ECOLOGY, BIOTECHNOLOGY, AGRICULTURE AND FORESTRY

IN THE 21ST CENTURY

PROBLEMS AND SOLUTIONS

EDITED BY
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The monograph is a collection of the results of scientists' achievements obtained directly in real conditions. The authors are recognized specialists in their fields, as well as young scientists and graduate students of Ukraine. The studies are conceptually grouped in sections: biotechnology, ecology, agriculture, forestry, sustainable development of the economy and the principles of effective agribusiness. The monograph will be of interest to specialists in biotechnology, ecology, breeding, plant protection, agrochemistry, soil science, forestry, agribusiness, etc., researchers, teachers, graduate students and students of specialized specialties of higher educational institutions, as well as everyone who is interested in sustainable development in the agricultural sphere and Green Deal Implementation strategies.

Keywords: sustainable development, modern technologies, agricultural production, biotechnology, ecology, plant protection, forestry, agribusiness.

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COMPARATIVE ANALYSIS OF THE EVALUATION OF HABITAT CONDITIONS ON THE RIGHT BANK OF THE VELYKA BABKA RIVER (A TRIBUTARY OF THE SEVERSKIY DONETS RIVER, UKRAINE) USING PHYTOINDICATION AND SOIL INVESTIGATION METHODS

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Introduction

In Ukraine, the main method of determining the type of forest vegetation conditions is the comparative–ecological method of assessing soil conditions by their forest vegetation effect (species composition and productivity of indigenous forest groups), which became basic during the development by E.V. Alekseev and P.S. Pogrebnyak of the "edaphic network" (Pogrebnyak, 1955). The edaphic grid is based on two main soil properties that determine its fertility – this is the content of moisture and nutrients (trophicity). In accordance with this, the grid is a coordinate system: the abscissa axis – trophopes – areas that differ in nutrient content), and the coordinate axis – hygrotopes, areas with different humidity. The intersection of the gyrotope and trophotope gives an edaphotope (edatope) – a type of forest growth conditions, indicating the overall productivity of the forest area. Unconditional advantages of this method are relatively

insignificant labor intensity, cost and high forestry value. One of the components of the method of comparative ecological assessment of lands is phytoindication analysis, which is based on the correspondence of plant species and associations to certain environmental conditions (Tsyganov, 1983; Bondaruk &Tselishchev, 2018; Bondaruk, 2020). Such ecological groups of plants are called ecomorphs. In relation to humidity, the following main ecomorphs of plants are distinguished – hygrophytes, mesophytes and xerophytes, and in relation to trophicity – megatrophs, mesotrophs and oligotrophs.

Material and methods

The purpose of our research is to compare the methods of phytoindication and soil survey in the assessment of local growth conditions. According to this method, the main indicators of the productivity of forest lands are the species composition of the forest stand and its productivity, and the auxiliary ones are the composition of the above ground (grass) cover. Thus, when assessing the level of fertility of forest lands, the phytoindication method can be an alternative to more time–consuming soil studies.

The studies were based on the principles of forestry and ecological typology with the use of phytoindication methods, field and laboratory (potentiometric analysis of acidity) soil studies (Vorobyov, 1962; Methods…2003, 2005; Polupan 2005; Polupan 1981; Tsyganov, 1983; Vedmid&Raspopina, 2010; World Reference…, 2006). According to the degree of acidity (pH_{H2O}), the soils were differentiated into: strongly acidic (pH < 4), moderately acidic (pH 4–5), weakly acidic (pH 5–6), near–neutral (6.0–7.0), neutral (6.1–7.0), slightly alkaline (pH 7–8).

Should be noted that the research area chosen by us (Chuguyevo–Babchanska dacha, in Kharkiv region) has always been and remains extremely attractive for natural scientists. Among them are the giants of forestry science – H.M. Vysotskyi, I.I. Tomashevskyi, H.G. Makhov. Their research was widely covered in forestry literature – "Forest Journal" (issues 9–10, 1906; issue 2, 1908; issue 8–9, 1912; "News of the Kharkiv Agricultural Institute" (issue 10), 1928), in fundamental of works on soil science – "Soils of Ukraine" by H. Makhov (1930) (Vysotsky, 1928; Makhov, 1930). By the way, H.M. Vysotskyi, noting the great value of the forests of Chuguyevo–Babchansk dacha as a research object, noted that "...these forests are an almost exhaustive object of the Forest–Steppe Zone in the most typical ratio of two or three major formations (types on a broad

scale)..." (Vysotsky, 1928).

