ECOLOGY

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ECOLOGICAL PHYTOMONITORING: HISTORICAL REVIEW, CURRENT STATE AND PROSPECTS

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Due to climatic changes and strengthening of human influence on biosphere there is a question about these factors consequences for the Earth vegetation cover. Strategies and adaptation ways of arboreal plants to the environmental changes underlie the research and prognostication of these variations. Last century, in 50^{th}, a new biological direction emerged, "phytomonitoring". This term was found out in 1987 by research assistants of plant biocybernetics laboratory, Leningradsky AFI [9, 10]. In the beginning this direction was called "physiological monitoring" [10]. Due to different engineered microsized sensors, which permitted to get information about plant physiological state not damaged them, the cycle of investigations in study of possibility to registrate automatically different physiological processes in intact plant was carried out. The research objective was to develop automatical control systems concerning plant vital functions [14].

"Physiological state" means applying of non-damaging methods set in phytofisiological and ecological researches which reserve continuity of plant organism, and special data measuring systems which enable to get continuous and synchronic information about diverse processes in plant vital functions. This term also implies getting information about degree and direction of controlled plant parameters, such as: intensity of photosynthesis, different plant organs growth, CO_2 gas exchange, water regime, mineral nutrition, productivity and etc. Physiological state reflects optimal environmental conditions for plant necessities.

Monitoring cannot cover all plant physiological processes. Construction of data technology demands a minimal set of the most informative parameters, capable to characterize plant functional state to the full, and become markers of their functional state. A set of such basic physiological parameters, registered continuously, was suggested in 1987 [10].

Later it was found out absolute values of measured parameters were not the most informative and representative (though they are considered in data interpretation), but forms of curves, made due to their diurnal recording, multidiurnal trends of parameters changes.

Nowadays phytomonitoring as a new methodology has been totally recognized. Phytomonitoring courses are given in many well-known universities (Lvov, Sain-Petersburg, Ural Universities and others.). This term became generally accepted not only in scientific area of CIS, but in Australia, Holland, Israel, the USA, Chile and etc. At the same time, being accepted this term lost its original tenor. As any plant observation (even contemplation) applying different methods of its state assessment are called phytomonitoring as well.

Though "phytomonitoring" should be connected to its original occurrence in the scientific terminology.

Further development of methodology, and especially instrument base for phytomonitoring, increased a number of tasks actual for different scientific directions. Largely computer engineering promoted this concept [13].

Methodology and instrumental base of phytomonitoring became useful for specialist from other scientific areas, such as: ecology, selection, crop variety testing, introduction and for cultivation in protected and open ground [3, 5, 11, 12, 15, 16].

Ecophysiological researches haven`t got developed theoretical and resource base yet, necessary for collection and analyses of plant physiological state. Regular plant inspections are carried out on definite territories with the purpose to assess evolution of plants state and prognosticate its develop allowing for environmental changes in this region. Applying of phytomonitoring and instrumental base can make it possible to reveal peculiarities of parameters response, which characterize different processes of plant vital functions. radial trunk augmentation (integral parameter) and methods intended for study of different processes of plant vital functions.

Principal methods:

- Measurement of linear and relative velocities of xylem streams in different plant organs (body, trunk, root, branches, shoots and etc.);
- Study of the turgor changes in these organs effected by environment (linear dimension);
- Study of different organs growth and biomass increasing
- Study of water potential in plant organs
- Study of xylem moisture deficit concerning arboreal plants;
- Study of the main mineral nutrition elements concentration (P, N, K) in xylem exudates;
- Study of CO_2 – gas exchange (photosinthesis and respiration);
- Measurement of leaves optical properties from different angles to study characteristics of their water regime and drought-resistance;
- Indirect research methods of plant reproductive sphere (obtain the valuable and vigorous seeds and etc.).

Multivariate approach, based on collection and analysis of unique ecological and physiological characteristics of arboreal trees, growing in areas with different level of human influence, underlies these researches.

Ecological phytomonitoring makes it possible to assess anthropogenic effects on natural vegetable complexes, revealing probable consequences and in the long term accumulation of systematized database of plant functions.

Practical applying of such a database of plant functions consists of further prognostication of ecological situation in a specific region.

Function of phytomonitoring instrumental base lies in continuous monitoring of plant characteristics and environmental parameters, systematical analysis of data and their temporal variation.

Technical base of informative and measuring phytomonitoring complex should include the following:

- Sensors collecting information about plants and environment;
- Electronic module for sensor signal processing to display it on a computer;
- Special software.

