOVA, RACHKOVSKAYA *et al.*, 1987; KARAMYSHEVA and DASHNJAM, 1990), although A. A. YUNATOV (YUNATOV, 1950; YUNATOV, DASHNJAM, GERBIKH, 1979) described some communities of the desertified steppes in the "transi-

tional" stripe between dry and desert steppes of Mongolia.

The desertified steppes of Mongolia are very peculiar. The steppe bunch grasses, forbs and shrubs, for example, *Stipa krylovii, Cleistogenes squarrosa, Agropyron cristatum, Artemisia frigida,* species of *Caragana* g. have an important phytocoenotic role, as well as North Gobian feather grass and bunch grass species (*Stipa gobica, S. glareosa, S. klemenzii, Cleistogenes songorica,* etc.). The species *Artemisia* of the Subgenus *Seriphidium*, which are usual for desertified steppes of the Kazakhstan and Black Sea Subregion, are not typical for such ones in Mongolia. Xerophilous dwarf semi-shrubs are especially represented in psammophytic and petrophytic type of desertified steppes, but there are no the hyperxerophilous Central Asian dwarf semi-shrubs (as *Anabasis brevifolia*, species of *Ajania, Salsola,* etc.) amongst them.

Only some types of desertified steppes, distributed in the west of Mongolia, namely in the Ubsu-Nur Pan, in the Barun-Khurai Hollow (Dzhungarian Gobi) are very similar to the North Turan–Kazakhstanian ones. They have the floristic composition, the constitution of communities and the structure of vegetation cover much like those of North Turan and Kazakhstan. For example, complexes of steppe bunch-grass communities on the light chestnut soils and dwarf semi-shrubs communities on solonets in Western Mongolia are the analogues to the same complex of communities in Kazakhstan. The desertified steppes in Mongolia as well as in Kazakhstan are bound up with light chestnut soils.

There are some geographical types of desertified steppes to be distinguished within Mongolia.

The Mongolian Altai submountain and mountain steppes (fig. 15: *24*) are rather broadly distributed at 1700 (2100)–2250(2350) m ab. s. l. The dominants include the following bunch-grass species: *Stipa glareosa, Agropyron cristatum, A. nevskii*. In some place, for example, not far from Kobdo Somon and in lowhills between Kobdo and the Ulegei Mts. the desertified steppes with dominance of *Stipa gobica* occur. The *Stipa glareosa* steppes are more typical for the Mongolian Altai Mts. and are distributed over the whole subzone of desertified and desert steppes of Western Mongolia (Table XII: *1,2*). The group of bunch-grass species includes also steppe species *Stipa krylovii, Agropyron cristatum*. The quantity of forbs species is inconsiderable (*Plantago minuta, Panzeria lanata, Gueldenstaedtia monophylla, Heteropappus hispidus*) and they do not have a prominent role. It is typical for dwarf semi-shrubs (*Ptilotrichum canescens*, etc.) as well. The *Agropyron nevskii* steppes are limited to the Western Mongolia namely to Mongolian Altai including the Dzhargalant Ula Range (KARAMYSHEVA, BUJAN-ORSHIKH, BEKET *et al.*, 1984). They are restricted in the western part of Gobi Altai (VOLKOVA, 1984, 1994) and in the lowhills of the western part of Big Lake Pan. They also occur in the Atas-Bogdo-Ula Mts. (BANZRAGCH, VOLKOVA, RACHKOVSKAYA, 1978). These steppes belong to the petrophytic type and therefore the petrophilous forbs and semi-shrubs (*Saussurea pricei, Allium eduardii, Stellaria dichotoma, Goniolimon speciosum*) are especially usual. It is typical for shrubs (*Caragana bungei, C. pygmaea, Amygdalus pedunculata*) as well (Table XII: *3*).

The Gobi Altaian steppes are characterised by prominent role of *Agropyron cristatum* and *Stipa gobica* (fig. 15: *25*). *Artemisia frigida, Ajania fruticulosa, Saussurea pricei* and other petrophilous plants are especially abundant there (KARAMYSHEVA, VOLKOVA, RACHKOVSKAYA, *et al.*, 1987). The desertified steppes, which are located in the Barun Khurai Hollow (fig. 15: *23, 26*), as well as in the Ubsu-Nur Pan (fig. 15: *26*), are peculiar in their floristic composition. Some North Turanian species such as *Artemisia gracilescens, A. shrenkiana, Stipa orientalis, Psathyrostachys juncea* and some Dzhungarian species such as *Nanophyton erinaceum* have a considerable role in these communities (Table XII: *4–I, 4-II, 5–7*). The complexity of the vegetation cover is typical for these territories exactly.

The desertified steppes of the Lake Valley west part (fig. 15: 28) are rather diverse by their composition being mainly *Stipa glareosa* steppes (KARAMYSHEVA, VOLKOVA, RACHKOVSKAYA, *et al.*, 1987). There are the different combinations of *Stipa glareosa, Cleistogenes squarrosa* and *Agropyron cristatum* communities (fig. 15: *28a*; Table XII: *8, 9*) on the sand soils around the Bor-Khara-Els and Mongol Els sand massifs. The hemipsamophilous and psammophilous forbs (*Ephedra sinica, Serratula centauroides*) and *Asterothamnus heteropappoides*, as well as shrubs (*Caragana bungei*) are plentiful there. The psammophytic grass, forb and shrub communities with abundance of *Psammochloa villosa, Vicia costata, Hedysarum fruticosum, Iris tenuifolia, Allium mongolicum, Ephedra sinica*, etc. and *Artemisia klementzae* grow in sands massifs (fig. 15: *28b*).

On the gravelly deposits the petrophytic forbs, petrophytic semi-shrubs communities are widely spread (fig. 15: *28c*). *Artemisia* communities (*A. rutifolia, A. santolinifolia*), petrophilous forbs and shrubs (*Amygdalus pedunculata, Berberis sibirica, Caragana bungei*) grow on granites.

Central and Eastern Mongolia–North-Gobian desertified steppes (fig. 15: *29, 30, 31*) are represented by *Stipa krylovii–S. klemenzii–Cleistogenes squarrosa* and *Stipa gobica–S. glareosa–Cleistogenes songorica* communities (Table XII: *10, 11*). The petrophytic forb–bunch-grass steppes with *Artemisia frigida, Stipa klemenzii, S. gobica, S. krylovii, Agropyron cristatum* are distributed on the gravelly deposits. Petrophilous forbs and dwarf semi-shrubs (*Thymus gobicus, Dracocephalum foetidum*) with participation *Artemisia rutifolia* and *A. santolinifolia* are spread on granites.

VI. DWARF SEMI-SHRUB–BUNCH-GRASS AND BUNCH-ONION DESERT STEPPES (fig. 16)

This subzonal type of steppes, which includes the communities of specific composition and structure, is distributed in the extreme south of the Eurasian Steppe Region on the boundary with Central Asian Desert Region. These communities located on the territories with ultracontinental climate are endemic for Central Asia and have no analogues in another arid region of Palaearctic. The main areas of these steppes are related with Mongolia (YUNATOV, 1950, 1974), but they are also typical for China (KHOU, 1979, 1983) and penetrate to the Chu steppe (in the territory of Kazakhstan).

The dominating synusia of bunch grasses is constituted by the endemic Central Asian feather-grass species *Stipa gobica, S. klemenzii, S. glareosa*, also *Cleistogenes songorica* and Gobian bunch-onion *Allium polyrrhizum*. The hyperxerophilous North Gobian dwarf semi-shrubs – the species of the Genera *Anabasis, Salsola, Eurotia* (*Chenopodiaceae*), *Ajania* (*Asteraceae*), *Reaumuria* (*Tamaricaceae*) and other are the co-dominants. The synusia of summer-autumn annuals is observed in the desert steppes as in the desertified and dry ones especially in the years with moisture summer periods. Besides the species growing in the dry and desertified steppe such as *Artemisia palustris, Chamaerhodos erecta, Chenopodium aristatum, Ch. album, Dontostemon integrifolius, Salsola collina,* the annual grasses

(*Eragrostis minor, Aristida heymannii*, etc.) occur in desert steppes.

The desert steppes are notable for their poor floristic composition. There are no more than 10–15–20 sp. on 1 are. The total cover degree is insignificant. In most favourable years it is equal to 10–15 %, but in dry ones declines to 5–7 %. The height of the grass canopy does not exceed 10–15 cm. The communities of the desert steppes are related with brown desert steppe soils.

The detail analysis of the Mongolian desert steppes is given in monographs by A. A. YUNATOV (1950, 1974), who has distinguished these specific communities on Mongolian territory and has described them for the first time. We agree with YUNATOV's opinion that the term "Central Asian" should be attributed exactly to these steppe types, but neither to the true Mongolian dry steppes nor to the meadow and forb–bunch-grass Dahuria-Mongolian steppes.

The comprehensive investigations of the typological diversity and geographical distribution of the Gobian desert steppes were conducted by E. I. RACHKOVSKAYA (EVSTIFEEV, RACHKOVSKAYA, 1976, 1977; RACHKOVSKAYA, 1993) in 70-80th. The complex morphological and ecological-physiological description of the basic plants of desert steppe is in the collective monograph "Desert steppe and northern deserts of the Mongolian People's Republic" (LAVRENKO, 1980a).

A. A. YUNATOV (1974) has distinguished and described concretely the following Mongolian desert steppes: *Stipa glareosa–S. gobica–Anabasis brevifolia* communities (Table XIII: *6,7*); *Stipa gobica–S. glareosa–Cleistogenes songorica–Artemisia xerophytica* communities; *Stipa glareosa–S. gobica–Brachanthemum gobicum* communities; *Stipa gobica–S. glareosa* with species of g. *Caragana.* The last-mentioned communities are distributed on the soils of light texture and on gravelly ones. The diversity of *Allium polyrrhizum* formation (Table XIII: *9*) has been studied by E. I. RACHKOVSKAYA (EVSTIFEEV, RACHKOVSKAYA, 1977).

During the recent works the connection between some desert steppe types and the certain botanical-geographical regions has been precised (KARAMYSHEVA, VOLKOVA, RACHKOVSKAYA *et al.*, 1987). The North-Western Gobi types (fig. 16: *35*) are notable for the prevalence of *Stipa glareosa* and the presence of some endemic and subendemic species such as *Chenopodium frutescens, Asterothamnus heteropappoides,* etc.. *Stipa glareosa–Anabasis brevifolia–Chenopodium fruticosum* communities (Table XIII: *1-4*) and *Agropyron nevskii–Eurotia ceratoides* communities with petrophilous forbs and semi-shrubs (*Lagochilus ilicifolius, Ephedra sinica, Zygophyllum pterocarpum*) and communities of *Caragana leucophloea* are distributed in lowhills in the western part of the Lakes Valley (fig. 16: *35c*). There are the shrub steppe communities (*Amygdalus pedunculata, Caragana bungei*) on granites. Series of psammophilous grass (*Psammochloa villosa, Leymus racemosus*), semi-shrub (*Hedysarum fruticosum*), *Artemisia* (*A. xerophytica, A. sphaerocephala*) with *Corispermum patelliforme, Stipa glareosa, Cleistogenes squarrosa*, and shrub (*Caragana bungei*) communities are wide-spread in the sand massifs (fig. 16: *35a, b*). In the Barun-Khurai Hollow the desert steppes of Dzhungarian type occur (fig. 16: *34*): complex of *Stipa glareosa–Artemisia gracilescens* communities with *Stipa glareosa–Nanophyton erinaceum* communities. Eastern Gobi types (fig. 16: *38*) are characterised by a significant role of *Salsola passerina*, while on sands – by the presence of *Caragana korshinskii* (Table XIII: *8*).

Agropyron nevskii–Stipa glareosa–Eurotia ceratoides with *Caragana leucophloea* communities and *S. glareosa–Eurotia ceratoides* with *Ajania achilleoides* and *A. fruticulosa* communities (fig. 16: *32, 33*) are related with the submountain of Gobi and Mongolian Altai. *Stipa gobica–S. glareosa–Anabasis brevifolia* with *Allium polyrrhizum* communities; *Stipa gobica–S. glareosa–Ajania fruticulosa* communities are typical for North Gobi (fig. 16: *36, 37*) as well as *Stipa glareosa* or *Stipa glareosa–S. gobica–Reaumuria soongorica* communities (Table XIII: *5*).

BOTANICAL-GEOGRAPHIC DIVISION OF THE DAHURIA-MONGOLIAN (CENTRAL ASIAN) SUBREGION

First attempts to make the schemes of the botanical-geographic division of Mongolia were carried out by V. L. KOMAROV (1908) and N. V. PAVLOV (1929), but these systems had just preliminary characters. Their merits and demerits has been discussed by A. A. YUNATOV (1950). V. I. GRUBOV (1959, 1963, 1982) published the schemes for the whole Mongolia and its southern part, which he included into Central Asian desert region of the Ancient Mediterranean Dominion. These substantial schemes are characterised by the floristic approach and do not take into account the regularities of the vegetation cover composition in full measure.

The problem of the Eurasian Steppe Region regionalization has been thoroughly analysed in a great number of publications by E. M. LAVRENKO (1940, 1942, 1947 a, 1947b, 1948, 1954, 1956, 1968, 1970 a, 1970b, 1980b, etc.).

We have to emphasise once more the great role of A. A. YUNATOV, who had definited and interpretated of the extraordinary peculiarities of Mongolian steppe vegetation and had elaborated of its place within the general system of the botanical-geographic division of the whole Eurasian Steppe Region. A. A. YUNATOV created his own scheme, which was worked out in details up to the main units (districts) for the whole Mongolian territory.

When A. A. YUNATOV was writing his candidate thesis "Desert steppes of Northern Gobi in the Mongolian People's Republic" in 1940 (unfortunately, this very interesting book has been published only at 1974), he declared against LAVRENKO's idea to interpretate the steppe region of Mongolia only as a province or group of provinces. A. A. YUNATOV wrote, that the peculiarity of the Mongolian steppe "was more considerable and would have been better underlined if the Transbaykal territory, the Mongolian People's Republic, Inner Mongolia and probably the badly known Manchzhuria had been interpretated as a special Mongolian or Mongolia-Manchzhurian subregion" (YUNATOV, 1974 : 95).

Earlier A. A. YUNATOV (1950) has singled out the desert steppes as a separate North Gobi desert steppe province. It was based on the speciality of this steppe vegetation, which had developed in the dry and cold climate of Central Asia. E. M. LAVRENKO (1970a) interpretated the desert steppes only as the subzone within the Mongolian steppe province, that is as a unit of lower significant.

In addition to the North Gobi desert steppe plain province A. A YUNATOV. has singled out also the Dahuria-Mongolian steppe province (the plain) and two mountain provinces: Mongol Altai, which includes the Mongolian Altai Mts. and Chu steppe in the East Kazakhstan and Khangaian one (the Khangai Mts. and the Orkhon-Selenga lowlands).

The Dahuria-Mongolian steppe province, in YUNATOV's interpretation, occupies large territories southward and eastward from the Khangai Mts., southward and northward from the Kerulen

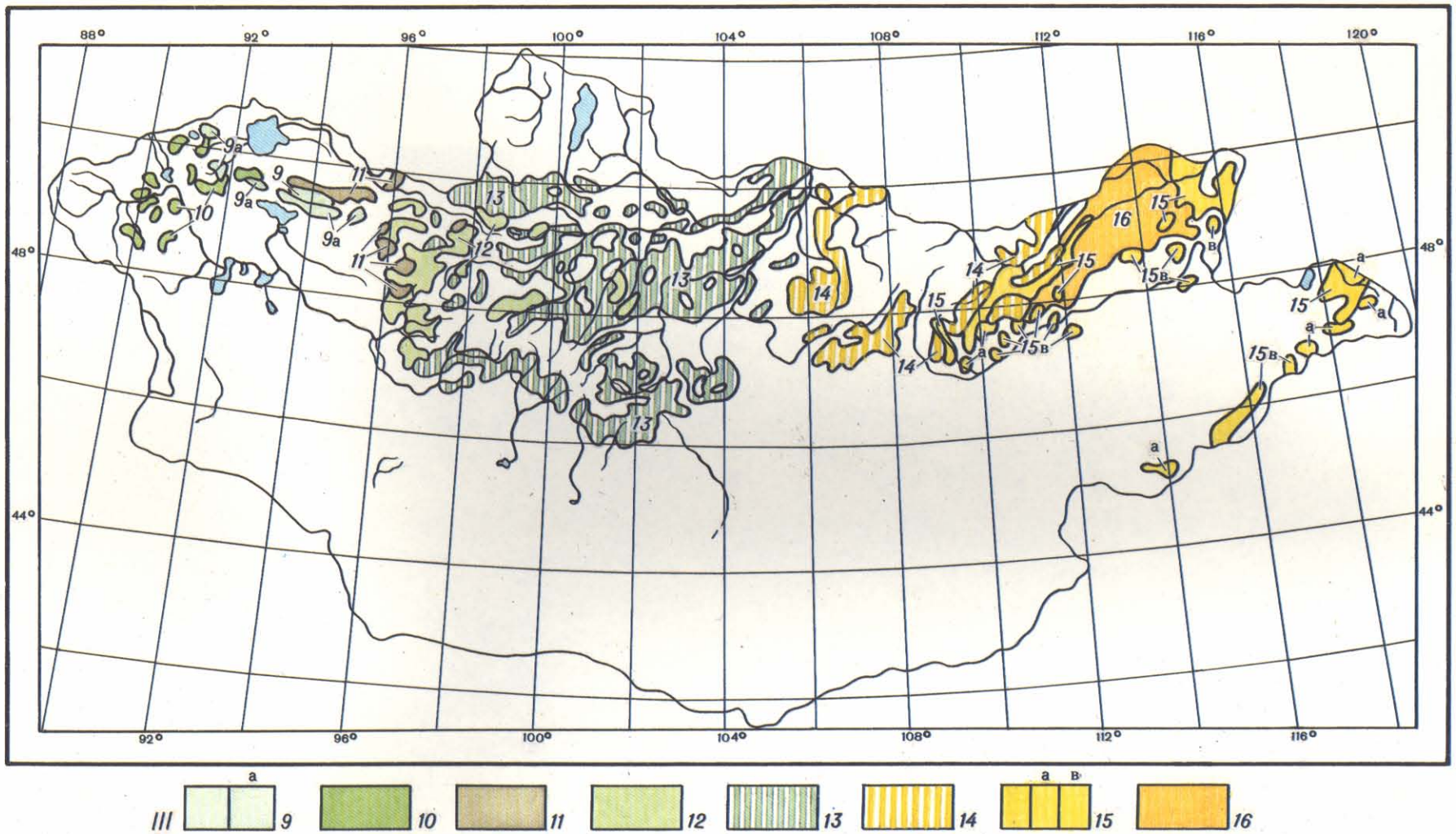

Fig. 13. III. Distribution of the forb–bunch-grass and caespitose forb steppes: *9.* East Kazakhstan–West Mongolian; *10.* Mongol Altaian; *11.* West Khangaian; *12.* West Khangaian; *13.* Khangaian; *14.* Khenteian; *15.* Dahuria–Mongolian; *16.* East Mongolian.

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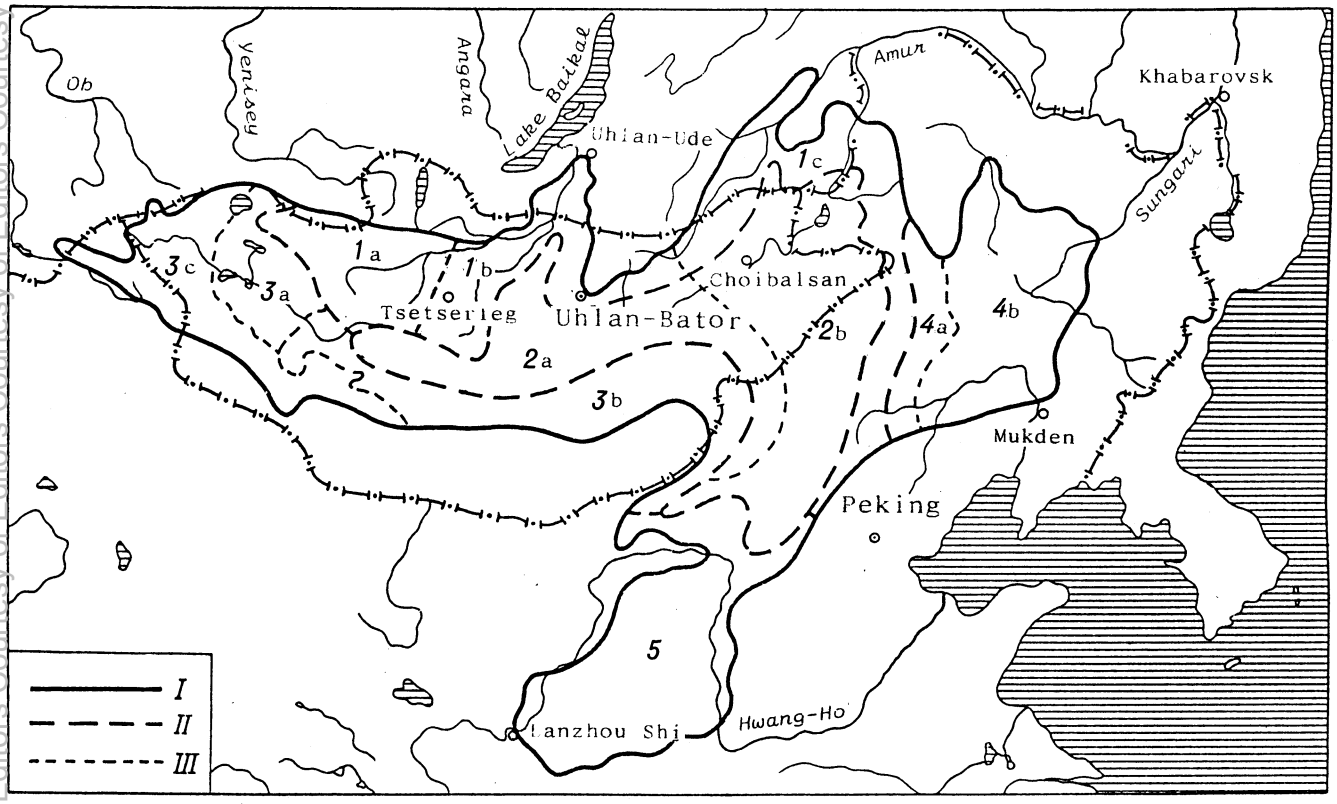

Fig. 17. The division of the Central Asian subregion of the Eurasian Steppe Region into provinces (According to LAVRENKO, KARAMYSHEVA, NIKULINA, 1991).

Borders: *I* – of the subregion; *II* – of the province; *III*. of the sub-province. *1.* Khangai-Dahurian mountain forest-steppe province: **a.** West Khangaian sub-province; **b.** Orkhon–Lower Selenga sub-province; **c.** Nerchinsk–Onon sub-province. *2.* Mongolian steppe province: **a.** Middle Khalkha sub-province; **b.** East Mongolian sub-province. *3.* North Gobi desert steppe province: **a.** The Big Lake Pan sub-province; **b.** North-Eastern Gobi sub-province; **c.** Mongolian Altai mountain steppe sub-province. *4.* Manchzhurian forest-steppe (meadow steppe) province: **a.** Songhuian forest-steppe sub-province; **b.** South Khinganian mountain forest-steppe sub-province. *5.* Shaxi–Gansuian forest-steppe and steppe province.

River and eastward from the Khentei Mts. up to the Russian and China frontiers. This province in LAVRENKO's opinion is unsuccessful, as the most of its districts westward and eastward from the Khentei Mts., included in the Dahuria-Mongolian steppe province, are characterised, according to YUNATOV himself, by considerable afforestation.

The scheme of the botanical-geographic division, demonstrated here (fig. 17), is based on LAVRENKO works (1970 a, 1980 a) but is rather similar to one by YUNATOV (1950). Its differences from YUNATOV's one are the following: 1) the position of the southern boundary of the North Gobi desert steppe province; 2) the position of the boundary between the Dahuria-Mongolian plain steppe province and the Khangai–Dahurian mountain forest-steppe one; 3) the interpretation of the botanical-geographic position of the Mongolian Altai Mts.

The boundaries of the provinces and sub-provinces have been corrected according to the new "Vegetation map of Mongolia", published in the National Atlas of Mongolia (KARAMYSHEVA, DASHNJAM, 1990).

Following YUNATOV (1950) and LAVRENKO (1970a, 1980a; LAVRENKO, KARAMYSHEVA, NIKULINA, 1991), we ascribe Mongolian steppe territory to the Dahuria–Mongolian (Central Asian) steppe subregion. The subregion is characterised by both floristical and vegetation distinctions, namely by the set of formations or another syntaxa, which are related with plakor or nonplakor habitats and by the set of altitudinal types in mountains i. e. the belt's "column". When we characterised the Mongolian steppe flora (see "Peculiarities of Mongolian steppe flora") and the main zonal and altitudinal types of communities we constantly pay attention to the peculiarities of Mongolian flora and vegetation as compared with the Kazakhstan and Black Sea ones. These distinctions are not only the result of the long adaptation processes to the considerably different natural condition. They also show affect the specific ways of the evolution and the time of elaboration of the main floristic and coenotic complexes.

Provinces and sub-provinces are singled out within the subregion. The spatial distribution of vegetation cover, that is the presence of the clearly pronounced latitudinal stripes and the existance of definite proportion between the different ecological types of communities are to be taken into account when provinces and sub-provinces are singled out. It concerns also the environment forming species namely the edificators and dominants of plakor or non plakor habitat (KARAMYSHEVA, RACHKOVSKAYA, 1973). The analysis of nonplakor vegetation is very important especially for the territories, where the plakor habitats are practically absent. Mongolia is amongst them. It is important also because the constant exchange between plakor and nonplakor communities takes place in processes of the vegetation development. As a floristic criterion the quantitative correlation of the geoelements mainly according to the longitudinal groups is the basis of the province definition. The differences of genera's compositions or sometimes, especially for mountain provinces, family ones are important for provinces.

We distinguish the separate provinces for the northern forest-steppe and for the southern steppe parts of subregion, just as it was made in above mentioned publications by LAVRENKO and YUNATOV. It is necessary to do, as when we carry out the division of forest-steppe territories we take into consideration not

only the structure and composition of the steppe communities, but also the forest ones, which occupied the considerable large territories especially in the past.

In the East-European forest-steppe province the forests are represented by deciduous mainly oak (*Quercus robur*) ones, in West Siberia–North Kazakhstanian – by small-leaves birch (*Betula pendula, B. pubescens*) and aspen (*Populus tremula*) – birch ones. In mountain forest-steppe of Transbaykal and Mongolia the larch (*Larix sibirica* and *L. gmelinii*, the latter – in the eastern part of Khentei and further eastward) and the birch (*Betula platyphylla*, often secondary) forests are usual.

Also "blocks" of provinces, consisting of forest-steppe and steppe provinces are represented. The evolution of the vegetation within these "blocks" of provinces leads in modern time and led in past to the exchanging of some species. The boundary between provinces and sub-provinces are not linear as there are the broad "transitional" stripes.

We shall now consider the distinctive vegetational features of provinces and sub-provinces.

DAHURIA–MONGOLIAN "BLOCK" OF PROVINCES

1. The Khangai–Dahurian mountain forest-steppe province (LAVRENKO, 1970 a; LAVRENKO, KARAMYSHEVA, 1993) includes the Khangai Mts. and the main part of the Selenga River basin in Mongolia. The western Transbaykal on both sides of the Selenga R. namely the Western Selenga Dahuria and foot-hills of the Khentei Mts., as well as forest-steppe of Dahuria, Nerchinsk Dahuria in Russia also are situated in this province. The western foot-hills of the Greater Khingan in China is a part of this province. Now we make the description of the provinces and sub-provinces vegetation for Mongolian territory only.

The Khangai-Dahurian mountain forest-steppe province is characterised by the specific altitudinal regularities of the vegetation (belt's "column"), which are exactly pronounced in the Khangai Mts. (YUNATOV, 1950). According to the data of Z. V. KARAMYSHEVA and D. BANZRAGCH (1977) the regularities of plant communities in the Khangai Mts. are rather intricate.

Figure 18 illustrates the distribution of vegetation along 92° E. l. from the South Khangai Plateau up to the foothills in the northern slope of the Tarbagatai range. The zonal replacements of vegetation are revealed first of all. So, the plains on the southern slope of Khangai at 1700–1950 (2000) m in Bogd-Uul massif (46° 27' N. l.) occupy by the different types of desertified steppes on the light chestnut soils. *Stipa klemenzii* steppes with dry-steppe grasses and forbs (*S. krylovii, Cleistogenes squarrosa, Iris bungei*) are especially typical (fig. 18: *1*). On the northern foothills of the Tarbagatai range (48° 12' N.l.) on 1700–1800 m the forb–bunch-grass *Stipa krylovii–Poa attenuata–Koeleria macrantha* steppe with *Potentilla tanacetifolia, Veronica incana* and another species of xerophylous and xeromesophylous forbs on the dark chestnut soils are distributed (fig. 18: *3*).

In addition to these zonal changes on the intermountain plains the altitudinal replacement of communities on the slope of separate massifs is observed. More over the belt "columns" on the different slopes are not the similar, as well as the upper and lower boundaries of the belts and sub-belts. On the southern slopes there are only two belts: the steppe belt and high mountain one. The steppe belt includes the sub-belt of the desertified steppes, dry bunch-grass and forb–bunch-grass ones (fig. 18: *1–4*), which are replaced by high mountain steppes with *Kobresia* and high mountain forbs (fig. 18: *6*). Only in the massifs, which are located on the axial range, the large areas are occupied with the mesophytic types of forb–bunch-grass steppes (fig. 18: *4*), mountain meadow steppes (fig. 18: *5*), steppified meadows and more mesophytic types of high mountain steppes (fig. 18: *6*). The high mountain belt has a large extend and differentiation, and at the high of 3000 m there is a well distinguished sub-belt with fragment of the steppified *Kobresia* meadows (fig. 18: *16*) and tundra *Dryas oxyodonta and Salix berberifolia* communities (fig. 18: *13*), moss-lichen and moss-sedge communities (fig. 18: *19*). At the 3300 m the aggregations of the high mountain cryopetrophilous forbs and dwarf semishrubs (*Waldheimia tridactilites, Dryadanthe tetrandra, Cerastium lithospermifolium*, etc.) occur (fig. 18: *20*).

The altitudinal regularities of the vegetation in the mountains on the northern macroslope in Dash-Dagva Ul, 47° 42' , in the Tarbagatai Range and in the Bulnai Range are distinguished by great peculiarities. There is a pronounced asymmetry not only in details of vegetation structure (the number of sub-belts, the position of its upper and lower boundaries), but in the set of belts itself. On the southern slopes the forb–bunch-grass steppes, the meadow ones (fig. 18: *4, 5*), the steppified meadows, *Dasiphora fruticosa* thickets prevail. On the northern slopes the forest belt is situated above the steppe one. The forest belt is represented by the several sub-belts (BANNIKOVA , KHUDJAKOV, 1976): 1. the sub-belt of "subtaiga", that is *Larix sibirica* forests with some Nemoral forbs (fig. 18: *7*); 2. the sub-belt of "pseudotaiga", that is *Larix sibirica* forests with *Rhytidium rugosum* (fig. 18: *8*); 3. sub-belt of the true boreal larch (*Larix sibirica*) forests and "cedar" – larch (*Larix sibirica–Pinus sibirica*) ones (fig. 18: *9, 10*).

Forest belt is replaced by the tundra belt, which also includes some sub-belt: the sub-belt of *Pinus sibirica–Larix sibirica* open boreal woodlands combined with *Betula rotundifolia* thickets and moss-lichen and *Kobresia* communities (fig. 18: *11, 12*); tundra sub-belt (*Empetrum sibiricum, Salix rectijulis, S. recurvigemmis, Dryas oxyodonta*, etc.), *Caragana jubata, Betula rotundiflia* thickets (fig. 18: *14, 15*) and humid cryophytic meadow's sub-belt (fig. 18: *17–19*). Prevalence of tundra and open boreal woodlands makes the high mountain vegetation of Mongolia similar to the high mountain landscapes of South-Eastern Siberia. So while analasing the regularities of altitudinal vegetation replacements in the Khangai Mts. one should not treat it as a common Central Khangaian arid type as it was written by YUNATOV (1950). It is necessary to distinguish two belt's "columns": the South Khangaian arid type and the North Khangaian one "transitional" to the boreal South-Eastern Siberian.

Khangai–Daurian mountain forest-steppe province is divided into 3 sub-provinces: a. West Khangaian sub-province; b. Orkhon–Lower Selenga and c. Nerchinsk–Onon ones.

