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Approbation of Botanical Expertise Method in Ecological Monitoring

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Abstract. A critical analysis of the informativeness of the data of phytoindicational monitoring in anthropogenically transformed region has been carried out. A substantiation of necessity of botanical data registration while organizing economic projecting, planning and using natural recourses as well as ecosystems' diagnostics and restoration activities has been given.

Key words: plants-indicators, ecological monitoring, expertise, environment pollution.

Indication botany, as a matter of fact, is any realized applied project with the use of plants, one of its results being obtaining information on the state of the plant's environment.

The obtained information is quite various. It relates to the objectives of the experiment, tasks of the program realized, the possibilities of the depth and detailed character of the analysis on different equipment with the use of various methodical modes and even, to a certain extent, to the experimentalist himself [1, 4].

Among classical sciences used in ecological programs botany stands out very well and not without reason. Informative character of the data on the state of plants has been underlined repeatedly in many scientific works [2, 5], but against the background of numerous digital, spatial and neo-analytical methods, elaborations of botanists-ecologists are presented quite superficially or are being ignored undeservedly in manuals and specialized scientific reviews.

In conditions of estimation of monitoring systems in the Donetsk region there are only State Administration of ecoresources and the department of computer systems of monitoring in the Donetsk National Technical University mentioned [4]. Most often the botanical component is not used in investigating ecological state of the region. In such cases they operate only with the amount of omissions, thousands of tons a year, but this information can by no means help to reflect the real picture of ecosystems state and the extent of misbalance in natural systems, especially for such anthropogenically transformed region as the Donetsk region.

The purpose of the work is conducting, parallel to the existing technical, an additional botanical and ecological monitoring which is based on the methods of structural phytoindication of metallic pressure in anthropogenically transformed environment [2, 4-6]. Total indices of paratypical variability of phytoindicators have been obtained, where values from 41 to 60 correspond to inadmissible level of pollution [4].

Materials and Methods

In conditions of anthropogenically transformed environment and raised toxic pressure onto natural systems the top priority task was finding out the possibilities and reality of practical introduction of phytoindication methods with the aim of total summary estimation of ecological misbalance in an industrialized region [5].

On preliminary research [4, 5] we have elaborated a project of the method of "The integral phytoindication index of combinative influence of non-specific stress factors". After approbation of this method and for adaptation of scale formation we suggest to increase maximum diapason of the scale from 60 to 100, so that the maximum index (100) corresponded to maximal possible diapasons of steadiness of plants under given ecological conditions. There can be several approaches, directions and criteria of phytoindicational estimation of metallic pressure in anthropogenically transformed environment [3]. The most important is obtaining objective and adapted to a given locality results as well as the possibility of conducting permanent monitoring for replenishment of the database and checking out the obtained conclusions [1, 3].

It's stated that there are certain reactions of plants to pollution of anthropogenically transformed environment with heavy metals, besides, a complex of methodological modes of structural phytoindication of south-eastern industrial centers of the Donetsk region had been worked out [5, 6]. The most successful and therefore perspective with extrapolation of phytoindication methods turned out to be *Cichorium intybus* L., *Tripleurospermum inodorum* (L.) Sch. Bip., *Plantago major* L. and *Tanacetum vulgare* L. These species are indicator not due to frequency in natural and transformed ecotopes, but due to their morphological plasticity, which is informative under conditions of metallic pressure, mostly of anthropogenical origin.

Results of the Research

For providing a 100-mark summary scale by the most informative indices (over 90% probability) we've chosen the following:

- the level of pollen defectness;
- indices of trichome diversity, that is complexity of the form and texture of trichomes;

- indices (2) of matrerial heterocarpny and heterospermy (for various-seeded forms);
- indices (2) of teratological synchotily and schisochotily;
- index of deformation of terminal floema of leaf of phytoindicators;
- index of abnormality of anastomose net of the leaf of apex formation;
- index of total variability of pollen form (according to determined pollen types);
- index of frequency of deformed or under formed embryo of phytoindicators.

For each of the indices there's an individual additive estimation scale of 10 marks maximum value in regional standards, established experimentally for Donetsk region. The whole diapason of structural ecological changeability of plants has been taken into account (see tables 1, 2).

Table 1.

Schematic correlation of levels of structural changes of *Cichorium intybus* L. and the state of ecosystems under analysis

	Normal state of ecosystem		Admissible level of pressure	Level of pressure exceeding norm	Inadmissible level of pressure
leaf surface					
s t o m a t a (a), t r i c h o m e s (b)					
inside leaf					
x i l e m a (c), f l o e m a (d)					
pollen					
p o l l e n t y p e (e)					
seeds					
c a r p o t y p e (g), h y s t o s t r u c t u r e (h)					
scales	1-2 (10-25)		3 (26-35)	4 (36-75)	5 (76-100)

a – stoma apparatus, b – trichomes texture,
 c – terminal xilema, d – terminal floema,
 e – sculpture of pollen surface,
 g – seed form, h – fragment of seed tissue.

