Botanical Studies in the Vashlovani Protected Areas;

A Literature Review

Georgian Carnivore Conservation Project

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An overview of the vegetation of the Eldari lowland and Vashlovani Protected Areas

The study area is located in the in the extreme south-eastern part of Georgia and covers the extreme eastern and south-eastern parts of the Iori upland and Eldari lowland (within Georgia's borders). The altitude of the area ranges from around 100 m to 900 m a.s.l.

Brief overview of the vegetation of the Eldari lowland

The Eldari lowland (Samukhi valley) is a part of the broader Kura-Arax accumulative valley, and forms its north-western end. Its major portion lies on the territory of Georgia with only the extreme southern part being in Azerbaijan. The Eldari lowland is a plane, subtly inclined towards the south-east (where it is crossed by the river Iori). The climate is dry. Mean annual precipitation ranges from around 200-350 mm. Precipitation is unequally distributed throughout the year with two peaks in spring and autumn and two troughs in summer and winter. Mean annual temperature is 14.2°C, evaporation 1,000-1,200 mm, moisture coefficient 0.3-0.5. The soils are represented by the grey type of various degrees of salinization.

The plant cover is dominated by desert (semi-desert) types represented by communities of various formations. The major formation is *Artemisieta lerchianae* covering the largest portion of the lowlands. Other formations distributed in the area are *Salsoleta ericoidis*, *S. nodulosae* and *S. dendroidis*. Phytocoenoses of *Gamanthus* formation are also recorded in the area. The desert vegetation spread on the Eldari lowland (and on the entire study area) is a part of the desert vegetation of the East and South Caucasus, in its turn pertaining to the South Caucasian type of the Irano-Thuranian deserts.

Owing to broad ecological amplitude, *Artemisia lerchiana* makes up pure communities with ephemerals and ephemeroids as well as mixed communities with either various dwarf shrubs and semi-shrubs of the family Chenopodiaceae, or steppe sod-forming species. In particular, the following plant communities of Artemisieta can be found on the Eldari lowland:

1. Artemisietum pooso bulbosum var. vivipara-ephemerosum
2. Artemisietum-salsoleto ericoidis ephemerosum
3. Artemisietum-salsoleto nodulosae ephemerosum
4. Artemisietum tamaricoso ephemerosum
5. Artemisieto-bothrioclooso ischaemum ephemerosum

Of the listed communities Artemisieto-pooso-ephemerosum is the most characteristic and widespread.

The *Salsola* formation is represented by the following plant communities:

1. Salsoletum nodulosae-artemisioso ephemerosum
2. Salsoletum nodulosae ephemerosum
3. *Salsola nodulosa + Gamanthus pilosus + Petrosimonia brachiata*

Despite the small size of the distribution range, the *Salsola* formation is distinguished by typological diversity. The following communities of this formation are recorded on the study area:

1. Salsoletum dendroidis-artemisiosum lerchianae
2. Salsoletum dendroidis-anabasiosum aphyllae
3. Salsoletum dendroidis-kalidiosum capsicum
4. Salsoletum dendroidis-salsolosum nodulosae
5. Salsoletum dendroidis-artemisioso-alhagiosum
6. Salsoletum dendroidis tamaricosum ramosisissimae

The listed communities of *Salsola* formation are widespread on the Kura-Arax lowland, while their distribution range is rather limited on the Eldari lowland and the formation is, in most cases, represented by separate phytocoenoses.

Besides the desert vegetation, on the northern and north-western parts of the Eldari lowland plant communities of arid open forest, shiblyak-type hemixerphilous scrub, phrygana-like and steppe (*Bothriochloeta ischaemum*) vegetation occur.

On the Eldari lowland the spatial distribution of vegetation cover follows a certain pattern and is directly connected with geo-morphological processes, soil mechanical composition and, most of all, degrees of soil salinization. In particular, Artemisietum bothriochloosum association occurs on moderately clayey soils formed on subtly salinized pro-luvial layers of alluvial fans and their bottoms. Southwards, salinization slightly increases and on subtly salinized heavy clayey soils, formed on proluvial deposits, Artemisietum pooso-ephemerosum makes up a broad line. Further south, the association is replaced by Artemisietum salosolosum ericoidis and Salsoletum ericoidis artemisosum, growing on subtly and moderately salinized heavy clayey soils formed on proluvial deposits. In the eastern part of the lowland the surface inclination (although small) causes seizing of proluvial deposition and salt migration, which in turn results in increased clayiness and strong salinization of the soil. Owing to proximity to the river Iori, the ground contains a small amount of filtration moisture. Consequently, the vegetation cover is different and represented by *Salsola dendroides* formation (with phytocoenoses of various associations) and Artemisietum tamaricosum.

It is noteworthy that along with the micro-zonal distribution of formations and communities, azonal distribution of some vegetation types is observed on the Eldari lowland. In particular, in conditions of plane topography of the lowland, distribution of *Salsola nodulosa* formation is azonal. *S. nodulosa* is a gypsum-loving plant and bare gypsum-containing foothill slopes in a dry area provide it with the most suitable habitat. Its presence on the Eldari lowland is connected with increased content of gypsum in the soil, which in turn is a result of gypsum migration from adjacent anticlinal ridges (Kumro, Duzdagh, etc.) because of plane erosion. Such gypsum layers are spread in the central and eastern parts of the Eldari lowland (from Kumro and Duzdagh to the village Burunkvakhi, on one side, and from Kumro and Duzdagh to the Mingechaur water reservoir, on the other). Consequently, the distribution range of *S. nodulosa* on the Eldari lowland covers these areas. Therefore, it is not only the *S. nodulosa* formation that has azonal distribution on the Eldari lowland but also relevant communities of *Artemisia lerchiana* and *Salsola dendroides* formations, where *S. nodulosa* is a sub-dominant are represented. These communities are:

Artemisietum salsolosum nodulosae and Salsolsetum dendroidis salsolosum nodulosae.

Distribution of arid open forest, shiblyak-type hemixerophilous scrub, phrygana-like and steppe vegetation communities are also azonal on Eldari lowland. Their distribution is connected with specific topographic and soil conditions (alluvial fans of dry ravines, hills, etc.), where soil salinization is relatively low.