1a. West Khangaian sub-province (LAVRENKO, KARAMYSHEVA, NIKULINA, 1991; LAVRENKO, KARAMYSHEVA, 1993) stretches eastward approximately up to 100° East longitude. This sub-province is characterised by a greatest number of the boreal elements in all of the belts, especially in taiga and tundra ones. We will mention some of them (KARAMYSHEVA, BANZRAGCH, 1976, 1977). *Arctous erytrocarpa* (North Holarctic sp.) has been collected in humid moss-larch and "cedar" (*Pinus sibirica*) – larch forest. *Carex iljinii*, which is unique to the forests and boreal open woodlands of Eastern Siberia, Angara-Sajan districts and Dahuria, has been revealed more southern then before. Formerly this species has been collected only in the Khubsugul Lake Hallow. It concerns also *Rhododendron ledebouri. Linnea*

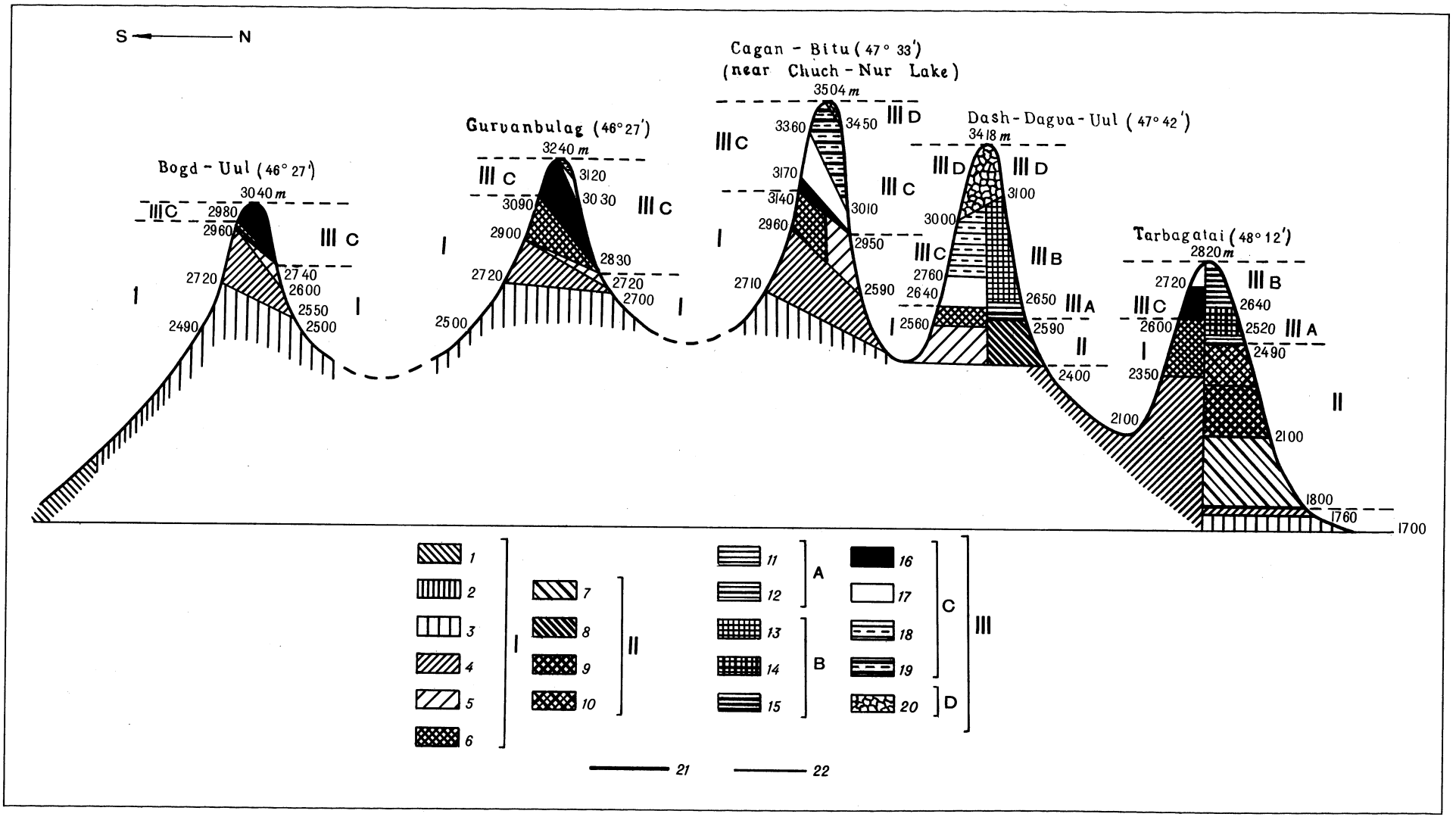

Fig.18. Altitudinal replacements of the vegetation in the Khangai Mts.
I. Steppe belt: *1.* desertified *Stipa klementzii* steppes; *2.* mixed bunch-grass *Stipa krylovii–Cleistogenes squarrosa–Agropyron cristatum–Koeleria macrantha* dry steppes; *3.* mixed bunch-grass steppes poor in forbs; *4.* forb–bunch-grass *Festuca lenensis–Poa attenuata* steppes with *Amblynotus rupestris, Androsace incana, Thalictrum foetidum, Aster alpinus,* etc.; *5.* meadow *Helictotrichon schellianum–Festuca sibirica–F.lenensis–Carex pediformis* steppes; *6.* high mountain cryoxerophytic mixed bunch-grass steppes with *Kobresia*; **II.Forest belt**: *7. Larix sibirica* forest with nemoral forbs and grasses (*Aconitum septentrionale, Lathyrus humilis, Thalictrum minus, Aegopodium alpestre, Aquilegia sibirica, Festuca rubra, Poa sibirica,* etc.); *8. Larix sibirica* and *Larix sibirica–Pinus sibirica* forest with *Rhytidium rugosum, Dicranum, Polytrichum, Brachythecium* sp.div., with some boreal forbs and semi-shrubs (*Pyrola incarnata, Linnea borealis,* etc.); *9. Larix sibirica* or *Larix sibirica–Pinus sibirica* boreal forest with *Juniperus sibirica, Ribes altissima,* boreal and high mountain forbs and semi-shrubs (*Vaccinium vitis-idaea, Linnea borealis, Saxifraga cernua, Saussurea alpina,* etc.); *10. Larix sibirica–Pinus sibirica boreal* moss–shrub forest with *Betula rotundifolia* in understorey. **III. High mountain belt. A.** Open woodlands ("Gol'tsy"): *11. Pinus sibirica–Larix sibirica* or *Pinus sibirica* open woodlands alternating with *Salix, Betula* sp.div. thickets; *12. Larix sibirica* open woodlands alternating with moss–lichen and *Kobresia* communities. **B.** Mountain tundra: *13. Dryas oxyodonta, Salix berberifolia* tundra communities alternating with moss–sedge and *Kobresia* communities; *14. Betula rotundifolia* thickets, *Caragana jubata* thickets with mosses and lichenes; *15. Empetrum sibiricum* communities alternating with *Dryas* and moss-sedge communities. **C.** Psychrophytic high mountain herbaceous communities: *16. Kobresia* communities with steppe forbs and grasses; *17. Carex stenocarpa, C.melanantha* and *Kobresia sibirica* communities with high mountain species; *18. Kobresia sibirica–Ptylagrostis mongholica* communities; *19.* Moss–lichen communities alternating with humid *Carex* and *Kobresia* communities with high mountain meadow and swamp species . **D.** Sub-nival sub-belt: *20.* rocky placer with aggregatons of cryo-petrophilous forbs (*Waldheimia tridactylites, Claytonia joanneana, Rhodiola quadrifida, Saxifraga macrocalyx, Gentiana algida,* etc.). Borders: *21.* of the belts; *22.* of the sub-belts.

borealis, Empetrum sibiricum, which were considered to be rare ones for Khangai before, are common species now. To the group of species with Southern Siberian areas *Saxifraga hieracifolia* belongs, which grows in moist sedge communities in Khangai. *Oxytropis saposhnikovii* (Altai–North Mongolian sp.), *Carex rigidioides* (East-Siberian sp.), *Salix divaricata* (the common plant in tundra belt of Khubsugul Lake Hallow and Transbaykal territory) has been collected in the Khangai Mts. The distribution in mountains of north-western Khangai forest belt of *Cicerbita azurea* (typical component of *Larix* forest of South-Eastern Altai) is of interest. Among the high mountain species *Carex atrofusca, Saussurea glacialis* (Holarctic sp.) should be named. The list of the new finds of the boreal species has been considerably filled out during last year investigations (SKVORTSOV, 1983; GUBANOV, KAMELIN, DARIIMA, 1986,1987; GUBANOV, KAMELIN, 1988; GOLUBKOVA, KAMELIN, 1989).

Flora of Western Khangai sub-province is characterised by absence of some "eastern" species, which is a considerable importance in next Orkhon-Lower Selenga sub-province. As to the steppe flora of Western Khangai, its composition is very specific. Just in this sub-province there are many species, which have the basic areas in more western districts of Eurasian Steppe Region. We have already mentioned such species as *Helictotrichon altaicum, Stipa zalesskii, S. capillata, S. kirghisorum, Festuca valesiaca.* In addition to them *Ferula soongorica* (Middle Asia–Kazakhstanian sp.), *Androsace ovczinnikovii* (Kazakhstan–West Mongolian petrophilous sp.), *Melandrium viscosum* (West Palaearctic steppe sp. with irradiations to the East Siberia steppe "islands"), *Ancathia igniaria, Gypsophila patrinii* (Central-East Kazakhstan–West Mongolian sp.) can be named. The finding of *Onosma transrhymnense,* which appears on the northern slope of the Khan-Khukhiin Ula Ridge after sufficient break of its area, is of great interest.

The altitudinal regularities of the vegetation cover, that is the belt's "column", in Western Khangai is rather similar to the Central Khangai one. There are a differences ("asymmetry") in belts and sub-belts composition on the slope of different exposure (fig. 19). However in Khan-Khukhiin Ula the more complicated example of "asymmetry" was found. This is due not only to the climatic conditions in the modern period, but also to the differences in the flora and vegetation probably caused by the history of territory.

The belt's "column" of vegetation on the northern macroslope includes the steppe belt, the forest and the high mountain ones (KARAMYSHEVA, SUMERINA, BEKET, *et al.*, 1985).

The steppe vegetation is represented by the several altitudinal types of communities: *Stipa sareptana* communities often in complex with *Artemisia schrenkiana* ones are found in the sub-belt of desertified steppe (fig. 19: *2*). Such complex is typical for Kazakhstan desertified steppes. In the dry steppe sub-belt *Stipa capillata–Artemisia frigida* communities with *Caragana pygmaea* and *Spiraea hypericifolia,* similar to the same of Central Kazakhstan ones (KARAMYSHEVA, RACHKOVSKAYA, 1973), are spread (fig. 19: *3*). In the forb–bunch-grass steppe sub-belt (fig. 19: *4*) and meadow steppe sub-belt (fig. 19: *5*) *Helictotrichon altaicum* and *Carex pediformis* steppes with dominance of *Coluria geoides* among the forbs should be noted. The communities with similar composition grow in the Tarbagatai Range (STEPANOVA, 1962), Tannu-Ola Range (SOBOLEVSKAJA, 1950) and in the Kalbinskii Range (KARAMYSHEVA, RACHKOVSKAYA, 1973).

The vegetation of the forest belt is also peculiar. *Larix sibirica* with *Iris ruthenica* forests broadly distributed in Central Khangai, as well as some types of moss (*Rhytidium rugosum*) larch forests are absent here. But there are larch and "cedar"-larch (*Larix sibirica–Pinus sibirica,* fig. 19: *8*) forests similar to the Altaian ones (KRYLOV, RECHAN, 1967; KOROTKOV, 1976). The herbaceous larch forest with Altaian species *Cicerbita azurea* (fig. 19: *7*) are among them. There are the spruce (*Picea obovata*) and spruce-larch forests in Khan-Khukhiin-Ula also.

The "cedar"-larch open woodlands (fig. 19: *9*), shrub and dwarf-shrub (*Betula rotundifolia, Salix* and *Dryas* sp.) tundra (fig. 19: *10*) are situated above the forest belt. These communities combine with *Kobresia* and *Carex* cryophytic high mountain meadows (fig. 19: *11*).

In regard to the vegetation of the southern macroslope there are only two altitudinal belts there: steppe belt and high mountain one. The prevailing communities have many features that are common to the Mongolian and Central Asian ones (fig. 19: *2–4*). The general regularities of the West Khangai vegetation are depicted on the vegetation map (fig. 20).

1b. Orkhon–Lower Selenga sub-province includes so called Orkhon-Selenga lowmountains and south-eastern part of Khangai and, is to a certain extent, "transition" stripe between the West Khangai and Nerchinsk–Onon sub-provinces. Its natural condition, flora and vegetation have been described in numerous publication of forest-steppe field station of the Joint Soviet-Mongolian complex biological expedition of Ac. Sci. USSR and Mongolia, which is situated in Eastern Khangai (SKVORTSOV, 1983; LAVRENKO, BANNIKOVA, 1983, 1986).

Eastern Khangai has rather rich flora (848 sp.) exceeding $^1/_3$ (38%) of the whole Mongolian flora. The last year floristic investigations revealed as much as 15 species unknown for Khangai and more them 80 species unknown for Eastern Khangai. Many high mountain species are among them: *Poa alpina, Cerastium lithospermifolium, Draba eriopoda, D. sibirica, Saxifraga setigera, Chrysosplenium peltatum,* etc.

Some Dahuria-Mongolian, Dahuria–East Mongolian, Manchzhurian species, that main areas are distributed in more eastern regions, begin to play the prominent phytocoenotical role here. *Filifolium sibiricum, Saposhnikovia divaricata, Leymus chinensis, Stellera chamaejasme* and some others are amongst them.

On the other hand, some "western" species, which have a significant role in West-Khangaian sub-province penetrate into this sub-province. So, *Festuca valesiaca, Helictotrichon altaicum, Stipa sareptana* and another sp. have been found on the territory of the forest-steppe field station. The finding of *Caragana spinosa,* which area lies at the West Mongolia, is of special interest.

The altitudinal regularities of the Eastern Khangai vegetation have been studied by I. A. BANNIKOVA (BANNIKOVA , KHUDJAKOV, 1976; LAVRENKO, BANNIKOVA, 1983). Mixed bunch-grass, mainly *Stipa krylovii* with *S. baicalensis* or *Festuca lenensis* steppes on dark chestnut soils are distributed on the foothills (pedestal) of the mountain at 1550–1700 m ab. s. l. They are replaced by meadow forb–grass and *Stipa baicalensis–Carex pediformis -Festuca kryloviana* with *Dasiphora fruticosa* steppes rich in forbs on the mountain chernozems and by steppified meadow (*Bromus inermis–Carex pediformis*) on the meadow chernozems soils. More higher (1700–1900 m ab. s. l.) the subtaiga-meadow steppe sub-belt is situated, where the *Stipa baicalensis–Carex pediformis* rich in forbs steppes and steppified meadows with dominance of *Bromus inermis, Poa pratensis, Festuca kryloviana, Helictotrichon schellianum* combine with larch (*Larix sibirica*) forests. The prevailing species in the

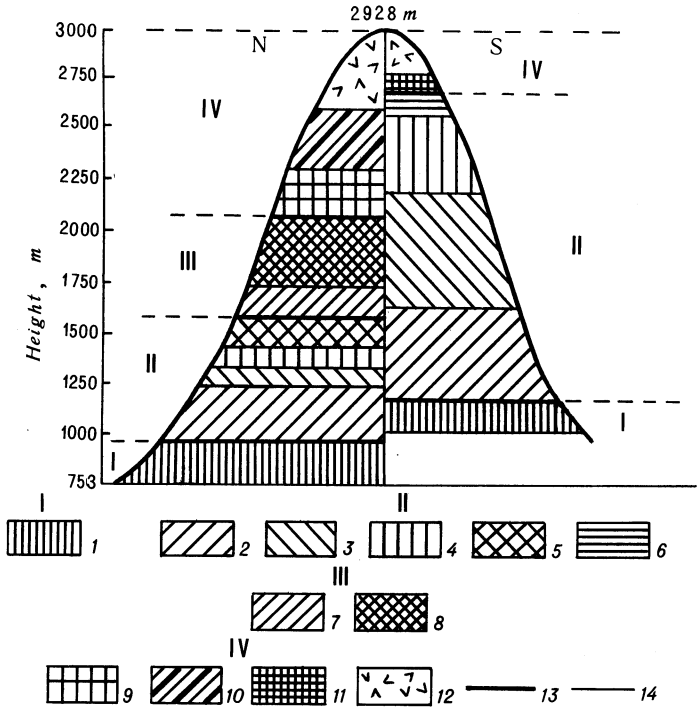

Fig. 19. Altitudinal replacements of the vegetation in the Khan-Khukhiin Ula Range.
I. Desert: *1. Nanophyton erinaceum* deserts with steppe and desert steppe grasses (*Stipa glareosa, Psathyrostachys juncea, Cleistogenes squarrosa*) partly in complex with *Artemisia schrenkiana–A.frigida–Potentilla acaulis* communities on the foothills of the northern macroslope; *Reaumuria soongorica* deserts with desert–steppe grasses (*Stipa glareosa*), *Allium polyrrhizum* and *Convolvulus gortschakovii*; *Anabasis brevifolia–Stipa glareosa* deserts with *Chenopodium frutescens* on the foothills of the southern macroslope. **II. Steppe belt:** *2.* desertified *Stipa sareptana–Festuca valesiaca–Koeleria cristata–Nanophyton erinaceum* steppes partly in complex with *Artemisia schrenkiana* communities on the northern slope; desert *Stipa glareosa–Anabasis brevifolia* or *Stipa glareosa–Reaumuria soongorica* steppes on the southern slope; *3.* dry *Stipa capillata–Festuca valesiaca–Artemisia frigida* steppes with *Spiraea hypericifolia* and *Caragana pygmaea* on the northern slope; *Stipa krylovii–Agropyron cristatum–Cleistogenes squarrosa* steppes with *Caragana bungei* and *C.pygmaea* on the southern slope; *4. Festuca valesiaca* steppes with xero-mesophilous and petrophilous forbs (*Dianthus versicolor, Galium verum, Dracocephalum origanoides, Oxytropis filiformis, etc.*) on the northern slope; *Festuca lenensis* steppes with xero-mesophilous and petrophilous forbs (*Rheum undulatum, Potentilla sericea, Polygonum angustifolium,* etc.); *Agropyron cristatum* steppes with petrophilous forbs and dwarf semi-shrubs (*Smelovskia mongolica, Ptilotrichum canescens, Thesium refractum,* etc.); *Artemisia santolinifolia* serial communities on the southern slope; *5. Helictotrichon altaicum–Carex pediformis* steppes with mesophilous and xero-mesophilous forbs (*Coluria geoides, Trifolium lupinaster, Scabiosa comosa, S.ochroleuca, Polygala hybrida, Sedum hybridum,* etc.) and shrubs (*Dasiphora fruticosa, Cotoneaster melanocarpa*) on the northern slope; *Festuca lenensis* with petrophilous cushion forbs (*Minuartia verna, Arenaria meyeri, Eritrichium pauciflorum, Aster alpinus,* etc.) on the southern slope; *6.* high mountain mixed bunch-grass *Festuca lenensis–Koeleria macrantha–Poa attenuata* steppes with steppe petrophilous forbs (*Minuartia verna, Leontopodium ochroleucum,* etc.), sedges (*Carex rupestris, C.macrogyna*) and *Kobresia* (*K.humilis, K.simpliciuscula*); **III. Forest belt:** *7. Larix sibirica* forest with forest and meadow-forest species (*Carex amgunensis, Bromus korotkyi, Agrostis trinii, Cicerbita azurea, Vicia cracca, Geranium pseudosibiricum, Lilium martogon,* etc.); *8.* boreal *Larix sibirica* and *Larix sibirica–Pinus sibirica* forests with boreal forbs and semi-shrubs (*Pyrola incarnata, P.secunda, Linnea borealis, Vaccinium vitis-idaea, Cystopteris fragilis*), mosses (*Hylocomium splendens, Aulacomnium palustre, Dicranum, Pleurozium sp.div.*) and shrubs (*Rosa acicularis, Lonicera altaica, Spiraea media*) on the northern slope. **IV. High mountain belt:** *9. Larix sibirica–Pinus sibirica* open woodlands alternating with schrub thickets (*Betula rotundifolia, Salix* sp.div.) on the northern slope; *10.* high mountain tundra: *Dryas oxyodonta* tundra with *Kobresia myosuroides, K.simpliciuscula, Carex stenocarpa, Hierochloë alpina* alternating with *Carex and Kobresia* communities on the northern slope; *11.* psychrophytic high mountain herbaceous communities: *Carex ledebouriana, C.stenocarpa* communities, *Kobresia sibirica* communities with highmountain forbs (*Claytonia joanneana, Polygonum viviparum, Saxifraga hirculis*) alternating with lichen tundra (*Cetraria* sp.div.); *12.* rocky placer with aggregations of the high mountain cryopetrophilous forbs. **Borders:** *13.* of the belts; *14.* of the sub-belts.

grass stand are *Sanguisorba officinalis, Vicia cracca, Polygonum alopecuroides, Campanula turczaninovii* and othes species.

The vegetation of the taiga-meadow belt (1900–2350 m ab. s. l.) is represented by the local larch or "cedar" – larch forests combined with steppified meadows. *Rhytidium rugosum* and some species of boreal mosses (*Hylocomium splendens, Aulacomnium palustre, Pleurozium schreberi, Polytrichum alpestre,* etc.) dominate in moss storey in forests, as well as *Vaccinium vitis-idea, Pyrola incarnata* and other boreal semi-shrubs prevail in understorey.

The "column" of belt includes high mountain meadow belt, where *Kobresia myosuroides* or lichen–sedge (*Carex rupestris*) communities on high mountain frozen soils combine with open woodlands (*Pinus sibirica*) with *Festuca altaica, Carex ledebouriana.* The cryophytic *Festuca lenensis* steppes with *Carex rupestris, Kobresia filifolia, Thalictrum alpinum, Potentilla nivea* occupy the small plots.

1c. Nerchinsk–Onon sub-province (Dahuria in the narrow sense) occupies the lowhills of the eastern Khentei Mts. up to the Greater Khingan Mts. *Filifolium sibiricum, Leymus chinensis, Stellera chamaejasme, Saposhnikovia*

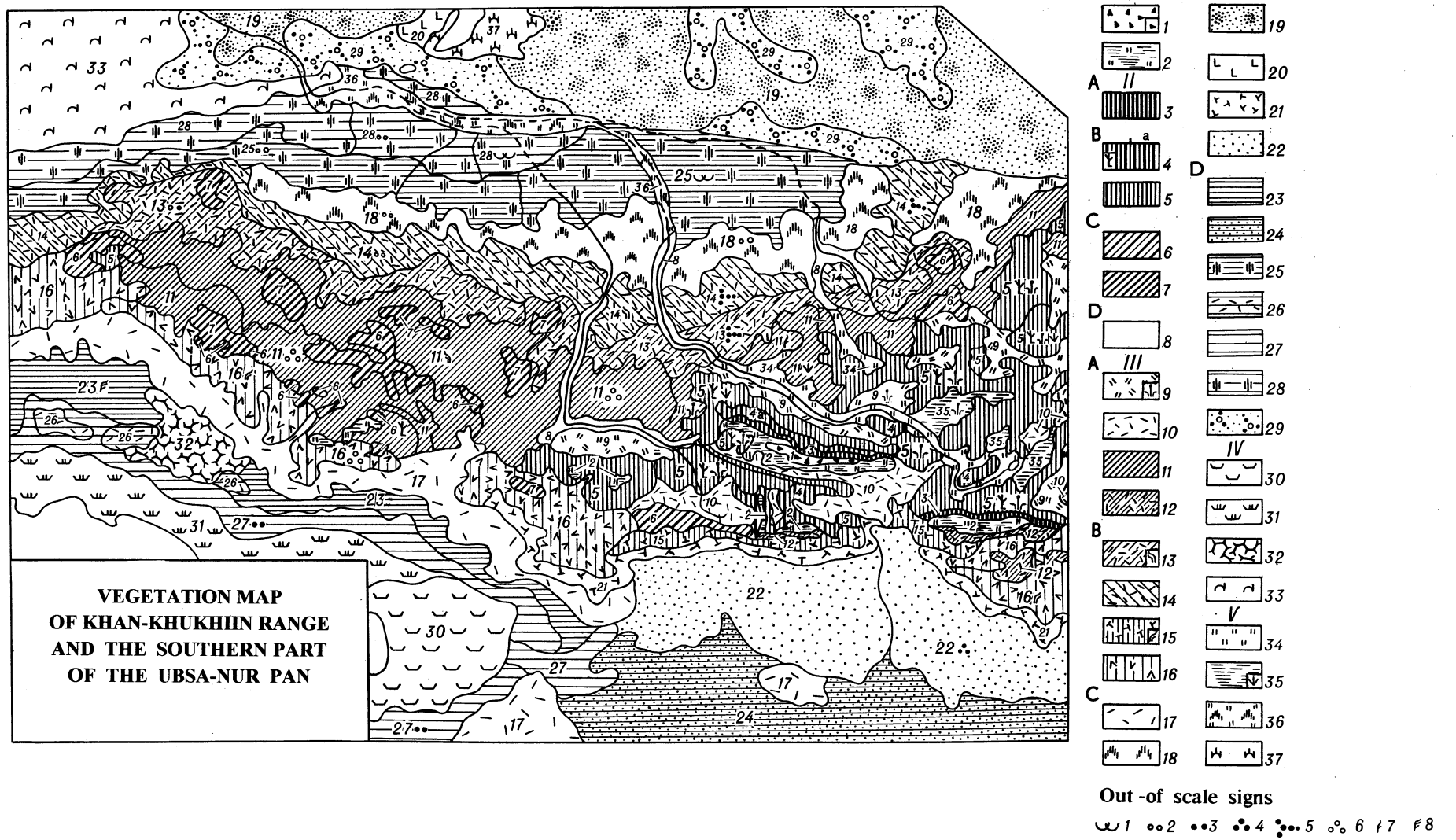

Fig. 20. Vegetation map of the Khan-Khukhiin Ula Range and southern part of the Ubsa-Nur Pan.

Fig.20. Vegetation map of the Khan-Khukhiin Ula Range and southern part of Ubsa-Nur Pan.
I. High mountain tundra. Psychrophytic *Carex, Kobresia* and herbaceous communities: *1.* rocky placer with fragments of *Dryas oxyodonta* tundra, moss and moss-shrub (*Betula rotundifolia, Salix recurvigemmis, S.rectijulis*) tundra and high mountain *Carex melanocarpa, Kobresia sibirica* communities alternating with alpine meadows (*Myosotis suaveolens, Trollius asiaticus,* etc.) and the aggregations of the high mountain forbs (*Hedysarum inundatum, Claytonia joanneana, Melandrium apetalum,* etc.); *2.* high mountain *Carex* (*Carex melanocarpa, C.stenocarpa, C.melananthiformis*), *Kobresia* (*K.sibirica*) communities rich in mosses (*Drepanocladus incinatus, Tomenthypnum nitens, Colliergon giganteum*).
II. Forest. A. High mountain open woodlands ("Gol'tsy"): *3. Larix sibirica–Pinus sibirica* woodlands alternating with *Betula rotundifolia* thickets with mosses (*Hylocomium splendens, Aulacomnium turgidum, A.palustre, Dicranum elongatum*) or *Salix* (*S.saposhnikovii, S.glauca, S.rectijulis*) thickets and *Kobresis sibirica* communities with *Helictotrichon asiaticum, Thalictrum alpinum, Potentilla gelida, Hedysarum inundatum.* **B.** Boreal forests: *4. Larix sibirica–Pinus sibirica* forests with boreal forbs, semi-shrubs (*Vaccinium vitis-idaea, Linnea borealis, Pyrola incarnata, Cicerbita azurea*) and mosses (*Hylocomium splendens, Aulacomnium palustre, Climacium dendroides*), *4a. Larix sibirica–Pinus sibirica* forests with shrubs (*Lonicera altaica, Rosa acicularis, Dasiphora fruticosa*) and forest forbs (*Bromus korotkyi, Carex amgunensis, Cicerbita azurea, Thalictrum minus*) in the understorey. **C.** Sub-boreal steppified forests: *6. Larix sibirica* forests with *Agrostis trinii, Calamagrostis obtusata, Carex amgunensis, Lilium martagon, Dianthus superbus, Trifolium lupinaster, Cicerbita azurea,* etc.; *7. Larix sibirica* forests alternating with steppe shrub thickets (*Cotoneaster melanocarpa, Dasiphora fruticosa*). **D.** Poplar flood-land forest: *8. Populus laurifolia* forest with *Salix pseudopentandra* and *Betula hippolytii* alternating with meadows (*Geranium pratense, Sanguisorba officinalis, Valeriana officinalis, Thalictrum minus,* etc.).
III. Steppe. A. Steppified meadows and meadow steppes: *9.* forb–grass and grass–forb steppified meadows (*Coluria geoides, Schizonepeta multifida, Scabiosa ochroleuca, Myosotis suaveolens, Veronica incana, Dianthus versicolor, Gentiana decumbens, Cerastium arvense, Helictotrichon schellianum, Carex pediformis*) alternating with *Dasiphora fruticosa* thickets; petrophytic sedge–forb steppified meadows (*Artemisia laciniata, A.commutata, Sanguisorba officinalis, Polygonum alpinum, Leontopodium ochroleucum, Silene repens, Aster alpinus, Androsace ovczinnikovii, Carex pediformis*); forb–sedge–grass meadow steppes (*Helictotrichon altaicum. H.schellianum, Carex pediformis, Phleum phleoides, Coluria geoides, Trifolium lupinaster, Schizonepeta multifida,* etc.) alternating with schrub thickets (*Berberis sibirica, Lonicera microphylla, Cotoneaster melanocarpa*); *12.* high mountain forb–bunch-grass steppes (*Festuca lenensis, F. kryloviana, Carex rupestris, Oxytropis chionophyla, Saussurea saichanensis, Eritrichium pauciflorum, Potentilla crebridens*) alternating with petrophytic serial forbs communities (*Arenaria formosa, Minuartia verna,* etc.). **B.** Forb–bucnh-grass steppes: *13. Festuca valesiaca–Stipa capillata* steppes with petrophilous forbs (*Gypsophilla patrinii, Coluria geoides, Dracocephalum origanoides,* etc.) and *Caragana pygmaea* alternating with petrophytic forb communities: *14.* petrophytic forb–bunch-grass *Festuca valesiaca–Poa attenuata–Artemisia frigida* steppes with petrophilous forbs (*Arenaria capillata, Goniolimon speciosum, Orostachys spinosa, Allium tenuissimum,* etc.); *15.* petrophytic *forb* or *forb–wormwood* (*Artemisia santolinifolia, A.commutata, Chamaerhodos altaica, Thalictrum foetidum, Leontopodium ochroleucum,* etc.) serial communities alternating with petrophytic *Poa attenuata* steppes; *16.* petrophytic forb or forb–bunch-grass *Festuca valesiaca* steppes with *Thesium refractum, Pedicularis achilleifolia, Smelovskia mongolica.* **C.** Bunch-grass dry steppes: *17.* mixed bunch-grass *Stipa krylovii–Cleistogenes squarrosa–Poa attenuata–Koeleria macrantha* steppes with *Caragana bungei* and *C.pygmaea*; *18. Stipa capillata–Festuca valesiaca–Cleistogenes squarrosa–Artemisia frigida–Potentilla acaulis* steppes with *Spiraea hypericifolia* and *Caragana pygmaea*; *19.* psammophytic bunch-grass steppes alternating with psammophytilous forbs (*Gypsophila paniculata, Vincetoxicum sibiricum,* etc.) communities; *20.* petrophytic *Festuca valesiaca* steppes with *Melandrium viscosum, Alyssum lenense* and *Caragana pygmaea* alternating with petrophytic forb (*Orostachys spinosa, Youngia tenuifolia, Melandrium viscosum,* etc.) communities and shrub thickets (*Spiraea hypericifolia, Berberis sibirica*); *21.* petrophytic forb–bunch-grass *Festuca valesiaca* steppes with *Artemisia commutata, Oxytropis aciphylla, Dracocephalum foetidum*; *22. Stipa krylovii–Cleistogenes squarrosa* with *Stipa gobica* steppes. **D.** Dwarf semi-shrub–bunch-grass desertified and desert steppes: *23. Stipa gobica–S.krylovii* steppes with *Asterothamnus heteropappoides, Potentilla astragalifolia, Gypsophila desertorum*; *24. Stipa gobica–Cleistogenes squarrosa* steppes with *Asterothamnus heteropappoides, Allium tenuissimum* and *Caragana pygmaea*; *25. Stipa capillata–Festuca valesiaca–Artemisia frigida* steppes in complex with *Artemisia schrenkiana* and *Nanophyton erinaceum* communities; *26.* petrophytic *Stipa gobica–S.klemenzii–Eurotia ceratoides* steppes with *Ajania fruticulosa. Limonium chrysocomum*; *27. Stipa gobica–S.glareosa–Anabasis brevifolia* with *Reaumuria soongorica* steppes; *28. Stipa sareptana–Festuca valesiaca* steppes in complex with *Artemisia schrenkiana* communities; *29.* psammophytic forb and grass (*Leymus racemosus, Bromus korotkyi, Iris tenuifolia, Hedysarum fruticosum*) serial communities.
IV. Dwarf semi-shrub deserts: *30. Reaumuria soongorica–Stipa gobica* with *Eurotia ceratoides* deserts; *31. Anabasis brevifolia–Allium polyrrhizum–Stipa glareosa–S.gobica* deserts; *32.* petrophytic serial (*Convolvulus gortschakovii, Chesneya mongolica,* etc.) communities; *33. Nanophyton erinaceum* desert with *Psathyrostachys juncea* and *Stipa glareosa.*
V. Psychrophytic, mesophytic and halophytic meadows: *34. Carex dichroa–C.orbicularis* meadows with *Kobresia sibirica, Eriophorum polystachyon* alternating with *Larix sibirica* forests (at the flood-lands); *35. Kobresia sibirica–Polygonum viviparum–Lagotis integrifolia* high mountain meadows alternating with *Carex orbicularis–C.dichroa–C.stenocarpa* communities; *36. Leymus secalinus–L.paboanus* halophytic meadows; *37. Achnatherum splendens* halophytic communities.
Out-of scale signs: *1. Oxytropis aciphylla, Artemisia globosa* communities with psammophilous plants (*Gypsophila paniculata, Agropyron sibiricum*); *2. Caragana bungei* thickets; *3. Caragana leucophloea* thickets with *Eurotia ceratoides*; *4. Caragana spinosa* thickets alternating with *Salix caesia, S.ledebouriana* thickets (at the flood-lands); *5. Caragana spinosa* thickets with steppe plants; *6. Dasiphora fruticosa* thickets; *7. Stipa zalesskii* meadow steppes; 8. *Spiraea hypericifolia, Lonicera microphylla* thickets with *Stipa kirghisorum.*

divaricata and others above mentioned species, which occasionally penetrate into the neighbouring from west Orkhon-Lower Selenga sub-province, begin to predominate here.