Ecological researches permit to find out specific features of variations in different processes of arboreal plant vital functions connected with environmental changes, and determine the most sensitive ones to either external effects, which can be useful for indication and monitoring.

In these researches special attention is given to the Crimea and its South Coast particularly (SCC), the city of Yalta and Nikitsky Botanical Gardens.

Water regime and drought-resistance of bushes, growing in Arboretum of Nikitsky Botanical Gardens under conditions of the lower belt microclimate, have been analyzed. Rapid methods, permitting to obtain ecophysiological characteristics of the studied species, have been applied. As a result of the studies well-known by scientific sources peculiarities of their water regime and drought-resistance have been clarified. According to these parameters a line of the studied species drought-resistance has been differentiated.

Dynamic models of correlation between studied species ecophysiological characteristics and main environmental factors have been constructed in the course of the research.

Difference between experimental and calculated values isn`t over 10-15%, what is quite acceptable for prognostication purposes in Biology.

Results of these researches are of biological significance and can be applied as a source of additional information while make a comparative assessment of plant drought-resistance, develop evaluation criterion of genotypic species drought-resistance, which enables to differentiate plants in passport system.

Such a differentiation makes it possible to recommend these plant species for cultivation in a specific region of SCC allowing for its microclimatic specific features. Comparative sensitivity of applied methods was studied as well.

It was conducted an investigation in selection of forest and ornamental cultures for dry climate of South Ukraine, Khersonskaya region, Novaya Kahovka area.

Selection of plants resistant to dry conditions is of a large importance for agriculture. Plants used in landscaping of forest belts should possess such a characteristic. Methods of phytomonitoring made it possible to study water regime and drought-resistance of 14 ornamental culture species, construct a line of their relative drought-resistant, calculate dynamic models of correlation between ecophysiological characteristics of the studied plant varieties and the main environmental factors. As a result of this work, it`s possible to make recommendations in growing of the most drought-resistant species in the definite region [4].

Methodology and instrumental base of phytomonitoring were also applied to investigate the growth dynamics of arboreal plants being under conditions of Karadag natural reserve [4]. Study cases were *Quercus pubescens* Willd. and *Pistacia atlantica* subsp. Mutica.

Growth dynamics through the whole vegetation period was under control, dependence of the trunk diameter from main environmental factors (integral plant growth parameter) was investigated as well.

Equalizations of linear regression, characterizing these dependences, were constructed in the course of the research. Two variants were used for construction of these models: the first variant was based on values of air and soil temperature, temporary, the second one used hourly accumulation of the temperature values from the beginning of vegetation period. In the first case models accuracy included error 30-40%, but the second case error made 15-20%, what was of prognostication significance.

Conducted researches enabled to assess trunk growth dynamics of the studied species and prognosticate it in further years depending on climatic conditions of the region.

Development of the instrumental base advanced methodological component of phytomonitoring. A certain contribution was made in development of the methodological base. Applying of the modern exploratory equipment made it possible to obtain and process a lot of data, presented in monographs [4, 6, 7]. A number of different methods in determination of different parameters of plant vital functions has been developed and patented [8].

Pioneer incompleted phytometrical systems [8] were replaced by innovative systems, applying modern achievements of electronics.

In late 90th of XX century and in the beginning of XXI, based on the modern computer engineering the following foreign companies created small-sized phytomonitoring systems, which made it possible to measure different parameters of environment and plants: Phytech Ltd., Phyto-Sensor Group, Dynamax Inc., Skye Instruments Ltd., Decagon Devices Inc., Spectrum Technologies Inc., PP Systems, Li-Cor Inc., Daletown Company Ltd., Regent Instruments Inc., Hoogendoorn and etc. This development still has been carried out.

We don`t dispose systematized data about unfavorable ecology effect on plant life, physiological changes of plants being under long-term influence of this factor, otherwise we don`t dispose information about evolution of plant functions. Lacking of such systematized data for now doesn`t give an opportunity to assess their changes in future. Therefore our investigations result is to make a list of parameters for this databank, that is plant functions for study, what standard means to use it further. It is a compromise task of desire to use modern methodologies in full measure and costs for data collection procedure. Results of these investigations make it possible to:

- research correspondence of plant metabolism to environment, permitting determine natural or anthropogenic stresses or their absence;
- compare characteristics of "urban" and "unpolluted" plants, which will reveal differences of favorable and unfavorable environmental conditions, if they are important for plant living;
- formulate principal concepts of ecological monitoring databank and to start filling data base:
- assess if it is reasonable to use plants as an indicator of their growth area concerning ecological point.