An important characteristic of the Eldari lowland vegetation is the development of ephemeral (*Astragalus asterias*, *A. striatellus*, *Medicago minima*, *M. orbicularis*, *Torularia contortuplicata*, *T. torulosa*, *Malvalthaea transcaucasica*, *Arenaria serpyllifolia*, *Bombicilaena erecta*, *Bromus japonicus*, *Erodium cicutarium*, *Herniaria hirsuta*, *Garhadiolus angulosus*, *Trachynia distachya*, *Sterigmostermum tomentosum*, *Phleum paniculatum* and many others) and ephemeroid (*Poa bulbosa* var. *vivipara*, *Catabrosella humilis*, *Allium rubellum*, *Gagea commutata*, etc.) synusia, which is a result of the unequal distribution of precipitation throughout the year. The synusia are especially well formed in *Artemisia lerchiana* formation, where soil salinization is not very high. Along with increases in soil salinization, the number of ephemeral and ephemeroid species decreases; the lowest number of species of these groups is found in communities of *Salsola dendroides* formation. In ephemeral plants, synusia halophyte ephemerals (*Spergularia diandra*, *Aizoon hispanicum*, *Eremopyron orientale*, *E. triticem*, *Parapholis incurva*, *Tripleurospermum parviflorum*, *Psylliostachys spicata*, *Strigosella africana*, *Leptaleum filifolium*) predominate. In parallel, the proportion of annual halophytes with a long growing season (*Gamanthus pilosus*, *Petrrosimonia brachyata*, *Suaeda confusa*, *Salsola soda*, etc.) increases. It is also noteworthy that in the southern part of the lowland species characteristic to herbaceous tugai communities connected with presence of filtration moisture in the ground (*Alhagi pseudalhagi*, *Alopecurus myosuroides*, *Limonium meyeri*, *Aeluropus littoralis*, *Polygonum argyrocolem*, *P. aviculare*, *Elytrigia repens*, *Plantago lanceolata*) are found.

Brief overview of the vegetation of the Vashlovani Protected Areas

In Vashlovani Protected Areas various climate and soil zones are distinguished from the south to the north. In particular, mean annual temperature decreases from 14°C to 11°C, and mean annual precipitation increases from around 250 mm to 700 mm. In parallel evaporation decreases from 1,000 mm to 700-800 mm and consequently, moisture coefficient rises, ranging from 0.3 to 0.5 in the southern part and from 0.5 to 1.0 in the Mt. Shavi Mta vicinity. In the southern part of the area, arid forest brown soils are present with intra-zonal inclusion of moderately and subtly salinized grey soils of Eldari lowland soil type. Monoclinal ridges, located in the southern part (Kaladara, Kumro, Duzdagh, “Didi Chrdili”, “Patara Chrdili”, etc.), also steep slopes of Midjniskure and Usakhelo Mta massifs are in the major part devoid of genuine soil cover and are represented by bare substratum, cemented conglomerates, sandstone formed on the weathering crust, scree and salinized clayey and sandy-clayey badlands. Northwards grey-brown, black-like and black soils are spread. Humus carbonate and brown soils are present on Mt. Shavi Mta and adjacent areas.

The Vashlovani PAs have diverse flora and vegetation. The presence of various climatic zones (from the south to the north), diversity of topographic and soil

conditions, geology, current geo-morphological and geophysical processes underlie the plant diversity. Often, a mosaic distribution of different plant communities on the relatively small area makes the PAs attractive and interesting to tourists and scientists.

The vegetation cover of the PAs include arid open forest, steppe, shiblyak-type hemixerophilous scrub, semi-desert (desert), phrygana-like vegetation, foothill deciduous forest and riparian forest communities. Landscapes of limestone rocky areas are largely present on the area. In places, fragments of hygrophilous (wetland) vegetation occur. The vegetation cover of the limestone ecosystems of Dedoplistskaro is worth mentioning separately.

The vegetation distribution pattern from the south to the north includes the following zones: arid forest, steppe and foothill deciduous forest. The other vegetation types in Vashlovani Protected Areas are mostly present in a form of intrazonal inclusions into the zonal vegetation pattern. Their development is related to specific topographic and soil conditions and geological origin.

Semi-desert (desert) vegetation is represented by two ecological variants: plane deserts and foothill deserts.

Plane desert vegetation is a continuation of the Eldari lowland desert vegetation and is similar to the latter. It is formed on planes, slopes and hills with moderately and subtly salinized grey soils. Plane desert vegetation is spread in the southern part of the PAs from 100 to 300 m a.s.l. and includes Bugha-Moedani, planes of middle and lower parts of the river Lekistskali. Small fragments can be found in the lower part of the Alazani-river valley (Midjniskure) where subtly and moderately salinized grey soils are present. The main formation on the PA is Artemisieta lerchianae. Relatively small areas are occupied by Salsoleta nodulosae. In contrast to the Eldari lowland, in the PAs *Artemisia lerchiana-Botriochloa ischaemum* communities are more widespread, which is caused by reduced soil salinity. The community is relatively well represented in Lekistskali gorge, on Kumro and Bugha-Moedani.

Foothill deserts are fragmentarily present on the Vashlovani PAs in a form of intrazonal inclusions in the zone of arid open forests. Their distribution range spreads from 200 to 450 m a.s.l. and includes Pantishara gorge, Kaladara, Kumro (Kumuro), Duzdagh, Midjniskure, Usakhelo Mta and Vashlovani depression. Salinized (often gypsum-rich) clayey and clayey-sandy badlands and hills devoid of genuine soil cover form characteristic landscape. Plant cover is mainly represented by Salsoletum nodulosae, Artemisietum lerchianae and Gamanthetum pilosus communities. Characteristic species are: *Salsola nodulosa, Artemisia lerchiana, Gamanthus pilosus, Reaumuria alternifolia, Stachys fruticulosa, Suaeda dendroides, Eremopyron orientale, Zygophyllum fabago, Agropyron pectinatum, Caccinia macranthera*, etc. Slopes without vegetation cover with single individual plants are not rare.

Phtygana-like vegetation is fragmentarily distributed in the Vashlocani PAs from 100 to 450 m a.s.l. and include Pantishara gorge, Kaladara, Kumro (Kumuro), Duzdagh, Midjniskure, Usakhelo Mta and Vashlovani depression. It is present in a form of intrazonal inclusions in the zone of arid open forests. It mainly contains communities of Reaumurieta alternifoliae and Caraganeta grandiflorae formations. Rarely Atraphaxieta spinosae communities can also be found.