There are many species with eastern type of area, for example *Armeniaca sibirica, Iris dichotoma, Clematis hexapetala, Scutellaria baicalensis, Adenophora stenanthina. Paeonia lactiflora, Senecio argunensis* that almost entired in eastern districts of the sub-province. There is a very short description of the vegetation of the Orkhon–Lower Selenga sub-province in A. A. YUNATOV (1950) and E. M. LAVRENKO (1970 a) publications.

2. Mongolian steppe province [Dahuria–Mongolian steppe province without districts of 12, 13 and 18 (YUNATOV, 1950), which have been included by E. M. LAVRENKO (1970 a) into Khangai–Dahurian mountain forest-steppe province; dry steppe subzone of the Mongolian steppe province (LAVRENKO,1970a)]. This province occupies the large areas from the Southern and South-Eastern foothills of the Khangai Mts. in the west up to the western foothills of the Greater Khingan Mts. in the east.

Earlier E. M. LAVRENKO (1970 a) embraced the dry and desert steppes of Mongolia into united province as it had been done by him for the Black Sea and Transvolga–Kazakhstanian provinces of Eurasian Steppe Region (LAVRENKO, 1970b). The detail treatments, carried out in Mongolia in recent years show the specific features of the dry communities and desert steppe ones. Owing these works the provincial division of the Mongolian steppe zone as well as the position of the subzonal boundaries have been determined more exactly. We regard the Mongolian steppe province only as the true dry bunch-grass steppes, but consider the desert steppes as an independent province. This idea corresponds with A. A. YUNATOV (1974) conception. As it has been mentioned above the feather grasses of the Mongolian

dry steppes are represented by species of Section *Leiostipa.* They could be united into the aggregation *Stipa capillata* s.l. or "Species Row" *Capillatae,* but in considerably narrow sense, than R. YU. ROZHEVITS (1934) interpretated this Row. In the desert steppes the species of the Section *Smirnovia* determined by N. N. TSVELEV (1976) prevail. This Section includes the group of very low feather grasses (*Stipa glareosa, S. gobica, S. klemenzii, S. tianschanica*) called in Russia as "kovyl'ki". The floristic composition of the desert steppes differs significantly from the dry bunchgrass ones (GRUBOV, 1990; RACHKOVSKAYA, 1993).

Stipa krylovii predominates in Mongolian steppe province[5]. *Cleistogenes squarrosa* (Eastern Black Sea-Kazakhstan–Mongolian sp.), *Agropyron cristatum* (Eastern Siberia–Central Asian sp.), *Koeleria macrantha, Poa botryoides* (Mongolia–East Siberian sp. with irradiation to southern mountains up to the Eastern Tien-Shan and the Alashan' Ridge) and *Leymus chinensis* (Eastern Siberia–Manchzhuria–Mongolian sp.) are the co-dominant and often dominant species also. *Stipa klemenzii* (Mongolian sp. with the sporadic distribution in the southern part of Khangai, Gobi Altai and in Dahuria up to Russian frontier) is a typical species on the gravelly carbonate soils and in the northern stripe of the province. *Stipa grandis* predominates on the sand soils. *Artemisia frigida* (Holarctic or more exactly – East Palaearctic–North American sp.) is also the constant components of these steppes. There are some species of xerophilous forbs and semi-shrubs. *Potentilla bifurca, P. acaulis* (South Siberia–Kazakhstan–Mongolian sp.), *Bupleurum scorzonerifolium, Astragalus melilotoides* (Manchzhuria–Mongolia-Dahurian sp.), *Allium bidentatum, A. anisopodium, Haplophyllum dauricum, Bupleurum bicaule, Convolvulus ammanii* (Dahuria-Mongolian sp.; the latter is distributed in East Kazakhstan also), *Serratula centauroides,* etc. are amongst them. *Artemisia adamsii* is the ordinary species on the rodent (*Lasiopodomys brandtii*) settlements. The rare thickets of *Caragana* sp.div. are usual for these steppe communities also. In particular *Caragana microphylla* and *C. stenophylla* are typical for the more northern types of steppes as well as *C. pygmaea* (Dahuria–Mongolian sp.) grows in the southern types.

Some data for the eastern part of the Mongolian steppe province vegetation are published by E. M. LAVRENKO (1970) and by German scientists (DANERT, GEIEZ, HANELT, 1961). They worked in 1950th in the northern part of Inner Mongolia (Barga steppe) and in North-Eastern (Manczhurian) plain of China.

A floristic composition of the Inner Mongolian steppe does not differ from the same subzonal types of steppes within the Mongolian province.

Mongolian steppe province is divided into two sub-provinces: a. Middle Khalkha (the more western) sub-province and b. East Mongolian one. The boundary between them passes approximately along 114° East l.

2a. Middle Khalkha sub-province. The steppes of this sub-province are thoroughly described by A. A. YUNATOV (1950). The dry steppe field station of the Joint Soviet-Mongolian complex biological expedition has situated on this territory (Somon Undzhul) in 1970–1980th. The detail morphologic-biological investigations of the main component of the dry steppe communities , as well as the floristical, phytocoenological and faunistical investigations in the typical biogcocoenoses have been carried out (LAVRENKO, 1984, 1988).

The Middle Khalkha steppes have all characteristic features that are peculiar to Mongolian true steppes. Mixed bunch-grass *Stipa krylovii–Cleistogenes squarrosa–Agropyron cristatum–Poa botryoides* steppes with xerophilous forbs and shrubs (especially *Caragana microphylla*) occupy the large area on the deluvial-proluvial plains. They combines with halophytic meadow communities (*Iris halophylla* or *Achnatherum splendens*) on the flat saline pans or with petrophytic forb and shrub (*Caragana stenophylla, C. microphylla, Amygdalus pedunculata*) communities on the slopes of low hills, which are also typical for this territory. The various types of *Festuca lenensis* steppes prevail on the slopes of the high hills, as well as *Cleistogenes squarrosa* steppes with abundance of *Caragana microphylla* on the sandy-loam soils.

2b. East Mongolian sub-province occupies the large areas eastward and south-eastward from the Khentei Mts. up to the frontiers with Russia and China.

The lake-alluvial, deluvial-proluvial plains prevail there. Their altitudes above the sea level do not exceed 1000 m all along and gradually become lower (up to 700–550 m) to the east and north-east. The large areas of the plains are westward from the Buir-Nur Lake and near the Khukh-Nur Lake especially. The flat and undulate plains alternate with separate lowmountans for example Tumen-Tsogt and Matad-Ula 1200–1300 m ab. s. l., as well as with a flat saline pans.

The dark chestnut soils, chestnut and light chestnut ones predominate there.

The zonal regularities of the vegetation are not manifested distinctly on this territory because of the Pacific Ocean monsoon's influence and due to the meridional stretching of the Greater Khingan Mts. The zones have rather longitudinal disposition here. The monotony and uniformity of the East Mongolia plains' vegetation are perfectly illustrated by the profile, which crosses the Menengiin Tal plain from 47° 40' up to 46° 25' N latitude (fig. 21). Only on the foothills of Khentei and Greater Khingan, as well as on the slopes of the low mountains more mesophytic steppe vegetation appears.

The characteristics of the Eastern Mongolian steppes have been described in publications by B. DASHNJAM (1966, 1974), E. A. VOLKOVA (1988). The floristic originalities of the plant communities are depicted on the Vegetation map of MPR (KARAMYSHEVA, DASHNJAM, 1993). From the middle of 1980th the steppe field station of the Joint Soviet-Mongolian complex biological expedition existed in the Eastern Mongolia near Somon Tumen-Tsogt. The principal attention was given to the all-around investigation of the composition and structure dynamics of the main ecosystems in the connection with the burrowing activity of animals. The transformation of the ecosystems, which is the result from the cattle grazing and ploughing has been the subject of investigation.

During the last years the flora of Eastern Mongolia and Dahuria has been substantially supplemented (GUBANOV, KAMELIN, BUDANTSEV, *et al.*,1989).

The steppes of this sub-province differ from the Middle Khalkha one in the greater presence of the rhizomatous grass *Leymus chinensis*, which coenotic role increases on the faintly saline soils. The communities of the Eastern Mongolian steppes are enriched also with South Siberia-Dahuria-Mongolian and

[5] TSVELEV N. N. (1968) thinks that the area of *Stipa krylovii* Roschev. occupies a great part of Central Asia (except of its southern territries). At the southern of its distribution area *Stipa krylovii* is found in the mountain steppes: in the middle mountain belt of the Alashan' ridge, in the low mountain belt of Richtkhofen ridge (the Nan'-Shan' Mts.) and in the mountains surrounding the Tsaidam Hollow (YUNATOV, 1950; LAVRENKO, 1966; KHOU, 1979, 1983). The isolated plots of *Stipa krylovii* distribution area is situated in Central Jakutia and in the Jana River upper reaches. As TSVELEV notes (1968) *S. krylovii* is rather similar to *S. sareptana* (Eastern Black Sea–Kazakhstan sp.) being its geographycally replaced race.

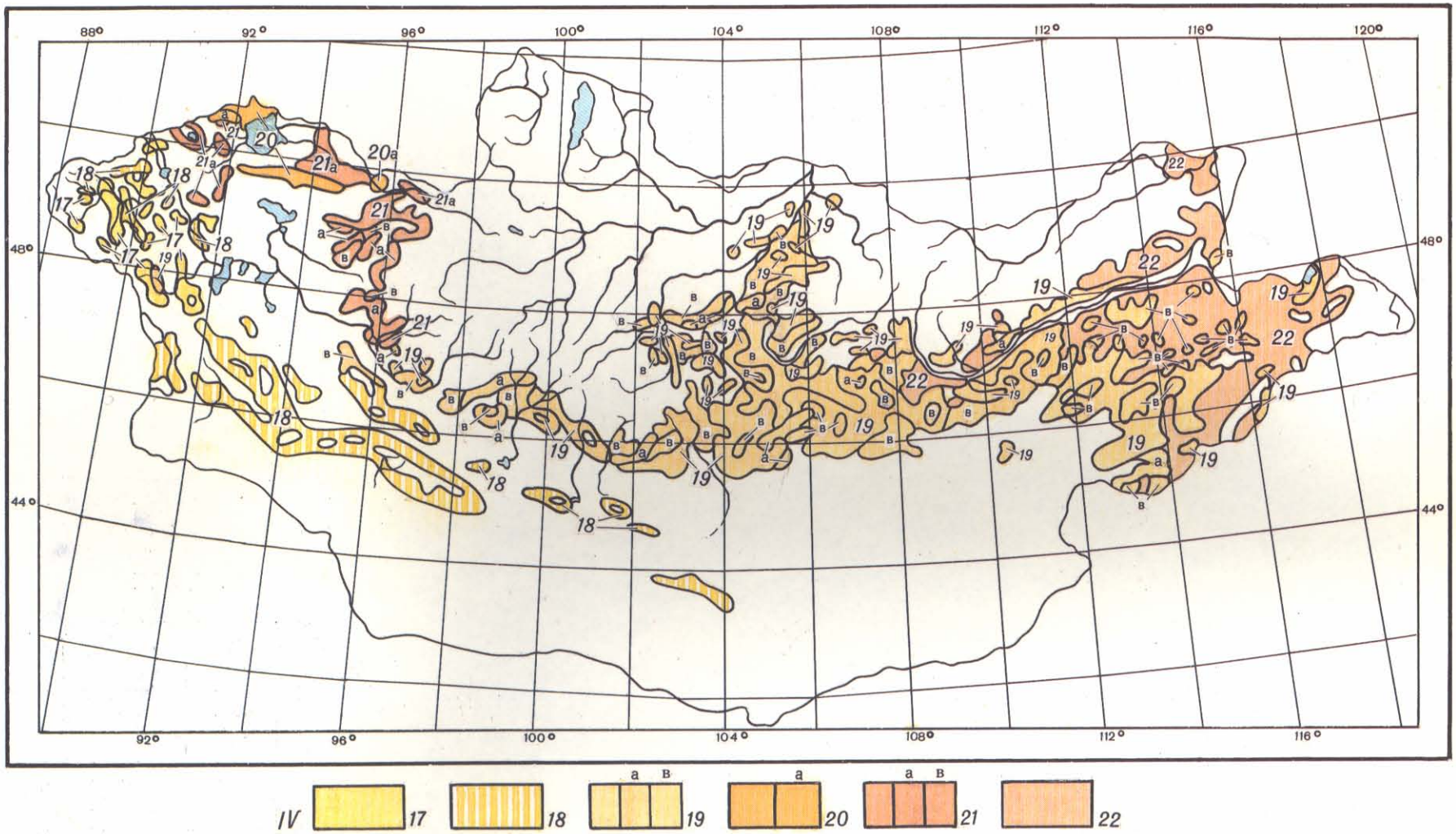

Fig.14. IV. Distribution of the bunch-grass and rhizomatous grass dry steppes: *17.* Mongol Altaian and Khangaian; *18.* Mongol Altaian and Gobi Altaian; *19.* Mongolian; *20.* West Mongolian; *21.* West Mongolian; *22.* East Mongolian.

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Manchzhurian species of forbs (*Haplophyllum dauricum, Cymbaria dahurica, Lespedeza dahurica, L. hedysaroides, Astragalus melilotoides, A. tenuis, Saposhnikovia divaricata, Bupleurum scorzonerifolium, etc.*) The species of onium (*Allium senescens, A. bidentatum, A. anisopodium, A. odorum, A. condensatum*) are especially typical for this type of steppes. There are also some South Siberia-Kazakhstan-Mongolian sp. (*Potentilla acaulis, P. bifurca, Glycyrrhiza uralensis*). Abundance of these forb species even in East Mongolian dry steppes (especially more northern types) differ them from the poor communities of the Middle Khalkha steppes.

The Eastern Mongolian steppes are characterised by the abundance of wormwood species: *Artemisia frigida, A. tanacetifolia, A. commutata, A. adamsii,* and some annuals and biennial ones (*A. anethifolia, A. scoparia,* etc.), as well as species of *Carex* (*C. korshinskyi, C. duriuscula;* the latter is broadly dispersed in the communities degraded as a result of the cattle grazing). *Carex pediformis* is the typical species in the bunch-grass steppes that are rich in forb on the hill slopes.

The Eastern Mongolian steppes are the mixed bunch-grass ones. The dominants and co-dominants of these steppes are the same as in the Middle Khalkha ones. *Stipa krylovii* and *Stipa baicalensis* are the prevailing species in more northern mesophytic type of steppes, *Stipa sibirica* are distributed in more mesophytic steppes and on the gravelly soils also, *Stipa grandis* grow on the light soils; *Agropyron cristatum, Poa botryoides, Cleistogenes squarrosa, Koeleria macrantha* are the typical components of steppe communities. *Cleistogenes kitagawae* occur in more mesophytic types of steppes.

On the plains near the Khukh Nur Lake with the stratified soils (the loam stretches under by sandy) the communities with specific floristic composition are distributed. The xerophilous species (*Cleistogenes squarrosa, Agropyron cristatum*) combine with the mesophilous ones (*Filifolium sibiricum, Sanguisorba officinalis, Iris dichotoma, Hemerocallis minor,* etc.), which are more typical for the meadow steppes of Dahuria.

On the saline pans on the central part of East Mongolia (Tamsag-Bulak and south-westward from it) *Achnatherum splendens, Leymus chinensis, Carex duriuscula* communities grow while *Allium polyrrhyzum, Reaumuria soongorica, Limonium bicolor,* and annual species of *Salsola* and *Suaeda* grow on solonets and solochaks.

The vegetation of the low mountains and high hills (Matad-Ula, Tumen-Tsogt) is distinguished by the very rich composition. *Stipa baicalensis* or *Filifolium sibiricum* communities with *Stellera chamaejasme, Polygonum divaricatum, P. valerii, Oxytropis myriophylla* and other species that have a prominent role in Nerchinsk–Onon subprovince are distributed here. *Festuca lenensis* communities with some petrophilous species (*Androsace incana, Amblynotus rupestris, Thymus dahuricus, Chamaerhodos trifida, Arctogeron gramineum, Oxytropis filiformis,* etc.) are typical on the gravelly soils. Presence and sometimes dominance of *Armeniaca sibirica* is rather usual there, as well as of the other petrophilous shrubs (*Dasiphora fruticosa, D. parvifolia, Spiraea aquilegifolia).*

On the top of the low mountains the following types of steppes are spread: *Festuca lenensis* rich in petrophilous forbs (*Oxytropis filiformis, Pulsatilla bungeana, P. turczaninovii, Peucedanum hystrix, Aster alpinus, Trifolium lupinaster*); *Stipa baicalensis–Festuca sibirica–Helictotrichon schellianum* rich forbs (*Hemerocallis minor*) and *Filifolium sibiricum* rich in forbs communities. All of these types of steppes are usual for the Nerchinsk–Onon subprovince.

Some regularities and characteristic features of Eastern Mongolian vegetation depict on the map and on the profile (fig. 21 , fig. 22).

As it has been found *Caragana microphylla* rather often appears as a landscape species in the different ecological type of plant communities from the meadow steppes up to the desertified ones. The distribution of this species is connected with the settlements of the burrowing rodents. They destroy the compact calcareous horizon of soils, that are responsible for its loosening and for the creating more favourable condition for the shrubs growing (GURICHEVA, DMITRIEV, 1983; DMITRIEV, GURICHEVA, 1983; DMITRIEV, 1985; DMITRIEV, KHRAMTSOV, 1994; DMITRIEV, KHUDJAKOV, 1989; KHRAMTSOV, DMITRIEV, KHUDJAKOV, *et al.*, 1993; KHRAMTSOV, DMITRIEV, 1995).

The investigations on the field station corroborated that the heterogeneity (mosaic and complexity) of both vegetation and soil were the result of the burrowing activity of rodents (**Lasiopodomys brandtii, Microtus gregalis, Marmota sibirica**) and hare-like (**Ochotona dahurica**). The activity of these animals had undoubtedly influenced the functioning of the Mongolian steppe communities in the past and continues to determine its present state. In fact, the diversity and ecological peculiarities of burrowing animals determines not only the composition of the vegetation but its horizontal structure (GURICHEVA, DMITRIEV, 1983; DMITRIEV, GURICHEVA, 1983; DMITRIEV, KHRAMTSOV, 1994; KHRAMTSOV, DMITRIEV, 1995).

The proportion of the basic communities that developed on the soils not affected by the burrowing activity of animals, and zoophytochors, that is serial ecosystems which related with settlements of animals fluctuates from 10 up 80–90 % in different types of landscapes. The vegetation of the zoophytochors is usually a contrast with the background ones both by its more mesophytic composition and its structure. *Caragana microphylla* is the most typical (terriophylous) species that grows exclusively on the burrows (DMITRIEV, 1985; DMITRIEV, KHRAMTSOV, 1994; KHRAMTSOV, DMITRIEV, 1995). The annual and biennial species of *Artemisia* also luxuriantly grow on the new or on the renewed burrows. The common composition of these communities, as well as background one is naturally connected with their zonal and regional position and the texture of the soils.

The cattle-breeding activity is not the least factor for the existence and present diversity of the Mongolian steppes (KHRAMTSOV, DMITRIEV, 1993; KHRAMTSOV, DMITRIEV, KHUDJAKOV, *et al.*, 1993). Some peculiarities of the vegetation cover dynamics and transformation, as they exist in the Eastern Mongolian steppes, are shown on the figure (fig. 22).

3. North Gobi desert steppe province [North Gobi desert steppe provinces and Mongolian Altai mountain steppe ones (YUNATOV, 1950, 1974); desert steppe subzone of the Mongolian steppe province (LAVRENKO, 1970a)] occupies the areas from the western part of Mongolia at the frontier with Russia up to the eastern frontier of the country. At the extreme east the desert steppe subzone extends to the south in longitudinal direction on the territory of China. It includes the Big Lake Pan, the Lake Valley and the deluvial-proluvial plains in the south and south-east foothills of Khangai. The Mongolian Altai and the northern part of Gobi Altai (the Ikhe-Bogdo, Baga-Bogdo and Arts-Bogdo Mts.) also belong to this province, as well as the foothills at the southern macroslope of the Khangai Mts. (KARAMYSHEVA, BANZRAGCH, 1977).

At the boundary between the true dry bunch-grass steppes and dwarf semi-shrub–bunch-grass ones there is a narrow "transition" stripe that we determine as a subzone of desertified steppes.

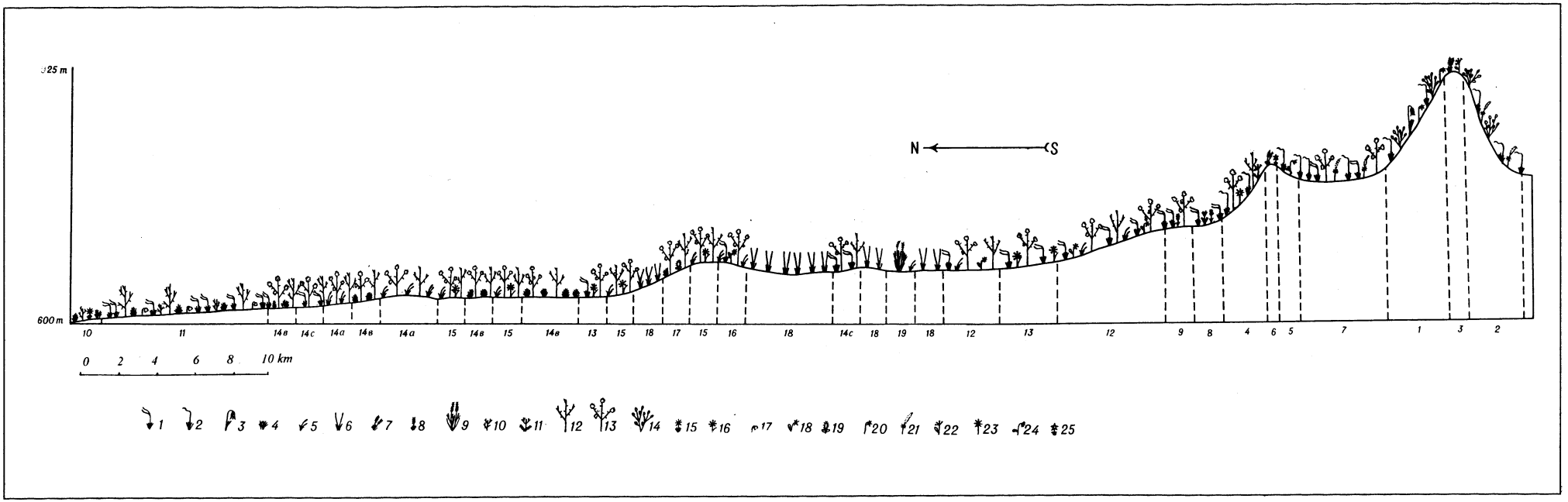

Fig.21. Regularity of the vegetation on the Meningiin Tal Plain (Eastern Mongolia).

Bunch-grass rich in forbs petrophytic steppes on the chernozem soils: *1. Filifolium sibiricum,* and bunch-grass (*Stipa sibirica–S.baicalensis–Koeleria mukdensis) steppes* with forbs (*Scutellaria baicalensis, S.scordiifolia, Leontopodium leontopodioides, Lilium pumilum, Polygala tenuifolia,* etc.) and shrubs (*Armeniaca sibirica, Caragana microphylla*) on the northern slope; *2.* Mixed bunch-grass (*Stipa baicalensis–Festuca lenensis–Stipa sibirica–Cleistogenes kitagawae*) steppes with forbs (*Galium verum, Polygonum divariatum, Thalictrum squarrosum, Alyssum lenense,* etc.) and shrubs (*Armeniaca sibirica, Caragana microphylla*) on the southern slope; *3.* Petrophytic forb communities (*Arctogeron gramineum, Amblynotus rupestris, Filifolium sibiricum,* etc.) on the top.

Forb–bunch-grass steppes on the chernozem soils: *4.* Mixed bunch-grass (*Stipa baicalensis–S.krylovii–Koeleria mukdenensis–Agropyron cristatum–Leymus chinensis*) steppes with forbs (*Scutelaria baicalensis, Saposhnikovia divaricata, Allium condensatum, Lespedeza dahurica, Filifolium sibiricum,* etc.) and shrubs (*Caragana microphylla, C.stenophylla*) on the north slope; *5.* Mixed bunch-grass (*Stipa baicalensis–S.sibirica–Festuca lenensis–Agropyron cristatum*) steppes with forbs (*Alyssum lenense, Bupleurum scorzonerifolium, Thalictrum squarrosum,* etc.) on the southern slope; *6.* Petrophytic forb (*Arctogeron gramineum, Orostachys spinosa, O.malacophylla, Arenaria capillaris, Allium anisopodium, A.condensatum,* etc.) communities on the top; *7.* Mixed bunch-grass (*Stipa baicalensis–S.sibiricus–Koeleria mukdenensis–Cleistogenes kitagawae*) steppes with forbs (*Galium verum, Potentilla tanacetifolia, Lespedeza dahurica, Filifolium sibiricum,* etc.) on the plain.

Bunch-grass and rhizomatous grass dry steppes on the dark chestnut soils: *8.* Mixed bunch-grass (*Stipa krylovii–S.sibirica–Cleistogenes squarrosa–Poa attenuata–Agropyron cristatum*) steppes with wormwoods (*Artemisia frigida, A.scoparia*) and xerophilous forbs (*Serratula centauroides, Astragalus melilotoides*) (hemipsammophytic type); *9.* Mixed bunch-grass (*Stipa krylovii–Agropyron cristatum–Koeleria macrantha*) steppes with xerophilous forbs (*Haplophyllum dauricum, Allium anisopodium,* etc.) and shrubs (*Caragana microphylla, C.stenophylla*); *10.* rhizomatous grass (*Leymus chinensis*) and mixed grass (*Cleistogenes squarroa–Leymus chinensis*) steppes with *Carex duriuscula* and *Allium polirrhizum* (hemihalophytic type).

Bunch-grass and rhizomatous grass steppes on the chestnut soils: *11. Stipa krylovii*, or *Stipa krylovii–Cleistogenes squarrosa* steppes with xerophilous forbs (*Haplophyllum dauricum, Bupleurum bicaule, Asparagus dahuricus, Cymbaria dahurica,* etc.) and onions (*Allium bidentatum, A.anisopodium*); *12. Stpa krylovii–Cleistogenes squarrosa* steppes with wormwoods (*Artemisia frigida, A.scoparia*); *13. Stipa krylovii–Cleistogenes squarrosa–Koeleria macrantha* steppes with onions (*Allium anisopodium, A.bidentatum, A.senescens*); *14.* Mixed bunch-grass *Stipa krylovii–Koeleria macrantha–Cleistogenes squarrosa* complex steppes with *Caragana microphylla* and *C.stenophylla*: *14a.* with dominance *Cleistogenes squarrosa* and shrubs; *14b.* with dominance *Stipa krylovii* and shrubs; *14c.* with dominance *Stipa krylovii, Artemisia frigida* and shrubs; *15. Koeleria macrantha–Stipa krylovii* steppes with onions (*Allium anisopodium, A.bidentatum*); *16. Koelria macrantha—Cleistogenes squarrosa–Agropyron cristatum* steppes with petrophilous forb (*Orostachys malacophylla, Goniolimon speciosum,* etc.); *17.Cleistogenes squarrosa* steppes with *Caragana microphylla*; *18. Leymus chinensis–Cleistogenes squarrosa* steppes with *Artemisia frigida, A. scoparia*; *19.* Leymus *chinensis–Stipa krylovii* steppes with *Achnatherum splendens* (halophytic type).

Pictures of plants: *1 – Stipa krylovii; 2 – Stipa baicalensis; 3 – Stipa sibirica; 4 – Cleistogenes squarrosa; 5 – Koeleria mukdenensis; 6 – Leymus chinensis; 7 – Festuca lenensis; 8 – Poa attenuata; 9 – Achnatherum splendens; 10 – Artemisia frigida; 11 – Artemisia commutata; 12 – Caragana stenophylla; 13 – Caragana microphylla; 14 – Armeniaca sibirica; 15 – Allium polirrhyzum; 16 – Orostachys spinosa; 20 – Lilium pumilum; 21 – Galium verum; 22 – Filifolium sibiricum; 23 – Leontopodium leontopodioides; 24 – Bupleurum bicaule; 25 – Arctogeron gramineum .*

Earlier A. A. YUNATOV proposed that there should be two subzonal steppe types namely the desertified steppe and desert one. They reflected the increasing of the xerophytization of the environmental conditions and demonstrated the changes of the steppe communities composition at the southern boundary of the Eurasian Steppe Region (YUNATOV, 1974: 29).

Desertified steppes of Mongolia as well as of Kazakhstan ones (which analogues they are), are connected with light chestnut soils while the desert steppes grow on the brown desert steppe soils (GERASIMOV, LAVRENKO, 1952). The boundary between the desert steppes and desertified one has been made more precise on the basic of the new map of vegetation (KARAMYSHEVA, DASHNJAM, 1990). The areas of the desert steppes in the conception accepted here were shown well on the vegetation map of Asia (LUKICHEVA, 1964) and China (KHOU, 1979,1983).

The vegetation of this province has been well studied by A. A. YUNATOV (1974) and by the botanist worked during 70–80th at the field station of the Joint Soviet-Mongolian complex biological expedition (LAVRENKO, 1980 a, b; 1984). This station was situated on the northern foothills of the Gobi Altai Mts.

Dominant species of desert steppe communities are *Stipa gobica, Cleistogenes songorica* (North Gobi sp.), *Stipa glareosa* (Central Asian sp.) and *Allium polyrrhisum* (Gobi-Mongolian sp.) which prevails on the light saline soils. The typical components are the desert dwarf semi-shrubs: *Anabasis brevifolia* (North Gobi sp.), *Salsola passerina* (East Gobi sp.) as well as *Oxytropis aciphylla* and *Artemisia caespitosa,* etc. *Caragana leucophloea, C. bungei* can be mentioned amongst the shrubs.

Forbs are not abundant. *Iris tenuifolia* (Kazakhstan-Mongolian sp.), *Allium mongolicum* (Gobi-Mongolian sp. especially abundant in the west part of the Big Lake Pan), *Scorzonera divaricata* (Gobi-Mongolian sp.), *Gypsophilla desertorum, Potentilla astragalifolia, Lagochilus ilicifolius, Peganum nigellastrum* (North Gobi sp.) are more usual. It is know that the desert steppes similar to the Mongolian ones are distributed more southward on the territory of China. So, on the vegetation map of China (KHOU, 1979, 1983) the steppes with dominance of *Stipa gobica* are depicted along the southern frontiers of Mongolia and then southward up to 45° N. l. Several types of the desert steppes, which are distributed in Mongolia can be mentioned there: *Stipa gobica–Artemisia frigida; Stipa gobica–Reaumuria soongorica; Stipa gobica–Salsola passerina; Stipa gobica–S. glareosa—Artemisia xerophytica; Stipa gobica–Caragana sp.*

In some districts between the southern frontier of Mongolia and Hwang Ho River there are the desert steppes with dominance of the Central Asian sp. *Stipa brevifolia* (LAVRENKO, 1959).

North Gobi desert steppe's province is divided into 3 sub-province: a) the sub-province of the Big Lakes Pan; b) North-Eastern Gobi sub-province and c) Mongol Altai an mountain steppe sub-province.

3a. The sub-province of the Big Lakes Pan occupies the system of Lake Pans that are situated between the Mongolian Altai Mts. and the southern foothills of Khangai. At the west it is limited by the East Tannu-Ola Ridge. The extensive Lakes (Ubsu-Nur, Khirgiz-Nur, Khara-Nur, Khoit-Dalai-Nur, Khara-Us-Nur) are found on the bottoms of the most deep pans. The Shargyn Gobi Pan, that earlier was included into Big Lakes Pan sub-province, now is interpretated as a part of the neighbouring North-Eastern Gobi sub-province.

The general type of relief is the flat lake-alluvial plains, which alternate with the separate massifs of the hills. However in some districts the high mountain ranges exist, where there are the well-pronounced altitudinal regularities of the vegetation (KARAMYSHEVA, BUJANORSHYKH, BEKET, *et al.*, 1984).

There are great distinctions in the vegetation of the different lake pans. For example, the lake-alluvial plains around Khirgiz-Nur lake, Khara-Nur lake, and other more eastern located lakes are covered by typical Central Asian and North Gobi desert and desert steppe communities: *Stipa glareosa* with *Anabasis brevifolia* and other dwarf semi-desert shrubs or *Stipa glareosa–Reaumuria soongorica* desert steppes are replaced by *Stipa glareosa–Cleistogenes squarrosa* with *Caragana bungei* desertified steppes on higher part of lake bottom. The abundance of some endemic and rare species, for example, *Asterothamnus heteropappoides* is typical for these steppes. *Chenopodium frutescens* (endemic of Achit-Nur lake, Ureg-Nur, Khirgiz-Nur ones) is usual in the petrophytic variants of desert and desert steppes. The isolated locality of *Haloxylon ammodendron* communities exists in the hollow between the Mongolian Altai Mts. and the Dzhargalant-Ula Ridge. It is the most north-western point of *Haloxylon ammodendron* distribution area. The petrophytic *Agropyron nevskii* communities are found at the slopes of hills.