Therefore in the course of ecological phytomonitoring analysis from the historical point it was revealed, emergence of this direction in the scientific area was going on as far as instrumental base (especially computer engineering) was improving. It permitted to set and solute complicated tasks and apply methodology and instrumental base of phytomonitoring in other fields of knowledge.

Lately due to GIS technologies there is an opportunity to create a common urban natural and informative space, which includes natural and ecological issues. The main functions of this issue are monitoring consequences of entrepreneurial activity on local and regional levels. Results of ground mapping or remote viewing from air transport or space can be sources of updated information. Applying of GIS technologies is useful for monitoring vital functions of local and introduced plant species, revealing cause-effect chains and correlations, assessment of favorable and unfavorable nature conservation measures within ecosystem and its separate elements, response and correction of these measures according to changeable environmental conditions [1, 2].

Developed GIS programs: ESRI ArcViev 3.2a, Arc Gis 9.2 and etc. Program City Green 5, which permits to solve a number of ecological problems using updated information, has been integrated into ESRI ArcViev 3.2a as a separate bloc:

1. Informational system "Catalogue of water objects"
2. Informational system "Green plantations"
3. Informational system "Atmosphere air"
4. Informational system "Land resources, relief"
5. Informational system "Engineering constructive works, roads"

Informational system "Green plantations" to be available for City Green 5, should possess ecological and physiological plant characteristics (plant species, age, crown size and others) to estimate ecological situation of a certain area (park, public garden, nature reserve, ward and some others). It makes possible to solve the following problems:

- Assess state of adjusted seaside water area, nature reserves and parks, and prognosticate their development being under anthropogenic effect;
- Develop and implement modernization programs of real productions and change the specialty and liquidate ecologically dangerous enterprises according to their parameters of influence on ecological resources;

Coordinate programs of activities of all state services and monitoring systems, which are specialized on observation and situation value of SCC territory.

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The article focuses on historical review of the new direction in Biology, phytomonitoring, its emergence and development. Applying of phytomonitoring methods gives an opportunity to get continuous and synchronic data about various processes of plant vital functions. Research of the natural and anthropogenic effects on vegetation cover is of great importance. Phytomonitoring methods permitted to determine plant-resistance and adaptation level to diverse stress factors and competitive ability being under conditions of climatic changes and environmental pollution. The research ultimate goal is to prognosticate ecological situation of the certain region and make recommendations for ecological problems solution.

Key words: *phytomonitoring, express-method, prognostication of the ecological situation.*

FLORA AND VEGETATION

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POPULATION *MEDICAGO MARINA* L. ON SPLIT OF THE DONUZLAV LAKE. PHYTOINDICATION OF ITS ECOLOGICAL AMPLITUDE.

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Introduction

Vegetation is a formative element of environment, in complex with other elements it informs about ecological landscape conditions being a part of them. Out of desert area in the coastal zones of the oceans, seas, rivers and lakes sandy landscapes are developed. Within such landscapes there are dunes, unstable accumulative and deflationary sandy relief forms, emerged out of desert area [6].

Plants of coastal dunes become indicators of accumulation and erosion [12]. Projective cover and a height of the plant stand caused sand deposition around plants, reduction of erosion [9, 11]. As well as sand delivery and favorable wind direction, vegetation is the most important factor in dune development, being an indicator of formative processes [9, 10].

One of the mediterranian species, growing on foredunes, *Medicago marina* L., on the place of ecotone of cenosis with classes *Ammophiletea Br.-Bl. et R. Tx 1943u Festucetea vaginatae* Soo 1968 em Vicherek 1972 (occasionally this species was found on the front of foredunes). This species is quite rare for the Crimea (only 2 populations are known), their size decreases due to loads on littoral ecosystem [8]. This variety was noted as a rare species and included into the Red list of rare plants in the Crimea (1999), Red Data Book of Ukraine (2009). IUCN granted this species a status – lack of data, and this fact emphasizes urgent necessity to study *Medicago marina* L. population in the Crimea more thoroughly, its ecological and coenotic characteristics.

The research objective is to conduct phytoindication of ecological amplitude of *Medicago marina* L within split of the Donuzlav lake.

Research tasks: 1) determine floristic composition of the split in the locality of *Medicago marina* L.; find out minimum, optimum and maximum points for the studied