Protein ratio in *Leymus chinensis* (Trin.) Tzvelev phytomass as a quality index of the forage indicators and growth ecological conditions

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Abstract. *L. chinensis* (Trin.) Tzvelev is a valuable hay and fattening grazing plant. The paper objective is to study *L. chinensis* production and protein ratio in communities growing under different ecological conditions of West Transbaikalia. It was established that the leymus community primary production is 1029–2370 g/m^2 a year; the aboveground phytomass is almost completely formed by *L. chinensis*. The biochemical composition, forage value and protein ratio of the edificator are determined by the growing conditions, and complies with regulatory indicators, in general.

L. chinensis is widely spread in Transbaikalia, Northern Mongolia and Northern China, where it forms almost monospecies communities. It is of great importance as a component of productive pastures and hayfields, used to restore degraded lands and fast disturbed lands. However, it's recently observed changes in *L. chinensis* reproductive functions and productivity [1-5]. This fact stipulates a comprehensive study of the species in different soil-ecological and climatic conditions, including its biochemical composition and nutritional value. Leymus meadows are widespread in West Transbaikalia throughout the mid and lower Selenga River basin, especially in the Uda, Ona, Kodun, Dzhida River valleys. They grow on riverbed ridges, central floodplain elevated sections, terrace zones, talus trains, as well as in gentle slope lower parts. Humidification is atmospheric, mostly. However, the degree of studying the leymus community composition and structure is low, their research was carried out in the 1970–90s [6], i.e. before the period of climate aridization. The characteristics of the species composition and productivity are given to compare the indicator changes currently.

In 2018, the investigations were carried on in Ivolga (populations: Gurul'ba, Khubiskhal, Komsomol'skoye), Selenga (populations: Shchuchka, Arbuzovo) and Kabansk (population Kabanskaya) districts of the Republic of Buryatia. The study objects were leymus communities growing on different soils of the meadow steppe and steppe floodplain meadows and haloxerophytic steppe (Table 1).

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Table 1. *Leymus chinensis* communities of West Transbaikalia

No of description., community, soil. Population	Geographical coordinates	Total projective coverage, %	Leymus projective cover, %	Species number	Co-dominants
Ivolga steppe					
1. *L.chinensis*, alluvial dark humus soil. Gurul'ba	N 51.81344° E 107.38135° h – 514,0 м	65	58	10	-
4. *L. chinensis*, dark salt marsh. Khubiskhal	N 51.76877° E 107.37521° h – 503,3 м	85	65	13	-
13. *Carex duriuscula* + *L. chinensis*, layered alluvial humic soil. Komsomol'skaya	N 51.82847° E 107.55963° h – 491,0 м	75	47	9	*Carex duriuscula*
Selenga steppe					
10. Forb-*L. chinensis*, light humic lithosol. Shchuchka	N 51.41169° E 106.56108° h – 650,0 м	50	10	14	*Carex duriuscula, Potentilla acaulis, Artemisia frigida Veronica incana*
11. *Carex duriuscula* + *L. chinensis*, meadow chestnut soil. Arbuzovo	N 51.33872° E 106.61755° h – 642,4 м	75	40	14	*Carex duriuscula, Achnatherum splendens, Leymus littoralis, Leymus buriaticus*
Kabansk forest-steppe					
12. Forb-*L. chinensis*, alluvial light humus soil. Kabanskaya	N 52.11628° E 106.55603° h – 455,6 м	55	25	15	*Berteroa incana,Leymus buriaticus, Carex duriuscula, Potentilla bifurca, Papaver nudicaule*

Key sites were situated in the dry-steppe (descriptions 1, 4, 13; 10, 11), and forest-steppe (description 12) zones differ in temperature and humidity parameters. Due to climate aridization, precipitation has decreased and its distribution has changed compared with the long-term average values, especially in the forest-steppe zone; dry vegetation periods have become more frequent. The climate aridity has strengthened since 2000 to nowadays: less rainfall and their distribution change over the growing season compared to long-term data. For example, evaporation during the growing season (May-September) in 1990-2000 was 110 mm, in 2000-2010 – 117 mm; Ivanov moisture coefficient – 0.44 and 0.33 respectively; de Marton aridity index – 27.1 and 23.2; the Ivanov's biological climate efficiency factor – 777 and 668.

The botanical composition of leymus communities in West Transbaikalia is represented by 51 species, 20 families, and 40 genera. Three leading families (*Poaceae*, *Asteraceae, Rosaceae*) are identified by the species number entering them, which cover 56.8% of the species total amount and reflect the complex of the steppe soil and climatic conditions. The species number varies in communities from 9 to 15. The leymus community total projective cover changes in fames of 55-85%, the edificator cover is from 10 to 65%.

The species composition of leymus communities is represented mainly by the steppe complex with different xerophytic species of the Asian range. The biomorph main share falls on rhizome species, a portion of annual plants is significant as well. The similarity

species composition of leymus communities is in the weak-middle interval, it's conditioned by the great participation of single-species families and genera.

