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# FORMATION OF THE LUPINE NARROW-HAIRED SYMBIOTIC POTENTIAL DEPENDING ON THE CULTIVATION TECHNOLOGY ELEMENTS

**Abstract.** The influence of sowing terms, seed sowing norms and fertilization on the process of tuber bacteria formation on the root system of lupine plants is analyzed. The dynamics of lupine symbiotic potential depending on these factors is investigated. As it was found, the number and weight of tubers on this plant was different both in the vegetation phases and on sites fertilized and non-fertilized by mineral fertilizers. The most favorable conditions for the formation of the symbiotic apparatus of lupine are created шт April, with the norm of seeding 1.1 million seeds per 1 hectare, as well as for the application of mineral fertilizers in the norm $P_{60}K_{90}$. The introduction of nitrogen fertilizers in the norma 60 and 90 kg/ha of the active substance had an inhibitory effect on the formation of the symbiotic productivity. Consequently, the most favorable conditions for mineral nutrition for forming the maximum number of tubers, including active ones, during the vegetative period of lupine, are created by adding phosphoric-potassium fertilizers at the rate of $P_{60}K_{90}$ and the administration of two extra-root feedings.

**Keywords**: symbiotic potential, sowing terms, seed sowing norms, total number of tubers, number of active tubers, total symbiotic potential, active symbiotic potential.

## INTRODUCTION

In the conditions of the energy crisis, the high cost of mineral and deficit of organic fertilizers, the decrease in soil fertility is observed, thus, the development and use of crop rotation, agricultural systems with a deficit-free balance for humus and nutrients are highly important today [36]. The listed causes, as well as the deficiency of vegetable protein, cause increased interest in legumes [12; 67]. Unfortunately, they account for only about 3% in the crops structure in Ukraine (with other legume crops - 7-8%), and about 20 - 25% or more in global agriculture [146; 147]. One of the undeservedly forgotten crops, which should occupy a proper place in the agricultural production in our country, is lupine narrow-leaved [9; 25; 37; 38]. It is high-protein, yielding seed and green mass culture, which is unpretentious to the weather conditions [8; 53; 202]. Lupine is considered not only as a high-protein culture for Precarpathian, but also as a factor of energy conservation and agriculture biologization, an inexhaustible, constantly renewable source of organic matter [17; 18; 79; 80].

This crop is poorly developed in the Carpathian region, and there are practically no scientific research devoted to the development of of the technology elements for its cultivation. This became the motivation to study the influence of sowing terms, seed rates and fertilization on the growth and development of plants, their formation of symbiotic activity indicators, crop yields, and quality of lupine seeds.

## MATERIALS AND METHODS

Experiments were carried out on sodskin-podzolic surface-gleyled medium-sandy soils of the feed-production laboratory of the Institute of Agriculture of the Carpathian region (Lishnia, Drohobych district, Lviv region

According to our soil survey, the arable (0-20 cm) layer of soil on the experimental field is characterized by the following agrochemical fertility indices:

1) humus content of (by Tyurin) – 2.2%. The supply is low;
2) hydrolytic acidity (by Kappen) – 3.87 – 4.05 mg.equivalent / 100 g of soil;
3) pH of salt – 5,2 (slightly acidic);
4) easilyhydrolyzed nitrogen (by Tyurin) – 35-38 mg / kg of soil. The supply is low;
5) mobile phosphorus (by Kirsanov) – 71 – 112 mg / kg of soil. The supply is low;
6) exchangeable potassium (by Maslova) – 113 – 130 mg / kg of soil. The supply is moderate;
7) the degree of saturation with the bases – 46.7%.

Description of the soil section at the experimental site:

He (0 – 24) – humus-eluvial horizon, gray, loose structure.

$E_{(gl)}$ (22 – 44) – eluvial, light gray, dense, lamellar structure. There are iron-manganese nodules in the form of peas and a few roots. The transition to the next horizon is gradual.

$I_{(gl)}$ (44 – 74) – Iluvial horizon of grayish-brown color, heavy loamy with iron-manganese inclusions, strongly condensed, slightly water-permeable. There are only separate walk of worms and roots in it.

$_{P(gl)}$ (160 cm and more) - a soil-forming rock - deluvial loam of brown color, a deep structure, less dense comparing the illuvial horizon.

Schemes of two experiments included the following factors: in an experiment with the study of the of sowing and seeding norms of lupine seedlings – factor A – the sowing time: sowing April 5 (K); sowing April 15; sowing April 30; factor B – sowing norms: 0.7; 0.9 and 1.1 million germinated seeds per 1 hectare in an experiment with fertilizer – Factor A – fertilizer – without fertilizers (K); $P_{60}K_{90}$; $N_{60}R_{60}K_{90}$; $N_{90}P_{60}K_{90}$; Factor B – foliar nutrition by Vauxal Microplate – without feeding (K); one feeding; two feedings.

The experiment replication is four-time, the placement of variants is systematic in two tiers. The accounting area of the experimental plot is 25 $m^2$, the total area is 43.5 $m^2$.

The number and weight of tubers, total and with hemoglobin, the total and active symbiotic potential were determined by the method of G.S.Posypanov [23].

During soybean cultivation on the experimental site, common agrotechnics for this zone were used.

## DISCUSSION

Studying the features of the formation of the lupine symbiotic apparatus, we paid special attention to such indicators as the time of tubers appearance on the plant roots, the appearance of active tubers, their decay, as well as the number and weight of tubers depending on the technological cultivation methods.

Our observations on the formation of the narrow-leaf lupine symbiotic apparatus showed that the seedlings and the norms of mineral fertilizer application significantly affected this process.

At the same time, the fastest tubers appeared for the sowing of narrow-leafed lupine in the early term. After the germination, they appeared on day 7, while for the average seeding time – in about 8 – 9 days, and for sowings in the late term – in 10 days after the germination.

Regarding the influence of the mineral fertilizers norms, the fastest tubers appeared on the experimental variants without the use of mineral fertilizers and on sites containing phosphoric-potassium fertilizers at the rate of $P_{60}K_{90}$ (11 days after the germination). The addition of the

same mineral nitrogen at a dose of 60 and 90 kg / ha against the background of phosphoric-potassium fertilizers $P_{60}K_{90}$ delayed the tubers formation for 3 – 4 days. Accordingly, the tubers appeared about 13 to 14 days after the germination.

The effectiveness of airborne nitrogen absorption by leguminous cultures depends on the activity of tuberous bacteria residing on the roots of plants and which, in turn, are divided into active, slow-acting and inactive. It is known that the tubers become pink during the optimal activity, due to the presence of a pigment leggemoglobin [213]. We have found that for sowing lupine early on the pink color of the tubers appeared already for 6-7 days, for sowing in the middle term - for 5 - 6, and for sowing in the late - 4 days after the appearance of the tubers. The appearance of pink tubers and, respectively, nitrogen fixation was delayed for 5 – 7 days in the experiment with the introduction of mineral fertilizers in the normal $N_{60}P_{60}K_{90}$ and $N_{90}P_{60}K_{90}$ compared to the plots without introducing full mineral fertilizers and with the introduction of $P_{60}K_{90}$.

An important element in controlling the dynamics of the symbiotic apparatus formation in lupine plants is the determination of the number and mass of tubers. We have found that the indices of the number for both common and active tubers on a single lupine plant varied depending on the phase of growth and development, sowing dates, seed sowing norms, mineral fertilizer norms, and extracorporeal feeding by Wuxal Microplanter. In particular, the highest number of common and active tubers during the growing season was formed on plants of early sowing date (Table. 1).

*Table 1*

**Dynamics of the number of lupine tubers depending on the vegetation phase, sowing times and seed sowing norms, pc./ plant**

| Period of sowing Factor A | Seed sowing norm, million pcs / ha Factor B | Vegetation phases | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | branching | | anthesis | | beginning of seeds filling | | physiological ripeness | |
| | | total | active | total | active | total | active | total | active |
| April 5 | 0.7 (K) | 18.4 | 9.2 | 34.8 | 17.1 | 40.5 | 20.4 | 37.0 | 18.1 |
| | 0.9 | 20.3 | 10.1 | 36.1 | 18.8 | 41.4 | 22.2 | 38.8 | 19.6 |
| | 1.1 | 22.4 | 12.1 | 38.1 | 20.4 | 46.4 | 23.4 | 43.1 | 21.1 |
| Average for the period | | 20.4 | 10.5 | 36.3 | 18.7 | 42.7 | 22.0 | 39.6 | 19.6 |
| April 15 | 0.7 | 16.4 | 7.6 | 29.1 | 15.0 | 33.4 | 17.4 | 31.0 | 14.9 |
| | 0.9 | 17.3 | 8.6 | 31.3 | 16.5 | 35.3 | 19.2 | 33.5 | 16.6 |
| | 1.1 | 18.7 | 9.8 | 32.9 | 17.9 | 37.5 | 21.0 | 35.3 | 18.0 |
| Average for the period | | 17.5 | 8.6 | 31.1 | 16.5 | 35.4 | 19.2 | 33.3 | 16.5 |
| April 30 | 0.7 | 12.8 | 6.6 | 25.9 | 13.0 | 30.5 | 15.6 | 26.3 | 13.4 |
| | 0.9 | 14.5 | 6.8 | 27.6 | 14.8 | 31.7 | 16.5 | 29.2 | 15.4 |
| | 1.1 | 15.5 | 8.0 | 28.4 | 15.7 | 34.9 | 18.2 | 30.6 | 16.4 |
| Average for the period | | 18.5 | 7.1 | 27.3 | 14.5 | 32.4 | 16.7 | 28.7 | 15.1 |
| $LSD_{05}$, pcs./plant A | | 1.81 | 0.44 | 1.26 | 0.64 | 0.92 | 0.62 | 0.99 | 0.58 |
| B | | 1.81 | 0.44 | 1.26 | 0.64 | 0.92 | 0.62 | 0.99 | 0.58 |
| AB | | 3.14 | 0.76 | 2.19 | 1.10 | 1.59 | 1.07 | 1.72 | 1.01 |

These rates were significantly lower for sowing lupine in the middle, and especially in the late period. Thus, the total number of tubers in the early stage of sowing in the branching phase was 18.4 - 22.4 pcs. per plant, including active ones - 9.2 - 12.1 pcs. per plant; for the average, respectively, 16.4 - 18.7 and 7.6 - 9.8 pcs. / plant, and in the late stage - 12.8 - 15.5 and 6.6 - 8.0 pcs / plant, respectively. A tendency to increase the total number of tubers and their active part with an increase in the seed rate from 0.7 to 0.9 and 1.1 million pcs./ha was also admitted. Thus,

the largest total number and the number of active tubers formed during the sowing of lupine narrow-leafed in the early period was with a seeding rate of 1.1 million pcs./ha.

Accumulation of both common and active tubers on the root system of lupine narrow-leaved plants continues in the flowering phase and reaches a maximum in the phase of the seeds filling. The number of tubers had high absolute values, and only slightly decreased in the phase of seeds physiological maturity. Thus, the number of common tubers in the phase of seeding was 40.5 in control, and 37.0 units per plant in the phase of physiological maturation; the number of active tubers was respectively 20.4 and 18.1 pc / plant. The noted tendency was seen in all versions of the experiment, regardless of sowing period and sowing norm (Fig. 1).

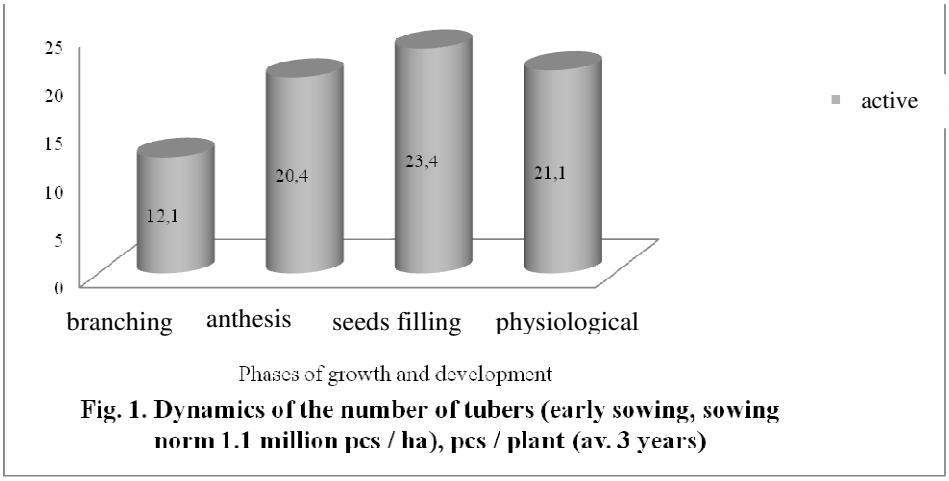


**Fig. 1. Dynamics of the number of tubers (early sowing, sowing norm 1.1 million pcs / ha), pcs / plant (av. 3 years)**

A similar tendency in the formation of total and active tubers in different phases of growth and development lupine plants was observed in the experiment with the study of different mineral fertilizers norms and root-end fertilization with Wuxal Microplanter. Maximum number of tubers: 33.5 total, including 22.4 active / plant, were formed in the phase of beginning seeds filling adding phosphoric-potassium fertilizers with the norm $P_{60}K_{90}$ in combination with two non-root fertilization with Wuxal Microplant. In the phase of physiological maturation, these indices were 30.0 total and 19.6 active / plant respectively (Table. 2; Fig. 2).

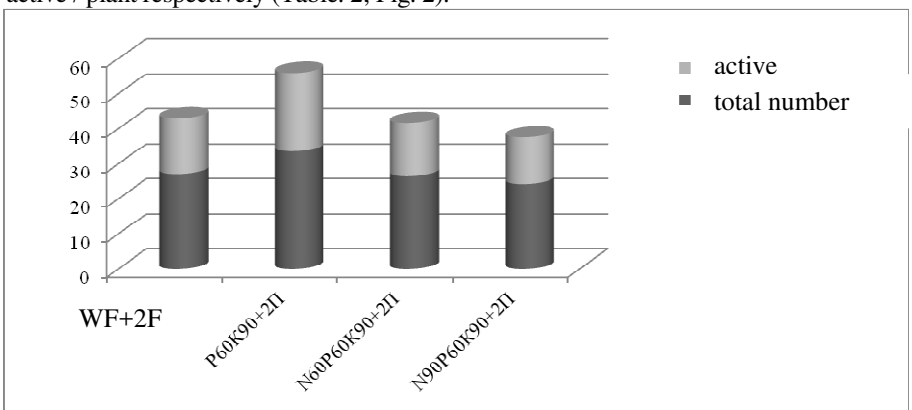


**Fig. 5.2. Number of tubers dynamics depending on the fertilization (seeds filling phase), pcs / plant (2009-2011)**

Our research also showed that the introduction of medium (60 kg / ha) and high (90 kg / ha) norms of mineral nitrogen slows the development of tubers from 26.2 and 26.2 units / plant to 23.1 and 21.6 in lupine plants. This is due to the inhibitory effect of the latter on the formation of a symbiotic apparatus in lupine plants

Indigenous nutrition by Wuxal Microplanet positively influenced the dynamics of the formation for the total number of tubers and including active in lupine plantsat various levels of mineral nutrition, including nitrogen. This, in our opinion, can be explained by the activation of physiological and biochemical processes in plants, which contributes to the increase in the assimilating substances flow to the symbiotic apparatus. Consequently, the most favorable mineral nutrition conditions for forming the maximum number of tubers, including active ones, during the vegetative period of the lupine, are created by adding phosphoric-potassium fertilizers $P_{60}K_{90}$ and conducting two extra-root infusions.

The dynamics of the tubers mass accumulation oper plant, depending on the effect of sowing, sowing dates and fertilization, was similar to the dynamics of their formation. The largest total tubers mass was 1.31 and the mass of active was 1.00 g / plant, was formed in the phase of seeds filling for early seeding with a seed rate of 1.1 million pcs. per hectare (Table. 3).

*Table 3*

**The dynamics of the lupine tubers mass depending on the sowing period and seeding norms, g / plant (average for 3 years)**

| Sowing period, factor A | Sowing norm, million pcs./ha Factor B | Vegetation phases | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | branching | | anthesis | | beginning of seeds filling | | physiological ripeness | |
| | | total | active | total | active | total | active | total | active |
| April 5 | 0.7 (K) | 0.55 | 0.22 | 1.13 | 0.47 | 1.22 | 0.70 | 1.19 | 0.69 |
| | 0.9 | 0.70 | 0.24 | 1.19 | 0.59 | 1.26 | 0.83 | 1.24 | 0.81 |
| | 1.1 | 0.93 | 0.27 | 1.22 | 0.63 | 1.31 | 1.00 | 1.29 | 0.96 |
| Average for the period | | 0.73 | 0.24 | 1.18 | 0.56 | 1.26 | 0.84 | 1.24 | 0.82 |
| April 15 | 0.7 | 0.28 | 0.14 | 1.02 | 0.38 | 1.13 | 0.55 | 1.10 | 0.51 |
| | 0.9 | 0.33 | 0.16 | 1.06 | 0.49 | 1.16 | 0.62 | 1.14 | 0.59 |
| | 1.1 | 0.49 | 0.21 | 1.09 | 0.61 | 1.21 | 0.69 | 1.18 | 0.66 |
| Average for the period | | 0.36 | 0.17 | 1.06 | 0.49 | 1.16 | 0.62 | 1.14 | 0.58 |
| April 30 | 0.7 | 0.20 | 0.12 | 0.77 | 0.29 | 1.10 | 0.42 | 1.08 | 0.40 |
| | 0.9 | 0.25 | 0.13 | 0.96 | 0.33 | 1.13 | 0.51 | 1.10 | 0.49 |
| | 1.1 | 0.35 | 0.16 | 1.04 | 0.42 | 1.16 | 0.60 | 1.14 | 0.57 |
| Average for the period | | 0.26 | 0.14 | 0.92 | 0.35 | 1.13 | 0.51 | 1.10 | 0.48 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $LSD_{05}$, g/plant | A | 0.04 | 0.02 | 0.07 | 0.01 | 0.01 | 0.04 | 0.02 | 0.01 |
| | B | 0.04 | 0.02 | 0.07 | 0.01 | 0.01 | 0.04 | 0.02 | 0.01 |
| | AB | 0.10 | 0.04 | 0.13 | 0.05 | 0.02 | 0.06 | 0.03 | 0.05 |

These indices were higher by 0.09 and 0.3 g / plant compared to control. This was reflected in the formation of the tubers mass per area unit (Annex 3.1 - 3.6). In these variants, the total mass and active tubers mass per 1 hectare was 633.3 and 324.6 kg in the phase of beginning seeds filling, which is 140.0 and 74.6 kg / ha more compared with the control variant.

Regarding the influence of the mineral fertilizers norms, the maximum mass of the total was 1.02 g / plant and active tubers - 0.49 g / plant was also marked in the phase of beginning seeds filling for the variations with phosphoric-potassium fertilizers with the norm of $P_{60}K_{90}$ and the performing two foliar infusions with Wuxal Microplant. A similar trend was observed in the formation of the total and active tubers mass per area unit.

The introduction of medium (60 kg / ha) and elevated (90 kg / ha) norms of mineral nitrogen also reduced the mass of total and active tubers, both in one plant and in area unit. Thus, the smallest mass of tubers - 0.59 g / plant for total and 0.27 g / plant for active was detected in the phase of seeds filling when $N_{90}P_{60}K_{90}$ was added. In the case of the introducing complete mineral fertilizers with the norm $N_{60}P_{60}K_{90}$ these indices were slightly higher and amounted to 0.65 and 0.29 g / plant and 430 and 253 kg / ha. The total and active tubers mass was 0.75 and 0.41 g / plant and 433 and 240 kg / ha in variants without mineral fertilizers. Thus, the introduction of average and high nitrogen fertilizer norms also affects the dynamics of the total and active tubers mass, as well as the dynamics of their number.

Objective indicators for the formation and functioning of the lupine symbiotic apparatus are total and active symbiotic potentials.

According to our research results, lupine plants formed sufficiently high TSP and ASP indices and depended on the sowing periods, seeding norms and mineral nutrition level.

The obtained data showed that the largest total and active symbiotic potential in lupine is formed in terms of early sowing period (April 5) during the period of seed filling – physiological maturation and is 55.5 and 28.7 thousand kg. days / ha. (Table 4).

*Table 4*

**Influence of sowing periods and seed sowing norms on the symbiotic potential dynamics of lupine, ths. rg.d./ha (average for 3 years)**

| Sowing period, factor A | Sowing norm, million pcs./ha Factor B | Interphase periods | | | | | | Per vegetation | |
|---|---|---|---|---|---|---|---|---|---|
| | | branching-anthesis | | anthesis-seeds filling | | seeds filling-physiological maturation | | | |
| | | TSP* | ASP** | TSP | ASP | TSP | ASP | TSP | ASP |
| 5 April | 0.7 (K) | 29.6 | 11.1 | 45.0 | 19.0 | 48.6 | 24.6 | 41.1 | 18.2 |
| | 0.9 | 36.2 | 14.2 | 51.5 | 23.6 | 55.3 | 29.6 | 47.6 | 22.5 |
| | 1.1 | 41.0 | 17.8 | 57.8 | 27.1 | 62.8 | 32.1 | 53.9 | 25.6 |
| Average for the period | | 35.6 | 14.4 | 51.4 | 23.2 | 55.5 | 28.7 | 47.5 | 22.1 |
| April 15 | 0.7 | 25.6 | 9.6 | 39.9 | 15.4 | 43.6 | 19.3 | 36.3 | 14.7 |
| | 0.9 | 31.1 | 12.4 | 45.3 | 18.6 | 49.2 | 21.8 | 41.8 | 17.6 |
| | 1.1 | 35.3 | 15.5 | 51.7 | 23.8 | 57.1 | 28.6 | 48.1 | 22.7 |
| Average for the period | | 30.6 | 12.5 | 45.6 | 19.3 | 50.0 | 23.2 | 42.1 | 18.3 |
| April 30 | 0.7 | 19.5 | 8.1 | 32.8 | 13.8 | 38.2 | 17.2 | 30.5 | 13.0 |
| | 0.9 | 24.7 | 10.6 | 38.6 | 16.1 | 42.4 | 19.4 | 35.3 | 15.4 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1.1 | 28.9 | 13.9 | 43.5 | 20.7 | 48.8 | 24.4 | 40.4 | 19.6 |
| Average for the period | | 24.4 | 10.8 | 38.3 | 16.8 | 43.1 | 20.3 | 35.4 | 16.0 |
| $LSD_{05}$ | A | 1.95 | 0.65 | 2.12 | 1.23 | 2.83 | 1.67 | 1.86 | 1.06 |
| | B | 1.95 | 0.65 | 2.12 | 1.23 | 2.83 | 1.67 | 1.86 | 1.06 |
| | AB | 3.38 | 1.13 | 3.67 | 2.12 | 4.89 | 2.89 | 3.22 | 1.83 |

Note TSP* – total symbiotic potential; ASP** – active symbiotic potential.

There is also a trend, which is manifested in the reduction of TSP and ASP when decreasing the sowing norms. Thus, over the years of research, the TSP and ASP values for vegetation period ranged from 30.5 to 41.1 in variants with a seed rate of 0.7 million pcs./ha and from 13.0 to 18.2, from 35.3 to 47.6 and from 15.4 to 22.5 at 0.9 million pcs / ha; from 40.4 to 53.9 and from 19.6 to 25,6 thousand kg. days / ha at 1.1 million pcs. / ha (depending on the dates of sowing). Thus, the largest values of TSP and ASP figures are formed at the early stage of sowing with the norm of sowing 1.1 million pp./ha, which were 50.4 and 23.0 in 2009, - 59.2 and 28.3 in 2010, and 52,2 and 25,7 thousand kg. days / ha in 2011. TSP and ASP in these variants amounted to 53.9 and 25.6 thousand kg. days / ha on average over the years of research. The aforementioned indicators were greater than the control by 12.8 and 7.4 ths. rg. days / ha, or by 31.1 and 40.6%.

The mineral nutrition level for plants was also influenced by the formation of the total symbiotic and active symbiotic potentials of lupine. It was noted that the highest total symbiotic potential of lupine during the growing season was formed when mineral fertilizers were introduced in the norm $P_{60}K_{90}$. The lowest value for this index was observed with the introduction of mineral fertilizers in the norm $N_{90}P_{60}K_{90}$, which was 30.3 thousand kg. days / ha on average over the years of research. The addition of mineral fertilizers in the normal $N_{60}P_{60}K_{90}$ provided a slightly higher index of 33.3 thousand kg. days / ha. Consequently, the introduction of mineral nitrogen had little inhibitory effect on the formation of a lupine symbiotic potential, which led to obtaining minimal values of the total symbiotic potential.

We also found that the growth of the total symbiotic potential for lupine is ensured by the use of Wuxal Microplant with different norms of mineral fertilizers. It was noted that two fecal feeding on the backgrounds of $N_{60}P_{60}K_{90}$ and $N_{90}P_{60}K_{90}$ provided an increase of this index of 37.6 and 34.4 thousand kg. days / ha. However, the highest value for the total symbiotic potential, which is 41.5 thousand kg day / ha, was formed on the variants where two foliar nutrition was carried out and phosphorus-potassium fertilizers were introduced in the norm of $P_{60}K_{90}$, which is 11.1 thousand kg days / ha more compared to control.

The formation of the active symbiotic potential during the vegetative period for the lupine plant has a similar character as the formation of the general symbiotic potential. In particular, the value for the active symbiotic potential for the period of branching-anthesis was dependent on the introduction of different mineral fertilizers norms in combination with folair feedings from 8.9 to 16.7 thousand kg days / ha, during the period of anthesis-seeds filling – 16,2 – 24,5 thousand kg. days / ha, seeds filling-physiological maturation – 19.1 – 26.5, and 14.7 – 22.6 thousand kg. days / ha on average for the vegetation period respectively.

The most favorable conditions for the formation of the maximum value for the active symbiotic potential were created by applying phosphoric-potassium fertilizers in the normal range of $P_{60}K_{90}$ in conjunction with two non-root crop supplements by Wuxal Microplant. At the same time, the indice of active symbiotic potential was 22.6 thousand kg day / ha, which is 7.4 ths. kg d / ha more in comparison with control variants without the introduction of mineral fertilizers. It is also 4.0; 2.8; 6.4 ths. kg days / ha exceeded the

parameters of the variants, where two non-root nutrition under the background of variants without fertilization was carried out, with the addition of $N_{60}P_{60}K_{90}$ and $N_{90}P_{60}K_{90}$. The addition of $N_{60}P_{60}K_{90}$ and $N_{90}P_{60}K_{90}$ with two non-root nutritions also led to a decrease in these indices.

Consequently, the most favorable conditions for the effective process of symbiotic fixation of atmospheric nitrogen by the tuber bacteria on the roots of the lupine and the formation of the maximum indices for the total and active symbiotic potential are created on early-seeding variants with a seed norm 1.1 million pcs per hectare, as well as due to the introduction of phosphoric-potassium fertilizers in the norm of $P_{60}K_{90}$ and the use of two extra-root infusions of Wuxal Microplant. The introduction of medium ($N_{60}$) and high ($N_{90}$) norms of nitrogen fertilizers negatively influenced the formation of these indicators.

## CONCLUSIONS

The most favorable conditions for the formation of the symbiotic apparatus in the lupine are created for its sowing on April 5 with the sowing norm1.1 million of germinated seeds per 1 hectare, as well as for the addition of mineral fertilizers in the norm of $P_{60}K_{90}$. The introduction of nitrogen fertilizers in the norm of 60 and 90 kg / ha of the active substance had an inhibitory effect on the formation of the symbiotic productivity for the plant.

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## АНОТАЦІЯ

## ФОРМУВАННЯ СИМБІОТИЧНОГО ПОТЕНЦІАЛУ ЛЮПИНУ ВУЗЬКОЛИСТОГО ЗАЛЕЖНО ВІД ЕЛЕМЕНТІВ ТЕХНОЛОГІЇ ВИРОЩУВАННЯ

В умовах енергетичної кризи, високої вартості мінеральних і дефіциті органічних добрив відбувається зниження родючості ґрунту, тому розробка і використання сівозмін, систем землеробства з бездефіцитним балансом гумусу та поживних речовин на сьогоднішній день є досить актуальними. Однією з незаслужено забутих культур, яка повинна зайняти належне місце у сільськогосподарському виробництві нашої країни, є люпин вузьколистий. У Передкарпатті ця культура малопоширена і наукових досліджень з розробки елементів технології вирощування її практично не проводились. Це і стало мотивацією до вивчення впливу строків сівби, норм висіву насіння та удобрення на ріст і розвиток рослин, формування ними показників симбіотичної активності, величини урожаю і якості насіння люпину вузьколистого. Досліди проводились на типових для Передкарпаття дерново-підзолистих поверхнево-оглеєних середньосуглинкових ґрунтах лабораторії кормовиробництва Інституту сільського господарства Карпатського регіону (с. Лішня Дрогобицького району Львівської області).

Вивчаючи особливості формування симбіотичного апарату люпину вузьколистого, особливу увагу було звернуто на такі показники як час появи бульбочок на коренях рослин, час появи активних бульбочок, їх розпад, а також кількість і маса бульбочок залежно від досліджуваних нами технологічних прийомів вирощування. Проведені спостереження за формуванням симбіотичного апарату люпину вузьколистого показали, що строки сівби та норми внесення мінеральних добрив мали істотний вплив на цей процес. При цьому найшвидше бульбочки з'являлись за сівби люпину вузьколистого в ранній строк. Після сходів вони появилися на 7 день, тоді як за середнього строку сівби – приблизно через 8-9 днів, а за сівби в пізній строк – через 10 днів після сходів. Щодо впливу норм мінеральних добрив, то тут найшвидше бульбочки з'являлись на варіантах досліду без застосування мінеральних добрив та на ділянках з внесенням фосфорно-калійних добрив з розрахунку $P_{60}K_{90}$ (через 11 днів після сходів). Внесення ж мінерального азоту у дозі 60 та 90 кг/га на фоні фосфорно-калійних добрив $P_{60}K_{90}$ затримувало утворення бульбочок на 3-4 дні. Відповідно тут бульбочки з'являлись приблизно через 13-14 днів після сходів. Позакореневі підживлення Вуксалом Мікроплантом позитивно впливали на динаміку формування загальної кількості бульбочок і в тому числі активних у рослин люпину вузьколистого при різних рівнях мінерального живлення, в тому числі і азотного. Це можна пояснити активізацією фізіолого-біохімічних процесів у рослинах, що сприяє збільшенню надходження асимілюючих речовин до симбіотичного апарату.

Найбільш сприятливі умови для формування симбіотичного апарату люпину вузьколистого створюються за сівби його 5 квітня з нормою висіву 1,1 млн. схожих насінин на 1 га, а також за внесення мінеральних добрив у нормі $P_{60}K_{90}$. Внесення

азотних добрив у нормі 60 і 90 кг/га діючої речовини мало інгібуючий вплив на формування симбіотичної продуктивності культури.

Отже, найбільш сприятливі умови мінерального живлення для формування максимальної кількості бульбочок, в тому числі активних, протягом вегетаційного періоду люпину вузьколистого створюються при внесенні фосфорно-калійних добрив з розрахунку $P_{60}K_{90}$ та проведенні двох позакореневих підживлень.

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# PHENOLOGICAL OBSERVATIONS ON THE DEVELOPMENT PHASES OF RAPE PLANTS

**Abstract.** The article discusses the phenological observations for the development phases of spring rape plants. The duration of interphase periods of spring rape, depending on the sort, fertilization and herbicides, is shown. A dispersion analysis for interphase periods was conducted: germination-stooling, stooling-budding, budding-flowering. It was established that the length of the vegetation phases for plants had its features in colder and wet terms under the pre-Carpathian climatic conditions and depended on the climatic features of the year and the biological characteristics of the sort, the doses of mineral fertilizers and herbicides. In particular, in the period of germination-stooling, the largest share of influence falls on fertilizers – 78%; much less on herbicides – 7%, on the interaction of sort and fertilizers – 4%; sort and herbicides – 1%, while during stooling-budding the greatest part of influence falls on fertilizers – 30%; on herbicides – 25%, on the interaction of sorts and fertilizers – 5%; fertilizers and herbicides – 1%. It was shown that the effects of fertilizers and herbicides on the duration of the vegetative period was felt, mainly in the early phases of vegetation for the sorts Oksamyt and Maria; this effect was leveled out in later phases. It was the shortest for the sites fertilized with phosphorus and potash fertilizers. Additional use of nitrogen fertilizers on the background of phosphoric-potassium fertilizers prolonged the duration of vegetation for the plants.

**Keywords:** spring rape, sort, fertilizer, developmental phase, climatic conditions.

## INTRODUCTION

Phenology of rape plants is characterized by the dates of the following vegetation phases of: germination, stooling, budding, flowering, fruiting, and maturation. The first phase, the germination of plants, is characterized by the appearance of cotyledon leaves on the soil surface. In the second phase, stooling occurs with the formation of shoots with buds on the apex. The third phase is the budding. It is characterized by raising the buds of the stem over the upper leaves; And flowering: the beginning – the appearance of flowers in the basis of inflorescence; full (70-80% of flowers blooms) – formation in the bottom of inflorescences of the first pods; end (10-15% of flowers blooms) – filling inflorescences with pods.

At flowering, flowers begin to blossom at 5 o'clock in the morning; at 8-9 o'clock they are completely open and are up to 20 o'clock in this state. Then, they are closed and they begin to open about 6-7 hours the next day, that is 1-2 hours later, they are closed again at 20 hours. This continues for 3-4 days, after which the petals fade and fall away. Fruit formation occurs practically within the period of flowering [6, 8, 9].

The maturation can be observed by the changes in the color of seeds. It begins to ripen from the moment when the seeds gain a light green color (70% of moisture), then it greens (60% of moisture) and has a mat-green color with a transition to yellow in the semi-technical (50% moisture) state. In this period, the seeds are spherical, large, in a mucous membrane and, when crushed, split into halves. The final stage of seeds maturation is called technical.

The duration of vegetation growing for the rape and the time of reaching depends on the sort and hydrothermal conditions of the year. In the conditions of Northern Europe with a moderate marine climate, rape is sown in April and harvested in September. The vegetation period lasts for 160 days. In western Canada, with a moderately continental climate, rape is sown in May, harvested in September, and the vegetation period lasts 120 days [7].

The cultivation of the plant organism by the necessary nutrition elements during the growing season contributes to increasing the productivity of the culture. At the same time, the increase in fertilizer rates affects the duration of interphase periods. This is especially true for crops that are sufficiently or excessively supplied with nutrients, in particular nitrogen [2].

In the conditions of right-bank forest-steppe of Ukraine, according to G.I. Karychkovska [4], the duration for the most of the interphase periods depends first on weather conditions, which consisted of a certain time of rape development, rather than from the investigated factors, in particular, the combination of different forms of fertilizers with different ways of introduction. The fertilizer rate varied within $N_0P_0K_0$ - $N_{60}P_{60}K_{60}$.

In the conditions of the Northern Forest-steppe of Ukraine, interphase periods, as it is shown by the research of P.S. Vyshnevsky [1] depend largely on the weather conditions taking place during the growing season of culture, and on the mineral nutrition level, seed rates, timing and sowing methods.

## MATERIALS AND METHODS

The research was carried out at the Drohobych Ivan Franko State Pedagogical University on the sod-podzolic medium-sand soils typical for the Precarpathian, at the experimental field of the farm "Svitanok" in the Drohobych district of the Lviv region. The ornithine (0-20 cm) layer of soil (prior to fertilization) was characterized by the following fertility indices: $pH_{KCl}$ - 5.2-5.4, humus content (by Tyurin) - 2.0-2.3, easily hydrogenated nitrogen (by Cornfield) - 52-74 mg, mobile phosphorus (by Kirsanov) - 60-75 mg, exchangeable potassium (by Kirsanov) - 110-120 mg/kg of soil.

The research was carried out taking into account all the requirements of the experimental research techniques (B.O. Dospekhov, 1985). The experimental scheme included three factors: factor A – sorts (Oksamyt and Maria); factor B - norms of nitrogen fertilizers ($P_{60}K_{90}$ - background - K; background + $N_{30}$; background + $N_{60}$ and background + $N_{90}$); factor C - herbicides (Butizan and Comand).

The area of the experimental plot: the accounted area - 25 $m^2$, the total - 42 $m^2$, the options placement - systematic in two tiers. Repeatability is four-time. Five-way crop rotation with such alternation of crops was used for experiments: one-year grass with sowing clover-timothy mixture; clover-timothy mixture; spring barley, spring rape; winter wheat.

Phosphate (in the form of granulated superphosphate) and potassium (in the form of potassium chloride) fertilizers were applied under silt plowing, nitrogen (in the form of ammonium nitrate) - in spring, according to the experimental scheme, in pre-sowing cultivation.

Soil herbicides Butizan 400, 40% k.s. and Comand, 48% k. was introduced in three days after sowing with the norm 2,5 and 0,20 l/ha respectively.

Agrotechnique of rape growing on experimental sites is generally acceptable for the zone, with the exception of experimental variants. Norm of rape sowing - 1.5 million of germinated seeds per 1 hectare, treated with insecticidal and fungicidal agents, 20% (2.0 l/t). Plants were treated with insecticide Fastak with a rate of 0,15 l/ha and one more time in the flowering phase with insecticide Vantex, 60 (0,05 l/ha) to protect from the damage by the flower pot in the budding phase.

Rape was harvested in the phase of full ripeness by direct harvesting ("SAMPO-500").

*Table 1*

**Duration of interphase periods of rape, depending on sort, fertilizer and herbicides**

| Sort Factor A | Fertilizers Factor B | Herbicides Factor C | Sowing-germination | | Germination-stooling | | Stooling-budding | | Budding-flowering | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | days | $\sum t^0C$ | days | $\sum t^0C$ | days | $\sum t^0C$ | days | $\sum t^0C$ |
| Oksamyt | $P_{60}K_{90}$ (background) | Butizan | 6 | 63.5 | 35 | 468.9 | 11 | 150.4 | 18 | 330.6 |
| | | Comand | 6 | 63.5 | 33 | 442.3 | 13 | 171.4 | 18 | 333.1 |
| | background+ $N_{30}$ | Butizan | 6 | 63.5 | 38 | 503.1 | 10 | 133.7 | 19 | 355.9 |
| | | Comand | 6 | 63.5 | 36 | 477.5 | 12 | 166.6 | 19 | 352.6 |
| | background+ $N_{60}$ | Butizan | 6 | 63.5 | 40 | 535.6 | 9 | 147.8 | 19 | 343.4 |
| | | Comand | 6 | 63.5 | 39 | 519.7 | 10 | 165.7 | 19 | 354.6 |
| | background+ $N_{90}$ | Butizan | 6 | 63.5 | 39 | 543.5 | 8 | 126.0 | 20 | 357.2 |
| | | Comand | 6 | 63.5 | 39 | 522.9 | 10 | 162.6 | 19 | 347.9 |
| Maria | $P_{60}K_{90}$ (background) | Butizan | 6 | 63.5 | 35 | 467.8 | 10 | 165.0 | 18 | 351.2 |
| | | Comand | 6 | 63.5 | 34 | 432.5 | 12 | 186.4 | 18 | 312.6 |
| | background+ $N_{30}$ | Butizan | 6 | 63.5 | 38 | 514.3 | 8 | 124.8 | 19 | 350.9 |
| | | Comand | 6 | 63.5 | 37 | 496.3 | 10 | 138.7 | 18 | 342.3 |
| | background+ $N_{60}$ | Butizan | 6 | 63.5 | 38 | 512.4 | 9 | 125.6 | 19 | 328.3 |
| | | Comand | 6 | 63.5 | 37 | 504.7 | 10 | 140.6 | 18 | 327.8 |
| | background+ $N_{90}$ | Butizan | 6 | 63.5 | 40 | 526.7 | 8 | 128.7 | 18 | 348.1 |
| | | Comand | 6 | 63.5 | 39 | 508.4 | 10 | 143.1 | 20 | 348.2 |
| Oksamyt | $P_{60}K_{90}$ (background) | Butizan | 8 | 167.8 | 20 | 382.8 | 18 | 363.8 | 116 | 1927 |
| | | Comand | 7 | 147.1 | 21 | 368.3 | 17 | 364.8 | 116 | 1891 |
| | background+ $N_{30}$ | Butizan | 8 | 166.8 | 20 | 363.0 | 18 | 366.4 | 117 | 1985 |
| | | Comand | 8 | 154.0 | 17 | 336.1 | 18 | 370.0 | 116 | 1940 |
| | background+ $N_{60}$ | Butizan | 8 | 159.2 | 20 | 375.6 | 20 | 398.9 | 119 | 2026 |
| | | Comand | 8 | 152.8 | 17 | 357.1 | 20 | 391.9 | 119 | 2006 |
| | background+ $N_{90}$ | Butizan | 8 | 165.2 | 19 | 384.4 | 20 | 402.7 | 121 | 2042 |
| | | Comand | 7 | 143.0 | 19 | 382.0 | 20 | 391.9 | 120 | 2019 |
| Maria | $P_{60}K_{90}$ (background) | Butizan | 8 | 161.4 | 20 | 389.9 | 20 | 420.5 | 118 | 2019 |
| | | Comand | 7 | 152.8 | 18 | 354.8 | 21 | 431.7 | 117 | 1934 |
| | background+ $N_{30}$ | Butizan | 8 | 171.3 | 19 | 392.2 | 20 | 409.0 | 120 | 2026 |
| | | Comand | 7 | 151.5 | 19 | 376.0 | 20 | 405.4 | 118 | 1974 |
| | background+ $N_{60}$ | Butizan | 8 | 169.9 | 19 | 383.9 | 19 | 377.6 | 119 | 1961 |
| | | Comand | 7 | 149.3 | 18 | 354.6 | 19 | 396.1 | 116 | 1937 |
| | background+ $N_{90}$ | Butizan | 8 | 169.9 | 21 | 430.4 | 17 | 375.4 | 118 | 2043 |
| | | Comand | 7 | 143.7 | 20 | 411.6 | 17 | 365.9 | 118 | 1985 |

## DISCUSSION

In the colder and wet weather conditions of Precakarpathians, the duration of the vegetation phases for plants had its peculiarities and depended on both the climatic features of the year and the biological characteristics of the sort, the doses of mineral fertilizers and herbicides (Table 1).