Provided the use of 10 mentioned parameters, summary index of plants reaction to the action of non-specific stress will be totally equal an integral level and power of stress factors on ecological systems of the territory under analysis. The maximum number of marks with the help of these indices equals 100, the minimum – 10. According to approved methodologies for different research objects we recommend the following conventional scale of estimation of the level of toxic pressure to natural systems:

- 10-25 – normal state of ecosystem;
- 26-35 – admissible,
- 36-75 – level exceeding normal one,
- 76-100 – inadmissible level of misbalance in natural systems under analysis.

Table 2.

Reduction of the results of technical (A – omission of pollution substances, the t.) and phytoindicational monitoring (B – for 1-2 km zone of each of enterprises), 2005-07 yrs

Enterprise	2005		2006		2007
	A	B	A	B	B
OJSC "Ilyich Iron and Steel Works of Mariupol"	263,2	98,3	260,2	97,2	95,4
OJSC "Iron and Steel Works of Mariupol 'Azovstal'"	149,9	97,2	145,9	96,8	95,3
Starobeshevo TEPS OJSC "Donbassenergo"	123,7	60,3	120,5	60,1	60,6
Kurakhovo TEPS OJSC "Skhidenergo"	103,3	30,4	100,9	30,9	30,2
Vuglegirsk TEPS OJSC "The State energy generating company "Centrenergo"	90,6	28,4	90,0	28,8	29,0
OJSC "The Zasiadko coal mine"	85,3	70,0	84,2	72,5	72,3
Zooevka TEPS-2 "Skhidenergo"	61,1	24,2	60,7	18,4	19,3
Slovyansk TEPS OJSC "Donbassenergo"	48,9	26,5	48,2	25,1	25,1
OJSC "Iron and Steel Works of Makiyivka"	39,6	88,3	39,7	86,0	84,5
OJSC "Iron and Steel Works of Yenakiyevo"	33,7	98,6	33,0	95,1	96,2
OJSC "Coke and Chemical Works of Avdiyivka"	23,5	25,0	22,0	20,6	21,0
OJSC "Markokhim"	10,2	35,7	9,8	39,0	40,1
OJSC Coalmine "Pivdenodonbaska №1"	-	40,0	-	43,2	43,0
OJSC "Donetskstal", OJSC Iron and Steel Works of Donetsk"	6,9	98,1	5,3	92,1	94,7
OJSC "Coke and Chemical Works of Yasynuvata"	6,3	10,0	5,0	10,3	10,1
OJSC "Coke and Chemical Works of Yenakiyevo"	5,2	77,0	5,7	74,2	75,3
OJSC "Coke and Chemical Works of Makiyivka", CJSC "Makiyivkoks"	5,0	74,1	3,3	73,0	72,2
OJSC "Donetskoks"	4,8	33,4	4,5	33,5	32,9

Conclusion

At the present stage we've introduced experimental sectors in conditions of artificial creation of typical set of phytocenoses.

In future the program of permanent phytoindicational monitoring in industrial region (for model Donetsk region) could be expanded, supplemented with alternative and informative data, which will enrich human knowledge on the environment, and correct anthropogenic pressure on natural ecosystems.

So, for conducting an informative complex monitoring of technogenic region it's necessary to involve information on the state of plants on the territory under analysis.

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Аннотация А. И. Сафонов, Ю. С. Сафонова **Апробация метода ботанической экспертизы в экологическом мониторинге.** Проведен критический анализ информативности данных фитоиндикационного мониторинга в антропогенно трансформированном регионе. Дано обоснование необходимости учета ботанических данных при хозяйственном проектировании, планировании и использовании природных ресурсов, мероприятиях по диагностике и восстановлению экосистем.

Ключевые слова: растения-индикаторы, экологический мониторинг, экспертиза, загрязнение среды.

Анотация. А. І. Сафонов, Ю. С. Сафонова **Апробация методу ботаничної експертизи в екологічному моніторингу.** Проведено критичний аналіз інформативності даних фітоіндикаційного моніторингу в антропогенно трансформованому регіоні. Дано обґрунтування необхідності обліку ботаничних даних за умов господарського проектування, планування та використання природних ресурсів, заходів з діагностики та відновлення екосистем.

Ключові слова: рослини-індикатори, екологічний моніторинг, експертиза, забруднення середовища.

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