The grassy ecosystem production is determined and limited by many factors: species composition, moisture regime, nutrient provision, and growing season duration. The leymus community primary production has been estimated according to R. Whittaker [7] as normal (Table 2). The latter assessment is the most objective for leymus communities in West Transbaikalia.

Table 2. Phytomass production of leymus communities, g/m^2 a year (above the line - communities, below - L. chinensis aboveground phytomass)

Number of description., community, soil	Primary production			Aboveground / Underground
	aboveground	underground	total	
Uda steppe				
24. Forb-*L. chinensis*, alluvial sod layered soil	117±9 / 105±4	1755±88	1872	1:15
Ivolga steppe				
1. *L. chinensis*, alluvial dark humus soil	117±9 / 116±9	1178±93	1295	1:10
4. *L. chinensis*, dark salt marsh	145±13 / 144±13	2050±399	2195	1:14
13. *Carex duriuscula* + *L. chinensis*, alluvial layered humic soil	93±9 / 93±9	2277±80	2370	1:24
Selenga steppe				
10. Forb-*L. chinensis*, light humus lithosol	107±20 / 49±4	2035±215	2142	1:19
11. *Carex duriuscula* + *L. chinensis*, meadow chestnut soil	123±15 / 122±21	1691±387	1814	1:14
21. *Iris*-*L. chinensis*, dark salt marsh	130±8 / 66±4	1693±101	1823	1:13
Kabansk forest-steppe				
12. Forb-*L. chinensis*, alluvial light humus soil	67±3 / 60±4	962±119	1029	1:14

The aboveground phytomass part is 3.9-9.0% of the total primary productivity. The underground phytomass is accumulated in 0-10 cm soil layer (80.4-92.7%). This indicator variation is determined by soil and ecological conditions including different projective covering and various biomorphs of species forming the community. The primary production of leymus communities is 92.8-99.1% of the total phytomass reserves. A different ratio of the aboveground and underground phytomass characterizes the diversity of species and biomorphic compositions, the grass stand density, as well as the level of external factor effect (grazing, recreation).

The *L. chinensis* edificator almost completely forms the community aboveground production, except for the forb-*L. chinensis* community (description 10), where its share is 45.6%. It's due to environmental conditions (the Shchuch'e Lake shore), which increase humidity of air surficial layers, and contribute to other species development. It was previously noted [8], the leymus community aboveground production averaged 124 g/m^2 (81-158) in the 1970s, before aridization. Currently, this value has slightly decreased, 117 g/m^2 (93–145). The difference in the maximum and minimum aboveground phytomass between communities is 2.2 times.

The biochemical composition and forage value of *L. chinensis* depended on soil and ecological conditions of growth (Table 3). For example, in dark salt marsh, *L. chinensis* (description 4) was characterized by a low content of almost all indicators compared with

other communities on the non-saline soils of the Ivolga and Selenga steppes. The same is character is observed for *L. chinensis* growing in the Kabansk forest-steppe. However, the factors causing low indicators of fodder value are related to increased precipitation and soil moisture compared to steppe conditions.

It should be noted a higher content of crude protein and crude fat in leymus dry matter in comparison with their amounts before aridization, 7.02–10.8% and 1.31–1.96%, respectively [8]. Perhaps, it is related to this species adaptation to long-term aridization, which causes its vegetative propagation due to decrease of a generative one, i.e. high nutrient reserves determine the energy of vegetative growth and reproduction. These reasons affect the protein ratio, which is an indicator of the nutrient digestibility. There is a gradation of the protein ratio: if its value is <1:6 it's narrow; 1:6-8 – medium; > 1:8 - wide. Growing animals better digest food and absorb nutrients at a narrow protein ratio, adults – at normal one (1:8-10). The forage digestibility is deteriorating under a wider ratio. According to the median of nutrient biochemical compound content and protein ratios, *L. chinensis* phytomass in West Transbaikalia corresponds mainly to high-quality food standards, except for *L. chinensis* growing in haloxeromorphic steppe communities, and the iris-leymus community on dark salt marsh.

Table 3. Protein ratio and digestible nutrient content in the *L. chinensis* phytomass

No. of description, community	Crude protein	Crude fiber	Crude fat	NES	Protein ratio
	%				
Ivolga steppe					
1. *L. chinensis*	12.21	20.18	2.95	31.04	1:4.7*
4. *L. chinensis*	8.83	21.83	2.52	32.27	1:6.8**
13. *Carex duriuscula* + *L. chinensis*	16.,1	16.12	3.32	29.68	1:3.3*
Selenga steppe					
10. Forb-*L. chinensis*	12.21	18.22	2.19	33.25	1:4.6*
11. *Carex duriuscula* + *L. chinensis*	10.46	22.88	1.98	30.71	1:5.5*
Kabansk forest-steppe					
12. Forb-*L. chinensis*	7.66	21.77	2.45	35.33	1:8.2***

Note: * - narrow, ** - medium, *** - wide; NES - non-nitrogen extractive substances

Thus, the leymus community primary production is 1029–2370 g/m^2 a year; the aboveground phytomass is formed almost completely by *L. chinensis*. The edificator biochemical composition, forage value and protein ratio are determined by growing conditions, but, in general, comply with regulatory indicators.

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