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THE EVALUATION OF THE SUCCESSIONAL DYNAMICS OF THE VEGETATION COVER OF FOREST COMMUNITIES BASED ON INDICATORS OF SPECIES SATURATION

ОЦЕНКА СУКЦЕССИОННОЙ ДИНАМИКИ РАСТИТЕЛЬНОГО ПОКРОВА ЛЕСНЫХ СООБЩЕСТВ ПО ПОКАЗАТЕЛЯМ ВИДОВОЙ НАСЫЩЕННОСТИ

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Abstract. One of the most important criteria for assessing the state of the vegetation cover is the analysis of the intensity of succession processes in the ecosystem. Existing models of successions, as a rule, are distinguished on the basis of an analysis of the floristic composition by the quantitative participation of representatives of various life forms in them. It should be noted that this indicator alone is not enough to characterize such a complex process as a change in a plant community over a long period of time. In addition, the ratio of life forms recorded at a certain point in time cannot be the only indicator of the rate of succession. For an objective assessment of the speed and sequence of successions, additional parameters must exist.

The article considers the results of assessing the successional dynamics of the vegetation cover of forest communities based on the analysis of species saturation indicators in areas with different forest stand densities. The predominance of Quercus robur, Acer platanoides, and Tilia cordata in the tree layer intensifies competition for light and significantly reduces the number of species in subordinate layers. The results obtained made it possible to reveal the relationship between species richness and the rate of succession development. It has been established that the increase in the abundance of edificators is accompanied by an increase in the duration of succession series.

Аннотация. Одним из важнейших критериев оценки состояния растительного покрова является анализ интенсивности сукцессионных процессов в экосистеме. Существующие модели сукцессий, как правило, выделяют на основе анализа флористического состава по количественному участию в них представителей различных жизненных форм. Следует отметить, что одного этого показателя недостаточно для характеристики такого сложного процесса, как изменение растительного сообщества за длительный период времени. Кроме того, соотношение жизненных форм, зафиксированных в определенный момент времени, не может быть единственным показателем скорости сукцессии. Для объективной оценки скорости и последовательности сукцессий должны существовать дополнительные параметры.

В статье рассмотрены результаты оценки сукцессионной динамики растительного покрова лесных сообществ на основе анализа показателей видовой насыщенности на участках с разной полнотой древостоя.

Преобладание в древесном ярусе *Quercus robur*, *Acer platanoides* и *Tilia cordata* усиливает конкуренцию за свет и значительно снижает численность видов в подчиненных ярусах. Полученные результаты позволили выявить взаимосвязь между видовой насыщенностью и скоростью развития сукцессии. Установлено, что рост обилия эдификаторов сопровождается увеличением продолжительности сукцессионных серий.

Keywords: succession, dynamics, vegetation cover, forest communities, species saturation, competitiveness, edificators.

Ключевые слова: сукцессия, динамика, растительный покров, лесные сообщества, видовая насыщенность, конкурентоспособность, эдификаторы.

Introduction. In modern ecology, there are many indicators characterizing the state of the vegetation cover of ecosystems. One of the classic tools is registration of species richness. This parameter has established itself as one of the most objective quantitative indicators in various directions of investigation. The research of species richness is one of the main areas related to the protection of forests [1]. One of the most important criteria for assessing the state of the vegetation cover is the analysis of the intensity of succession processes in the ecosystem under study. Existing models of succession, as a rule, are distinguished on the basis of an analysis of the floristic composition by the quantitative participation of representatives of various life forms in them [2]. Currently this approach should be recognized as very superficial due to the variety of classifications of vital forms. However, this indicator alone is clearly not enough to characterize such a complex process as the change in the plant community over a long period of time. In addition, the ratio of life forms recorded at a certain point in time cannot be an indicator of the rate of succession. Obviously, for an objective assessment of the dynamics of successional processes, there must be additional parameters that

determine the "approach" of the vegetation cover to an equilibrium, subclimax, or quasiclimax state.

One of the objective parameters characterizing the state of an ecosystem is its species richness or species abundance. Despite the fact that this indicator has been used for a very long time, it remains very relevant in modern research. In particular, it is used to assess the productivity of ecosystems and the degree of their stability [3], and to study the adaptation mechanisms of plant communities [4]. As is known, in forest communities, as the tree layer develops and competition for light intensifies dramatically increase, species richness decreases significantly. Undoubtedly, the distribution of species in different forest layers and species richness in general are influenced by many environmental factors [5, 6], but it is also clear that there is a relationship between the rate of succession and species richness.