Communities of Reaumurieta alternifoliae are distributed on clayey and clayey-sandy badlands and hills devoid of genuine soil cover. Characteristic species are: *Reaumuria alternifolia, Artemisia lerchiana, Stachys fruticulosa*, *Atraphaxis spinosa, Caragana grandiflora, Zygophyllum fabago, Agropyron pectinatum,Stipa caspia, Lappula barbata, Caccinia macranthara, Ephedra procera*, etc.

The major range of Caraganeta grandiflorae covers Lekistskali gorge and Kumro, where it quite often occupies significant areas on slopes. The communities are formed on eroded clayey slopes. Characteristic species are:*Stipa lessingiana, Agropyron pectinatum, Reaumuria alternifolia, Artemisia lerchiana, Stipa caspia, Stachys fruticulosa, Ferula szowitsiana, Crinitaria villosa, Tulipa eichleri,* etc.

Arid open forests are spread from 100 to 600 m a.s.l. within the PAs. They are distributed in Eshmaki, Mamachay and pantishara gorges, Vashlovani depression, on Kaladara, "Didi Chrdili", "Patara Chrdili", Kumro and Bugha-Moedani, Midjniskure and Usakhelo Mta massifs, in Lekistskali, Alpadara, Chaybulaki and Sarkliskuri gorges. The relief forms include slopes, hills and planes. Soils are of forest brown type; clayey and subtly salinized grey soils can also be found. Rarely this type of the landscape is found on cobblestone of dry ravines and alluvial fans.

The major formations of the arid open forests are: *Pistacieta muticae* and Junipereta (*Juniperus. foetidissima, J. polycarpos*), rarely communities of *Aceretum ibericae* and *Pyretum salicifolia* also occur. *Pistacieta muticae* communities grow in lower parts of the slopes and on mild relief forms (wavy hills and plane places, alluvial fans, ravine edges). Best represented these are in the Vashlovani depression; can also be found in the Lekistskali and Pantishara gorges, Ghoristskali and Alpadara goreges, Midjniskure, etc. The principal plant communities are:

- **a.** *Pistacia mutica* community on *Botriochloa ischaemum* background. Characteristic species are: *Bothriochloa ischaemum, Paliurus spina-christi*, *Jasminum fruticans*, *Rhamnus pallasii,* etc.
- **b.** *Pistacia mutica* community on *Stipa* background. Characteristic species are: Stripa lessingiana, Stipa capillata, *Paliurus spina-christi*, *Jasminum fruticans, Rhamnus pallasii*, etc.
- **c.** *Pistacia mutica* community on semi-desert background. Characteristic species are: *Artemisia lerchiana*, *Bothriochloa ischaemum*. Synusia of ephemerals/ephemeroids is well formed.

Juniperus formation is spread throughout the distribution range of the arid open forests.

They mainly cover middle and upper parts of moderately and very steep north-facing slopes. The formation is represented by various plant communities. Characteristic species are: *Paliurus spina-christi*, *Jasminum fruticans*, *Berberis iberica*, *Lonicera iberica*, *Cotinus coggygria*. In some communities *Caragana grandiflora* predominates in the undergrowth.

Acerata ibericae communities are rare. Small areas occupied by these communities can be found in gorges directed towards the river Alazani (e.g. Arpadara gorge). The following species also constitute the communities: *Paliurus spina-christi*, *Quercus iberica*), *Cotinus coggygria*, etc.

Pyretum salicifoliae communities are also rare. Small plots with these communities occur in Lekistskali gorge and Mt. Shavi Mta vicinity. Characteristic is the steppe herbaceous cover.

On the PAs **steppe** is found in the upper part of the river Lekistskali gorge, in Nagomrebi, Chighoetkhevi, Zilicha and Mt. Shavi Mta area. The steppe is developed on grey-brown, black-like and humus-carbonate soils. Two formations are distinguished: Bothriochloeta ischaemum and Stipeta (*S. lessingiana, S. capillata*).

Bothriochloeta ischaemum occurs in Nagomrebi, Chighoetkhevi, the river Lekistskali gorge, Vashlovani depression, Mt. Shavi Mta area, etc. It is found on hills, slopes and plane places of various exposure, mainly from 200 to 600 m a.s.l. and is represented by various plant communities, of which the following are noteworthy:

1. Bothriochloeta ischaemum with *Festuca* and *Stipa*. Characteristic species are: *Festuca valesiaca, Stipa lessingiana*, *Potentilla recta*, *Scorzonera biebersteinii*, *Galium verum*, *Eryngium campestre*, etc. with abundance of ephemerals and ephemeroids in spring.
2. Bothriochloeta ischaemum with *Stipa*. Characteristic species are: *Stipa lessingiana, S. capillata, Polygala transcaucasica, Phleum phleoides, Thymus tiflisiensis, Galium verum, Inula germanica*, etc.
3. Bothriochloeta ischaemum with *Paliurus*. Characteristic species are: *Paliurus spina-christi, Thymus tiflisiensis*, *Galium verum*, *Phleum phleoides*, *Potentilla recta*, etc.

Stipeta is fragmentarily distributed in a form of small plots from 400 to 840 m a.s.l. Its communities grow on upland plane areas at the tops of ridges on grey-brown (Duzdagh, Nagomrebi, Vashlovani Reserve) and humus-carbonate (end of Kashebi, Mt. Shavi Mta) soils. *Stipa lessingiana* and *S. capillata* predominate. Ephemerals and ephemeroids are abundant in spring.

On the Vashlovani PAs shiblyak-type hemixerophilous scrub is fragmentarily distributed from 200 to 1000 m a.s.l. Its principal formations are: Paliureta spina-christi, Mixtofruticeta and Carpineta orientalis. Of them Paliureta spina-christi is the most widespread and characteristic. Paliureta spina-christi present there is of either primary, or secondary origin. The secondary scrub is formed as a result of arid open forest and foothill deciduous forest clear cutting. Steppe herbaceous cover is characteristic to this community. Characteristic species are: *Bothriochloa ischaemum, Galium verum, Phleum phleoides, Potentilla recta, Inula germanica, Festuca valesiaca,* etc.

