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Analysis of Bioresource Collections on Climatic Rhythms and Phenological Processes

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ABSTRACT

A comprehensive assessment of dendrological resources for the formation of forest reclamation complexes is a process of qualitative and quantitative expansion of economically important plants and a scientifically based choice of the best possible option. The development of methods for improving the bioresources of degraded landscapes is aimed at the adaptive organization of land use in forestry and water management, recreation, urban planning, landscaping of settlements based on a comprehensive assessment of dendrological resources and increasing their biodiversity. The Federal Research Center of Agroecology of the Russian Academy of Sciences for a long period of its existence has created a network of experimental stations (cadastre No. 34:34:000000:122, 34:34:060061:10; Nizhnevolzhskaya station for the selection of tree species; 34:36:000014:178; West Siberian AGLOS; 22:23:010003:0014; Volga AGLOS; No. 63:23:0908001:0002) with dendrological collections located in different soil and climatic zones (Altai Krai, Samara and Volgograd regions) – typical areas of the arid zone with stable and moderate (in some years acute) summer moisture deficiency.

Keywords: bioresource, climatic, environment

INTRODUCTION

It is often possible to determine the prospects for the introduction of certain systematic, geographical and ecological groups only experimentally, testing many species of various biological groups over a number of years and comprehensively analyzing the results. According to the method of phylogenetic complexes, it is proposed to concentrate in the place of introduction the maximum number of the most valuable species related genetically, to introduce generic complexes and from the diversity of species to select the most promising and stable in the new forest conditions.

Based on the analysis and generalization of long-term experimental material on dendrological resources in arid conditions, taking into account comprehensive studies, it is possible to identify the biodiversity of plants, their biological potential, economic suitability for use in protective and landscaping plantations of degraded landscapes. The objectives of the research included: (i) study of the scale of dendrological resources of the arid region by geographical origin and age categories; (ii) analysis of bioresource collections on climatic and phenological rhythms in connection with changes in climatic conditions; (iii) determination of the characteristics of growth processes; (iv) comprehensive assessment according to bioecological, biocenotic, biochemical, biosocial criteria; (v) to classify biodiversity by invasive status (using the example of the collections of the Kulunda Arboretum).

Due to the aggravation of the ecological situation and the decrease in biodiversity, more and more attention is being paid to the rational use of its components, including plants of cultivated species, as not only a key autotrophic component and an energetically active link in all ecosystem processes of the biosphere, but also a convenient object of Environmental Research. In solving the above problems, a number of ways and approaches to improving the state of the environment already exist and continue to be developed. A significant share of the planet is occupied by anthropogenic transformed ecosystems, the sustainable use of which often includes anthropocentric approaches. The current crisis state of the environment in recent decades has prompted increasing attention to biocentric approaches, in which the ecological imperative is not the subordination of nature to human interests, but the coordination, harmonious combination of human activity and the laws of nature.

It does not lose its relevance to manage the viability of plants of cultural forms within certain ecosystems, for which methods and concepts based on a complex of structural and functional features of adaptive changes as adaptive mechanisms to environmental conditions require increasing improvement. An important step in expanding the functional capabilities and harmonizing vegetation with the conditions of existence is to consider the “responses” of plants to their adaptations to a certain amplitude of fluctuations in environmental factors at different levels of integration of living matter.

In the process of adaptation of living organisms and populations to environmental conditions, their vitality is determined by limiting abiotic and biotic factors that form the structural and functional organization, productivity of the biocenosis and ecosystem in particular. Thus, in arid conditions of the forest – steppe, steppe, the viability of natural and cultivated species is limited by moisture, in low – fertile-by the content of nutrients, organic matter; in saline soils-by the content of calcium sulfate, etc.

MATERIALS AND METHODS

Theoretical and experimental studies are based on the study of the bioecology of tree species in the genotype-environment system using forest-reclamation zoning and equipment (S230Kit conductometer, Dualex Scientific device; luxmeter LXP-10A). As well as reproductive features allocated for the targeted use of their own bioresources, taking into account the possibility of a comprehensive study of potential invasive qualities and assessment of biotic potential.

The effectiveness of the mobilization of woody plants was determined by an integrated quantitative method, which made it possible to establish the correspondence of the biorhythms of plant development over the duration of the growing season, taking into account their lag or advance relative to the general norm characteristic of the region (Figure 1). An increase in precipitation deficit during the growing season (with an annual total of 262–417 mm) and indicators of average monthly air temperatures was found.

These conditions influenced the duration of phenological phases in taxa of trees and shrubs of various botanical families and geographical origin (North America, Europe, Caucasus, Crimea, Far East, Central Asia, Japan, China, Korea). A multi-year time schedule of the onset of phenophases and their frequency response is constructed taking into account solar (12.5–16.5 hours) and thermal resources (5–24 °C) of the corresponding decades of April-October (Volgograd region). In 90% of woody species, the onset of the budding phase of leaf buds is provided with sunshine for more than 13.5 hours and an average daily air temperature from 5 to 15 °C (Table 1).

The areas of work on the enrichment of dendroflora include the preservation of the gene pool of collections, the creation of a fund of adapted planting material, its introduction into the culture of artificial cenoses and the formation of multifunctional forest plantations from them – landscaping, utility protection, ravine-girder, pasture protection, etc. (Fig. 2).

