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High Mountain Meadows Mesofauna for Pastures Rehabilitation

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Abstract. **The aims of this work are to study a quantitative parity of dominant soil inhabitants in High-Mountainous pastures of the South Caucasus and to define inhabitants' roles in decomposition of plants. Species composition, horizontal and vertical distributions, seasonal dynamics were defined in soil layers by standard methods used in soil zoology. A role of soil invertebrate-saprophages was shown in plant litter destruction processes, in enhancement of biological cycle of high mountain ecosystems and in maintenance of soil natural fertility. Furthermore, the work presents a study of trophic structures and estimation of saprophages role in soil biota. The basic groups of high mountain meadows invertebrate-saprohages (millipedes, earthworms, caterpillars) were determined. The results showed that in trophic structures of animals' population soil saprophages made up 50-80 % and the basic stream of energy was directed through detrital food chains in a soil cycle.**

Key words: ***soil mesofauna, saprophages, ecosystem, trophic structures, high-mountainous pastures, moisture.***

1 INTRODUCTION

At present under the assumption of ecological changes caused by global warming and human impact, the study of high mountain ecosystems is one of the most actual scientific problems. As livestock farming is the main agricultural branch in high mountain regions of Georgia, the determination of optimal balance among livestock production and grazing impact on animal diversity is important for the development of sustainable grazing systems [7]. A significant area of high mountain regions of Eastern Georgia is used as pastures and adjacent areas are occupied with technical agricultures (potato, cereal crops). Plant litter decomposition rate, soil structure and formation of humus horizon greatly depend on vital activity of soil mesofauna.

For biogeocenological researches ecosystems of relatively simple structures are the most convenient and less studied. Such are high mountain regions where ecosystems of simple structures are formed in relatively small areas with rather severe conditions for living organisms.

The activity of soil inhabitants determines the rate of plant residues' destruction, their mineralization and accordingly the rates of organic compounds' turnover. A character of plant litter destruction, its structure and humus horizon formation are entirely dependent on the activity of representatives of soil micro- and mesofauna (millipedes, wood lice, earthworms, caterpillars, dipterans' worms, etc.). Structure of animal population in agrocenoses should be defined by edaphic factors related both to history of soil development and to recent biodynamics, as well. Taxonomic composition of macrofauna in different soil types in ecotones is formed on the basis of zonal elements, partly retained in field agrocenoses. Soil inhabitants serve as bioindicators for soil treatment. Characteristic features of animal populations within their geographical ranges are preserved in soil. In parcels of soils isolated from their main areas characteristic structure of animal population is destroyed and becomes similar to that in ambient soil types. Edaphic factor affects the diversity of soil animal population in agricultural lands and perennial one-crop systems [6].

In soil zoology investigations of soil invertebrates' metabolism and productivity are connected with a quantitative estimation of soil saprophages' role in the humification and mineralization processes of leaf litter. Metabolic activity of soil saprophages should be estimated by a quantity of applied food and by chemical and mechanical properties of litter [4] and also depends on physiological state of animals. Soil zoologists began to study a quantitative amount of saprophages metabolism, taking into account the influence of environmental factors on the speed of metabolic processes, physiological condition of animals during their activities and the life cycle.

Quantitative determination of consumed food calories and participation of soil saprophages in energy transformation of plant remains through detritus food chain allows to follow up the dynamics of energy transmission of applied organic substances and reveal

quantitative parameters of soil invertebrates' participation in transmission of energy through this chain.

Soil invertebrates appear as bio- indicators of soil state. We consider that the study of mesofauna structure of high mountain soils and estimation of their role in trophic chain should become the most effective methods of ecological monitoring of these ecosystems types. Their role is significant in mixing of various soil layers, in increasing water flow and aeration, in improvement of its physical and chemical characteristics, in enrichment of organic matters with products of the vital activity. Representatives of mesofauna also play an important role of saprophage-humificators and take an active part in bringing organic compounds of plant litter into deep layers of soil and in enrichment of soil mineral horizon which leads to deepen its profile and formation. Invertebrate-saprophages release the energy and nutrient elements that are accumulated by green plants. Saprophytic complex of soil inhabitants is the basic group whose action determines the rate of biological cycle and the level of the primary productivity and what is more essential :they may be used for soil diagnostics as sensitive indicators of soil regime.

The aims of this work are to study a quantitative parity of dominant soil inhabitants in High-Mountainous pastures of the South Caucasus and to define their roles in decomposition of plants. For these researches we have planned the following tasks:

►To study specific composition of soil inhabitants of high mountain meadows.

►To study invertebrate-saprophages distribution in soil.

►To study trophic structure of complexes of mesofauna.