Results and discussion

According to geographical zoning, the research objects are the Left Bank Forest Steppe of Ukraine, and according to forest typology, they are Slobozhansky Forest Vegetation District. Trial areas were laid according to the ecological profile across the valley of the Velyka Babka River – from its floodplain, floodplain terrace to the right root bank, the height difference was 110 m (Fig. 1).

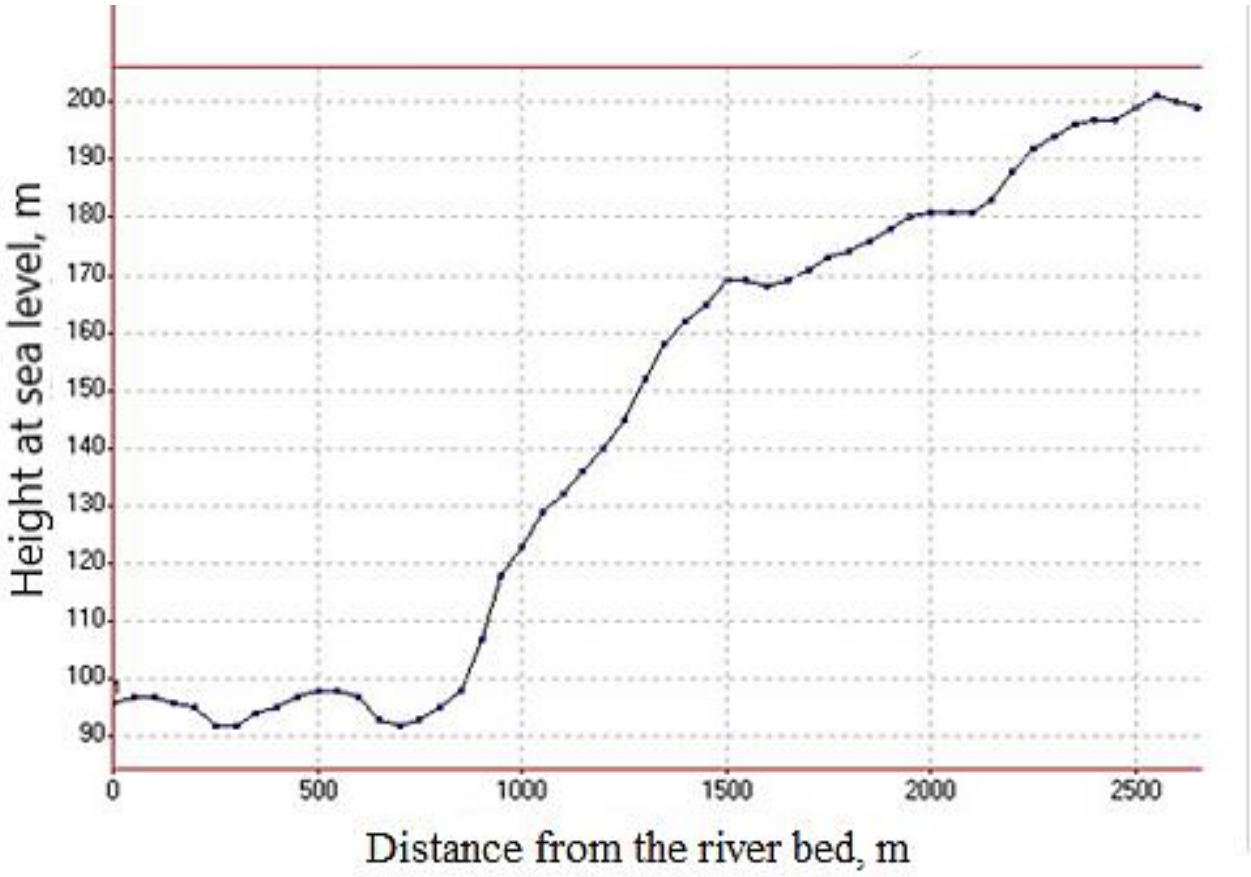

Figure 1. Height profile of the research route through the valley of the Velyka Babka River

On all test plots, full–profile (2 meters and deeper) soil sections were laid, the species composition of the herbaceous and tree–shrub (if any) vegetation layers were described in detail, and the productivity of the latter was determined.