The vegetation of more western Ubsu Nur Pan is very peculiar (KARAMYSHEVA, BAZRAGCH, 1976 a,b; KARAMYSHEVA, SUMERINA, BEKET, et.al., 1985). A. A. YUNATOV (1950) and P. HANELT (1970) wrote earlier that some Turanian and Dzhungaria-Turanian communities for example, *Nanophyton erinaceum* one, are distributed here. Many new data about spreading of some communities not typical for the Mongolian vegetation have been replenished now. We have mentioned them already when described the vegetation of foot-hills of the Khan-Khukhiin-Ula ridge (see also fig. 20). Some vast sand massifs (Borig-Del-Els, Bor-Khara-Els, Mongol-Els) are located in this sub-province. The vegetation of these sand massifs is characterised by series of communities and aggregations of psammophilous plants. Psammophytic grass (*Psammochloa villosa, Bromus korotkyi, Elymus racemosus*) aggregations, forb (*Iris tenuifolia*), semi-shrub (*Hedysarum fruticosum, Ephedra sinica*) ones are widespread. The communities of *Artemisia* (*A. klementzae, A. xanthochroa,* etc.) are typical for Mongol Els sand massif. The shrub thickets of *Caragana bungei* broadly distribute at the periphery of the Borig-Del-Els sands. In the eastern part of these sands *Larix sibirica* woodlands grow with *Caragana arborescens* in the shrub layer and *Helictotrichon altaicum, Coluria geoides, Onosma transrhymnense* and other species in herbaceous layer. In the central part of the Borig-Del-Els sands *Stipa pennata* (West Palaearctic sp.) communities with *Gypsophylla paniculata* and other psammophilous plants have been described (Lavrenko, KARAMYSHEVA, NIKULINA, 1991).

Achnatherum splendens communities grow on the shores of the lakes as well as *Kalidium gracile* sometimes *K. foliatum* distribute on solonchaks.

3b. North Eastern Gobi sub-province occupies rather narrow stripe from the Shargyn-Gobi Pan at the west, includes also the Lake Valley and stretches up to Sain-Shained Somon at the east. To the south-east from Sain-Shained the desert steppes stripe takes the meridional direction, following along the eastern shore of the Hwang Ho River up to the Loess Plateau, which locates at the north from Lanzhou Shi.

The vegetation of this sub-province is characterised by the typical North Gobi communities. *Stipa gobica, S. glareosa, Cleistogenes songorica* and *Allium polyrrhizum* are the dominants and the xerophilous dwarf semi-shrubs *Anabasis brevifolia, Artemisia xerophytica, Reaumuria soongorica* and especially *Salsola passerina* are co-dominance here. Some shrubs (*Caragana leucophloea, C. korshinskyi*) can

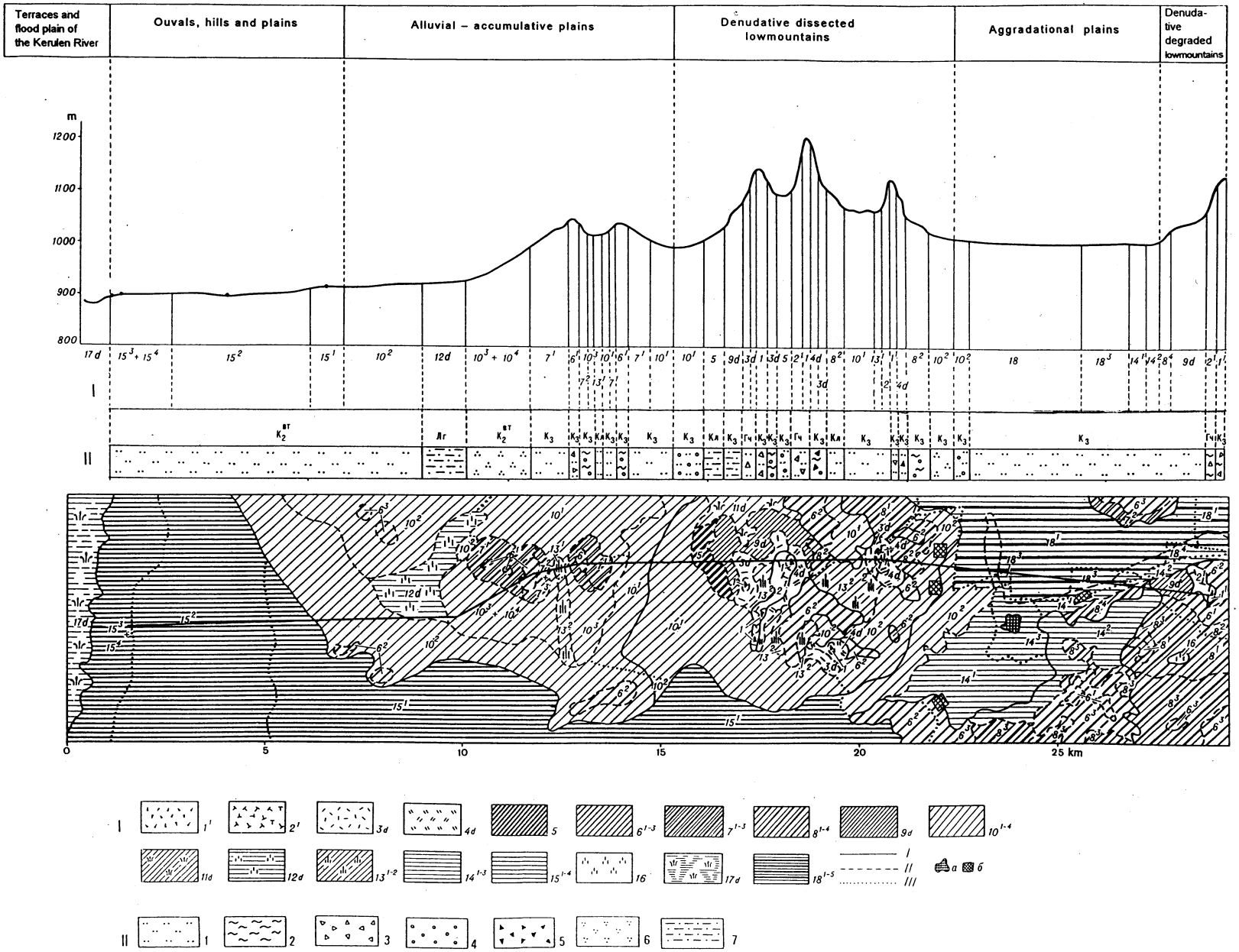

Fig. 22. The profile across plains and lowmountains and fragment of the vegetation map in the Eastern Mongolia (Somon Tumen Tsogt).

Fig.22. The profile across plains and lowmountains and fragment of the vegetation map in the Eastern Mongolia (Somon Tumen Tsogt).

1. The legend of the vegetation map:

VEGETATION OF THE STEEP CUT LOWMOUNTAINS

Grass–forb and forb–grass meadow steppes on the mountain chernozems

1. *Festuca lenensis* communities rich in petrophilous forbs (*Filifolium sibiricum, Oxytropis filiformis, Amblynotus rupestris, Androsace incana, Allium bidentatum, Alyssum lenense, Potentilla sericea*) with *Artemisia commutata, Stipa baicalensis* and *Spiraea aquilegifolia* (*petrophytic type*).
   1[1]. *Amblyonotus–rupestris–Androsace incana–Oxytropis filiformis* communities.
2. *Festuca lenensis–Oxytropis myriophylla* with forbs (*Clematis hexapetala, Stellera chamaejasme, Sanguisorba officinalis, Silene jenisseensis, Shizonepeta multifida*), with *Artemisia gmelinii* and *Dasiphora parvifolia* in complex with *Caragana microphylla–Stipa grandis* and *Spiraea aquilegifolia* communities (*petrophytic type*):
   2[1]. *Festuca lenensis* communities in complex with *Caragana microphylla–Stipa grandis* and *Spiraea aquilegifolia* communities.

Forb–grass and grass–forb true steppes with shrubs on the dark chestnut soils

3d. *Filifolium sibiricum–Festuca lenensis* communities rich in petrophilous forbs (*Oxytropis filiformis, O.myriophylla, Leusea uniflora, Shizonepeta multifida, Sanguisorba officinalis)* with grasses (*Stipa grandis, S.sibirica, Agropyron cristatum*) and shrubs (*Dasiphora parvifolia, Spiraea aquilegifolia, Armeniaca sibirica, Caragana microphylla, C.stenophylla*) (*petrophytic type*).

4d. *Artemisia gmelinii–Lespedeza dahurica* communities with sedges (*Carex korshinskyi, C.pediformis*), grasses (*Stipa sibirica, Agropyron cristatum*), forbs (*Lilium pumilum, Iris dichotoma*) and shrubs (*Spiraea aquilegifolia, Armeniaca sibirica, Ulmus macrocarpa*) (*petrophytic type*).

5. *Filifolium sibiricum–Stipa grandis* communities rich in forbs (*Saposhnikovia divaricata, Adenophora stenanthina, Serratula centauroides, Thalictrum squarrosum, Medicago ruthenica, Stellera chamaejasme*) in complex with *Stipa grandis–Caragana microphylla–Stipa sibirica* communities (*psammo-pelitophytic type*).

VEGETATION OF THE DEGRADED LOWMOUNTAINS

Grass-forb and forb-grass steppes on the dark chestnut soils

6. *Festuca lenensis–Pulsatilla bungeana–Arctogeron gramineum* communities with *Artemisia commutata* and *Caragana stenophylla* in complex with *Stipa grandis—S.sibirica–Festuca lenensis* communities (*petrophytic type*):
   6[1]. *Festuca lenensis–Arctogeron gramineum–Androsace incana* communities in complex with *Caragana microphylla–Stipa grandis* communities;
   6[2]. *Festuca lenensis–Pulsatilla bungeana* communities with *Thymus dahuricus, Artemisia commutata* in complex with *Stipa grandis–S.krylovii–Caragana microphylla* communities with annual forbs (*Axyris amaranthoides, Chenopodium acuminatum*);
   6[3]. *Medicago ruthenica–Bupleurum scorzonerifolium–Thymus dahuricus* communities in complex with *Artemisia dracunculus–Caragana microphylla–Axyris amaranthoides* communities;
7. *Filifolium sibiricum–Festuca lenensis* communities with grasses (*Leymus chinensis, Poa botryoides, Stipa grandis, Koeleria macrantha, Stipa baicalensis*) in complex with *Caragana microphylla–Stipa grandis* communities with *Polygonum divaricatum* (*hemipetrophytic type*):
   7[1]. *Filifolium sibiricum–Lespedeza dahurica* communities with *Cleistogenes squarrosa* and *Artemisia commutata* in complex with *Stipa grandis–Caragana microphylla* communities with *Polygonum divaricatum;*
   7[2]. *Lespedeza dahurica–Artemisia commutata* communities in complex with *Caragana microphylla–Stipa grandis–S.sibirica* communities with *Polygonum divaricatum;*
   7[3]. *Artemisia dracunculus–Stipa grandis–Axyris prostrata* communities with *Polygonum divaricatum.*
8. *Stipa grandis–Koeleria macrantha–Poa botryoides–Cleistogenes squarrosa* communities in complex with *Stipa sibirica–Caragana microphylla* communities (*hemipetrophytic-hemipsammophytic type*):
   8[1]. *Cleistogenes squarrosa–Poa botryoides–Koeleria macrantha–Stipa krylovii* communities in complex with *Stipa sibirica–S.grandis–Caragana microphylla* communities;
   8[2]. *Cleistogenes squarrosa–Artemisia frigida–Carex duriuscula* communities in complex with *Caragana microphylla–Stipa grandis–S.krylovii–Leymus chinensis* communities with annual forbs (*Axyris amaranthoides, Chenopodium acuminatum, Salsola pestifera*);
   8[3]. *Leymus chinensis–Cleistogenes squarrosa–Carex duriuscula* communities in complex with *Caragana microphylla–Stipa grandis–S.krylovii–Axyris amaranthoides* communities;
   8[4]. *Leymus chinensis–Carex duriuscula–Cleistogenes squarrosa–Artemisia adamsii* communities in complex with *Axyris amaranthoides–Leymus chinensis–Carex duriuscula* rich in annual forbs (*Chenopodium acuminatum, Salsola pestifera*) communities with *Caragana microphylla.*
9d. *Stipa grandis–Stipa sibirica–Leymus chinensis–Thymus dahuricus* communities with shrub (*Caragana stenophylla*) in complex with *Stipa sibirica–S.grandis* communities with *Caragana microphylla* (*hemipetrophytic-pelitophytic type*).

VEGETATION OF THE OUVALS, HILLS AND PLAINS IN THE MOUNTAINS

Grass steppes rich in forbs on the dark chestnut soils

10. Mixed forb (*Serratula centauroides, Heteropappus altaicus, Medicago ruthenica, Astragalus tenuis, Bupleurum scorzonerifolium, Silene jenisseensis, Gypsophilla dahurica, Scabiosa comosa*) communities with grasses (*Stipa grandis, S.krylovii, S.sibirica, Poa botryoides, Leymus chinensis, Festuca lenensis*) in complex with *Stipa grandis–S.sibirica–Caragana microphylla* communities with *Polygonum divaricatum* (*hemipsammophytic type*):
    10[1]. *Stipa grandis–Poa botryoides–Koeleria macrantha–Cleistogenes squarrosa* communities in complex with *Stipa grandis–S.sibirica–Caragana microphylla* communities with *Polygonum divaricatum;*
    10[2]. *Lespedeza dahurica–Cleistogenes squarrosa–Leymus chinensis–Stipa krylovii* communities in complex with *Stipa grandis–Stipa sibirica–Caragana microphylla* communities with *Polygonum divaricatum;*
    10[3]. *Artemisia frigida–Stipa grandis–Cleistogenes squarrosa* communities in complex with *Stipa grandis–Stipa sibirica–Caragana microphylla* communities with *Polygonum divaricatum;*
    10[4]. *Thymus gobicus–Artemisia xanthochroa–Chenopodium aristatum* communities in complex with annual *Axyris amaranthoides–Chenopodium acuminatum–Salsola pestifera* communities with *Caragana microphylla* and *Polygonum divaricatum.*

VEGETATION OF THE VALLEYS AND GORGES IN LOW HILLS PENEPLANE

Sedge–grass rich in forbs meadow steppes and steppified meadows on the meadow–chestnut soils

11d. *Leymus chinensis–Stipa sibirica* communities with forbs (*Galium verum, Artemisia frigida, Serratula centauroides, Adenophora stenanthina, Polygonum divaricatum*) and *Bromopsis inermis* (*pelitophytic type*).

12d. *Hemerocallis minor* communities with grasses (*Stipa krylovii, Cleistogenes squarrosa, Festusa lenensis*) and forbs (*Sanguisorba officinallis, Iris dichotoma*) in complex with *Caragana microphylla–Stipa sibirica–Stipa grandis* communities and *Dasiphora parvifolia* communities (*psammo-pelitophytic type*).

13[1]. *Stipa grandis–Leymus chinensis* communities with forbs (*Sanguisorba officinalis, Adenophora stenanthina, Polygonum divaricatum, Phlomis tuberosa*);
13[2]. *Leymus chinensis–Stipa grandis* communities with forbs (*Serratula centauroides, Adenophora stenanthina*) and dwarf semi-shrubs (*Artemisia frigida, Kochia prostrata*).

VEGETATION OF THE PLAINS

Forb–grass and grass–forb true steppes on the dark chestnut soils

14. *Stipa krylovii–Stipa grandis–Leymus chinensis* communities with forbs (*Medicago ruthenica, Serratula centauroides, Thalictrum squarrosum, Galium verum , Euphorbia discolor, Allium tenuissimum*) in complex with *Stipa sibirica–Caragana microphylla* communities (*pelitophytic type*):
14[1]. *Stipa grandis–Agropyron cristatum–Cleistogenes squarrosa–Leymus chinensis* communities with wormwoods (*Artemisia frigida, A.scoparia*) in complex with *Stipa grandis–Stipa sibirica–S.krylovii–Caragana microphylla–Axyris amaranthoides* communities;
14[2]. *Leymus chinensis–Stipa krylovii–Cleistogenes squarrosa communities* in complex with *Artemisia dracunculus–Stipa krylovii–Stipa sibirica–Caragana microphylla* communities;
14[3]. *Leymus chinensis–Carex duriuscula–Cleistogenes squarrosa* communities in complex with *Axyris amaranthoides* and *Artemisia dracunculus* communities with *Caragana microphylla.*
15. *Stipa grandis–Stipa krylovii–Agropyron cristatum–Koeleria macrantha* communities rich in forbs (*Serratula centauroides, Medicago ruthenica, Heteropappus altaicus, Astragalus tenuis, Potentilla tanacetifolia, Allium anisopodium, A.tenuissimum, A.odorum*) in complex with *Caragana microphylla–Stipa grandis–Stipa sibirica* communities (*hemipsammophytic type*):
15[1]. *Cleistogenes squarrosa–Agropyron cristatum–Stipa grandis–Stipa krylovii* communities in complex with *Caragana microphylla–Stipa grandis–Stipa sibirica* communities;
15[2]. *Cleistogenes squarrosa–Carex duriuscula* communities in complex with *Stipa grandis–Stipa sibirica–Caragana microphylla;*
15[3]. *Carex duriuscula–Artemisia frigida* communities in complex with *Carex duriuscula–Artemisia frigida–Chenopodium aristatum* communities with *Caragana microphylla*;
15[4]. *Thymus gobicus–Agropyron cristatum–Carex duriuscula* communities with *Caragana microphylla.*

Halophytic meadow vegetation on the meadow-solochak and solonets soils

16. Complex *Carex duriuscula–Leymus chinensis–Stipa krylovii* communities, *Carex enervis–Hordeum brevisubulatum and Hordeum brevisubulatum–Artemisia anetifolia* communities.

VEGETATION OF THE FLOOD-LANDS

Meadows and shrub thickets

17d. *Iris lactea–Leymus chinensis communities*; *Potentilla anserina–Sanguisorba officinalis–Carex enervis* communities with *Hordeum brevisubulatum*; *Salix miyabeana* communities.

18[1]. Fallow and cereal crops;
18[2]. Initial stage of restoration (1–3 years): *Artemisia mongolica–A.macrocephala* weed communities;
18[3]. *Leymus chinensis* communities (3–7 years);
18[4]. Mixed grass *Leymus chinensis–Stipa grandis–S.krylovii–S.sibirica* communities with *Polygonum divaricatum* and xeromesophilous forbs (*Pulsatilla turczaninovii, Oxytropis myriophylla, Festuca lenensis)* (10–15 years);
18[5]. *Stipa grandis–Stipa krylovii–Agropyron cristatum–Poa botryoides* communities with *Polygonum divaricatum* in complex with *Caragana microphylla–Stipa grandis–Stipa sibirica* communities (second virgin lands) (30–35 years).

Conventional signs: *I* – boundaries of the relief types, *II* – boundaries of the elements of relief (top, slope, shelf, etc.), *III* – boundaries of the plots with different degree of degradation; *a* – settlement, *b* – winter cattle-breeding and sheeps farms. Ciphers 1–4 are used to designate the communities degraded by grazing of domestical ungulates (4 – is the highest degree of degradation). The communities, that degree of degradation need in more precise definition, are marked by index "d".

II. Mechanical composition and type of the soils: 1 – loamy sand, 2 – light loam, 3 – with break-stone, 4 – with debris, 5 – with boulders, 6 – sandy, 7 – sandy – loam layered structure; **Гч** – mountain chernozem, $К_3$ – dark chestnut, $К_2$ – chestnut, $К_2^{вт}$ – chestnut of highest degree of the degradation, **Кл** – meadow-chestnut, **Лг** – meadow.

be mentioned. (The latter distributes on the light soils.) The desert steppes differ by some species that don't have a prominent role, but distinguish the vegetation of this sub-province from the neighbouring Big Lakes Pan sub-province. The distribution area of *Iris bungei* marks well the boundary the North Eastern Gobi desert steppe sub-province (GRUBOV, EGOROVA, 1977). *Stipa brevifolia* (Central Asian sp.) is sporadically met in the steppes of this sub-province. *Stipa brevifolia* has a broken distribution area. It can be met in the south-east desert steppe subzone of Mongolia and China, the low mountain belt of RIKHTGOFEN ridge (LAVRENKO, 1966) and in another districts of Central Asia up to Himalayas Mts. At the extreme west it extends up to Inner Tien Shan. At the south on the loess hills Stipa brevifolia forms the open communities (LAVRENKO, 1959).

The Shargyn-Gobi pan vegetation is typical for North Eastern Gobi subprovince. The bottom of the pan is occupied by *Haloxylon ammodendron* communities. The unique peculiarity of the Shargyn Gobi vegetation is presence of the *Halimodendron halodendron* thickets (Iran–Turanian sp.). This isolated location are insulated considerably from the main distribution range, that is connected with Kazakhstan and Middle Asia. The mountain massifs, which surround this pan, have a high mountain belt with small glaciers and small plots of *Larix sibirica* forests.

The typical North Eastern Gobi desert steppes have been studied in details at the field station of the Joint Soviet-Mongolian complex expedition (LAVRENKO, 1980a, 1981) .

3c. Mongol Altaian mountain steppe sub-province includes the Kobdo and Mongol Altaian mountain steppe districts according to V. I. GRUBOV and A. A. YUNATOV (1952) and also some mountain massifs of Gobi Altai, which A. A. YUNATOV attributed to the North Gobi desert steppe province. The Gurvan-Saikhan and Khurkh-Ula Ridges and other more low ridges on the eastern outskirts of Gobi Altai can be included into Gobi desert zone (EVSTIFEEV, RACHKOVSKAYA, 1976; LAVRENKO, 1980b). A. A. YUNATOV (1950) look up the Mongolian Altai Mts. as a separate province. Flora of the high mountains and partly mountains are

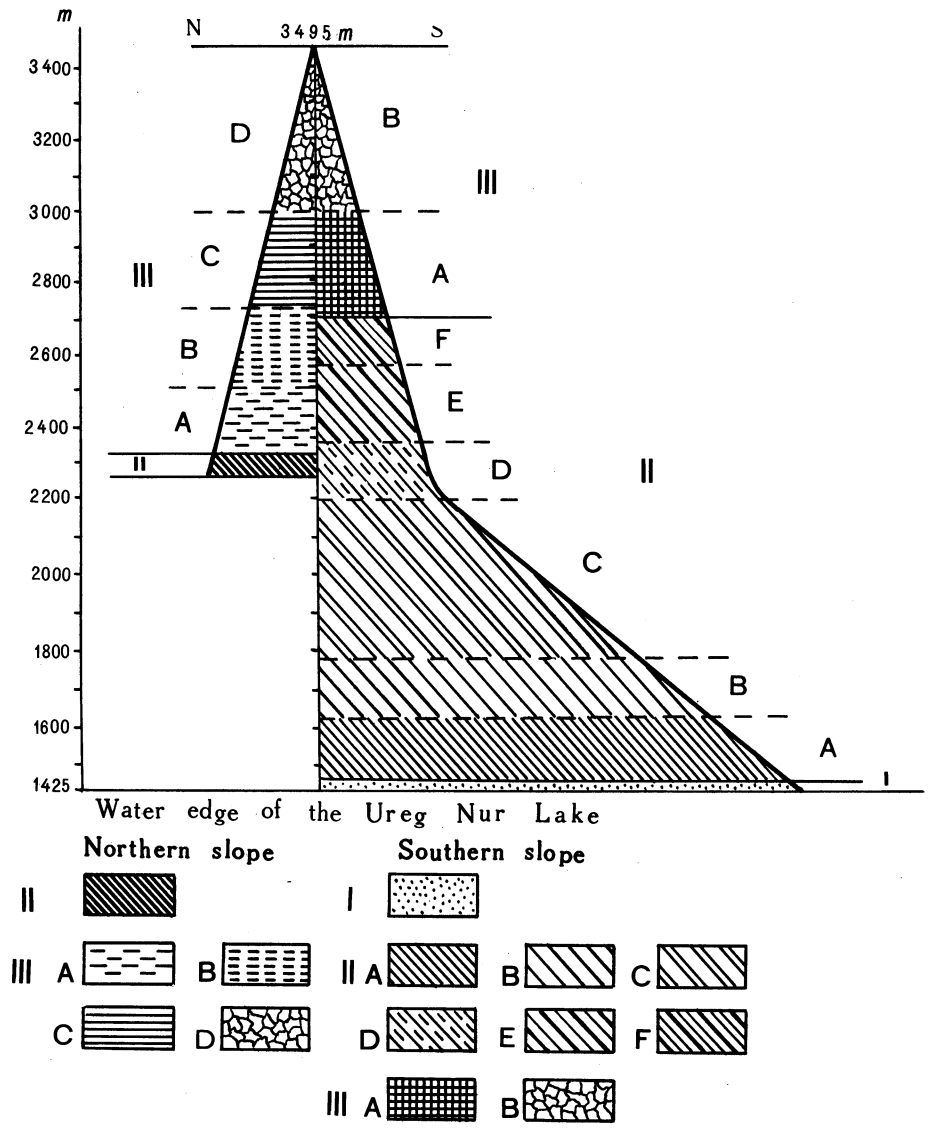

Fig. 23. Altitudinal replacements of the vegetation in the northern part of the Mongol Altai Mts.

Northern slope. **II. Steppe.** Steppified meadows and meadows steppes. Grass–forb (*Thalictrum alpinum, Senecio campester, Aster alpinus, Galium verum, Valeriana officinalis, Gentiana macrophylla)* communities with *Dasiphora fruticosa.* **III. High mountain vegetation. A.** Psychrophytic meadows. *Kobresia myosuroides* communities with high mountain cryophytilous forbs (*Polygonum ellipticum, Hedysarum inundatum,* etc.) and grasses (*Helictotrichon mongolicum, Festuca altaica, Ptylagrostis mongholica,* etc.) alternating with *Dryas oxyodonta* and *Betula rotundifolia* tundra. **B.** *Kobresia* meadows alternating with moss-lichen tundra (*Cetraria, Cladonia, Alectoria* sp. div.) and aggregations of the high mountain cryophilous forbs (*Parrya excapa, Driadanthe tetranda, Veronica macrostemon,* etc.). **C.** Rocky placer with aggregations of the high mountain cryophilous forbs. **D.** Sub-nival rocky placer without vascular plants.

Southern slope. **I. Desert.** *Anabasis brevifolia–Stipa glareosa* deserts with *Chenopodium frutescens.* **II. Steppes.** Plain steppes. **A.** Dwarf semi-shrub–bunch-grass desert steppes. *Stipa glareosa–Agropyron cristatum–Anabasis brevifolia* desert steppes with *Chenopodium frutescens.* **B.** Dwarf semi-shrub–bunch-grass desertified steppes. *Cleistogenes squarrosa–Stipa glareosa* desertified steppes with *Eurotia ceratoides.* **C.** Bunch-grass dry steppes. *Stipa krylovii–Cleistogenes squarrosa* with *Caragana pygmaea* and petrophilous forbs (*Orostachys spinosa, Allium senescens*) alternating with petrophilous wormwood (*Artemisia rutifolia, A. santolinifolia*) and shrub (*Atraphxis frutescens, Caragana bungei*) communities. Mountain steppes. **D.** Bunch-grass dry steppes. *Agropyron cristatum–Stipa krylovii* steppes with petrophilous forbs (*Smelovskia alba, Oxytropis trichophysa, Thalictrum foetidum, Allium stellerianum, A. altaicum,* etc.). **E.** Forb–bunch-grass steppes. *Helictotrichon altaicum* steppes with wormwoods (*Artemisia monostachya, A. frigida*) and forbs (*Astragalus mongholicus, Trifolium eximium, Polygonum alpinum, Euphorbia humifusa*). **F.** High mountain steppes. *Festuca lenensis–Agropyron cristatum* with *Artemisia argyrophylla* and high mountain cryophilous forbs (*Thalictrum alpinum, Melandrium apetalum, Draba pygmaea, Thlaspi cochleariformis, Androsace dasyphyla, Papaver pseudocanescens*) alternating with **Carex rupestris** communities. **III. High mountain vegetation. A.** Forb–grass cryophytic communities *Festuca brachyphylla–Helictotrichon mongolicum* with high mountain forbs (*Saxifraga sibirica, Potentilla nivea, Oxytropis oliganha, Artemisia argyrophylla,* etc.). **B.** Sub-nival rocky placer with aggregations of the high mountain cryophilous forbs (*Dryadanthe tetrandra, Veronica macrostemon*).

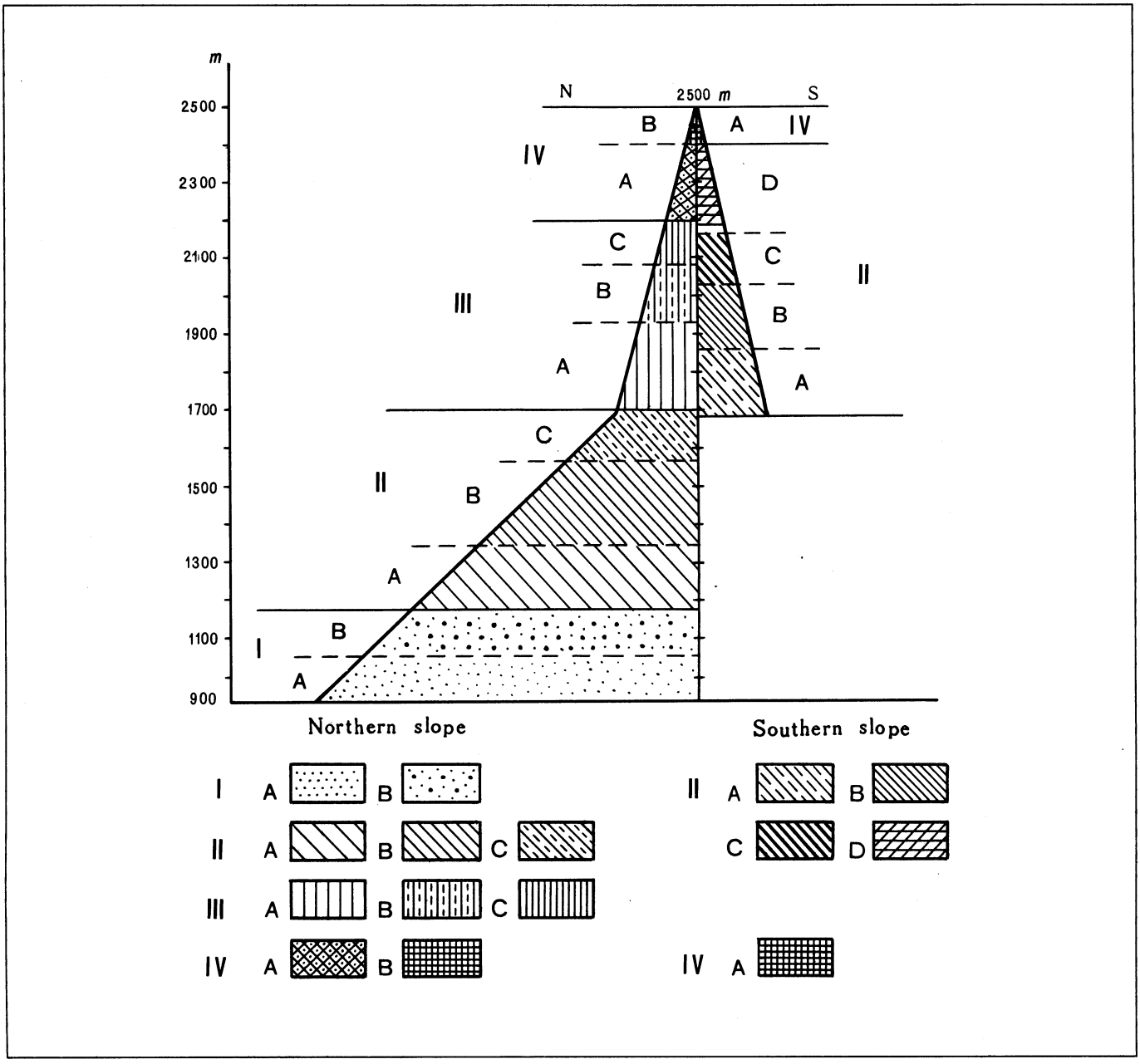

Fig. 24. Altitudinal replacements of the vegetation in the Tsagan-Shibetu Mts. (north-western part of the Mongol Altai Mts.).

Northern slope. I. Desert. A. Dwarf semi-shrub deserts. *Nanophyton erinaceum* deserts with *Stipa glareosa* and *Cleistogenes squarrosa.* **B.** Bunch-grass dwarf semi-shrub deserts. *Nanophyton erinaceum–Stipa glareosa–Agropyron cristatum–Psathyrostachys juncea* with *Asterothamnus heteropappoides.* **II.Steppes. Plain steppes. A.** Desertified steppes. *Stipa krylovii–S. glareosa–Agropyron cristatum–Cleistogenes squarrosa* steppes with *Nanophytin erinaceum.* B. Dry steppes. *Stipa krylovii—Koeleria macrantha–Cleistogenes squarrosa–Artemisia frigida* steppes with *Caragana bungei.* **Mountain steppes. C.** Mixed bunch-grass steppes. *Festuca lenensis–Koeleria macrantha–Poa attenuata* steppes with *Galium verum, Dianthus versicolor, Veronica incana, Leontopodium ochroleucum* alternating with *Helictotrichon altaicum* rich in forbs steppes and *Carex pediformis–Helictotrichon altaicum* meadow steppes with *Coluria geoides, Polygonum alpinum, Scabiosa ochroleuca,* etc. **III. Forests. Mountain forests. A.** *Larix sibirica* forests with shrubs (*Lonicera altaica, Ribes nigra*) and forest plants (*Calamagrostis obtusata, Lilium martagon, Atragene sibirica, Aquilegia sibirica,* etc.). **B.** Boreal *Larix sibirica–Pinus sibirica* forests with boreal species (*Vaccinium vitis-idaea, Arctous erythrocarpa,* etc.) alternating with *Betula rotundifolia* thickets. **C.** open woodlands *Larix sibirica–Pinus sibirica* with shrubs (*Spiraea alpina, Dasiphora fruticosa*) and high mountain species (*Festuca altaica, Polygonum viviparum, Polemonium pulchellum, Trollius asiaticus*). **IV. High mountain vegetation. A.** Tundra. *Dryas oxyodonta–Festuca brachyphylla–Helictotrichum mongolicum* tundra with *Arenaria formosa, Pedicularis oederi, Thalictrum alpinum, Claytonia joanneana,* etc. **B.** High mountain cryophytic meadows. *Carex rupestris—Kobresia myosuroides* with *Arenaria formosa, Potentila gelida, Minuartia biflora, Saussurea schanginiana,* etc.