II. MATERIAL AND METHODS

Standard methods applied in soil zoology [1] were used to study species composition of soil inhabitants of high mountain meadows, their distribution and trophic structure. A complex research of high-mountainous ecosystems and components, their vital activities were investigated in Eastern Georgian High Mountainous pastures. Traps were used for gathering of soil invertebrates.

Research material was gathered in three plots: two from uplands (hills) (1650 м above sea level) and the third (II) one in depression (1620 м above sea level). The distance between plots was 1-1,5 km.The territory represented a pasture with an intensive sheep graze. A registration of large invertebrates was carried on with a standard digging up method and with the follow-up manual soil sift [1]. A probe size was 50x50 cm.

Registration of each plot was carried on in the following terms: June, October, May and July. The depth of the soil was up to 50cm. The amount and biomass of invertebrates were calculated in all layers. Biomass identification was estimated by the weight of a fixed individual (70˚spiritus-fixation). During the manual soil sifting procedures the following groups of mesofauna: earth warms, millipedes, insects and mollusks were detected.

Dominant groups and a number of mesofauna's basic representatives are given in Table 1.

TABLE 1. DOMINANT GROUPS & QUANTITIVE MESOFAUNA (Tsalka Region)

Dominant groups	**Experimental plots**		
	I Hill	***II Depression***	***III Hill***
Lumbricidae	344	219	266
Myriopoda	188	5	429
Insecta	155	103	153
Total	687	327	848

Only one species of *Helicidae – Euompalia selecta (Kliku)* was found among the mollusks.

Saprophages were contained in glass vessels of 500 cm^3 in laboratory conditions. Experiments to determine feeding activity readings for each species of soil inhabitant invertebrates were carried out in vitro at temperature +20˚C, for 10-20 times within 4-6 days. We tried to keep a constant humidity (about 75%). Both root and leaf residues were used as food.

Within the experimental period saprophages were kept separately in Petri cups.

III. RESULTS

Steppe species *N. jassyensis* turned to be dominant species similar to species of all other South Georgian Plateau regions. But in depression plots *N. jassyensis* are not found.

A large amount of moister-loving species - *Dendrobaena alpina, D. veneta* and *D. schemachaensis* [2] were found in these regions.

In soil probes the following six orders and eleven families were discovered: *Cicadidae (Homoptera), Forficulidae (Dermaptera), Carabidae, Scarabaeidae, Elateridae, Tenebrionidae, Byrrhidae, Curculionidae (Coleoptera), Geometridae (Lepidoptera), Tentheridinidae, Formicidae (Hymenoptera), Asilidae, Muscidae (Diptera).*

Table 1 clearly shows a leading position of earthworms both in ennobled and depression plots. But it should be noted that in depression a number of mesofauna representatives was several times less in comparison with raised sites. In our opinion the reduced number was caused by higher humidity of soils that was proved by presence of hygrophilous kinds of mesofauna, such as earthworms *Dendrobaena veneta, D. schemachaensis, D. alpina* and by complete absence of steppe kind *Nicodrilus jassyensis* on the site.

IV. DISCUSSION

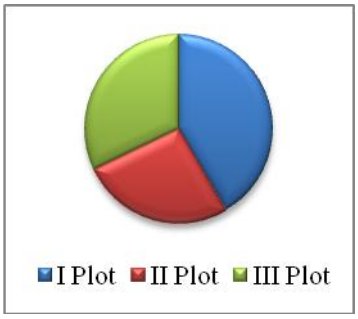
The estimation of high mountain meadows' primary productivity requires a complex investigation of all components of the ecosystems and their interactions.

Moreover, soil invertebrates directly affect plant productivity.

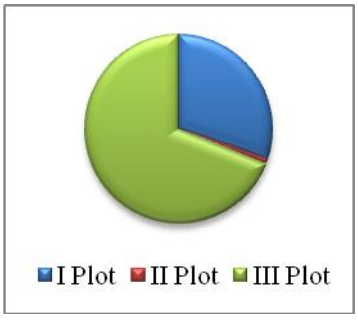
Soil mesofauna structure stability greatly depends on pasture loading. An excessive overloading of pastures often leads to unrecoverable results which can be revealed with tamping and packing of soil and destruction of plant cover. All these events cause withdrawal of important species actively involved in soil forming processes from faunistic complex.

The comparison of basic mesofauna groups' quantity in the investigated plots is resulted in Figure 1.

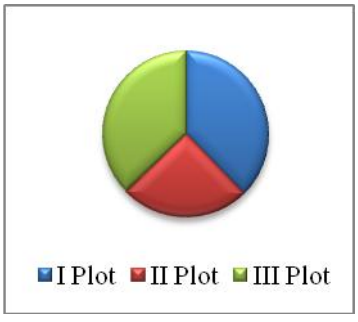
In the third plot with the highest population of invertebrates, millipedes made 50.6 % from an aggregate number. The second place in abundance held earthworms – 31.4 % and insects- only 18 %. In the first plot the quantity of earthworms contained 50 %, but their absolute quantity was 1.5 times more in comparison with the third plot.