Purpose of research. The purpose of this work was to determine the intensity of the passage of one or another stage of succession based on taking into account changes in species abundance in areas with different densities of tree dominants.

Objects and methods of research. The studies were carried out on the territory of the Galichya Gora nature reserve and the Voronezh upland oak forest in 2020-2022. The Galichya Gora tract with an area of 19 hectares is a steep right slope of the Don valley with outcrops of Upper Devonian limestones. In accordance with the botanical and geographical zoning, Galichya Gora belongs to the Eastern European forest-steppe province of the Eurasian steppe region. On the territory of the reserve, the development of woody vegetation with the displacement of steppe grasses and shrubs, especially on the northern slope of the tract, has long acquired an irreversible character. The Voronezh upland oak forest is a natural-territorial complex typical of the forest-steppe. In addition to oak (in a significant part of the territory of coppice origin), the tree layer is formed by *Fraxinus excelsior L., Tilia cordata Mill., Acer platanoides L*. Succession activity in this type of plant communities is slowed down, the values of population parameters are close to optimal [7]. Descriptions on sample plots were carried out on

the territory of Old-growth plots of the Voronezh upland oak forest in the rightbank district forestry of the Prigorodnoye forestry of the Voronezh region.

The sites were established on transects (figure 1, 2). The sample plots dimensions were 20 m x 20 m. The quantitative participation of species was determined using the Brown-Blanquet scale. Species abundance was calculated on an area of 400 m^2.

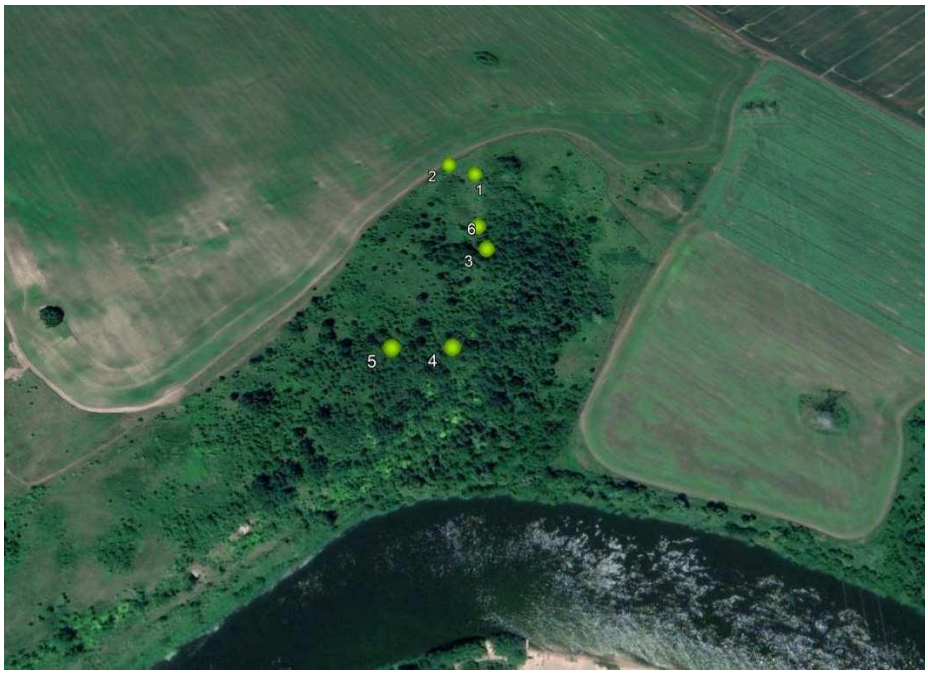

Figure 1. **Map-scheme of the location of sample plots in the territory of the tract Galichya Gora**

The sample plots on Galichya Gora included both areas where grassland communities were still preserved, as well as areas completely occupied by trees and shrubs, as well as with relatively well-formed forest communities.

Figure 2. **Map-scheme of the location of sample plots on the territory of the Voronezh upland oak forest**

On the territory of the Voronezh upland oak forest 7 sample plots were laid.

Results and Discussion. The values characterizing the floristic composition of the Galichya Mountain are presented in table 1.