Mixtofruticeta is of the secondary origin and is formed as a result of arid open forest and foothill deciduous forest clear cutting. It exists in a form of small plots fragmentarily scattered on the PA territory and is represented by relatively xerophilous variants in the southern part of the area and by relatively mesophilous variants in its northern part. Characteristic species are: *Paliurus spina-christi*, *Cotinus coggygria*, *Rhamnus pallasii*, *Rhamnus cathartica*, *Berberis vulgaris*, *Mespilus germanica*, *Cotoneaster intergerrimus, C. morulus, C. meyeri*, *Cerasus incana*, *Crataegus caucasica*, *Pyrus salicifolia*, *Prunus divaricata*, *Prunus spinosa,* etc. Herbaceous cover is made up of steppe and meadow-steppe species.

Carpineta orientalis is found on the PAs in Artsiviskhevi on humus-carbonate soils. Herbaceous cover is made up of oak forest and steppe species.

In the Vashlovani PAs so-called **"Mixtures" ("Areulebi")** are found. They include dry and very deep and narrow gorges where a mixture of arid open forests, on the one hand, and foothill desert and phrygana-like vegetation occurs. Elements of steppe and shiblyak-type hemixerophilous scrub is also present there. Slopes are eroded and mainly contain clay-sand, sandstone or clay. On account of peculiar topographic and soil conditions none of the vegetation types dominates on the areas. As a result plants of different habitats irregularly grow side by side.

In Vashlovani PAs foothill deciduous forests grow only on Mt. Shavi Mta. They are formed on humus-carbonate soils. The deciduous forests are represented by two formations: Fraxineta excelsior and Querceta ibericae. Ash forest is distributed in the upper part of the mountain. The undergrowth consists of: *Euonymus verrucosa*, *Ligustrum vulgare*, *Cornus mas*, *Prunus divaricata*, etc.; and the herbaceous cover of: *Allium paradoxa, Viola odorata, Scilla sibirica, Smirnium perfoliatum*, *Geum urbanum*, *Torilis japonica*, etc. Oak forests grow on northern slopes of Mt. Shavi Mta. The undergrowth consists of: *Carpinus orientalis*, *Euonymus verrucosa*, *Cornus mas*, *Prunus divaricata,* etc.; and the herbaceous cover of: *Viola odorata*, *Scilla sibirica*, etc.

Riparian forests are fragmentarily distributed on terraces of the river Alazani. The largest groves remain in Djumaskure. Smaller plots exist in the village Sabatlo vicinity, outflows of Arpadari and Midjniskure. Riparian forests are represented by plant communities of two formations: Populeta hybridae and Querceta pedunculiflorae. Poplar forests are more widespread, while oak forest distribution range is relatively limited. The following species are characteristic to the riparian forests: *Smilax exelsa*, *Periploca graeca*, *Vitis sylvestris*, *Amorpha fruticosa* (an invasive species), *Hedera helix,* etc.

In Djumaskure *Junglans regia*, *Pterocaria pterocarpa*, *Hedera pastuchovii*, *Cydonia oblonga* are found.

In Datviskhevi a small grove of *Populus euphratica* is found – this is a unique locality of the species in Georgia.

On the Vashlovani PAs, mainly in the Lekistskali gorge hygrophilous (wetland) vegetation fragments can be found. They are mostly represented by *Phragmites australis* and *Arundo donax* communities.

Limestone rocky areas are present in Dediplistskaro vicinity and include Artsiviskhevi, a protected area of the Nature Monument category. This local landscape is formed by a narrow canyon of limestone rocks. The vegetation contains shiblyak-type hemixerophilous scrub and limestone rock plant complexes. The latter is represented by local endemics *Campanula kachetica* and *Galium pedemontanum.* These species are known only from Dedoplistskaro limestone habitats. *Thymus kariaginii*, endemic to the Caucasus, is also found there.

Brief literature review of winter pastures on the Eldari lowland and Vashlovani Protectes Areas

The study area served as winter and transitional pasture mainly for hibernation of sheep from ancient times.

The following pasture types occur on the area:

1. Semi-desert (desert);
2. Arid open forests (mainly of *Pistacia mutica*);
3. Steppe;
4. Hemixerophilous scrub.

Data on biomass and productivity of the winter pastures of the study area are very poor. Below literature overview on these pastures is presented.

Semi-desert (desert) type pastures on the study area occur on the Eldari lowland, Kumro, Bugha-Moedani, lower and middle parts of the Lekistskali gorge. By nutritional value the plants of these pastures may be divided into the following major groups:

1. Desert xerophilous dwarf shrubs and semi-shrubs;
2. Ephemerals;
3. Ephemeroids;
4. Annuals of long growth season from the family Chenopodiaceae;
5. Perennial grasses.

Floristically the group of xerophilous dwarf shrubs and semi-shrubs is not rich. The principal species are: *Artemisia lerchiana*, *Salsola ericoides*, *Salsola dendroides*, *Salsola nodulosa*, *Kochia prostrata*, *Kalidium capsicum*. The most widespread of them is *Artemisia lerchiana*. It is one of the best fodder plants of the winter pastures and the main food for hibernating sheep. As reported by Kakulia (1952), artemisia is a plant of high nutritional value, which is proved by its chemical composition (proteins 17.03%, fat 12.14%, cellulose 18.47%). 1 kg of artemisia biomass is equal to 0.51 kg nutritional units with 0.05 kg digestive protein. Protein to extracted substances ratio is satisfactory (1:8.4).

Kochia prostrata is also a good fodder plant, although is found in small amounts on the study area (Kakulia 1949, 1967).

Of the semi-shrubs of the genus *Salsola, S. nodulosa* is thought to be the best fodder plant for sheep. In contrast, *S. dendroides* is less grazed. The least grazed by sheep is *S. ericoides*, generally thought to be unsatisfactory fodder plant (Kakulia 1952).

On winter pastures of the study area other desert dwarf shrubs and semi-shrubs (*Aellenia glauca*, *Kalidium caspicum*, *Anabasis aphylla*, *Camphorosma monspeliaca*, *Reaumuria alternifolia*, *Stachys fruticulosa*, *Noaeae mucronata*) are relatively rare (some of them occur locally) and insignificant for feeding sheep in winter. Besides, on account of high content of salts and some other substances they are not grazed by sheep, or are grazed only in case of absence of other plants.