Earth worms



Millipedes



Insects

Figure 1: Quantitative distribution of main soil inhabitants

The second plot was the least occupied and differed with sharp domination of earthworms. Larvae of bugs were mostly found in soil that contained 80% of a mesofauna aggregate number. In depression the general amount of insects' larvae was lower than in raised plots as the population of soil invertebrates was mainly presented with the steppe xerophilous forms requiring much more heat for their development and naturally well-warmed soils. Ground beetles prevailed among adult beetles, also weavers and lamellicorn beetles just being burst from pupae. The researched plots differed slightly from each other due to their group and species insect sampling. A level of soil maggot amount was similar.

Depth of mesofauna representatives occurrence was 50 cm in all three plots. The most populated were the top horizons of soil, in particular up to 30 cm. There were only individual species of weevils larvae and lamellicorns that lay deeper.

General distribution of main soil inhabitants biomass on the experimental plots is presented in Table 2.

TABLE II. DOMINANT GROUPS BIOMASS OF MESOFAUNA (Tsalka Region)

Dominant groups	**Experimental plots (g/m^2)**		
	I	II	III
Lumbricidae	555.5	383.9	425.0
Myriopoda	262.7	31.0	1193.7
Insecta	103.6	162.0	168.5
Mollusca	2.85	1.5	42.0
Total	924.65	678.3	1829.2

High indices of invertebrates biomass in the third plot differed. The basic part of animals' biomass consisted of the diplopods dominated in quantities. Their biomass exceeded to 65%, whereas the biomass of earthworms made up 23% of the general biomass of invertebrates and insects - 9%. The third plot differed in biomass shells which reached 42 g/m^2 (2.5 % from the general biomass of invertebrates).

In the first plot biomass of saprophages was twice lower than in the third one. The dominant place was ranked by earth worms whose biomass was equal to 60%. Biomass of centipedes was four times less than in the third plot and was equal to 28,4%, as for the insects - they were equal to 11 % of the whole amount of invertebrates.

In the second plot biomass of earth worms dominated (66%), but the absolute indications of their biomass was less than in the first and the third plots. Biomass of insects was the same in the third plot and was equal to 28% of the whole amount of soil animals of the second plot.

The estimation data of soil invertebrates biomass according to soil horizons are shown in Figure 2. The upper soil horizon (0-10 cm) differs where the whole biomass is consentrated.

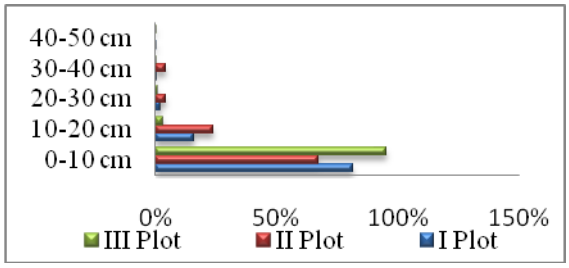


Figure 2: Vertical distribution of main soil mesofauna groups on experimental polts

Seasonal dynamics of quantities of millipedes *Anuroleptophyllum caucasicum* is shown in all plots on Figure 3. Sharp fluctuations of the saprophages amount are clearly observed in the drawings. In the second plot during the summer there was a mass destruction of millipedes that was caused by an abundance of precipitations in the form of hailstones and low temperatures. Thus, in autumn their number was practically leveled to zero in the second plot. In May in all three plots the percentage parity was almost identical and fluctuated from 12 to 17 %.

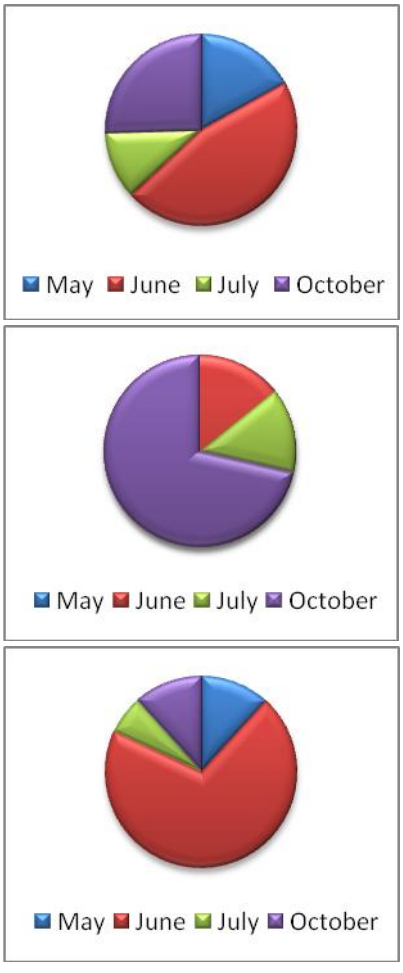


Figure 3: Seasonal dynamic of quantities of *Anuroleptophyllum caucasicum* ind./m^2

