The current state of the steppe vegetation classification system in the Volga region

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Abstract. Steppe vegetation in the Volga region is one of the predominant types of vegetation. At present, it has survived only in areas inconvenient for human economic and recreational activities. Its research is necessary to understand the structure and composition of zonal vegetation and distribution patterns to predict changes in the modern vegetation cover. The relevance of studying the steppe vegetation of the Volga region is also due to the creation of the project “Vegetation of Russia”. We studied the steppe vegetation of the Volga region in the period from 2011 to 2020 from the standpoint of the J. Braun-Blanquet approach. Field studies covered all the diversity of the steppe vegetation represented in the region - herb-rich grass steppes, herb-grass steppes, grass steppes and desert and their psammophytic, petrophytic and halophytic edaphic variants within Ulyanovsk, Penza, Samara, Saratov, and Volgograd Oblasts, the western part of Orenburg Oblast and the northern part of Astrakhan Oblast. The syntaxonomic analysis of our own materials and literature data made it possible to establish 65 associations, 47 subassociations and 2 variants. They are assigned to the class Festuco-Brometea, the orders Festucetalia valesiacae, Helictotricho-Stipetalia, Tanaceto achilleifolii-Stipetalia lessingianae and the alliances Festucion valesiacae, Agropyron pectinati, Centaureion sumensis, Stipion korshinskyi and Tanaceto achilleifolii-Stipion lessingianae.

1. Introduction
The steppe vegetation in the Volga region is one of the predominant types of vegetation. However, at present, it has survived only in areas inconvenient for economic and recreational human activity. Its research is necessary to understand the structure and composition of zonal vegetation and the patterns of their distribution in order to predict changes in the modern vegetation cover. The relevance of studying steppe vegetation in a large region of Russia - the Volga region - is also due to the creation of the project “Vegetation of Russia” [1].

Our studies covered all the diversity of the represented in the region steppe vegetation – herb-rich grass steppes, herb-grass steppes, grass steppes and desert and their psammophytic, petrophytic and halophytic edaphic variants within Ulyanovsk, Penza, Samara, Saratov, and Volgograd Oblasts, the western part of Orenburg Oblast and the northern part of Astrakhan Oblast.
2. Materials and Methods
We studied the steppe vegetation of the Volga region in the period from 2011 to 2020 from the standpoint of the approach by J. Braun-Blanquet [2]. 727 geobotanical relevés were made for the 25-100 m² sites using standard techniques [3]. The total grass projective cover was estimated as a percentage (%). The abundance scale by B.M. Mirkin was applied to assess the abundance of plant species on the survey sites [4]. The relevés were then introduced into a database “Vegetation of the Volga and Ural rivers basins” [5] developed on the basis of the TURBOVEG program [6] and processed using the JUICE program [7]. Syntaxonomic analysis was performed using the approach suggested by J. Braun-Blanquet [2].

The classification units identified on the basis of field data from 2011-2020 have been compared with the literary ones [8-23]. The latter were also used in the preparation of the prodromus presented below. The names of syntaxa are given according to the “International Code of Phytosociological Nomenclature” [24]. The system of higher syntaxa is given in accordance with “Vegetation of Europe...” [25]. The Latin names of plants are given according to the summary by S K Cherepanov [26].

3. Results and Discussion
Analysis of literature data [8-23] and syntaxonomical analysis of our own geobotanical materials made it possible to establish 65 associations, 47 subassociations and 2 variants. They belong to the class Festuco-Brometalia Br.-Bl. et Tx. ex Soó 1947, Helicotricho-Stipetalia Toman 1969 and Tanaceteto achillefolii-Stipetalia lessingianae Lysenko et Mucina in Mucina et al. 2016 and alliances Festucion valesiaceae Klika 1931 nom. conserv. prop., Agropyroion pectinati Golub et Uzhametskaya 2016, Centaureion sumensis Golub et Uzhametskaya 2016, Stipion korshinskyi Toman 1969 and Tanaceteto achillefolii-Stipion lessingianae Royer ex Lysenko et Mucina in Mucina et al. 2016.