Ephemerals and ephemeroids are important on desert type pastures, especially in early spring, when other fodder plant resources are exhausted. The following species of

ephemerals are considered good fodder herbs: *Medicago minima*, *Astragalus asterias*, *Astragalus striatellus*, *Bromus japonicus*, *Lolium rigidum*, *Trigonella orthoceras*, *Trigonella spicata*, *Vicia cinerea*, *Eremopyron orientale*, *Eremopyron triticeum*, etc. Of ephemeroids *Poa bulbosa* var. *vivipara* is noteworthy; this is one of the widespread species on winter pastures and is thought to be a plant of high nutritional value. Another well-grazed epemeroid is *Catabrosella humilis*, although its distribution range as well as the population size is rather limited. Of ephemeroids the following species are also well-grazed by sheep: *Allium rubellum*, *Tulipa eichleri*, *Merendera trigina*, *Crocus adamii*, *Gagea commutata*, *Gagea caroli-kochii*.

Because of high salt content, annuals of the family Chenopodiaceae with prolonged growth season (*Seidlitzia florida*, *Gamanthus pilosus*, *Petrosimonia brachiata*, *Salsola soda*, *Suaeda confusa*) are considered as fodder plants of relatively low nutritional value.

In the semi-desert (desert) type pastures the most widespread and important for sheep hibernation are artemisia communities. As reported by Kakulia (1952), in spring 1 ha of *Artemisia lerchiana* community with *Poa bulbosa* var. *vivipara* yields on average 5.5 centners of dry weight, of which artemisia accounts for 3 centners, while the rest 2.2 centners are made up of the herbs from the group of ephemerals (it can be assumed that the author considers *P. bulbosa* var. *vivipara* among ephemerals – N. Lachashvili).

Agricultural characteristics of the winter pastures of the Eldari lowland were studied in 1948-1950 by Sh. Nakhutsrishvili (1958). Observations were conducted in the communities of *Artemisia lerchiana* and *A. lerchiana-Salsola ericoides*. Biomass was collected from autumn (30 November) to spring (30 April) inclusive. Total yield and proportion of each fraction (artemisia, grasses, legumes, forbs) were studied for dry and raw biomass. Seasonal productivity variation was studies. The results of this investigation are given in the tables (1-4) below.

Table 1. The total yield and proportions of each fraction in the communities of *Artemisia* in Eldari lowland, the 1948-1949 grazing season

#	Collection date (day/month)	Dry and raw biomass	Average monthly yield per Hectare	Yield by fraction				
				Grasses	Legumes	Forbs	*Artemisia lerchiana*	Dry mass
1	30/XI	6.78 / 5.01	6.78 / 5.01	0.3 / 0.15	0.2 / 0.02	2.7 / 0.7	26.5 / 14.8	38.6 / 43.5
2	10/XII	8.25 / 3.80		0.4 / 0.17	0.2 / 0.07	2.6 / 0.9	31.0 / 12.3	47.1 / 24.6
3	20/XII	7.01 / 4.58	6.93 / 3.98	0.8 / 0.41	0.1 / 0.05	1.8 / 0.6	24.5 / 16.1	42.7 / 28.6
4	30/II	5.52 / 3.57		1.1 / 0.5	0.2 / 0.08	2.5 / 0.8	13 / 8.8	48 / 25.2
5	19/I	6.13	6.08	0.4	0.2	1.3	21.1	38.2

		5.37	5.01	0.2	01	0.5	15.8	36.6
6	29/I	6.03 / 4.66		0.6 / 0.35	0.4 / 0.15	1.6 / 0.5	28.0 / 20.0	32.0 / 25.5
7	8/II	5.17 / 4.57		0.3 / 0.1	0.1 / 0.02	1.2 / 0.45	10.0 / 9.2	37.6 / 35.8
8	18/II	5.57 / 4.89	5.67 / 4.76	0.5 / 0.21	0.3 / 0.05	2.4 / 0.7	16.7 / 11.5	38.5 / 36.5
9	28/II	6.05 / 4.82		0.4 / 0.18	0.3 / 0.1	1.2 / 0.3.7	19.2 / 15.6	39.2 / 32.0
10	10/III	5.01 / 4.15		1.1 / 0.42	0.8 / 0.25	3.0 / 0.8	13.9 / 10.8	31.3 / 29.3
11	20/III	4.41 / 3.36	4.71 / 3.41	1.2 / 0.5	0.1 / 0.02	3.1 / 0.7	15.5 / 9.1	24.2 / 23.1
12	31/III	4.72 / 2.73		4.0 / 1.4	0.82 / 0.3	12.4 / 2.5	13.5 / 6.7	16.5 / 16.4
13	9/IV	6.86 / 2.36	20.27	7.3 / 2.0	1.2 / 0.35	25.5 / 5.6	25.7 / 7.2	8.5 / 8.5
14	19/IV	24.21 / 5.38		24.4 / 74	4.1 / 1.1	149.0 / 24.4	56.6 / 15.4	8.0 / 5.5
15	29/IV	29.74		25.0	4.8	203.0	58.1	6.5

Table 2. The total yield and proportions of each fraction in the communities of *Artemisia* in Eldari lowland, the 1949-1950 grazing season

#	Collection date (day/month)	Dry and raw biomass	Average monthly yield per Hectare	Yield by fraction				
				Grasses	Legumes	Forbs	*Artemisia lerchiana*	Dry mass
1	30/X	12,25	12.26	0.03	0.01	0.08	2.81	8.75
		11,38	11.38	0.01	0.005	0.02	2.05	8.75
2	1/XI	8.83		0.12	0.007	0.11	2.52	6.08
		8.24		0.04	0.002	0.03	2.09	6.08
3	10/XII	13.61	11.07	0.17	0.02	0.27	3.84	9.31
		11.22	9.88	0.05	0.007	0.06	2.69	8.42
4	20/XII	10.78		0.13	0.01	0.15	2.30	8.19
		10.19		0.05	0.005	0.05	1.90	8.19
5	20/II	6.18	6.18	0.06	0.002	0.13	0.75	5.24
		5.94	5.94	0.02	0.001	0.04	0.65	5.23
6	1/III	8.81		0.19	0.01	0.21	0.31	7.09
		7.28		0.05	0.004	0.005	0.94	6.24
7	10/III	6.61	7.79	0.32	0.04	0.23	1.56	4.46
		5.39	6.12	0.09	0.01	0.05	0.82	4.42
8	20/III	7.95		0.51	0.03	0.34	0.49	4.58
		5.69		0.15	0.007	0.06	0.94	4.54
9	1/IV	12.73		0.82	0.14	1.33	6.32	4.12
		6.41		0.21	0.04	0.25	1.79	4.12
10	10/IV	23.38	15.50	4.04	0.23	6.70	9.02	3.39
		8.26	7.05	1.16	0.06	1.23	2.42	3.39
11	20/IV	10.40		1.55	0.16	2.28	4.44	1.97
		6.5		0.93	0.08	1.05	2.47	1.97