According to the results of our studies, the duration of the sowing-germination period varied from 5 to 7 days and depended, basically, on the conditions of the year.

Biological characteristics of sorts and fertilizers did not affect the duration of the interphase period for the sowing-germination.

The sum of positive temperatures during this period of growth and development of spring rape plants varied within the range of 46.2-77.1°C, depending on the year, and on the average – 63.5 °C. This indicator also did not depend on the sort, fertilization and herbicide.

In the subsequent periods of rape plants growth and development, the influence of technological factors, in particular biological characteristics of the sort, fertilizers and herbicides on the duration of the vegetative phases, in particular on the germination-stooling, was intensified. This period in the growth and development of spring rape is very responsible, because at this time the laying and forming of the covering organs of flowers, pomace and stamenum hills is possible, and it is possible to change the number of flowers in the inflorescence with agrotechnical techniques, and affect the seed yield of the culture at the same time.

On average, the duration of the germination-stooling period for the Oksamyt sort varied depending on the fertilization and the applied herbicides from 33.7 to 40.7 days with the sum of positive temperatures from 442.3 to 543.5 °C. At the same time, the shortest (33.7 days with a sum of positive temperatures of 442.3 °C) was at sites where phosphorus and potash fertilizers were introduced at the rate of $P_{60}K_{90}$ in the autumn and the herbicide Command was added to the seedlings. The introduction of nitrogen fertilizers against the background of phosphoric-potassium in spring in the pre-sowing cultivation prolonged this period of vegetation from 38.0-36.0 days with a sum of positive temperatures of 503.1-477.5 °C for the fertilization of $N_{30}P_{60}K_{90}$ to 40.7-39.0 days from the sum of positive temperatures 543.5-522.9 °C for fertilization $N_{90}P_{60}K_{90}$. The introduction of the herbicide Comand for all variants with fertilizer shortened the period of germination-stooling.

For the sort Maria, the duration of the vegetation period for the germination-stooling varied within 34.3-39.3 days. As for the sort Oksamyt, it was the shortest at areas with adding phosphoric-potassium fertilizers at the rate of $P_{60}K_{90}$ and adding before sprouting with herbicide Comand.

Additional introduction of nitrogen fertilizers in early spring under pre-sowing cultivation contributed to the extension of this period and it was the longest at sites with the introduction of complete mineral fertilizers $N_{90}P_{60}K_{90}$.

In the case of using herbicide Comand in pre-sprouting phase, it significantly reduced the vegetation period of the germination-stooling. Thus, if during the introduction of the butizan herbicide, the duration of the germination-stooling period was, depending on the level of mineral nutrition, 35.3-39.3 days with a sum of positive temperatures 467.8-530.0 ° C, then when the Comand was added, the period was 34.3 -38.7 days with a sum of positive temperatures 432.5-513.4 ° C.

The variance analysis for the data obtained on average for three years of these studies showed that the anthropogenic factors such as fertilizers, herbicides, interaction of sorts with fertilizers and sorts with herbicides had a significant impact on the duration of the germination-stooling period (Fig. 1).

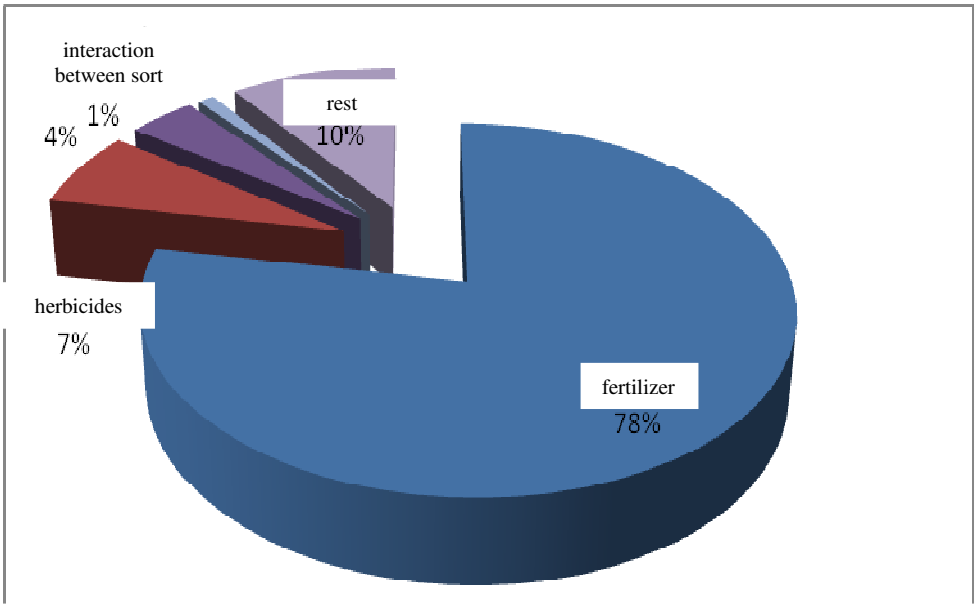


**Fig. 1 Share of the influence of technological methods of cultivation on the duration of the germination-stooling period**

At the same time, the largest share of influence falls on fertilizers - 78%; much less on herbicides - 7%, on the interaction of sorts and fertilizers - 4%; sort and herbicides - 1%. The remaining 10% is the rest.

The stooling-budding period for rape is important because it falls on VI-VIII stages of organogenesis by F. M. Kuperman and is associated with the formation of generative organs of the flower: stamens and pistils, growth of the flower organs and inflorescences, with the formation of generative organs. During this period, it is quite possible due to the high level of providing nutrition elements, especially phosphorus, to regulate the number of flowers in the inflorescence and their fertility.

As our studies showed, the duration of the stooling-budding period was short and depended, first, on weather conditions of the year, the level of mineral nutrition and the adding of herbicide to control weeds on rape crops.

The mathematical processing of the data obtained during the years of research on the duration of the interphase stooling-budding period showed that it, depends on the level of mineral nutrition and the introduction of herbicides for the Oksamyt sort, lasted from 8 to 13.0 days with a sum of positive temperatures 126.0-171.4 °C. At the same time, it was the longest in plants grown at sites fertilized from autumn only with phosphorus-potash fertilizers at the rate of $P_{60}K_{90}$. An additional introduction of nitrogen fertilizers by 30-90 kg of active substance per 1 h in early spring under pre-sowing cultivation, reduced this period from 11-13 days and the sum of positive temperatures of 150.4-171.4 ° C in the areas without nitrogen fertilization up to 8.0-10.7 days and the sum of positive temperatures 126.0-162.6 °C in the areas with full of mineral fertilizers $N_{90}P_{60}K_{90}$.

During the vegetation period, the stooling-budding period was slightly shorter in for the sort Mariya compared to the Oksamyt sort. As in the previous sort, the stooling and the budding was the longest (10,7-12,3 days with the sum of positive temperatures 165,0-186,4 ° C) for areas under the basic cultivation of soil and with the introduction of only phosphoric-potash fertilizers of $P_{60}K_{90}$ in the calculation. Nitrogen fertilizers, introduced in early spring under pre-

sowing cultivation on the phosphoric-potassium background, reduced the duration of this period, and it was the shortest at the introduction of complete mineral fertilizers $N_{90}P_{60}K_{90}$ in the calculation.

The results of the spraying with Comand herbicide extended the duration of this vegetation period for the plants of the Oksamyt sort for 1.4-2.7 days, and for 1.0-2.0 days for the sort of Maria.

The variance analysis for the data obtained on average for three years of these studies showed that the anthropogenic factors such as fertilizers, herbicides, interaction of a sort with fertilizers and fertilizers with herbicides, had a significant impact on the duration of the stooling-budding period. At the same time, the greatest share of influence falls on fertilizers - 30%; on herbicides - 25%, on the interaction of sorts and fertilizers - 5%; fertilizers and herbicides - 1% (Fig. 2).

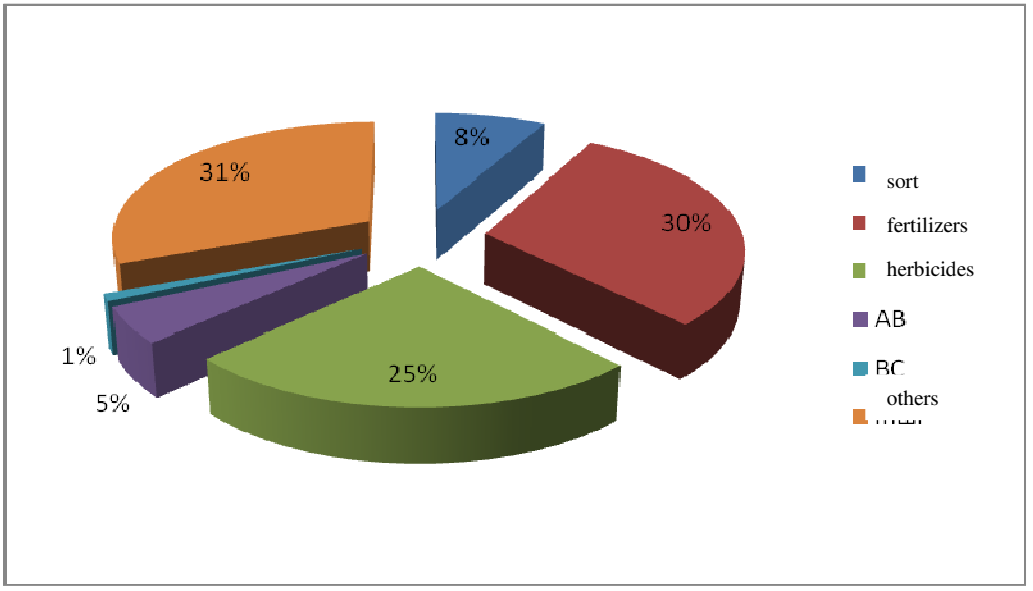


**Fig. 2 Share of the influence of technological methods of cultivation on the duration of the stooling-budding period**

According to F.M. Kuperman, the budding-flowering takes place in the VIII-IX stages of organogenesis and is associated with the further growth of the organs of the flower and inflorescences, as well as flowering and fertilization of the moth. In this period of vegetation, it is possible to influence the fertility of flowers, the number of seeds in a pod and on the plant.

As our three-year research data showed, the duration of the budding-flowering period fluctuated within certain limits and largely depended on the climatic conditions of the year, the sort, the level of mineral nutrition and the used herbicides (see Table 3).

The budding-flowering period for the sort of spring rape Oksamyt was somewhat shorter at sites where, only plowing of phosphorus and potash fertilizers was carried out from autumn at the rate of $P_{60}K_{90}$, and amounted to 18.3 days with a sum of positive temperatures of 330.6-333.1 °C. This period (19.7-19.0 days with the sum of positive temperatures 357.2-347.9 °C) was somewhat longer at sites with the introduction of complete mineral fertilizers $N_{90}P_{60}K_{90}$.

For the Maria sort, this period was prolonged from 18.3-17.7 days with the sum of positive temperatures 351.2-312.6 °C at sites with fertilizers $P_{60}K_{90}$ to 18.3-19.7 days with a sum of positive temperatures 348.1-348.2 °C at the introduction of full mineral fertilizers $N_{90}P_{60}K_{90}$.

The clear pattern was not observed for the change in the duration of the budding-flowering period from the introduced herbicides in the sorts Oksamyt and Maria.

The next vegetation period of flowering plants-emergence of pods is characterized by the fact that it is not long and lasts 7-9 days depending on the conditions of the year with the sum of positive temperatures 143.0-171.3 °C. It coincides with the IX-XI stages of organogenesis according to F.M. Kuperman, when the rape plants are blooming massively, pods are formed and the plastic substances are accumulated in the seeds. Compliance with the requirements of cultivation technology ensures the growth of seed filling and their mass.

As the data of our phenological observations showed, there was no difference in the duration of this period between years of research and fertilizer variants. Only the tendency to some reduction of this vegetation period of plants at the introduction of herbicide Comand during pre-sprouting is noted in comparison with the Butizan herbicide.

Vegetation period of rapeseed plants, the emergence of pods-initial maturation coincides with the XI stage of organogenesis by F.M. Kuperman, and takes place at the end the pods formation, lightening them at the bottom of the plants. There is an intense accumulation of plastic substances in the seeds. In addition, the fill and grain size of the seeds depends on compliance of planting technology elements with the previous stages of growth and development.

The conducted phenological observations showed that this vegetation period of rape plants is longer than the previous and lasts, depending on the climatic conditions of the year, biological characteristics of the sort, the level of mineral nutrition of plants and herbicides, from 15 to 23 days with a sum of positive temperatures from 315.5 to 437.7 °C.

A clear trend for the dynamics of the duration for this and the next period (initial maturation-complete maturation) was not observed with the change in the sort, norms of the introduction of mineral fertilizers and herbicides during the study. This, in our opinion, can be explained by a sharp cessation of the nutrients receipt from fertilizers in the plant.

As for the duration of the growing season for rape plants from sowing to harvesting, there is a certain dynamics depending on the factors studied by us.

On average, over three years of research, the duration of the vegetation period for the Oksamyt sort was 114-121 days with the sum of positive temperatures 1891-2042 °C. It was the shortest on sites fertilized with phosphorus and potash fertilizers. An additional introduction of nitrogen fertilizers against the background of phosphoric-potassium prolonged the vegetation period of plants for this sort from 116-114 days and the sum of positive temperatures 1927-1891 °C in the background control to 121-120 days and the sum of positive temperatures 2042-2019 °C in the sites fertilized with complete mineral fertilizers $N_{90}P_{60}K_{90}$. The same trend was observed for the sort Maria.

There is no clear trend in changing the length of the growing season depending on the herbicides, although there was a tendency to reduce it in the sites with the introduction of the Comand compared with butizan.

Speaking about the structure of the growing season for rapeseed plants of the Oksamyt sort, it is the following: it is 5.1-5.2% of the growing season duration for the period of sowing-germination; 30.2-29.0% for germination-stooling; 9.2-11.2% for stooling-budding; 15.5-15.8% for flowering-budding; 6.9-6.0% for the flowering-emergence of pods; 17.0-18.0% emergence of pods-initial maturation; and 16.0-14.6% for the initial maturation-complete maturation.

## CONCLUSION

The influence of fertilizers and herbicides on the growing season duration was observed mainly in the early phases of vegetation for the rape sorts Oksamyt and Maria. This effect was leveled off in later phases.

It was the shortest on sites fertilized with phosphorus and potash fertilizers. Adding of nitrogen fertilizers on the background of phosphoric-potassium fertilizers prolonged the duration of vegetation for plants.

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## АНОТАЦІЯ

## ФЕНОЛОГІЧНІ СПОСТЕРЕЖЕННЯ ЗА ФАЗАМИ РОЗВИТКУ РОСЛИН РІПАКУ ЯРОГО

Забезпеченість рослинного організму необхідними елементами живлення впродовж вегетації сприяє підвищенню продуктивності культури. Разом з тим, збільшення норм удобрення впливає на тривалість проходження міжфазних періодів. Особливо це стосується культур, які достатньо чи надмірно забезпечені поживними речовинами, зокрема азотом.

В умовах правобережного Лісостепу України, за даними Каричковської Г. І., тривалість більшості міжфазних періодів в першу чергу залежала від погодних умов, які складались на певний час розвитку ріпаку ярого, ніж від досліджуваних чинників, зокрема поєднання різних форм добрив з різним способом внесення. Норма добрив коливалась у межах $N_0P_0K_0 – N_{60}P_{60}K_{60}$.

Дослідження проводили при Дрогобицькому державному педагогічному університеті імені Івана Франка на типовому для Передкарпаття дерново-підзолистому середньосуглинковому ґрунті дослідного поля селянсько-фермерського господарства „Світанок” Дрогобицького району Львівської області. Орний (0–20 см) шар ґрунту (до внесення добрив) характеризувався такими показниками родючості: $pH_{KCl}$ – 5,2–5,4, вміст гумусу (за Тюріним) – 2,0–2,3, легкогідролізованого азоту (за Корнфілдом) – 52–74 мг, рухомого фосфору (за Кірсановим) – 60–75 мг, обмінного калію (за Кірсановим) – 110–120 мг/кг ґрунту.

Дослідження проводили з урахуванням усіх вимог методик дослідної справи (Доспехов Б. О., 1985). Схема досліду включала три фактори: фактор А – сорти (Оксамит і Марія); фактор В – норми азотних добрив ($P_{60}K_{90}$ – фон – К; фон + $N_{30}$; фон + $N_{60}$ і фон + $N_{90}$); фактор С – гербіциди (бутізан і команд).

У статті розглянуто фенологічні спостереження за фазами розвитку рослин ріпаку ярого. Показано тривалість міжфазних періодів ріпаку ярого залежно від сорту, удобрення і гербіцидів. Проведено дисперсійний аналіз міжфазних періодів: сходи-стеблування, стеблування-бутонізація, бутонізація-цвітіння.

Встановлено, що в умовах більш холодного і вологого за кліматичними умовами Передкарпаття тривалість проходження фаз вегетації рослин мали свої особливості і залежали як від кліматичних особливостей року так і біологічних особливостей сорту,

доз внесення мінеральних добрив і гербіцидів. Зокрема, в період сходи-стеблування найбільша частка впливу припадає на добрива – 78 %; значно менше на гербіциди – 7 %, на взаємодію сорту і добрив – 4 %; сорту і гербіцидів – 1 %, а в період стеблування-бутонізація найбільша частка впливу припадає на добрива – 30 %; на гербіциди – 25 %, на взаємодію сорту і добрив – 5 %; добрив і гербіцидів – 1 %.

Показано, що за результатами досліджень вплив добрив і гербіцидів на тривалість вегетаційного періоду відчувався, в основному, в ранніх фазах вегетації ріпаку ярого сортів Оксамит і Марія, в більш пізніх фазах цей вплив нівелювався. Найкоротшим він був на ділянках, удобрених лише фосфорно-калійними добривам. Додаткове внесення азотних добрив на фоні фосфорно-калійних подовжувало тривалість вегетації рослин.

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# ALLUVIAL SOILS IN OLD – RIVER BED OF WISŁOK IN «PRADOLINA PODKARPACKA»

**Abstract.** Alluvium accumulated over the centuries by river waters, at their bottom is the source of nutrients available to plants. From the point of view of 21st century agriculture, they can create opportunities for the development of this branch of economy.

This paper presents the characteristics of alluvial soils of the Wisłok river bed in the area between Rzeszów and Łańcut, three soil profiles are located on the right bank of the river bed along the cross-section of the valley in Krasne. They are characterized by their location in terrain, morphological, physicochemical and chemical properties. The soils formed on the lateral cross-section of the valley are made of eluvium belong to the brown, humus and proper alluvial soils, while on the old accumulation terrace they have lost their stratification, and the soil process is similar to the brown soils. The results of studies show that both arable land and grasslands located in the valley of the Old Wisłok are characterized by high nutrient content, which determines their high fertility.

**Key words**: grain size, organic matter, sorption capacity, available forms of nutrients

## INTRODUCTION

Water conditions and the nature of the substrate in the upper reaches of the river mainly determine the lithogenesis of inflowing soils. The first observations of these soils in the Wisłok Valley were carried out by Dobrzański in the 1950s [4]. The waters of Wisłok cross the Krosno and Cretaceous layers on a considerable length, and then pass through the belt of the Podkarpacie loess and finally beneath Rzeszów flow among glacial rocks [8, 15]. The Wisłok Valley in the early 37 km, from the source of the Besko is very narrow and has a longitudinal slope – source 760 and Besko 288 m.n.p.m. - which is not conducive to the accumulation of water-based material. Only below the Besko there are significant valley extents in the area of the Jasielsko-Sanockie Pits and below Babica - and the fall of the valley floor is remarkably reduced, and consequently the accumulation processes increase [4]. After passing Rzeszów Wisłok, affects the area of the Podkarpackie Pradeland, where it changes its character to a typical lowland. There are extensive accumulation areas with large thicknesses formed from deposited alluvium. At the bottom of the valley can be observed numerous changes in the river bed, which occurred in the holocene, also in historical times [7]. The current Wisłok riverbed was formed during the huge floods around the middle of the 18th century [9, 6]. In the valley of the lower Wisłok, there are light, medium and heavy alluvial soils and marsh soils in the lowering of the area.

The aim of the study was to recognize the soil structure and the soil-forming process in the old – river bed of Wisłok on selected sections of Krasne and to determine their agricultural suitability in relation to their location.

## METHODS

The research was conducted on the soil of the old river bed of Wisłok. In the four crossings of the valley in Pobitno, Załęże, Krasne and Krzemienica, 11 soil profiles were exposed at different distances from the river bed and at different altitudes to the water level. 55 soil samples from the distinguished genetic levels were taken for laboratory testing. Samples

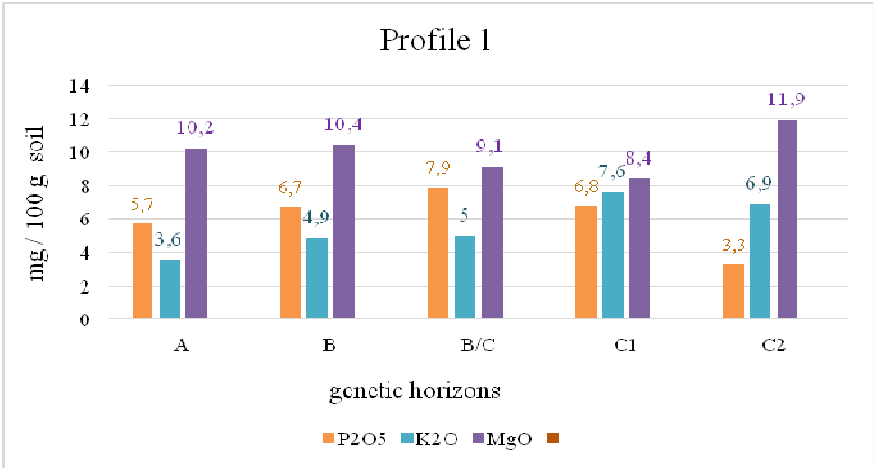
were dried and sieved through a 1 mm mesh screen. The paper presents soil characteristics within the old river bed valley in Krasne village. The following laboratory tests were carried out on the obtained soil material: grain-size distribution with the Casagrande method as modified by Prószyński, pH reaction in 1 M KCl with the potentiometric method, hydrolytic acidity and the sum of exchangeable bases with the Kappen method, organic carbon determination with the Tiurin method, available forms of phosphorus and potassium by Egner-Riehm method and that of magnesium with Schachtschabel's method.

## RESULTS AND DISCUSSION

River basins are young Holocene soils formed in specific ecological, hydrological and geomorphological circumstances, conditioned by the nature of the river, its length, the characteristics of its catchment and climate [10, 5]. The main factor in their formation are surface flow soils which, depending on time, volume and flow velocity, determines the spatial and vertical distribution of alluvial deposits, their granulometric composition and microstructure [11,13,1,2]. Alluvial soils located in the old river bed of Wisłok are characterized by high variability in terms of granulometric composition. Similar conclusions have been made by Malinowski [12] conducting research on the soils of the vicinity of the Cedyński Landscape Park.

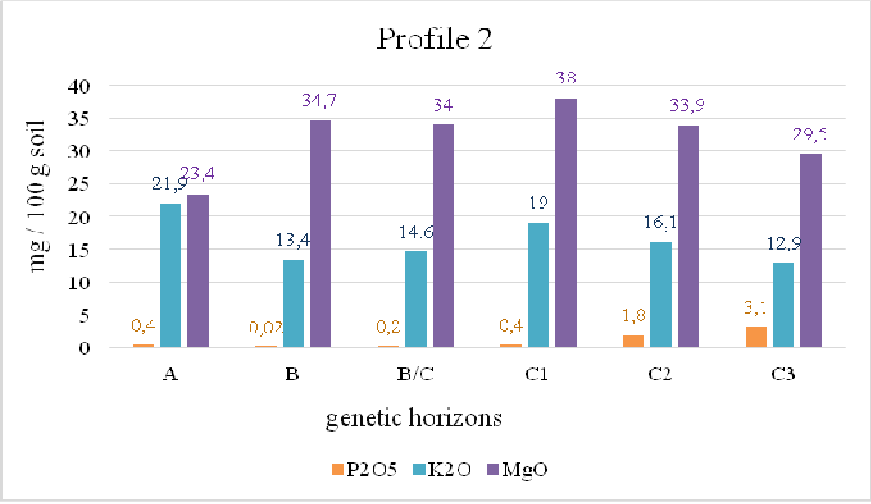
The first profile in Krasne was located on permament grassland at the height of 201 a.s.l at a distance of 1600 meters from the water mirror, 9 meters above the river bed. At its depth there is a plain dust with a sand content of 15 to 23%, silt and clay fraction to 33 % and a colloidal clay content of 7 to 10%.

The soil reaction to a depth of 70 cm is acidic, below slightly acidic and the associated hydrolytic acidity decreases systematically with depth and takes values from 5.6 to 2.1 mmol (+) / 100g soil. The humus level is up to 14 cm and the organic carbon content is 1.45%. The capacity of the sorption complex at different genetic horizons of this soil is 8 to 28 mmol (+) / 100 g soil, and the saturation level of the sorption complex at depth 0-69 cm is about 50%, below is 80-90%. At the particular genetic horizons of this soil, there is a low abundance in easily available phosphorus and potassium, while magnesium is in average level (Figure 1). Similar low content of available phosphorus and potassium was found in the sois occurring in the Ina River Valley [3]. The organic carbon content of the entire profile is 8.8 kg / $m^2$. This soil belongs to alluvial brown soil.



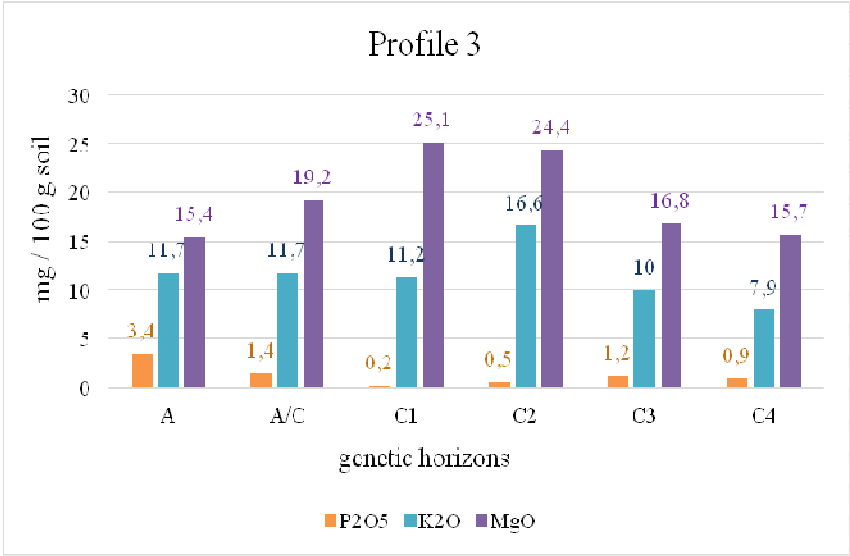

**Ryc. 1. Content of available forms of selected macroelements with differentiation into genetic horizons - profile 1.**

The second profile was exposed next to the cultivated field, about 350 meters from the old river bed, at an altitude of 195 m. a.s.l. and 3 meters above the water mirror. In level ap there is an medium clay located on heavy clay. Below, up to a depth of 125 cm is loam, which reaches the silty layer. The content of sand in the humus horizon reaches 30% and decreases with depth, while the content of silt and clay fraction reaches 88% at a depth of 75-100 cm. This level also has the highest fraction of colloidal clay - 52%. The humus level has a thickness of 16 cm and a high organic carbon content - 3.91%, while below it, in the level of browning, is 1.46%. The soil reaction to a depth of 75 cm is very acidic (4.1 - 4.6 pH in KCl solution), while deeper is acidic (pH 5). The hydrolytic acidity decreases with the depth from 10 mmol (+) / 100g of soil in humus horizons to 2.2 mmol (+) / 100g of soil in the mother rock. The sorption capacity in whole profile is high and reaches 40.4 mmol (+) / 100g of soil. The degree of saturation of the sorption complex with bases is 92% on the depth of 125-150 cm and decreases upwards. The content of available forms of phosphorus is low, magnesium is high, potassium is high in the humus level and average in the rest of the profile (Figure 2), which is associated with agricultural production and the use of mineral fertilizers. The total organic carbon content of the entire profile is 16.0 kg / $m^2$. Similar results were obtained by H. Czyż et al. in studies of humus soils in the valley of the Warta estuary [14]. This soil belongs to humus alluvial soils characterized with high usability value.




**Ryc. 2. Content of available forms of selected macroelements with differentiation into genetic horizons - profile 2.**

In the third profile, located at 193 m a. s. l. , about 500 meters from the river bed, 1 meter above the water surface, in the humus horizon there is a silt loam deposit on silty clay. At a depth of 100-150 cm there is a silty soil with a sand content of 9 to 19%. The content of silt and clay fraction reaches 64% at a depth of 75-100 cm and the fraction of colloidal clay at this level reaches 26%. The organic carbon content in Ap horizon is 1.34%. The soil reaction measured in 1M KCl takes values from 4.2 to 4.7 pH, very acidic at depth 0-38 cm, while below it is acidic. The hydrolytic acidity decreases with depth and ranges from 2.37 to 5.36 mmol (+) / 100g soil. The saturation of the sorption complex with bases at this level is 75% and the highest value is reached at a depth of 100 cm - 81%. The content of available forms of phosphorus is low, potassium is medium, while magnesium is high at a depth of 38-100 cm and average in other levels (Figure 3). The organic carbon content of this profile is 9.0 kg / $m^2$. This soil belongs to the proper alluvial soils.




**Ryc. 2. Content of available forms of selected macroelements with differentiation into genetic horizons - profile 3.**

**Table 1. Selected morphological, physical and chemical characteristics of soils in Krasne**

| Profile | Genetic horizons | Depth in cm | Hh[1] | S[2] | T[3] | V[4] | $P_2O_5$ | $K_2O$ | MgO | pH | | % C org. | Mass of C. org. in kg/m$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mmol (+) / 100 g soil | | | % | mg / 100 g soil | | | $H_2O$ | KCl | | |
| 1 | A | 0-14 | 5,6 | 7,0 | 12,6 | 55,6 | 5,7 | 3,6 | 10,2 | 5,3 | 4,2 | 1,5 | 8,8 |
| | B | 14-69 | 4,4 | 3,6 | 8,0 | 45,0 | 6,7 | 4,9 | 10,4 | 5,6 | 4,3 | 0,7 | |
| | B/C | 70-100 | 2,9 | 25,3 | 28,1 | 90,0 | 7,9 | 5,0 | 9,1 | 6,2 | 5,0 | 0,4 | |
| | C1 | 101-125 | 2,1 | 7,9 | 11,9 | 81,5 | 6,8 | 7,6 | 8,4 | 6,5 | 5,3 | 0,4 | |
| | C2 | 126-150 | 3,0 | 4,3 | 17,3 | 82,7 | 3,3 | 6,9 | 11,9 | 6,5 | 5,2 | 0,3 | |
| 2 | A | 0-16 | 10,1 | 30,3 | 40,4 | 75,0 | 0,4 | 21,9 | 23,4 | 5,2 | 4,1 | 3,9 | 16,0 |
| | B | 17-36 | 6,4 | 35,2 | 41,6 | 84,6 | 0,02 | 13,4 | 34,7 | 5,6 | 4,2 | 1,5 | |
| | B/C | 37-75 | 4,7 | 33,1 | 37,9 | 87,3 | 0,2 | 14,6 | 34,0 | 5,8 | 4,4 | 0,9 | |
| | C1 | 76-100 | 4,4 | 34,0 | 38,4 | 88,5 | 0,4 | 19,0 | 38,0 | 6,0 | 4,6 | 0,7 | |
| | C2 | 101-125 | 3,0 | 26,2 | 29,2 | 89,7 | 1,8 | 16,1 | 33,9 | 6,4 | 5,0 | 0,5 | |
| | C3 | 126-150 | 2,2 | 26,5 | 28,7 | 92,3 | 3,1 | 12,9 | 29,5 | 6,4 | 5,0 | 0,3 | |
| 3 | A | 0-26 | 5,4 | 17,1 | 22,5 | 76,0 | 3,4 | 11,7 | 15,4 | 5,3 | 4,2 | 1,3 | 9,0 |
| | A/C | 27-38 | 5,1 | 12,5 | 17,6 | 71,0 | 1,4 | 11,7 | 19,2 | 5,5 | 4,2 | 0,9 | |
| | C1 | 39-75 | 3,6 | 12,3 | 15,9 | 77,4 | 0,2 | 11,2 | 25,1 | 6,0 | 4,7 | 0,6 | |
| | C2 | 76-100 | 3,4 | 14,5 | 17,9 | 81,0 | 0,5 | 16,6 | 24,4 | 6,0 | 4,7 | 0,5 | |
| | C3 | 101-125 | 2,7 | 10,7 | 13,4 | 79,9 | 1,2 | 10,0 | 16,8 | 5,6 | 4,5 | 0,2 | |
| | C4 | 126-150 | 2,4 | 9,1 | 11,5 | 79,1 | 0,9 | 7,9 | 15,7 | 5,8 | 4,6 | 0,2 | |

[1]Hh - Hydrolytic acidity
[2]S - Capasity exchangeable cations
[3]T - Total cation exchangeable capacity
[4]V - Base cation saturation

## CONCLUSIONS

1. Alluvial soils in the area of old river bed of Wisłok were created of repeatedly moved alluvia and delluvia.
2. The grain-size distribution along the river bed is not related to the distance from the source, but depends on local changes in the water flow rate.
3. Typologically, these soils belong to the proper, brown or humus alluvial soils.
4. Arable land and grassland in the Old Wisłok Valley are rich in nutrients and their usefulness depends on the water-air relations in the soil.

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## ABSTRACT

## GLEBY ALUWIALNE W STARORZECZU WISŁOKA MIĘDZY RZESZOWEM I ŁAŃCUTEM

W rejonie Rzeszowa Wisłok wpływając na teren Pradoliny Podkarpackiej rozpoczyna swój bieg nizinny. Spadek względny jego dna - na odcinku około 60 km od Rzeszowa do ujścia do Sanu wynosi 0,456‰, co sprzyja odkładaniu aluwiów. Trzeciorzędowy materiał erodowany w górskim i podgórskim odcinku rzeki miesza się tu z osadami deluwialnymi okresu mioceńskiego, przesortowanymi przez wody topniejącego lodowca i najstarszymi osadami plejstoceńskimi. W osadach nowożytnych w wyniku nakładających się procesów erozyjnych i akumulacyjnych, związanych z wysokimi stanami wód, powierzchnia gleb w obrębie Pradoliny Podkarpackiej była dynamicznie zmieniana, co prowadziło nawet do wielokrotnej zmiany przebiegu głównych rzek. Badaniami terenowymi objęto gleby w dolinie starorzecza w czterech poprzecznych przekrojach, w miejscowościach Pobitno (2 profile), Załęże (3 profile), Krasne (3 profile), Krzemienica (3 profile). Opisano ich położenie w rzeźbie terenu oraz budowę morfologiczną w wyznaczonych reprezentatywnych profilach i pobrano 55 prób glebowych z wydzielonych poziomów genetycznych do badań laboratoryjnych. W artykule przedstawiono charakterystykę gleb w obrębie doliny starorzecza w miejscowości Załęże. Z obserwacji terenowych i analizy map topograficznych wynika, że Pradolina Podkarpacka w omawianym rejonie ma charakter płaski, przy deniwelacjach sięgających kilku metrów. Słabe urzeźbienie powierzchni ogranicza prędkość przepływów wód powierzchniowych i sprzyja sedymentacji materiału aluwialnego, co prowadzi do jej wypełnienia i dalszego zmniejszenia prędkości przepływów. Silna rozbudowa sieci starorzecza Wisłoka między Rzeszowem i Łańcutem wskazuje na wielokrotną zmianę jego przebiegu w czasach nowożytnych. Między Rzeszowem i Łańcutem starorzecza Wisłoka cechuje się dużą liczbą zakoli i meandrów, co dobrze odzwierciedla współczynnik jego rozwinięcia (stosunek długości koryta między dwoma punktami do odległości między nimi.) wynoszący średnio 1,5, a w niektórych miejscach przekraczający wartość 3. Zróżnicowane lokalnie rozwinięcie koryta starorzecza oddziaływuje na warunki sedymentacji aluwiów i decyduje o rozkładzie uziarnienia w obrębie doliny/

Gleby aluwialne w starorzeczu Wisłoka poniżej Rzeszowa wytworzyły się z aluwiów i deluwiów wielokrotnie przemieszczanych. Poprzeczny przekrój doliny Wisłoka charakteryzuje się zmiennym uziarnieniem. W części przyległej do starorzecza w profilach występuje warstwowanie i dominują frakcje o ∅< 0,02 mm, zaś w obrębie starych terasów akumulacyjnych frakcja pyłu. Dynamika procesów glebotwórczych zależy od odległości od koryta rzeki. Mady właściwe występują na najmłodszej terasie. Mady brunatne występują na starych zgrądowiałych terasach akumulacyjnych położonych powyżej 10 metrów od współczesnego lustra wody. Mady próchniczne występują niezależnie od położenia w rzeźbie terenu. Wartość rolnicza gleb wytworzonych z osadów aluwialnych w dolinie Wisłoka zależy nie tyle od zawartości przyswajalnych form składników pokarmowych lecz od zaawansowania procesu glebotwórczego.

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# FUNCTIONAL ORGANIZATION OF PHYTONEMATODES FROM SOIL OF FIR OAKWOOD IN UKRAINIAN CARPATHIANS

**Abstract.** The quantitative characterization and functional organization of phytonematodes from soils of fir oak wood is investigated. It was established that the number of soil nematodes groupings in the conditional primary ecosystem of the oak wood in spring was represented by all functional groups; the least settling of soil with phytonematodes was registered in the summer period; their number increased in autumn.