Southern slope. II. Steppes. Sub-mountain steppes. **A.** Bunch-grass dry stepes. *Agropyron cristatum–Leymus secalinus–Artemisia frigida* steppes with petrophilous forbs dwarf semi-shrubs (*Oxytropis tragacathoides, Dracocephalum foetidum, Goniolimon speciosum Artemisia santolinifolia*) and shrubs (*Lonicera microphylla, Caragana bungei*). Mountain steppes. **B.** Forb–bunch-grass steppes. *Poa attenuata–Leymus secalinus* steppes with petrophilous forbs (*Allium altaicum, Vicia costata, Lophanthus chinensis, Astragalus mongolicus, Smelovskia alba,* etc.) and shrubs (*Berberis sibirica, Lonicera microphylla*). **C.** Bunch-grass rich in forbs steppes. *Helictotrichon altaicum* steppes with petrophilous forbs and dwarf semi-shrubs (*Artemisia monostachya, A. santolinifolia, Chamaerhodos altaica, Astragalus mongolicus, Cerastium arvense, Leontopodium ohroleucum,* etc.). **D.** High mountain steppes. *Festuca lenensis–Poa attenuata–Koeleria macrantha* steppes with cryophilous forbs (*Androsace dasyphylla, Oxytropis chionophyla, Trifolium eximium, Papaver pseudocanescens,* etc.) alternating with *Carex rupestris* communities. **IV. High mountain vegetation.** *Carex rupestris* communities with high mountain forbs (*Arenaria formosa, Saussurea schanginiana, Potentilla nivea).*

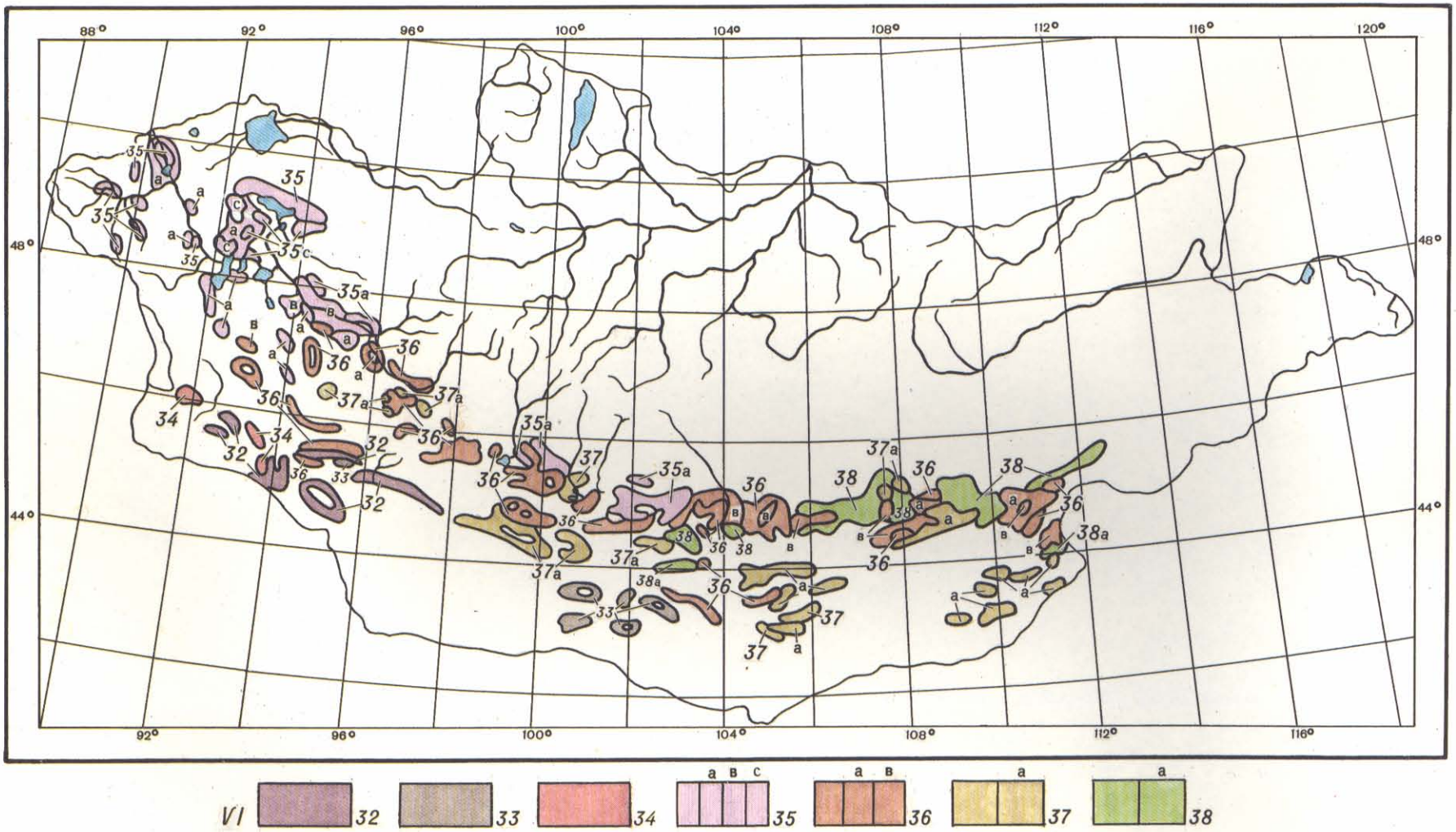

Fig. 16. VI. Distribution of the dwarf semi-shrub–bunch-grass desert steppes: *32.* Mongol Altaian; *33.* Gobi Altaian; *34.* Dzhungarian; *35.* North-Western Gobian; *36.* North Gobian; *37.* North Gobian; *38.* East Gobian.

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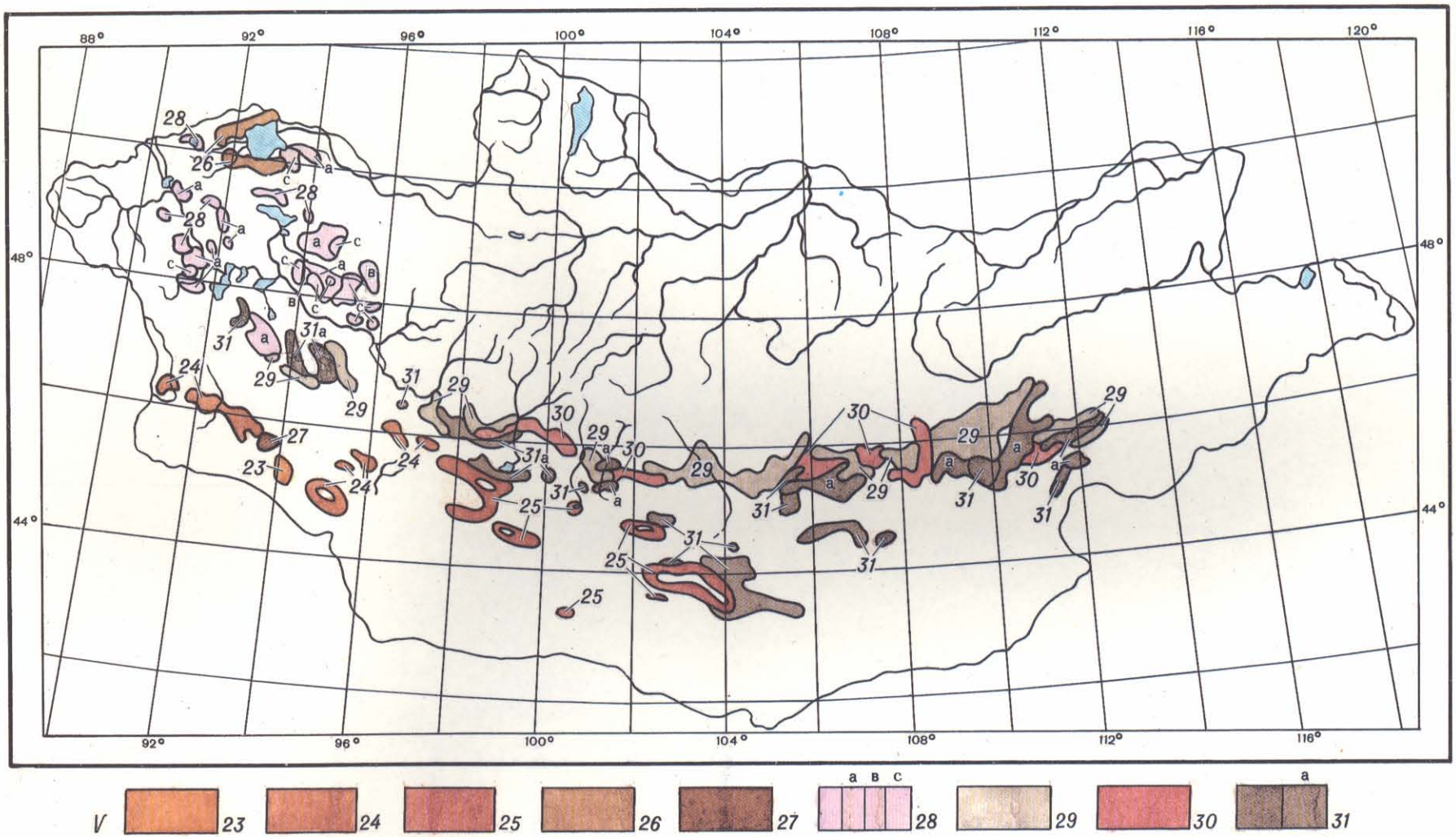

Fig. 15. V. Distribution of the bunch-grass and dwarf semi-shrub–bunch-grass desertified steppes; *23.* Dzhungarian; *24.* Mongol Altaian; *25.* Gobi Altaian; *26.* Dzhungarian; *27.* Dzhungarian; *28.* North-Western Gobi–Mongolian; *29.* North Gobi–Mongolian; *30.* North Gobi–Mongolian; *31.* North Gobi–Mongolian.

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enriched with xerocryophilous high mountain Altaian elements; in high mountain these elements even prevail. In cryophytic meadows *Kobresia* species dominate, chiefly *Kobresia smirnovii* (Dzhungaria-Altaian high mountain sp.) and *K. myosuroides* (Holarctic arcto-alpine sp., which is also usual in Khangai). *K. capilliformis* (Mongolia–Tien Shan–Pamir Alaian sp.) is more rare species. *K. humilis* spread only in Mongolian Altai and West Khangai. These species can be found not only in high mountain *Kobresia–Carex* cryophytic meadows, but also in the high mountain mixed bunch-grass steppes with cryophilous forbs and two species: *K. filifolia* (North Central Asia–Siberian mountain sp. also wide spread in the mountain steppes of the Khangai–Dahurian province) and *K. simpliciuscula* (Holarctic, basically arcto-alpine sp.) occur mainly in high mountain and sometimes even in mountain *Stipa krylovii* steppes (EGOROVA, 1967).

Some boreal species penetrate into this sub-province mainly into its north-eastern and north-western parts. *Rhododendron dahuricum* is the only species of five *Rhododendron* ones that occur in Mongolia. It grows in the *Larix sibirica* forests in the north-western part of Mongolian Altai. Four species of *Vaccinium* aggregation can be found in Mongolia; they are *Vaccinium vitis-idaea, V. myrtillus, V. uliginosum, V. oxycoccus (Oxycoccus microcarpus),* and only *Vaccinium vitis-idaea* penetrates in Mongolian Altai. Three species of *Pyrola* have been marked for Mongolia, two of them, *P. rotundifolia* and *P. incornata,* grow in north-west of Mongolian Altai and *P. incornata* – in Gobi Altai

In the north-western districts of Mongolia Altain some Middle Asia and Iran-Turanian sp., for example *Scaligeria setacea* (Dzhungaria–Tien-Shanian sp.), *Eremostachys molucelloides* (Iran-Turanian sp.), *Phlomis oreophila* (Middle Asian mountain meadow steppe sp.) occur.

The communities with dominance of North Gobi desert elements are distributed on the flat intermountain pans (for example Achit-Nur one). The penetration of them on the bottoms of the inter mountain hollows can be caused by the "pan's effect".

The regularities of the Mongolian Altai vegetation can be explained by the altitudinal differentiation. A. A. YUNATOV (1950) described only the single type of the belts "column" Mongol Altaian and attributed it to arid type. The recent investigations have shown that the altitudinal regularities in these mountain ridges have more complicated character. It is necessary to distinguish a few specific variants of the altitudinal "columns".

The pedestals of the mountain ranges which are situated on the northern slope of the Mongolian Altai Mts. are covered with the desertified *Stipa gobica–S. glareosa–Agropyron nevskii* steppes, which are replaced higher by dry true *Stipa krylovii* and then mixed bunch-grass *Festuca lenensis–Poa attenuata–Koeleria macrantha–Agropyron cristatum* ones. At the high boundary of the steppe belt the cryophytic high mountain *Festuca lenensis–Agropyron cristatum–Artemisia argyrophylla* steppes are distributed. The tops of the mountains are covered with the cryophytic *Carex* and *Kobresia* meadows. Thus, there are two altitudinal belts in these ranges: the steppe belt and high mountain one (fig. 23).

In the central part of Mongolian Altai the "column" of belts is similar to the above described one however the high mountain belt is represented by the cryophytic cushion communities. *Stellaria pulvinata, Potentilla nivea, Saussurea saichanensis* and other cryophilous cushion plants prevail there.

In the Tsagan-Shibetu massif, in the Jamat-Ula Range and Turgen one, that are located in the north-eastern and north-western part of Mongolian Altai the altitudinal vegetation regularities differ considerably from the Central Mongolian one. The boreal *Larix* and even spruce-larch forests grow on the northern slopes; higher they are replaced by the *Pinus sibirica* open woodlands and shrub thickets (*Betula rotundifolia*) and then *Dryas oxyodonta* tundra, alternating with cryophytic meadows and moss-lichen tundra. On the southern slopes *Helictotrichon altaicum* and *Carex pediformis* meadow steppes, which are absent in the central part of Mongolian Altai grow (KARAMYSHEVA, 1988) (fig. 24). Thus this belt "column" can not be attributed to the arid type and can be referred to the subboreal one.

The Gobi Altaian variant differs by the absence of the high mountain belt and by the poor development of the high mountain steppe sub-belt.

Table II.

Descriptions of the higher mountain steppes.
Formations: Festuca lenensis and Festuca kryloviana

№ № of columnes	1	2	3	4	№ № of columnes	1	2	3	4
Dwarf semi-shrubs					Leontopodium ochroleucum	+	1-2	+	·
Artemisia argyrophylla	·	·	+	8-9	Melandrium brachypetalum	·	+	+	·
Artemisia borealis	·	·	+	+	Eritrichium pauciflorum	+	1-2	·	·
Artemisia commutata	·	·	+	1-2	Gentiana decumbens	+	·	·	·
Artemisia frigida	10	·	·	·	Hedysarum pumilum	·	·	10	·
Artemisia santolinifolia	·	·	+	·	Iris tigridia	·	·	+	·
Ephedra monosperma	·	·	+	2-3	Minuartia verna	+	·	+	1-2
Long-lived perennial					Orostachys spinosa	·	·	·	2-3
Grasses					Oxytropis chionophyla	+	3-5	·	·
Agropyron cristatum	3-5	·	+	·	Oxytropis nitens	+	·	+	·
Festuca kryloviana	·	2-3	20	25	Oxytropis oligantha	·	·	·	10
Festuca lenensis	25	30	·	20	Oxytropis strobilacea	+	·	·	·
Helictotrichon asiaticum	·	1-2	·	·	Papaver pseudocanescens	·	+	·	·
Koeleria macrantha	3-5	·	2-3	5-8	Patrinia sibirica	·	·	+	·
Leymus gmelinii	·	·	+	1	Pedicularis abrotanifolia	+	·	·	·
Poa attenuata	+	2-3	·	3-5	Pedicularis achilleifolia	·	·	+	·
Sedges, Kobresia					Plantago komarovii	·	·	·	+
Carex macrogyna	·	20	·	·	Potentilla acaulis	·	·	+	·
Carex melanathaeformis	·	·	+	·	Potentilla crebridens	·	1-2	·	·
Carex rupestris	+	·	·	·	Potentilla nivea	+	5	·	·
Kobresia filifolia	20	·	·	·	Potentilla sericea	·	·	+	·
Kobresia humilis	·	·	3-5	·	Pulsatilla campanella	·	·	+	·
Kobresia myosuroides	1-2	10	·	·	Ranunculus pedatifidus	·	+	+	+
Forbs					Rhodiola rosea	+	·	·	·
Allium altaicum	·	·	·	+	Rumex acetosella	·	+	·	·
Allium amphibolium	·	·	·	+	Saussurea leucophylla	·	+	·	·
Allium lineare	·	·	+	·	Saussurea saichanensis	·	+	·	·
Amblynotus rupestris	·	1	+	+	Saussurea schanginiana	+	·	·	+
Androsace dasyphylla	·	·	+	1-2	Saussurea subacaulis	+	·	·	·
Androsace villosa	1	1-2	·	·	Saxifraga hirculus	·	+	·	+
Arenaria capillaris	+	2-3	·	·	Senecio campester	·	+	·	·
Artemisia tanacetifolia	+	·	·	·	Sibbaldianthe adpressa	+	·	+	+
Aster alpinus	·	·	1	+	Silene jenisseensis	·	·	+	·
Bupleurum bicaule	·	·	+	·	Stellaria pulvinata	·	·	·	20
Campanula turczaninovii	·	+	·	·	Stevenia cheirathoides	·	·	+	·
Cerastium arvense	·	+	·	·	Thalictrum alpinum	+	+	·	+
Chamaerhodos altaica	·	·	12	·	Thalictrum foetidum	·	·	3	·
Clausia aprica	·	·	+	+	Thalspi cochleareforme	·	+	·	+
Draba altaica	·	·	+		Tulipa uniflora	·	·	1-2	+
Draba lanceolata	·	·	+	+	**Annual and biennial forbs**				
Draba subamplexicaule	·	·	+	·	Androsace lactiflora	·	·	+	·
Dracocephalum origanoides	·	·	+	·	Androsace septentrionalis	·	·	+	·
					Erysimum flavum	·	+	·	·

1. **Festuca lenensis–Kobresia filifolia.** Baijan-Khongor Aimak, Central Khangai, intermountain hollow near Khukh Nur Lake. H. – 2600 m. TCD[1] – 60–65 %. № 96K. 20.07.1972.
2. **Festuca lenensis–Carex macrogyna–Kobresia myosuroides.** Baijan-Khongor Aimak, Central Khangai, Gurvan-Bulak Somon, the Gurvan-Bulak Mts., southern macroslope. H.– 3080 m. TCD – 70–80 %. № 69K. 12.07.1972.
3. **Festuca kryloviana–Kobresia humilis** rich in cryoxerophilous forbs. Ubsu-Nur Aimak, Turgen Somon, Turgen River Valley. H. – 2350 m. TCD – 50 %. № 10K. 08.07.1973.
4. **Festuca kryloviana–F.lenensis–Koeleria macrantha–Stellaria pulvinata.** Khovd Aimak, the Dzhargalant Mts., eastern macroslope. H. – 2800 m. TCD – 75–80 %. № 270K. 08.08.1980.

Note: The index of total cover degree (in %) are presented in the tables II–XIII. Symbol "+" show species with total cover degree less than 1 %.

[1] TCD – Total cover degree

Table III.

Descriptions of the mountain meadow steppes.
Formations: Helictotrichon altaicum, Carex pediformis, Stipa zalesskii, Festuca lenensis, Festuca kryloviana

№ № of the columnes	1	2	3	4	5	6	7	8	9	10
Shrubs										
Berberis sibirica	·	·	·	·	10	·	·	·	·	·
Caragana bungei	1-2	·	1-2	·	·	·	5-8	·	·	·
Cotoneaster melanocarpa	·	·	·	·	·	1-2	·	·	·	+
Dasiphora fruticosa	5-8	2-3	5-6	5	3-5	5-8	·	+	·	·
Dwarf semi-shrubs										
Alyssum lenense	+	1	+	+	·	+	+	+	+	1
Artemisia commutata	+	+	+	+	1-2	·	3-5	+	5-8	8
Artemisia frigida	·	·	·	·	·	·	3-5	+	·	·
Artemisia santolinifolia	+	·	·	1-2	·	·	·	·	·	·
Dianthus versicolor	+	1	+	+	+	+	·	+	2-3	1
Ephedra monosperma	·	·	·	·	·	·	+	·	·	·
Ptilotrichum tenuifolium	·	·	·	·	·	·	·	·	·	+
Thesium refractum	·	·	·	+	·	+	·	·	+	·
Thymus altaicus	2-3	·	3-5	2-3	·	·	·	·	·	·
Thymus gobicus	·	·	·	·	·	+	·	8	8	·
Long-lived perennial Grasses										
Agropyron cristatum	·	·	·	·	·	·	·	·	·	+
Agrostis trinii	·	+	·	3-5	·	·	·	·	·	·
Bromus inermis	1-2	·	1	·	·	1-2	+	·	·	·
Festuca kryloviana	·	20	·	10	·	·	·	·	·	·
Festuca lenensis	2-3	·	2-3	·	1-2	·	5-8	20	25	25
Festuca sibirica	·	·	·	·	·	·	·	+	·	·
Festuca valesiaca	·	·	·	·	·	2-3	·	·	·	·
Helictotrichon altaicum	35	20	40	5-8	12	5-7	+	·	·	·
Helictotrichon schellianum	3-5	3-5	3-5	3-5	3-5	5-7	·	+	·	1
Hierochloë odorata	·	·	·	·	·	+	·	·	·	·
Koeleria macrantha	1-2	+	1-2	1-2	+	·	3-5	3	1-2	1
Leymus gmelinii	·	·	·	·	1-2	·	·	·	·	·
Phleum phleoides	·	1-2	1-2	2-3	·	+	·	·	·	·
Poa attenuata	·	2-3	2-3	3-5	5	·	3-5	2	2-3	·
Poa botryoides	·	·	·	·	·	·	·	·	·	1
Stipa capillata	2-3	1	2-3	1-2	·	1-2	1-2	·	·	·
Stipa zalesskii	·	·	·	·	·	60	·	·	·	·
Sedges										
Carex korshinskyi	·	5-8	2-3	25	·	·	·	+	·	·
Carex pediformis	10	25	10	·	20	10	45	5	20	18
Carex rupestris	·	·	·	·	+	·	·	·	·	·
Forbs										
Aconitum barbatum	·	·	·	·	·	+	·	·	·	·
Adenophora lamarckii	·	·	·	·	+	·	·	·	·	·
Adenophora stenanthina	·	·	·	·	·	·	·	+	·	+
Allium bidentatum	·	·	·	·	·	·	·	+	+	·
Allium lineare	+	·	+	·	·	·	·	·	·	·
Allium prostratum	·	·	·	·	·	·	·	·	·	1
Allium schoenoprasum	·	·	·	·	·	+	·	·	·	·
Allium strictum	·	·	·	·	+	·	·	·	·	·
Amblynotus rupestris	·	·	·	+	+	·	+	+	5-8	·
Androsace dasyphylla	·	·	·	·	+	·	·	·	·	·
Androsace incana	·	·	·	·	·	·	·	+	3-5	+
Androsace villosa	·	·	·	·	·	·	5-8	·	·	·
Arctogeron gramineum	·	·	·	·	·	·	·	+	10	·
Arenaria capillaris	·	·	·	·	+	·	1-2	5	·	·
Artemisia laciniata	·	+	+	·	·	·	·	·	1-2	·
Artemisia tanacetifolia	1-2	·	·	·	·	+	·	·	·	·
Aster alpinus	+	1	5	+	1-2	5	1-2	+	5	·
Astragalus adsurgens	·	·	·	·	1	·	+	·	·	·
Astragalus austrosibiricus	·	+	·	·	·	·	+	·	·	·
Astragalus mongholicus	+	·	1	·	+	+	·	·	·	·
Astragalus tenuis	·	·	·	·	·	·	·	·	·	+
Bupleurum bicaule	1-2	+	1-2	2-3	+	+	+	·	·	·
Bupleurum multinerve	·	·	·	·	+	·	·	·	1	·
Bupleurum scorzonerifolium	·	·	·	·	·	·	·	+	·	+

Table III (continuation)

№ № of the columnes	1	2	3	4	5	6	7	8	9	10
Cerastium arvense	2-3	1	+	1-2	·	·	·	·	·	·
Chamaerhodos altaica	·	·	·	·	+	·	2-3	+	2-3	·
Chryzanthemum zawadskii	·	·	·	·	·	·	·	·	·	1
Clausia aprica	·	·	·	·	+	·	·	·	·	·
Coluria geoides	1-2	12	+	12	·	8	+	·	·	·
Cymbaria dahurica	·	·	·	·	·	·	·	+	·	·
Draba lanceolata	·	·	·	·	+	+	·	·	·	·
Dracocephalum origanoides	·	·	·	·	·	·	+	·	·	·
Echinops latifolius	·	·	·	·	·	·	·	·	·	2
Galatella dahurica	·	·	·	·	·	+	·	·	·	·
Galium verum	+	+	+	+	·	+	+	+	2-3	·
Gentiana decumbens	+	+	+	+	+	1	·	+	·	·
Gentiana macrophylla	·	·	·	·	+	·	·	+	·	·
Goniolimon speciosum	·	·	·	·	·	·	+	·	+	·
Gypsophila patrinii	·	·	·	·	·	·	2-3	·	·	·
Iris tigridia	·	·	·	·	+	·	+	+	+	·
Ixeridium gramineum	·	·	·	·	·	·	·	·	·	+
Leontopodium ochroleucum	3-5	1	3-5	1-2	1-2	1	+	+	1-2	·
Leuzea uniflora	·	·	·	·	·	·	·	+	+	·
Limonium flexuosum	·	·	·	·	·	·	·	+	·	·
Myosotis sylvatica	·	+	·	·	·	·	·	·	·	·
Onobrychis sibirica	·	+	·	·	+	·	·	·	·	·
Orostachys malacophylla	·	·	·	·	·	·	·	+	·	+
Orostachys spinosa	+	·	+	·	+	+	+	·	1-2	·
Oxytropis chionophyla	·	·	·	·	3-5	·	·	·	·	·
Oxytropis myriophylla	·	·	·	·	·	·	·	·	·	+
Oxytropis nitens	·	·	·	·	·	·	·	·	·	1
Oxytropis strobilacea	+	1	+	+	·	+	·	·	·	·
Papaver croceum	·	·	·	·	·	·	·	·	·	+
Papaver nudicaule	·	·	·	·	+	·	·	·	·	·
Patrinia sibirica	·	·	·	·	+	·	·	·	·	·
Pedicularis achilleifolia	·	·	·	·	·	+	·	·	·	·
Pedicularis flava	·	·	·	·	+	·	·	+	·	·
Pedicularis rubens	·	·	·	·	·	·	·	+	+	·
Peucedanum histrix	·	·	·	·	+	·	+	+	·	+
Phlojodicarpus sibiricus	·	·	·	·	·	·	·	·	1-2	·
Phlomis tuberosa	·	·	·	·	·	+	·	·	·	·
Polygala hybrida	1-2	+	+	·	·	+	·	·	·	·
Polygonum alpinum	·	·	·	·	+	·	·	·	·	·
Polygonum angustifolium	·	·	·	·	·	+	·	+	1	1
Polygonum ellipticum	·	·	·	·	·	·	·	·	·	1
Potentilla acaulis	+	1	·	+	·	·	5-8	·	·	·
Potentilla bifurca	·	+	·	·	·	·	·	·	·	·
Potentilla nivea	·	·	·	·	+	·	·	·	·	·
Potentilla sericea	·	·	·	1-2	·	·	+	2-3	+	·
Pulsatilla ambigua	+	+	+	·	+	·	+	·	·	·
Pulsatilla turczaninovii	·	·	·	·	·	·	·	+	+	·
Rumex acetosella	·	·	·	·	·	+	·	+	+	·
Sanguisorba officinalis	·	·	·	·	+	1	·	·	+	+
Saussurea saichanensis	·	·	·	·	+	·	·	·	·	·
Saussurea salicifolia	·	·	·	·	·	·	·	+	·	1
Scabiosa comosa	·	·	·	·	·	·	·	·	2-3	·
Scabiosa ochroleuca	1-2	+	·	·	·	+	·	·	·	·
Schizonepeta multifida	3-5	1	3-4	+	·	5-8	·	·	·	·
Scorzonera radiata	·	·	·	·	·	+	·	·	·	·
Sedum hybridum	·	·	·	·	+	+	·	·	·	·
Senecio campester	·	·	·	·		+	·	+	+	·
Serratula marginata	·	·	·	·	·	·	+	·	·	·
Sibbaldianthe adpressa	·	·	·	·	·	·	+	·	·	·
Silene jenisseensis	·	·	·	·	+	·	·	+	+	+
Silene repens	·	·	·	·	·	·	+	·	·	·
Stellera chamaejasme	·	·	·	·	·	·	·	5	1-2	·
Thalictrum foetidum	+	·	·	+	+	1	+	·	·	1
Thalictrum petaloideum	·	·	·	·	·	+	·	+	+	+
Thlaspi cochleareforme	·	·	·	·	·	·	·	+	·	·
Trifolium lupinaster	+	·	+	·	·	1	·	·	·	·
Veronica incana	15	8-10	15	10	·	5-8	+	·	·	·
Vicia multicaulis	+	·	·	·	·	+	+	+	+	·
Youngia tenuifolia	·	·	·	·	+	·	+	·	·	·

Table III (continuation)

№ № of the columnes	1	2	3	4	5	6	7	8	9	10
Annual and short-lived perennial										
Androsace filiformis	+	·	·	·	·	·	·	·	·	·
Androsace lactiflora	·	+	+	·	·	·	·	·	·	·
Androsace septentrionalis	·	·	·	·	·	·	·	+	+	·
Dontostemon integrifolius	·	·	·	·	+	·	·	+	·	·
Erysimum cheiranthoides	·	·	·	·	·	·	+	·	·	·
Erysimum flavum	·	·	·	·	+	·	·	·	·	·
Euphrasia tatarica	+	+	+	+	·	·	·	·	·	·
Gentiana acuta	·	+	·	·	·	·	·	·	·	·
Gentiana riparia	+	·	+	+	·	+	·	·	·	·
Fern										
Botrychium lunaria	·	·	·	·	·	+	·	·	·	·
Lichenes										
Aspicilia desertorum	·	·	·	·	·	·	·	3	·	·
Parmelia vagans	·	·	·	·	·	·	·	4	·	·

1. **Helictotrichon altaicum–Carex pediformis** rich in forb with *Dasiphora fruticosa.* Ubsu Nur Aimak, Under Khangai Somon, Western Khangai, the Khan-Khukhiin-Ula Range, northern macroslope. H. – 1630m. TCD – 80 %. № 101K. 24.07.1973.
2. **Helictotrichon altaicum–H.schellianum–Festuca kryloviana–Carex pediformis** rich in forbs with *Dasiphora fruticosa.* Ubsu Nur Aimak, Khangai Somon, the Khan-Khukhiin-Ula Range, the Torbchi-Obo Mts. H. – 1640m. TCD – 90 %. № 99K. 24.07.1973.
3. **Helictotrichon altaicum–Carex pediformis** rich in forbs with *Dasiphora fruticosa.* Under Khangai Somon, Western Khangai, the Khan-Khukhiin-Ula Range, northern slope. H. – 1650m. TCD – 80 %. № 103K. 24.07.1973.
4. **Festuca kryloviana-Helictotrichon altaicum–H.schellianum–Carex pediformis** rich in forbs with *Dasiphora fruticosa.* Ubsu Nur Aimak, the Khan-Khukhiin-Ula Range, the low mountain on the northern macroslope. H. – 1570. TCD – 90 %. № 97K. 24.07.1973.
5. **Helictotrichon altaicum–Poa attenuata–Carex pediformis** rich in forbs with shrubs (*Berberis sibirica, Dasiphora fruticosa*), Ubsu Nur Aimak, Turgen Somon, Mongolian Altai, north-east part. H. – 2300m. TCD – 60 %. № 15K. 09.07.1973.
6. **Stipa zalesskii–Carex pediformis** rich in forbs with shrubs (*Dasiphora fruticosa, Cotoneaster melanocarpa*). Ubsu Nur Aimak, Under Khangai Somon, the Khan-Khukhiin-Ula Range. Torbchi Obo Mts. H. – 1630m. TCD – 95 %. № 103K. 24.07.1973.
7. **Carex pediformis** rich in forbs with *Caragana bungei*. Ubsu Nur Aimak, Khjargas Somon, the Khan-Khukhiin-Ula Range Northern macroslope. H. – 1600m. TCD – 80-90 %. № 43K. 15.07.1973.
8. **Festuca lenensis–Carex pediformis** rich in forbs with *Dasiphora fruticosa.* Arkhangai Aimak, Eastern Khangai, low mountain near Tsetserleg. H. – 1700m. TCD – 50 %. № 25K. 17.07.1970.
9. **Festuca lenensis–Carex pediformis** rich in forbs with *Dasiphora fruticosa.* Arkhangai Aimak, Eastern Khangai, low mountain near Tsetserleg. H. – 1700m. TCD – 50-60 %. № 26K. 17.07.1970.
10. **Carex pediformis–Festuca lenensis.** Sukhe-Bator Aimak, Munkh-Khan Somon. The Munkh-Khan Mts., the northern slope. H. – 1580 m. TCD – 70 %. № 167.1Kh. 25.08.1989.