The alliance Festucion valesiaceae unites the communities of herb-rich grass steppes, which are confined to typical and carbonate chernozems. They are common on the terraces of the Bol’shaya Tarkhanka, Tergala and Savrusha, Volga, Bol’shoj Irgiz, Chardym, Karaj и Maly Melik rivers, on the slopes of the ridges of the Bugulma-Belebey Upland, Obshchya Syyt Upland and in the Caspian Lowland. These communities were described by us in the Shentalinsky, Isaklinsky, Pokhvtistenovskiy, Syzranski and Bol’sheglushitski Districts of Samara Oblast, in the Khvalynsky, Tatischevsky, Atkarsky, Novoburassky, Romanovsky, Balashovsky, Saratovsky, Krasnoarmeyski, Ivanteevsky, Perelyubsky, Sovetsky and Aleksandrov-Gajsky Districts of Saratov Oblast and in the Kamyshevsky, Dubovsky, Svetloyarsky and Pallasovsky Districts of Volgograd Oblast.

The alliance Centaureion sumensis includes the continental relict stony steppes. The coenoses are described on the chalk slopes of the Privolzhskaya Upland (Stavropol’skiy District, Samara Oblast; Khvalynskiy District, Saratov Oblast).

The alliance Agropyroion pectinati unites the steppe communities confined to ordinary and carbonate chernozems, often heavily eroded. They are common on the slopes of the Attsa, Malejka, Kubra Tisherek, Cheremshanchik, Kamyslinka, Kondurcha, Khoroshen’kaya, Padovka, Bol’shoj Kinel, Maly Kinel and Bol’shoj Tolkaj, Kutuluk and Volga rivers valleys, on the carbonate chernozems of the northern slopes of the Zhigulevsk mountains, on the southern calcareous chernozems and dark-kashtanozem calcareous soils of the ridges of the Syrtovaya Plain, on the ridges spurs of the Obshchya SYrt Upland (the Talovskaya Steppe section of the Orenburg State Reserve in the Pervomayskiy District of Orenburg Oblast) and Siny SYrt Upland (the “Sinie Gory” Nature Monument in Ozinsky District of Saratov Oblast), on the terraces of the Bol’shoy Irgiz, Karaj, Karamysh and Eruslan rivers, in the Caspian lowland. These communities were described by us in the Sengileevsky and Radishchevsky Districts of Ulyanovsk Oblast, in the Shentalinsky, Kamyslinsk, Sergievsksy, Krasnoarmeyski, Syzranski, Stavropol’skiy, Pokhvtistenovskiy, Kinel, Kinel-Cherkasskiy, Borsky, Alekseevsky, Neftegorsky and Bol’sheglushitski Districts of Samara Oblast, in the Pervomayskiy District of Orenburg Oblast, in the Romanovsky, Saratovsky, Krasnoarmeyski, Perelyubsky, Ozinsky,
The alliance *Stipion korshinskii* includes the communities of dry steppes. They are found on the slopes of the Sok river valley on typical carbonate chernozems (Kamyshinsk District of Samara Oblast).

The alliance *Tanacetum achilleifolii-Stipion lessingianae* unites the communities of dry and desert steppes. They are associated with southern calcareous chernozems and dark-katsanozem calcareous soils and are common on the slopes of the Tabunnaya Ovsyanka, Bol’shoy Irgiz, Kurdyum, Volga, Eruslan, Solyanka and Bol’shoy Uzen’ valleys, ridges of the Syrtovaya Plain, Obschy Syrt and Siny Syrt Uplands and in the Caspian Lowland. These communities were described by us in the Borsky, Alekseevsky, Pestravsky, Bol’sheleshchensky Districts of Samara Oblast, in the Tatishchevsky, Krasnoarmejsky, Saratovsky, Fyodorovsky, Perelyubsky, Krasnokutsky, Ozinsky, Novouzensky and Aleksandrov-Gajsky Districts of Saratov Oblast, in the Kamyshinsk, Ol’khovskiy, Dubovsky, Gorodishchensky, Svetloarysky, Staropoltavsky and Pallasovsky Districts, Volgograd Oblast, in the Akhtubinsky District of Astrakhan Oblast.