The peculiarity of seasonal changes in the number of phytonematodes in the recreationally loaded area ($FirO_3$), in comparison with the conditionally indigenous, is the low population of the soil at the beginning of the vegetation. The habitat of soil phytonematodes on anthropogenically transformed area is mainly due to saprophages, but their share is also considerably smaller than in the primary ecosystem, and the share of phytogelmints increases significantly.

**Keywords:** fir oak wood, biocenosis, soil nematodes, bioindication.

## INTRODUCTION

Nematodes are one of the most common organisms in the animal world, which account for four quintals of the entire animal world. They are an important component of the fauna in any terrestrial or aquatic ecosystem. Growth of interest in nematodes attracts the researchers' attention in terms of their use as bioindicators. Currently about 20 thousand species of nematodes are described and 4 thousand of them are related to plants [4, 6].

Nematodes are common in all water and terrestrial ecosystems without exception, and play an important role in the processes of group composition regulation and activity of microflora. This systematic group made the transition from seawater to fresh and from there to the ground [15]. There are about 2000 species of nematodes living in the soil. Nematodes are geogridobions, that is, live and move in groundwater tapes. The mechanical composition of soils, soil moisture and availability of food are the most important factors determining the diversity of fauna nematodes in the soil [3, 4, 5].

Soil nematodes, like inhabitants of litter and surface soil layers, first are exposed to harmful substances accumulated in the environment, react to the influence of various substances and can be used for bioindicatory purposes. It is expedient to use them as a bioindicative group for functional organization of soil invertebrates. Information on the structural organization of groups, the participation of the certain species co-populations in it, and the peculiarities of their seasonal changes, makes it possible to identify bioindicative groups of organisms, on which basis it is possible to estimate the influence on external factors for biogeocoenosises [7, 8].

Most species of phytonematodes are characterized by mediated connections with plants and are fed by fungi and bacteria, using dead organic plant remains as a source of nutrition, or become plants parasites. They affect the formation of primary products, take part in destructive processes, their livelihoods contribute to more complete use of energy resources and balance processes in the ecosystem. All this makes them good indicators for the ecological state of the soil and the functioning of the soil block of invertebrates in the ecosystem [6,7].

In primary ecosystems, primary nematode complexes are formed in the framework of the biogeocoenosis type, for which a certain seasonal dynamics of the number and ratio of trophic, ecological and functional groups is characteristic [1, 8].

The autotrophic unit has the greatest influence on the formation of phytonematode groups, since the development of these or other species of herbivorous and saprobionous nematodes depends directly and indirectly on the species composition of plants, the chemistry of their precipitations and decay [17, 18]. The dimensions and autecological features of the species from the above groups of nematodes are crucial for the formation of the species composition for predatory phytonematodes groups. In general, the structural organization of the phytonematological group, primarily species composition, depends on the vegetation edificator. Certain influence on the formation of the nematode fauna is also due to other components of soil zoocenosis. The combination of these influences determines the specific features of the structural organization for primary nematode complexes in different vegetation groups, and they depend on growth conditions, species composition and vegetation cover structure within the limits of vegetation zones [7, 8, 9].

In different types of biogeocenosis, these complexes differ in species diversity, quantitative ratio of taxa, indices of the soil population and the participation in this process of trophic groups, the features of the seasonal dynamics of the group, etc., but they have a common feature, namely: regardless of their location above the sea level and vegetation zones, the same phytomede complexes remain the same in their functional organization, in particular, the share of energy consumed by phytophagus is 1–2% in most cases, the saprophages are about 90%, the rest belongs to predators. Actually, this general property of the primary soil nematodes complexes is an indicator for the naturalness (naturality) of the ecosystem [5, 6].

The main signs of changes in the structural and functional organization of soil nematodes in anthropogenically simplified and secondary ecosystems are the following: impoverishment of species diversity or even the emergence of new types of phytogelmints, changes in the ratio of taxonomic, trophic and functional groups of nematodes, in particular, increasing the proportion and the quantitative indices of phytoparasitic species [5, 9].

The general objective of the work involves, based on the bioindicative properties of the soil nematodes, to establish the natural state of the oak groves, provided that the natural structure of the stands is restored. In this publication, the task is to analyze the quantitative characteristics and features of the functional organization for phytomematods of the fir seedlings in the Precarpathians of Ukraine.

## MATERIALS AND METHODOLOGY OF RESEARCHES

The research was carried out in fir oak woods within the Drohobych foothills of the Dniester Pre-Carpathian region on the territory of Truskavets and Drohobych forestry in old forests with different anthropogenic loads. These forests are bicolour and formed by Abies alba and Quercus robur; Acer pseudoplatanus, Carpinus betulus and Tilia cordata are common [10]. They are characterized by the natural structure of woodlands. The least anthropogenically altered fir-tree FirO2 (49°15'50"N, 23°31'48"E), located in Dobrogostiv forestry, is 414 m high. The forest ecosystem FirO1 (49°17'44"N, 23°30'35"E) is 343 m high and FirO3 (49°17'20"N, 23°28'23"E) is on 398 m high. They are located in Truskavets forestry and undergo a recreational load.

Sampling was carried out in spring, summer and autumn 2015–2017. Soil samples were taken by a biocenometer with a 5,5 cm cavity diameter. The isolation of nematodes was carried out using a commonly applied Berman method with a three-time repeat, using the Kempson instrument. Exposure was at least 48 hours, after which nematodes were fixed by formalin. To establish a functional organization of fixed nematodes, temporary water-glycerine preparations were made [2].

## RESEARCH RESULTS AND DISCUSSION

It was established that the formation of nematode groups in fir-oak ecosystems occurs with the participation of such functional groups: saprophages, predators and phytophages.

The research results in 2015 showed that the number of soil nematodes groups of anthropogenically fir-tree transformed area (FirO1) amounted to 90,1 thousand individuals per 1 $m^2$ in the spring and was represented by all functional groups, including saprophages – 88,0%, predators – 8,0%, phytophagous – 6,0%. In the summer, more than 99,5 thousand individuals per 1 $m^2$ were registered, where the sapropages are 87,4%, predators – 7,7%, phytophages – 4,9%, their number was 86,5 thousand individuals per 1 $m^2$ in the autumn: sapropages – 87,3%, predators – 6,9%, phytophages – 5,8% (see Table 1).

In the conditional primary ecosystem, which is a nature reserve and recreationally unloaded (FirO2), the number of soil nematodes groups was about 266 thousand individuals per 1 $m^2$ in the spring and was represented by all functional groups, including saprophages – 91,5%, predators – 5,4%, phytophages – 3,1%. In the summer, the smallest population of phytonematodes was recorded 88,7 thousand individuals per 1 $m^2$: saprophagous – 91,4%, predators – 5,8%, phytophages – 2,8%, their number increased in autumn and amounted to 111,7 thousand individuals per 1$m^2$, where the sapropages are 90,8%, predators – 6,2%, phytophages – 3,0%.

**Table 1.**

**Functional organization of the soil phytonematodes of fir grove in Precarpathians (2015)**

| Vegetation period | Trophic group,% | | |
|---|---|---|---|
| | **2015** | | |
| | Saprophages, % | Predators, % | Phytophages, % |
| **FirO1** | | | |
| spring | 88,0 | 8,0 | 6,0 |
| summer | 87,4 | 7,7 | 4,9 |
| autumn | 87,3 | 6,9 | 5,8 |
| **FirO2** | | | |
| spring | 91,5 | 5,4 | 3,1 |
| summer | 91,4 | 5,8 | 2,8 |
| autumn | 90,8 | 6,2 | 3,0 |
| **FirO3** | | | |
| spring | 85,5 | 8,9 | 5,6 |
| summer | 85,2 | 9,2 | 5,7 |
| autumn | 84,9 | 9,2 | 5,9 |

FirO1 – fir grove (anthropogenically transformed);
FirO2 – fir grove with grasses (natural structure of woodlands);
FirO3 – fir grove with small cover (recreationally loaded).

At the recreationally loaded area (FirO3), the number of soil nematodes groups amounted to about 20 thousand individuals per 1 $m^2$ in the spring, among which saprophages are 85,5%,

predators – 8,9%, phytophages – 5,6%. In the summer 82,0 thousand individuals per 1 $m^2$ were registered: saprophages – 85,2%, predators – 9,1%, phytophages – 5,7%. In the autumn, the number of phytonematode groups increased and amounted to 117,8 thousand individuals per 1 $m^2$, among which the sapropages – 84,9%, predators – 9,2%, phytophages – 5,9%.

The research results in 2016 showed that the number of soil nematodes groups in the monitoring area of fir groves (FirO1) was about 63,2 thousand individuals per 1 $m^2$ in the spring and was also represented by all functional groups, including saprophages – 88,5%, predators – 7,4%, phytophagous – 4,1%. In the summer, the amount of phytonematodes was more than 109,3 thousand individuals per 1 $m^2$, where the share of saprophages was lower and amounted to 86,7%, however, the share of phytophages increased by 5,9%. In the autumn, the number of phytonematodes increased to 229,9 thousand individuals per 1 $m^2$ and had the following characteristics: saprophages – 87,5%, predators – 7,4%, phytophages – 5,1% (see Table 2).

The number of soil nematodes groups in the area (FirO2) amounted to about 257,4 thousand individuals per 1 $m^2$ in the spring period and was represented by all functional groups, among which saprophages were 90,5%, predators – 6,4%, phytophages – 3,1%. In the summer period, the least settling of soil with phytomedicides was recorded as 105,6 thousand individuals per 1 $m^2$, including saprophages – 91,0%, predators – 6,0%, phytophages – 3,0%. In the autumn, the number of phytonematodes increased and amounted to 146,6 thousand individuals per 1 $m^2$, among which sapropages were 90,8%, predators – 6,3%, phytophages – 2,9%.

**Table 2.**

**Functional organization of the soil phytonematodes of fir grove in Precarpathians (2016)**

| Vegetation period | Trophic group,% | | |
|---|---|---|---|
| | **2016** | | |
| | Saprophages, % | Predators, % | Phytophages, % |
| **FirO1** | | | |
| spring | 88,5 | 7,4 | 4,1 |
| summer | 86,7 | 5,9 | 7,4 |
| autumn | 87,5 | 7,4 | 5,1 |
| **FirO2** | | | |
| spring | 90,5 | 6,4 | 3,1 |
| summer | 91,0 | 6,0 | 3,0 |
| autumn | 90,8 | 6,3 | 2,9 |
| **FirO3** | | | |
| spring | 85,4 | 9,1 | 5,5 |
| summer | 84,9 | 9,3 | 5,8 |
| autumn | 85,2 | 9,0 | 5,8 |

FirO1 – fir grove (anthropogenically transformed);
FirO2 – fir grove with grasses (natural structure of woodlands);
FirO3 – fir grove with small cover (recreationally loaded).

In the studied area (FirO3), the number of soil nematodes groups amounted to about 82,5 thousand individuals per 1 $m^2$ in the spring, among which saprophages were 85,4%, predators –

9,1%, phytophages – 5,5%. In the summer, 242,5 thousand individuals per 1 $m^2$ registered: sapropages – 84,9%, predators – 9,3%, phytophages – 5,8%. In the autumn, the number of groups was 96,8 thousand individuals per 1 $m^2$, among which saprophages were 85,2%, predators – 9,0%, phytophages – 5,8% (see Table 2).

The research results in 2017 showed that the number of soil nematodes groups of anthropogenically fir-tree transformed area (FirO1) amounted to 139,4 thousand individuals per 1 $m^2$ in the spring and was represented by all functional groups, including saprophages – 86,5%, predators – 8,1%, phytophagous – 5,4%. In the summer, more than 56,3 thousand individuals per 1 $m^2$ were registered, where the sapropages are 85,4%, predators – 8,3%, phytophages – 6,3%, their number was 202,6 thousand individuals per 1 $m^2$ in the autumn: sapropages – 87,3%, predators – 7,8%, phytophages – 4,9% (see Table 3).

**Table 3.**

**Functional organization of the soil phytonematodes of fir grove in Precarpathians (2017)**

| Vegetation period | Trophic group,% | | |
|---|---|---|---|
| | **2017** | | |
| | Saprophages, % | Predators, % | Phytophages, % |
| **FirO1** | | | |
| spring | 86,5 | 8,1 | 5,4 |
| summer | 85,4 | 8,3 | 6,3 |
| autumn | 87,3 | 7,8 | 4,9 |
| **FirO2** | | | |
| spring | 90,3 | 6,5 | 3,2 |
| summer | 89,9 | 7,2 | 2,9 |
| autumn | 91,3 | 5,6 | 3,1 |
| **FirO3** | | | |
| spring | 83,8 | 10,9 | 5,3 |
| summer | 84,2 | 10,7 | 5,1 |
| autumn | 85,1 | 9,4 | 5,5 |

FirO1 – fir grove (anthropogenically transformed);
FirO2 – fir grove with grasses (natural structure of woodlands);
FirO3 – fir grove with small cover (recreationally loaded).

In the conditional primary ecosystem, which is a nature reserve and recreationally unloaded (FirO2), the number of soil nematodes groups was about 94,1 thousand individuals per 1 $m^2$ in the spring and was represented by all functional groups, including saprophages – 90,3%, predators – 6,5%, phytophages – 3,2%. In the summer, the smallest population of phytonematodes was recorded 111,4 thousand individuals per 1 $m^2$: saprophagous – 89,9%, predators – 7,2%, phytophages – 2,9%, their number increased in autumn and amounted to 240,0 thousand individuals per 1$m^2$, where the sapropages are 91,3%, predators – 5,6%, phytophages – 3,1%.

At the recreationally loaded area (FirO3), the number of soil nematodes groups amounted to about 130,6 thousand individuals per 1 $m^2$ in the spring, among which saprophages are

83,8%, predators – 10,9%, phytophages – 5,3%. In the summer 152,3 thousand individuals per 1 $m^2$ were registered: saprophages – 84,2%, predators – 10,7%, phytophages – 5,1%. In the autumn, the number of phytonematode groups increased and amounted to 30,4 thousand individuals per 1 $m^2$, among which the sapropages – 85,1%, predators – 9,4%, phytophages – 5,5% (see Table 3).

In the recreationally loaded area (FirO3), compared to the conditionally primary ecosystem (FirO2), the share of saprophages decreases, while the share of phytophagous animals increases slightly. The features of seasonal changes in the number of phytonematodes in the recreationally loaded area (FirO3), in comparison with the conditionally indigenous, is the low population of the soil at the beginning of the vegetation. The habitat of soil phytonematodes on anthropogenically transformed area is mainly due to saprophages, but their share is also significantly smaller comparing the primary ecosystem.

Economic activity in the areas (FirO1) and (FirO3), which results in significant changes in plant cover, led to the formation of secondary unstable phytonematodic complexes, accompanied by significant changes in the functional organization of nematode groups.

In general, the number and functional organization of phytonematode groups influence the recreational load and successional processes of restoring the natural structure in the oak grove.

Knowing the qualitative and quantitative characteristics for the primary complexes of soil nematodes, in a particular, the type of biogeocoenosis, the indicators of the structural and functional organization for their groups can be used as indicators for the belonging of a specific biogeocenosis ecosystem to the primary, or to assess the state of their naturalness.

## CONCLUSIONS

The use of bioindicative characteristics of primary phytonematode complexes for specific types of biogeocoenoses enables to determine the belonging of biogeocenous ecosystems to the primary or to establish the magnitude of their naturalness according to the structural and functional parameters of the soil nematodes groups.

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## АНОТАЦІЯ

## ФУНКЦІОНАЛЬНА ОРГАНІЗАЦІЯ ФІТОНЕМАТОД ҐРУНТУ ЯЛИЦЕВИХ ДІБРОВ ПЕРЕДКАРПАТТЯ УКРАЇНИ

Загальна мета роботи передбачає на основі біоіндикаційних властивостей угруповань ґрунтових нематод встановити стан природності ялицевих дібров за умови відновлення їхньої природної структури деревостанів. У цій публікації поставлене завдання проаналізувати кількісні характеристики та особливості функціональної організації фітонематод ґрунту ялицевих дібров Передкарпаття України.

Дослідження проводили в ялицевих дібровах у межах Дрогобицького передгір'я Дністровського Передкарпаття на території Трускавецького та Доброгостівського лісництв у старовікових лісах, які мають різне антропогенне навантаження.

У результаті досліджень встановлено, що формування нематодних угрупувань у ялицево-дубових екосистемах відбувається за участю таких функціональних груп: сапрофаги, хижаки і фітофаги.

На рекреаційно навантаженій площі (ЯлД3), порівняно з умовно первинною екосистемою (ЯлД2) частка сапрофагів менша, проте збільшується частка фітофагів. Особливістю сезонних змін чисельності фітонематод на рекреаційно навантаженій ділянці (ЯлД3), порівняно з умовно корінною, є мала заселеність ґрунту на початку вегетації. Заселення фітонематодами ґрунту на антропогенно трансформованій площі відбувається в основному за рахунок сапрофагів, але їх частка також є істотно меншою, ніж у первинній екосистемі. Господарська діяльність на площах (ЯлД1) і (ЯлД3), унаслідок якої відбуваються суттєві зміни рослинного покриву, призвела до формування вторинних нестійких фітонематодних комплексів, що супроводжується значними змінами функціональної організації нематодного угруповання.

Загалом рекреаційне навантаження і сукцесійні процеси відновлення природної структури в ялицевих дібровах позначаються на чисельності та функціональній організації фітонематодних угруповань.

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# THE ROLE OF *AMBLYSTEGIUM SERPENS* AND *BRACHYTHECIUM MILDEANUM* IN THE CHANGE OF AMMONIA CONTENT IN THE CARPATHIAN WELLS WITH DIFFERENT TYPE OF ANTHROPOGENIC LOAD

**Abstract.** The article analyzes the role of bryophytes Amblystegium serpens and Brachythecium mildeanum in forming the quality of drinking water. Bryophytes can change the chemical properties of the water environment: accelerate the of nitrification phase, reduce the of ammonia nitrogen content, etc. [1, 14, 20]. This ability is provided by ammonia-binding properties of plants.

It was investigated that aquatic plants operate several enzyme systems for conversion of nitrogen compounds, especially ammonium binding that are activated by water pollution. The main form of nitrogen assimilation in organic compounds is known to be ammonium ions. Researches show [16] that the ammonium nitrogen assimilation occupy important enzymes glutamate synthetase cycle. Key enzyme among them is the glutamine synthetase enzyme. In terms of lack for reduced nitrogen in the cell, the genes, which products are involved in the assimilation of hard assimilable sources of nitrogen, are activated. Plant enzymes are exposed to external factors not directly but through a change in orientation of the physiological processes of metabolites and their transport characteristics. GS and HDH regulation and the relative contribution of these enzymes in the process of ammonium assimilation in various organs during the growth and development for various nutrition types are studied insufficiently [20]. The changes of ammonium ions content in wells water at surveyed areas with different type of anthropogenic pressure and assimilation ability of Amblystegium serpens and Brachythecium mildeanum was established. It is shown that the activity of of nitrogen metabolism enzymes in mosses are closely linked to the $NH_4^+$ content in water: the natural NH4 + level for its binding is sequentially performed by activating ammonia-binding plants enzymes, and at the increased content it is mainly performed due to the NADP-glutamate dehydrogenase.

**Keywords:** ammonium, Amblystegium serpens, Brachythecium mildeanum, drinking water, wells, Carpathian region, glutamate dehydrogenase, glutamine synthetase.

## INTRODUCTION

Aquatic plants growing in places, where the sources of drinking water supply are contaminated, can be used for the study of adaptation to various factors, as well as the indicators of toxic pollution, including the effect of heavy metals [11, 13].

In accordance with the adaptation to their existence in the certain hydrological regime, the aquatic plants have different accumulation and retention mechanisms. It was found that of the dead part of the moss cover has relatively high hydrolytic acidity, due to which the mosses cells are characterized by a large absorption capacity and can retain the large quantities of both hydrogen ions and other chemical elements [4].

Bryophytes reflect the ecological status of a water ecosystem more adequately in terms of long-term exposure to chemical environmental factors. In particular they are able to remove significant quantities of physiologically active substances from the water – phenols ,

heavy metals, pesticides and nutrients [8, 9, 13]. Most of these elements are accumulated in dead plant remains, particularly in the leaves, stems and inflorescences [2, 11,6], which may adversely affect the water quality, causing deterioration in gas mode, increased ammonia content and collected previously substances may enter water again. However, it was found [10, 12] that a decrease in water temperature significantly slows down the process of macrophytes degradation. It means that higher water plants are not significant polluters by indigenous substance in the autumn-winter period [17].

## MATERIALS AND METHODS

The studied territory of Pre-Carpathians was nominally divided into four parts by the nature of anthropogenic load - technologically transformed, recreational, rural and urban area [1]. The outskirts of Truskavets are the main objects of Carpathians natural reserve fund, and the wells located within this territory were identified as the recreation area. The territory of Drohobych and Stryi districts was identified as rural. Mykolaiv district, where the large enterprise (OJSC "Mykolaivtsement") is located, and the city Drohobych (where JSC "SPC - Galicia" is located) were identified as the technogenically tranformed area. The cities Boryslav, Drohobych, and Stryi were identified as the urbanized area. Study of the species composition in water bodies showed that all investigated wells contain bryophytes plants. In particular, creeping Amblistehium (Amblystegium serpens) was found in the wells of rural area. Brachythecium mildeanum was found in the wells at technogenic, recreational and urban areas - (table Identification of the species was carried out at the Institute of Hydrobiology of NAAS of Ukraine.

The ammonium content was determined photometric method for qualitative reaction with Nessler reagent at a wavelength of 420 nm. Water pH was determined using ionometer MI – 150. The free oxygen content was determined by Winkler iodometric method. The activity of glutamate dehydrogenase (EC 1.4.1.2) was established by spectrophotometric method for NADH oxidation speed at 340 nm [16]. Glutamine synthetase (EC 6.3.1.2) activity was studied in synthetase reaction [7].

## RESULTS AND DISCUSSION

Studies showed that the predominant form of nitrogen compounds in the well water at all investigated areas are ammonia nitrogen and nitrates. The ammonium compounds concentration varies 0,24-8,87 mg/L, its maximum water content was found in urban areas (8.87 mg/L), where its content exceeds the MPC by 4.5 times.

The highest $NH_4^+$ concentration in wells water at urban area was in July and it was 8.9 mg/L. In the next study period, this index is reducing, reaching a value of 3.8 mg/L (August), 2.8 mg/L (November), 1.8 mg/L (February), and rose again: 6.8 mg/L (October), 4.5 mg/L (December).

The ammonium ion content wells water technogenically transformed territory was 3.5 mg/L in March, its contents decreased three times in May, and increased again in June. During July-October $NH_4^+$ content rose again to a mark of 2.1 mg/L, but it fell again to the lowest level 0.3 mg/L in November. In November - February there was a rapid increase in its concentration to the maximum value 6.1 mg/L.

The water at the recreation area had a slight increase, the sharp decline in 2-3 times to 2.7 - 3.0 mg/L (July) for the $NH_4^+$ concentrations. The maximum value for this indicator was established in March (6.7 mg/L) and August (4.2 mg/L), a decline for this indicator to the lowest level was registered in October (0.8 mg/L), but later $NH_4^+$ concentrations slightly increased (2.8 - 3.0 mg/L), and this figure was again consistently low during November-February.

The ammonium content in the water of rural area was the highest in March - 8.0 mg/L. Later there was a rapid increasing to 2.7 mg/L (May), increase in July (5.8 mg/L), again fell sharply in October and reached the lowest level (1.8 mg/L), but NH4 + concentration again rapidly increased in November to February to 6.0 mg/L.

By quantitative indicators for NH4 + compounds, the content in well water for respective territories is as follows: Urban > Rural > Recreational > Technogenically transformed.

The presence of ammonium ions in groundwater is the result of microorganisms. In some cases, ammonium ions can form due to anaerobic recovery of nitrites and nitrates. Elevated levels of ammonium ions indicates the deterioration for water sanitary condition. The increased concentrations are caused by the inflow of household wastewater, nitrogen and organic fertilizers in the groundwater. High ammonia nitrogen content in wells water is often accompanied by the presence of other undesirable substances, such as manganese, iron, hydrogen sulfide, etc.

$NH_4^+$ concentration indicators exceeded the MPC in all studied wells. It may be due to high flow rates of nitrogen compounds in the water from anthropogenic sources, a violation of local biogeochemical cycles and the physical and chemical environmental factors: pH, oxygen mode, pollution by heavy metals, etc.

pH in the water at the studied area during the observation period the ranged from 6.35 (weakly acidic) - 7.45 (slightly alkaline).

The water at technogenically transformed territory had hydrogen ion content, which ranged from 6.35 - 6.75. pH of water at the recreational area ranged from 6.8 - 7.45 during the study period. The water at urban territory had hydrogen ion content, which ranged from 6.4 - 7.2. pH of water at the rural area ranged from 6.5 - 7.3. Moreover, the increase of this indicator was recorded in winter and spring, and decrease was recorded in summer and autumn.

A direct correlation relationship between pH and ammonia content in wells water for agricultural area in March (r = 0,9), water in urban areas in June (r = 0,94), water in technogenically transformed territory in March (r = 0,52 ), water in recreation area in July (r = 0,96).

The dissolved oxygen content in water of wells located on the territory of Precarpathian region ranged from 3.9 to 8.0 mg/L. As further study showed, the dissolved oxygen concentration in the cold season is higher than in the summer due to the increase in its solubility. The dissolved oxygen concentration in the water is determined by its consumption in water for oxidation of organic matter, sediments, as well as by the conditions of its production by phytoplankton and algae in the process of photosynthesis.

The ammonia concentration correlated with the $O_2$ content with the correlation index r = 0,80 (August RA), r = 0,79 (June UT), r = 0,75 (Aug. TT).

**Table 1.**

**Hydrochemical parameters of water samples from wells in Carpathian region at the territories with different character of anthropogenic load (M ± m; n = 5)**

| Area | Hydrochemical parameters | | |
|---|---|---|---|
| | $NH_4^+$, mg/L | $O_2$, mgO/L | pH, mol/L |
| June | | | |
| Technogenically transformed | 2.75±0.14 | 5.3±0.17 | 6.3±0.1 |
| Recreational | 3,8±0, 17 | 5.6±0.2 | 6.9±0.15 |
| Urbanized | 3.9±0.12 | 8.1±0.22 | 6.8±0.11 |
| Rural | 3.6±0.11 | 6.9±0.14 | 6.95±0.21 |

| | | | |
|---|---|---|---|
| September | | | |
| Technogenically transformed | 2.14±0.085 | 4.2±0.12 | 6.6±0.14 |
| Recreational | 4.3±0.17 | 3.8±0.18 | 7.1±0.25 |
| Urbanized | 3.84±0.07 | 5.4±0.21 | 6.8±0.2 |
| Rural | 2.4±0.11 | 4.6±0.12 | 6.55±0.22 |

**The activity of glutamate dehydrogenase.** Glutamate dehydrogenase is one of the key enzymes for inorganic nitrogen assimilation. During the study, the trend a sharp increase in NADH-glutamate dehydrogenase at technogenic territory 10 times from (0.05 ± 0.003) · 10-3 in June to (0.58 ± 0.43) · 10-3 was observed in September. The same trend is observed for changes in the recreational area from (0.03 ± 0.002) · 10-3 in June to (0.05 ± 0.002) · 10-3 in September and urban - from (0.15 ± 0.01) · 10-3 in June to (0.20 ± 0.018) · 10-3 in September, although the changes are fairly minor. A somewhat different situation was for the rural area. The decrease in activity of NADH-glutamate dehydrogenase from (1,55 ± 0.15) · 10-3 in June to (1.08 ± 0.079) · 10-3 in September was observed. The activity of NADPH-glutamate dehydrogenase increased in all studied areas. In particular, for the technogenic area - from (0.17 ± 0.02) · 10-3 in June to (0.39 ± 0.023) · 10-3 in September; for recreational area - from (0.06 ± 0.002) · 10-3 to (0.07 ± 0.004) · 10-3; in urban area - from (1.02 ± 0.009) · 10-3 to (1.07 ± 0.01) · 10-3. In the rural area, downward trend in activity from (0.25 ± 0.026) · 10-3 to (0.07 ± 0.065) · 10-3 remained again. The lowest activity of NADPH-glutamate dehydrogenase was observed in the recreational area, and the largest - in rural area.

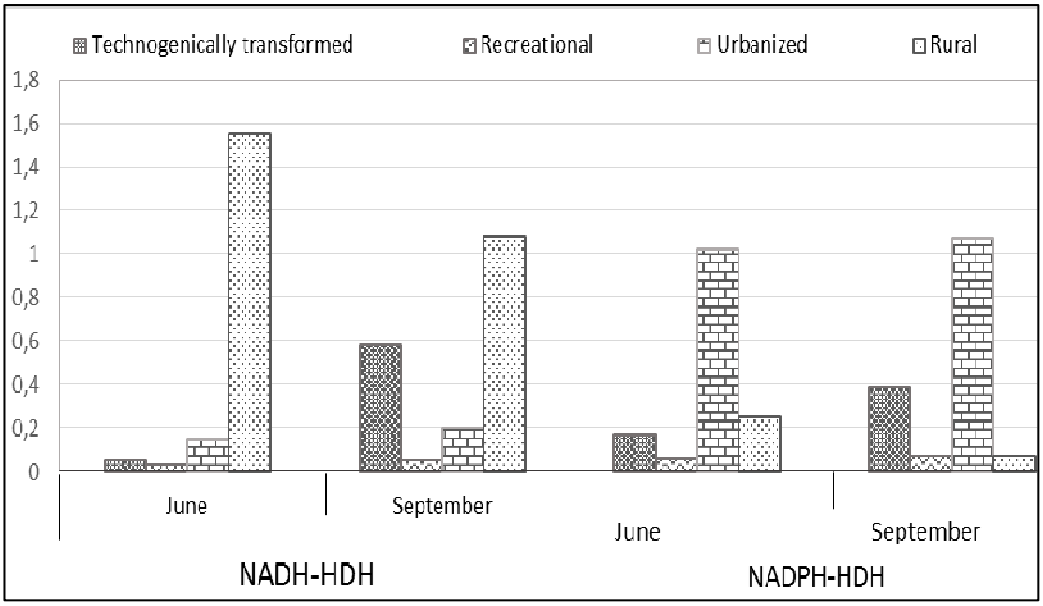


**Fig. 1 NADH and NADPH Activity (NADH mmol/mg of protein min) - dependent glutamate dehydrogenase in Amblystegium serpens and Brachythecium mildeanum (M ± m, n = 3)**

**Glutamine synthetase activity.** Glutamine synthetase catalyzes the key reaction of ammonia assimilation and reaction product – glutamine, amide or amine groups donor is involved in the synthesis of all major nitrogenous cell metabolites [8].

The conducted studies showed that the activity at the technogenic territory doubled from 1.516 ± 0.010 in June to 3.03 ± 0.05 in September. The activity grew 2.5 times at the recreational territory – from 0.979 ± 0.065 in June to 2.43 ± 0.07 in September. In urbonavantazheniy territory glutamine synthetase activity increased 6 times from 0.642 ± 0.023 in June to 4,88 ± 0.25 during the autumn. The rapid growth in the activity at rural area from 0.807 ± 0.026 to 9,76 ± 0,76 is also observed.

Studying glutamine synthetase activity (GS) in bryophytes, an inhibition and activation of enzymatic reactions depending on the study period was obserwed (Fig. 2).

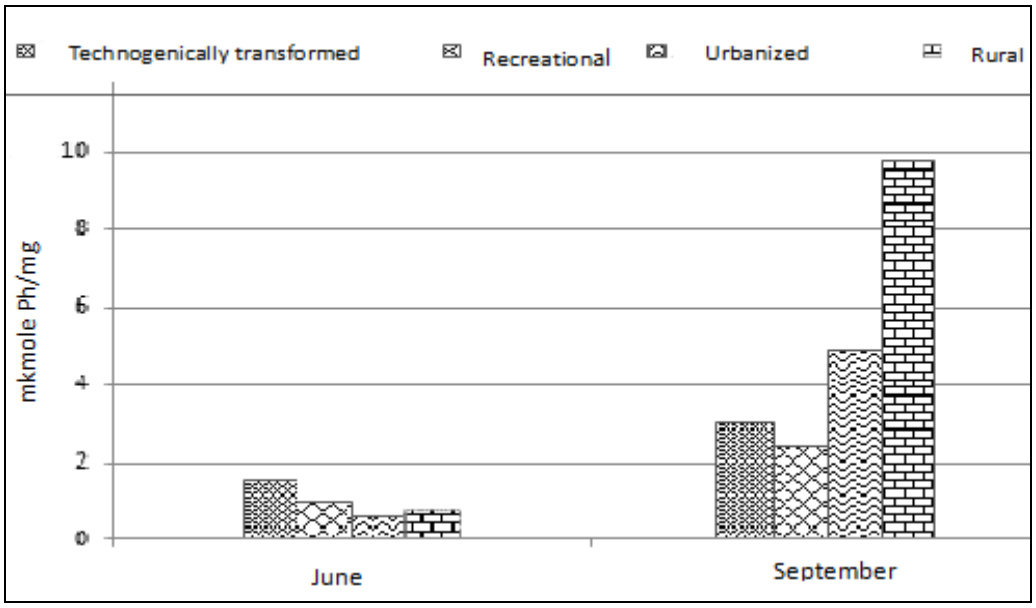


**Fig. 2. Glutamine synthetase activity in Amblystegium serpens and Brachythecium mildeanum. (M±m, n = 3)**

GS enzyme has high affinity for ammonium [14], thus, when the significant concentrations were observed in June, the enzyme functional activity is quickly lost.

## CONCLUSIONS

Regulation of enzyme activity in bryophytes mainly depends on the ammonium content, taxonomic identity and character of anthropogenic load. Our studies indicate that the level of nitrogen exchange in mosses is associated with the ammonia concentration in water: the increase leads to increased ammonia activity of the studied enzymes, and vice versa. reduced activity of NADN-dependent glutamate dehydrogenase in June in *Brachythecium mildeanum* was experimentally investigated for the water at technogenically transformed and recreational areas, due to increasing ammonium concentration. Reduction of ammonia content in September leads to the increase of enzyme activity. It is typical for *Brachythecium mildeanum* at the urban area and for *Amblystegium serpens* at the rural area.

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## АНОТАЦІЯ

## РОЛЬ *AMBLYSTEGIUM SERPENS* ТА *BRACHYTHECIUM MILDEANUM* У ЗМІНІ ВМІСТУ АМОНІЮ У КОЛОДЯЗЯХ ПРИКАРПАТТЯ З РІЗНИМ ХАРАКТЕРОМ АНТРОПОГЕННОГО НАВАНТАЖЕННЯ

В умовах прогресуючого забруднення джерел питного водопостачання водні рослини, які мешкають у них, можуть використовуватися як для вивчення процесів адаптації до дії різних чинників, так і в якості індикаторів забруднення токсичними речовинами.

Дослідження видового складу колодязів Прикарпаття з різним характером антропогенного навантаження показало, що у колодязях агронавантаженої території наявний Амблістегій, або Амблістегіум повзучий (Amblystegium serpens). У колодязях техногеннотрансформованої, рекреаційної та урбанізованої територій – Брахитеціум середній (*Brachythecium mildeanum*). Встановлено, що мохоподібні можуть змінювати хімічні властивості водного середовища: відмерла частина мохового покриву має досить високу гідролітичну кислотність, завдяки чому їх клітини характеризуються значною поглинальною здатністю і можуть у великих кількостях утримувати не лише йони водню, а й інших елементів, прискорювати фазу нітрифікації.

Досліджено, що у водних рослин функціонує декілька ферментних систем перетворення нітрогенвмісних сполук, насамперед, зв'язування амонію, які при забрудненні води активуються. Відомо, що головною формою асиміляції нітрогену в органічних сполуках є іони амонію. Дослідження показують [16], що в асиміляції амонійного нітрогену важливе місце посідають ферменти глутаматсинтетазного циклу. Ключовою серед цих ферментів є глутамінсинтетаза. В умовах недостатньої кількості відновленого нітрогену в клітині активуються гени, продукти яких беруть участь в асиміляції важко засвоюваних джерел нітрогену. Рослинні ферменти піддаються впливу зовнішніх факторів не безпосередньо, а через зміни спрямованості фізіологічних процесів, складу метаболітів, і особливостей їх транспортування. Регуляція ГС і ГДГ, і відносний внесок цих ферментів в процес асиміляції амонію в різних органах в процесі їх росту і розвитку за різних типів живлення вивчені недостатньо.

Встановлено зміну вмісту іонів амонію у воді колодязів досліджуваних територій з різним характером антропогенного навантаження та асиміляційну здатність Amblystegium serpens та Brachythecium mildeanum. Показано, що активність ензимів нітрогенного обміну у мохоподібних тісно пов'язана з вмістом NH4+ у воді: за природного рівня NH4+ його зв'язування здійснюється послідовним активуванням амонійзв'язучих ензимів рослин, а за підвищеного вмісту – переважно за рахунок НАДФ-глутаматдегідрогенази.

Експериментально досліджено зниження активності НАДН–залежної глутаматдегідрогенази у червні в Brachythecium mildeanum у воді техногенно-трансформованої та рекреаційної територій, що пов’язано із зростанням концентрації амонію. Зменшення вмісту амонію у вересні сприяв зростанню активності ферменту. Це характерно для Brachythecium mildeanum урбонавантаженої території та Amblystegium serpens аграрної

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# INFLUENCE OF SOIL INVERTEBRATES ON SOIL FORMATION PROCESSES

**Abstract.** It was found during the research that the faunistic composition of the representatives of the soil mesofauna in the soils of the Koblo village of the Staryy Sambir district is quite rich. The species diversity of arthropods (soil animals living in the soil during a part of the life cycle, a largely larval stage and temporarily inhabiting the soil) is the most numerous type represented by 3 classes, 7 rows, 13 families and 16 species. Carnivorous worms (permanent soil inhabitants) are represented by 5 genera and 8 species. Only three families and four species represent mollusks (temporarily living in soil) in the soils of the Koblo village of the Staryy Sambir district. The ecological features of the distribution of soil mesofauna in different types of ecotopes, in particular meadows, fields and agricultural land, are analyzed. The most favorable conditions for soil invertebrates were formed on fields and meadows (the number could range from several dozen to two hundred individuals per square meter). They play an important role in the soil formation processes, the disposal of dead plants and animals remains.

***Keywords***: soil invertebrates, soil reclamation, Staryy Sambir district.

## INTRODUCTION

At the present stage of the biosphere evolution, the productive activity of humanity has led to a significant impact on the natural environment, which is manifested itself in the creation of artificial ecosystems, where the substance-energy exchange has changed. Invertebrate animals play a significant role in their functioning as a structural element of ecosystems [23].

Soil invertebrates are saprophages, provide the maximum possible decomposition of plant remains and are an important natural factor in preserving the soil fertility [3, 8].

Analyzing the qualitative and quantitative characteristics of invertebrates, it is possible to establish the effectiveness of the ecosystems functioning, to predict their development, to draw conclusions about the use of their biotic potential [4].

Soil biocenoses are represented by a wide variety of invertebrate animals, namely: the simplest (sarcodic, flagella, infusoria), nematodes, colloquials, oligochaetes (lumbricides and enchitrides), vein mollusks, helices (spiders, mites and psevdosporpiums), crustaceans, polygons, and insects. These animals include more than 90% of the mass of all heterotrophs and affect the processes of primary products formation, dead organic matter decomposition, and soil formation [17].

Mesofauna is an important component of biogeocoenoses. It occupies the main place in the zooma and the cenosis composition, which significantly affects the processes of organic remains transformation, the chemical elements migration in the horizons of the soil profile, soil formation, biological processes stimulation and succession of organisms in soil biogeocoenoses. Without taking into account the soil mesofauna, it is impossible to make a general inventory of the animal world. At the same time, soil mesofauna includes a significant amount of forest and agricultural pests, and therefore is of great practical importance.

Among the representatives of the soil invertebrate's mesofauna, there are many stenobiont species. In fact, they meet the requirements for indicating the state of the environment and can serve as monitoring objects.

Solving the problem in the bioindicative goals can only be based on the study of the soil invertebrates grouping in general, including mesofauna representatives [7].