The studies covered a variety of landscapes – floodplain, meadow, meadow–steppe, forest (oak forests).

The first experimental section on the route was a typical section of the floodplain of the Velyka Babka River. The following species predominate in the grass cover: Inula heleniuw L., Angelica sylvestris L., Urtica dioica L., Symphytum officinale L., Stachys palustris L.

An analysis of the composition of ecomorphs indicates that the site belongs to a humid meadow and moderately variable type of moisture, and in terms of trophicity it is a transitional type from rich to fairly rich soils. Such soils are characterized by a significant nitrogen content and a slightly acidic reaction of the soil solution.

Figure 2. Meadow light loamy soils on sandy loamy alluvium

According to the results of the soil survey, it was found that the floodplain of the River Velyka Babka is composed of meadow light loamy soils on sandy loamy alluvium (Umbric Fluvisols Oxyaquic) (Fig. 2). In these soils, a well–formed sod layer (up to 7 cm) is distinguished; the total thickness of the humus profile is 73 cm.

In terms of productivity, meadow medium–thick light loamy soils are among the most fertile, which is confirmed by the above–mentioned composition of ecomorphs.

Moving further along the route, we explored the terraced part (old channel) of the Velyka Babka River.

The grass cover of this area is represented by the following species: *Centaurea jacea* L., *Lysimachia nummularia* L., *Coronilla varia* L., *Geranium pratense* L., *Dactylis glomerata* L., *Trifolium prantense* L., *Erigeron Canadensis* L., *Sonchus arvensis* L., *Galium mollugo* L., *Plantago media* L., *Eryngium planum* L.. The tree–shrub layer is represented by *Quercus robur* L. (II class of bonitet) in the first layer and *Pyrus communis* L. up to 12 m high in the second layer, in the undergrowth – *Acer tataricum* L. and *Prunus spinosa* L.

Ecomorphs of this territory indicate an intermediate type of moisture between dry forest–meadow and meadow–steppe, i.e., from slightly humid to moderately humid. In the grass cover, there are species that indicate that the reaction of the environment varies from slightly acidic to neutral, and the nitrogen content from high to low levels. Thus, uneven nitrogen content is observed in the soil, but in general, the composition of ecomorphs,

indicating the trophicity (nutritional value) of the soil of the old channel of the Velyka Babka River, shows that the soils in this area are quite fertile (middle type between rich and moderately rich).

Figure 3. Alluvial meadow soil on loamy alluvium

A soil survey of this site showed its confinement to alluvial meadow soils (Gleyic Fluvisols Oxyaquic) (Fig. 3).

The profile of these soils was formed in accordance with the change in the riverbed. So, behind a thick layer of sod lies a dark grayish–brown horizon, which is replaced by a dark gray (almost black) humus horizon. The total thickness of the humus layer is 61 cm. The inflow of water starts from a depth of 145 cm.

Soddy medium loamy medium thick soils are quite productive in terms of their potential level of fertility, which is generally confirmed by the method of phytoindication assessment of growing conditions.

A slight difference can be traced in the level of soil acidity, which, according to the composition of ecomorphs, is determined to a greater extent as neutral, and according to potentiometric analysis, as weakly alkaline. However, as an approximate field method for determining acidity, such a small difference is quite acceptable. The variation in nitrogen content, as indicated by ecomorphs, is fully explained by the uneven humus content of the soil in relation to the formation of the modern riverbed.

The next test site was laid on a leveled ledge in the middle part of the right root bank of the River Velyka Babka. The herbaceous cover of this area is formed by the following species: *Sonchus arvensis* L., *Inula Britannica* L., *Angelica sylvestris* L., *Hypericum perforatum* L., *Fragaria viridis* Weston., *Linaria vulgaris* Mill., *Medicago lupulina* L., *Galium mollugo* L., *Artemisia vulgaris* L., *Lotus corniculatus* L. The tree–shrub tier is represented by single specimens of *Pyrus communis* L. of natural origin, 10.0 m high, 12–years–old *Prunus spinosa* L. and Acer tataricum L. of artificial origin, 7.5 m high.

The composition of ecomorphs is overwhelmingly similar to their composition in the previous site, with the exception of species that are indicators of habitat moisture, which indicate an increase in soil dryness.