Below is the prodromus of the steppe vegetation in the Volga region.

Class *Festuco-Brometea* Br.-Bl. et Tz. ex Soó 1947

Order *Festucetalia valesiacae* Soó 1947

Alliance *Festucetum valesiacae* Klika 1931 nom. conserv. propos.

Ass. *Eremogono-Salvietum nutantis* Uzhemtskaya in Ilijina et al. 1991 nom. inv., ass. *Gypsophilo paniculatae-Astragalo-Linosyris* Uzhemtskaya 1992 nom. inv., ass. *Potentillo argenteae-Stipetum capillatae* Mitroshenkova et Lysenko 2007, subass. *Potentillo argenteae-Stipetum capillatae* typicum Mitroshenkova et Lysenko 2007, subass. *Potentillo argenteae-Stipetum capillatae scorzoneretosum hispanicae* Mitroshenkova et Lysenko 2007, subass. *Potentillo argenteae-Stipetum capillatae potentilletosum humifusae* Mitroshenkova et Lysenko 2007, ass. *Achilleo setaceae-Gypsophyletum paniculatae* Mitroshenkova et Lysenko 2007, subass. *Campanulo sibiricae-Galietum verum* typicum Mitroshenkova et Lysenko 2007, subass. *Campanulo sibiricae-Galietum verum agrimonietosum eupatoriae* Mitroshenkova et Lysenko 2007, subass. *Campanulo sibiricae-Galietum verum festucetosum valesiacae* Mitroshenkova et Lysenko 2007, ass. *Sanguisorbo officinalis-Centauretum scabiosae* Mitroshenkova et Lysenko 2009, subass. *Sanguisorbo officinalis-Centauretum scabiosae* typicum Mitroshenkova et Lysenko 2009, subass. *Sanguisorbo officinalis-Centauretum scabiosae* salvietosum pratensis Mitroshenkova et Lysenko 2009, subass. *Sanguisorbo officinalis-Centauretum scabiosae* linarietosum vulgaris Lysenko et Mitroshenkova 2009, ass. *Veronicico spicatetosum* acc. Mirroshenkova et Lysenko 2009, ass. *Festuco valesiacae-Salvietum tesquicolae* Mitroshenkova et Lysenko 2009, ass. *Tanacetum vulgaris-Echinopetum sphearocephalus* Mitroshenkova et Lysenko 2009, ass. *Salvio pratensis-Gentietum tinctoriae* Mitroshenkova et Lysenko 2009, ass. *Melioto officinalis-Centauretum diffusae* Mitroshenkova et Lysenko 2009, ass. *Verbasco orientalis-Festucetum valesiacae* Mitroshenkova et Lysenko 2009, ass. *Sileno viscosae-Artemisio campestris* Mitroshenkova et Lysenko 2009, ass. *Scorzoneropsis hispanicae-Dordotentetum vulgaris* Mitroshenkova et Lysenko 2009, ass. *Globulario punctatae-Potentilletum arenariae* Mitroshenkova et Lysenko 2009, ass. *Artemisio austriacae-Festucetum valesiacae* Karpov et al. ex Lysenko et Rakov 2010 nom. invers. propos., subass. *Artemisio austriacae-Festucetum valesiacae* typicum Karpov et al. in Lysenko et Rakov 2010 nom. invers. propos., subass. *Artemisio austriacae-Festucetum valesiacae* artemisietosum nitrosae Lysenko et Oparin 2011, subass. *Artemisio austriacae-Festucetum valesiacae* limonietosum sareptani Lysenko et Oparin 2011, subass. *Artemisio austriacae-Festucetum valesiacae* stipetosum capillatae Lysenko et Mitroshenkova 2011, ass. *Salvio tesquicolae-Festucetum valesiacae* Uzhemtskaya in Gubov et Uzhemtskaya 2016, subass. *Salvio tesquicolae-Festucetum valesiacae* centauretosum trichocephalae Uzhemtskaya 1992 nom. inv., subass. *Salvio tesquicolae-Festucetum valesiacae* stellarietosum gramineae Uzhemtskaya 1992 nom. inv., ass. *Artemisio marschallianae-Bromopsietum inermis* Lysenko 2018, subass. *Artemisio marschallianae-Bromopsietum inermis* typicum Lysenko 2018, subass. *Artemisio marschallianae-Bromopsietum
inermis astragaletosum variii Lysenko 2018, subass. Artemisio marshallianae-Bromopsietum inermis chamaecyrtetosum rutenichi Lysenko 2018, ass. Centaureo sumensis-Stipetum borysytetosicae Lysenko 2018, subass. Centaureo sumensis-Stipetum borysytetosicae calamagrostietosum epigeii Lysenko 2018, subass. Centaureo sumensis-Stipetum borysytetosicae koelerietosum cristaetar Lysenko 2018, ass. Artemisio marshallianae-Stipetum pennavae Lysenko et al. 2020, ass. Astragalo variii-Bromopsietum inermis Lysenko in Lysenko et al. 2020, ass. Veroniceto prostratae-Artemisietum nitrosae Lysenko in Lysenko et al. 2020, ass. Galateto angustissimae-Spiraeetum litovinovii Lysenko in Lysenko et al. 2020, ass. Euphorbetum glareosae-Festucetum valesiaceae Lysenko et al. 2020, ass. Hedysarto grandiflori-Bromopsietum ripariae ass. prov., ass. Cariceto supinare-Stipetum pennavae ass. prov., acc. Carici praecoci-Stipetum pennavae ass. prov., acc. Astragalo ciceri-Stipetum pulcherrimae ass. prov., acc. Centaureo ruthenicae-Stipetum pulcherrimae ass. prov., ass. Carici supinare-Stipetum pulcherrimae ass. prov., ass. Astragalo austriaci-Gypsophiletum altissimae ass. prov., ass. Centaureo marshallianae-Stipetum capillatae ass. prov., subass. Centaureo marshallianae-Stipetum capillatae typicum ass. prov., subass. Centaureo marshallianae-Stipetum capillatae lineotosum perenne subass. prov., ass. Astragalo rupifrangi-Stipetum capillatae ass. prov., ass. Ellytrigio repentis-Stipetum capillatae ass. prov., ass. Thymo marshallianae-Festucetum valesiaceae ass. prov., subass. Thymo marshallianae-Festucetum valesiaceae typicum subass. prov., subass. Thymo marshallianae-Festucetum valesiaceae allietosum flavescentis subass. prov., subass. Thymo marshallianae-Festucetum valesiaceae hedysarotosum grandiflorae subass. prov., subass. Thymo marshallianae-Festucetum valesiaceae plantaginetosum urvillei subass. prov., ass. Astragalo variii-Festucetum valesiaceae ass. prov., subass. Astragalo variii-Festucetum valesiaceae thymietosum marshallianii subass. prov., ass. Potentillo bifurcae-Festucetum valesiaceae ass. prov., ass. Eremogone biebersteiniana-Festucetum valesiaceae ass. prov., ass. Artemisio marshallianae-Festucetum valesiaceae ass. prov.