The urgency of the study is explained by the insufficient level of information about the influence of soil invertebrates on soil-forming processes.

## MATERIALS AND METHODS

The material was collected during 2012-2016 in the Staryy Sambir district. 120 samples were taken for research. To study the species composition of the soil mesofauna, we used MS methods. Gilyarova and KK Faculatti [2, 13]. The animals were sown in season, in accordance with methods generally accepted in soil zoology [18]. Classes of dominance are determined by the approach of G. Stoker and A. Bergman [20].

## DISCUSSION

The bulk of the mesophauna consists of soil oligochaetes of the lumbricidae family, polygons, insects and their larvae.

Soil invertebrates, as a structural element of ecosystems, play an important role in their functioning, in the processes of the matter and energy transformation [5]. Since most of the soil invertebrates are saprophages, the higher the diversity of this trophic group, the more efficiently and completely they carry out the work on the destruction of dead vegetation, contribute to the maintenance of the phyto-component of the ecosystem by nutrient elements, and improve the soil.

Ants belong to those animals that not only adapt themselves to the existence conditions, but also actively rebuild the environment. The role of ants in soil formation is less described than earthworms, but it is known that the vast majority of species build nests exactly on the ground, with the walk sometimes reaching a depth of several meters, forming a real maze. At the same time, the mechanical structure of the soil, its permeability for air and water is improved. The layer of humus under an antler, especially in poor sandy soils, is 2-3 times larger than around [14].

Our researches were conducted on 3 sites (meadow, field and agricultural plot).

***Table 1***

**Taxonomic diversity of the most common arthropods in the study area**

| Phylum | Class | Order | Family | Species |
|---|---|---|---|---|
| Arthropoda (Arthropoda) | Insects *(Insecta)* | Shaftoptera *(Hymenoptera)* | Ants *(Formicidae)* | Black ant *(Lasius niger* L*)* |
| | | | | Ravenous ant *(Formica pratesis)* |
| | | | | Лісова мураха *(Formica rufa* L.*)* |
| | | | Wasps (*Vespidae)* | Common wasp *(Vespula vulgaris* L.*)* |
| | | Orthoptera *(Orthoptera)* | Crickets *(Tettigoniidae)* | Wart-biter *(Decticus verrucivorus* L.*)* |
| | | True bugs *(Hemiptera)* | Pagaronia *(Cercopdiae)* | European Alder Spittle Bug *(Aphrophora alni* F.*)* |
| | | Beetles | Ladybugs (*Coccinellidae*) | Seven-spot ladybird (Coccinella septempunctata L.) |
| | | | Ground beetles *(Carabidae)* | Corn ground beetle (*Carabus cancelatus* I.) |
| | | | Pyrochrodae *(Pyrochrodae)* | Cardinal beetle *(Pyrochroa coccinea* L.*)* |

| | | | | |
|---|---|---|---|---|
| | | *(Coleoptera)* | Attelabidae *(Deporausdae*) | Attelabus *(Deporaus betulae* L.) |
| | | | Click beetles *(Elateridae* ) | Click beetle *(Hemicrepidius hirtus* L.*)* |
| | | | | Elater *(Elater sanguineus* P.*)* |
| | | True bugs *(Hemiptera)* | Bishop bugs (*Miridae*) | Lucerne bug *(Adelphocoris lineolatus* G.*)* |
| | Myriapoda *(Myriapoda* ) | Millipebes *(Diplopoda)* | Drupes (*Lithobiomorpha* | Brown centipede (*Lithobius forficatus* L.*)* |
| | Arachnids *(Arachnida)* | Spiders (*Araneae*) | Nursery web spiders *(Pisauridae)* | Wart-biter (*Decticus verrucivorus* L.*)* |
| | | | | Raft spider *(Dolomedes fimbriatus* L.*)* |

All groups of organisms directly (trophic bonds) or indirectly (sharing space, changing the existence environment) are interconnected, that is, they form a particular complex.

The species diversity of arthropods (these are soil animals living in the soil during a part of the life cycle, a largely larval stage and temporarily inhabiting the soil) in the soils of the Koblo of the Staryy Sambir district are the most numerous type represented: 3 classes, 7 rows, 13 families and 16 - species (Table 1).

Carnivorous worms (permanent soils) are represented by 5 genera and 8 species (Table 2).

***Table 2***

**Taxonomic diversity of rainbow worms in the study area**

| Phylum | Class | Order | Family | Genus, author | Spesies, author |
|---|---|---|---|---|---|
| Little worms (Annelida) | Oligochaetes (Oligochaeta) | Haplopaxides (Haplotaxida) | Rainworms (Lumbricidae) | *Allolobophora,* Eisen | Green worm *(Allolobophora chlorotica* S.*)* |
| | | | | *Dendrodrilus*, Omodeo | Dendrodrilus octaedra *(Dendrodrilus octaedra* S.*)* |
| | | | | | Dendrodrilus rubidus *(Dendrodrilus rubidus subrubicundus* E.*)* |
| | | | | *Octolasion*, Orley | White worm (*Octolasion lacteum O.*) |
| | | | | *Eiseniella,* Michaelsen | Eiseniella tetraedra *(Eiseniella tetraedra tetraedra* S.*)* |
| | | | | *Aporrectodea,* Orley | Розовий червяк *(Aporrectodea rosea* S.) |
| | | | | | Aporrectodea longa *(Aporrectodea longa* U.*)* |
| | | | | | Grey worm *(Aporrectodea caliginosa caliginosa* S.*)* |

The mollusks (temporarily inhabiting the soil) in the soils of the village Koblo of the Staryy Sambir district are represented by only three families and four species (Table 3)

***Table 3***

**Taxonomic diversity of the most common molluscs in the study area**

| Phylum | Class | Family | Species |
|---|---|---|---|
| Mollusks (*Mollusca*) | Gastropods (*Gastropoda*) | Ramshorn Snails (*Planorbidae*) | Ram Snail (*Anisus Vortex*) |
| | | Bladder Snails (*Physidae*) | Common Bladder Snail (*Physa Fontinalis*) |
| | | Roundback Slugs (*Arionidae*) | Grey Garden Slug (*Deroceras Reticulatum*) |
| | | | Grey Field Slug (*Agriolima Agrestis*) |

Analyzing the data during the research period from 2012 to 2016, in the experimental sites 28 species of invertebrates whose living is closely or indirectly related to the soil are the most common.

Permanent inhabitants and those who live in the soil during part of their life cycle are rainworms, ants, beetles and mollusks. Their number is presented in table 4.

As it can be seen from Table 4, rainstorms and ants are the main soil forming in our research.

On meadows (Table 4), meadow ants dominate, which are directly proportional to the soil and influence its physical and chemical properties, namely, they play an important role in the soil formation processes, utilization of plants and animals dead remains. They have such a significant importance in nature due to the large number of individuals of their colonies.

***Table 4***

**The total number of mesofauna in different parts of the study area**

| Experimental sites | Dominant vegetation groups | Number of rainbow worms, ex. / $m^2$ | Number of antches, ex. / $m^2$ | Number of beetles, ex. / $m^2$ | Number of mollusks, ex. / $m^2$ |
|---|---|---|---|---|---|
| Site №1 Meadow | *Phagmites australis L.Trifolium pretense L., Dactylis glomerata L. Gymnadenie conopsea subsp; Bromus squarrosus L, Achillea colina d. Populus tremula, Pyrus communis, Sorbus aucuparia* | 53 | 104 | 14 | 36 |
| Site №2 Field | *Achilea millefolium L., Calamagrostis epigeios L., Trifolium pretense L., Dactylis glomerata L., Taraxacum officenale Wigg., Tussilago farfara L. Melica nutans, Elytrigia repens, Ranunculus acris* | 79 | 64 | 4 | 24 |
| Site №3 Agricultural land | Vegetable crops: *Solanum tuberosum*, *Daucus sativus, Beta crassa, Phaseolus vulgaris*, *Vicia faba* | 12 | 63 | 20 | 8 |

Ants belong to those animals that not only adapt themselves to the existence conditions, but actively rebuild the environment. The role of ants in soil formation is illuminated less than earthworms, but it is known that the vast majority of species build nests exactly on the ground, with the walk sometimes reaching a depth of several meters, forming a real maze. At the same time, the mechanical structure of the soil, its permeability for air and water is improved.

Rain worms dominate on the fields, whose activities are one of the special factors of soil formation.

Potential sources of organic matter in the soil are aboveground and root residuals from woody and herbaceous plants, biomass of invertebrates and microorganisms. The green plants biomass (phytomass) and its annual growth (primary production) are several dozen or even hundreds of times greater than the biomass of animals and microorganisms. However, the active livelihoods of the latter, their specific chemical composition, high protein content determine their role in the humus formation and of nitrogen compounds accumulation in the soil. In sod-podzolic soils, the biomass of invertebrates is 7-12 g / $m^2$ [9].

A significant role of rainworms is noted in the biogenic degradation processes of plant residues [9], they enrich the soil with nutrient calcite [10], which neutralizes the soil acidity, and contributes to the creation of optimal conditions for the plants development. On excrements, bacteria, actinomycetes, mushrooms develop here, which are ten times more than in the surrounding soil.

The effect of rainworms on soil processes varies depending on their ecological group and species forming it. Therefore, earthworms Lumbricus terrestris and other nursery can be considered as one of the most functionally active soil animals in the temperate zone [1].

Rain worms expose almost all the chemical components of plant residues. Due to symbiosis with microorganisms and a wide range of enzymes in the esophagus, this accelerates the transformation process of organic matter. In the digestive tract, there is not only a mechanical mixing and connection of organic and mineral particles, but also the structuring of "chimes". Each section of the digestive tract of earthworms corresponds to a certain stage of metabolism [5]. In the anterior gut, there is dispersion of the food substrate and enveloping it with mucus. In the middle gut, it lasts for several hours. Separate particles of the food substrate, which do not mix with each other, are surrounded by flour. In the intestine, the food substrate is compacted, and within it, there is a spatial structuring of the components. The center contains microorganisms, detrital remnants that are surrounded by flour, and on the surface of the food substrate there are muddy clay fractions and dispersed organic particles [19, 21]. Under the action of enzymes proteases, proteins quickly decompose on amino acids, and decomposition of sugars occurs with the enzyme sucrose. Starch hydrolysis occurs with the enzyme amylase. Microorganisms that produce cellulose enzyme decompose cellulose. Lipids are decomposed more slowly than proteins, carbohydrates and starch. The slowest decomposed substance is lignin. Oxiductase enzymes, lyases, esterases and lactase are involved in this process [1, 5]. Actually, all the products of splitting detritus and minerals are excreted in the soil in the form of coprolites that are enriched with potassium, magnesium, calcium, phosphorus, and nitrates [16]. According to Pakhomov [9], in comparison with the ground, the coprolitic earthworms are 1.5 times more enriched with phosphorus oxides, 2.5 times by potassium oxide, and 3 times by nitrogen.

Conditions in the intestines of rainworms are favorable for both aerobic and anaerobic microorganisms, while in the soil more favorable conditions are found for aerobic microorganisms [15].

The mechanical activity of rainworms, caused by movement in the soil profile, improves the conditions of air, moisture exchange, and migration of nutrients [22]. Thus, the population of the rainforest Aporrectodea caliginosa with a density of 100 specimens. / $m^2$ can pass 1058 km per 1 hectare of soil surface within one week and drag into mechanical turnover about 7.9. tons of soil [19]. Species populations (*Lumbricus terrestris, Aporrectodea caliginosa*) with a density of 346-471 units / $m^2$ with an average biomass of 56.9 - 61.2 g / $m^2$ can produce about 18 - 22 kg / $m^2$ of coprolite per year. Secondary biological products can

range from 81.7 to 218.5 g / $m^2$. The rate of nitrogen return to soil due to animal mortality is 1.5-3.9 g / $m^2$ [5].

The number of rainworms can reach several hundreds per square meter [6]. In a biotope with a high population density of rainworms, the volume of niches can be a significant part of the total pore space of the soil and provide an important route for the movement of water and air in the soil [5, 9].

The source of nitrogen is the worms' consumption of plant residues [1, 5]. According to Williams et al. [21] rain-storms with a density of 5 cc / cm3 can mineralize about 40 kg / ha of nitrogen per year (the species Lumbricus terrestris is about 60 kg / ha nitrogen per year). In general, excrement of rain worms is characterized by a significant saturation of nitrogen in comparison with the surrounding soil. The source of nitrogen is plant residues consumed by rainworms [9]. Due to the consumption of plant residues, they facilitate the redistribution of organic substances in the soil horizon [1, 5, 12].

Taking into account the above data, the amount of nitrogen mineralized by rainworms during the year in different parts of our territory can be calculated (Table 5).

***Table 5.***

**Decomposition of plant residues by rainworms on experimental sites**

| Experimental sites | Site №1 meadow | Site №2 field | Site №3 agricultural land |
|---|---|---|---|
| Number of rainbow worms, $m^2$ | 53 | 79 | 12 |
| Amount of nitrogen, kg / ha per year | 424 | 632 | 96 |

As it can be seen from Table 5, in sites number 1 and number 2, due to rain-plowed worms, about 424 and 632 kg / ha of nitrogen per year are mineralized. At the site number 3, the formation of nitrogen is insignificant (96 kg / ha nitrogen per year), due to the small number of rainworms. These data indicate that the remains of the fields are the fastest decaying plant and other origins, slower on the meadows, rather slowly in the agricultural land.

## CONCLUSIONS

The faunistic composition of the soil mesofauna representatives in the soils of the Koblo village of the Staryy Sambir district is quite rich.

The species diversity of arthropods (soil animals living in the soil during part of the life cycle, a largely larval stage and temporarily inhabiting the soil) is the most numerous type represented by 3 classes, 7 orders, 13 families and 16 species.

Carnivorous worms (permanent soils inhabitants) are represented by 5 genera and 8 species.

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The most favorable conditions for soil invertebrates were formed on fields and meadows (the number could range from several dozen to two hundred individuals per square meter). They play an important role in the soil formation processes, the disposal of dead plants and animals remains.

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## АНОТАЦІЯ

## ВПЛИВ ГРУНТОВИХ БЕЗХРЕБЕТНИХ НА ГРУНТОТВОРЧІ ПРОЦЕСИ

На сучасному етапі еволюції біосфери виробнича діяльність людства призвела до значного впливу на природне середовище, що проявилося у створенні штучних екосистем, у яких змінився речовинно-енергетичний обмін. Безхребетні тварини як структурний елемент екосистем відіграють значну роль у їх функціонуванні.

Ґрунтові безхребетні – сапрофаги, забезпечують максимально можливий розклад рослинних решток і є важливим природним чинником збереження родючості ґрунту.

Аналізуючи якісні і кількісні характеристики угруповань безхребетних тварин, можна встановити ефективність функціонування екосистем, спрогнозувати їх розвиток, зробити висновки щодо використання їх біотичного потенціалу.

Мезофауна є важливим компонентом біогеоценозів. Вона займає основне місце в зоомасі та складі ценозу, істотно впливає на процеси трансформації органічних решток, міграції хімічних елементів у горизонтах ґрунтового профілю, ґрунтоутворення, стимулювання біологічних процесів та сукцесії організмів у біогеоценозах ґрунту. Без обліку мезофауни населення ґрунту неможливо скласти загальний кадастр тваринного світу. Разом з тим, мезофауна ґрунту включає значну кількість лісових і сільськогосподарських шкідників, а тому має велике практичне значення.

Під час проведення дослідження нами встановлено, що фауністичний склад представників ґрунтової мезофауни у грунтах села Кобло Старосамбірського району є досить багатим.

Видове різноманіття членистоногих (це ґрунтові тварини, що живуть у ґрунті протягом частини життєвого циклу, здебільного личинкову стадію та тимчасово мешкають у ґрунті) є найчисельнішим типом який представлений: 3 – класами, 7 – рядами, 13 – родин та 16 – видами. Кільчасті черви (постійні мешканці ґрунтів) представлені 5 родами та 8 видами. Молюски (тимчасово мешкають у ґрунті) у грунтах села Кобла Старосамбірського району представлений лише трьома родинами та чотирма видами.

Проаналізовано екологічні особливості поширення ґрунтової мезофауни у різних типах екотопу, зокрема луки, поля та сільськогосподарського угіддя.

Найбільш сприятливі умови для грунтових безхребетних тварин сформувалися на полях та луках (кількість може сягати від кількох десятків, до двох сотень особин на квадратний метр).

Грунтові біоценози села Кобла Старосамбірського району представлені найрізноманітнішими безхребетними тваринами, а саме: нематодами, коловертками, олігохетами (люмбрицідами і енхитреїдами), черевоногими молюсками, хеліцеровими (павуками, кліщами, косариками, псевдоскорпіонами), ракоподібними, багатоніжками, комахами. Ці тварини становлять понад 85 % маси усіх гетеротрофів і впливають на процеси формування первинної продукції, розкладу відмерлої органічної речовини, ґрунтоутворення.

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# ORIGANUM VULGARE VEGETATION IN CARPATHIAN FOOTHILLS FITOCENSOSES OF DHOHOBYCH DISTRICT

**Abstract**. The article examines features of Origanum vulgare populations that represent the meadow biocoenoses of foothill lowlands and mountain areas of Drohobych district. Studied groups of plants from different locations have proper coenotic characteristics. The research have found that the surrounding countryside of the Skhidnytsia village is characterized by a thick growth of O. vulgare, in Luzhok Dolishniy area plants of this species occur rarely, in Dovhe Hirske area moderately thick. The uneven distribution of O. vulgare in the studied areas of the Drohobych district is caused by its growth dependence upon different environmental conditions and anthropogenic influence. Some O. vulgare populations locus within the studied territories is superseded by more competitive species as a result of successional processes.

**Key words**: Origanum vulgare, species, population, natural resources, medicinal raw material.

## INTRODUCTION

Protection, conservation and rational use of vegetable life is an important and necessary factor for the functioning of the environmental components in modern conditions. It helps to normalize human life and activities. Violation of biotic interactions due to the anthropogenic transformation of the environment is a well-recognized fact. For this reason, issues of conservation, maintenance, reproduction and detailed study of biotic diversity are one of the most important tasks [3].

Ukraine possesses significant natural resources of various types of plants, including medicinal plants [3, 8]. The Carpathian flora is rich and carries great potential for practical use of medicinal plants. Therefore the need for medicinal raw materials used for phytotherapy medications is increasing. However, uncontrolled harvesting, intensive exploitation of natural plant resources and the lack of limits on annual harvesting leads to a reduction of the medicinal plants species area due to the degradation of their populations [10]. The resource potential of many valuable species is modest, therefore, the discovery of plant reserves and the evaluation of resources, the development of scientific support of their use are a matter of national importance [3, 8]. Due to the constant process of anthropogenic transformation and an increasing annual harvest of medicinal raw materials, it is important to conduct a periodic inventory of medicinal plant reserves.

Particular attention in this matter is given to medicinal plants of the Lamiaceae family, and O. vulgare in particular. This plant grows naturally in lawns, dry meadows and light forests. Traditionally O. vulgare e is being used as a culinary herb and medicinal plant. Seldom it is be used even in decorative gardening [4].

O. vulgare herbage contains up to 1,5% of essential oils, flavonoids, tannins (up to 20%), ascorbic acid (in leaves 0,57%), bitter substances, pigments [13, 15]. The essential oil consists of thymol and carvacrol (up to 44%), bi- and tricyclic sesquiterpenes – up to 12%, free spirits – up to 15%, geranyl acetate – up to 5%. The fruitage contains up to 30% of drying fatty oils [1, 6, 18]. O. vulgare is widely used in medicine in combination with other herbs. The herb is used as a sedative matter, enhances the secretion of digestive and bronchial glands, and intestinal motility. Is also helpful to cure the respiratory tract inflammation problems. Recommended as

anti-sclerotic, hypothetical, analgesic, anti-inflammatory and deodorizing matter [10, 12-17, 21].

The O. vulgare population has declined significantly for the last decades, caused primarily by the anthropogenic factors negative impact on the environment. For this reason, many countries launched its growing in farms. Therefore, finding and studying natural O. vulgare populations in the territory of the Carpathian region is a scientific matter of great interest.

## RESEARCH METHOD AND CONDITIONS

Areas of the O. vulgare natural growth were defined on the basis of the preliminary analysis of the species composition of the meadow biocoenoses. As a result of the received data, authors have determined the directions of the future research survey [3, 8]. Accepted methods of botanical science (discount areas and zones, model samples). Identification of plant species was carried out using botanical field guides [2, 9].

Authors have selected three trial monitoring areas in Drohobych district, 0,5 hectares each, with an aim to monitor the dynamics of populations and resources of O. vulgare.

Area 1 (49°26'59"N, 23°22'10"E) – the environs of Luzhok Dolishniy village – the lowland region of Drohobych district.

Area 2 (49°19'56"N, 23°14'42"E) – the environs of Pidbuzh urban-type settlement – foothill zone of Drohobych district.

Area 3 (49°23'47"N, 23°40'56"E) – the environs of Dovhe Hirske village – mountain zone of Drohobych district.

The monitoring areas were selected taking into account different levels of anthropogenic load on phytocoenoses. The plant is very sensitive to human-made impact.

Authors analyzed the phytocoenotic growth conditions of O. vulgare, height of plants, and number of bions in different age groups, peculiarities of anthropogenic load on the areas. As a result of the research, the density of growth of O. vulgare was analyzed. An estimation method of the direct census was used to determine the density of individual species in the coenosis. Such estimation is usually carried out according to the scale of the number of species in phytocoenosis, according to the scale proposed by Drude in particular [3, 6, 8].

## DISCUSSION OF THE RESULTS

The studied area is a part of Drohobych district pre-mountain sculptural hill. It occupies the territory between Dnister and Stryj rivers. The average height reaches ca. 300–400m above the sea level. Drohobych hills are divided by the wide valleys of Bystrica Pidbuzka, Tysmenytsia, Kolodnytsia-Nezhukhivka rivers and numerous streams. Salt deposits zone reveals the dependence of erosion dismemberment on lithology (area of the Kolodnytsia river valley).

The experimental material was selected and studied in the course of field research during 2014–2016. The article analyses O. vulgare populations representing the meadow biocoenoses of lowland, foothill and mountainous areas. Studied groups of plants from different locations have proper coenotic characteristics.

The population of O. vulgare in the terrain of Luzhok Dolishniy village consists of individual point locations. According to our observations, this area has a high pasture load. Massive flowering of plants was observed from the end of the third ten-day of June.

The population of O. vulgare in the terrain of the Pidbuzh village consists of many separate point locations. Massive flowering was observed at the end of June.

The population of the O. vulgare in the terrain of Dovhe Hirske consists of several separate point locations. In this area, mass flowering was observed at the beginning of the first

tenday of July, which is 8–9 days later than in other areas. This meadow biocoenosis is characterised with low pasture load.

Studied plant populations differ in terms of projective coverage and density of structures. The projective cover of the grass, which includes the population of Luzhok Dolyshniy village, reaches up to 70%. For Pidbuzh urban-type settlement projective cover is ca. 75%. Dovhe Hirske area projective coverage of the grass is ca. 80%.

The vegetation period of O. vulgare includes the following phases: the first year (germination, rosette); second year (restoration of vegetation, stalk formation, flowering, fruiting, ripening of seeds).

The phenological observations of O. vulgare plants growing in the studied areas showed that the spring regeneration of the species occurred during March at an average daily temperature of +6ºC. The phase of budding evolved in 2nd–3rd ten-day of June. Large blooming observed from the second ten-day of June to the second ten-day of July, beginning with the second year of vegetation. The total blooming time of plants was 20–35 days. Ripening of seeds continues from August to late fall. Seeds are very small, the weight of 1000 is 0,1 g. The time period from the beginning of vegetation to seeds ripening takes 184–198 days in average.

Morphological characteristics of O. vulgare were studied as one of the research objectives. The top leaf-bearing part of the reproductive shoots was collected during the phenological phase of large blooming. The experimental plant samples of O. vulgare were 50–70cm high. The stalks of the plants were straight, slightly hairy, leaf-bearing. Leaves are opposite, with slightly hairy propagula, oblong-ovoid, plain, glandular, slightly hairy below. The length of the leaf varies from 1,1 to 2,2 cm, and the width is 0,4–1,1 cm. Flowers are small, numerous, collected in oblong spicules, which form a panicle. Fruits - triangular nuts in length of 0,2–0,4 mm. The average blooming time is 28–35 days.

When analyzing the abundance of selected populations, it should be noted that the most significant differences have been found among the indicators of an abundance of reproductive shoots (more than twice) and phenological phases. Determining the abundance helps to define the degree of participation of plants in the coenosis. For such needs, we applied an estimation method of the direct census (see Table 1).

**Table 1. Growth of Origanum vulgare (2014-2016)**

| № | Location of Origanum vulgare natural growth areas | Density |
|---|---|---|
| 1. | Pidbuzh (area 1) | Cop2 – thick growth of plants |
| 2. | Luzhok Dolishniy (area 2) | Sp – rare growth of plants |
| 3. | Dovhe Hirske (area 3) | Cop1– moderately thick growth |

As a result of the research, it was found that in the terrain of the urban-type settlement Pidbuzh (area 1) the growth of O. vulgare plants is thick; in the terrain the village Luzhok Dolishniy (area 2) plants of this species occur rarely; in the terrain of the village of Dovhe Hirske (area 3) the frequency of the growth of O. vulgare is moderately thick.

It is evident that the O. vulgare population in Pidbuzh fully uses available mineral and natural resources and is characterized by the optimal (for given conditions) quantity and abundance. In our opinion, such characteristic clearly confirms that the natural conditions for this plant population are stable and advantageable. However, certain location spots of the species in this area may be displaced by more competitive species, since successional processes are a natural and direct consequence.

The ontogenetic spectrum of Luzhok Dolishniy village terrain is slightly different. This population demonstrates the inhibition of reproduction processes. First of all, this is connected

with the successional processes of the location of the species. The basis of these processes is the colonization of meadow coenosis with vegetation of shrub species (Betula pendula Ehrh., Alnus incana L., Rosa canina L., Prunus spinosa L., Malus sylvestris Mill.). Strengthening of the phytocoenic role of the adventitious species and the intensification of interspecific competitive relations reduces the viability of the plants of O. vulgare. Consequently, the structure of species population changes and the tendency towards fragmentation increases. High shading of herbs and well-developed phytomass of other species negatively impact the development of O. vulgare. A better reproduction of its population can be achieved with the aid of several factors. One possible option is the reaction to the absence of anthropogenic pressure – the cessation of cattle grazing, economic activity and destructive harvesting of plants.

The population of O. vulgare in the teof the village of Dovhe Hirske is in a satisfactory condition. It does not have a dominant role in phytocoenosis, forms small underbrush. By reason of given climatic and geographical conditions of this mountainous area, phonological phases of vegetation, blooming and ripening occur later. The uneven distribution of O. vulgare in studied areas of Drohobych district is characterized by the uneven growth under various environmental and anthropogenic conditions.

## CONCLUSIONS

As a result of the research, it was found that O. vulgare population on examined territory represent meadow biocoenoses of foothill lowlands and mountain areas of Drohobych district. Studied groups of plants from different locations have proper coenotic characteristics.

However, certain location spots of the species in this area may be displaced by more competitive species, since successional processes are a natural and direct consequence. Therefore, the constant observation of certain locations is required. From this point of view monitoring studies are of great importance. They allow to estimate the condition of plant population and predict dynamic tendencies and possible changes.

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## АНОТАЦІЯ

## ПОШИРЕННЯ *ORIGANUM VULGARE* В ЛУЧНИХ ФІТОЦЕНОЗАХ ПЕРЕДКАРПАТТЯ ДРОГОБИЧЧИНИ

Досліджено особливості зростання популяцій *Origánum vulgáre,* які представляють лучні біоценози низинних, передгірських і гірських регіонів Дрогобицького району. Досліджені групи особин з різних місцезнаходжень перебувають в оптимальних ценотичних умовах.

В результаті досліджень встановлено, що в околицях с.м.т. Підбуж рослини материнки звичайної рясні, в околицях села Лужок Долішній рослини даного виду трапляються рідко, в урочищі села Довге Гірське частота трапляння *O. vulgare* помірно рясна.

Популяція *O. vulgare* с.м.т. Підбуж максимально використовує доступні мінеральні та енергетичні ресурси і має оптимальні (для даних умов) чисельність і рясність. Така характеристика однозначно засвідчує, що умови існування цієї популяції є стабільними

та сприятливими. Однак, окремі локуси популяції на цій території можуть витіснятися більш конкурентноспроможними видами, оскільки сукцесійні процеси є закономірним і спрямованим наслідком.

Онтогенетичний спектр популяції села Лужок Долішній демонструє пригнічення процесів відтворення. Це, насамперед пов'язано із сукцесійними процесами місцезростання виду. В основі цих процесів – заростання лучних ценозів чагарниковими видами (*Betula pendula* Ehrh., *Alnus incana L.*, *Rosa canina L.*, *Prunus spinosa* L., *Malus sylvestris* Mill.). За посилення фітоценотичної ролі адвентивних видів й загострення міжвидових конкурентних відносин знижується життєздатність особин материнки звичайної, унаслідок чого змінюється просторова структура популяцій і посилюється тенденція до їхньої фрагментації. Висока зімкнутість особин та добре розвинута фітомаса інших видів негативно впливають на розвиток особин *O. vulgare.* Інтенсивніше відтворення цієї популяції може стимулювати відсутність антропогенного тиску – припинення випасання худоби, господарська діяльність та нищівне збирання рослин.

Популяція *O. vulgare* в околицях села Довге Гірське знаходиться в задовільному стані. У фітоценозі вид не має домінуючої ролі, формує незначні зарості. Враховуючи кліматично-географічні умови цієї гірської території фенологічні фази вегетації, цвітіння і плодоношення настають найпізніше.

Нерівномірний розподіл особин *O. vulgare* в межах досліджуваних територій Дрогобицького району характеризує їх нерівномірне зростання за різних екологічних умов та антропогенного навантаження. Тому необхідний безпосередній контроль за станом окремих локалітетів, які перебувають на різних стадіях сукцесійних змін. З цього погляду важливими є моніторингові дослідження, на основі яких можна оцінити життєвий стан популяції виду, спрогнозувати їхні динамічні тенденції й можливі зміни.

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# EFFECTIVENESS OF THE USE OF LIMACIDES AS TO THE REDUCTION OF THE NUMBER OF SPANISH SNAILS (*ARION LUSITANICUS*) IN THE DROHOBYCH CITY TERRITORY

**Abstract.** The topic is relevant, as it is associated with the peculiarities of ecology and distribution of the Spanish snail *(Arion lusitanicus)* in the territory of the Drohobych city. The article demonstrates the effectiveness of the use of limacids as to the reduction of the number of Spanish snails *(Arion lusitanicus).* The work has a practical orientation. The practical value of the work is that the chemicals tested by us can be used to reduce the number or complete destruction of the colonies of the Spanish snail *(Arion lusitanicus).* The proposed methods for combating Spanish snail may be used during laboratory classes in the discipline "Zoology", and will also be useful for farmers, agrofirms, individual and collective farms.

The article analyzes the scientific and popular science literature on the research problem, as well as the results of the conducted researches, shows the influence of the limacids on the reduction of the number of Spanish snail (Arion lusitanicus) in the territory of the Drohobych city.

**Key words:** slugs, spanish snail (*Arion lusitanicus*), colonies, limacides, measures of struggle.

## INTRODUCTION

The relevance of the study is that the coverage of this problem could contribute to reducing or eliminating the population of the Spanish snail *(Arion lusitanicus)* in the territory of Drohobych city and would contribute to the improvement of the ecological situation in the city.

The number of anthropochorous species in the terrestrial malacafauna of any country or region is steadily increasing. This is facilitated by the intensive economic and transport links that are characteristic of the modern world, as well as the increasingly noticeable global climate changes [1; 2; 9].

A vivid example of the species is a Spanish snail (Arion lusitanicus), whose area in the second half of the twentieth century significantly expanded thanks to the anthropochorous. At the end of the twentieth century several large colonies of the species were registered in the southeast of Poland [16; 23; 24; 25; 26; 27], which created the danger of A. lusitanicus penetration into the west of Ukraine, especially on the territory of the Lviv region. In Ukraine, this slug appeared for the first time in 2006 in the western part of the country. Everything points out that it was imported from Poland.

At the beginning of the XXI century, the relevant services of the quarantine and plant protection began to receive complaints from inhabitants of certain settlements of Lviv region about the appearance of large orange snails and their damage to agricultural and ornamental plants [3-8; 13-19]. The information provided by the mentioned services about specific places of localization of pests allowed us to discover the colonies A. lusitanicus in Drohobych [5; 7; 17; 20].

In the Drohobych city territory, the snail got in 2010 as a result of the activity of the private company Tandem (a company engaged in the cultivation and sale of flowers). The owners of this company brought them from Western Europe [21] together with products grown. That's how the Spanish snail spread in our territories (picture 1).

**Picture 1. Snails *A. lusitanicus* in the Drohobych city : orange and brown slugs**

Theoretically, the penetration of anthropochorous species of land molluscs into our city can significantly accelerate the process of their resettlement in the new region [11]. *A. lusitanicus* is able not only to quickly populate new territories and form large colonies [16; 17; 19; 22], but it can cause more or less significant economic losses [10; 12; 18]. In view of this, it is important to identify the *A. lusitanicus* colonies in the region and in Drogobych city in particular and to monitor their condition.

Thus, obtained data could be the basis for realisation of quarantine measures by the relevant services. In addition, the large and well-marked snails enable to clearly observe the process of gradual settlement of an anthropochorous species.

## METHODS

The program of our research was supposed to study the effects of the limacides (Patrol, Ulytsid and 2% aqua ammonia solution) as to the reduction of the number of Spanish slug *(Arion lusitanicus).* Such limacide as Patrol and Ulysides were purchased at a store specializing in the sale of seeds and pesticides. And 2% of aqua ammonia solution was prepared from ammonia immediately before use, because the drug is very unstable, rapidly decomposed and loses its properties.

**Characteristics of Ulysid preparation-limacides**

**Active substance:** ferrous phosphate.

**Form of the drug:** granules.

It is safely decomposed by soil microorganisms completely to the ferrous and phosphate. Granules are resistant to the rain.

**Function:** to fight slugs and snails on vegetables, fruit, citrus, flower, grapes, wild strawberries, strawberries, lettuce leaves, ornamental plants, and others.

**Use:** with the appearance of the first snails it is necessary to scatter granules on the surface of the soil, row spacings, tracks (about 3-5g/$m^2$). The active substance of the granules will lead to dehydration of slugs. Snails die under the ground. Multiplicity of treatments is 1.

**Ingredients:** corn mix, red pepper, mustard, ash, hop, sugar, kaolin, salt, ferrous phosphate salt.

**Safety:** safe for humans, used in organic gardening.

**Toxicity:** non-toxic for animals, has an unpleasant smell and taste for animals. Has no harmful effect on rainworms and bees.

**Patrol**

**Active substance:** methaldehyde, 6%.

**Form of the drug:** granules.

Highly effective preparation for the destruction of mollusks (snail and slug) in human life: on farmland, sports and recreation areas; in industrial, sanitary, household and other buildings; in recreation areas, in basements, cellars, in utility rooms and in places of fire tanks and garbage containers.

**Application method:** Spread the drug evenly in places where mollusks are detected or their presence is possible (table 1).

**Table 1. The consumption norm**

| The object against which it is processed | The consumption norm of the preparation | Area |
|---|---|---|
| mollusks, snails, slug | 20-30 g | 10 $m^2$ |

In contact with granules there is an instantaneous defeat of the body, mollusks get burns and they die. Multiplicity of treatments – 1.

Due to its composition, preparation is unattractive for eating by animals and birds and safe for the environment.

**2% aqua ammonia solution**

**Active substance:** ammonia.

**Form of the drug:** liquid.

The preparation instantly kills the snail and its eggs when in contact. But unfortunately the preparation is very unstable, it decomposes quickly and loses its properties. Therefore, we prepare the solution immediately before application and spray the plants and soil. Spraying is carried out late in the evening or at night. You need to be careful because getting a lot of ammonia on the leaves can cause them to bleach.

**Application method:** prepare 2% aqueous ammonia solution. To do this, take 2 ml of 10% ammonia and bring with water up to 10 ml. Immediately after dilution, the working solution is evenly sprayed in places where mollusks are detected. When spraying, direct contact of the working solution with the body of the snail is required. The consumption norm is 40 ml / $m^2$ .

The research was carried out on the private plots of dormitory in Drohobych city from August 1 to August 30 during 2015-2016. In total, we carried out 6 identical experiments (3 experiments in 2015 and 2016), each of which lasted 10 days. In general, weather conditions were conducive to research (table 2; 3).