Table 1. **The main indicators of the floristic composition on the studied sample plots on the territory of the tract Galichya Gora**

Indicators	Sample plots numbers					
	1	2	3	4	5	6
Species saturation/ 400 m^2	44	31	24	21	14	34
Species abundance	97					

Dominant species and their abundance	*Spiraea crenata L.* – 5 *Fragaria viridis (Duchesne) Weston.* – 4 *Galium verum L.* – 4	*Fragaria viridis (Duchesne) Weston.* – 6	*Acer tataricum L.* – 2	*Acer tataricum L.* – 4 *Quercus robur L.* – 6 *Melica altissima L.* – 4	*Quercus robur L.* – 6 *Euonymus verrucosa Scop.* – 4	*Cerasus fruticosa Pallas.* – 4 *Galium verum L.* – 4

It follows from the data in the table that part of the plots is occupied by shrubs (nos. 1, 5 and 6), however, the appearance of trees significantly reduces the species saturation (nos. 3, 4, 5). As Quercus robur grows, its edificatory influence increases, the rate of succession decreases, it is inversely proportional to the increase in the abundance of tree species (figure 3).

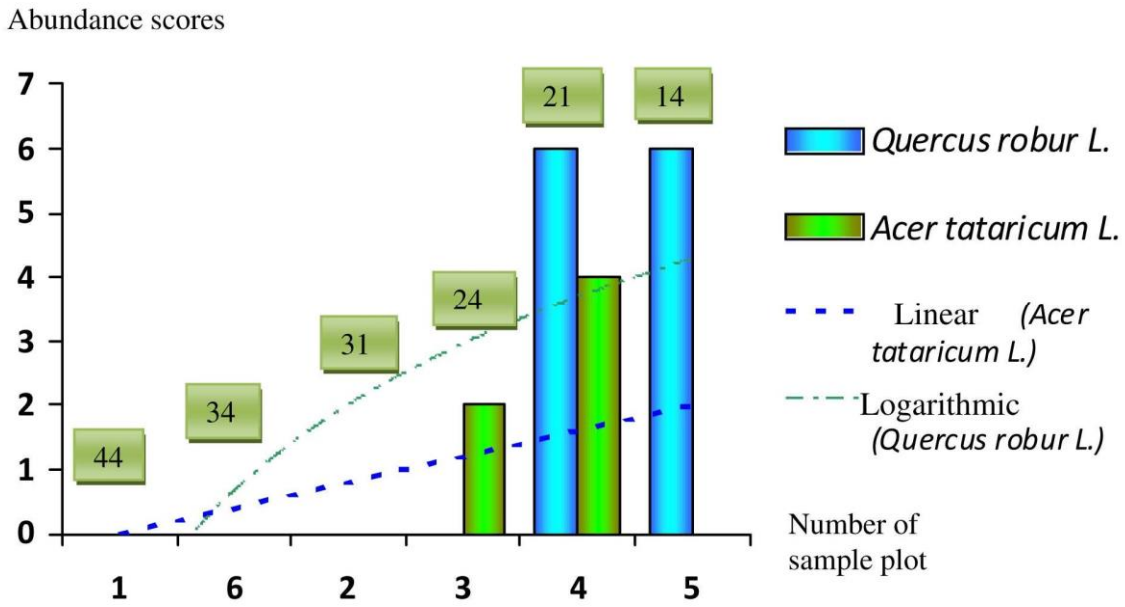

Figure 3. **The ratio of species saturation values and abundance scores in the studied areas of the Galichya Gora tract**

The data obtained make it possible to fairly accurately predict the direction of succession. If in previous works [8] it was indicated that Galichya Gora quickly

overgrows with *Acer tataricum*, then the analysis of the data obtained allows to conclude that this is only the initial stage of succession. Species diversity is dramatically decreasing due to the deficit of sun exposure, but the main role in the transformation of the steppe plant community into a forest one swiftly passes to *Quercus robur*. There is a readable logarithmic relationship between the increase in oak abundance and the decrease in species richness. On the territory of the Voronezh upland oak forest, despite the forest ecosystem that has existed for relatively long years, there are areas that have completely or partially lost their tree layer due to anthropogenic activity (power line clearings).

In particular, there are no woody plants in plots No. 3 and No. 5, *Acer platanoides* dominates in plots No. 2, 6, 7, and *Acer tataricum* dominates in plot No. 1, and *Quercus robur* prevails in plot No. 4 (table 2).

Table 2. **The main indicators of the floristic composition on the studied sample plots of the Voronezh upland oak forest**

Indicators	Sample plots numbers						
	1	2	3	4	5	6	7
Species /400 m^2	23	9	18	13	17	14	12
Species abundance	57						
Dominant species and their abundance	*Acer tataricum L.* – 5 *Agrostis canina L.* – 5	*Acer platanoides L.* – 6 *Aegopodium podagraria L.* – 4	*Fragaria vesca L.* – 4 *Poa nemoralis L.* – 5	*Carex pilosa Scop.* – 6 *Quercus robur L.* – 4 *Tilia cordata Mill.* – 5	*Chamaenerion angustifolium (L.) Scop.* – 6	*Acer platanoides L.* – 5 *Erodium cicutarium (L.) L'Her..* – 6	*Acer platanoides L.* – 4 *Tilia cordata Mill.* – 4

The relationship between species saturation and the rate of succession development remains unchanged (figure 4).