Table 3. The total yield and proportions of each fraction in the communities of *Artemisia lerchiana-Salsola ericoides* in Eldari lowland, the 1948-1949 grazing season

#	Collection date (day/month)	Dry and raw biomass	Average monthly yield per Hectare	Yield by fraction					
				Grasses	Legumes	Forbs	*Artemisia lerchiana*	*Salsola ericoides*	Dry mass
1	28/X	4.11	4.11	0.7	0.1	0.7	7.7	5.3	28.6
		2.69	2.69	0.35	0.03	0.25	5.9	5.3	14.9
2	8/XII	4.99		1.3	0.3	1.4	4.5	3.7	38.7
		3.65		0.5	0.1	0.6	2.2	3.3	29.9
3	18/XII	3.57	3.61	0.8	0.2	1.2	5.7	3.4	23.9
		2.98	2.84	0.3	0.07	0.3	4.7	3.1	21.1
4	17/I	2.25	3.42	1.0	0.2	1.4	2.1	4.4	13.6
		1.88	3.01	0.4	0.08	0.5	1.4	4.4	11.9
5	30/I	3.31		0.6	0.05	0.3	6.6	5.7	19.7
		3.02		0.2	0.03	0.3	5.4	5.2	18.0
6	6/II	5.03		0.4			4.3	7.4	40.6
		4.05		0.23			3.0	6.7	30.6
7	16/II	4.54	4.56	0.8	0.17	0.6	6.1	5.7	36.5
		3.98	3.88	0.3	0.07	0.16	5.2	5.2	28.9
8	26/II	4.12		0.9	0.07	0.9	8.6	4.2	26.1
		3.51		0.35	0.02	0.25	6.7	4.0	24.8
9	8/III	5.37	4.52	1.3	0.1	1.6	12.5	9.2	29.0
		3.70	3.11	0.37	0.07	0.42	8.6	7.9	19.7
10	28/III	3.67		4.4	0.2	1.3	12.6	2.9	15.3
		2.64		0.9	0.1	0.47	7.8	2.7	14.5
11	7/IV	5.86		6.5	0.5	3.7	35.7	3.3	8.9
		2.61		1.6	0.24	0.72	13.7	2.1	8.8
12	17/IV	9.24	10.19	11.4	2.3	4.5	41.2	24.8	8.2
		3.01	2.81	3.4	0.72	1.0	12.2	5.5	8.2
13	27/IV	15.49		15.3	3.1	28.0	56.0	43.5	7.4

Table 4. The total yield and proportions of each fraction in the communities of *Artemisia lerchiana-Salsola ericoides* in Eldari lowland, the 1949-1950 grazing season

#	Collection date (day/month)	Dry and raw biomass	Average monthly yield per Hectare	Yield by fraction					
				Grasses	Legumes	Forbs	*Artemisia lerchiana*	*Salsola ericoides*	Dry mass
1	2/XI	7.24	7.24	0.06	0.002	0.01	2.48	2.18	2.52
		5.39	5.39	0.03	0.001	0.005	1.99	1.94	2.43
2	5/XII	5.09	5.65	0.05			1.27	1.36	2.41
		4.64	5.13	0.01			1.01	1.31	2.31
3	15/XII	6.21		0.15	0.007	0.06	2.34	1.64	2.00
		5.62		0.12	0.002	0.02	1.89	1.64	1.99
4	25/II	4.04	4.04	0.16	0.005	0.13	1.48	0.96	1.31
		3.34	3.34	0.04	0.002	0.03	1.20	0.91	0.16
5	5/III	4.17		0.07	0.03	0.09	1.64	0.50	1.84
		3.47		0.04	0.01	0.02	1.33	0.46	1.60
6	15/III	4.55	4.17	0.18	0.01	0.13	1.49	0.79	1.20
		3.08	3.06	0.05	0.004	0.02	0.66	0.76	1.14
7	25/III	10.42		0.23	0.04	0.20	1.65	0.84	1.59
		3.65		0.08	0.01	0.04	0.65	0.71	1.59
8	5/IV	10.42		0.88	0.09	0.62	5.43	2.44	1.03
		3.65		0.28	0.02	0.12	1.49	0.71	1.03
9	15/IV	12.5	11.01	0.92	0.33	1.04	7.50	2.33	0.83
		4.58	4.79	0.35	0.09	0.21	2.30	0.80	0.83
10	25/IV	9.61		0.12		0.24	4.44	4.11	0.70
		6.12		0.05		0.15	2.62	2.62	0.70

It is clear from the tables presented that productivity of artemisia is higher in autumn than in winter and early spring, and from April its productivity remarkably increases. The other fractions (grasses, legumes, forbs) maintain almost equal biomass in autumn and winter but from early spring (February-March) their productivity increases and reaches its maximum in April. Therefore, in the period when productivity of artemisia is decreased, the proportion of the other fractions increases. Similar dynamics is observed in *Artemisia lerchiana-Salsola ericoides* communities. The author analyzing the material obtained concludes that:

1. No strong reduction is observed in biomass productivity during the whole season (even in winter the difference compared to autumn is small), while from April significant increase is apparent.
2. Rise of productivity in artemisia community is twice as much as in the community of *Artemisia lerchiana-Salsola ericoides,* which is related to the increase in soil salinity causing reduction of the number of ephemeral species present.
3. Ephemerals start their development from the end of March and grow rapidly so that, for instance, in the first third of April the green mass increase equals to 0.21 centners per 1 ha per day, 1.73 centners in the second third and 0.55 centners in the last third. In the same period the green mass increase in the community of *Artemisia lerchiana-Salsola ericoides* equals to: 0.21 centners in the first third,

0.33 centners in the second third, 0.62 centners in the last third. The biomass increases at the expense of grasses and forbs.

In the same paper grazing intensity of *Artemisia lerchiana, Salsola ericoides* and ephemerals is given (%). The table below (Table 5) presents the data of 1948-1949.