Alliance Agropyriion pectinati Golub et Uzhametskaya 2016

Ass. Diantho borbasi-Falcarietum vulgaris typicum Lysenko 2010, subass. Diantho borbasi-Falcarietum vulgaris astragaletosum testiculati Lysenko 2010, subass. Diantho borbasi-Falcarietum vulgaris scabioasetosum ochroleucae Lysenko 2010, subass. Diantho borbasi-Falcarietum vulgaris centauretosum pseudophyogiae Lysenko 2010, subass. Diantho borbasi-Falcarietum vulgaris psammophileletosum muralis Lysenko 2010, ass. Taraxaco serotini-Tragopogonetum dubii Uzhametskaya in Golub et Uzhametskaya 2016, ass. Orinthogalo fischnariano-Artemisietum lerchianae Uzhametskaya in Golub et Uzhametskaya 2016, ass. Astragalo albicaulis-Stipetum lessingianae Lysenko in Lysenko et al. 2020, ass. Agropyro pectinati-Artemisietum austriacae ass. prov., ass. Astragalo ucrainici-Agropyretum pectinati ass. prov., ass. Hedysarto razomovianum-Agropyretum pectinati ass. prov., ass. Potentillotum arenariae-Centaureetum marshallianae ass. prov., ass. Anthemo subintocratico-Stipetum lessingianae ass. prov., ass. Astragalo testiculati-Stipetum lessingianae ass. prov., subass. Astragalo testiculati-Stipetum lessingianae typicum subass. prov., subass. Astragalo testiculati-Stipetum lessingianae astragaletosum macropii subass. prov., subass. Astragalo testiculati-Stipetum lessingianae silenetosum wolgensis subass. prov., ass. Tanaceto achilleofoiae-Agropyretum cristiati ass. prov., ass. Veroniceto jaqinii-Agropyretum cristiati ass. prov., ass. Galio aparinae-Calophacetum wolgaricae ass. prov.