**Table 2. Characteristics of weather conditions during research in 2015**

| Date | Local time | Air temperature, $^oC$ | Atmospheric pressure, mmHg | Relative humidity, % | Rainfall, mm |
|---|---|---|---|---|---|
| 30.08.2015 | 23:00 | 19.4 | 764.9 | 85 | - |
| 30.08.2015 | 17:00 | 31.3 | 764.3 | 34 | - |
| 30.08.2015 | 11:00 | 27.0 | 766.9 | 48 | - |
| 30.08.2015 | 05:00 | 18.8 | 768.1 | 92 | - |

| | | | | | |
|---|---|---|---|---|---|
| 29.08.2015 | 23:00 | 20.7 | 768.6 | 87 | - |
| 29.08.2015 | 17:00 | 27.2 | 766.9 | 45 | - |
| 29.08.2015 | 11:00 | 26.2 | 767.2 | 53 | - |
| 29.08.2015 | 05:00 | 18.0 | 766.3 | 85 | - |
| 28.08.2015 | 23:00 | 16.7 | 764.2 | 88 | - |
| 28.08.2015 | 17:00 | 30.9 | 762.0 | 36 | - |
| 28.08.2015 | 11:00 | 29.8 | 762.2 | 45 | - |
| 28.08.2015 | 05:00 | 13.6 | 763.3 | 95 | - |
| 27.08.2015 | 23:00 | 17.9 | 763.4 | 83 | - |
| 27.08.2015 | 17:00 | 29.2 | 762.1 | 51 | - |
| 27.08.2015 | 11:00 | 22.7 | 764.5 | 69 | - |
| 27.08.2015 | 05:00 | 12.8 | 765.6 | 99 | - |
| 26.08.2015 | 23:00 | 14.0 | 765.8 | 95 | 5 |
| 26.08.2015 | 17:00 | 18.2 | 766.3 | 81 | - |
| 26.08.2015 | 11:00 | 15.7 | 767.1 | 90 | - |
| 26.08.2015 | 05:00 | 15.4 | 766.0 | 96 | 3 |
| 25.08.2015 | 23:00 | 18.6 | 764.2 | 79 | - |
| 25.08.2015 | 17:00 | 27.9 | 761.6 | 35 | - |
| 25.08.2015 | 11:00 | 28.6 | 762.0 | 37 | - |
| 24.08.2015 | 23:00 | 14.9 | 763.3 | 75 | - |
| 24.08.2015 | 17:00 | 27.9 | 761.8 | 35 | - |
| 24.08.2015 | 11:00 | 25.3 | 763.2 | 39 | - |
| 24.08.2015 | 05:00 | 6.4 | 764.2 | 97 | - |
| 23.08.2015 | 17:00 | 24.3 | 761.9 | 40 | - |
| 23.08.2015 | 11:00 | 22.2 | 763.3 | 41 | - |
| 23.08.2015 | 05:00 | 7.6 | 765.1 | 99 | - |
| 22.08.2015 | 23:00 | 15.0 | 765.2 | 79 | - |
| 22.08.2015 | 17:00 | 21.1 | 765.0 | 48 | - |
| 22.08.2015 | 11:00 | 19.7 | 766.5 | 42 | - |
| 22.08.2015 | 05:00 | 5.1 | 768.4 | 97 | - |
| 21.08.2015 | 23:00 | 10.3 | 769.2 | 71 | - |
| 21.08.2015 | 17:00 | 20.7 | 767.8 | 39 | - |
| 21.08.2015 | 11:00 | 19.8 | 769.0 | 51 | - |
| 21.08.2015 | 05:00 | 6.0 | 770.1 | 84 | - |
| 20.08.2015 | 23:00 | 11.0 | 769.2 | 59 | - |
| 20.08.2015 | 17:00 | 20.7 | 767.1 | 40 | - |
| 20.08.2015 | 11:00 | 20.1 | 767.8 | 39 | - |
| 20.08.2015 | 05:00 | 10.0 | 767.9 | 81 | - |
| 19.08.2015 | 23:00 | 15.1 | 766.3 | 60 | - |
| 19.08.2015 | 17:00 | 21.7 | 763.6 | 38 | - |
| 19.08.2015 | 11:00 | 19.1 | 764.2 | 46 | - |
| 19.08.2015 | 05:00 | 7.8 | 764.0 | 95 | - |
| 18.08.2015 | 23:00 | 12.4 | 763.0 | 91 | - |
| 18.08.2015 | 17:00 | 22.6 | 760.5 | 49 | - |

| | | | | | |
|---|---|---|---|---|---|
| 18.08.2015 | 11:00 | 19.0 | 761.0 | 63 | - |
| 18.08.2015 | 05:00 | 17.2 | 759.0 | 94 | - |
| 17.08.2015 | 23:00 | 18.5 | 758.5 | 88 | 0.4 |
| 17.08.2015 | 17:00 | 24.2 | 757.2 | 55 | - |
| 17.08.2015 | 11:00 | 23.5 | 757.1 | 57 | - |
| 17.08.2015 | 05:00 | 14.1 | 757.3 | 87 | - |
| 16.08.2015 | 23:00 | 18.4 | 757.0 | 65 | - |
| 16.08.2015 | 17:00 | 30.2 | 755.7 | 43 | - |
| 16.08.2015 | 11:00 | 27.3 | 756.7 | 58 | - |
| 16.08.2015 | 05:00 | 14.6 | 757.6 | 96 | - |
| 15.08.2015 | 23:00 | 19.8 | 757.1 | 66 | - |
| 15.08.2015 | 17:00 | 30.9 | 755.5 | 42 | - |
| 15.08.2015 | 11:00 | 25.8 | 757.5 | 45 | - |
| 15.08.2015 | 05:00 | 13.8 | 758.9 | 97 | - |
| 14.08.2015 | 23:00 | 19.2 | 759.8 | 89 | - |
| 14.08.2015 | 17:00 | 28.8 | 759.4 | 40 | - |
| 14.08.2015 | 11:00 | 25.0 | 761.8 | 45 | - |
| 14.08.2015 | 05:00 | 16.3 | 762.5 | 94 | - |
| 13.08.2015 | 23:00 | 21.6 | 761.8 | 71 | - |
| 13.08.2015 | 17:00 | 28.7 | 760.3 | 46 | - |
| 13.08.2015 | 11:00 | 27.2 | 761.8 | 51 | - |
| 13.08.2015 | 05:00 | 14.6 | 762.4 | 91 | - |
| 12.08.2015 | 23:00 | 24.0 | 762.7 | 69 | - |
| 12.08.2015 | 17:00 | 32.5 | 760.8 | 35 | - |
| 12.08.2015 | 11:00 | 26.7 | 762.7 | 52 | - |
| 12.08.2015 | 05:00 | 13.2 | 763.0 | 93 | - |
| 11.08.2015 | 23:00 | 18.2 | 762.1 | 75 | - |
| 11.08.2015 | 17:00 | 33.1 | 759.7 | 35 | - |
| 11.08.2015 | 11:00 | 27.2 | 761.1 | 52 | - |
| 11.08.2015 | 05:00 | 11.4 | 762.1 | 95 | - |
| 10.08.2015 | 23:00 | 17.0 | 761.5 | 90 | - |
| 10.08.2015 | 17:00 | 31.8 | 760.0 | 30 | - |
| 10.08.2015 | 11:00 | 29.6 | 761.2 | 48 | - |
| 10.08.2015 | 05:00 | 15.6 | 762.4 | 90 | - |
| 09.08.2015 | 23:00 | 18.6 | 762.6 | 76 | - |
| 09.08.2015 | 17:00 | 32.8 | 761.5 | 33 | - |
| 09.08.2015 | 11:00 | 30.0 | 763.2 | 46 | - |
| 09.08.2015 | 05:00 | 13.2 | 765.0 | 87 | - |
| 08.08.2015 | 23:00 | 16.8 | 765.1 | 68 | - |
| 08.08.2015 | 17:00 | 32.6 | 763.9 | 31 | - |
| 08.08.2015 | 11:00 | 29.8 | 765.6 | 40 | - |
| 08.08.2015 | 05:00 | 16.9 | 766.1 | 96 | - |
| 07.08.2015 | 23:00 | 22.7 | 765.4 | 70 | - |
| 07.08.2015 | 17:00 | 31.4 | 763.9 | 31 | - |

| | | | | | |
|---|---|---|---|---|---|
| 07.08.2015 | 11:00 | 27.6 | 764.7 | 39 | - |
| 07.08.2015 | 05:00 | 14.0 | 765.0 | 97 | - |
| 06.08.2015 | 23:00 | 19.0 | 764.5 | 80 | - |
| 06.08.2015 | 17:00 | 28.4 | 762.7 | 39 | - |
| 06.08.2015 | 11:00 | 24.9 | 763.8 | 53 | - |
| 06.08.2015 | 05:00 | 15.3 | 763.7 | 93 | - |
| 05.08.2015 | 23:00 | 17.8 | 763.6 | 86 | 0.3 |
| 05.08.2015 | 17:00 | 23.3 | 762.4 | 62 | - |
| 05.08.2015 | 11:00 | 29.2 | 761.8 | 40 | - |
| 05.08.2015 | 05:00 | 13.4 | 763.0 | 95 | - |
| 04.08.2015 | 23:00 | 19.2 | 762.2 | 87 | - |
| 04.08.2015 | 17:00 | 27.4 | 761.4 | 47 | - |
| 04.08.2015 | 11:00 | 25.2 | 763.0 | 56 | - |
| 04.08.2015 | 05:00 | 14.3 | 764.1 | 95 | - |
| 03.08.2015 | 23:00 | 18.3 | 764.2 | 74 | - |
| 03.08.2015 | 17:00 | 28.1 | 763.2 | 48 | - |
| 03.08.2015 | 11:00 | 24.2 | 764.4 | 60 | - |
| 03.08.2015 | 05:00 | 12.4 | 765.3 | 97 | - |
| 02.08.2015 | 23:00 | 17.2 | 765.2 | 78 | - |
| 02.08.2015 | 17:00 | 26.2 | 764.2 | 49 | - |
| 02.08.2015 | 11:00 | 24.5 | 765.1 | 42 | - |
| 02.08.2015 | 05:00 | 8.6 | 766.0 | 96 | - |
| 01.08.2015 | 23:00 | 12.8 | 765.4 | 91 | - |
| 01.08.2015 | 17:00 | 23.8 | 763.9 | 42 | - |
| 01.08.2015 | 11:00 | 20.6 | 765.4 | 49 | - |
| 01.08.2015 | 05:00 | 6.8 | 766.0 | 97 | - |

**Table 3. Characteristics of weather conditions during research in 2016**

| Date | Local time | Air temperature, $^{o}$C | Atmospheric pressure, mmHg | Relative humidity,% | Rainfall, mm |
|---|---|---|---|---|---|
| 30.08.2016 | 23:00 | 11.0 | 768.0 | 96 | - |
| 29.08.2016 | 17:00 | 29.0 | 759.5 | 38 | - |
| 29.08.2016 | 11:00 | 26.3 | 760.9 | 55 | - |
| 29.08.2016 | 05:00 | 12.1 | 763.0 | 98 | - |
| 28.08.2016 | 23:00 | 15.8 | 763.4 | 91 | - |
| 28.08.2016 | 17:00 | 29.9 | 762.6 | 36 | - |
| 28.08.2016 | 11:00 | 26.8 | 7648 | 47 | - |
| 28.08.2016 | 05:00 | 10.2 | 766.6 | 95 | - |
| 27.08.2016 | 23:00 | 15.0 | 766.5 | 89 | - |
| 27.08.2016 | 17:00 | 27.6 | 165.8 | 39 | - |
| 27.08.2016 | 11:00 | 25.3 | 767.8 | 44 | - |
| 27.08.2016 | 05:00 | 8.7 | 769.2 | 97 | - |
| 26.08.2016 | 23:00 | 13.0 | 768.5 | 96 | - |

| | | | | | |
|---|---|---|---|---|---|
| 26.08.2016 | 17:00 | 24.7 | 767.3 | 42 | - |
| 26.08.2016 | 11:00 | 22.2 | 768.7 | 51 | - |
| 26.08.2016 | 05:00 | 8.0 | 769.7 | 97 | - |
| 25.08.2016 | 23:00 | 125 | 769.1 | 96 | - |
| 24.08.2016 | 17:00 | 23.2 | 766.7 | 50 | - |
| 24.08.2016 | 11:00 | 20.2 | 768.1 | 72 | - |
| 23.08.2016 | 23:00 | 14.2 | 768.5 | 92 | - |
| 23.08.2016 | 17:00 | 20.6 | 767.5 | 64 | - |
| 22.08.2016 | 23:00 | 16.6 | 767.4 | 93 | - |
| 22.08.2016 | 11:00 | 18.8 | 764.6 | 83 | - |
| 22.08.2016 | 05:00 | 17.7 | 763.6 | 91 | - |
| 21.08.2016 | 23:00 | 17.8 | 762.3 | 96 | - |
| 21.08.2016 | 17:00 | 28.5 | 760.9 | 46 | - |
| 21.08.2016 | 11:00 | 27.0 | 762.8 | 45 | - |
| 21.08.2016 | 05:00 | 11.8 | 764.3 | 95 | - |
| 20.08.2016 | 23:00 | 14.8 | 764.0 | 83 | - |
| 19.08.2016 | 17:00 | 25.0 | 758.5 | 43 | - |
| 19.08.2016 | 11:00 | 24.2 | 760.4 | 47 | - |
| 18.08.2016 | 23:00 | 12.8 | 760.9 | 96 | - |
| 18.08.2016 | 17:00 | 20.6 | 759.3 | 58 | - |
| 18.08.2016 | 11:00 | 18.6 | 760.3 | 58 | - |
| 17.08.2016 | 23:00 | 8.9 | 761.2 | 93 | - |
| 16.08.2016 | 23:00 | 14.2 | 761.8 | 81 | - |
| 16.08.2016 | 17:00 | 20.3 | 761.3 | 54 | - |
| 16.08.2016 | 11:00 | 19.1 | 762.6 | 60 | - |
| 16.08.2016 | 05:00 | 9.6 | 763.6 | 92 | - |
| 15.08.2016 | 23:00 | 13.8 | 764.8 | 91 | - |
| 14.08.2016 | 17:00 | 24.2 | 763.7 | 48 | - |
| 14.08.2016 | 11:00 | 23.1 | 764.9 | 46 | - |
| 14.08.2016 | 05:00 | 17.2 | 765.9 | 73 | - |
| 13.08.2016 | 23:00 | 15.4 | 767.0 | 90 | - |
| 13.08.2016 | 17:00 | 20.8 | 766.9 | 47 | - |
| 13.08.2016 | 11:00 | 19.4 | 768.5 | 40 | - |
| 13.08.2016 | 05:00 | 6.2 | 769.6 | 82 | - |
| 12.08.2016 | 23:00 | 9.9 | 769.2 | 80 | - |
| 12.08.2016 | 17:00 | 18.2 | 767.3 | 54 | - |
| 12.08.2016 | 11:00 | 15.2 | 767.6 | 70 | - |
| 11.08.2016 | 23:00 | 12.8 | 766.0 | 91 | - |
| 09.08.2016 | 17:00 | 27.4 | 759.5 | 40 | - |
| 09.08.2016 | 11:00 | 25.4 | 762.0 | 49 | - |
| 08.08.2016 | 23:00 | 13.3 | 764.8 | 93 | - |
| 08.08.2016 | 17:00 | 24,8 | 764.5 | 35 | - |
| 08.08.2016 | 11:00 | 21.8 | 766.7 | 47 | - |
| 08.08.2016 | 05:00 | 7.7 | 768.7 | 97 | - |

| | | | | | |
|---|---|---|---|---|---|
| 07.08.2016 | 23:00 | 12.1 | 769.0 | 90 | - |
| 07.08.2016 | 17:00 | 22.0 | 768.0 | 51 | - |
| 07.08.2016 | 11:00 | 20.0 | 768.4 | 59 | - |
| 07.08.2016 | 05:00 | 15.4 | 767.8 | 88 | - |
| 06.08.2016 | 11:00 | 19.5 | 763.9 | 84 | - |
| 06.08.2016 | 05:00 | 17.5 | 762.4 | 93 | - |
| 05.08.2016 | 23:00 | 21.6 | 760.4 | 86 | - |
| 04.08.2016 | 17:00 | 27.9 | 761.0 | 45 | - |
| 04.08.2016 | 11:00 | 27.1 | 761.8 | 48 | - |
| 03.08.2016 | 23:00 | 15.1 | 762.4 | 96 | - |
| 03.08.2016 | 17:00 | 25.6 | 760.8 | 45 | - |
| 03.08.2016 | 11:00 | 22.2 | 761.7 | 57 | - |
| 03.08.2016 | 05:00 | 11.6 | 762.2 | 96 | - |
| 02.08.2016 | 23:00 | 15.9 | 761.8 | 94 | - |
| 02.08.2016 | 17:00 | 22.4 | 761.4 | 55 | - |
| 02.08.2016 | 11:00 | 20.1 | 763.0 | 68 | - |
| 02.08.2016 | 05:00 | 16.2 | 762.9 | 93 | - |
| 01.08.2016 | 23:00 | 17.9 | 762.1 | 94 | - |
| 01.08.2016 | 05:00 | 16.4 | 758.3 | 93 | - |

We have prepared four sections of 50x50 cm. Three of them were experimental and one control. In each of these plots, we placed 10 species of Spanish snail (*Arion lusitanicus*). Each area was separated from each other and thus the snails could not leave their area, and also migrate from one to another. In order for the slugs to feed well we spread the leaves of lettuce, cabbage, tomatoes and cucumbers each day along the perimeter of the experimental sites. On hot days, in order to prevent the harmful effects of sunlight on snails, in all areas, we created a shade to maintain their normal livelihoods (picture 2).

**Picture 2. Plots where experiments were carried out**

During the first three days we watched slugs and maintained the optimal conditions for their lives. During this period, no snail was died. On the fourth day, after they adapted to their new living conditions, we once applied chemical preparation against them. On the experimental areas №1 and №2, we evenly distributed the granules of the Ulysid and Patrol. And on the experimental area number 3 we sprayed with 2% ammonia solution with a paddle sprayer (table 4).

**Table 4. Scheme for carrying out experiments**

| Areas | Name of the limicide | Form of the preparation | Active substance | Consumption of the preparation |
|---|---|---|---|---|
| Control | – | – | – | – |
| Experimental area №1 | Ulysid | Granules | ferrous phosphate. | 1 g |
| Experimental area №2 | Patrol | Granules | Methaldehyde | 0,75 g |
| Experimental area №3 | 2% aqua ammonia solution | Granules | Ammonia | 10 ml |

Considering that the activity of snails falls at night, the treatment of all areas with the limacides was carried out after 11p.m.

## RESULTS OF RESEARCH AND ITS DISCUSSION

One of the most effective measures to combat snails is the use of chemicals. They may be different in influence and its ingredients, but for good use they show good results. We determined the effectiveness of the snails protection measures by counting the number of snails at night before processing and the number of dead snails in the morning of the next two days after it was carried out. As a rule, dead snails, were on the surface of the soil (sometimes in shelters, lying sideways in an elongated position and did not react to touching them).

As a result of the researches, it was found that among the chemicals we studied, the best results concerning the effect on the number of Spanish snail (Arion lusitanicus) showed a 2% aqua ammonia solution. While other preparations (Patrol and Ulysides) were ineffective in controlling this pest (Table 5).

Thus, in 2015 in the experiment № 1, the number of snails after treatment with the preparation Ulysid were 8 snails, the preparation Patrol were 6 snails, and 2% aqua ammonia solution was 1 snail, in experiment № 2 - the preparation Ulysid were 7 snails, the preparation Patrol were 6 snails, and 2% aqua ammonia solution was 0 snail, in experiment № 3 - the preparation Ulysid were 7 snails, the preparation Patrol were 5 snails, and 2% aqua ammonia solution was 1 snail.

It should be noted that the same tendency was noted during the research in 2016.

**Table 5. Influence of limicids on the number of Spanish snails (Arion lusitanicus)**

| Experiment number | Areas | Name of the limicide | Number of snails before processing | Number of snails after processing |
|---|---|---|---|---|
| Experiment №1 (01.08.2015-10.08.2015) | Control (without processing) | – | 10 | 10 |
| | Experimental area №1 | Ulysid | 10 | 8 |
| | Experimental area №2 | Patrol | 10 | 6 |

| | | | | |
|---|---|---|---|---|
| | Experimental area №3 | 2% aqua ammonia solution | 10 | 1 |
| Experiment №2 (11.08.2015-20.08.2015) | Control (without processing) | – | 10 | 10 |
| | Experimental area №1 | Ulysid | 10 | 7 |
| | Experimental area №2 | Patrol | 10 | 6 |
| | Experimental area №3 | 2% aqua ammonia solution | 10 | 0 |
| Experiment №3 (21.08.2015-30.08.2015) | Control (without processing) | – | 10 | 10 |
| | Experimental area №1 | Ulysid | 10 | 7 |
| | Experimental area №2 | Patrol | 10 | 5 |
| | Experimental area №3 | 2% aqua ammonia solution | 10 | 1 |
| Experiment №4 (01.08.2016-10.08.2016) | Control (without processing) | – | 10 | 10 |
| | Experimental area №1 | Ulysid | 10 | 8 |
| | Experimental area №2 | Patrol | 10 | 6 |
| | Experimental area №3 | 2% aqua ammonia solution | 10 | 0 |
| Experiment №5 (11.08.2016-20.08.2016) | Control (without processing) | – | 10 | 10 |
| | Experimental area №1 | Ulysid | 10 | 8 |
| | Experimental area №2 | Patrol | 10 | 7 |
| | Experimental area №3 | 2% aqua ammonia solution | 10 | 0 |
| Experiment №6 (21.08.2016-30.08.2016) | Control (without processing) | – | 10 | 10 |
| | Experimental area №1 | Ulysid | 10 | 9 |
| | Experimental area №2 | Patrol | 10 | 8 |
| | Experimental area №3 | 2% aqua ammonia solution | 10 | 2 |

In our opinion, the reason for this result is that local burns caused by granules of preparations such as the Patrol and the Ulysid based on the methaldehyde and ferrous phosphate don't lead to the dehydration and death of the Spanish snail (*Arion lusitanicus*). Only those snails were died on the body of which there were more than four granules of these preparations. It was under such conditions that the body of the snail received burns of a large body surface, which in turn led to dehydration and death (Diagram 1).

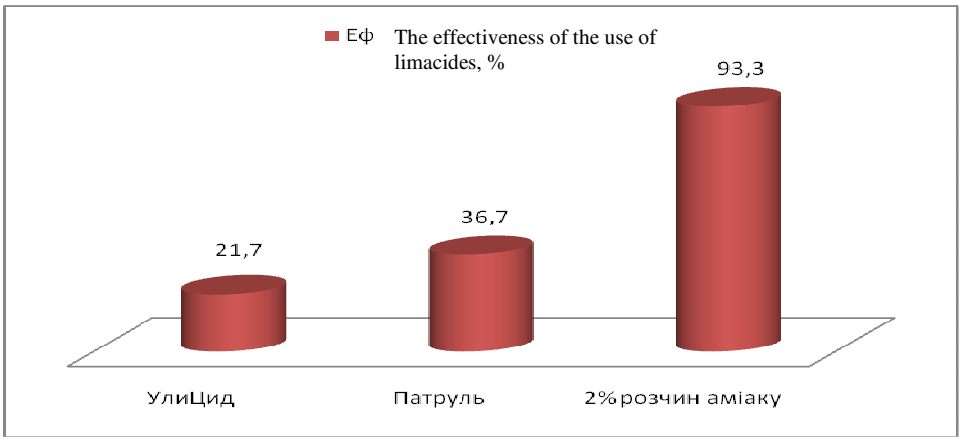


**Diagram 1. The effectiveness of the use of limacides**

At Diagram 1 we can be see the death of snails with the use of the preparation Ulysid was 21.7%, and the preparation Patrol was 36.7% during 6 experiments. As for 2% aqua ammonia solution, its high efficiency can be explained by the fact that uniformly sprayed sprayer working solution affects almost the entire body of the snail. That is what leads to its dehydration and instant death and makes up 93.3%.

## CONCLUSION

In the practical work of people, the role of snails manifests itself in two aspects: as transmitters of dangerous helminthiasis for domestic and industrial animals and as pests of many cultivated plants.

Since snails cause significant damage to crops, it is necessary to implement measures to combat them. Among these measures are agricultural, mechanical, chemical and biological. One of the most effective measures to combat snails is the use of limacides. They may be different in influence and its ingredients, but for good use they show good results.

During 6 experiments, the death of the Spanish snail *(Arion lusitanicus)* with the use of preparation Ulysid was 21.7%, and the preparation Patrol was 36, 7%.

As for 2% aqua ammonia solution, its high efficiency can be explained by the fact that uniformly sprayed sprayer working solution affects almost the entire body of the snail. That is what leads to its dehydration and instant death and makes up 93.3%

As a result of the researches, it was found that among the chemicals we studied, the best results concerning the effect on the number of Spanish *snail (Arion lusitanicus)* showed a 2% aqua ammonia solution. While other preparations (Patrol and Ulysid) were ineffective in the fight against this pest.

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## АНОТАЦІЯ

## ЕФЕКТИВНІСТЬ ЗАСТОСУВАННЯ ЛІМАЦИДІВ ЩОДО ЗНИЖЕННЯ ЧИСЕЛЬНОСТІ СЛИМАКА ІСПАНСЬКОГО (*ARION LUSITANICUS*) НА ТЕРИТОРІЇ МІСТА ДРОГОБИЧА

Слимаки (також слизні або слизняки) – це група наземних легеневих молюсків класу Черевоногих (*Castгopoda*) з частково або повністю редукованою черепашкою. Слизняки представлені як морськими, так і наземними видами.

Слимак іспанський (*Arion lusitanicus*) пересувається завдяки ритмічному скороченню м'язів ноги. Швидкість його пересування коливається від 6 до 8 см/хв. Тіло покрите тонкою ніжною шкірою, яку від висихання захищає слиз. Слиз дуже важливий, оскільки він допомагає їм рухатися, і містить волокна, які перешкоджають слизняку зіслизати вниз з вертикальних поверхонь. Так як ця речовина на 98 % складається з води, то відновлювати її слимакам життєво необхідно.

Слимаки – двостатеві істоти (гермафродити). Живуть від 1 до 3 років. Яйця відкладають купками по 10-35 штук в грунт на глибину 5-30 см в тріщини, під грудки землі, біля кореневої шийки рослин, а то й на вологу землю, а також під різними предметами. Плодючість шкідника в залежності від виду та умов сезону різна. Можуть витримувати різкі температурні коливання. Але на зимовий період перебувають у стані анабіозу.

Живуть на городах, у садах та парках, на виноградниках, поряд з помешканнями людей, а також заповзають у сараї, овочесховища, теплиці та парники. Активні слимаки в сутінках та в нічні години, а деякі особини в дощові і похмурі дні, коли все насичене вологою відправляються за поживою вдень. Слимаки ушкоджують дуже широкий діапазон культур. Крім знищення врожаю, слимаки погіршують товарні якості продукції. Пошкодження, завдані слимаками – це відкриті ворота для проникнення грибкових та інших інфекцій від рослини до рослини.

У практичній діяльності людей роль слимаків проявляється в двох аспектах: як передавачів небезпечних гельмінтозів для домашніх і промислових тварин і як шкідників багатьох культурних рослин.

Оскільки слимаки завдають значної шкоди сільськогосподарським культурам, потрібно впроваджувати заходи боротьби з ними. Серед цих заходів виділяють агротехнічні, механічні, хімічні та біологічні.

Одним із найдієвіших заходів у боротьбі із слимаками є застосування лімацидів. Вони можуть бути різними за впливом і своїм складом, але за правильного використання показують хороші результати.

Під час проведення 6 дослідів загибель слимака іспанського (*Arion lusitanicus*) із застосування прапатату УлиЦид становила 21, 7 %, препарату Патруль – 36, 7 %.

Що ж стосується 2 % розчину аміаку, то високу його ефективність можна пояснити тим, що рівномірно розпилений обприскувачем робочий розчин вражає майже все тіло слимака. Саме це призводить до його зневоднення та миттєвої загибелі і становить – 93,3 %.

У результаті проведених досліджень було встановлено, що серед досліджуваних нами хімічних препаратів найкращі результати щодо впливу на чисельність слимака іспанського (*Arion lusitanicus*) показав 2 % розчин аміаку. Тоді як інші препарати (Патруль та УлиЦид) були малоефективними у боротьбі з цим шкідником.

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# THE OCCURRENCE OF *AMPHIPLEURA PELLUCIDA* (KÜTZ.) KÜTZ. IN SOUTH-EASTERN POLAND

**Abstract.** Diatoms from the genus *Amphipleura* develops mainly in oligo- and mesotrophic standing and flowing waters. Studies conducted between 2007–2015, within the territory of south-eastern Poland, showed the occurrence of *Amphipleura pellucida* (Kütz.) Kütz., a species on the Polish Red List of Algae in the rare (R) category. The species developed mainly in individual form in the upper parts of the studied streams, and only within the area of the Magura National Park (Lower Beskids), where it was more frequent and reached the rank of 'dominant'. *Amphipleura pellucida* is a cosmopolitan, litoral species. It prefers standing waters, especially eutrophic and flowing slowly, and also brackish waters. The studies conducted showed that the species probably preferred water rich in calcium, alkaline or near to neutral pH, with moderate electrolyte content.

**Keywords:** *Amphipleura pellucida*, rare diatom taxa, flowing and standing waters

## INTRODUCTION

The genus *Amphipleura* Kütz. is characterized by a linear to lanceolate valve shape. Apices are slightly constricted. Raphe branches are greatly shortened and increase in length only slightly as the length of the valve increases. A long, low-profile median rib that bifurcates near the poles forms short branches around the raphe system. Striae are not visible under light microscope. The genus *Amphipleura* includes freshwater and marine species [1, 2, 13, 14].

*Amphipleura pellucida* (Kütz.) Kütz. is a cosmopolitan, freshwater species that develops more often in standing waters than flowing waters. The species is also found in brackish waters with low salinity, and in waters rich in calcium with high electrolyte content. The species is classified as R – rare on the Polish Red List of Algae [1, 2, 14, 16].

The aim of the work was to present new records of the rare species *Amphipleura pellucida* (Kütz.) Kütz. in south-eastern Poland, taking into account ecological preferences and different habitats.

## MATERIALS AND METHODS

The study was conducted between 2007–2015 in south-eastern Poland, mainly in flowing water (rivers and streams in the Wisłoka, Wisłok and San valleys), and less frequently in stagnant waters (Duszatyńskie Lakes, Rzeszów Reservoir) – Fig. 1.

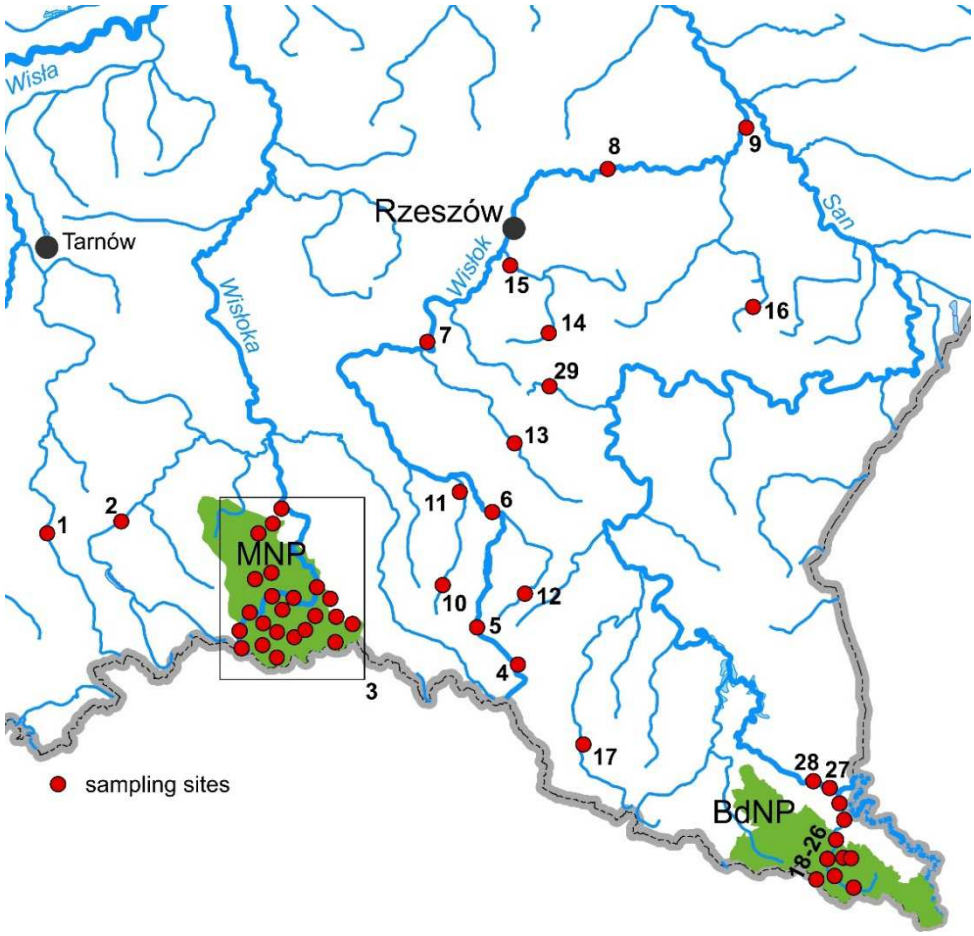


**Fig. 1. Location of study sites: 1 – Biała Tarnowska, 2 – Ropa, 3 – sites at the territory of Magura National Park (River Wisłoka with tributaries – 23 sampling sites), 4-9 – Wisłok, 10-11 – Morwawa, 12 – Pielnica, 13 – Stobnica, 14 – Ryjak (the Strug tributary), 15 – Strug, 16 – Mleczka, 17 – potok Olchowaty i Jeziorka Dusztyńskie (7 sampling sites), 18-26 –Wołosaty, Terebowiec and Rzeczyca, 27-28 – San, 29 – Baryczka.**

Samples were collected at each station from all available habitats, i.e. stones, mud and vascular plants. Materials were collected mostly from spring to autumn throughout the year, or only in spring and autumn (the Wołosaty stream and its tributaries), and then prepared and processed by the methods used in diatom studies [3]. Measurements of the pH and electrolytic conductivity were made directly in the field, while other chemical parameters were measured in the laboratory. The material was preserved in a 4% formalin solution. The treatment of the collected material, together with the preparation of the microscope, was carried out in the same way as presented in the paper by Noga et al. [8].

Diatoms were identified under Nikon ECLIPSE 80i and Carl Zeiss Axio Imager A2 light microscopes (LM) at a magnification of 1000×, and under a Hitachi SU8010 scanning electron microscope. Diatoms were identified using keys from Krammer, Lange-Bertalot [4] and Hofmann et al. [2]. The richness of the species was obtained by counting specimens in randomly selected fields of view under light microscope, up to a total of 400 valves. The most abundant (dominant) species were those with a sample share of more than 5%.

# RESULTS

Research conducted between the years 2007–2015 in south-eastern Poland showed the occurrence of the rare species *Amphipleura pellucida* (Kütz.) Kütz. (Fig. 2). As a single specimen, it grows in the River Wisłok, in the upper parts of the Rivers San, Wisłoka, Biała, Ropa Stobnica, Pielnica, Morwawa and Mleczka, and in the upper part of the River Strug and its tributary Ryjak. The species was also found in the Baryczka, Olchowaty, Wołosaty, Wołosatka and Terebowiec streams, in the Magura National Park in the Ryjak, Kłopotnica, Wilsznia, Krempna, Świerzówka, Rzeszówka, Zimna Woda and Baranie streams, and also in the Duszatyńskie Lakes.

For most positions, the species developed in the form of individual cells. *Amphipleura pellucida* was the dominant species (10–12% share in the diatom assemblage) only in the upper reaches of the Wisłoka and its tributary – Krempna. The largest populations formed on rocks, in the summer and autumn of 2013, at low water levels.

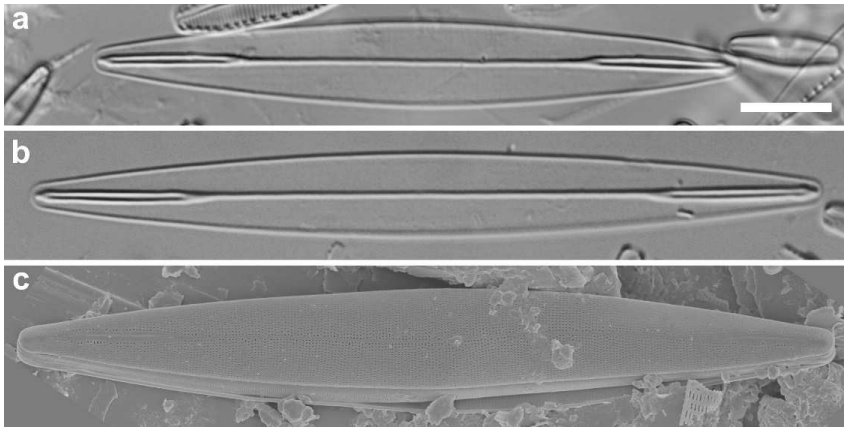


**Fig. 2. *Amphipleura pellucida:* a,b – light microscope images, c – scanning electron microscope image (SEM)**

The dimensions of *Amphipleura pellucida* cells were as follows: length from 64.0 to 94.1 µm, width of 7.2 to 9.4 µm, striae invisible under light microscope.

The rivers and streams in which the research was conducted were characterized by alkaline or near neutral-to-neutral pH (6.3–8.8) and medium or high conductivity values (340–530 $\mu S \times cm^{-1}$). At sites in the Low Beskids, where the most numerous populations were created, water was characterized by low biogenic content (mainly nitrogen and phosphorus), often below the limit of quantification. In contrast, $Ca^{2+}$ content was high, especially at the site on Krempna stream (69.4–76.4 $mg \times dm^{-3}$).

*Amphipleura pellucida* was found in materials collected from various habitat types, on stones, sand and mosses.

At the sites where *Amphipleura pellucida* was found in the diatom assemblages, the following species were most numerous: *Achnanthidium minutissimum* var. *minutissimum*, *A. pyrenaicum*, *Encyonema minutum, E. ventricosum*, *Encyonopsis subminuta*, *E. minuta*, *Diatoma ehrenbergii, D. moniliformis, D. polonica, Cymbella parva* and *C. excisa.*

## DYSCUSSION

*Amphipleura pellucida* is a cosmopolitan species, often reported in Poland [14, 15]. On the Polish Red List of Algae, it is a rare species – threat category R [16].

It is a freshwater, littoral species that prefers standing water, especially eutrophic one. It also develops in slow-flowing and brackish water [14]. It is considered a tolerant species, widely distributed in oligo- to eutrophic alkaline waters (pH>7) [3, 12, 14]. On the German Red List of Algae it is also in the R category (extremely rare), and is now an endangered species [5].

In south-eastern Poland this species occurs frequently in various types of flowing and standing waters. Typically, it was recorded individually in the upper sections of watercourses [6-11] - only in the rivers and streams of the Magura National Park (Low Beskids) it occur more frequently. *Amphipleura pellucida* was dominant in the upper reaches of the River, Wisłoka and in the Krempna stream (right tributary of the River Wisłoka) – the most numerous populations formed in summer and autumn in high calcium content (over 70 mg $l^{-1}$). The pH of the water was varied and oscillated between 6.5 to 7.9 pH; at the same time the conductivity values ranged from 297 to 530 µS $cm^{-1}$.

The study showed that *A. pellucida* prefers clean water, alkaline or approximately neutral, medium conductivity values and a high calcium content. The largest populations typically formed at low water levels.

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## ABSTRACT

## WYSTĘPOWANIE *AMPHIPLEURA PELLUCIDA* (KÜTZ.) KÜTZ. W POŁUDNIOWO-WSCHODNIEJ POLSCE

Rodzaj *Amphipleura* posiada najczęściej komórki kształtu wrzecionowatego lub lancetowatego z węzłem wyciągniętym środkowym wzdłuż podłużnej osi okrywy w postaci żeberka (sternum) rozwidlonego na końcach. W sternum zagłębione są krótsze ramiona rafy. Prążki są bardzo delikatne i niewidoczne w mikroskopie świetlnym. Do rodzaju *Amphipleura* należą zarówno gatunki słodkowodne jak i morskie. Badany gatunek – *Amphipleura pellucida* (Kütz.) Kütz. – jest kosmopolityczną, słodkowodną okrzemką, która częściej rozwija się w wodach stojących niż płynących. Występuje także w wodach słonawych o niskim zasoleniu oraz w wodach bogatych w wapń z wysoką zawartością elektrolitów. Gatunek w polskiej czerwonej liście glonów zaliczono do kategorii R – rzadkie. Celem pracy było przedstawienie stanowisk występowania *Amphipleura pellucida* na terenie południowo-wschodniej Polski, z uwzględnieniem preferencji ekologicznych i różnych typów siedlisk. Badania prowadzono w latach 2007–2015 w Polsce południowo-wschodniej, głównie w wodach płynących (rzeki i potoki w dolinie Wisłoka Wisłoki i Sanu), rzadziej w wodach stojących (Jeziorka Duszatyńskie, Zalew Rzeszowski) (Ryc. 1). Materiały na większości stanowisk zbierano w sezonach od wiosny do jesieni na przestrzeni roku lub tylko wiosną i jesienią (potok Wołosaty wraz z dopływami). Od 2007 roku *A. pellucida* była oznaczana w wielu rzekach i potokach na terenie południowo-wschodniej Polski (wzdłuż całego biegu Wisłoka, w górnych biegach Sanu,

Wisłoki, Białej, Ropy, Stobnicy, Pielnicy, Morwawy i Mleczki, także w Strugu i jego dopływie Ryjaku, w potokach: Baryczka, Olchowaty, Wołosaty, Wołosatka i Terebowiec, w potokach na terenie Magurskiego Parku Narodowego: Ryjak, Kłopotnica, Wilsznia, Krempna, Świerzówka, Rzeszówka, Zima Woda i Baranie oraz w Jeziorkach Duszatyńskich). Wymiary komórek *A. pellucida* wynosiły odpowiednio od 64.0 do 94.1 µm długości, od 7.2 do 9.4 µm szerokości, natomiast delikatne prążki były niewidoczne w mikroskopie świetlnym. *Amphipleura pellucida* była oznaczana w materiale pochodzącym z różnych typów siedlisk, tj. na kamieniach, piasku oraz wśród mchów. Na stanowiskach, na których stwierdzono występowanie tego gatunku, w zbiorowisku okrzemek najliczniej rozwijały się następujące gatunki: *Achnanthidium minutissimum* var. *minutissimum*, *A. pyrenaicum*, *Encyonema minutum*, *E. ventricosum*, *Encyonopsis subminuta*, *E. minuta*, *Diatoma ehrenbergii*, *D. moniliformis*, *D. polonica*, *Cymbella parva* oraz *C. excisa*. Na większości stanowisk gatunek rozwijał się w postaci pojedynczych komórek, głównie w górnych odcinkach badanych cieków. Rangę gatunku dominującego osiągnął tylko w górnym biegu Wisłoki i jej dopływie Krempnej (10–12% udziału w zbiorowisku okrzemek). Najliczniejsze populacje obserwowano na kamieniach, latem i jesienią 2013 roku, przy niskich stanach wody. Rozwijała się w wodach z wysoką zawartością jonów wapnia (ponad 70 mg $l^{-1}$), przy zmiennym odczynie wody (od 6.5 do 7.9) i średnich wartości przewodnictwa elektrolitycznego (od 297 do 530 µS $cm^{-1}$).