Table IV.

Descriptions of the mountain and plain meadow steppes.
Formations: Stipa baicalensis and Filifolium sibiricum

№ № of columnes	1	2	3	4	5	6	7	8
Shrubs								
Armeniaca sibirica	·	+	·	·	·	·	·	·
Caragana microphylla	·	3	·	·	·	·	+	·
Dasiphora fruticosa	5-8	·	·	·	·	·	·	·
Dasiphora parvifolia	·	·	2	·	·	·	·	·
Spiraea aquilegifolia	·	+	·	·	·	·	·	·
Dwarf semi-shrubs								
Alyssum lenense	·	·	·	·	·	·	·	1
Artemisia commutata	·	+	·	·	+	·	·	·
Artemisia frigida	·	+	·	·	·	·	2	·
Artemisia gmelinii	·	15	·	·	·	·	·	·
Dianthus versicolor	·	+	+	·	·	+	·	+
Ptilotrichum tenuifolium	·	·	·	·	+	·	+	·
Thymus dahuricus	·	·	+	·	·	·	+	+
Long-lived perennial Grasses								
Agropyron cristatum	·	1	·	·	·	·	·	·
Agrostis trinii	+		·	·	·	·	·	·
Bromus inermis	+	1	·	·	·	·	·	·
Festuca dahurica	·	·	·	·	·	·	4	
Festuca kryloviana	4	·	·	·	·	·	·	·
Festuca lenensis	+	·	·	·	·	+	·	·
Festuca sibirica	5	+	1	12	15	5	·	·
Helictotrichon schellianum	+	3	1	+	+	·	+	1
Hierochloë glabra	·	+	·	·	·	·	·	·
Koeleria macrantha	+	1	1	+	3	+	2	·
Leymus chinensis	·	3	·	+	·	·	2	2
Leymus gmelinii	+	·	·	·	·	·	·	·
Poa attenuata	+	·	·	·	·	·	·	·
Poa botryoides	·	+	10	+	+	·	2	·
Stipa baicalensis	40	10	4	15	+	3	·	1
Stipa sibirica	+	+	·	·	·	·	·	1
Sedges								
Carex korshinskyi	+	·	3	·	·	·	15	1
Carex pediformis	12	1	·	·	·	+	·	·
Forbs								
Adenophora gmelinii	·	·	·	·	·	+	·	·
Adenophora stenanthina	+	+	·	·	·	·	·	·
Adenophora tricuspidata	·	·	·	·	·	·	+	·
Allium anisopodium	·	+	·	+	+	+	·	·
Allium bidentatum	·	·	+	·	·	·	·	+
Allium lineare	+	·	·	·	·	·	·	·
Allium senescens	·	+	+	·	+	·	1	·
Allium tenuissimum	·	·	+	·	·	+	+	+
Androsace incana	+	·	·	·	+	·	·	+
Arenaria capillaris	+	·	·	·	+	·	·	·
Artemisia integrifolia	+	·	·	·	·	·	·	·
Artemisia laciniata	·	5	·	·	·	·	·	·
Aster alpinus	+	+	·	+	+	·	·	2
Astragalus adsurgens	2-3	·	+	+	·	+	·	+
Astragalus melilotoides	·	·	+	·	·	·	·	·
Astragalus tenuis	·	+	·	·	·	·	·	·
Bupleurum bicaule	·	3	·	·	·	·	+	·
Bupleurum scorzonerifolium	+	·	2	·	+	1	·	+
Campanula glomerata	+	·	·	·	·	·	·	·
Chamaerhodos trifida	·	·	·	·	·	·	+	·
Clematis hexapetala	·	+	·	·	·	·	·	·
Cymbaria dahurica	·	+	·	·	·	·	·	·
Delphinium dissectum	+	·	·	·	·	·	·	·
Chrysanthemum zawadskii	·	3	+	·	·	·	·	4
Echinops latifolius	+	·	+	·	·	·	·	·
Erigeron oreades	+	·	·	·	·	·	·	·
Euphorbia palassi	·	·	·	·	·	+	+	·
Filifolium sibiricum	·	7	·	12	20	40	15	30
Galium verum	1-2	+	1	·	·	·	1	1

Table IV (continuation)

№ № of columnes	1	2	3	4	5	6	7	8
Gentiana acutiloba	.	.	.	.	.	.	.	+
Gentiana barbata	.	.	+	.	.	.	.	.
Gentiana decumbens	.	.	.	.	+	.	.	.
Gymnodenia conopsea	+	.	.	.		+	.	.
Gypsophyla dahurica	.	.	.	+	+	.	.	+
Haplophyllum dauricum	.	.	.	.	.	.	.	+
Hemerocallis minor	.	+	.	+	.	2	+	.
Heteropappus altaicus	.	.	.	.	.	.	+	.
Heteropappus biennis	.	.	+	.	.	.	+	+
Hieracium umbellatum	.	+	.	.	.	.	.	.
Iris dichotoma	.	1	.	.	.	+	.	.
Leontopodium leontopodioides	.	1	2	+	.	.	+	+
Leontopodium ochroleucum	+	.	.	.	.	.	.	+
Lespedeza dahurica	.	3	.	.	.	.	+	.
Lespedeza hedysaroides	.	.	+	.	.	.	.	.
Leuzea uniflora	1-2	.	+	+	+	+	.	+
Lilium pumilum	+	+	.	.	.	.	.	.
Linaria buriatica	.	+	+	.	.	.	.	.
Linum sibiricum	.	.	+	.	.	.	.	.
Medicago ruthenica	.	2	5	.	.	+	.	+
Melandrium apricum	.	+	.	.	.	.	.	.
Orostachys malacophylla	.	.	.	+	.	.	1	.
Orostachys spinosa	.	.	+	.	.	.	.	+
Oxytropis filiformis	.	.	.	.	+	.	.	.
Oxytropis myriophylla	2-3	8	10	+	+	+	.	30
Oxytropis nitens	.	.	.	+	2	7	+	+
Oxytropis oxyphylla	.	.	+	.	.	.	.	+
Papaver nudicaule	+	.	.	.	.	.	.	.
Papaver rubro-aurantiacum	.	+	.	.	.	.	.	.
Parnassia laxmannii	+	.	.	.	.	.	.	.
Pedicularis rubens	2-3	.	.	.	.	.	.	.
Pedicularis striata	.	2	.	+	3	+	+	.
Pimpinella thellungiana	.	.	.	.	.	+	+	.
Phlomis tuberosa	.	+	.	.	.	.	.	.
Polygala sibirica	.	.	.	.	.	+	.	.
Polygonum angustifolium	+	.	+	.	+	.	.	+
Polygonum divaricatum	.	.	.	.	.	.	+	.
Polygonum valerii	.	3	.	.	.	3	.	.
Potentilla acaulis	.	+	7	.	.	.	+	1
Potentilla leucophylla	.	+	.	.	+	.	+	+
Potentilla sericea	+	.	.	.	.	.	.	.
Potentilla strigosa	.	+	.	.	.	.	.	.
Potentilla tanacetifolia	5-8	.	+	.	.	+	.	+
Potentilla verticillaris	.	+	.	.	.	.	.	.
Pulsatilla bungeana	.	.	.	+	2	+	5	.
Pulsatilla turczaninovii	.	5	.	.	.	.	.	.
Rumex acetosa	.	.	+	.	.	.	.	.
Sanguisorba officinalis	2-3	+	1	+	.	15	.	+
Saposhnikovia divaricata	.	2	.	+	+	.	+	+
Scabiosa comosa	+	.	+	.	.	+	+	+
Schizonepeta multifida	3-5	.	+	.	.	+	.	+
Scorzonera austriaca	.	+	.	.	.	.	.	.
Scorzonera radiata	+	.	.	.	.	.	.	.
Scutellaria baicalensis	.	.	.	.	.	2	2	.
Scutellaria scordiifolia	+	+	.	.	.	.	.	.
Sedum aizoon	.	+	.	.	.	+	.	.
Sedum hybridum	+	.	.	.	.	.	.	.
Senecio campester	+	.	.	.	.	.	.	.
Serratula centauroides	.	+	+	+	.	.	+	.
Silene jenisseensis	.	2	+	.	+	.	+	+
Silene repens	+	.	.	.	.	.	.	.
Stellera chamaejasme	5-8	5	3	.	3	+	.	10
Taraxacum officinalis	+	.	.	.	.	.	.	.
Thalictrum minus	3-5	+	.	.	.	.	.	.
Thalictrum petaloideum	+	+	+	+	.	3	.	+
Thlaspi cochleareforme	+	+	.	+	.	.	.	.
Trifolium lupinaster	5-8	2	.	+	.	+	.	+
Valeriana officinalis	+	.	.	.	.	.	.	.
Veronica incana	.	+	+	.	.	.	1	.

Table IV (continuation)

№ № of columnes	1	2	3	4	5	6	7	8
Vicia amoena	·	2	+	·	·	·	·	·
Vicia cracca	2-3	·	·	·	·	·	·	·
Vicia multicaulis	+	·	·	·	·	·	·	·
Vicia nervata	·	·	·	·	·	+	·	·
Vicia unijuga	·	·	+	·	·	·	·	·
Youngia tenuifolia	·	+	·	·	·	+	·	·
Fern								
Botrychium lunaria	+	·	·	·	·	·	·	·
Annual and short-lived perennial								
Artemisia scoparia	·	·	+	·	·	+	·	·
Dontostemon integrifolius	·	+	·	·	·	·	·	·
Euphrasia tatarica	+	·	·	·	·	·	·	·
Halenia corniculata	+	·	·	·	·	·	·	·
Lichenes								
Parmelia vagans	2-3	·	·	·	·	70	·	70

1. **Stipa baicalensis–Carex pediformis** rich in forb with *Dasiphora fruticosa.* Arkhangai Aimak, Eastern Khangai, low mountain near Tsetserleg. H. – 1720m. TCD – 70 %. № 23K. 17.07.1970.
2. **Stipa baicalensis–Oxytropis myriophylla** with forbs. Sukhe-Bator Aimak, Tumen-Tsogt Somon, Tumen-Tsogt Mts. Eastern Mongolia. H.– 1225m. TCD – 90 %. № 304.1Kh. 04.08.1991.
3. **Stipa baicalensis–Oxytropis myriophylla** with forbs and shrubs (*Dasiphora parvifolia*). Khentei Aimak, Somon Norovlin. Mongolian Dahuria, the Eren-Daba Mts. H. – 1180m. TCD – 85–90 %. № 95.1Kh.31.07.1989.
4. **Stipa baicalensis–Festuca lenensis–Filifolium sibiricum** with forbs. Khentei Aimak, Somon Norovlin. Mongolian Dahuria, the Eren-Daba Mts. H. – 1150m. № 56.1Kh. 04.07.1989.
5. **Filifolium sibiricum-Festuca sibirica** with petrophilous forbs. Khentei Aimak, Somon Norovlin. Mongolian Dahuria, the Eren-Daba Mts. H. – 1130 m. TCD – 80 %. № 56.2Kh. 05.07.1989
6. **Filifolium sibiricum–Oxytropis nitens** with forbs (*Sanguisorba officinalis*) and lichenes. Eastern Aimak, the Greater Khingan Mts. The Plateau of bazalt. H. – 1100 m. Slope - W. TCD – 95–100 %. № 200. 1Kh. 20.07.1989.
7. **Filifolium sibiricum–Carex korshinskyi** with Festuca dahurica. Eastern Aimak, The plaines near the Greater Khingan Mts. H. – 920 m. TCD – 60 %. № 81.1Kh. 17.07.1989.
8. **Filifolium sibiricum–Oxytropis myriophylla** with lichenes. Khentei Aimak, Mongolian Dahuria, the Eren-Daba Mts. (the Schusyn Ar Mts.). H. – 1150 m. Slope – N. TCD – 95 %. № 92.1.2Kh. 30.07.1989.

Table V.

Descriptions of the forb–bunch-grass steppes.
Farmations: Helictotrichon altaicum, Helictotrichon schellianum, Filifolium sibiricum, Festuca dahurica

№ № of columnes	1	2	3	4	5	6	7
Shrubs							
Caragana microphylla	·	·	·	·	·	·	+
Caragana pygmaea	2-3	·	·	·	·	·	·
Spiraea hypericifolia	3-5	·	·	·	·	·	·
Dwarf semi-shrubs							
Alyssum lenense	·	+	·	·	·	·	1
Artemisia changaica	2-3		·	·	·	·	·
Artemisia commutata	·	5-8	·	·	·	·	·
Artemisia dolosa	·		3-5	·	·	·	·
Artemisia frigida	·	3-5	5-8	+	+	+	6
Dianthus versicolor	·	5-8	·	·	·	·	·
Ephedra monosperma	·	+	·	·	·	·	·
Kochia prostrata	·	·	·	·	·	+	·
Ptilotrichum tenuifolium	·	·	·	+	1	2	·
Thesium refractum	·	+	·	·	·	·	·
Thymus altaicus	·	2-3	·	·	·	·	·
Thymus dahuricus	·	·	·	1	·	·	·
Long-lived perennial Grasses							
Agropyron cristatum	·	1-2	+	·	·	2	1
Bromus inermis	3-5	·	·	·	·	·	·
Cleistogenes squarrosa	·	·	·	·	3	2	+
Festuca dahurica	·	·	·	·	·		4
Festuca lenensis	·	·	+	3	·	1	·
Festuca valesiaca	3-5	23	·	·	·	·	·
Helictotrichon altaicum	20	2-3	·	·	·	·	·
Helictotrichon schellianum	·	·	10	·	·	·	·
Koeleria altaica	·	·	+	·	·	·	·
Koeleria cristata	1-2	5-8	·	·	·	·	·
Koeleria macrantha	·	·	2-3	2	·	1	+
Leymus chinensis	·	·	·	+	1	3	6
Poa attenuata	·	·	2	·	·	·	·
Poa botryoides	+	·	·	1	·	2	+
Poa stepposa	·	5-8	·	·	4	·	·
Stipa baicalensis	·	·	+	·	3	+	·
Stipa capillata	10	·	·	·	·	·	·
Stipa grandis	·	·	·	·	1	2	+
Stipa krylovii	·	·	+	1	·	·	+
Stipa sibirica	·	·	·	·	·	+	·
Sedges							
Carex duriuscula	·	+	·	·	·	2	·
Carex korshinskyi	+	·	+	·	2	+	+
Carex pediformis	·	·	+	·	·	·	1
Forbs	·	·	·	·	·	·	·
Adenophora stenanthina	·	·	+	·	·	·	·
Allium anisopodium	·	·	·	+	·	·	·
Allium bidentatum	·	·	·	·	1	+	·
Allium lineare	·	·	+	·	+	+	+
Allium odorum	·	·	·	·	·	·	+
Allium senescens	·	·	·	·	·	·	+
Amblynotus rupestris	·	1-2	+	·	·	·	·
Androsace incana	·	·	+	·	·	·	·
Androsace villosa	·	+	·	·	·	·	·
Arenaria capillaris	·	3-5	+	·	·	·	·
Artemisia glauca	·	·	+	·	·	·	·
Asparagus dahuricus	·	·	·	·	·	·	+
Aster alpinus	1-2	18	+	·	·	·	·
Astragalus adsurgens		2-3	+	·	·	·	·
Astragalus austrosibiricus	+	·	·	·	·	·	·
Astragalus inopinatus	·	·	+	·	·	·	·
Astragalus mongholicus	·	·	·	·	·	+	·
Astragalus tenuis	·	·	·	1	·	+	+
Bupleurum bicaule	·	+	·	+	+	·	+
Bupleurum scorzonerifolium	·	·	2-3	·	·	3	·
Chamaerhodos trifida	·	·	·	·	·	2	·

Table V (continuation)

№ № of columnes	1	2	3	4	5	6	7
Clematis hexapetala	·	·	·	·	·	·	+
Coluria geoides	15	·	·	·	·	·	·
Cymbaria dahurica	·	·	+	·	+	+	·
Dracocephalum origanoides	·	+		·	·	·	·
Echinops latifolius	·	·	+	·	·	·	·
Euphorbia discolor	·	·	·	·	+	+	·
Filifolium sibiricum	·	·	·	35	10	15	·
Galium verum	1-2	1-2	+	+	·	+	+
Gentiana decumbens	·	1	+	+	+	·	·
Haplophyllum dauricum	·	·	·	·	+	·	·
Hedysarum fruticosum	·	·	·	·	·	·	+
Hemerocallis minor	·	·	·	·	·	·	+
Heteropappus altaicus	·	·	+	·	·	·	+
Iris dichotoma	·	·	·	+	·	+	+
Iris tigridia	+	+	+	·	·	·	·
Leontopodium leontopodiodes	·	·	·	+	·	·	+
Leontopodium ochroleucum	·	2-3	+	·	·	·	·
Lespedeza dahurica	·	·	·	·	·	·	3
Lilium pumilum	·	·	·	·	·	+	·
Lilium tenuifolium	·	·	·	·	·	·	+
Linaria acutiloba	·	·	+	·	·	·	·
Linaria buriatica	·	·	·	·	·	+	+
Linum sibiricum	·	·	+	·	·	·	·
Medicago ruthenica	·	·	·	+	+	4	·
Melandrium brachypetalum	·	·	·	·	·	·	+
Minuartia verna	·	+	·	·	·	·	·
Orostachys fimbriata	·	·	·	·	·	·	+
Orostachys spinosa	+	1	·	·	·	·	·
Oxytropis arenaria	·	·	·	·	·	·	+
Oxytropis myriophylla	·	·	·	+	·	+	·
Oxytropis nitens	·	·	+	·	·	1	·
Oxytropis strobilacea	2-3	+	·	·	·	·	·
Papaver rubro-aurantiacum	·	·	·	·	·	·	+
Pedicularis achilleifolia	·	+	·	·	·	·	·
Peucedanum histrix	·	1	+	·	·	·	·
Polygala tenuifolia	·	·	·	·	+	+	·
Polygonum alpinum	·	+	·	·	·	·	·
Polygonum angustifolium	·	·	+	·	·	·	·
Polygonum valerii	·	·	·	·	·	+	+
Potentilla acaulis	+	+	+	+	·	+	1
Potentilla bifurca	1	·	+	·	·	·	·
Potentilla leucophylla	·	·	·	·	+	1	·
Potentilla sericea	·	+	·	·	·	·	·
Potentilla tanacetifolia	·	·	·	·	·	+	1
Pulsatilla ambigua	·	+	5	·	·	·	·
Pulsatilla bungeana	·	·	·	·	2	10	·
Pulsatilla turczaninovii	1-2	·	·	·	·	+	5
Saposhnikovia divaricata	·	·	·	+	2	+	+
Scabiosa comosa	·	·	+	·	·	·	+
Scabiosa ochroleuca	2-3	·		·	·	·	·
Schizonepeta multifida	·	·	2-3	+	+	·	+
Scorzonera austriaca	·	·	·	·	+	+	·
Scutellaria baicalensis	·	·	·	2	·	·	·
Scutellaria scordiifolia	·	·	·	·	·	·	+
Senecio campester	+	·	+	·	·	·	·
Serratula centauroides	·	·	+	+	·	·	+
Sibbaldianthe adpressa	·	·	·	·	·	+	·
Silene jenisseensis	·	3-5	·	1	·	1	·
Stellera chamaejasme	·	·	+	+	+	·	·
Thalictrum foetidum	+	+	·	·	·	·	·
Thalictrum petaloideum	·	·	·	+	·	·	+
Thalictrum squarrosum	·	·	·	·	·	+	+
Thermopsis lanceolata	·	·	10	·	·	·	·
Thermopsis mongolica	2-3	·	·	·	·	·	·
Veronica incana	·	·	+	·	·	·	1
Annual and short-lived perennial							
Androsace septentrionalis	+	·	+	·	·	·	·
Artemisia scoparia	·	·		1	·	·	·
Chamaerhodos erecta	·	·	+	·	·	+	+

Table V (continuation)

№ № of columnes	1	2	3	4	5	6	7
Chenopodium aristatum	·	·	·	·	·	+	·
Erysimum flavum	·	·	·	·	·	·	+
Gentiana squarrosa	·	·	+	·	·	+	·
Lichenes							
Parmelia vagans	·	·	3	·	·	·	·

1. **Helictotrichon altaicum–Coluria geoides** with forbs and shrubs. Ubsu Nur Aimak, Tess Somon, eastern part of the Khan-Khukhiin-Ula Range. H. – 1420m. TCD – 70 %. № 20K. 02.07.1977.
2. **Festuca valesiaca** with mesoxerophilous forbs. Ubsu Nur Aimak, Khjargas Somon, Western Khangai the Khan-Khukhiin-Ula Range. Southern macroslope. H. – 2150m. TCD – 80 %. № 51K. 16.07.1973.
3. **Helictotrichon schellianum–Poa attenuata** rich in forbs. Arkhangai Aimak, Eastern Khangai, low mountain nears Tsetserleg Somon. H. – 1700 m. TCD – 45-50 %. № 24K. 17.07.1970.
4. **Filifolium sibiricum.** Eastern Aimak, Somon Gurvan-Dzagal. Plain. TCD -50 %. H. – 740 m. № 70.2Kh. 09.07.1989.
5. **Filifolium sibiricum** with grass and forbs. Sukhe-Bator Aimak, Somon Tumen-Tsogt. H.–1095m. TCD – 40 %. № 1-35Kh. 30.06.1990.
6. **Filifolium sibiricum** with petrophilous forbs (*Pulsatilla bungeana*). Sukhe-Bator Aimak, SomonTumen-Tsogt. H. – 1140 m. TCD – 50 % . № 1-8Kh. 15.07.1990.
7. Grass-forb with *Festuca dahurica* steppe. Eastern Aimak. Cis-Khingan sand plain on the left bank of the Khalkhin-Gol River. H. – 740 m. TCD – 70 %. № 76.1Kh. 16.07.1989.

Table VI.

Descriptions of the mountain mixed bunch-grass steppes with forbs

№№ of columnes	1	2	3	4	5	6	7
Shrubs							
Caragana microphylla	·	·	·	·	·	3-4	·
Caragana stenophylla	·	·	+	·	+	3-5	2-3
Dasiphora fruticosa	·	+	·	·	·	·	·
Dwarf semi-shrubs							
Alyssum lenense	·	+	·	·	·	·	1
Artemisia changaica	·	+	+	·	·	·	·
Artemisia commutata	·	·	·	·	·	10	3-4
Artemisia dolosa	+	·	5-8	5	·	·	·
Artemisia frigida	20	5-8	·	+	·	3-5	3-4
Artemisia santolinifolia	·	1-2	+	·	+	·	·
Ephedra monosperma	+	·	+	·	·	·	·
Ephedra sinica	·	·	·	·	+	·	·
Ptilotrichum canescens	·	·	5-8	·	2-3	+	1
Thymus gobicus	·	8	1-2	+	1-2	·	·
Long-lived perennial Grasses							
Agropyron aegilopoides	+	·	·	·	·	·	·
Agropyron cristatum	10	5	3-5	2-3	3-5	+	+
Festuca lenensis	·	12	15	40	5-8	10	30
Festuca sibirica	·	·	·	·	·	1-2	1-2
Festuca valesiaca	12	·	·	·	·	·	·
Helictotrichon schellianum	·	·	·	·	·	+	·
Koeleria macrantha	8	5-8	8	10	10	1-2	1-2
Poa attenuata	3-5	10	8	2-3	8	20	+
Stipa baicalensis	·	·	·	·	·	1-2	·
Stipa krylovii	·	·	+	+	1-2	·	·
Sedges							
Carex duriuscula	+	·	·	·	·	·	·
Carex korshinskyi	·	·	1	+	1	1-2	+
Carex pediformis	·	·	·	·	·	2-3	·
Carex stenophylloides	+	·	·	·	·	·	·
Forbs							
Allium bidentatum	·	·	+	+	+	+	+
Allium lineare	·	·	·	+	·	·	·
Allium tenuissimum	+	·	·	·	·	·	·
Amblynotus rupestris	2-3	+	·	1	·	+	·
Androsace incana	·	·	·	·	·	·	+
Androsace villosa	5	·	+	1	·	·	·
Arctogeron gramineum	·	1	+	2-3	·	·	4-5
Arenaria capillaris	2-3	1-2	+	2-3	·	+	4-5
Artemisia tanacetifolia	·	·	·	·	·	·	1-2
Aster alpinus	+	·	2-3	1-2	5-7	2-3	1-2
Astragalus inopinatus	·	·	·	1-2	·	·	20
Bupleurum bicaule	+	·	·	·	·	·	·
Bupleurum scorzonerifolium	·	·	+	+	·	+	+
Chamaerhodos altaica	·	·	+	+	·	·	·
Clausia aprica	+	·	·	·	·	·	·
Cymbaria dahurica	·	·	·	·	·	2-3	·
Dracocephalum origanoides	·	+	+	·	·	·	·
Echinops latifolius	·	·	·	·	·	+	+
Eritrichium pauciflorum	+	·	·	·	·	·	·
Euphorbia discolor	·	·	·	·	+	·	·
Gentiana decumbens	+	·	·	·	·	·	+
Goniolimon speciosum	·	·	·	·	·	+	+
Haplophyllum dauricum	·	·	·	·	·	·	+
Iris tigridia	·	+	+	·	+	+	·
Krylovia eremophyla	+	·	·	·	·	·	·
Leontopodium ochroleucum	+	·	·	·	·	2-3	·
Leuzea uniflora	·	·	·	·	·	+	·
Linaria acutiloba	·	·	·	+	·	·	+
Linum sibiricum	·	·	·	·	·	·	+
Medicago ruthenica	·	·	·	·	·	+	+
Orostachys malacophylla	·	·	·	·	·	+	+
Orostachys spinosa	+	·	·	·	·	·	·
Oxytropis filiformis	·	3-5	3-5	5-8	5-8	·	1-2

Table VI (continuation)

№№ of columnes	1	2	3	4	5	6	7
Oxytropis nitens	·	5	·	·	·	+	5
Panzeria lanata	·	·	+	·	+	·	·
Papaver nudicaule	·	·	·	·	·	+	·
Pedicularis achilleifolia	+	·	·	·	·	·	1
Pedicularis flava	·	·	+	+	1-2	·	+
Pedicularis striata	·	·		·	·	+	
Peucedanum histrix	+	·	+	1-2	·	+	2-3
Peucedanum vaginatum	·	·	·	·	·	·	+
Polygonum alpinum	·	·	·	·	·	·	·
Polygonum angustifolium	·	1-2	·	·	1-2	+	1
Potentilla acaulis	·	·	·	1	·	3-5	·
Potentilla bifurca	+	+	+	·	1-2	·	·
Potentilla conferta	·	·	+	·	2-3	·	·
Potentilla sericea	2-3	1-2	2-3	2-3	3-5	+	1-2
Potentilla strigosa	·	·	·	·	+	·	·
Potentilla viscosa	·	·	·	·	·	+	·
Pulsatilla bungeana	·	·	·	·	1-2	·	·
Pulsatilla turczaninovii	+	·	+	1-2	·	·	1-2
Rheum undulatum	·	+	+	·	3-5	·	+
Rhodiola rosea	·	+	+	·	+	·	·
Saussurea salicifolia	·	·	·	·	·	·	+
Scabiosa comosa	·	·	·	·	·	+	·
Schizonepeta multifida	·	·	·	+	·	·	·
Scorzonera austriaca	·	·	·	·	·	+	+
Sibbaldianthe adpressa	+	·	+	·	+	·	·
Silene jenisseensis	·	+	·	+	·	·	·
Silene repens	+	·	·	·	·	·	+
Smelovskia alba	+	·	·	·	·	·	·
Stellaria dichotoma	·	·	·	·	+	·	·
Thalictrum foetidum	·	3-5	5-8	·	5-8	·	·
Thalictrum petaloideum	·	·	·	·	·	+	1-2
Thermopsis dahurica	·	·	·	·	+	·	·
Thermopsis mongolica	·	·	+	·	·	·	·
Tragopogon trachycarpus	·	·	·	·	·	·	+
Veronica incana	·	·	·	+	·	·	·
Veronica pinnata	+	·	·	·	·	·	·
Youngia tenuifolia	·	·	·	·	·	·	1
Annual and short-lived perennial							
Androsace septentrionalis	+	·	·	·	·	·	·
Chamaerhodos erecta	·	·	·	·	+	·	+
Dontostemon integrifolius	·	·	+	·	+	·	+
Erysimum flavum	·	·	·	+		+	·
Plantago komarovii	+	·	·	·	·	·	·
Veronica ciliata	·	+	·	·	·	·	·

1. **Festuca lenensis–Koeleria macrantha–Agropyron cristatum**. Ubsu Nur Aimak, Bukh Muren Somon, Mongolian Altai. Bairam-Daba pass. H. – 2400 . TDC – 65 % . № 188K. 13.07.1978.
2. **Festuca lenensis–Poa attenuata–Koeleria macrantha–Agropyron cristatum** with forbs and *Dasiphora fruticosa.* Baijan-Khongor Aimak, Gurvan Bulak Somon, Southern macroslope of Central Khangai, the Gurvan-Bulak Mts. H. – 2890 m, southern slope. TDC – 40 %. № 77K. 13.07.1972.
3. **Festuca lenensis–Poa attenuata–Koeleria macrantha** with forbs. Baijan-Khongor Aimak, Central Khangai, Southern macroslope, the Bogd Ula Range. H. – 2550 m. TDC – 60 %. № 52K. 07.07.1972.
4. **Festuca lenensis–Koeleria macrantha–Poa attenuata** with forbs. Baijan-Khongor Aimak, Ikh-Tamis Somon, Eastern Khangai. H. – 1960m. TDC – 70 %. № 2K. 21.06.1971.
5. **Koeleria macrantha–Festuca lenensis–Poa attenuata** with mesoxerophilous forbs. Bajan-Khongor Aimak, Bulgan Somon, southern macroslope of the Khangai Mts., the Bogd Ula Mts. H. – 2690 m. TDC – 50–55 %. № 52K. 07.07.1972.
6. **Poa attenuata–Festuca lenensis** rich in forbs with shrubs (*Caragana microphylla, C.stenophylla*). Khentei Aimak. The Khentei Mts., southern foothills of the mountain. Khamar-Daba Pass. H.– 1700m. TDC – 60–70 %. № 1K. 17.06.1971.
7. **Festuca lenensis–F.sibirica–Koeleria macrantha** with forbs and *Caragana stenophylla.* Central Aimak, Baijan-Dsurkh Somon, The Khentei Mts., Khooltyn Daba Pass. H. – 1712 m. TDC – 60–65 %. №.1K. 02.07.1970.

Table VII.