Order Helicotricho-Stipetalia Toman 1969

Alliance Centaureion sumensis Golub et Uzhametskaya 2016

Ass. Scabioso-Asteretum alpini Czerapnin in Golub et al. 1995, ass. Pimpinello-Feruletum tataricae Czerapnin in Golub et al. 1995, ass. Thymo zhegulensi-Stipetum capillatae Lysenko 2018, ass. Alyso tortuosi-Artemisietum salsoloidis Lysenko in Lysenko et al. 2020, ass. Hedysarto grandiflori-Artemisietum salsoloidis ass. prov.

Order Tanaceto achilleofoiae-Stipetalia lessingianae Lysenko et Mucina in Mucina et al. 2016
Alliance *Stipion korshinskyi* Toman 1969  
Ass. *Astragalo austriaci-Stipetum korshinskyi* ass. prov.  
Alliance *Tanaceto achilleifolii-Stipetum lessingianae* Royer ex Lysenko et Mucina in Mucina et al. 2016  
Ass. *Tanaceto achilleifolii-Stipetum lessingianae* Lysenko et Kalmykova in Mucina et al. 2016, subass. *Tanaceto achilleifolii-Stipetum lessingianae* typicum Lysenko et Kalmykova in Mucina et al. 2016, subass. *Tanaceto achilleifolii-Stipetum lessingianae* astraegaletosum ucrainicis subass. prov., subass. *Tanaceto achilleifolii-Stipetum lessingianae* astraegaletosum macropi subass. prov., var. *Tanaceto achilleifolii-Stipetum lessingianae* astraegaletosum macropi var. typica, var. *Tanaceto achilleifolii-Stipetum lessingianae* astraegaletosum macropi var. *Koeleria sclerophylla*, ass. *Agropyro desertorum-Stipetum lessingianae* Lysenko 2019, ass. *Anabasio aphyllae-Stipetum lessingianae* Lysenko 2019, ass. *Stipo capillatae-Agropyretum desertorum* Lysenko 2019, subass. *Stipo capillatae-Agropyretum desertorum* typicum Lysenko 2019, subass. *Stipo capillatae-Agropyretum desertorum* stiptesosum lessingianae Lysenko 2019, subass. *Stipo capillatae-Agropyretum desertorum* alyssetosum turkestanici Lysenko 2019, subass. *Stipo capillatae-Agropyretum desertorum* caricetosum colchicae Lysenko 2019, ass. *Galio valantiit-Stipetum lessingianae* ass. prov., ass. *Tanaceto achilleifolii-Agropyretum desertorum* ass. prov., ass. *Limonio sareptani-Stipetum lessingianae* ass. prov., ass. *Tanaceto achilleifolii-Stipetum lessingianae* ass. prov., subass. *Tanaceto achilleifolii-Stipetum lessingianae* typicum subass. prov., subass. *Tanaceto achilleifolii-Stipetum lessingianae* phlometosum pungentis subass. prov.

4. Conclusion
The modern syntaxonomical system of the steppe vegetation in the Volga region, one of the regions of Eurasia, in which the steppe type of vegetation prevails, currently numbers 123 units. It is prepared for inclusion in the classification system of vegetation in Russia [1] and international classifications of vegetation in Europe and Eurasia. Pre-allocated syntaxa will be included in the system after publication.

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