Table 5

	24.02.1949	28.03.1949	09.04.1949	27.04.1949.
Ephemerals	65.7%	65.0%	58.3%	67.5%
Artemisia lerchiana	100%	83.3%	45.9%	13.0%
Salsola ericoides	-	20.7%	12.1%	3.2%
Whole herbaceous cover	58.6%	70.6%	49.2%	72.7%

As it is shown in the table above, artemisia is strongly grazed in February and March, and the grazing intensity drops from April (to 13.0%). *Salsola ericoides* is poorly grazed in the beginning of spring (only 20.7%); in April, at the time of ephemeral boom its grazing intensity is even lower reduced to 12.1% and more (to 3.2%).

The next table (Table 6) presents artemisia community grazing indices according to 1949-1950 data.

Table 6

	10.12.1949	21.03.1950	04.04.1950	13.04.1950
Grasses	83.0%	56.0%	80.1%	86.5%
Legumes	100%	40.0%	75.0%	88.0%
Forbs	76.1%	45.55	66.0%	73.2%
Artemisia lerchiana	63.8%	57.8%	30.0%	32.0%
Total herbaceous cover	74%	53.3%	41.7%	53.3%

On the basis of the data given in the table the author concludes that artemisia community is best grazed in December (74%). Then the grazing index significantly decreases, which is connected with % reduction of artemisia grazing intensity. In spring grazing mainly depends on ephemerals.

Grazing indices for *Artemisia lerchiana-Salsola ericoides* communities are given in the table below (Table 7).

Table 7

	15.12.1949	22.03.1950	06.04.1950	14.04.1950
Grasses	87.2%	55.5%	70.2%	90%
Legumes	100%	35.0%	65.3%	80%
Forbs	85%	47.3%	77.0%	78.6%
Artemisia lerchiana	60%	59.2%	57.5%	31.0
Salsola ericoides	45.3%	47.4%	48.4%	25.5
Whole herbaceous cover	**59.5%**	**54.0%**	**57.1%**	**45.9%**

Grazing intensity of Bothriochloeta ischaemum was also studied. In the beginning of April (the 3rd April) the herbaceous cover grazing was estimated to be 64%.

Ephemeral grasses were well grazed (72.4%) as well as legumes (73.8%). *Botriochloa ischaemum* was grazed at the rate of 68.6% and forbs at 54.6%.

M. Khachidze (1985) provides the following data for the Eldari lowland:
In *Artemisia lerchiana-Botriochloa ischaemum* community the green mass on 1 m^2 contains (April):

1. Perennial herbs – 120 g
2. Ephemerals – 160 g (grasses – 48 g, legumes – 52 g, forbs – 60 g)

In total on the area of 1 ha the green mass amount to 28 centners including 16 centners of ephemerals.

In *Artemisia lerchiana* community the green mass on 1 m^2 contains (April):

3. Perennial herbs – 80 g
4. Ephemerals – 208 g (grasses – 28 g, legumes – 120 g, forbs – 60 g)

In total on the area of 1 ha the green mass amounts to 28.8 centners including 20.8 centners of ephemerals.

It is clear from the data presented that proportion of ephemerals in higher in artemisia communities.

As reported by Sokhadze and Khachidze (unpublished data), according to the results of investigations carried out on the Eldari lowland in the 1970s, in different plant communities of the desert-type winter pastures the ratios of the raw biomass are as follows:

Artemisietum lerchianae

November, 1976. Green fodder productivity on 1 ha – 7.6 centners: artemisia – 7.0 centners, ephemerals and ephemeroids – 0.6 centners.

Winter. 100 kg green fodder is a completely dry state contains 47.74 kg nutritional units and 6.29 kg digestive protein.

Artemisia lerchiana + Bothriochloa ischaemum

Autumn, 01.11.1976. Fodder productivity on 1 ha – 11.4 centners: artemisia – 0.6 centners, *Botriochloa ischaemum* – 0.5 centners, ephemerals and ephemeroids – 0.4 centners.

Salsoletum ericoides

Spring, 16.04.1976. Green fodder productivity on 1 m^2 – 47 g: artemisia – 20 g, *Poa bulbosa* var. *vivipara* and ephemerals – 27 g.

Salsoletum dendroidis

Spring, 20.04.1976. Green fodder productivity on 1 m^2 – 24.5 g: artemisia – 8.5 g, *Poa bulbosa* var. *vivipara* and ephemerals – 16 g.

Salsoletum nodulosae

Winter. 100 kg fodder harvest contains 37.18 kg nutritional units and 4.04 kg digestive protein.

According to various authors (Kakulia 1952; Sokhadze, Khachidze, unpublished data; etc.), in the desert-type winter pastures Artemisietum lerchianae is the most productive community followed by Salsoletum nodulosae. Compared with the latter, the nutritional value of Salsoletum dendroidis and especially of Salsoletum ericoides is low. It is related to the nutritional values of the dominant (more precisely, edificatory) species as well as different degree of ephemeral-ephemeroid synusia development. The nutritional value of the *Gamanthus* communities is also very low because the communities are poor in ephemerals-ephemeroids and *Gamanthus* itself is a fodder plant of low quality, which is caused by high content of salts in the plant tissues.

Abdaladze and Chiboshvili (2004) describe current state of winter pastures on the territory of the Chachuna Protected Area adjoining the study area. Based on the analysis of various indices of a plant community (projective coverage, layer height, phytomass (total phytomass, green phytomass, dead phytomass)) the authors assessed actual and rational pasture load. They emphasize that plant cover of the winter pastures surveyed is strongly degraded – projection index of the communities is decreased (1.7 as much as on average) as well as their height (1.9 as much as on average). The total phytomass resource is also reduced (3.1 as much as on average). The authors conclude that the degradation is caused by overload of the pastures. Based on the phytomass indices they evaluate the actual load to be 23 as high as rational load (a copy of the original paper is attached).

Arid open forest type pastures

This type of pastures is mainly represented by various communities of the *Pistacia mutica* formation (the most widespread are the above mentioned communities). The nutritional value of this type of pastures depends on the herbaceous cover between pistachio-trees. These pastures are characterized by presence of plants of the semi-desert (desert) type, on the one hand, and plants of the dry steppe, on the other.