Descriptions of the lowmountain forb–bunch-grass steppes.
Formation: Festuca lenensis

№№ of columnes	1	2	3	4	5	6
Shrubs						
Amygdalus pedunculata	10	10	·	·	·	+
Caragana microphylla	+	+	+	·	·	+
Caragana pygmaea	+	+	·	·	·	·
Caragana stenophylla	·	·	1	+	·	+
Cotoneaster melanocarpa	·	·	·	·	·	·
Dasiphora fruticosa	+	10	·	·	·	·
Spiraea aquilegifolia	·	10	·	·	·	·
Dwarf semi-shrubs						
Alyssum lenense	+	+	+	2	·	+
Artemisia commutata	·	·	·	4	+	2
Artemisia frigida	1	·	·	·	·	·
Dianthus versicolor	+	·	·	·	+	·
Ptilotrichum tenuifolium	1	+	·	+	+	·
Thymus dahuricus	+	10	2	·	·	·
Long-lived perennial Grasses						
Agropyron cristatum	1	+	·	·	·	·
Cleistogenes squarrosa	·	·	·	+	·	·
Festuca lenensis	4	15	30	7	25	10
Festuca sibirica	·	+	·	·	·	·
Helictotrichon schellianum	·	·	·	+	·	·
Koeleria macrantha	+	+	+	+	3	1
Leymus chinensis	·	+	·	·	1	·
Poa botryoides	1	1	·	2	4	1
Poa stepposa	·	·	+	·	·	·
Stipa baicalensis	·	·	·	1	1	z
Stipa grandis	+	+	·	·	·	·
Stipa krylovii	1	+	+	·	·	+
Stipa sibirica	+	·	·	·	·	·
Sedges						
Carex duriuscula	·	·	·	·	2	·
Carex korshinskyi	1	2	2	+	·	1
Carex pediformis	·	·	·	2	·	·
Forbs						
Adenophora stenanthina	+	·	·	·	·	·
Allium bidentatum	·	·	+	+	·	·
Allium prostratum	6	·	·	·	1	+
Allium vodopjanovii	·	+	·	1	+	·
Amblynotus rupestris	+	·	1	2	1	+
Androsace incana	+	+	+	1	1	1
Arctogeron gramineum	·	3	·	1	·	1
Arenaria capillaris	·	·	1	2	·	1
Aster alpinus	·	+	·	·	·	·
Astragalus galactites	·	·	+	·	·	·
Astragalus mongholicus	·	·	+	·	+	·
Astragalus tenuis	·	·	·	·	+	·
Bupleurum bicaule	2	+	+	+	·	+
Bupleurum scorzonerifolium	·	·	·	·	3	·
Chamaerhodos trifida	·	1	+	1	·	12
Chryzanthemum zawadskii	·	+	·	+	+	·
Cymbaria dahurica	+	+	+	1	2	·
Filifolium sibiricum	2	·	·	2	7	·
Galium verum	2	+	·	·	·	2
Gentiana decumbens	·	·	·	·	+	·
Goniolimon speciosum	+	·	·	·	·	+
Gypsophyla dahurica	·	·	+	·	·	·
Haplophyllum dauricum	·	·	+	+	·	·
Heteropappus altaicus	+	+		+	·	·
Heteropappus biennis	+	·	·	·	·	·
Iris potaninii	·	·	·	·	·	+
Iris tenuifolia	·	·	·	+	·	·
Leotopodium ochroleucum	·	+	·	·	·	·
Leuzea uniflora	+	·	·	·	·	·
Linaria buriatica	·	+	·	·	·	·
Medicago ruthenica	+	+	1	2	+	+
Orostachys malacophylla	+	·	·	·	·	·

Table VII (continuation)

№№ of columnes	1	2	3	4	5	6
Orostachys spinosa	+	+	·	+	+	7
Oxytropis filiformis	+	·	·	3	1	+
Oxytropis myriophylla	·	·	·	+	+	·
Oxytropis nitens	+	·	+	+	·	+
Oxytropis oxyphylla	+	+	·	·	·	·
Papaver croceum	+	·	·	·	·	·
Pedicularis flava	+	+	·	+	·	·
Pedicularis striata	·	·	·	·	+	·
Polygonum angustifolium	1	+	+	+	+	+
Potentilla acaulis	·	+	+	·	·	·
Potentilla leucophylla	+	+	·	+	+	·
Potentilla sericea	2	1	+	+	·	3
Potentilla tanacetifolia	·	+	+	·	·	+
Potentilla verticillaris	·	+	+	+	+	·
Pulsatilla bungeana	8	+	1	+	5	1
Pulsatilla turczaninovii	·	·	·	·	+	·
Rheum undulatum	·	+	·	·	·	·
Saposhnikovia divaricata	·		·	·	+	·
Saussurea salicifolia	1	+	+	+	·	·
Scorzonera austriaca	·	·	·	+	·	·
Sedum aizoon	·	·	·	·	+	·
Serratula centauroides	+	·	·	+	+	·
Sibbaldianthe adpressa	·	+	·	·	·	·
Sibbaldianthe sericea	·	·	+	·	·	·
Silene jenisseensis	·	+	·	·	+	+
Stellera chamaejasme	·	+	·	+	+	·
Thalictrum squarrosum	2	·	·	·	+	·
Veronica incana	+	·	·	·	·	·
Youngia tenuifolia	+	·	·	+	·	·
Annual and short-lived perennial						
Artemisia scoparia	·	4	·	·	·	·
Dontostemon integrifolius	·	+	·	·	·	·
Erysimum flavum	+	·	·	·	·	·
Gentiana squarrosa	·	·	·	·	+	·
Hackelia thymifolia	+	·	·	·	·	+

1. **Festuca lenensis–Filifolium sibiricum** with *Amygdalus pedunculata*. Khentei Aimak, Berkh Somon. Middle Khalkha, the Berkh Mts. H. – 1200 m. TDC – 60 %. № 107.1Kh. 05.08.1989.
2. **Festuca lenensis–Filifolium sibiricum** with *Amygdalus pedunculata, Dasiphora fruticosa*. Sukhe Bator Aimak. Middle Khalkha, the Delger Obo Mts. H. – 1200m. TDC – 60 %. № 100.1Kh. 02.08.1989.
3. **Festuca lenensis** with petrophilous forbs. Sukhe Bator Aimak, Tumen-Tsogt Somon. Lowmountain. H. – 1300 m. TDC – 60%. № I-5.1Kh. 22.06.1990.
4. **Festuca lenensis–Poa botryoides–Carex pediformis** with petrophilous forbs. Sukhe Bator Aimak, Tumen-Tsogt Somon. Low-mountain, H. – 1090 m. TDC – 40 %. № II-2 Kh. 01.07.1990.
5. **Festuca lenensis–Filifolium sibiricum** with petrophilous forbs. Sukhe Bator Aimak, Tumen-Tsogt Somon. Eastern Mongolian, the top of the hill. H. – 1200m. TDC – 40 %. № III-109Kh. 04.08.1991.
6. **Festuca lenensis–Chamaerhodos trifida** with shrubs. Sukhe Bator Aimak. Middle Khalkha, the Dzan Shyre Mts. H. –1300 m. TDC – 40 %. № 165.1.1Kh. 25.08.1989.

Table VIII.

Descriptions of the lowmountain and plain forb–bunch-grass steppes.
Formations: Stipa baicalensis, Stipa grandis, Stipa krylovii

№№ of columnes	1	2	3	4	5	6	7	8
Shrubs								
Armeniaca sibirica	·	·	5-8	·	·	·	·	·
Caragana microphylla	2-4	·	2-4	4-5	+	+	3-5	1-2
Caragana stenophylla	1-2	5	·	2-3	+	+	1-2	·
Dwarf semi-shrubs								
Alyssum lenense	·	·	+	·	·	·	·	·
Artemisia changaica	·	·	·	·	·	·	·	1-2
Artemisia commutata	·	+	2-3	2-3	·	·	+	·
Artemisia dolosa	·	·	·	·	·	·	·	3-5
Artemisia frigida	+	10	2-3	2-3	·	·	+	·
Ephedra sinica	·	+	·	·	·	·	·	·
Kochia prostrata	+	+	·	1-2	+	·	·	·
Ptilotrichum canescens	+	·	+	·	·	·	1-2	·
Ptilotrichum dahuricum	·	·	·	·	·	+	·	·
Ptilotrichum tenuifolium	·	·	·	·	+	·	·	·
Thymus dahuricus	·	·	1	·	·	·	·	·
Thymus gobicus	·	·	·	·	·	·	·	1-2
Long-lived perennial Grasses								
Agropyron cristatum	+	5-7	1-2	5	+	+	+	5-8
Cleistogenes kitagawae	·	·	·	2-3	+	·	·	·
Cleistogenes squarrosa	5-7	5-7	1-2	·	·	4	2-3	5-8
Festuca lenensis	·	·	+	·	·	·	·	·
Koeleria macrantha	+	5	·	5	+	+	+	3-4
Koeleria mukdenensis	·	·	2-3	·	·	·	·	·
Leymus chinensis	1-2	1-2	1-2	1-2	1	2	5-7	2-3
Poa attenuata	·	1	·	·	·	·	·	5-6
Poa botryoides	+	·	+	·	+	+	·	·
Stipa baicalensis	35	30	20	25	·	·	·	·
Stipa grandis	·	·	·	·	7	2	·	·
Stipa krylovii	·	·	·	·	3	10	25	18
Stipa sibirica	·	·	+	·	·	·	·	
Sedges								
Carex duriuscula	·	·	·	·	·	·	·	+
Carex korshinskyi	+	1	·	1-2	·	2	+	·
Forbs								
Adenophora stenanthina	·	·	·	·	2	·	·	·
Allium anisopodium	·	+	1-2	+	·	·	·	·
Allium bidentatum	·	+	·	·	+	·	·	·
Allium condensatum	+	·	·	+	·	·	+	1-2
Allium lineare	·	·	+	·	·	·	·	·
Allium odorum	·	·	+	·	·	·	·	·
Allium senescens	·	·	1	3-5	·	·	·	·
Allium tenuissimum	·	+	·	·	+	+	·	·
Amblynotus rupestris	·	·	·	·	·	·	·	2-3
Androsace incana	·	·	·	·	·	·	·	1-2
Anemarrhena asphodeloides	1-2	·	·	·	·	·	·	·
Arenaria capillaris		·	·	·	·	·	·	+
Asparagus dahuricus	+	·	+	·	·	·	·	·
Astragalus adsurgens	·	·	+	·	·	·	·	·
Astragalus inopinatus	·	·		·	·	·	·	2-3
Astragalus melilotoides	+	+	+	·	·	·	·	·
Astragalus scaberrimus	·	5	·	+	·	·	·	·
Astragalus tenuis	·	·	·	·	+	·	·	3-5
Bupleurum bicaule	+	·	·	·	·	·	1-2	·
Bupleurum scorzonerifolium	·	+	·	·	10	+	·	+
Cymbaria dahurica	+	1-2	·	·	+	+	1-2	+
Echinops latifolius	·	+	·	·	·	·	·	·
Euphorbia discolor	·	·	·	+	·	+	+	·
Galium verum	·	+	·	·	·	+	·	·
Goniolimon speciosum	·	+	·	·	·	+	·	·
Haplophyllum dauricum	+	+	·	·	+	·	+	·
Hedysarum gmelinii	·	·	·	·	·	·	1-2	·
Heteropappus altaicus	+	1-2	+	1-2	+	+	·	·
Heteropappus hispidus	·	·	·		·	·	·	+
Iris dichotoma	·	·	·	1-2	·	·	·	·

Table VIII (continuation)

№№ of columnes	1	2	3	4	5	6	7	8
Iris tenuifolia	·	+	·	·	·	+	·	·
Iris tigridia	·	·	·	·	·	·	·	+
Lespedeza dahurica	5-7	·	·	·	·	·	·	·
Leuzea uniflora	·	·	1	·	·	·	·	·
Linum sibiricum	·	·	·	·	·	·	+	·
Medicago ruthenica	+	·	·	·	2	1	+	·
Olgaea lomonosovii	·	·	·	·	·	·	1-2	·
Oxytropis nitens	·	·	·	·	·	·		5-8
Oxytropis oxyphylla	·	+	·	·	·	·	·	·
Pedicularis venusta	·	·	·	·	·	·	·	1
Polygala sibirica	+	·	·	·	·	·	+	·
Polygonum divaricatum	·	·	+	·	·	·	·	·
Potentila acaulis	·	10	·	·	10	5	·	+
Potentilla bifurca	·	·	·	·	+	+	·	·
Potentilla conferta	·	·	·	·		+	·	·
Potentilla leucophylla	·	·	·	·	+	·	·	·
Potentilla sericea	·	·	·	·	·	·	·	+
Potentilla strigosa	·	·	·	·	·	+	·	·
Potentilla tanacetifolia	·	·	1	3-5	+	+	·	·
Potentilla verticillaris	·	·	·	·	+		+	1-2
Potentilla viscosa	+	·	·	·	·	2	·	·
Pulsatilla bungeana	·	·	2-3	·	·	·	·	·
Pulsatilla turczaninovii	·	·	·	·	3	·	·	·
Saposhnikovia divaricata	+	·	+	·	·	·	+	·
Saussurea salicifolia	·	+	·	·	+	+	1-2	·
Scabiosa camosa	·	·	·	·	·	·	·	+
Schizonepeta multifida	·	·	·	·	+	·	·	·
Scutellaria baicalensis	5-7	·	1	·	·	·	·	·
Scutellaria scordiifolia	·	·	·	1-2	·	·	+	·
Senecio integrifolia	·	·	·	·	·	·	·	+
Serratula centauroides	5-7	·	1	·	+	+	1-2	1
Silene jenisseensis	·	·	·	·	+	·	·	·
Sibbaldianthe adpressa	·	·	·	·	+	+	·	1-2
Stellera chamaejasme	·	·	·	·	·	·	·	1
Thalictrum squarrosum	+	·	3-4	1-2	+	·	+	·
Veronica incana	·	1-2	·	·	·	10	·	·
Annual and short-lived perennial								
Androsace septentrionalis	·	+	·	·	·	·	·	·
Artemisia scoparia	·	+	·	·	+	·	·	·
Chamaerhodos erecta	·	·	+	·	+	+	·	·
Dontostemon integrifolius	·	+	+	+	+	+	·	·
Erysimum flavum	·	+	·	1	·	·	·	·
Gentiana squarrosa	·	·	·	·	·	·	·	+
Lappula intermedia	·	+	·	·	·	·	·	·

1. **Stipa baicalensis–Cleistogenes squarrosa** with forbs and shrubs (*Caragana microphylla, C.stenophylla*). Sukhe Bator Aimak, Erdene-Tsagan Somon. Middle Khalkha, the plain near Erdene-Tsagan. H. – 1000 m. TCD – 55 %. № 35K. 01.07.1971.
2. **Stipa baicalensis–Agropyron cristatum–Cleistogenes squarrosa** with forbs and *Caragana stenophylla.* Sukhe Bator Aimak. Middle Khalkha, the Gantsyn-Tsagan-Obo Mts. near Plateau Dariganga. H – 1430 m. TCD – 70–80 %. № 37K. 07.07.1971.
3. **Stipa baicalensis** with forbs and *Armeniaca sibirica.* Eastern Aimak, western foothills of the Greater Khingan Mts., the Barun-Suul Mts. H. – 943 m. TCD – 45 %. № 34K. 01.07.1971.
4. **Stipa baicalensis** with forbs and shrubs (*Caragana microphylla, C.stenophylla*). Eastern Aimak, the plain near Tamsag Bulak. H. – 700 m. TCD – 60 %. № 11K. 26.06.1971.
5. Forb steppe with *Stipa grandis*. Eastern Aimak. Eastern Monglia. The plain, H. – 1050 m. TCD – 70 %. № 111.2Kh. 09.08.1989.
6. **Stipa krylovii** with mesoxerophylous forbs. Eastern Aimak, Matad Somon, low hill plain. H. – 820 m. TCD – 70 %. № 157.1Kh. 19.08.1989.
7. **Stipa krylovii–Leymus chinensis** with forbs and shrubs (*Caragana microphylla, C.stenophylla*). Sukhe Bator Aimak, Erdene-Tsagan Somon. Middle Khalkha, peneplain near Erdene-Tsagan. H. – 1200 m. TCD – 40-45 %. № 36.K. 02.07.1971.
8. **Stipa krylovii** with xerophilous and mesoxerophilous forbs and *Caragana microphylla.* Arkhangai Aimak. Eastern Khangai, low mountain near Tsetserleg Somon. H. – 1600 m. TCD – 55–60 %. № 22K. 17.07.1970.

Table IX.

Desciptions of the mountain bunch-grass steppes.
Formations: Festuca lenensis, Agropyron cristatum, Stipa krylovii

№№ of columnes	1	2	3	4	5	№№ of columnes	1	2	3	4	5
Shrubs						Bupleurum bicaule	+	+	+	1-2	+
Caragana bungei	·	·	·	5	5	Chamerhodos altaica	+	·	·	·	·
Caragana pygmaea	·	·	·	·	2-5	Convolvulus ammanii	·	+	·	+	+
Dwarf semi-shrubs						Dracocephalum fruticulosum	·	·	·	2-3	·
Alyssum lenense	+	+	·	·	·	Dracocephalum origanoides	·	+	·	·	·
Artemisia changaica	·	+	·	·	·	Euphorbia humifusa	·	·	+	·	·
Artemisia commutata	+	+	·	·	·	Goniolimon speciosum	·	+	·	·	·
Artemisia frigida	+	10	3-5	5	16	Gypsophila desertorum	·	·	+	+	+
Artemisia obtusiloba	·	·	1-2	·	·	Heteropappus altaicus	·	·	+	·	+
Ephedra monosperma	·	·	1	+	+	Iris tigridia	·	·	·	+	+
Kochia prostrata	·	·	·	·	2-3	Limonium flexuosum	+	·	·	·	·
Ptilotrichum canescens	+	+	·	·	·	Linum baicalense	+	·	·	·	·
Thymus gobicus	+	·	·	·	·	Orostachys spinosa	1-2	·	+	·	·
Long lived-perennial Grasses						Oxytropis filiformis	3-5	·	·	·	·
						Oxytropis gracillima	·	+	·	·	·
Agropyron cristatum	7-9	14	25	3-5	2-3	Oxytropis nitens	·	+	·	·	·
Cleistogenes squarrosa	·	+	·	·	+	Peucedanum histrix	2-3	+	·	·	·
Festuca lenensis	18	18	5-7	·	·	Potentilla acaulis	·	1-2	2-3	·	10
Koeleria macrantha	5-7	9	5-8	+	2-3	Potentilla bifurca	·	·	·	+	·
Poa attenuata	5	7	5-6	5-8	+	Potentilla sericea	1-2	·	3-5	·	·
Stipa krylovii	2-3	10	1-2	10	30	Pulsatilla ambigua	+	·	·	·	·
Sedges						Scorzonera austriaca	·	·	3-5	+	+
Carex duriuscula	+	5-7	·	+	·	Sibbaldianthe adpressa	·	+	·	·	·
Carex stenophyloides	·	·	+	z	+	Stellaria dichotoma	·	+	·	+	·
Forbs						Thalictrum foetidum	+	+	·	+	·
Allium altaicum	·	·	·	1-2	·	Thermopsis mongolica	·	·	·	5	·
Allium anisopodium	·	+	·	·	·	Veronica incana	1-2	·	·	·	·
Allium bidentatum	+	·	·	·	·	**Short-lived perennial and annual**					
Allium prostratum	·	+	·	·	·	Artemisia pectinata	·	·	+	·	·
Allium tenuissimum	·	·	·	·	+	Chamaerhodos erecta	·	+		·	·
Amblynotus rupestris	+	·	+	·	·	Dontostemon integrifolius	·	+	+	·	·
Androsace villosa	+	·	+	·	·	Erysimum flavum	+	+	·	·	·
Arenaria capillaris	20	·	·	·	+	Lappula intermedia	·	·	·	·	+
Arenaria meyeri	·	·	5-8	·	·	**Lichenes**					
Aster alpinus	1-2	·	·	·	·	Parmelia vagans	·	·	40	·	35
Astragalus brevifolius	·	·	3-5	2-3	+						

1. **Festuca lenensis–Agropyron cristatum–Koeleria macrantha–Poa attenuata** with petrophilous forbs. Baijan Khongor Aimak, Bogd Somon. Central Khangai, Southern macroslope. H. – 2520m. TCD – 50–55 %. № 15K. 27.06.1972.
2. **Festuca lenensis–Agropyron cristatum–Stipa krylovii–Koeleria macrantha–Poa attenuata– Artemisia frigida.** Baijan Khongor Aimak. Bogd Somon. Central Khangai, Southern macroslope. H. – 2300 m. TCD – 50–60 %. № 16K. 27.07.1972.
3. **Agropyron cristatum–Festuca lenensis–Koeleria macrantha–Poa attenuata–Artemisia frigida.** Ubsu Nur Aimak, Sagil Somon. North-eastern part of Mongolian Altai. Norh-western slope of the Tsagan-Shibetu Mts. Daltyn-Daba Pass. H. – 1870 m. TCD – 40–45 %. № 147K. 03.07.1978.
4. **Stipa krylovii–Poa attenuata–Agropyron cristatum.** Ubsu Nur Aimak, Turgen Somon. North-eastern part of Mongolian Altai, mountain near Achit Nur Pan. H. – 1950m. TCD – 35 %. № 61K. 22.07.1977.
5. **Stipa krylovii–Artemisia frigida** with *Caragana pygmaea* and *C.bungei.* Ubsu Nur Aimak, Sagil Somon. North-eastern part of Mongolian Altai, foothills of the Tsagan-Shibetu Mts. H. – 1400 m. TCD – 70 %. № 20K. 01.07.1977.

Table X.

Desciptions of the plain bunch-grass dry steppes.

Formations: Stipa krylovii, Stipa grandis, Cleistogenes squarrosa

№ № of columnes	1	2	3	4	5	6	7	8	9
Shrubs									
Caragana microphylla	5-8	3-5	·	3	·	+	·	+	10
Caragana pygmaea	2-3	·	·	·	·	·	·	·	5-6
Caragana stenophylla	·	2-3	+	+	2-3	+	+	+	15
Dwarf semi-shrubs									
Artemisia adamsii	·	1-2	+	·	3-5	·	·	·	+
Artemisia frigida	5	·	+	1-2	·	4	6	1	10
Ephedra sinica	·	·	·	1-2	·	·	·	·	·
Kochia prostrata	·	·	·	+	+	·	·	·	·
Ptilotrichum canescens	·	+	·	·	·	·	·	·	·
Ptilotrichum tenuifolium	·	·	·	·	·	+	·	·	·
Long lived-perennial Grasses									
Agropyron cristatum	5	1-2	+	+	5-6	1	·	·	9
Cleistogenes squarrosa	12	10	10	3-5	14	7	5	+	15
Koeleria macrantha	+	10	·	1-2	+	1	+	2	+
Leymus chinensis	+	1-2	·	+	1-2	+	+	7	4-5
Poa botryoides	5	1-2	·	·	+	·	+	·	+
Stipa grandis	·	+	1	15	20	20	20	25	·
Stipa krylovii	18	20	40	+	+	·	·	·	3-5
Sedge									
Carex duriuscula	+	·	·	·	+	·	·	·	+
Carex korshinskyi	·	+	·	1-2	5-7	+	·	·	·
Forbs									
Allium anisopodium	+	+	+	1	+	·	·	·	+
Allium bidentatum	+		+	+	+	+	·	·	1-2
Allium odorum	·	·	·	+	·	·	+	·	·
Allium senescens	·	·	·	+	·	·	·	·	·
Allium tenuissimum	·	·	+	·	·	+	+	·	+
Arenaria capillaris	·	+	·	·	·	·	·	·	·
Asparagus dahuicus	·	·	·	1-2	+	·	·	·	·
Astragalus galactites	1-2	·	+	+	+	+	·	·	+
Astragalus laguroides	·	·	·	·	·	·	·	·	+
Astragalus melilotoides	·	+	·	·	·	·	·	·	·
Astragalus scaberrimus	·	·	·	+	·	·	+	·	·
Bupleurum bicaule	·	·	+	2-3	·	2	+	·	·
Bupleurum scorzonerifolium	·	·	·	·	·	·	·	+	·
Convolvulus ammanii	1	·	·	·	·	·	·	+	·
Cymbaria dahurica	+	1	+	+	·	+	+	+	+
Euphorbia discolor	+	+	·	·	·	+	·	·	·
Galium verum		+	·	·	·	·	·	·	·
Haplophyllum dauricum	+	+		+	·	·	·	·	+
Heteropappus altaicus			+	+	·	+		+	+
Iris tenuifolia	+	·	·		·	·	·	·	·
Lespedeza dahurica	·	·	·	2-3	·	·	·	·	·
Limonium bicolor	·	·	·	·	·	·	+	·	·
Lynaria buriatica	·	·	·	·	·	+	·	·	·
Medicago ruthenica	+	+	·	·	·	·	·	·	·
Orostachys thyrsiflora	·	·	·	·	·	·	+	·	·
Oxytropis myriophylla	·	·	·	+	·	·	·	·	·
Potentilla acaulis	·	+	·	·	·	·	·	·	·
Potentilla bifurca	+	·	+	·	·	·	·	·	·
Potentilla conferta	·	·	+	·	·	·	·	·	·
Potentilla nudicaulis	·	·	·	·	·	·	·	·	+
Potentilla strigosa	·	·	·	·	·	·	+	·	·
Potentilla tanacetifolia	+	+	·	+	·	·	·	·	·
Saposhnikovia divaricata	·	·	·	·	·	+	·	·	·
Saussurea salicifolia	·	2-3	·	·	·	·	·	+	·
Serratula centauroides	·	·	·	·	·	·	+	+	+
Sibbaldianthe adpressa	+	+	·	·	·	·	·	·	+
Sibbaldianthe sericea	·	·	+	·	·	·	·	·	·
Thalictrum squarrosum	·	·	·	1-2	·	·	·	·	·
Veronica incana	·	+	·	·	·	·	·	·	·

Table X (continuation)

№ № of columnes	1	2	3	4	5	6	7	8	9
Short-lived perennial and annual									
Artemisia palustris	·	·	·	·	·	·	+	·	+
Artemisia scoparia	+	·	+	1-2	2-3	+	1	2	·
Chamaerhodos erecta	·	+	·	+	·	·	·	·	+
Chamaerhodos sabulosa	·	·	·	·	+	·	·	·	·
Chenopodium acuminatum	·	·	·	·	·	·	+	·	·
Chenopodium aristatum	·	·	+	·	+	·	+	·	+
Chenopodium strictum	·	·	·	·	+	·	·	·	1-2
Dontostemon integrifolius	·	+	·	·	+	·	·	·	+
Eragrostis minor	·	·	·	·	·	·	+	·	·
Lepidium densiflorum	·	·	·	·	·	·	·	·	+
Salsola australis	·	·	·	·	·	·	·	·	1
Salsola collina	·	·	·	·	+	·	·	·	1
Salsola pestifera	·	·	·	·	+	·	·	·	+

1. **Stipa krylovii–Cleistogenes squarrosa–Agropyron cristatum** with *Caragana microphylla*. Khentei Aimak, Under Khan Somon. Central Mongolia (Middle Khalkha), denudative plain. H. – 1000 m. TCD – 50 %. № 4K. 19.06.1971.
2. **Stipa krylovii–Koeleria macrantha–Cleistogenes squarrosa** with *Caragana microphylla* and *C.stenophylla*. Sukhe Bator Aimak, Bain-Term Somon. Eastern Mongolia, plain. H. – 1200 m. TCD – 50-60 %. № 6K. 21.06.1971.
3. **Stipa krylovii–Cleistogenes squarrosa.** Sukhe Bator Aimak, Tumen-Tsogt Somon. Plain. H. – 1110m. TCD – 50 %. № 113.1Kh. 09.08. 1989.
4. **Stipa grandis–S.krylovii–Cleistogenes squarrosa** with *Caragana microphylla, C.stenophylla* and psammophilous forbs. Eastern Aimak,Eastern Mongolia, plain near Tamsag Bulak Somon. H. – 600. TCD – 30–35 %. № 14K. 27.06.1971.
5. **Stipa grandis–Cleistogenes squarrosa–Carex korshinskyi** with *Caragana stenophylla.* Central Aimak, Unzhul Somon. Middle Khalkha, plain near Somon. H. – 1250 m. TCD – 50–55 %. № 001K. 23.06.1972.
6. **Stipa grandis–Cleistogenes squarrosa–Artemisia frigida.** Eastern Aimak, Matad Somon. Eastern Mongolia. TCD – 60 %. 950 m. № 134.1Kh. 13.08.1989.
7. **Stipa grandis–Cleistogenes squarrosa–Artemisia frigida.** Eastern Aimak, Tamsag Bulak Somon. Eastern Mongolia. Plain. TCD – 40 %. 650 m. № 150.1Kh. 18.08.1989.
8. **Stipa grandis–Leymus chinensis.** Sukhe Bator Aimak, Erdene Tsagan Somon. Middle Khalkha, plain. H. – 1130 m. TCD – 50 %. № 32.2Kh. 20.06.1989.
9. **Cleistogenes squarrosa–Agropyron cristatum–Leymus chinensis–Artemisia frigida** with *Caragana stenophylla* and *C.microphylla.* Central Aimak, Unzhul Somon. Middle Khalkha, plain near Somon. H. – 1200 m. TCD – 50–55 %. № 20K. 23.06.1972.

Table XI.

Descriptions of the plain and mountain bunch-grass dry steppes.

Formations: Festuca valesiaca, Agropyron nevskii, Stipa kirghisorum, Stipa krylovii, Stipa klemenzii

№№ of columnes	1	2	3	4	5	6	7
Shrubs							
Amygdalus pedunculata	·	·	·	·	·	+	·
Atraphaxis frutescens	·	1	·	·	·	·	·
Caragana bungei	+	1	12	·	·	·	·
Caragana microphylla	·	·	·	2-5	·	·	·
Caragana pygmaea	1-2	1-2	+	1-2	·	·	+
Caragana stenophylla	·	·	·	·	+	+	·
Dwarf semi-shrubs	·	·	·	·	·	·	·
Ajania trifida	·	·	·	·	·	2	·
Artemisia adamsii	·	·	·	+	·	·	·
Artemisia caespitosa	·	·	·	·	·	·	+
Artemisia commutata	·	·	·	+	·	·	·
Artemisia frigida	8	1-2	·	10	+	10	10
Artemisia klementzae	·	·	1-2	·	·	·	·
Artemisia monostachya	·	+	·	·	·	·	·
Artemisia obtusiloba	·	·	+	·	·	·	·
Ephedra sinica	·	+	·	·	+	+	·
Kochia prostrata	4-5	·	+	+	·	+	+
Oxytropis tragacanthoides	·	1	·	·	·	·	·
Ptilotrichum canescens	·	·	·	+	·	·	+
Ptilotrichum tenuifolium	·	·	·	·	·	+	·
Long-lived perennial Grasses							
Agropyron cristatum	2-3	·	+	+	2	3	1
Agropyron nevskii	·	10	·	·	·	·	·
Cleistogenes squarrosa	3-5	·	·	2-3	5	+	1
Festuca valesiaca	25	·	·	·	·	·	·
Koeleria cristata	2-3	·	·	·	·	·	·
Koeleria macrantha	·	·	·	1-2	·	·	+
Leymus chinensis	·	·	·	1-2	1	·	·
Poa botryoides	·	·	·	+	·	·	·
Poa stepposa	·	1-2	·	·	·	·	·
Psathyrostachys juncea	·	·	+	·	·	·	·
Stipa capillata	3-5	+	·	·	·	·	·
Stipa glareosa	·	·	·	+	·	·	·
Stipa gobica	·	·	·	+	·	·	·
Stipa kirghisorum	·	·	25	·	·	·	·
Stipa klemenzii	·	·	·	·	10	15	12
Stipa krylovii	·	·	·	18	·	·	+
Stipa orientalis	·	3-5	·	·	·	·	·
Sedges							
Carex duriuscula	·	·	·	+	+	·	·
Carex korshinskyi	+	+	1		+	·	·
Carex stenophylloides	·	·	·	·	·	·	+
Forbs							
Allium anisopodium	·	·	·	+	·	·	·
Allium bidentatum	·	·	·	·	·	·	1
Allium lineare	·	+	·	·	·	·	·
Allium mongolicum	·	·	+	·	·	·	·
Allium polyrrhizum	·	·	·	·	3	·	·
Allium tenuissimum	·	·	·	·	·	+	·
Androsace villosa	·	+	·	·	·	·	·
Arenaria capillaris	·	+	·	+	·	·	2-3
Asparagus dahuricus	·	·	·	·	+	+	
Aster alpinus	·	+	·	·	·	·	·
Astragalus laguroides	·	·	·	+	·	·	·
Bupleurum bicaule	+	+	·	+	·	·	+
Convolvulus ammanii	+	·	·	+	·	·	+
Cymbaria dahurica		·	·	·	+	+	+
Dianthus ramosissimus	+	·	·	·	·	·	·
Dracocephalum foetidum	·	4-5	·	·	·	·	+
Euphorbia discolor	·	·	·	·	+	·	·
Euphorbia humifusa	·	+	·	·	·	·	·
Euphorbia mongolica	·	·	+	·	·	·	·
Haplophyllum dauricum	·	·	·	+	·	+	+

Table XI (continuation)

№№ of columnes	1	2	3	4	5	6	7
Heteropappus altaicus	·	·	·	·	·	1	+
Heteropappus hispidus	·	+	·	·	·	·	·
Iris bungei	·	·	·	+	·	·	·
Iris potaninii	·	+	·	·	·	·	·
Iris tenuifolia	·	·	+	·	+	·	·
Lagochilus ilicifolius	·	·	·	·	·	·	+
Limonium bicolor	·	·	·	·	+	·	·
Linaria buriatica	·	·	·	·	+	·	·
Orostachys fimbriata	·	·	·	·		+	·
Orostachys spinosa	1	·	·	·	·	·	·
Oxytropis aciphylla	·	·	·	·	·	·	+
Panzeria lanata	·	·	·	·	·	·	+
Peucedanum histrix	·	+	·	·	·	·	·
Potentilla acaulis	5-7	+	2-3	·	·	·	·
Potentilla bifurca	+	·	+	+	·	·	·
Saussurea salicifolia	·	3-4	·	·	+	·	·
Scorzonera divaricata	·	·	·	+	·	·	·
Serratula centauroides	·	·	+	·	+	·	·
Sibbaldianthe adpressa	·	·	·	+	·	·	+
Silene jenisseensis	·	+	·	+	·	·	·
Stellaria dichotoma	·	+	+	·	·	·	·
Thermopsis lanceolata	·	·	·	+	·	·	·
Vicia costata	·	+	·	·	·	·	·
Youngia tenuifolia	·	+	+	·	+	·	·
Annual and short-lived perennial							
Artemisia scoparia	·	·	·	+	·	+	·
Chamaerhodos erecta	·	·	·	·	·	·	+
Dontostemon integrifolius	·	·	·	·	3	·	+
Salsola collina	·	·	·	+	·	·	·
Lichenes							
Parmelia vagans	5-8	·	·	·	·	30	·

1. **Festuca valesiaca–Stipa capillata** with *Caragana bungei* and *C.pygmaea*. Ubsu Nur Aimak, Barun-Turun Somon. Plain. H. – 1300 m. TCD – 50-55 %. № 20K. 14.06.1978.
2. **Agropyron nevskii–Stipa orientalis** with petrophilous forbs and shrubs (*Caragana bungei, Atraphaxis frutescens*). Ubsu Nur Aimak, Sagil Somon. Foothills of the Khan-Khukhiin Ula Range. H. – 1720 m. TCD – 25-30 %. № 36K. 28.06.1978.
3. **Stipa kirghisorum** with *Caragana bungei*. Ubsu Nur Aimak, Tes Somon. The Godzor Mts. H. – 1570 m. TCD – 40 %. № 16K. 12.06.1978.
4. **Stipa krylovii–Artemisia frigida** with *Stipa glareosa* and *S.gobica* and shrubs (*Caragana microphylla, C.pygmaea*). Central Aimak. Middle Khalkha, plain. TCD – 25–30 %. Yunatov (1974).
5. **Stipa klemenzii–Cleistogenes squarrosa.** Sukhe Bator Aimak, Asgat Somon. Middle Khalkha, low hills. H. – 1070 m. TCD – 40 %. № 29.1Kh. 19.06.1989.
6. **Stipa klemenzii–Artemisia frigida.** East-Gobi Aimak. The Khutliin-Bajan-Obo Mts, low hills. H. – 1100 m. TCD – 30 %. № 179.1Kh. 31.08.1989.
7. **Stipa klemenzii–S.krylovii–Cleistogenes squarrosa–Agropyron cristatum** with petrophilous forbs and *Caragana pygmaea*. Middle Gobi Aimak. Central Mongolia (Middle Khalkha), the Shire Ula Mts. H. – 1497 m. TCD –25 %. № 13K. 06.07.1970.