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# ADVENTIVES SPECIES IN REGIONAL THERIOFAUNA

**Abstract.** The composition of adventive fauna in Lviv region was investigated. Their impact on the autochthonous faunal complexes was analyzed. The ways of adventive species entering were studied. The composition of adventive species in the region was established. A success in forming of stable population of introduced species depended of mastering of natural ecosystems by them. On the contrary, a success of invasive species occurs in urban systems (house mouse, Norway rat, Kuhl's pipistrelle). The ways of species penetration are defined: introduced, reintrodutsenty. long invaydery, near invaydery, species pulsovyky.. the following species belong to introduced: *Oryctolagus cuniculus, Myocastor coypus, Ondatra zibethicus, Cervus Nippon, Nyctereutes procyonoides, Dama dama;* reintroductory species - *Bison bonasus*; long invaydery species - *Mus musculus*, *Rattus norvegicus*; Near invaydery species - *Eptesicus serotinus, Martes foina*, *Sciurus vulgaris carpathicus*; pulsatory species– *Capreolus capreolus, Lutra lutra, Meles meles, Sus scrofa.*

**Keywords:** adventive fauna, autochthonous faunal complexes, species, introduced, reintroducents. long invaydery, near invaydery, pulsatory species.

## INTORDUCTION

The modern period of fauna development is characterized by changes in their composition, directly or indirectly dependent on anthropogenic factor. This is determined by the following factors: numerous human experiments with the introduction of new species for hunting lands improvement; the destruction of natural complexes and the introduction of new species that were not previously a part of the local fauna. In general, the negative processes occurring at the level of the regional fauna are associated with the problems of some aboriginal species disappearance due to the destruction of natural systems, but the emergence of new species is becoming equally important [2].

Taking into account the various forms of direct or indirect influence, its composition is volatile both in space and in time. It is important to study the habitats of the indigenous species distribution, which can expand the boundaries for its existence, thus creating a danger to the local teriofauna. However, the most destructive changes in natural complexes are caused by adventitious species. The danger of other species entrance is the following: displacement of aboriginal species and biodiversity reduction; habitats transformation and reduction of its representativeness; loss of value and uniqueness in natural complexes. By studying the composition of the regional fauna, we do not have the right to ignore the adventists because of their participation in the functioning of the faunal complexes becomes more and more important and provokes further changes in the fauna.

A group of species that slowly or quickly became a part of natural biotic complexes and became an integral part is called the adventitious fauna.

By studying the composition of the regional fauna, we do not have the right to ignore the aAdventists because their participation in the functioning of the faunal complexes becomes more and more important and provokes further changes in the fauna.

The purpose of this work is to summarize the data on the adventitious fauna composition in Lviv region and to analyze its impacts on aboriginal faunal complexes.

All variety of mammal's species that are a part of the adventitious teroiofauna of the western regions of Ukraine can be divided into several groups characterized by their peculiarities of origin and systematic or ecological closeness to aboriginal species.

The conducted researches and analysis of literary data allowed highlighting ways of species entrance: introduced, reintroducents, long invadery, near invadery, pulsating species (table 1).

**Tab.1. – Adventist group as a part aboriginal mammal fauna**

| Group of species | Composition groups in Ukraine | Composition groups in region |
|---|---|---|
| Introduced species | n=10 *Cavia porcellus, Cervus Nippon, Dama dama, Mustela vison, Myocastor coypus, Nyctereutes procyonoides, Oryctolagus cuniculus, Ondatra zibethicus,Ovis orientalis, Procyon lotor* | n=5 *Cervus Nippon, Oryctolagus cuniculus, Myocastor coypus, Ondatra zibethicus, Nyctereutes procyonoides, Dama dama* |
| Reintroducents | n=3 *Bison bonasus, Equus gmelini, Equus hemionus* | n=1 *Bison bonasus* |
| Long invader | n=4 *Mus musculus, Rattus norvegicus, Canis aureus* | n=2 *Mus musculus, Rattus norvegicus* |
| Near invader | n=4 *Eptesicus serotinus, Pipistrellus kuhlii, Martes foina*, *Sciurus vulgaris carpathicus* | n=3 *Eptesicus serotinus, Martes foina*, *Sciurus vulgaris carpathicus*. |
| Pulsating species | n=6 *Alces alces, Capreolus capreolus, Desmana moschata, Lutra lutra, Meles meles, Sus scrofa* | n=4 *Capreolus capreolus, Lutra lutra, Meles meles, Sus scrofa* |
| Total | 31 | 15 |

Introduced species are species of living organisms that are a part of non-native groups, species outside their natural habitats. Most often, the term is used for species deliberately or accidentally brought to a new place because of human activity. The adaptation process of the introduced species in a new place is called introduction. The introduced species can significantly change the ecosystem of the region, and cause a significant reduction or even extinction in particular local flora and fauna.

The introduced species include *Oryctolagus cuniculus, Myocastor coypus, Ondatra zibethicus, Cervus Nippon deer, Nyctereutes procyonoides, Dama dama*.

*Oryctolagus cuniculus* is a species introduced in the early twentieth century. Acclimatization was carried out in the lands of the Gorodok, Mykolaiv and Yavoriv forestry of Lviv region. It threatens to the existence of *Lepus europaeus*.

*Myocastor coypus*. In the second half of the twentieth century, it was widely used as a domestic animal with artificial restraint for the sake of furs and meat in the contractors of the Lviv region. Enhanced farming led to escape from culture and distribution in floodplain complexes, urbocenosises.

*Ondatra zibethicus* is a rodent, introduced in the middle of the twentieth century from North America After the introduction and resettlement of the muskrat, there was a powerful outbreak of its size, after which, respectively, the decline. Today, the state of the population, probably, to some extent, "normalized" (taking into account the capacity of the environment). The number of species remains relatively stable in recent years. *Ondatra zibethicus* remains a valuable fur animal, which level of production largely depends on the fashion on its fur.

*Cervus Nippon* is preserved in very small quantities today, only on the territory of some hunting farms in the region. Today, there is a crossbreeding of females with noble deer, which displaces during the race of males. This issue requires further scientific research.

*Nyctereutes procyonoides* is a widespread predator in the plains of the region. Its number is estimated at about 120 individuals. This species settled places with high humidity: marshy river valleys, the outskirts of swamps, damp meadows, thickets of reeds on the shores of reservoirs, rarefied deciduous forests, characterized by a thick undergrowth. This is a typical Euriphag; except for various parts of plants, fruits, insects, invertebrates, small mammals, fish, it can consume birds (and their masonry and chicks), including and waterfowl, than to bring some damage to the hunting economy [3].

*Dama dama*. In Ukraine, the first introductions took place in the Middle Ages, in Transcarpathia and Galicia [1]. In 2012, the population was 75 heads.

The reintroduced species include species of genetically derived populations, which are destroyed by man in historical times, and use adjacent species for the restoration of lost forms. That is, the process of restoring species within the limits of the historical range and using the closest forms: *Bison bonasus*.

*Bison bonasus* is a typical representative of the regional fauna, destroyed in Ukraine in historical times. For the first time, 10 individuals of the population of this species were imported from the Belovezhskaya Pushcha to Korostiv Forestry (1965). Seasonal migrations of animals testify to the adaptability of bison to difficult mountain conditions of existence, which suggests the possibility of restoration in the Skole Beskids. In the summer 2009, 6 individuals of bison were imported to Maidan forestry from Germany. It is planned to create a bison herd to form a single Eastern Carpathian population within the national park "Skolevski Beskydy" and Bieszczady National Park (Poland) [5].

Long invaydery species, which appeared as a part of the wild fauna due to natural settlement, but with the assistance of humans are *Mus musculus, Rattus norvegicus*. These species with invasive potential are capable of expanding the range and increasing population size.

Mus musculus is a Sinanthrop species that penetrated Europe only in historical times. There is a tendency to expand the boundaries of the range, due to the development of man natural complexes.

*Rattus norvegicus* is a synanthropic, extreme generalist: lifestyle, agility and powerful reproductive potential helped him populate almost the whole world. It occurs in a variety of places, including garbage cans, sewers, basements - wherever it can find food and shelter. All-species, its forage spectrum is very broad and includes invertebrates, frogs, small mammals, eggs, as well as food products and waste. For a long time, a man tries to control (not always successful) the number of gray rats, because he is a serious problem and carrier of dangerous diseases. Individuals are able to develop resistance to rodenticides and other poisons that are highly toxic to many other mammals.

Near invaydery are species that have significantly changed their distribution within the region, but have not formally changed their belonging to the regional fauna: they are still a part of the fauna of Ukraine, but in part of the regions, they are new because of the expansion of their distribution boundaries. They do not show large scale changes, and habitat variations are gradual: *Eptesicus serotinus, Martes foina, Sciurus vulgaris carpathicus*.

*Eptesicus serotinus* is an aborigine species and is sedentary. Powerful populations are concentrated in the forest-steppe zone. In the south and north, populations are less numerous. This species is sinanthropus and its distribution at a minimum is due to the availability of settlements. It is registered on the territory of Skolivsky Beskydy, which testifies to the decline of the species expansion.

*Martes foina* is a typical species within the most natural areas, especially characteristic of mountainous areas. It is prone to synanthropy. The species extends its range to the north. The key reasons for this could be the dilution of populations of aboriginal species of forest stumps.

*Sciurus vulgaris carpathicus* is a subspecies of the normal selection, which distribution is limited to the Carpathian forests [4]. In general, it is believed that the distribution of red and dark forms is determined by the spread of dark hairpin and plain (light) beech-oak forests. Such

features contributed to the expansion of the synanthropic black form, which became dominant in most biotopes in the Carpathian region.

Pulsating species are mainly species of local fauna, which at least once significantly reduced areas within the region during historical times. Most of the pulsations are unnatural and generated by anthropogenic influences. Typically, such pulsations occur within the range of historical habitats of species. Sometimes, the pulsations become more powerful, and species are introduced into the new natural zones. Among the examples, the representatives of hunting fauna dominate: *Capreolus capreolus, Lutra lutra, Meles meles, Sus scrofa.*

*Capreolus capreolus* preferes to sparse biotopes with shrubs, hayfields with groups of trees and shrubs, cuttings and lawns with a growth of wood species. The goats perform vertical seasonal movements. In winter, with an increase in the snow cover height, they descend into the valleys, in the lower belt of mountains. In the spring, when the snow cover decreases, they climb higher up into the mountains.

*Lutra lutra* is a typical representative of the wetlands in the region.

*Meles meles* is quite a plastic species in its ecology. It can live and successfully multiply even in an urbanized environment, for example, in the countries of Western Europe where badgers live and arrange their burrows near residential buildings, in cemeteries, in parks and even under the walls of houses (this is provided that they do not persecute and are not destroyed by the man).

It is sporadically distributed in Precarpathian, Verkhnednistrovsky and Skole Beskydy (and not only), where there is a whole complex of necessary environmental conditions for a life of a badger. It suffers from the purposeful destruction by a man. Other environmental factors (environmental pollution, the disappearance of suitable places for life, etc.) are not the cause of the disappearance of badgers.

*Sus scrofa* expands its areal in search of food. Over the past few years, reports of the appearance of wild boar population come from locals in the region.

## INFLUENCE OF ADVENTITIOUS SPECIES ON AUTOCHTHONOUS FAUNAL COMPLEXES

Introduced species can significantly change the ecosystem of the region. In the case of natural invasions, virtually all species are immediately a part of the local fauna. This process is completed by the formation of synanthropic populations, that is, those living in conditions that are substantially transformed by man. Each invasion or introduction leads to the emergence of a new grouping of species in the native group, which leads to a restructuring in the entire structure of the groups. They cause a significant reduction or even extinction of particular species in local fauna.

## CONCLUSIONS

1. An analysis of the adventitious fauna composition and the particular features of individual species introduced or acclimatized artificially or infused naturally makes it possible to generalize.

2. Often, introduced species are able to significantly change the structure of the ecosystems in the region, and cause a significant reduction or even extinction of certain species in local fauna.

3. In the Lviv region, the number of adventists is the smallest comparing the other geographic regions, which is determined by the high degree of natural complexes conservation and unsuccessful attempts to acclimatize species in these regions.

4. In the case of natural invasions, virtually all species are immediately a part of the local fauna. This process is completed by the formation of synanthropic populations, that is, those living in conditions that are substantially transformed by man.

5. The success of the stable populations formation of introduced species depends on the development of their natural ecosystems. Instead, the success of invasive species takes place in urban systems.

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# АНОТАЦІЯ

# АДВЕТИВНІ ВИДИ У СКЛАДІ РЕГІОНАЛЬНОЇ ТЕРІОФАУНИ

Сучасний період розвитку фаун характеризується змінами їхнього складу, прямо або опосередковано залежними від антропогенного фактору.

Це визначається численними експериментами людини з інтродукцією нових видів з метою покращення мисливських угідь, трансформацією природних комплексів та вселенням нових видів, що раніше не були складовими місцевої фауни. Загалом негативні процеси, що відбуваються на рівні регіональної фауни, пов'язують з проблемами зникнення частини аборигенних видів внаслідок руйнації природних комплексів, проте не менш важливою стає поява нових видів.

Вивчаючи склад регіональної фауни, ігнорувати адвентистами ми не маємо права, оскільки їхня участь у функціонуванні фауністичних комплексів стає дедалі вагомішою та провокує подальші зміни фауни. Усе різноманіття видів ссавців, що входять до адвентивної частини таріофауни західних областей України, можна звести до кількох груп, що відрізняються особливостями походження та систематичною або екологічною близькістю до аборигенних видів.

Інтродуковані види – види живих організмів, що перебувають у складі неродинних їм угруповань, види за межами своїх природних ареалів. Процес освоєння інтродукованого виду на новому місці називається інтродукцією. До інтродукованих видів відноситься: кріль, нутрія, ондатра, норка американська. До ретроіндукованих видів відносяться види генетично вихідні популяції яких повністю знищені людиною в історичні часи і для відновлення втрачених форм використовують суміжні види. Тобто, це процес відновлення видів в межах історичного ареалу і використання найбільш близьких форм: бізон європейський.

До видів з інвазійним потенціалом (дальніх інвайдерів) відносяться види, що з'явилися у складі дикої фауни внаслідок розселення природним шляхом, проте за сприянням людини: миша звичайна, нетопир білосмугий, пацюк мандрівний.

Ближні інвайдери – це види, що помітно змінили своє поширення у межах регіону, проте формально не змінили своєї належності до регіональної фауни: як і раніше, вони входять до фауни України, проте у частині областей вони є новими внаслідок розширення меж свого поширення. Масштабних змін ареалів вони не демонструють, і зміни ареалів є поступовими : лилик пізній, куниця кам'яна, вивірка карпатська.

Види-пульсовики – це переважно види місцевої фауни, що протягом історичних часів принаймі один раз суттєво скоротили ареали в межах регіону: сарна європейська, видра річкова, борсук європейський, дикий кабан.

Аналіз складу адвентивної фауни та особливостей окремих видів, що інтродуковані чи акліматизовані штучним шляхом або інвазувалися природним шляхом, дозволяє зробити узагальнення. Часто інтродуковані види здатні істотно змінити структуру екосистем регіону, і стають причиною значного скорочення або навіть вимирання окремих видів місцевої фауни.

У Карпатах частка адвентистів є найменшою у порівняні з іншими географічними областями, що визначається високим ступенем збереження природних комплексів та невдалими спробами акліматизації видів у цих регіонах.

У випадку природних інвазій практично всі види відразу входять до складу місцевих фаун. Цей процес завершується формуванням синантропних популяцій, тобто таких, що мешкають у суттєво трансформованих людиною умовах.

Успіх у формуванні стійких популяцій інтродукованих видів залежить від освоєння ними природних екосистем. Натомість успіх інвазійних видів має місце в урбаністичних системах.

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# COMPARATIVE INFLUENCE OF INORGANIC FORMS OF CUPRUM AND CHROMIUM ON THE ACTIVITY OF HYDROLYTIC ENZYMES OF BULLS RUMEN

**Abstract.** Mineral elements play an important role in animal nourishment, they influence the function of hematopoiesis, endocrine glands, protective reactions of the body, microflora of the digestive tract, regulate metabolism, participate in protein biosynthesis, cellular membrane permeability. However, mineral substances are not formed in the body, that's why animals must receive them with food. The absence or lack of certain mineral elements, as well as the violation of their correlation in the diet reduces the effectiveness of the use of nutrients in feed and, as a result, productivity and violates the metabolic processes.

In experiments *in vitro* we have established the positive effect of Copper and Chromium salts on the enzymatic activity of microorganisms while applying into the incubation environment with the contents of bull's rumen, which led to a possible increase in the microbial mass, an increase in the activity of the hydrolytic enzymes of the rumen microorganisms.

**Keywords**: rumen fermentation, micronutrient nutrition, cellulosolytic and amylolytic activity.

## INTRODUCTION

Biochemical transformation of the nutrients of feed in the ruminant's rumens is the result of the vital functions of different taxonomic groups of microorganisms. The intensity of growth of microorganisms in the rumen and their metabolic activity depends on the contents of energy and protein, macro- and trace elements, and their availability in the animals' diet [6, 7].

Metabolic processes in the body of animals are aimed at the plastic and energy supply of their vital functions [8]. The vital functions and productivity of ruminants to a large extent depends on the contents of the mineral substances in the diet. The symbiotic relationship between the host animal and the microorganisms of the rumen creates the scientific basis for rational nutrition of ruminants [19, 20]. In this regard, trace elements play a very important role in the vital functions of the symbiotic microflora of the rumen [9, 15]. Mineral elements are part of proteins, they serve as activators of enzymes, vitamins and other biologically active compounds, that is, they are directly involved in the regulation of metabolic processes [16].

## METHODS OF RESEARCH

Gobies were picked on the principle of analogues: the breed (Ukrainian black-and-white milk), body weight (330-340 kg), age (24 months), which were fed fattening. The gobies were kept on leotards in typical rooms. The feeding was balanced by the nutritional value of the diet (feed units, digestible protein, minerals and vitamins) and corresponded to their age-related needs. The diet contained: meadow hay, silage, fodder, juicy food. Fodder consisted of barley (50%), wheat (25%), pea (10%) drank, sunflower meal (15%). Automatic drinking water tank. During the studies, we observed the general condition of the gobies, motor activity, consumption of food and water.

The experiment was conducted in the winter-stool period. The material for biochemical studies was the content of the rumen, which was taken 2 hours after the morning feeding of

animals using a device made on the basis of the Bunsen flask and Komovsky's vacuum pump, it was filtered through four layers of gauze and transported to the laboratory in a densely closed thermos. The filtrate of the rumen in the ratio of 1: 4 was added to the incubation vials with the medium of McDougall. The incubation was carried out under anaerobic conditions at a temperature of 38°C for 24 hours. with the addition of the test substances. The control point were samples that did not contain the test substance. In the samples under research, we determined the mass of rumen microorganisms [18], amylolytic activity of the rumen microorganisms [5] and cellulosolytic activity [2].

## RESULTS OF RESEARCH

Rumen microorganisms are characterized by different enzymatic activity: they ferment carbohydrates, break down proteins, synthesize essential amino acids, proteins, vitamins for various taxonomic groups of microorganisms - bacteria, infusoria, fungi, spirochetes.

The key indicator that characterizes the processes of digestion in the rumen of ruminants and the degree of their needs in amino acids are at the expense of microbial protein is the content of microorganisms and their mass [13, 14]. The results of studies have shown that when chromium sulphate is introduced into the incubation medium, activation of anabolic processes in microorganism cells is observed, resulting in an increase in their mass. In particular, adding to the medium of incubation of inorganic chromium in the concentration of 0.5-1.5 mM is likely to deplete the growth of microorganisms. Moreover, the most intense and the smallest of their growth was detected, respectively, at 1.0 and 2.5 mM. Growth of microorganisms increases at all investigated concentrations of inorganic cuprum, however, the most intense growth of rumen microorganisms after 24 hours of incubation in vitro is established when introducing into the incubation medium a Copper sulfate in an amount of 0.5 mM. When added to the incubation medium of other study doses, there were no probable differences.

It was found that the addition of low-dose of copper to the incubation medium stimulated the enhancement of cellulolytic activity of the rumen microorganisms, which was not observed when adding the highest studied dose of this element, indicating inhibition of cellulosolytic enzymes in the rumen. The highest cellulolytic activity of the rumen microorganisms was found after adding chromium chloride to an incubation medium of 1.0 mM, while it was the lowest after adding 2.5 mM.

Along with the growth of cellulosolytic activity under the influence of the inorganic cuprum, the amylolytic activity of the rumen microorganisms increased. In particular, after adding copper sulfate to the incubation in all investigated concentrations, amylolytic activity was higher compared to control. There were no feasible differences in the activation of amylolytic enzymes. The highest growth of amylolytic activity was observed after adding 0.5 and 1.5 mM of chromium chloride in an incubation medium. Adding of the highest concentration of 2.5 mM to the incubation medium did not change the growth rate of microorganisms and suppressed the cellulolytic activity of the rumen microorganisms to some extent. This indicates the inhibitory effect of the high concentrations of chromium chloride, because during the life of microorganisms, the hydrogen is released, resulting in its surplus, which can cause the suppression of the growth for certain groups of microorganisms, including cellulosolytic and amylosolytic.

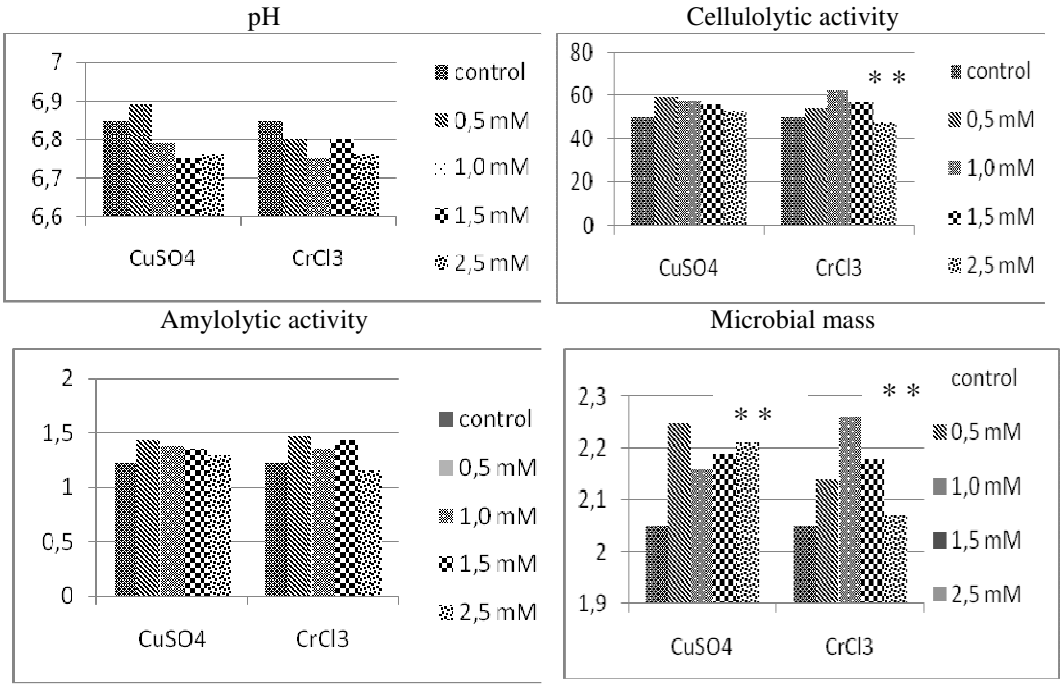


**Fig. 1 Influence of copper sulfate and chromium chloride on cellulolytic and amylolytic activity of rumen microorganisms of bulls**

## DISCUSSION

In Ukraine, the issue of mineral nutrition, as well as the provision of animals with trace elements was not studied enough. This problem should necessarily be linked to the presence of various climatic and geological zones of the country with unequal provision of mineral elements. There are a number of unexplained issues in the analysis of some aspects in the mineral exchange of ruminants. First of all, it concerns the absorption of certain elements from feed, the identification of the most available for absorption in their chemical forms, optimal concentrations in rations, depending on the type of the latter, the age of the animals and other exogenous and endogenous factors, the competition for carriers in the cells and the wall of the digestive tract, and their binding and depositing in tissues. Molecular mechanisms of individual trace elements action, on different f metabolism levels in the body (participation in enzyme reactions, in the action of hormones, vitamins), the possibility of substituting one another are little known.

The relevance of the study for this issue is due to the presence of data on the positive effects of Copper and Chromium on the productivity of cattle in the literature, especially in regions characterized by a shortage of mobile forms of trace elements in the soil and in feeds [1, 3]. It was shown that the addition of Copper salts to the ration of animals increases rumen motility, enzymatic and synthetic activity of microorganisms. It is known [4] that Chromium is a biologically active element. It participates in the nucleic acids exchange, is a part of the insulin receptors. Metabolism of Chromium is complex because of its different valence states.

As it is known [10, 12], Copper participates in cellular respiration, bone formation, connective tissue development, keratinization and pigmentation processes, in the immune response, the functioning of the central nervous system and reproductive organs. Copper is a

part of some enzymes, in particular phenol oxidase, ceruloplasmin, which plays an important role in providing Copper homeostasis in the body. When added to the diet of bulls as a mineral premix, made based on Copper sulfate in the rumen, it increases the number of microorganisms, improves the ammonia assimilation by microorganisms. Copper, after Iron and Zinc, is the third most widespread trace element in the animal body. It is known that Copper participates in cellular respiration, bone formation, connective tissue development, spinal cord myelitis, tissues keratinization and pigmentation, heart and the immune system functioning.

Cellulolytic activity of microorganisms increases in the cattle rumen under the influence of Chromium, the body increases the intensity of proteins and carbohydrates metabolism. These data are of interest as chromium plays a regulatory role in the replication and transcription processes in microorganisms. It is known [11] that this trace element is found in a large quantity in the genetic apparatus of eukaryotic cells, which may lie at the basis of its effect on the rumen microorganisms growth.

The efficiency of feeding animals depends both on the physiological state and on the diet balance by nutrients and biologically active substances, including mineral nutrition elements. Optimization of mineral metabolism is a limiting factor for increasing the livestock products obtaining.

## CONCLUSIONS

The positive effect of Copper and Chromium salts on the enzymatic activity of microorganisms in the incubation medium with the content of the rumen was established.

*In vitro* studies showed that the addition of 0,5 mM sulfuric acid and chromium chloride in a dose of 1.0 mM to an incubation medium with a rumen content had a more pronounced stimulating effect on the microbial cells proliferation and metabolic activity, which led to a potentially increased microbial mass, growth of hydrolytic enzymes activity of the rumen microorganisms.

Thus, the mineral elements are activators and inhibitors in metabolic processes not only in the animal organs and tissues, but also in the cells of the symbiotic microflora in the rumen.

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## АНОТАЦІЯ

## ПОРІВНЯЛЬНИЙ ВПЛИВ НЕОРГАНІЧНИХ ФОРМ КУПРУМУ ТА ХРОМУ НА АКТИВНІСТЬ ГІДРОЛІТИЧНИХ ФЕРМЕНТІВ РУБЦЯ БУГАЙЦІВ

Біохімічне перетворення поживних речовин корму в рубці жуйних є результатом життєдіяльності різних таксономічних груп мікроорганізмів. Інтенсивність росту мікроорганізмів у рубці та їхня метаболічна активність залежить від вмісту в раціоні тварин енергії і протеїну, макро- і мікроелементів та їх доступності Відсутність або

нестача окремих мінеральних елементів, а також порушення їхнього співвідношення в раціоні знижує ефективності використання поживних речовин кормів і, як наслідок, продуктивність та порушує процеси метаболізму.

Симбіотичний взаємозв'язок тварини-господаря і мікроорганізмів рубця створює наукову основу раціонального живлення жуйних. Кооперативна дія різних таксономічних груп мікроорганізмів – бактерій, інфузорій, грибів, спірохет забезпечує розщеплення поживних речовин кормів у рубці і використання утворених продуктів, за рахунок яких забезпечується ріст мікроорганізмів.

Бичків добирали за принципом аналогів: породою (українська чорно-ряба молочна), масою тіла (330–340 кг), віком (24 місяці), що перебували на відгодівлі. Бичків утримували на прив'язі в типових приміщеннях. Годівля була збалансована за поживною вартістю раціону (кормовими одиницями, перетравним протеїном, мінеральними речовинами, вітамінами) та відповідала їх віковим потребам. Раціон містив: сіно лугове, силос, комбікорм, соковиті корми. Комбікорм складався з ячмінної (50 %), пшеничної (25 %), горохової (10 %) дерті, соняшникової макухи (15 %). Водопій з автопоїлок. Під час досліджень спостерігали за загальним станом бичків, руховою активністю, споживанням корму і води. Під час досліджень спостерігали за загальним станом бичків, руховою активністю, споживанням корму і води.

Дослід проведений у зимово-стійловий період. Матеріалом для біохімічних досліджень слугував вміст рубця, який відбирали через 2 год. після ранкової годівлі тварин за допомогою приладу, виготовленого на основі колби Бунзена та вакуумної помпи Комовського, фільтрували його через чотири шари марлі і транспортували у щільно закритому термосі в лабораторію. Фільтрат рубця у співвідношенні 1:4 вносили у інкубаційні флакони з середовищем Мак Доугля. Інкубацію проводили в анаеробних умовах при температурі 38 ºС впродовж 24 год. з додаванням досліджуваних речовин. Контролем слугували зразки, у які не вносили досліджувані речовини. У досліджуваних зразках визначали масу мікроорганізмів рубця, амілолітичну активність мікроорганізмів рубця та целюлозолітичну активність.

Купрум впливає на різні сторони обміну речовин і ряд фізіологічних функцій у тварин, зокрема підвищує моторику рубця,і синтетичну активність мікроорганізмів. Хром відіграє регуляторну роль у процесах реплікації і транскрипції у мікроорганізмів.

В дослідах *in vitro* нами встановлено, що додавання купруму сірчанокислого у дозі 0,5 мМ та хлориду хрому у дозі 1,0 мМ в інкубаційному середовищі з вмістом рубця мало більш виражений стимулюючий вплив на проліферацію мікробних клітин та метаболічну активність, що призвело до вірогідного збільшення мікробної маси, зростання активності гідролітичних ферментів мікроорганізмів рубця.

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# RARE AND AZONAL PLANTS SPECIES IN THE CONDITIONS OF TECHNOGENIC ECOSYSTEMS OF LVIV PRECARPATHIAN

**Abstract.** The analysis of rare and azonal plants at technogenic ecotopes of Boryslav, Drohobych and Stebnyk was carried out. Their characteristics and features of growth conditions on these sites are presented. The role of azonal plant species in the initial stages of primary succession is shown. Such species are halophytes, in particular *Salicornia europaea L., Triglochin maritimum L., Triglochin palustre L., Puccinella distans L., Sagina nodosa L. (Fenzl), Salsola iberica Sennen et Pan, Tripolium vulgare L.* The frequency of azonal species occurrence within the technogenic ecotopes is described. Rare plant species from the Orchidaceae family and groups, in which they sprout, are characterized. The importance of rare species in the process of the primary succession is shown. The sozological status of rare plant species based on the phytososological index is described. The role of spontaneous places of rare plants a the destroyed lands as "corridors" for connection between "nuclei" of natural vegetation in the formation of regional ecological network is indicated.

**Keywords:** technogenic ecotopes, biodiversity, successions, halophytes, rare plant species, sozological significance, phytososological index, ecological network.

## INTRODUCTION

The global consequence of anthropogenic activities is the reduction of the species richness for the plant component of ecosystems, the diversity reducrion of plant communities, which reduces vegetation sustainability, decreasing the primary biological productivity of the biosphere, the potential use of plant resources of the Earth. In this regard, the main task of all humanity is to restore and preserve one of the essential components of biodiversity – phyto-diversity [18].

Within the boundaries of Lviv Carpathian region, the Drohobych-Boryslav Urban Complex was created, which was formed by the cities of Drohobych, Boryslav and Stebnyk. Its main feature is the development of the extractive industry.

Extraction of any type of minerals is accompanied by the formation of significant areas of disturbed lands, which are withdrawn from economic use for decades. Thus, dumps of used rock were created in Boryslav, due to the extraction of ozokerite and the development of oil pits. The activity of the Stebnyk Potash Plant (SCE “Polymineral”) led to the formation of dumps near the town of Drohobych and tailings (Stebnyk), which are characterized by a significant level of salinity. No objects can be used for building, or other development, and optimization of technogenic ecotopes occurs only by self-overgrowth.

Because of changes in soil and water regime, species composition of vegetation changes. Therefore, one of the consequences of intensive anthropogenic influences is the formation of azonal vegetation, which is attached to soils with significant salt content.

Sometimes such anthropogenic ecotopes are a reserve for rare plants, which rarely undergo treadmill and tearing down in these conditions. Although, their participation in the plant cover is not as significant as synanthropic species, but each rare species of plants has certain requirements for optimal conditions of growth, so when the species are characterized, it is important to pay attention to natural places of settlement. This will identify areas promising for biodiversity conservation.

## MATERIALS AND METHODS

The objects of research were florencenotic complexes formed on the territory of ozokerite dumps, dumps and tailing dumps of Stebnitsk potash plant. To study the vegetation, the route method of field research was used. Field investigations of phytopathogenic technogenic ecotopes were carried out using generally accepted geobotanical and floristic methods on populational-species, floristic and phytocoenic levels [20]. The basis for the analysis was more than 300 complete geobotanical descriptions, performed according to generally accepted methods.

During the research, traditional geobotanical methods were used: detailed, routine, semi-stationary and reconnaissance. Test sites were laid for descriptions in accordance with generally accepted approaches - up to 100 $m^2$. Given the fragmentation and dismemberment of many groups, the area of some descriptions does not exceed 10 $m^2$.

Identification of plant species was carried out using the key to plants (Dobrochayeva D.N., Kotov M.I., Prokudin Y.N., 1999). Latin names of species are given according to “Key to higher plants of Ukraine” (Dorochayeva D.N., Kotov M.I., Prokudin Y.N., 1999), taking into account the “A nomenclature checklist” (Mosyakin, Fedoronchuk, 1999) and “Angiosperm Phylogeny Group” (2009) [9, 15, 1].

## DISCUSSION

The cities of Drohobych, Boryslav and Stebnyk, which form the Drohobych-Boryslav Urban Agglomeration, belong to the Drohobych-Stryy geobotanical region of the Sambir-Ivano-Frankivsk geobotany district of oak forests. Natural vegetation forms forests here. They are mainly oak. Lakes occupy only about 5% of the area. The swamps, with the exception of small thickets of cane and horsetail, are absent [17].

The main massifs of oak forests are concentrated in the southwestern part of the district, where they occupy flat areas of interbeds with turf-podzolic surface-gleyed soils, much less in the northeastern part of the area, which is much-depleted [4].

The tree species in the vegetation cover of technogenic ecotopes of Boryslav, Drohobych and Stebnika occupy an insignificant area and occur as components of groups. Their ecological niche is occupied by plant species, which are the initial links of demotion processes in the changed ecosystems.

According to S.P. Zhukov, demutation processes always begin with syncentic successions, that is, the general tendency of successional changes is a digressive-demoturing [10, 11]. There is a destruction of plant groups in some places, and sometimes there are processes of syngenetic formation and restoration of vegetation - the formation of stable plant communities. Destruction and even the complete destruction of natural vegetation is at the stage of creating an industrial enterprise. Further successional processes take place in three stages: from the settlement of pioneer vegetation to the formation of plant groups, similar to zonal vegetation [3].

Consequently, the initial stage of succession on the studied objects is represented by pioneer species, which are also azonal at the same time.

The azonity of the plants groupings is determined by regional and local geological and geomorphological factors: relief, macroscopic exposition, lithology of anthropogenic rocks, and depth of occurrence and chemical composition of groundwater. "Alien" landscapes, different from the general background of a certain geographical zone, are formed under the influence of these factors [2].

The reason for significant participation of azonal species in the overgrowth of ozokerite waste dumps, dumps and tailings of the Stebnyk potash plant is a significant level of substrate salinity. Therefore, halophytic groups represent azonal vegetation within these technogenic

ecosystems. The basis of such groups are the following species: *Salicornia europaea, Triglochin maritimum, Triglochin palustre, Puccinella distans, Sagina nodosa, Salsola iberica and Tripolium vulgare.* [6,7,12,19].

Each of these halophytes encounters a different frequency within the investigated technogenic ecosystems of the Lviv Oblast (Figure 1). *Salicornia europaea* and *Tripolium vulgare* are involved most often in the plant cover in these technogenic ecosystems. These two species can form separate groups, or grow in one area. An interesting feature of them is that they form monodominational groups. Projective coverage is negligible – 30–50%. Their participation in the groups is 50–75%.

*Triglochin maritimum* (15–20%) forms a group with a total projective coating of 50–60%. In addition to this species, *Bolboschoenus maritimus (L.)* (50%) and *Triglochin palustre* (20–25%) are dominant in the group.

*Puccinella distans* (10–25%) is found in groups with *Odontites vulgaris Moench* (15%), *Lotus corniculatus L.* (20%), *Juncus effusus L.* (5%) and *Centaurium pulchellum Sw.* (5%). Projective coverage of the group is 60-70%.

The described groups are the initial stage of technogenic ecotopes overgrowth and are characteristic of the first stage of primary succession. This stage passes through the type positivity of model, that is, during the succession, an improvement in the existence conditions for the following types of plants [2]. It is characterized by underdeveloped vegetation, low species diversity, small biomass and productivity. As the succession develops, the number increases.

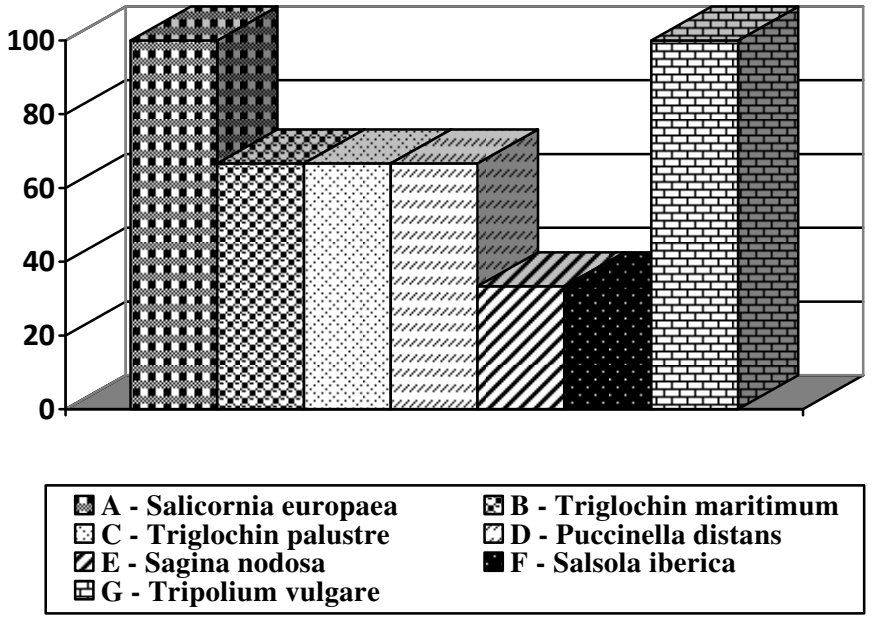


**Fig.1 Frequency of azonal species occurrence at dumps and tailings**

Interactions between organisms increase with the development of the succession range. The number and role of symbiotic relations especially increases. The habitat is more fully developed, trophic bundles are complicated, species biodiversity and projective coverage of groups increases [5, 13].

At the second succession stage, with the growth of species diversity, optimal conditions are created for the growth of rare plants - representatives of the Orchidaceae family: *Epipactis palustris (L.) Crantz, Epipactis helleborine (L.) Crantz, Gymnadenia conopsea (L.) R. Br., Dactylorchiza sambucina (L.) Soo, Dactylorchiza fuchsii (Druce) Soo.*

Projective coverage in groups, where the component is the species of the Orchidaceae family is 50–70%, occasionally 100%.