Steppe type pastures

This type of pastures pertains to the group of transitional pastures. It is mainly represented by *Botriochloa ischaemum* communities. As in the semi-desert (desert) type pastures, here the main food for sheep is ephemeral-ephemeroid plants; however, in contrast to the former type, the proportion of this group of plants is decreased in the latter type. In parallel, proportions of grasses and perennial forbs are increased. Of the perennial grasses steppe dominant (edificatory plants) are first of all worth mentioning: *Bothriochloa ischaemum*, *Stipa lessingiana*, *S. capillata*, *Festuca valesiaca*; also important are *Cleistogenes bulgarica*, *Phleum phleoides*, *Dactylis glomerata*, *Koeleria cristata*; of the perennial forbs *Onobrychis kachetica, O. radiata*, *Tragopogon* spp.; and of sedges *Carex bordzilovsky*.

As reported by Kakulia (1952), about 40% of the Shiraki-Eldari winter pastures are represented by Botriochloeta ischaemum. Agricultural value of this pasture varies by seasons. Botriochloeta ischaemum has high agricultural value in the second half of summer. In May the Botriochloa ischaemum produces 10.5 centners of green mass per 1 ha. Before summer drought the yield increases. In spring nutritional value of the green mass is good. In May its chemical composition is as follows: Proteins – 11.87%, nitrogen – 1.89%, fat – 3.82%, ash – 11.32%, cellulose – 31.7%, nitrogen-

free extract – 41.34%. As reported by these authors, by winter time Botriochloeta ischaemum produces 23 centners of phytomass on average per 1 ha.

Shiblyak-type scrub is also a transitional pasture. It contains the same grasses and forbs as steppe.

As reported by Kavrishvili (1965), average dry mass yield of the winter pastures is 14 centners/ha, of which about 50% is edible for sheep. According to this author, it means that the mass acquired as food by sheep is 6.9 centners per 1 ha, which equals to about 2.6 centners of nutritional units. The author mentions that average daily demand of one grazing sheep is 0.86 kg nutritional units and concludes that in case of 207-day grazing (from 15 October to 10 May), the winter pasture load must be on average 1.5 sheep per 1 ha. Taking into account the recent scale of winter pasture use and consequent plant cover degradation process, it is supposed that the allowable load must be much less on these pastures.

According to Sokhadze and Khachidze (unpublishes data), in 1941-1942, the load permitted for the semi-desert (desert) type pastures of the Eldari lowland was max. 2 sheep per 1 ha. In the 1970s 4-5 sheep hibernated on 1 ha on these pastures.

As reported by Lachashvili (1989), by the end of the 1980s 6-8 (sometimes more) sheep/ha hibernated on the Eldari lowland.

Because of overload on the pastures, the following weeds are widespread there: *Carduus albidus*, *Carduus arabicus*, *Carthamus lanatus*, *Sisymbrium loeselii*, *Hirscfeldia incana*, *Xeranthemum squarrosum*, *Silybum marianum*, *Eryngium biebersteinii*, *Eryngium caerulea*, *Centaurea solstitialis*, *Daucus carota*, *Centaurea iberica*, Artemisia scoparia, etc.

Below is a list of fodder plant species recorded on the study area (not taking into account their nutritional value). The nomenclature mainly follows Gagnidze (2005). The names are listed in alphabetic order.

1. *Aegilops* spp.
2. *Aellenia glauca*
3. *Aelurupus littoralis*
4. *Agropyron pectinatum*
5. *Alhagi pseudalhagi*
6. *Allium rubellum*
7. *Alopecurus myosuroides*
8. *Arundo donax*
9. *Artemisia lerchiana*
10. *Astragalus asterias*
11. *Astragalus striatellus*
12. *Atraphaxis spinosa*
13. *Bothriochloa ischaemum*
14. *Briza elatior*
15. *Bromus japonicus*
16. *Camphorosma monspeliaca*
17. *Caragana grandiflora*
18. *Carex schukuhrii*
19. *Catabros$_{\partial}$ lla humilis*
20. *Cleistogenes bulgarica*
21. *Crocus adamii*
22. *Cynodon dactylon*
23. *Dactylis glomerata*
24. *Elytrigia repens*
25. *Eremopyron orientale*
26. *Eremopyron triticeum*
27. *Festuca valesiaca*
28. *Gagea caroli-kochii*
29. *Gagea commutata*
30. *Gamanthus pilosus*
31. *Glycyrrhiza glabra*
32. *Kalidium capsicum*
33. *Kochia prostrata*
34. *Lagonychium farctum*
35. *Lathyrus aphaca*
36. *Lepidium vesicarium*
37. *Lolium rigidum*
38. *Medicago coerulea*
39. *Medicago minima*
40. *Medicago orbicularis*
41. *Medicago rigidula*

42. *Melilotus officinalis*
43. *Melilotus albus*
44. *Merendera trigina*
45. *Noaeae mucronata*
46. *Onobrychis cyri*
47. *Onobrychis kachetica*
48. *Onobrychis radiata*
49. *Petrosimonia brachiata*
50. *Phragmites australis*
51. *Phleum paniculatum*
52. *Phleum phleoides*
53. *Potentilla recta*
54. *Poterium polygamum*
55. *Reaumuria alternifolia*
56. *Salicornia europaea*
57. *Salsola dendroides*
58. *Salsola ericoides*
59. *Salsola nodulosa*
60. *Seidlitzia florida*
61. *Stachys fruticulosa*
62. *Stipa capillata*
63. *Stipa caspia*
64. *Stipa lessingiana*
65. *Stipa pulcherrima*
66. *Stipa tirsa*
67. *Suaeda dendroides*
68. *Suaeda microphylla*
69. *Suaeda confuse*
70. *Torularia contortuplicata*
71. *Torularia torulosa*
72. *Tragopogon* spp.
73. *Trifolium arvensis*
74. *Trifolium bonannii*
75. *Trifolium campestre*
76. *Trifolium spp.*
77. *Trigonella monspeliaca*
78. *Trigonella orthoceras*
79. *Trigonella spicata*
80. *Tulipa eichleri*
81. *Vicia angustifolia*
82. *Vicia cinerea*
83. *Vicia hirsute*
84. *Vicia pannonica*
85. *Vicia sativa*
86. *Vicia tetrasperma*
87. *Vicia variabilis*

Besides the listed species, the study area must also support other fodder plants but there are no other data in the literature.

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