Table XII.

Descriptions of the lowmountain and plain desertified steppes.
Formations: Stipa glareosa, Agropyron nevskii, Agropyron cristatum, Festuca valesiaca, Stipa sareptana

№№ of columnes	1	2	3	4-I	4-II	5	6	7	8	9	10	11
Shrubs												
Atraphaxis frutescens	·	·	2	·	·	·	·	·	·	·	·	·
Caragana bungei	·	·	+	·	·	·	+	·	·	·	·	·
Caragana leucophloea	·	·	·	·	·	+		·	·	·	·	·
Caragana pygmaea	3	+	1	·	·	·	1-2	+	+	·	8	+
Dwarf semi-shrubs												
Ajania achilleoides	·	·	·	·	·	·	·	·	·	·	+	1-2
Ajania trifida	·	·	·	·	·	·	·	·	·	·	·	+
Alyssum lenense	·	·	·	·	·	·	·	·	·	3	·	·
Anabasis brevifolia	·	·	·	·	·	·	·	·	·	·	·	+
Artemisia caespitosa	·	·	·	·	·	2	·	·	1-2	·	2-3	+
Artemisia commutata	·	·	·	·	·	·	·	·	·	·	+	·
Artemisia frigida	10	10	·	15	·	+	+	1-2	·	2	+	+
Artemisia klementzae	·	·	·	·	·	·	·	·	·	8	·	·
Artemisia rutifolia	·	·	2	·	·	·	·	·	·	·	·	·
Artemisia schrenkiana	·	+	·	·	15	10	10	20	·	·	·	·
Artemisia xerophytica	·	·	·	·	·	·	·	·	·	·	+	·
Ephedra sinica	·	·	·	·	·	·	·	·	+	1-2	·	·
Eurotia ceratoides	·	·	1	·	·	+	·	·	·	·	+	+
Kochia prostrata	·	·	·	1	·	+	+	1-2	3-5	+	+	+
Nanophyton erinaceum	·	·	·	·	18	13	·	·	·	·	·	·
Ptilotrichum canescens	·	·	·	·	·	·	·	·	·	·	+	+
Long-lived perennial Grasses												
Agropyron cristatum	4	3	·	+	+	+	2-3	+	10	4-5	+	·
Agropyron nevskii	·	·	8	·	·	·	·	·	·	·	·	·
Cleistogenes songorica	·	·	·	·	·	·	·	·	·	·	3-5	8
Cleistogenes squarrosa	·	·	·	2-3	1-2	2-3	·	2-3	·	10	2-3	·
Festuca tschujensis	+	·	·	·	·	·	10	·	·	·	·	·
Festuca valesiaca	·	·	·	18	5	15	·	18	·	·	·	·
Koeleria cristata	·	·	·	15	2-3	1-3	8	5-8	·	·	·	·
Poa botryoides	+	·	·	·	·	·	3-5	·	·	1-2	·	·
Psathyrostachys juncea	·	·	·	·	·	·	·	+	·	·	·	·
Stipa glareosa	10	10	7	·	·	·	+	·	5-7	14	10	4
Stipa gobica	·	·	+	·	·	·	·	·	·	·	8	4
Stipa sareptana	7	8	·	7	1-2	3-5	12	18	+	·	·	·
Sedges	·	·	·	·	·	·	·	·	·	·	·	·
Carex duriuscula	·	1	·	+	+	1-2	·	·	·	·	+	+
Carex sabulosa	·	·	·	·	·	·	·	·	·	1-2	·	·
Carex stenophylloides	·	·	·	·	·	·	·	·	1-2	·	·	·
Forbs												
Allium anisopodium	·	·	·	·	·	·	·	·	·	1	·	·
Allium mongolicum	·	·	·	+	·	+	·	+	·	·	+	+
Allium polyrrhizum	·	·	·	·	·	·	·	·	·	·	1-2	+
Allium tenuissimum		+	·	·	·	·	+	·	·	·	·	·
Amblynotus rupestris	·	·	·	·	·	·	1	·	·	·	·	·
Asparagus gobicus	·	·	·	·	·	·	·	·	·	·	+	+
Asterothamnus heteropappoides	3	5	·	·	·	·	3-5	·	1-2	·	·	·
Astragalus brevifolius	·	·	·	·	·	·	·	·	+	+	·	·
Astragalus delutus	·	·	·	·	·	+	·	·	·	·	·	·
Astragalus galactites	1	+	·	·	·	·	·	·	·	·	·	·
Astragalus laguroides	1	+	·	·	·	·	·	·	·	·	+	·
Astragalus monophyllus	·	·	·	·	·	·	·	·	·	·	·	+
Bupleurum bicaule	+	+	·	·	·	·	+	·	+	·	·	·
Convolvulus ammanii	+	+	·	+	·	+	·	+	+	·	+	+
Dracocephalum fruticulosum	+	+	·	·	·	·	+	·	·	·	·	·
Goniolimon speciosum	·	·	·	·	·	·	·	+	·	·	·	·
Gypsophila desertorum	+	+	·	·	·	·	+	·	·	·	·	·
Haplophyllum dauricum	·	·	·	·	·	·	·	·	·	·	+	+
Hedysarum gmelinii	·	·	·	·	·	·	+	·	·	·	·	·
Hedysarum pumilum	·	·	·	·	·	·	·	·	·	1	·	·
Heteropappus hispidus	·	·	·	+	+	·	·	1-2	·	+	+	+
Iris bungei	·	·	·	·	·	·	·	·	·	·	+	+
Iris tenuifolia	·	·	·	·	·	·	·	·	·	1-2	+	·
Lagochilus ilicifolius	·	·	·	·	·	·	·	·	·	·	+	+

Table XII (continuation)

№№ of columnes	1	2	3	4-I	4-II	5	6	7	8	9	10	11
Melandrium viscosum	·	·	·	·	·	·	·	·	·	+	·	·
Orostachys spinosa	·	·	·	·	·	·	·	+	·	+	·	·
Oxytropis aciphylla	·	·	·	·	·	·	·	·	+	·	·	+
Panzeria lanata	·	·	·	·	·	·	·	·	·	+	·	·
Peganum nigellastrum	·	·	·	·	·	·	·	·	·	·	+	+
Potentilla acaulis	·	·	·	6	5-8	5	2-3	1-2	·	5-6	·	·
Potentilla astragalifolia	+	+	+	·	·	·	·	·	·	·	·	·
Potentilla bifurca	·	·	·	·	·	·	·	·	+	·	+	·
Scorzonera austriaca	+	+	·	+	·	+	2-3	+	+	·	·	+
Scorzonera divaricata	·	·	·	·	·	·	·	·	·	·	+	·
Sibbaldianthe adpressa	+	+	·	·	·	·	·	·	·	·	+	·
Stellaria dichotoma	·	·	+	·	·	·	·	·	·	·	+	·
Veronica pinnata	·	·	·	·	·	·	+	·	·	·	·	·
Vicia costata	·	·	·	·	·	·	·	·	·	+	·	·
Vincetoxicum sibiricum	·	·	·	·	·	·	·	·	·	+	·	·
Youngia tenuifolia	·	·	+	·	·	·	·	·	·	·	·	·
Annual and short-lived perennial												
Artemisia pectinata	·	·	·	·	·	·	·	·	·	·	+	+
Artemisia scoparia	·	·	·	·	·	·	·	·	·	·	+	+
Bassia dasyphylla	·	·	·	·	·	·	·	·	·	+	·	·
Chamaerhodos erecta	·	·	·	·	·	·	+	·	·	·	·	·
Chamaerhodos sabulosa	·	·	·	·	·	·	·	·	·	·	·	+
Coryspermum mongolicum	·	·	·	·	·	·	·	·	·	+	+	·
Dontostemon crassifolius	·	·	·	·	·	·	·	·	·	·	·	+
Dontostemon senilis	+	·	+	·	·	·	·	·	·	·	·	·
Eragrostis minor	·	·	·	·	·	·	·	·	·	·	·	+
Salsola collina	·	·	·	·	·	·	·	·	·	·	+	·
Salsola pestifera	·	·	·	·	·	·	·	·	·	·	+	+
Lichen												
Parmelia vagans	·	·	·	·	·	3-5	·	·	·	·	·	·

1. **Stipa glareosa–S. sareptana–Agropyron cristatum–Artemisia frigida** with *Caragana pygmaea.* Ubsu-Nur Aimak. North-eastern part of Mongolian Altai. Ureg Nur Lake hollow. H. – 1600 m. TCD – 35 %.
2. **Stipa glareosa-S. sareptana-Artemisia frigida** with *Asterothamnus heteropappoides.* Ubsu-Nur Aimak. North-eastern part of Mongolian Altai. Ureg Nur Lake hollow. H. – 1600 m. TCD – 35 %.
3. **Agropyron nevskii–Stipa glareosa** with shrubs (*Atraphaxis frutescens, Caragana pygmaea, C.bungei*). Ubsu-Nur Aimak. North-eastern part of Mongolian Altai, Achit Nur Lake hollow. H. – 1860 m. № 175K. 9.07.1978. TCD – 20–25 %.
4. **Festuca valesiaca–Koeleria cristata** communities (I) in complex with **Nanophyton erinaceum–Artemisia schrenkiana** communities (II). Ubsu Nur Aimak, Khjargas Somon. Western Khangai, the Khan-Khukhiin-Ula Rangle, foothills of northern macroslope. H. – 1020 m. TCD: I – 60 %; II – 35-40 %. № 38K. 14.07.1973.
5. **Festuca valesiaca–Nanophyton erinaceum–Artemisia schrenkiana.** Ubsu–Nur Aimak, Khjargas Somon. Western Khangai, the Khan-Khukhiin-Ula Rang, foothills of northern macroslope. H. – 1050 m. TCD – 40–45 %. № 37K. 14.07.1973.
6. **Stipa sareptana–Festuca tschujensis–Artemisia schrenkiana** with *Caragana pygmaea.* Ubsu Nur Aimak, Turgen Somon. Mongolian Altai, Ureg Nur Lake pan. H. – 1730 m. TCD – 40 %. № 19K. 10.07.1973.
7. **Stipa sareptana–Festuca valesiaca–Artemisia schrenkiana.** Ubsu–Nur Aimak, Dzun–Gobi Somon. Western Khangai, the Khan-Khukhiin-Ula Range, foothills of the northern macroslope. H. – 1090 m. TCD – 60 %. № 85K. 17.07.1973.
8. **Agropyron cristatum–Stipa glareosa–Kochia prostrata** with *Asterothamnus heteropappoides.* Ubsu-Nur Aimak, Umne Gobi Somon. Alluvial plain of the Burgastyn Gol Rives. H. – 1700 m. TCD – 20–25 %. № 57K. 21.06.1978.
9. **Stipa glareosa–Cleistogenes squarrosa–Artemisia klementzae.** Ubsu Nur Aimak, Dzun Gobi Somon. Borig-Del-Els sand massifs, hollow. TCD – 50–55 %. № 23K. 14.06.1978.
10. **Stipa gobica–S.glareosa** with *Caragana pygmaea.* Middle Khalkha. TCD – 19–20 %. Yunatov, 1974: 69p.
11. **Stipa gobica–S.glareosa–Cleistogenes songorica.** Middle Khalkha. TCD – 17–20 %. Yunatov, 1974: 45p.

Table XIII.

Descriptions of the plain desert steppes.
Formations: Stipa glareosa, Stipa gobica, Allium polyrrhizum, Stipa klemennzii

№ № of columnes	1	2	3	4	5	6	7	8	9	10
Shrubs										
Caragana pygmaea	·	·	+	5	·	+	·	+	·	·
Caragana stenophylla	·	·	·	·	·	·	·	·	+	·
Zygophyllum xanthoxylon	·	·	·	·	·	+	·	·	·	·
Dwarf semi-shrubs										
Ajania achilleioides	+	·	·	+	·	+	1	+	·	·
Ajania fruticulosa	·	·	+	·	·	·	·	·	·	·
Anabasis brevifolia	1-2	2-3	1-2	2-3	3-5	5-8	3-4	2	·	·
Artemisia caespitosa	·	1	·	+	·	·	·	·	·	·
Artemisia frigida	+	·	·	·	·	+	·	·	·	10
Artemisia xerophytica	·	·	·	+	1	·	1-2	·	·	·
Chenopodium frutescens	·	1	2-3	5-8	·	·	·	·	·	·
Convolvulus fruticosus	·	·	·	·	·	·	+	·	·	·
Eurotia ceratoides	·	+	+	·	+	+	·	·	·	·
Kochia prostrata	+	·	·	·	·	·	·	+	·	+
Ptilotrichum canescens	·	·	+	·	·	+	+	·	1	·
Reaumuria soongorica	·	·	·	·	1-2	·	·	+	·	2
Salsola passerina	·	·	·	·	·	+	·	3-5	·	4
Long-lived perennial Grasses										
Agropyron nevskii	·	·	1-2	·	·	·	·	·	·	·
Cleistogenes songorica	·	·	·	·	·	·	1	+	·	·
Cleistogenes squarrosa	·	·	·	·	+	·	·	·	·	1
Stipa klemenzii	·	·	·	·	·	·	·	·	·	8
Stipa glareosa	10	12	4-5	18	10	8	3	2-3	·	·
Stipa krylovii	·	·	·	·	·	·	·	·	1	·
Stipa gobica	·	·	·	·	·	5-8	3	3-5	·	·
Sedges										
Carex duriuscula	+	·	·	·	·	+	·	+	1	+
Carex stenophylloides	·	+	·	+	·	·	·	·	·	·
Forbs										
Allium bidentatum	3	·	·	·	·	·	·	·	·	·
Allium mongolicum	4	·	·	·	1	·	·	·	·	·
Allium polyrrhizum	·	·	+	·	1	·	2-3	·	12	·
Asterothamnus heteropappoides	1-2	+	+	·	·	·	·	·	·	·
Astragalus brachyphyllus	·	·		·	·	·	+	·	·	·
Convolvulus ammanii	·	·	+	·	·	·	·	+	2	·
Gypsophilla desertorum	+	+	+	+	+	·	·	·	·	·
Guedenstaedtia monophylla	·	·	+	·	·	·	·	·	·	·
Heteropappus altaicus	·	·	·	·	·	·	·	·	2	10
Heteropapus hispidus	·	·	·	·	·	+	+	·	·	·
Iris tenuifolia	·	·	·	·	·	+		·	·	·
Lagochilus ilicifolius	·	·	·	·	·	+	+	·	·	·
Olgaea leucophylla	·	·	·	·	·	·	+	·	·	·
Orostachys spinosa	·	·	·	·	+	·	·	·	·	·
Oxytropis aciphylla	·	·	·	·	·	+	·	+	·	·
Oxytropis monophylla	·	·	·	+	·	·	·	·	·	·
Potentilla astragalifolia	+	·	+	·	+	·	·	·	·	·
Potentilla bifurca	·	·	·	·	·	·	·	·	1	·
Rheum nanum	·	·	·	·	·	·	·	+	·	·
Scorzonera austriaca	·	·	·	·	+	·	·	·	·	·
Scorzonera divaricatum	·	+	·	+	·	+	·	·	·	·
Scorzonera pseudodivaricata	·	·	+	·	·	·	·	·	·	·
Zygophyllum rosovii	·	+	·	·	·	·	·	·	·	·
Annual forbs and grasses										
Artemisia macrocephala	·	·	+	·	·	·	·	·	·	·
Artemisia pectinata	+	·	+	·	·	+	+	+	·	1
Artemisia scoparia	·	·	·	·	·	+	·	+	·	·
Bassia dasyphylla	·	·	·	+	·	·	·	·	·	·
Dontostemon crassifolius	·	·	·	·	+	·	·	·	·	·
Dontostemon integrifolius	·	·	·	·	·	·	+	·	·	·
Dontostemon senilis	·	+	+	+	·	·	·	·	·	·
Eragrostis minor	+	·	·	+	·	·	·	·	·	·
Lepidium densiflorum	·	·	·	·	·	·	·	·	+	·

Table XIII (continuation)

№ № of columnes	1	2	3	4	5	6	7	8	9	10
Plantago minuta	·	·	·	+	·	·	·	·	·	·
Salsola pestifera	·	·	+	+	·	+	·	+	·	·

1. **Stipa glareosa–Anabasis brevifolia–Asterothamnus heteropappoides.** Ubsu Nur Aimak, Turgen Somon. Mongolian Altai, Ureg Nur Lake hollow. H. – 1500 m. TCD – 20 %. № 23K. 10.07.1973.
2. **Stipa glareosa–Anabasis brevifolia** with *Chenopodium frutescens.* Ubsu Nur Aimak, Naran Bulak Somon. Alluvial plains of the Naran River. H. – 1350 m. TCD – 10–15%. № 68K. 22.06.1978.
3. **Stipa glareosa–Chenopodium frutescens–Anabasis brevifolia.** Ubsu-Nur Aimak, Ulgii Somon. Peneplain near Somon. H.– 1650 m. TCD – 10–15 %. № 149K. 07.08.1979.
4. **Stipa glareosa–Chenopodium frutescens–Anabasis brevifolia** with *Caragana pygmaea* Ubsu Nur Aimak, Naran Bulak Somon. Peneplain. H. – 1300 m. TCD – 25–30 %. № 74K. 22.06.1978.
5. **Stipa glareosa–Anabasis brevifolia–Reaumuria soongorica.** Ubsu Nur Aimak, Khjargas Somon. Western Khangai, the Khan-Khukhiin-Ula Range, foothills of southern macrosope. H. – 1260 m. TCD – 10-15 %. № 56K. 16.07.1973.
6. **Stipa gobica–S.glareosa–Anabasis brevifolia.** TCD – 15–20 %. Yunatov (1974:64).
7. **Stipa glareosa–S.gobica–Anabasis brevifolia–Allium polyrrhizum.** Bajan Khongor Aimak, Bogd Somon. Southern foothills of Khangai. H.– 1240 m. TCD – 10–15 %. № 13K. 25.07.1972.
8. **Stipa gobica–S.glareosa–Salsola passerina.** TCD – 12–15 %. Yunatov (1974:64)
9. **Allium polyrrhizum.** Sukhe-Bator Aimak, Khaldzan Somon. Low hills. H. – 1030 m TCD – 5 %. № 189.1Kh. 01.09.1989
10. **Stipa klemenzii–Artemisia frigida–Salsola passerina**. Sukhe-Bator Aimak, Khankhoryn Somon, Middle Khalkha. Plain. H. – 870 m. TCD – 25 %. № 181.1Kh. 31.08.1989

РЕЗЮМЕ

Предисловие. Территории, занятые степной растительностью, составляют более половины площади Монголии. Зона степей протягивается от западного (90° в. д.) до восточного (102° в. д.) государственных рубежей страны, а на юге достигает 44° с. ш., что намного южнее, чем в соседнем Казахстане, где граница с пустынными устойчиво совпадает с 48° с. ш. Граница между бореально-лесной и степной зонами имеет сложное очертание. Большинство геоботаников относит к лесной зоне горные территории вокруг оз. Хубсугул (севернее 50° с. ш.) и сниженные окраины горного массива Хэнтей.

Степи распространены в Монгольском и Гобийском Алтае (местами до высоты свыше 3 тыс. м над уровнем моря), где образуют хорошо выраженный высотный степной пояс с несколькими подпоясами.

Степные сообщества проникают, далеко на север в лесную зону и даже в зону тундр, преимущественно по южным склонам гор и коренным берегам рек. Такие природные особенности свойственны только ультраконтинентальному Восточносибирско-Центральноазиатскому сектору Палеарктики.

Природные условия. Климат Монголии характеризуется резкой континентальностью, что проявляется, в первую очередь, в суровости зимнего периода, сопоставимого с суровостью климата Гренландии. Минимальные t января достигают -40, -45°; максимальные t июня – +30, +41°. Количество осадков незначительно: от 300–400 мм на севере (и в верхних поясах гор) до 140–150 мм на юге, причем около 90 % из них выпадает в летние месяцы, что определяет отсутствие летнего засушливого и сухого периодов.

Зимой над большей частью территории Монголии устанавливается устойчивый антициклон, препятствующий проникновению влажного и сравнительно теплого воздуха с запада. Незначительная мощность снегового покрова (5–10 см), низкие отрицательные t приводят к глубокому промерзанию почвы, формированию сезонно-мерзлых грунтов и сохранению реликтовой "вечной мерзлоты". Значительно отличаются природные условия западной Монголии (климат более близок к соседнему Казахстану) и восточной Монголии (влажный муссонный климат). Именно в этих регионах проходят западная и восточная границы ультраконтинентального Восточносибирско-Центральноазиатского сектора Палеарктики.

Развитие "вечной мерзлоты" определяет многие особенности природы Монголии, в частности, формирование специфических криоксерофитных степей и травяных сообществ кобрезиевников и горных тундр в высокогорьях, где мерзлота распространена на более чем 80 % площади. Лесные массивы на северных склонах гор, расположенных в степной зоне также связаны с "островами" вечномерзлых грунтов. Такие "острова" встречаются далеко на юге степной зоны (даже в подзоне пустынных степей) в депрессиях около родников.

Рельеф степной зоны Монголии сложен. Разнообразны по своей геоморфологии крупные горные массивы и хребты – Хангай, Хэнтей, Монгольский Алтай (с наиболее высокой точкой Монголии 4374 м над уровнем моря), часть хребтов Гобийского Алтая, западные отроги Большого Хингана. Обширные делювиально-пролювиальные равнины с наиболее низкими отметками в северо-восточной части страны (560 м над ур. м.) чередуются с мелкосопочниками и низкогорьями. Аллювиальные озерные равнины с системой озерных впадин и крупных песчаных массивов характерны для западной части. Особенностью является общее высокое положение территории Монголии над уровнем моря (более чем 80 % страны лежит на высоте свыше 1200 м).

Почвы относятся к нескольким типам: черноземы занимают небольшие площади в горных массивах Хэнтея, Хангая, Монгольского Алтая, Большого Хингана. Темнокаштановые, каштановые и светлокаштановые почвы сменяются последовательно с севера на юг в подзонах настоящих и опустыненных степей. В пустынных степях господствуют бурые пустынно-степные почвы.

Особенностью степных почв Монголии является их легкий механический состав: преобладают легкосуглинистые и супесчаные, часто щебнистые почвы. Ливневой характер летних осадков способствует хорошему промачиванию почв и глубокому вымыванию солей, в связи с чем для Монголии в отличие от Казахстана, не характерно распространение солонцов и солонцеватых разностей зональных типов почв.

Особенности состава жизненных форм. Как и все степные сообщества Евразиатского умеренного пояса, монгольские степи сформированы многолетними длительновегетирующими, главным образом, поликарпическими микротермными ксерофильными и часто склерофильными растениями, в основном, дерновинными злаками из р.р. *Stipa, Festuca, Helictotrichon, Agropyron, Cleistogenes, Koeleria, Poa* и др. Они образуют доминирующую синузию (эдификаторы, доминанты) и создают основную часть фитомассы.

В отличие от Казахстана, где в настоящих степях господствуют крупно- и плотнодерновинные злаки, монгольские степи сформированы мелко- и рыхлодерновинными и даже корневищными (*Leymus chinensis*) видами. Обильны также дерновинные осоки (*Carex pediformis*) и дерновинные луки. Степи с доминированием видов р. *Allium* характерны для Центральной Азии.

Обычными компонентами степных травостоев являются виды разнотравья, причем его количество и состав экологических групп меняется с севера на юг вдоль климатического градиента увлажнения.

Только в Монголии, а также в соседнем Забайкалье и во Внутренней Монголии в Китае, встречаются разнотравные степи из *Filifolium sibiricum*. Полукустарнички образуют доминирующую синузию только в сообществах пустынных, а также в петрофитных и псаммофитных вариантах настоящих степей.

В горных степях в обилии произрастают растения, имеющие форму роста плотных или рыхлых подушек. Большая роль в степях Монголии, как и Казахстана, принадлежит кустарникам (преимущественно виды р. *Caragana*, а также *Spiraea, Cotoneaster, Dasiphora, Amygdalus, Armeniaca* и др.). В отличие от Казахстана, в монгольских степях отсутствуют эфемеры и эфемероиды, но в обилии произрастают летне-осенние однолетники, главным образом однолетние виды р. *Artemisia*, а также *Dontostemon, Chamaerhodos, Bassia, Axyris* и др.

Мхи и лишайники не свойственны степям Монголии. Только в луговых степях отмечен лесной мох *Rhytidium rugosum*, а в высокогорных степях – *Aulacomnium palustre* и другие лесные и тундровые мхи.

Особенности флоры. При сравнении казахстанских степей с монгольскими выявляются многие специфические флористические осо-

бенности последних. Так, в восточно-европейских и казахстанских степях доминируют ковыли из секции Stipa, лишь изредка встречающиеся в западной Монголии. В монгольских степях господствуют ковыли из секции Leiostipa (*Stipa krylovii, S. baicalensis, S. grandis, S. capillata, S. sareptana*). Два последних вида широко распространены в Казахстане и заходят только в западную часть Монголии. Петрофмитностепной вид *Stipa orientalis* (из секции Barbatae) также встерчается на западе. *Stipa sibirica* (из секции Achnatheropsis) произрастает в разнообразных типах степей. В пустынных степях господствуют ковыли из секции Smirnovia (*Stipa gobica, S. klemenzii, S. glareosa*; последний вид произрастает также в Чуйской степи в Восточном Казахстане). Степные виды р. *Festuca* доминируют лишь в горных и петрофитных степях Монголии, тогда как в Причерноморье и Казахстане степная овсяница *Festuca valesiaca* широко распространена во всех зональных типах степей от луговых до опустыненных.

Обычными компонентами опустыненных степей Казахстана являются виды р. *Artemisia* из подрода *Seriphidium*. Лишь некоторые виды из этого подрода (*Artemisia gracilescens, A. terrae-alba, A. schrenkiana, A. sublessingiana*) играют существенную фитоценотическую роль в степях Западной Монголии. Господствующие в Монголии виды р. *Artemisia* относятся к подродам *Artemisia* и *Dracunculus*. В пустынных степях доминируют не полыни, а полукустарнички из сем. *Chenopodiaceae* (*Chenopodium, Anabasis, Salsola* и др.), сем. *Compositae* (*Ajania*) и сем. *Tamaricaceae* (*Reaumuria*).

Имеется большое число монгольских, восточносибирско-монгольских, даурско-восточномонгольских видов и родов, которые не проникают на запад в Казахстанские степи, например р.р. *Amblynotus, Arctogeron, Cymbaria, Saposhnikovia, Sibbaldianthe, Dontostemon, Filifolium, Anemarrhena, Stellera, Panzeria, Schizonepeta, Olgae, Lespedeza* и многие другие. Некоторые роды обычные в Казахстанских степях (например, *Centaurea, Jurinea*) в Монголии представлены немногочисленными видами, а другие, такие как *Crambe, Trinia, Verbascum, Sideritis*, не встречаются вовсе.

Только в западную Монголию проникают такие роды, как *Onosma, Coluria, Eremostachys, Helichrysum, Herniaria, Tetracme, Ziziphora, Ferula, Piptatherum, Nanophyton, Rindera, Cicerbita, Syrenia* и др.

Во флоре монгольских степей прослеживаются флористические связи с восточными регионами Древнего Средиземья (в понимании М.Г. Попова), тогда как во флоре Причерноморья и Казахстана проявляется родство с растительностью западной части Древнего Средиземья, особенно с древней Паннонией и степной флорой Кавказа и Малой Азии. В степной флоре Монголии выделено 5 крупных географических групп: 1) южносибирско-североМонгольская; 2) собственно монгольская; 3) центральноазиатская; 4) западнопалеарктическо-западномонгольская; 5) восточноазиатская. Эти группы подразделяются на более мелкие. Например, группа 4 объединяет причерноморско-казахстанско-западномонгольские, восточноказахстанско-западномонгольские, среднеазиатско-западномонгольские геоэлементы. К 5-ой группе относятся маньчжурские, дауро-монгольские, дауро-восточномонгольские и др. виды.

Общие ботанико-географические закономерности степной растительности. Главные ботанико-географические закономерности растительности обусловлены: широтными изменениями климата в соответствии с климатическими градиентами (увеличением засушливости климата и усилением интенсивности солнечной радиации), долготными (меридиональными) сменами (увеличение континентальности климата), высотно-поясной дифференциацией и разнообразием эдафических (почвенно-грунтовых) условий.

Русские геоботаники традиционно выделяют следующие зональные типы степей (широтная дифференциация):

1. Луговые степи;
2. Настоящие или типичные степи:
   а. Разнотравные и богаторазнотравные дерновиннозлаковые степи;
   б. Сухие дерновиннозлаковые степи;
3. Опустыненные полукустарничково-дерновиннозлаковые и дерновиннозлаковые степи;
4. Пустынные полукустарничково-дерновиннозлаковые степи.

Эти зональные типы являются главными подразделениями в представленном на стр. 21–23 – списке основных типов монгольских степей.

Большая часть территории Монголии располагается в пределах Восточносибирско-Центральноазиатского ультраконтинентального сектора Палеарктики. На западе вдоль границы с Западносибирско-Казахстанским континентальным сектором и на востоке по границе с Притихоокеанским муссонным секторами имеются контактные ("буферные") зоны, где распространены степи "гибридного" состава и наблюдается проникновение "восточных" и "западных" флористических геоэлементов.

Степные сообщества в горах Монголии подразделяются на высокогорные, горные, низкогорные, предгорные, мелкосопочные, равнинные и котловинные, при этом каждый из этих высотно-поясных типов сообществ отличается присутствием групп так называемых "дифференцирующих" видов, как правило, не встречающихся в других типах сообществ.

Трудно выделить особые формации, которые были бы приурочены к определенным высотным подпоясам. Так, *Festuca lenensis, F. kryloviana* доминируют в высокогорных криоксерофитных степях, но произрастают и в средне- и низкогорьях. Формации *Helictotrichon altaicum, Poa attenuata* также, как и формации *Festuca tschujensis, Agropyron nevskii* относятся к типично горным, но широко встречаются в низкогорьях, а последние две формации представлены и в предгорьях, и в мелкосопочниках. Горы не только вызывают высотно-поясные смены растительности, но и оказывают влияние на закономерности растительности на предгорных равнинах ("предгорно-гумидная зональность") и в межгорных впадинах ("котловинный эффект"). Особенности и разнообразие почвенно-грунтовых условий обусловливают выделение различных эдафических вариантов степей (псаммофитных, петрофитных, галофитных и т. д.).

Основные зональные и высотно-поясные типы степей. В перечень типов степей включены как широкораспространенные и типичные, так и редкие своеобразные по своему составу и характерные только для отдельных регионов страны. Все они отличаются друг от друга составом доминантов и содоминантов и присутствием группы "дифференцирующих" видов.

Высокогорные степи характеризуются доминированием как типично степных ксерофитных видов, так и специфических видов криоксерофитного разнотравья, часто с по-

душковидной формой роста, и примесью аркто-альпийских видов (*Carex rupestris*, виды р. *Kobresia*).

Луговые горные и низкогорные степи – сообщества с доминированием мезоксерофильных и ксеромезофильных дерновинных, рыхлодерновинных и корневищных злаков, осок и примесью богатого разнотравья, которое часто преобладает по покрытию и запасам фитомассы.

В настоящих разнотравно-дерновиннозлаковых степях господствующую синузию формируют дерновинные злаки, сопутствующее разнотравье относится к группе мезоксерофитов и ксеромезофитов.

Сухие дерновиннозлаковые степи отличаются примесью бедного по родовому составу и не обильного ксерофитного разнотравья.

В монгольских опустыненных степях в отличие от казахстанских отсутствует синузия ксерофитных полукустарничков, а наблюдается содоминирование степных (*Stipa krylovii, Cleistogenes squarrosa, Agropyron cristatum,* и др.) и пустынностепных (*Stipa gobica, S. glareosa, Cleistogenes songorica*) злаков. Полукустарнички обильны в псаммофитных и петрофитных вариантах опустыненных степей.

Пустынные степи, эндемичные для Центральной Азии и не имеющие аналогов в других аридных областях Палеарктики, сформированы гиперксерофитными ковылями, луками и полукустарничками.

Сводные таблицы описаний (стр. 46–70) дают представление об основных типах степей. Выделено 56 зональных, высотно-поясных, географических и эдафических типов.

Ботанико-географическое районирование Дауро-Монгольской (Центральноазиатской) подобласти.

В схеме районирования представлено разделение Дауро-Монгольской подобласти Евразиатской степной области на ботанико-географические провинции и подпровинции. При районировании учитывались фитоценотические критерии, а именно: состав и соотношение площадей, занятых плакорными и неплакорными сообществами – на равнинах, "колонка поясности" – в горах. Принимались во внимание и флористические критерии: присутствие или отсутствие определенных географических элементов – "дифференцирующих" видов, родов, реже семейств.

На территории Монголии выделяются 3 провинции:

1. Хангайско-Даурская горная лесостепная провинция с тремя подпровинциями: а) Западнохангайской; б) Орхон-Нижнеселенгинской; в) Нерчинско-Ононской.

2. Монгольская степная провинция с двумя подпровинциями: а) Среднехалхаской, б) Восточно-монгольской.

3. Северогобийская пустынно-степная провинция с тремя подпровинциями: а) Подпровинцией Котловины Больших озер, б) Северо-восточно-гобийской подпровинцией, в) Монголоалтайской степной подпровинцией.

Северогобийская пустынностепная провинция выделена в качестве самостоятельной провинции в отличие от схемы Е. М. Лавренко. Она близка к Северогобийской провинции в понимании А. А. Юнатова, но без пустынных районов на ее южной границе. Уточнены по новой "Карте растительности Монголии" из Национального Атласа МНР границы всех провинций и продпровинций.

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