According to the life strategy, the species found in the Orchidaceae family belong to both the exploiters and the patients [14].

The strategy of the explorers is presented by *Epipactis helleborine*. *Epipactis helleborine* is a co-dominant group of *Equisetum telmateia Ehrh* (20–25%) and *Juncus effusus* (10–15%).

Patients behave like *Gymnadenia conopsea, Dactylorchiza sambucina* and *Dactylorchiza fuchii.*

*Gymnadenia conopsea* forms the group with *Calamagrostis epigeios Roth* (10–15%) and *Centaurea jacea L.* (10–15%); *Dactylorchiza sambucina* forms a grouping together with *Dactylis glomerata L.* – 25%, *Trifolium pretense L.* – 10–15%, *Lotus corniculatus* – 10%.

*Dactylorchiza fuchii* (Druce) participates in the formation of groups with a projective grass covering of 50–60%. The group is located on the territory of the ozokerite dumps and is attached to the middle part of the rocky slope. It is formed by the following species: *Calamagrostis epigeios, Carex distans L., Daucus carota L., Polygala vulgaris L.* and *Polygala comosa Schkuhr, Crepis mollis (Jacq) Aschers.*

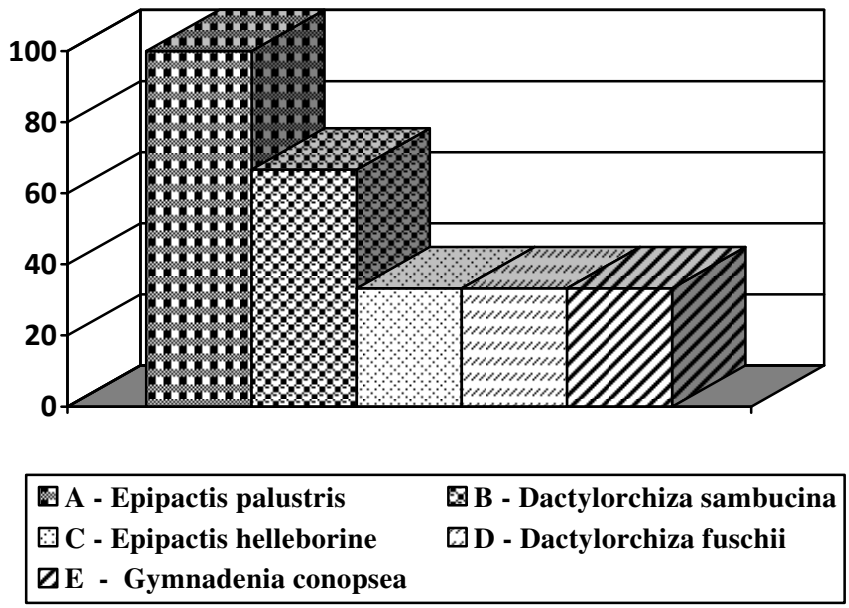


**Fig.2 Frequency of Orchidaceae family species occurrence**

Each of the Orchidaceae family species is found at a different frequency on the investigated technogenic objects. A diagram (Figure 2) can represent the correlation of these species.

After analyzing Fig. 2, it is seen that the most optimal conditions are for *Epipactis palustris*. This species sprouts in groups with a projective coating of 70–100%. The main dominant species in this group are *Calamagrostis epigeios* (50%), co-dominants are *Stenactis*

*annua (L.)* Ness. (10%), *Tussilago farfara L.* (10%), *Lotus corniculatus* (15%) *Achillea millefolium* L. (15%).

Rareness indicators of the particular species are its rarity categories according to the IUCN Red List Categories [21] and the environmental categories defined in the Red Data Book of Ukraine [8]. These figures are given in the table.

Y. Cherzhovsky proposed to use the so called indexes for the evaluation of rare species [4]. Integral assessment of the species sozological status, taking into account the complex of characteristics for its regional populations, reflects the outphytososological index (OPI). There are five classes of phytososological indexes: 1 – (OPI 4,0-6,9); 2 – (OPI 7,0-8,9); 3 – (OPI 9,0-10,9); 4 – (OPI 11,0-12,9); 5 – (OPI 13,0-15,2). The growth of the index value corresponds to an increase in the sozological significance of the species, or indicates an increase in the threat to a certain species in the region [3].

The studied species of the Orchidaceae family can be classified into two classes according to the outphytososological index: Class 2 – (OPI 7.0-8.9) – *Epipactis helleborine, Dactylorchiza fuchsia, Dactylorchiza sambucina*; Class 3 – (OPI 9.0-10.9) – *Epipactis palustris, Gymnadenia conopsea*. Most attention is required to the species of *Epipactis palustris*, which is listed in the Red Book of Ukraine and in the European Red List and at the same time has the highest OPI class.

**Table 1. Rare plants species of technogenic ecotopes at the Drohobych-Boryslav Urban Complex and their sozological evaluation**

| Plant species | IUCN | RB | OPI |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| *Epipactis palustris* (L.) Crantz, | LR | B | 9,1 |
| *Epipactis helleborine* (L.) Crantz, | – | H | 7,7 |
| *Gymnadenia conopsea* (L.) R. Br., | – | B | 9,4 |
| *Dactylorchiza sambucina* (L.) Soo, | – | B | 8,8 |
| *Dactylorchiza fuchsii* (Druce) Soo. | VU | H | 7,9 |

**Note:** column 2: Criteria for the rare species of IUCN: EX (Extinct) – disappeared taxon; CR (Critically-Endangered) – a taxon that is under critical threat of extinction; EN (Endangered) – endangered taxon; VU (Vulnerable) – Vulnerable; LR (LowerRisk) – a low-risk taxon; Box 3: Nature conservation status of the species in the Red Book of Ukraine: C – endangered; B – vulnerable; P – rare; H – invaluable.

Assessing the sozological perspective of ecosystem changes on the territory of the ozokerite dumps, waste dumps and tailings of the Stebnyk potash plant, it can be said about sozological neutral changes in vegetation cover.

Sozologically neutral changes in the vegetation cover are changes occurring because of the spontaneous development of phytosystems in anthropogenically transformed landscape and biota, that is, anthropogenic evolution of the vegetation cover [16]. As a result of such changes, vegetation groups, or vegetation species that are not originally specific to the region can be formed, but which formation became possible due to the anthropogenic creation of new ecotopes that were previously absent in the region. These changes, for the most part, are due to the growth of regional phyto-diversity.

## CONCLUSIONS

After analyzing the groups formation on technogenic ecotopes of the Drohobych-Boryslav Urban Complex with the participation of species from the Orchidaceae family and azonal species, a certain generalization about the significance of anthropogenic influence for the formation of the vegetation of the region can be made. Anthropogenic transformation of ecotopes at the same time causes both depletion of the regional flora due to the changes in the soil cover, water regime, and hence the loss of typical plants location, as well as the enrichment of the regional flora due to the emergence of new species non-typical for a given locality.

In technogenic ecosystems, suitable enough settlements are found in a large number of rare plants, many of which actively propagate, form populations under these conditions, thereby increasing the species richness of the flora on technogenic ecotopes. On the other hand, such spontaneous places of rare plants on disturbed lands can serve as "corridors" for communication between the "nuclei" of natural vegetation in the formation of a regional ecological network.

In our study, these species are *Epipactis palustris, Gymnadenia conopsea, Dactylorchiza sambucina, Epipactis helleborine, Dactylorchiza fuchsii*. They grow well in the conditions of salt excess and waterlogging and are not exposed to those factors that caused their extermination, caused the giving the status of protected species (drying of biotopes, plowing of plants for use with a medicinal purpose, recreational loading, building up of territories).

In addition, groups of azonal plants are important for groups of technogenic ecotopes, which are the basis for the initial stages of primary successions. They change the soil and hydrological conditions of the affected areas, thus contribute to self-overgrowth, and biodiversity increase.

Among the technogenic ecotopes of the Drohobych-Boryslav Urban Complex, such species are *Salicornia europaea, Triglochin maritimum, Triglochin palustre, Puccinella distans, Sagina nodosa, Salsola iberica, Tripolium vulgare*.

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## АНОТАЦІЯ

## РІДКІСНІ ТА АЗОНАЛЬНІ ВИДИ РОСЛИН В УМОВАХ ТЕХНОГЕННИХ ЕКОСИСТЕМ ЛЬВІВСЬКОГО ПРИКАРПАТТЯ

В межах Львівського Прикарпаття сформувався Дрогобицько-Бориславський урбопромисловий комплекс, який утворений містами Дрогобич, Борислав і Стебник. Основна його особливість – розвиток видобувної галузі промисловості. Це призвело до утворення значних площ порушених земель, які вилучені з господарського використання на десятки років. Так, в м. Бориславі внаслідок добування озокериту та розробки нафтових шурфів виникли відвали використаної породи. Діяльність Стебницького калійного заводу (ДГХП “Полімінерал”) призвела до утворення відвалів поблизу м. Дрогобич і хвостосховищ (м. Стебник).

Внаслідок зміни ґрунтового та водного режиму змінився видовий склад рослинного покриву досліджуваних екосистем. Сформувалися асоціації азональної рослинності, що не характерна для природних екосистем регіону. Також ці техногенні екотопи є резерватом для рідкісних рослин. Хоча, їх участь в рослинному покриві не така значна, але кожен рідкісний вид рослин має певні вимоги до оптимальних умов зростання, тому при його характеристиці важливо звертати увагу на природні місця поселення. Це дасть змогу визначати території, які є перспективні для збереження біорізноманіття.

Руйнування й навіть повне знищення природної рослинності в межах техногенних екосистем Дрогобицько-Бориславського урбопромислового комплексу призвело до виникнення сингенитичних сукцесій. Сукцесійні процеси проходять у три стадії: від

поселення піонерної рослинності до формування рослинних угруповань, схожих із зональною рослинністю.

Первинна стадія сукцесії на досліджуваних об'єктах представлена піонерними видами, які одночасно є азональними. Основною причиною значної участі у заростанні азональними видами відвалів озокеритовидобутку, відвалів та хвостосховищ Стебницького калійного заводу є значний рівень засолення субстрату. Тому, в межах цих техногенних екосистем, азональна рослинність представлена галофітними угрупованнями. Основою таких угруповань є види: *Salicornia europaea L.*, *Triglochin maritimum L.*, *Triglochin palustre L.*, *Puccinella distans L.*, *Sagina nodosa (L.) Fenz*, *Salsola iberica Sennen et Pan*, *Tripolium vulgare L.*

На другій стадій сукцесії, при зростанні видового різноманіття, створюються оптимальні умови для зростання рідкісних рослин – представників родини *Orchidaceae*: *Epipactis palustris* (L.) Crantz*, Epipactis helleborine* (L.) Crantz, *Gymnadenia conopsea* (L.) R. Br., *Dactylorchiza sambucina* (L.) Soo, *Dactylorchiza fuchsii* (Druce) Soo.

Проективне покриття в угрупованнях, де компонентом виступають види родини *Orchidaceae* становить 50-70%, зрідка 100%.

За життєвою стратегією виявлені види родини Orchidaceae належать як до експлерентів, так і до патієнтів.

Досліджувані види родини *Orchidaceae* за аутфітосозологічним індексом можна віднести до двох класів: 2 клас – (АФІ 7,0-8,9) – *Epipactis helleborine, Dactylorchiza fuchsia, Dactylorchiza sambucina;* 3 клас – (АФІ 9,0-10,9) – *Epipactis palustris, Gymnadenia conopsea.* Найбільшої уваги потребує вид *Epipactis palustris,* який занесений до Червоної книги України та до Європейського червоного списку й одночасно має найвищий клас АФІ.

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# MODELING THE FOREST COVER TRANSFORMATION BASED ON CARTOGRAPHIC SECTIONS FOR DIFFERENT PERIODS

**Abstract.** The research outlines the ways for further use of the mapping method in retrospect and geographical studies for the nature and human transformation in the geosystems of small rivers basins. The article contains an overview of the main theoretical and methodological works devoted to this problems. The known cartometry research methods were tested for the study of the forest area dynamics in the period from 1880 to the present time. A geoinformation model of the forest cover dynamics was created, which reflects the change in the area of forest areas during the 130-year period. The methods of remote sensing of the Earth, which provided the geoinformation model with information about the current state of the forest cover, were actively engaged. The research results are presented in a number of cartographic models. In particular, schematic maps of forest cover for four periods, as well as for changes in these indicators over the period were developed and analyzed according to calculations.

**Keywords:** geoinformation model, cartographic research method, basin system, forest cover, forest area, transformation processes.

## INTRODUCTION

For the long history of the environment conversion, the structure of natural landscapes has undergone significant changes. It led to the formation of natural-economic systems, which significantly reduced the self-regulation ability, and to the emergence of complex ecological and geographical problems. The wooded area is an important ecological condition indicator, as forests play an important role in the ecological stability due to their water conservation, safety, hygiene and health functions. An important feature of forests is the ability to self-regeneration and self-regulation. Therefore, the study of their state, quantity, and forecasting the dynamics of changes is extremely relevant to the present day.

Forest cover is mainly analyzed within the administrative units or forestry, where the information on the status and availability of forested areas is collected. However, such an approach does not take into account the systemic principle and does not reflect the real picture for the influence of forests on the state of other geosphere components. The most informative is to assess forest cover within the separate basins of small rivers. Small river is closely related to landscape and reflects negative processes occurring in the watershed much faster, as they act as natural drainage for the agricultural land, are the most vulnerable in case of neglecting environmental requirements and react to changes in the areas in the fastest way.

The study of woodland should begin with a retrospective investigation of the anthropogenic transformation of forest cover based on mapping models for various periods. This method will provide more substantiated approach to a system of measures optimizing the natural resources, and prospects for development of the studied area.

**Previous studies (level of scrutiny).** The analysis of the territorial complexes transformation is widely discussed by many scientific schools. In particular, there are significant gains in landscape ecology, geoecology, environmental monitoring, landscape geochemistry and geophysics, applied physical geography, urban ecology, hydroecology and environmental river morphology. Theoretical and methodological basis for the research of transformation processes is given in the works of A.D. Armand, O.P. Havrylenko, S.A. Grodzinsky, M.D. Grekov, E.A. Klementova, I.P. Kovalchuk, I.B.

Koynova, F.N. Milkyy, A.G. Potapova, A.M. Tretyak, P.H. Shyshchenko. Transformation processes in land use were studied by B.M. Danylyshyn, M.A. Hvesyk, I.P. Kovalchuk, T.O. Yesiukov, Ye.A. Ivanov, M.A. Petrovska, P. Verburg, A. Valz, D. Lisio, P. Ksorba [2; 3; 5; 6; 7; 12; 13; 14; 19; 24]. Transformation forest area were studied by Hart C., Hecht S., Kandel S., Gomes I., Cuellar N, Pommerening, A., Edwards E., Hale S., Ireland, D., Osvaldo A., Gustavo J., Redo D., Bass J., Kivinen S, Berg A., Moen J. [16, 17, 18, 20, 21, 22, 23]

The most common modeling method for a geographer is the representation of the studied phenomenon on the map and conducting further studies using this model [1]. Basics of cartographic research method were developed by Professor K. Salischev [10], improved and developed by Professor O. Berlyant [1]. The research of R. Sossa were dedicated to the historical maps as a source of information about the territory of Ukraine [11]. Recent advances in thematic mapping make this method quite promising. However, as a significant attention has been paid to the filling of maps with information, rather than to the receipt of new data on their basis. There is no doubt that the fastest filling of this gape is extremely relevant and requires the development of appropriate methods for map analysis. The analysis includes maps for obtaining qualitative information and quantitative characteristics for phenomena and processes, the study of relationships and interdependencies in ecosystems, their dynamics and evolution, setting trends and forecasting future states of geosystems [11].

## MATERIALS AND METHODS

To assess transformation processes for the forest cover, topographic maps from the years 1880, 1922, 1945 and QuickBird satellite images from the year 2009 were used. The maps of the same scale, projection and coordinate system were best matched [1]. However, the maps constructed at significant intervals of time, each of which has its own corresponding time of creation, a way of representing the earth's surface, are used most often for determining transformational changes. Therefore, it is often necessary to analyze maps with different conditional symbols. It complicates the process for comparing time-consuming material and cartographic material itself, since maps were created on paper, which eventually undergone deformations (under the influence of environmental factors). Therefore an important condition for a correct analysis of transformational changes is the reliable binding of maps to the coordinate system and among themselves. Technically, this procedure is performed by Georeferencing module in the ArcGIS 9.0 software [15].

The product in this analysis is, typically, a map for the dynamics (changes) of the studied geographic object. However, the application of GIS technology usually gives some intermediate image and the so-called transitions table (matrix), where all the differences between the compared images are fixed [4].

Transformation processes in the forest cover were studied in the basin system of Berezhnytsya River at sub-basin thalweg network of different level. Berezhnytsya River is a tributary of the Dniester River, small river of Precarpathians, which flows out of Dolyna district, Ivano-Frankivsk region and flows through the territory of Zhydachiv and Stryi districts, Lviv region.

## DISCUSSION

The development of the vegetation of the basin is associated with the process of formation of the forest zone of Europe, which begins at the early Pliocene, when this area freed from the sea. A significant imprint on the development of vegetation was quaternary glaciation. After the glacier, there were new conditions that contributed to the development of broad-leaved forests and meadow vegetation. Carpathian region had covered with forest vegetation, mostly oak and hornbeam forests. Great changes in natural vegetation made man. It destroyed the forest and herbaceous vegetation, and their place had occupied by cultivated plants.

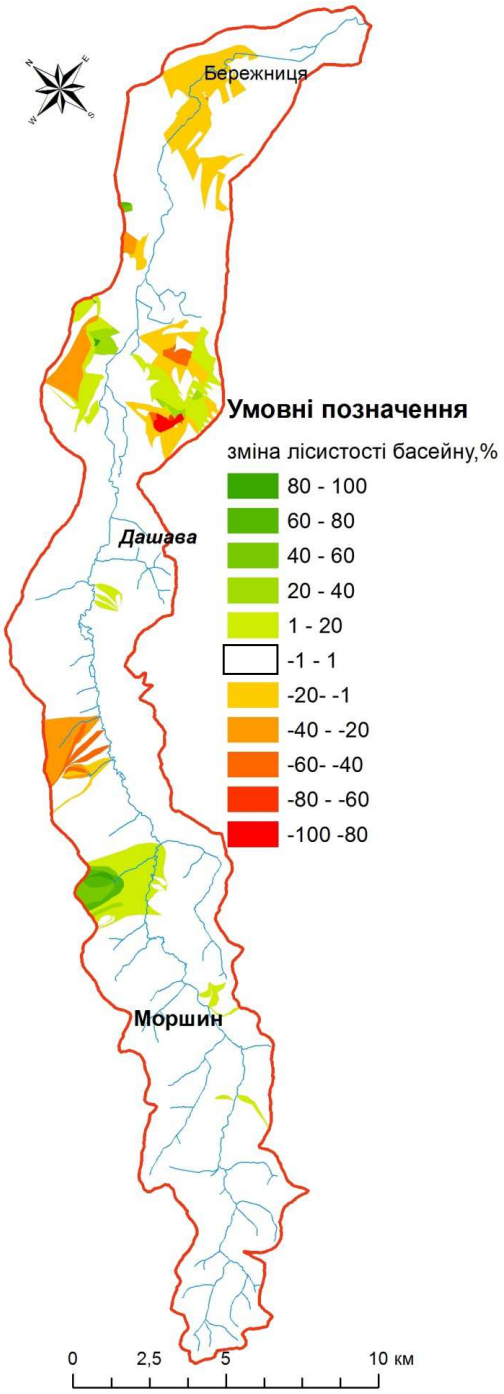


**Figure 1. Change of forest area of the basin system of the Berezhnytsia River from 1880 to 1914 (in the context of sub-basins)**

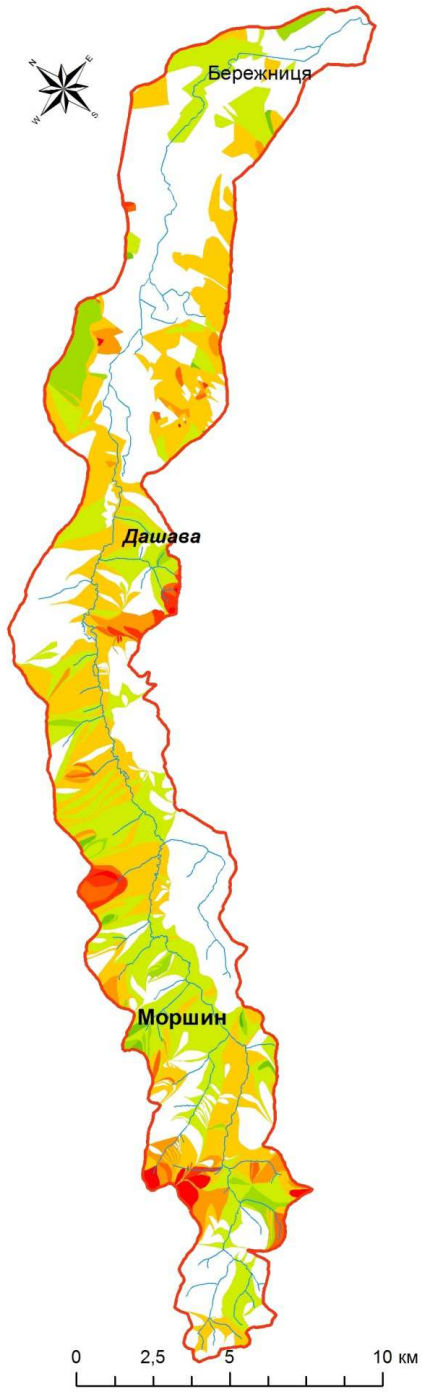


**Figure 2. Change of forest area of the basin system of the Berezhnytsia River from 1914 to 1945 (in the context of sub-basins)**

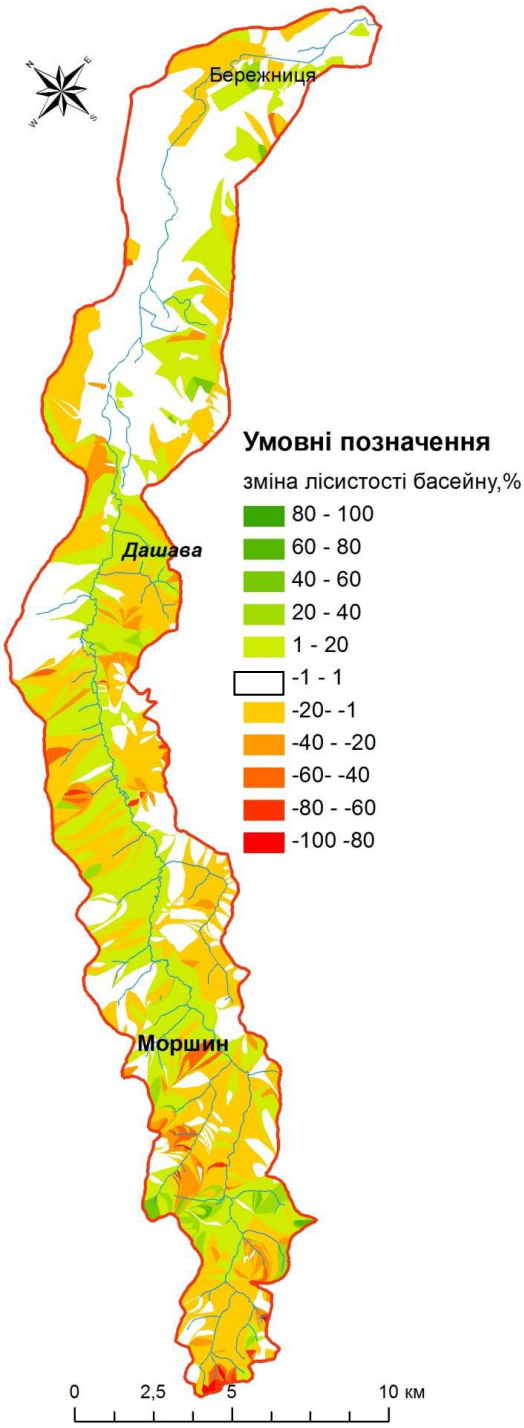


**Figure 3. Change of forest area of the basin system of the Berezhnytsia River from 1945 to 2009 (in the context of sub-basins)**

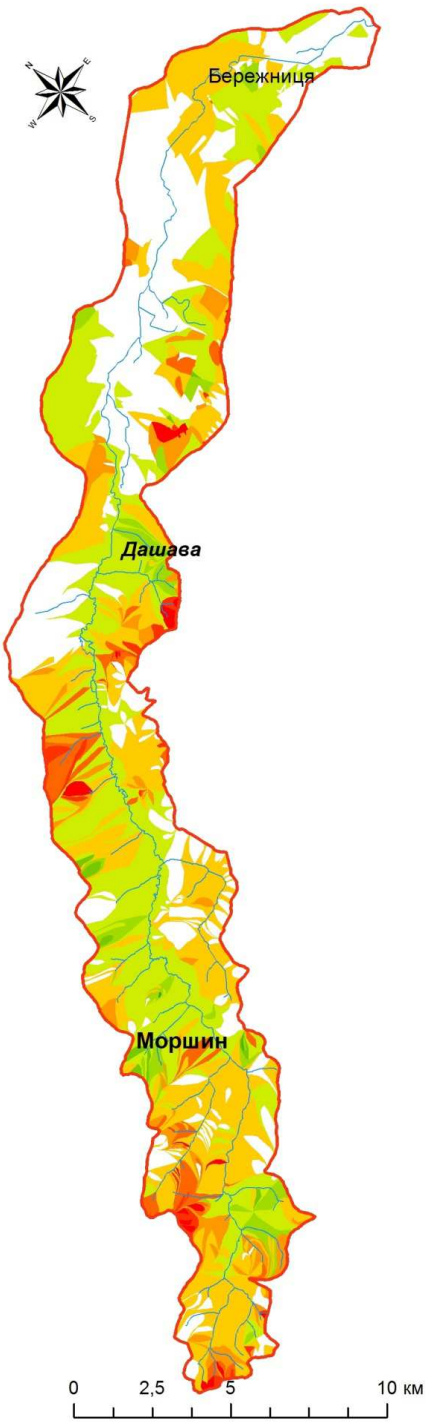


**Figure 4. Change of forest area of the basin system of the Berezhnytsia River from 1880 to 2009 (in the context of sub-basins)**

Currently, in the basin, forests occupy higher spaces, small areas that are not suitable for cultivation may occur meadow vegetation. Forests located in the Berezhnytsia river basin are mostly broad-leaved, less commonly mixed coniferous forests. Typical forest vegetation here is oak-hornbeam forests with an admixture of birch and alder and fir-spruce rocks. Often found largeleaf linden and littleleaf linden, norway spruce and rowan. The main forest species are durmast oak, european beech, european hornbeam, maple, elm, sycamore maple, linden, birch, aspen, spruce, sweet cherry, european crab apple, european pear

The simulation results for the forest cover transformation showed that the smallest changes occurred in the studied basin for the first period of study (1880-1914, 34 years) (Figure 1). In particular, the change of forest cover in the lower part of the basin was due to the involvement of wetlands in the agricultural cultivation, which contributed to the expansion of the ameliorative network in the area. The forest cover increased near the homestead Pyla and the village Hanivtsi. It decreased in the subsequent periods.

Significant changes occurred within the second period of study (1914-1945, 31 years) (Figure 1). The sharpest changes were detected in the upper part of the basin, where there were active forests cutting. Thus, the forestland was transferred to the category of arable land near the homestead Smolianyy, the similar processes were detected around the village Dashava, where the growing of village and its industrial development led to a decrease in forest area. The increase of agricultural land due to reducing the forestland area was observed in the lower part of the basin (except margins of the village Berezhnytsya and Zabolotivtsi, where the process was stopped due to the waterlogging, thus the forestland area increased in this territory).

In the third period of study (1945-2009, 64 years) (Figure 1b), significant changes in the forest cover occurred mainly in sub-basins of 1-2 levels. Significant deforestation for industrial purposes occurred in the upstream. Reducing forest cover in this part of the basin resulted in the creation of three suburban settlements (in Dolishne village council). Along with the decrease in forest cover, inverse processes were observed within the Berezhnytsya River basin, which were equally typical throughout the studied area. This is due to the activation of succession processes on abandoned farmland. The basin succession processes occured for various reasons and were sometimes opposite. Thus, the areas near the settlements were overgrown with woody vegetation due to the reduction of the farms and small villages role in the economic development of the region and, consequently, the workforce outflow from the territory. In particular, such processes were most actively developing near the homestead Smolianyy. The increase in forest cover occurs near most settlements due to the overgrowing of abandoned unproductive agricultural land, as the intensity of arable land use increased. The same processes occurred because of the decrease in cattle population, which was observed in all settlements of this region and significantly increased the part of untreated lands.

Among herbaceous formations on the plains, dominant place belongs to meadows (11% of Berezhnytsya River basin), the most common among which are after-forest dry-valley meadows. In terms of specific areas, a steppe vegetation survived (as meadows turned into steppe). The lowest redeployed areas of river floodplains are covered with marshy wet and peat meadows (1.5% of the studied area). The following plants grow in the Berezhnytsya floodplain: fescue grass, bluegrass, foxtail grass, arctic brome, timothy-grass, June grass, sow-thistle, marsh bedstraw, oxeye daisy, Ragged-Robin. On the highly located ground, fragrant herbs, honey grass, sedges (plain, yellow, white), oxeye daisy, polygala crested, plantain lanceolate are occurred. The swampy meadows are rich in such cereals as the common ocher, the floating and large sweat-grass, bullrush, horsetails (river and marsh), sedge (yellow, pollen and others) and small grains (honey grass, prayer coastal), common cottongrass, common rush. Moss peat meadows are also known, where moss cover of sphagnum mosses dominates. The diversity of cultural vegetation is determined by diversified agricultural production [8, 9].

## CONCLUSIONS

Analysis of models for forest cover changes in the Berezhnytsya River basin for nearly 130-year period shows that most of the forest cover changed. Only those basins remained unchanged, which structure did not include forests, or those parts of forestlands located at considerable distances from settlements. Over the years, the forest was cut for different purposes: commerce, to create new settlements (homestead Smolianyy and suburban settlements within Dolishne village council), to expand farmland. In addition, the reversible processes took place, which lead to post-anthropogenic succession, and the abandoned lands were overgrown with woody vegetation.

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## АНОТАЦІЯ

## МОДЕЛЮВАННЯ ТРАНСФОРМАЦІЇ ЛІСОВОГО ПОКРИВУ НА ОСНОВІ РІЗНОЧАСОВИХ КАРТОГРАФІЧНИХ ЗРІЗІВ

У статті окреслено шляхи використання картографічного методу у історико-географічних дослідженнях природокористування та антропогенного перетворення басейнових геосистем річок. Задіяно відомі методи картографічних досліджень для вивчення динаміки лісовкритих площ за період з 1880 року до сучасності. Результати проведених досліджень відображені на низці картографічних моделей. В результаті геінформаційного моделювання, побудовано і проаналізовано картосхеми лісистості на чотири часові періоди, а також динаміка цих значень за досліджувані проміжки.

Перший обліковий період тривав 34 роки (1880-1914рр) і характеризувався найменшими змінами лісистості території басейну. Нижня частина басейну зазнала змін внаслідок залучення до сільськогосподарського обробітку заболочених земель, чому сприяло збільшення меліорованих територій на даній території. Спостерігається тимчасове збільшення лісових масивів довкола хутора Пила та села Ганівці., яке зменшилось в наступні періоди.

Другий обліковий період (1914-1945рр) був приблизно такої ж тривалості як і попередній, але суттєво відрізнявся кількістю змін. Найгостріше вони відчулися у верхній частині басейну, де активно проводилась вирубка лісових масивів. Поблизу хутора Смоляний лісові угіддя перейшли в категорію оброблюваних земель, подібна ситуація відбувалася і в околицях смт Дашава. Цей процес був супутній до росту селища та його промисловості і призводив до зменшення площ лісів. Збільшення сільськогосподарських угідь шляхом зменшення площ лісових угідь спостерігається і в нижній частині досліджуваного басейну. Винятком є околиці с. Бережниця та Заболотівців, де цей процес супроводжується заболоченням території, і як наслідок на цій території збільшується кількість лісових угідь.

Великі зміни в лісовому покриві відбулися , в основному, в підбасейнах 1-2 порядків протягом третього облікового періоду(1945-2009 рр, 64 роки). Значні промислові вирубки лісів здійснювалися у верхній течі. Зменшенню лісистості вданій частині басейну сприяло створення трьох дачних поселень. Однак в цей період в басейні річки Бережниця спостерігаються зворотні процеси, рівномірно поширені по всій досліджуваній території. Цьому сприяла активізація сукцесійних процесів на сільськогосподарських угіддях, які втратили своє сільськогосподарське призначення. В досліджуваному басейні сукцесійні

процеси виникають з різних причин та інколи мають протилежний характер. Зокрема, території поблизу хуторів та невеликих сіл заросли деревною рослинністю за рахунок зменшення ролі в економічному розвитку регіону та, як наслідок, відтоку з них робочої сили.. Найактивніше такі процеси спостерігались поблизу х. Смоляний. Підвищення лісистості формується поблизу багатьох населених пунктів через заростання покинутих малопродуктивних земель сільськогосподарського призначення. Такі ж процеси відбулись внаслідок зменшення поголів'я великої рогатої худоби, яке спостерігається в усіх населених пунктах даного регіону, що значно збільшило частку необроблюваних земель.

Створена модель зміни лісистості басейнової системи р.Бережниця протягом майже 130-ти річного періоду вказала, що більша частина лісових масивів була змінена. Показники лісистості незмінні тільки в басейнах, у структурі яких не було лісу, або та частина лісового покриву, яка розташована на значних відстанях від населених пунктів. Вирубка лісу протягом цього періоду відбувалася з різною метою: промисловою, для створення нових поселень, для збільшення площ сільськогосподарських угідь. Також в басейні спостерігаються і зворотні процеси внаслідок яких розвинувся ряд постантропогенних сукцесій і покинуті землі заростали деревною рослинністю.

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# SYMBOLISM OF BIBLICAL PLANTS USED IN GARDEN ART

*,, For the Lord, Thy God, has introduced you to the land of the beautiful, earth full in the streams, springs and streams that spurt in the valley and on top to land wheat, barley, vines, fig and pomegranate trees to the land of olives, olives and honey*"
(Pwt 8,7-8)

**Abstract.** Research into the scriptures and later church literature, painting, sculpture, architecture, and archaeological discoveries have allowed to extract the species of plants called Biblical. These plants were used to create the monastic gardens which consisted of close, a square courtyard inside the buildings of the church and the monastery. It was a garden closed to the outside world, served to pray and contemplate the monks. In wirydarz planted plants, whose symbolism led the thought toward God. In addition to the ornamental function, the plants were curative and were an element which emphasized the sphere of the sacrum and alluded to a yearning for a paradise. Examples of such assumptions are the Biblical gardens, which are found around the world, including in Poland. One such garden is the Biblical garden in Myczkowce. The article lists just a few of the extensive list of plants with the biblical symbolism. As studies have shown, it is worth remembering that both past and modern ornamental qualities are not the only reason why such plants and not other crops apply.

**Key words**: Biblical plants, Myczkowce, Daktylowiec, Wawrzyn szlachetny, laur, Mirt zwyczajny, Dyptam jesionolistny, *Dictamnus albus, Myrtus communi, Phoenix dactylifera, Laurus nobilis, Ficus carica, Moses bush, Burning shrub, wirydarzconvent gardens, Herbularius, hortus medicus.*

## INTRODUCTION

Archaeological discoveries, literary applications, paintings and engravings allow to extract the plant species used in ancient gardens. Because of the Christian tradition, a large number of plants have been attributed a symbolic meaning, which today is used in many ways. In addition to decorative ornaments in the building, motif in painting and literature, symbolic plants for Christianity are present in garden art. Many of the species of plants mentioned in the Bible have not survived the test of time, but some of them can be found in the gardens today. On the first mention of biblical plants we are already in the first books of the Old Testament. These plants may appear under different names, sometimes they are colloquial names that have changed with time. Contemporary Biblical vegetation researchers in the work on identifying these plants were based on original texts in Hebrew, Greek and Aramaic. [16] The current list of biblical plants includes only 203 taxa considered by all biblical plant researchers. The following article is intended to analyse the garden's assumptions, in which the old and modern plants with symbolic significance for Christianity are used today. [18]

## METHODOLOGY

The article uses available literature in the form of books, periodicals, articles, observations in the field, photographs of own authorship, Web pages and analysis and inventory of modern and old garden assumptions.

## TEST RESULTS

In Christianity, plants have always played a great role. With the symbolic significance of the plants we meet in the Bible, legends, old applications and mythology. Plant motifs are also present in the urban architecture. The buildings are often decorated with plant ornaments. In addition, archaeological findings, mosaics, cultural and horticultural monuments give proof that, since the earliest times, the plants have had not only a consumer or ornamental character, but also symbolic. They touches every realm of Christian culture. The art of garden was rich in references to the mystical and spiritual sphere. The modern symbolic significance of plants is used in the reconstruction of ancient historic gardens, in the creation of monastic gardens, biblical and thematic gardens. Studies and analyses have shown similarity in the use of plants mentioned in the Bible in garden assumptions.