It is necessary to take into account considerable seasonal fluctuations in destruction processes of plant remains providing a quantitative estimation of sarcophages' activities. Similar sharp fluctuations of a given species number were also noted by other scientists-researchers, namely in Lesser Caucasus in Alpine short grassy meadows of Azerbaijan [3, 5].

Some data of biomass indicators have showed that the third plot also differed from other plots. Almost 18% of millipedes' biomass was concentrated there that was observed during gatherings in June. General biomass of basic groups from the third plot mesofauna prevailed two and three times over other plots. The basic part of biomass consisted of millipedes that prevailed in number in this plot. Both in number and in animals' biomass the top horizon of soil definitely differed.

The amount of saprophages obviously prevailed in trophic structures of these ecosystems. Earthworms and millipedes were active destroyers of plant remains. Naturally, in meadow soils the basic food resources for these saprophages were the remains of roots and for millipedes – decayed parts of plants. Among larvae there were also representatives of saprophytic complex, namely – larvae of lamellicorn bugs. In investigated pasturable plots there was a considerable quantity of dung beetles. Numerous amounts of bugs were discovered in the first and second plots.

Phytophages groups in meadow soils of observable area were represented by dominating genera of weevil's larvae *Adelognatha* and *Phanerognatha*, darkling beetles - *Cylinndritonus brevicolis*, carabid beetles - *Carabus maurus, C. adamsi*, and larvae elaterids - *Selatosomus latus, Agriotes obscures*, etc.

Predators' complex was represented by genera *Clivina, Carabus, Notiophilus*, etc., and also larvae dipterans. The quantity of saprophages in all three plots made more than 80% from total mesofauna.

V. CONCLUSIONS

The research conducted by us showed that the level of population of soil invertebrates differed almost 10 times (55-850 ind./ м^2) in a subalpine belt short grass meadow of the Lesser Caucasus. Cardinal distinctions quantity of soil mesofauna depended also on a mesorelief feature within one plot.

Millipedes, wood lice and earthworms were the dominating groups among animal population of meadow ecosystems. In trophic structure of soil inhabitants saprophages made 50-80%. It allowed concluding that the basic stream of energy in a soil cycle was directed through detrital food chains.

In the subalpine meadows the mesofauna great bulk was concentrated in a top soil horizon (0-30 cm) and in soil surfaces under shelters. The largest number of saprophages at the edge of stony taluses was higher that was proved by the rules of ecotone [8] effect. The tendency of soil saprophages to dwell on a soil surface at big heights was defined and the basic limiting factor was the lack of heat, increasing with a height.

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REFERENCES

[1] M.S. Ghilarov, " Accounting of large invertebrates (mesofauna)", Methods of Study on Soil Zoology, (eds. B.R. Striganova). 1987, pp. 9-26.

[2] E.Sh Kvavadze, "Earthwarms (Lumbricidae) of Mountine Black Earth of Georgia", "Mecniereba", Tbilisi, 1979, pp.143-157.

[3] N.G. Samedov, L.A Bababekova, "Landscape Variations of Mesopopulation Amount and Biomass in Soils of Miner Caucasus Region in Azerbaijan", Pedobiologia, Bd. 6, 1980, pp.387-392.

[4] B. R Striganova, "Feeding of Soil Saprophagues", "Nauka", Moscow, 1980, p. 242(*references*).

[5] B.R Striganova, N. G Loginova, "Role of Millipedes in Biological Turnover in Alpine Medows of Miner Caucasus", Gen. Biology, vol.45, #2, 1984, pp. 196-202

[6] B.R Striganova, "Effect of Edaphic Factor on Formation of Soil Animal Population in agrocenoses", Zool. J. vol. 82, #2, 2003 pp. 178-187

[7] M. F. Wallis De Vries, A. E. Parkinson, J. P.Dulphy, M. Sayer and E. Diana, "Effects of Livestock Breed & Grazing Intensity on Biodiversity and Production in Grazing Systems", 4, Effects on Animal Diversity. Grass and Forage Science, vol.62, Issue 2, 2007, pp. 185-197.

[8] F.E. Clements, "Nature and Structure of Climax" Ecology, vol. 24, 1936, #1, pp. 252-284

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