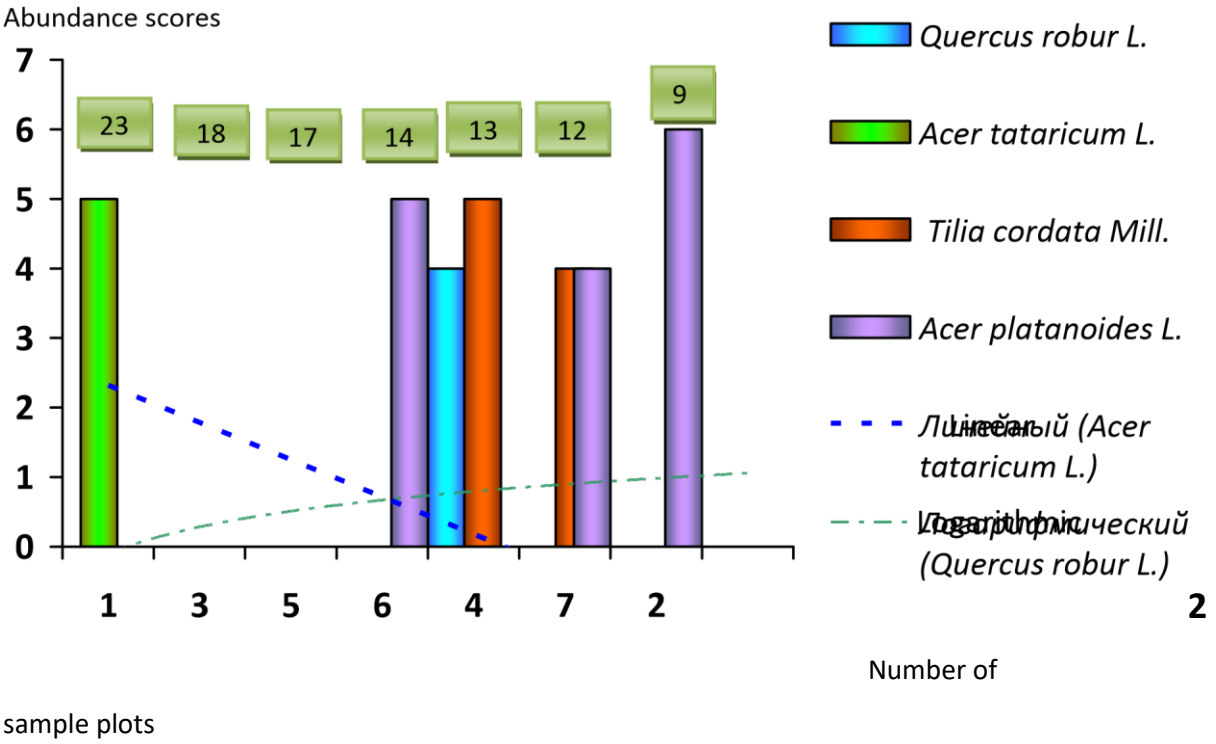

Figure 4. **The ratio of species saturation values and abundance scores in the studied sites of the Voronezh upland oak forest**

An increase in the abundance of edificators is accompanied by a decrease in the rate of succession. The trend towards a decrease in species saturation persists even if the structure of the tree layer becomes more complex (plots no. 4, 7), in particular, the appearance of the codominant *Tilia cordata*.

Trend lines of abundance indicators clearly illustrate the intensity of demutation successions, and also make it possible to make a medium-term forecast of the offensive of succession series in forest plant communities that are actively crowding out herbaceous ones. In more stable, longformed forest communities, indicators of species abundance can be useful in characterizing local disturbances of vegetation cover due to anthropogenic activities.

Conclusion. As a result of the studies carried out in communities with different intensity of succession dynamics, it was found that in certain series of succession, the indicator of the degree of restoration of the forest plant community can be not only the species composition of the forest stand and indicators of the abundance of dominants of the first tier, but also the overall species saturation of the study area. The analysis of

the obtained results showed that the slope of the trend lines for the abundance of edificators is a rather unambiguous criterion illustrating the activity of a successional series, especially in the early stages of recovery.

Thus, the use of the index of species saturation, taking into account the abundance scores of tree layer dominants, significantly increases the information content of the study results regarding the established successional trend and the assessment of the rate of passage of succession series.

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