So, according to ecomorphs, the type of moisture corresponds to the dry forest–meadow regime. The results of the soil survey showed that alluvial carbonate–gley hydrogenic–ferruginous soils were formed in this

area on loamy river deposits (Calcic Fluvisols Petrogleyic) (Fig. 4).

Figure 4. Alluvial carbonate–gley hydrogenou–ferruginou soil

Their peculiarity is layering, which manifests itself in the alternation of greenish–gray and rusty–ocher layers under a shallow (up to 13 cm) gray–brown humus layer. The reaction of the soil solution of the upper horizons ranges from 7.15 to 7.5 units. pH. This practically coincides with the level that was determined by the phytoindication method, namely, the transition of the reaction of the soil solution from slightly acidic to neutral. The productivity of these soils is limited mainly by their dryness.

Further along the ecological profile, on the upland of the right root bank of the River Velyka Babka, in the forest, another test plot was laid.

The grass cover consists of: Vicia cracca L., Stellaria graminea L., *Hypericum perforatum* L., *Fragaria viridis* Weston., *Medicago sativa* L., Medicago romanica Prod., *Poa pratensis* L., *Galium verum* L., *Plantago media* L., *Cichorium intybus* L., *Lotus corniculatus* L.

The forest plantations of the site are represented by mixed highly productive (I–II class of bonitet) forest stands of natural, coppice origin of the second generation and consist of two tiers (table). In the first tier – *Quercus robur* L., *Fraxinus excelsior* L., *Acer platanoides* L., in the second – *Acer platanoides* L., *Acer compestre* L., *Quercus robur* L. (Table 1.).

Table 1

Forestry and taxation characteristics of fresh ash–linden oak forest of Chuguyvo–Babchanske Forestry

№ quarter	Area, ha	Tier	Stand composition	Age, years	Diameter, cm	Height, m	Site class	Stock of timber, м^3/ha
152	21,0	1	8POK 2AH	115	40,0	24,5	I	550,0
		2	7NOM 2 FIM 1 POK	50	20,0	17,0	III	85

Note: POK – Pedunculate Oak (*Quercus robur* L.); AH – European Ash (*Fraxinus excelsior* L.), NOM – Norway Maple (*Acer platanoides* L.); FIM – Field Maple (*Acer campestre* L.)

The characteristics of the edaphic conditions, based on the composition of the ecomorphs, are as follows. Moisture type – average between dry forest–meadow and meadow–steppe; the degree of moisture variation is also average between weak and moderate; acidity ranges from slightly acidic to neutral. The soils are depleted in nitrogen, which is their main difference from the soils of the previous plots.

Forest area on the right bank of the River Velyka Babka is composed of dark gray forest soils on loesses (Greyic Phaeozems Albic) (Fig. 5).

Figure 5. Dark gray forest soil on loesses

These soils are formed under the predominant influence of humus–accumulative, loess (illimerization) and clay–illuvial elementary soil processes, the course of which is clearly reflected in their profile: under the gray–brown humus–eluvial horizon 43 cm thick, a compacted illuvial dark gray–brown horizon. The total thickness of the humus layer is 58 cm. The parent rock lies on average at a depth of 120 cm.

According to the potential level of fertility, dark gray forest soils, along with chernozems, are the most productive soils in Ukraine. The reaction of the soil environment is slightly acidic, approaching neutral 6.3–6.95 units. pH. Thus, the degree of acidity determined by the potentiometric method completely coincides with that established during the phytoindication assessment.

Comprehensive soil–phytocenotic studies made it possible to attribute the last forest community to fresh ash–linden oak forests.

So, the regular gradual changes in the biotopes of the ecological profile along the valley of the River Velyka Babka is associated primarily with changes in geomorphological conditions that determine the redistribution of moisture and, as a result, with a significant variety of soils. With a more or less stable, generally significant, level of trophicity in the surveyed territories, their productivity is primarily limited by the soil moisture regime, which is clearly illustrated by the composition of ecomorphs and the productivity of the tree–shrub layer. The most tense situation with moisture, namely with its insufficient level, develops in the middle part of the right root bank of the river, which reflects the almost complete absence of natural woody vegetation in this area. In general, the results of the research showed that the assessment of growing conditions by the phytoindication method is quite accurate and largely coincides with their

assessment, carried out by the methods of soil survey and chemical analysis of the soil (some difference is observed in the determination of soil acidity, but it is insignificant and therefore it can be neglected).

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