In the Middle Ages the church's significance grew, and monasteries were played as places where philosophy, science and art were promoted according to Bible Records. According to the assumptions of medieval art the garden was subordinate to religion. It was full of symbols in it, reflecting the rapture that the man felt towards the world which God created. One of them was precisely chosen vegetation. Not without reason in the records of the medieval gardens we come to recurring motifs in the creation of gardens, and plant species. 4]

One of the characteristic elements of the monastic gardens was close. It was located in the assembly of the church and monastery. Square or rectangular was surrounded by arcades. M. Kranz writes that Close was a peculiar, *Hortus Conclusus, a garden closed to the outside world and its temptations, but open to God and his will.* " Inside the central location was a well as a symbol of life, sculpture or tree-referring to the "Tree of Life" in the center of the Paradise Garden. Through the cyclic measlesd. The solution and dying was a symbol of a new life. The tree of its Christian symbolism also binds with the cross on which Jesus died. Close is divided into four apartments planted with flowering plants, shrubs or herbs. In addition to the ornamental function, plants had a therapeutic function and were That emphasized the sphere of *Sacrum* And he alluded to a yearning for a paradise. Close intended for recreation, was a sign of paradise, to which, as was thought, leads the way of contemplation. Some of the plants alluded to the symbolism of Marian, a tribute to the symbolism of Jesus, and Biblical events. [9] Red roses (*Rosa*) was identified with martyrdom, innocence and purity of faith with white lily, in turn Violet odorata (V*Iola odorata)* He was a symbol of fidelity, loving perseverance and great humility. Passion Flower (*Passiflora)* been Instrument of Christ's passion. Five anther-Five wounds, nevus of the pillar-three nails, laces-crownsę Thorns. Symbolically Rose Also Refers to the martyrdom of Jesus Christ. The red colour signifies blood, five okwiatu-five wounds of Christ, and thorns of the crown. In addition, the rose is the symbol of Mary, which is called the Rose of Zion, the spiritual rose. The rose blooms among the thorns It alludes to Mary immaculately conceived among sinners. It is also a sign of the passing of temporal things and the love of Our Lady to God and people. The Symbol of the Rose was initiated by the Christian Rosary, and Giving the Golden rose to the pope is one way of expressing homage and appreciation. [3] The rose flower is very often attributed to the holy benefactors who, according to the applications, gave gifts against The prohibitions and these turned in roses. In medieval Greece she was a symbol of Aphrodite-the goddess of love, and in Rome the feast was celebrated in honor of the dead, and the tombs were decorated with roses. [17] It is mentioned in the Book of Wisdom (2.8). There was a custom donning wreaths by revelers in which there were roses among others. Syrah In the Book of Wisdom he mentions the Rose bush as a plant of wisdom, *I grew up like a palm tree in Engaddi, like rose bushes In Jerychu, like a wonderful olive on the plain, I grew up like Platan*" (Syr 24.14) [15]. Today's Rose is A well-known plant At Wide colour scale and applications. The fruits used in medicinal contain a lot of essential oils, organic acids, sugars and pectin. Have action diuretic and spasmolithics. The fruit is also used to produce, among other things, jams, oils and syrups in culinary art. [9, 13]

The inherent element of the monastery Wirydarz was *Buxus sempervirens*. It was created from the perimeter of garden accommodation. He was highly valued in ancient Egypt. In Persia it was believed that surrounded by a ribbon twig boxwood, attacheding over the entrance to the house protected the inhabitants from the spells and diseases. According to the applications of Boxwood was made titulus, nailed to the cross of Jesus. In ancient times, it was considered a plant that could cause miracles, and was a symbol of fidelity and eternity. In the Bible, Boxwood is mentioned in the Book of Isaiah (that 60.13). [2, 11] "In the Desert I plant Cedars, acaciass, and olives; I spread in the wilderness of Cypresses, Elm and boxwood next to each other "(is 41, 19). "The Pride of Lebanon will come to you: Together cypresses, Elm and boxwood, to beautify my holy place. and wsławią the place where my feet stand "(Iz 60, 13). In Poland it has been cultivated since medieval times. Used as an ornamental plant, for discounts, fringes, hedges, topiary. It is also used for the production of honey in culinary art and also has healing properties. Furniture products are produced from wood. [1.8] Boxwood is an evergreen shrub or tree 3-5 m. Leathery leaves, single, shiny and dark green. Zielonkawożółte flowers. The fruit is a hard, brown handbag. [10] It is found in North Africa, Central Europe and Asia Minor. Next to Boxwood, the garden accommodation Wirydarza filled with ivy (Hedera Helix). Due to durable in winter, it refers to the fidelity and permanence of life. In Christianity, in the period of Christmas ivy decorated houses and churches. Because of the evergreen leaves, it represented a symbol of immortality and a soul that never dies. Ivy been with a feeling of timeless love, friendship, attachment and caring. The monastic gardens, on the model of the ancient gardens of perystylowych, often adorned topiarami, which are cut forms of plants, and small trees characteristic of the time in which Jesus lived. [4] One such plant is a noble laurel (Phoenix Dactylifera) colloquially called Laure. We have already stumbled upon the mention of Wawrzynie in the oldest applications. In ancient times Laurel was treated as a divine Apollo tree, which is why the wreaths of the winners were always adorned with laurel twigs. Soldiers returning from the field of battle carried twigs laurel as a symbol of penance and purification from being shed on the Battle of Blood. [7] In one of the works Ovid preached: "You will always decorate, o laurel tree, my hair, lira, my bow. You will receive a gift from the chieftains of the Lazio, where the Capitol will be among the voices of triumph. " The leaves provide the buildings from lightning and the household against diseases. Bay Wreaths also received scholars as a scientific symbol. In the New Testament, Laurel was seen as a sign of victory over sin. There was no conclusive or laurel in the Bible because of problems with language translation. It was probably presented in the description of the mountain caramel, where it is commonly found. In Greek mythology and Roman laurel is a plant meaning wisdom and glory, in the Christian tradition and the Resurrection of Christ. [15] Laurel naturally occurs in the countries of the Mediterranean region: North Africa, southern Europe, Part of West Asia including Israel, Lebanon, Turkey, Syria. It is an evergreen shrub, or a small tree height to 10m. The elliptical leaves, leathery, after a fragrant scent, the yellow flowers appear from March to April. The fruit is bitter in taste dark berry with a content of as much as 39% of the oil. Cultivated in ancient Greece and Rome, Laurel is treated as an ornamental plant and hedges. In Poland, because of its harsh winters, it is a potted plant that should be placed in a room for the cooler period. It is also used in medicinal and cosmetics. [2] leaves and fruits form the raw herbalist. In larger quantities the leaves are toxic, contain 30% oily oils, starches, sugars. The rich substances of flavonoids, which act against MRSA, are also used for blood disorders, treatment of coughs, treatment of rheumatic diseases and skin. With the leaves producing essential oils and medicinal tinctures, bathing in water containing a laurel decoction helps alleviate pain in limbs and dangerous animal bites. The world-wide laurel also applies to the kitchen as a spice. In addition, they deter pests in food cupboards. Also used in perfumery. [5]

Another element of the monastic foundation was Herbularius Hortus Medicus. It was a dedicated area of the garden where herbs and medicinal plants were grown. Mention of plants with healing effects are found in the Bible. One such plant is sage (salvia), Ruta (ruta), mint

(Mentha), fennel (Anethum), chamomile (Anthemis). [4] The Ruta was a symbol of chastity and virginity. An interesting fact is that in England the Ruta symbolizes lost virginity, in Lithuania the bride Bears before the wedding wreath of the routes which symbolizes its purity. In antiquity it was used medicinally by antispasmodic and diuretic effects. In Luke's Gospel (11.42) It was mentioned that the Jews had the supply of routes and fennel to pay the temple tax. It was believed that Ruta and Koper possess the magical power of strippinging evil and sorcery. Ruddy is described in the Bible as a symbol of a short and ephemeral human life on earth. Today used both as an ornamental plant and as a medicinal product for cosmetics, perfumes and pharmaceuticals. Once used as a herb and spice, Clary Sage was associated with Maryjnymi devotions, it healing and mercy. In turn, Rosemary was regarded as a symbol of love, fidelity and death. [3]

Nowadays, the symbolism of plants, thanks to preserved literature and knowledge, allows reconstruction of old garden assumptions. A good example is the reconstruction of the Garden of Cordoba, showing the use of plants known from biblical cards and later monastic gardens. The garden was created as a model of the former, known only from the literary transmissions of Byzantine garden art. The garden uses ornamental trees such as poplars, Cedars, cypresses, oaks, maples, olives. From the bushes meet we can roses, wawrzyny, of, Bukszpany. From fruit trees granatowce, apple, figs, apricots, migdałowce. Each of these plants has its symbolic significant pertaining to biblical events and the lives of the then people. Today, in establishing gardens at the monasteries, there is a great emphasis on restoring the old state. In Kalwaria, Pacławska was developed the Wirydarz concept project, which includes the development of space in the pattern of ancient, medieval church courtyards. The project includes the use of the biblical symbolism of plants including: Boxwood Evergreen, Common ivy, red rose, Laurel Noble. Lublin Pobrygidkowski Monastery sustains the former courtyard, which has remained unchanged or slightly altered since the 15th century. The same is true of the close in the band cathedral in Pomeranian Stone. The houses filled with vegetation reflect the medieval foundations of the monastic gardens. Among the plants we meet here, among others Żywotniki, barbed holly and oak. [12] Another noteworthy form of the use of symbolic vegetation is the Biblical gardens. Present in North America, Europe (in Germany there are as many as 100), Asia, Austria. There are four in Poland. They are founded by churches, monasteries, and as demonstration gardens. In the gardens of these plants are planted with the Christian symbolism, the plants mentioned in the scriptures. They are aimed at bringing together the events described in the Bible, and showing the Holy Land on which Jesus Christ lived. The largest is the Biblical landscape reserve in Neot Kedumim in Israel. The selection of plants in such gardens is carried out on the basis of their symbolism and presence on the Bible cards. We should not confuse modern Biblical gardens with attempts to reconstruct the gardens mentioned in the Bible like the Garden of Solomon, or "Rajskimi gardens" of ancient Persia. Each biblical garden is different due to its different geographical location, climatic conditions, availability and features, and designers ' creativity. Gardens of this type are a place of research on the flora, tourist attraction, and also influence the popularization of the Bible and human consciousness. Nowadays, the use of plants with a unique meaning and charm has become very popular. Plants are very keen to plant, which, apart from the visual qualities, have an additional application or especially relevant to the faith, style or epoch. One of the most interesting biblical gardens in Poland is located on Foothills Przemyśl, and more specifically in Myczkowce. A 80-acre garden was founded in 2010 year. The project was developed by Dr. Ing. Zofia. It contains over 110 symbolic plants, separated stops, among others: Menora, Jacob's Well, the passage through the Red Sea,the Temple of Solomon. Each stop tells the passage of Bible history with quotes along with the symbolic significance of plants. [18]

At the first stop in the biblical Myczkowce Garden, the Book of the Bible "we can meet a very symbolic plant, namely the date competent Phoenix dactylifera. Popularly known as the palm tree, cultivated in many countries of the world. Large tree height up to 25 m. Leaves up to

3m long. A single leaf is made up of long leaves, which can reach up to 150. The fruit is a red-brown drupes called Dactyl. In countries with warm climates, dactyl palms are grown as garden plants, in Polish treated as a potted plant that requires a transfer to the room for winter. The culinary art uses DAKTYLOWCA fruits which are very sweet and nutritious. More than 50% of their composition is sugars and vitamins. [5] distilled fruits are also used for the production of palm wine. The fruits are rich in antioxidants and exhibit anti-mutagenic properties. The pits have been used in as, they produce jewelry from them, while with a sediment of leaf brushes. The wood obtained from the extensive DAKTYLOWCA stem is used as a building material and for firewood. [3] Date was cultivated by the oldest people of the ancient Middle East including by Assyrians. During the 40-year-old wandering the desert by the Jewish people was known and cultivated for the mating of shelters, it is now still used in this way. In 1965, archaeologists found the seeds of DDAKTYLOWCA before 2000 years in claims Masada in Israel. One of the seeds of germinate. [6] In the Bible, the word date was listed 26 times as the name of the plant, the name of the village and the name of the woman. The Book of the True Truth states that God led his people to land wheat and barley, vines, fig trees, pomegranate trees, olives and date palms (Deuteronomy 8.8). Also mentioned in the Bible the word honey signifies the sweetness of dates syrup. For the Jewish people, date was a symbol of justice and victory. [6] In the New Testament, during Jesus entry into Jerusalem, the population was just dactyl leaves. During the feast of the Sukkot of the leaves of this tree are arranged bouquets used in Thanksgiving, in turn there are mentions that the Tor during the war forbade slices of dactyl trees. (WIP 20,19-20) [12].

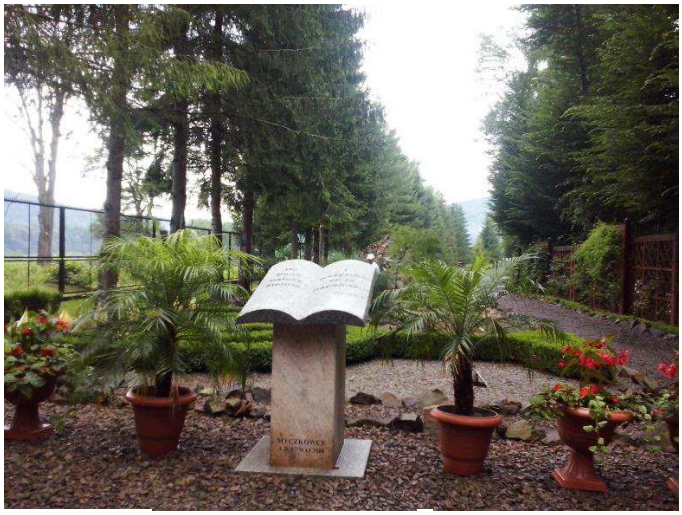

**Fig.1 *Laurus nobilis* (Daktylowiec właściwy), author: Tonika Markowicz.**

Another present in the Myczkowce Biblical garden. The plant is Dyptam Jesionolistny (Dictamnus albus). This is a particularly interesting plant. The Polish name comes from the shape of leaves reminiscent of the ash leaves. It occurs naturally on the shores of the Mediterranean Sea and on the Syrian peninsula. Perennial from the Rurowatych family, it reaches a height from 50-120 cm. Flowers in pink or and with a diameter of up to 5cm bloom from May to June. The fruit is a 5-cell handbag, which after greenie cracks, throwing black seeds on a much distance. Dyptan is treated as frost resistance plant, but it tolerates replanting. An interesting fact is that by the Italian glandular plant secretes essential oils, which in the warm, windless days after the close of the flames can be ignited. You will see a short-lived blue flame which does not destroy the plants. Dyptan is counted as the plant of the host butterfly of

the Queen Paz. In Poland, it is covered by strict species protection. [3] due to its aesthetic value it is used as an ornamental plant in gardens and on rebates, it contains dyktaminę toxic in high doses. In turn, rich in essential oils such as estragole, limonene and Cymon is counted as medicinal plants. Tincture of leaves and flowers soothes rheumatic pains, ware of the rhizomes treated stomach aches and fevers. Also used in perfumery, leaves distilled with water are used as cosmetics. Dyptam is the symbol of eternal, divine Love which burns, but does not burn. It is also identified with the whole Church which, despite persecution (fire) has not been destroyed (it has not burnt out). On hot days, a large concentration of essential oils can lead to their self-ignition. For this reason, many scholars claim that this is dyptam the burning bush of Moses. [20] "When Moses grazed the sheep of his mother-in-law, Jetry, he brought the sheep into the depths of the desert and came to the mountain of God Horeb. Then he appeared to him the Angel of the Lord in the Flame of fire, from the center of the Bush [Moses] saw, as the bush glowed with fire, and did not burn away from him "(ex. 1-2). [15]


**Fig.2 *Dictamnus albus* (Dyptam jesionolistny*),* author: Aneta Błądzińska.**

The inseparable element of every garden created to approximate biblical events is myrtle (Myrtus communi). It is native to Africa and parts of West Asia, among others in Israel, Jordan and Syria. It is a evergreen shrub or low tree reaching up to 5m tall. The leaves are leathery and shiny, the white flowers bloom from May to July. The fruit is a white or black and blue berry with a aromatic-sweet taste. Shoots, flowers and leaves strongly axillary. The application of Myrtle is very wide. In Poland it is used as a potted ornamental plant, not hibernate in the ground, so it is necessary to transfer the plants to a bright and cool room during the cooler period. This plant is very human-friendly, because it sanitizes the air in the flats, saturatinging them with great ions. It is also used in culinary arts as a spice for meat dishes and salads, in folk medicine valuable because of the bactericidal and Antispasmodic properties. In the medicinal, Myrtle leaves are used which, after the disappearance, emit a characteristic camphor-resinous fragrance. Also used to treat upper respiratory tract, and stomach problems. In cosmetics is used for the production of perfumes, toothpastes, men's cosmetics. Formerly of flowers and Fruit of mirt produced a cosmetic called angelic water. [3] The presence of Myrtle in culture is very well documented. It is one of the four plants that the Jews consume during the feast of Sukkot, the feast of the Tabernacles. "Go up and bring in the olive branches, pine branches, mirt branches, palm branches and branches of other deciduous trees to make shelters according to the recipe" (Nehemiah) [15]. Because of the easy rebirth after a fire, it is considered symbol of

purification and renewal. For centuries mirt twigs symbolize fidelity, beauty, fertility and love. In ancient Greece and Rome, the wreaths of the bride always regimes the branches of the myrtle. To this day stuck in veils and wreaths are decorative elements. They are also used for decorating gromnics, altars, paintings of saints, roadside chapelss and figurines. The old legends proclaim that Adam fleeing from Paradise broke a branch of Myrtle fortunately. Another says he was banished from Paradise because he broke the one branch when professed love Eve. Greek mythology claims that the gods transformed the mother of Adonis Myrrhę into a fragrant bush of mirt in order to protect her from the wrath of her father. [17] In the Bible, Myrtle symbolizes peace and joy (Isaiah), as well as immortality and the victory of life over Death (the book of Zechariah). "Here's a rider on the horse stood among the Mirts in the valley, and behind him horses chestnut, kare and white (...). But they themselves turned to the angel of Yahweh, who stood among the Mirts and haves: We went through the earth along and breadth, and there is peace in everywhere "(for 1, 8-11).


**Fig.3 *Myrtus commun* (Mirt zwyczajny). author: Tonika Markowicz.**

The most memorable plants which are the equipment of biblical gardens are the green cotton and the common fig. Green Cotton is also found under another name of Indian cotton (Gossypium herbaceum). Subtotal height up to 1.5 m. Yellow blooms. It is a fibre-giving plant used for making cotton, which is obtained from long hairs that surround the seeds. In some countries also grown as an ornamental plant. The seeds are used to produce edible and technical oil. [23] The fibres of this plant are used for the manufacture of cordage. The Bible was mentioned in the Book of Esther as Karpas. It was a constituent of the veil in the Temple of Jerusalem [20], Jesus cried laud and gave up the spirit. Then the veil of the Temple torn two, from top to bottom. And Centurion, who stood in front of him, seeing that he gave his spirit in this way, he said: Truly this man by the Son of God "(Mk 39-40). [15] In turn, the common fig (Ficus carica) is a tree or shrub 10 m tall. Leaves from underneath hairy, the fruit is a peanut called figs. The plant was already cultivated by ancient civilizations in the Middle East. In Poland, it is treated as a potted plant, peaceful. Ficus is used in the kitchen, where the fruits of groceries are used. Dried and roasted figs may be used as a substitute for coffee. Lawns wood is used for technical products. In folk medicine, figs were used for anemia and cardiovascular disorders as well as stomach discomfort. In the Bible, the Ficus was replaced until 70 times. [22] In the Book of Genesis, the first people staying in Paradise ate the fruit from the tree of

knowledge of good and evil. [5] After awareness that they are naked, spletli of twigs fig strips. Hence the term "fig". When announcing something good and valuable biblical prophets always relied to the fruits of figs. In turn, the tree of Fig together with the vine symbolised prosperity and peace. The fact is that the Talmund Babylonian for the beheading of the fig tree was the death penalty. In Luke's Gospel in the Parable of Jesus about the fig tree, the mechanism of irregular fruiting of the fig tree was described. [3]

It is difficult to mention in the article all the symbolic plants which it uses for the creation of the Biblical gardens and the monastic gardens. Due to the climatic and geographical barriers, some plants were used only abroad, while others were only in Poland. From the biblical plants used in both garden assumptions, it is worth mentioning also: Cedar Lebanese (Cedrus Lebanon), Cyprzyk Czteroklapowy (Tetraclinis articulata), cypress Evergreen (Cupressus sempervirens), Rock Oak (Quercus coccifera), J Wild Boar (Malus sylvestris), flax (Linum usitatatissimum), European Olive (Olea europaea), Pinia Pine (Pinus pinea), Winoroś (Vitis vinifera), Almond (Prunus dulcis).


**Fig.4 *Gossypium herbaceum (*Bawełna zielona*), author: Aneta Błądzińska**

## CONCLUSIONS

In ancient times, the Middle Ages as well as modern plants are used not only because of their aesthetic values. Their useful properties and symbolism are very important. The use of these advantages of plants is large significantly in garden art. In the Middle Ages in the gardens created by the monasteries were used plants which were mentioned on the cards of the Bible because of, among other things, their symbolism. This allowed the creation of a garden that reflected the enthusiasm of man to the world as the work of God, and forced contemplation and reflection. This was especially important when establishing wirydarz. Today, attempts to recreate the old garden assumptions with the use of these plants are undertaken. Biblical gardens are an excellent form of using alternative plants not only for decorative purposes, but also for scientific and awareness.

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## ABSTRACT

## SYMBOLIKA ROŚLIN BIBLIJNYCH UŻYWANYCH W SZTUCE OGRODOWEJ


Badania nad Pismem Świętym i późniejszą literaturą kościelną, malarstwem, rzeźbą, architekturą, oraz odkrycia archeologiczne pozwoliły wyodrębnić gatunki roślin zwane biblijnymi. Każda roślina zakwalifikowana do tej grupy posiada swoje symboliczne znaczenie bardzo często wykorzystywane między innymi w średniowieczu. Rośliny te służyły do tworzenia ogrodów przyklasztornych w których w skład wchodził wirydarz, czyli kwadratowy dziedziniec wewnątrz budynków kościoła i klasztoru. Był to ogród zamknięty dla świata zewnętrznego, służył do modlitwy i kontemplacji zakonników. Wirydarz obsadzano roślinami,

których symbolika kierowała myśli ku Bogu. Poza funkcją ozdobną, rośliny pełniły funkcję leczniczą oraz były elementem, który podkreślał sferę *sacrum* i nawiązywał do tęsknoty za rajem. Niektóre jak róża, lilia czy naparstnica odnosiły się do symboliki Maryjnej. Z kolei inne jak męczennica wiązane były z Chrystusem. Z kolei Bukszpan i bluszcz kojarzono z wiecznością i nieśmiertelnością. Wirydarz przeznaczony do rekreacji. Dostępny tylko dla zakonników. Przy klasztorze tworzono także ogród użytkowy i ogród szpitalny obsadzany roślinami dekoracyjnymi, użytkowymi i ziołami. Wiele z nich było charakterystycznych dla chrześcijaństwa, kojarzono je z wydarzeniami biblijnymi. Współcześnie rośliny te można spotkać w przydomowych ogrodach, parkach, przy ośrodkach wypoczynkowych oraz ogrodach edukacyjnych. Przykładem takich założeń są ogrody biblijne, zakładane na całym świecie, w tym w Polsce. Ogrody te stanowią doskonałe miejsce do badań nad florą biblijną. Jednym z takich ogrodów jest biblijny ogród w Myczkowcach. Jego funkcją jest przybliżenie wydarzeń opisanych w Piśmie Świętym. Ogród został założony w 2010 roku, znajduje się w nim 110 gatunków roślin, które zostały wspomniane na kartach Biblii. W ogrodzie wyróżnić można poszczególne przystanki opowiadające odrębną historię. Przy każdym z przystanków zostały umieszczone tablice z cytatami z biblii oraz przykazaniami, oraz opis poszczególnych roślin. Poza symboliką biblijną rośliny te mają szerokie zastosowanie współcześnie. Poza walorami ozdobnymi posiadają zastosowanie w kuchni, w perfumerii, stosowane są do wyrobu leków i farmaceutyków. W artykule wymieniono zaledwie kilka z obszernej listy roślin o symbolice biblijnej. Dyptam jesionolistny (*Dictamnus albus)* sporych rozmiarów krzew, kwitnący od maja do czerwca na kolor biały jest nazywany także krzewem Mojżesza i gorejącym krzewem. Swoje odniesienie do płonącego krzewu zawdzięcza dużej ilości olejków lotnych, które w upalne dni mogą ulec samozapaleniu, bez uszkodzenia rośliny. Mirt zwyczajny (*Myrtus communi)* w Biblii wspomniany przez Zachariasza symbolizuje nieśmiertelność i zwycięstwo życia nad śmiercią. Do dziś gałązkami mirtowymi zdobi się wianki i welony ślubne. W Polsce uprawiany jest jako doniczkowa roślina pokojowa, ponieważ ze względu na brak mrozoodporności nie zimuje w gruncie. Ciekawostką jest fakt, że mirt nasyca powietrze w mieszkaniach korzystnymi dla człowieka jonami. Wawrzyn szlachetny (*Laurus nobilis)* współcześnie wykorzystywany głownie jako przyprawa, poza walorami ozdobnymi jest także składnikiem wielu leków i farmaceutyków. W Mitologii uznawany za drzewko bogów, symbolizował chwałę i zwycięstwo. W Biblii przypisywano mu symbol zwycięstwa nad grzechem. Biblijnych wzmianek o daktylowcu właściwym (*Phoenix dactylifera*) jest bardzo wiele. Najpowszechniej kojarzony jest z momentem, kiedy Jezus wjeżdżał do Jerozolimy. Tamtejsza ludność witając go trzymała właśnie liście daktylowca powszechnie nazywanego palmą. Powiedzenie „listek figowy" pochodzi z zawartej w Księdze Rodzaju przypowieści, w której pierwsi ludzie przebywający w raju skosztowali owocu z Drzewa Poznania Dobra i Zła. Czyli z drzewa figowego. Po uświadomieniu sobie, iż są nadzy, spletli z gałązek figowych przepaski. Jak wykazały badania warto pamiętać, że zarówno dawniej, jak i współcześnie walory ozdobne nie są jedynym powodem, dla którego stosuje się takie a nie inne rośliny.

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# ANALYSIS OF AGE-RELATED CHANGES IN EYE REFRACTION IN CHILDREN

**Abstract.** In the work highlighted statistics on epidemiological study of eye disease in children of different age groups. The analysis detection of decreased visual acuity among pupils Truskavets according checkups. Found that most of today's pupils discovered ophthalmologic pathology that leads to visual impairment. Most pupils diagnosed myopia weak and average degree and spasm of adoption, that pathology in the genesis of any significant value owned by visually-intense activities inherent to school. Ophthalmic pathology detection rate increases in direct proportion to age. Among the possible causes of incomplete detection of ophthalmic pathology, it should be noted the low interest of children and their parents in the timely diagnosis and correction of the pathology of the visual organ, drawbacks in the organization of preventive examinations, as well as the inadequate efficiency of primary health care physicians in the health care system conserning the allocation of risk groups and targeted preventive work with them.

**Keywords:** children, refraction, refractometry, myopia, hypermetropia, astigmatism, eutropia.

## INTRODUCTION

The subject of state's special care should be the health of children and youth. Unfortunately, in recent years its condition can't be called satisfactory by many parameters. Among many negative factors that influence on the health and reveal a disturbance of vision in children of preschool age and schoolchildren of all ages are illnesses, injuries and excessive enthusiasm by computers [22].

An important link in the activities of the domestic health care system and one of the most urgent medical and social problems is the protection of children's vision: prevention and treatment of diseases and eye injuries, prevention of blindness and weak vision, reduction of disability due to eye diseases [4, 5, 16].

The problem of child's blindness and weak-vision is one of the most pressing problems of ophthalmology, and overcoming of child's blindness is a priority direction of the world's health care system. According to the global problem of fighting blindness of WHO «Vision – 2020», in the world there are almost 1.5 million blind children and every minute one child is blind. It is believed that by preserving such negative trends, the number of blind children in the world will reach 2 million to 2020. It is proven that in 50% of cases, blindness and weak vision can be prevented. To do this, it is necessary to implement preventive and rehabilitation measures at the national level which will reduce the number of children with reduced vision, to ensure implementation of the basic rights of the child to health, education, worthy life, as well as reduce the economic burden of this problem for the national budget. According to the data of appeals to the health care institution the morbidity of children and teenagers, not only doesn't decrease, but also tends to increase [8].

According to scientists and practitioners, the scope of work aimed at preventing visual impairment in children is extremely low [28]. While pathology of the organ of vision is one of the main reasons restricting the choice of a profession by pupils [12].

It is admitted that 80% of schoolchildren experience unreasonable stressful overworks at school [31]. A distinctive feature of modern education and upbringing is the computerization of

pre-school and school establishments and the development of children's computer vision syndrome. In addition, schools often use out-of-date equipment that is unsuitable for use [28].

During the last two decades, in Ukraine have occurred the decline in the standard of living of the population and a reduction in the availability of medical care and all this has hit, first of all, to the most vulnerable groups of the population to the children [9, 26, 30]. This situation has had a negative impact on the qualitative indicators of the health of the child population, including ophthalmology. Pathology of the organ of vision in children may be the result of adverse social, economic, behavioral, medical and organizational and other factors of the environment [14].

According to the Ministry of Health of Ukraine, during the last 10-15 years, the number of children with pathology of the organ of the vision increased significantly. About 840 thousand children suffer from various ophthalmologic diseases: myopia, hyperopia, strabismus, astigmatism, amblyopia [30].

In recent years, in Ukraine there has been a negative dynamics of indicators that characterize the state of ophthalmic health of the children's population. According to many authors, this tendency is stipulate both to the influence of socio-economic factors and to the methodological shortcomings in the development of the health care system, in which the priority was given mainly to the medical and diagnostic direction. There was an imbalance between therapeutic practice and medical prophylaxis in favor of the first, which complicated the implementation of the strategy of health promotion and prevention of diseases among children, including ophthalmologic.

For Ukraine, ophthalmologic pathology in school-age children is extremely relevant to the socio-medical problem. The increase of the morbidity and prevalence of eye diseases and adnexa among children is noted. In the structure of the pathology revealed during child's preventive examinations during 2006-2016 the first place was occupied with decreased visual acuity.

A number of authors affirm that over 30% of modern schoolchildren suffer from myopia and an alarming tendency of increasing the prevalence of visual impairment today not only doesn't decrease but doesn't stabilize. The given indicators of morbidity and prevalence of diseases of the organ of the vision testify to the insufficient effectiveness of the measures taken in Ukraine as to their prevention. In children's health programs, special attention should be given to schoolchildren, the largest contingent, which make up for about 70% of the total child population [19, 28].

The analysis of scientific and methodological literature shows that the vast majority of research on the problem of ophthalmic pathology in children is devoted to the study of its clinical aspects and the organization of specialized ophthalmologic medical care for children with already formed pathology [2, 4, 5, 8, 15, 24, 25].

As to the problem of prevention of visual impairment, the vast majority of works relate to the issues of hygienic assessment and standardization of visual work of schoolchildren and the provision of sanitary and hygiene support for school activities. Deeply studied causes of visual disturbances have been studied, ways of their prevention and correction [6] have been developed, while observing the hygienically regulated mode of the day, work on the computer.

The state of ophthalmic health of children is one of the integral indicators of the health of the nation. Significant intensity of the defeat of the child population with ophthalmic diseases raises the problem of preserving and strengthening ophthalmologic health as one of the most important and relevant ones.

The aim of the study is carrying out a statistical analysis of refractive changes in children of different age groups.

## METHODS

According to S. O. Rykov the deterioration of vision in children is stipulated both the influence of socio-economic factors and the formation of an disbalance between therapeutic

and preventive care in favor of the first, which complicates the implementation of the strategy of strengthening the ophthalmic health of children [30].

The analysis of the state of ophthalmologic health was carried out in a complex way with the use of all possible sources of information and included an assessment:

- frequency of detection of reduced visual acuity during medical examinations of children and pupils of separate age groups;

- frequency of detection of visual impairment with an analysis of their causes with a specially conducted ophthalmologic examination of school-age children.

Compulsory ophthalmologic examination of schoolchildren included: assessment of visual acuity (visiometry), and refractometry.

Refractometry is the objective definition of refraction, which was carried out using a Hartinger refractometer or autorefractometer.

The object of the observation at the stage of the research were the students of 6-11 classes (at the age of 11-16, in which the most frequent is the formation of visual impairment) of comprehensive schools in the Truskavets city. All students were studied at schools that were located in typical buildings, they had a one-off work regime and satisfactory sanitary conditions for the education of children.

The study followed by ophthalmologic examination enrolled 180 students 6-11 classes. The average age of children was 13.9 ± 2.7 years. Girls accounted for 54.2 ± 3.1% of all examined.

The statistical processing of the study materials was carried out using Statistica 6.0 and Microsoft Excel 2010 statistical software packages.

## RESULTS OF RESEARCH

Unfavorable tendencies in the ophthalmic morbidity of the children's population necessitate constant control over their visual functions during preventive medical examinations. The medical-statistical method analyzes reporting forms No. 31 of sectoral statistical reporting of the Ministry of Health of Ukraine [29].

The analysis is done dynamically in terms of three groups of schoolchildren, pupils of 6-7 classes, pupils of 8-9 and 10-11 classes.

Frequency and the procedure for carrying out obligatory medical preventive examinations of schoolchildren in Ukraine are regulated by the Order of the Ministry of Health of Ukraine. In accordance with this order, the junior specialists with medical education carry out the examination of pupils' visual acuity every year. Obligatory review of children is provided by ophthalmologist for 6 years (before entering the school) and 11 years. Schoolchildren of another age are looked at by an ophthalmologist for shows. Such a system of preventive examinations does not allow timely detection of ophthalmologic pathology among schoolchildren.

Therefore, the problem of timely diagnosis of visual impairment and eye diseases in children of other age periods, whose visual analyzer is subject to considerable stress, is particularly relevant.

The analysis of the frequency of detection of reduced visual acuity among Truskavets city schoolchildren according to the preventive examinations carried out in the context of the separate age groups of schoolchildren showed the following unfavorable tendencies:

- the frequency of detecting reduced visual acuity among schoolchildren in Truskavets city increases with schooling from 41.6% among schoolchildren of the sixth grade to 51.6% among pupils ofthe ninth grades and 55% anomg eleventh grades, more than 1.1 times for time at school.

In order to obtain more complete information on the incidence of visual impairment among school children, we conducted a special research in which an ophthalmologic examination of 180 schoolchildren (pupils of 6, 7, 8, 9, 10, 11 classes) was performed.

The results of the research are presented in Table 1.

**Table 1.**

**The results of ophthalmologic examination of schoolchildren in Truskavets city**

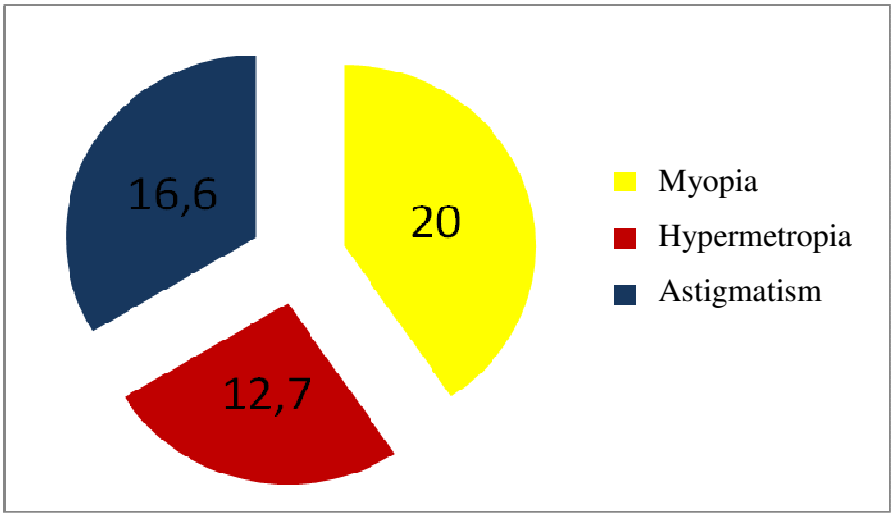
| The number of examined pupils (180) | Ophthalmologic pathology is revealed | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Myopia | | Hypermetropia | | Astigmatism | | Emeteropia | |
| | абс | P±m (%) | абс | P±m (%) | абс | P±m (%) | абс | P±m (%) |
| 6-7 grade (n=60) | 10 | 17±4,2 | 6 | 9±3,2 | 9 | 15±3,7 | 35 | 59±5,1 |
| 8-9 grade (n=60) | 12 | 20±3,9 | 8 | 13±3,3 | 11 | 19±3,9 | 29 | 48±4,3 |
| 10-11 grade (n=60) | 14 | 23±4,1 | 9 | 14±3,6 | 10 | 17±3,7 | 27 | 46±4,2 |

According to the materials presented in this table, almost half of modern schoolchildren (49,4 ± 3,3%) found ophthalmologic pathology, which leads to visual impairment of pupils. Most often, myopia was diagnosed of the weak and middle degrees (20 ± 2,6%), as well as spasm of adoption (16,6 ± 2,4%) , that is, pathology in the genesis of which significant importance belongs to the visual-intense activity inherent in school education. The analysis of the correlation between the frequency of detection in prophylactic examinations of reduced visual acuity and other abnormalities in schoolchildren's health (hearing loss, speech defects, scoliosis and posture disorders) revealed a relationship between vision and posture impairment. It is established that increasing the duration of study at school raise the density of this connection between the specified pathology.

The frequency of detection of ophthalmic pathology increases directly in proportion to the age of children from 41.6 ± 3.1% among sixth grades pupils to 55.0 ± 3.9% among graduates of schools. First of all, this dynamics is due to an increase in the frequency of spasm of adaptation and myopia of weak degree (see Diagram 1).

**Diagram 1.**

**The structure of the pathology prevalence of the visual analyzer among children (11-16 years) in% (n = 180)**



The results of our researches confirm the data of other authors regarding the increase in the prevalence of visual impairment with the experience of schooling, as well as the higher frequency of detection of this pathology during special studies, compared to the official statistical reporting [6].

The analysis of preventive with schoolchildren showed that it is not conducted qualitatively, therefore, in order to improve the effectiveness of preventive measures, improve the ophthalmologic service of students, develop a healthy lifestyle and ensure the safety of the educational process, the following measures should be taken:

- to expand the application of the experience gained in advanced ophthalmologic clinics in Ukraine as to the work with school contingents and school medics;
- to form prevention programs for a healthy lifestyle involving schoolchildren and their parents in their organization;
- to conduct prophylactic examinations of schoolchildren with the involvement of parents in accordance with the orders of the Ministry of Health of Ukraine with the following phases: medical nurse - pediatrician - specialists;
- to create conditions for a screening examination of children in order to detect hidden pathology of vision, the formation of "risk groups";
- to provide high-quality specialized and highly qualified ophthalmic care, as well as to increase the level of sanitary education of parents and children on issues of hygiene and vision prevention.
- to ensure continuity in the work of preschool-school and district outpatient-polyclinic services;
- to equip school's medical cabinets according to the current equipment plan with the involvement of local educational institutions for their organization;
- to provide the complete set of posts of the medical staff, which are in the regular layout of schools;
- to provide conditions for motor activity of children in schools, prevention of hypodynamia, physical education, and support for other initiatives aimed at strengthening children's health.

Among the possible causes of incomplete detection of ophthalmic pathology, it should be noted the low interest of children and their parents in the timely diagnosis and correction of the pathology of the visual organ, drawbacks in the organization of preventive examinations, as well as the inadequate efficiency of primary health care physicians in the health care system conserning the allocation of risk groups and targeted preventive work with them.

## CONCLUSIONS

1. According to the results of a specially conducted ophthalmologic examination, 180 schoolchildren in Truskavets city found that almost half of students (49,4 ± 3,3%) had ophthalmologic pathology, which leads to visual impairment. Most often students were diagnosed with myopia (20 ± 2.6%), as well as spasm of adaptation (16.6 ± 2.4%).

2. The frequency of detection of ophthalmic pathology increases directly in proportion to the age of children from 41.6 ± 3.1% among sixth grades pupils to 55.0 ± 3.9% among graduates of schools. This dynamics is due to the increase in the frequency of spasm of adaptation and myopia of a weak degree.

3. The conducted researches have revealed the features of the formation of refraction in children of different age groups. The accelerated eutrophication in children 11-13 years old and retardation of refractogenesis in children aged 14-16 years, as well as the connection of refraction with the indicators of physical development and general-somatic pathology were revealed.

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## АНОТАЦІЯ

## АНАЛІЗ ВІКОВИХ ЗМІН РЕФРАКЦІЇ ОКА У ДІТЕЙ

Вивчення впливу способу життя на розвиток дітей та формування органа зору є однією з актуальних проблем соціальної медицини та спрямоване на визначення реальних можливостей цілеспрямованого збереження здоров'я та зору підростаючого покоління. На особливу увагу потребують школярі – найбільш численний контингент, який становить близько 70% серед всього дитячого населення.

Встановлено, що умови та спосіб життя сучасних школярів суттєво відхиляються від раціональних та необхідних для формування здорового підростаючого покоління і збереження функції органа зору. Найбільш поширеними соціально-гігієнічними чинниками негативного впливу на здоров'я сучасної популяції школярів є нераціональний режим дня, зокрема, скорочення тривалості нічного сну, перебування на свіжому повітрі, недостатня фізична активність, пасивний відпочинок (за комп'ютером або телевізором), а також незадовільна організація позашкільної діяльності та гігієнічного забезпечення зорової роботи. Дію цих чинників зазнає понад 50% дітей шкільного віку.

Завершення розвитку органа зору та становлення багатьох зорових функцій відбувається у віці, який співпадає з періодом навчання у школі, яке є зоровонапруженою діяльністю. Патологія органа зору є одним з найчастіших відхилень у стані здоров'я сучасних школярів. Частота виявлення зниженої гостроти зору за час навчання у школі зростає у 3-5 разів і в 11 класі становить 30 %.

Для забезпечення формування повноцінного трудового потенціалу країни необхідно шукати можливості збереження зору сучасної популяції дітей, постійно вдосконалювати роботу з охорони зору підростаючого покоління. Переважна більшість досліджень, спрямованих на обгрунтування превентивних заходів у школярів, концентрується на вивченні та запобіганні негативному впливу санітарно-гігієнічних чинників шкільного середовища. Менш досліджена роль керованих поведінкових факторів ризику у формуванні патології органа зору у дітей шкільного віку, хоча оздоровлення способу життя є потужним важелем впливу на стан як соматичного, так і офтальмологічного здоров'я дітей.