Deviation of living conditions from the Optimum, which for a certain species for each of the factors has its own significance, determines the response of plants – environmental stress, as a set of protective physiological reactions that occur in the plant body in response to exposure to low or high temperatures, dehydration, lack of nutrients, exposure to pollutants, radiation, and the like.

The ecological characteristics of organisms are based on their reaction to the influence of environmental factors. Any species (organisms, their populations) reacts differently to this or that ecological factor, which generally determines its viability, distribution area, contributes to the formation of its largest (or optimal or minimum) biomass and the highest (lowest) population density, which confirms the law of optimum V.E. Shelford, the essence of which is that the existence of

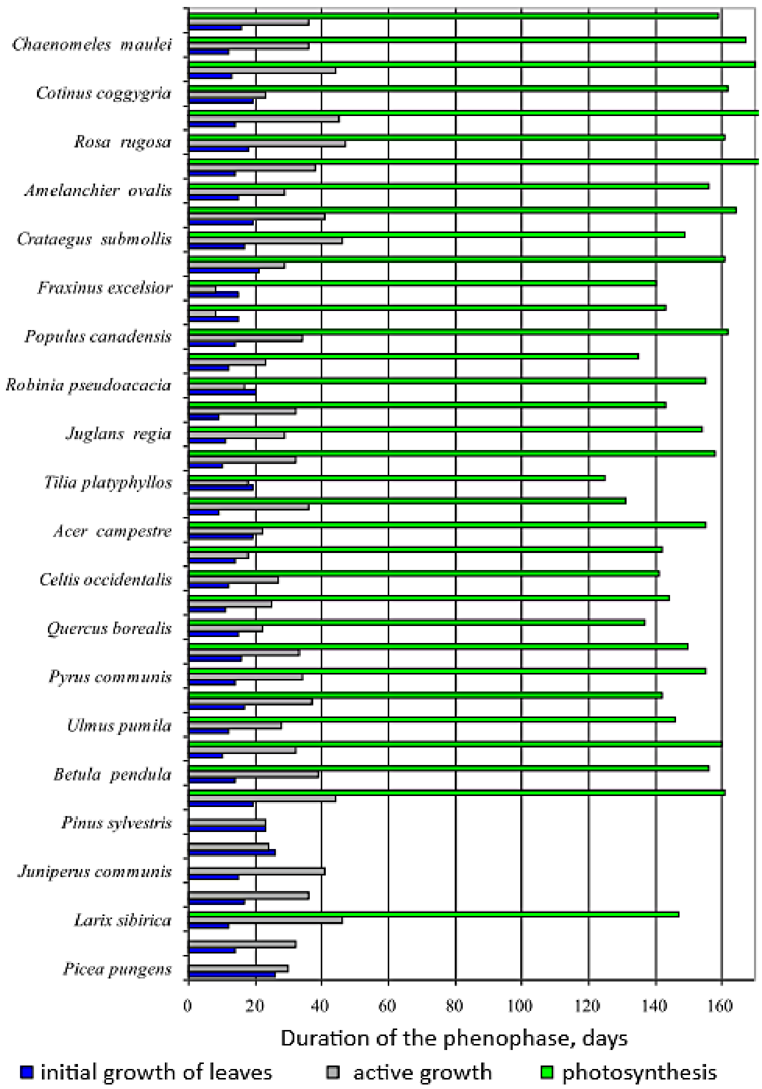

Figure 1. Characteristics of growth processes of woody species in conditions of chestnut soils

an organism is determined by the range of minimum and maximum values of a certain factor-tolerance limits.

Each species has its own characteristics and the body is able to survive only in the range of variability of this factor, which is also called the amplitude. Both very high (maximum) and very low (minimum) values of environmental factors can be harmful to the body. Their critical values, above or below which organisms cannot exist, are critical points between the values of which there is a zone of ecological tolerance.

Important in the realization of plant potential in specific conditions is the optimal value of environmental parameters, at which the highest vitality is observed-the viability of the cultivated species. And if natural species "settle "in more favorable places of growth for them, then for artificially created plant forms, a person himself" selects "such conditions, or" finds " the right genotype for them. The viability and productivity of cultivated species as primary links of autotrophic consortia, biocenoses in addition to natural and climatic factors are determined by anthropic (fertilizers, pesticides), which are leading in ensuring maximum biological productivity of cultivated plant forms (varieties, lines, hybrids) and determine the physiological and biochemical, morphological, consortium, etc. optimums of environmental factors. For any species, the autecological optimum (the conditions under which the species reaches maximum development in the absence of competition) and the synecological Optimum of the species, or the biocenotic Optimum of the species (the conditions under which the species reaches maximum development in the presence of competition) are important.

Table 1. Distribution of species by the onset of phenophases

Month (decade)	*	**	RLP	NCW	KCW	OBL	KRP	PLD	LST
			Number of indications pcs. (%)						
IV(2)	13.5	5...10	4(8.5)	1(2.1)					
IV(3)	14.5	10...15	23(49.0)	8(17.1)	4(8.5)				
V(1)			19(40.4)	17(36.2)	11(23.4)	16(34.0)			
V(2)	15.5	15...18	1(2.1)	11(23.4)	8(17.1)	25(53.2)	1(2.1)		
V(3)	16	18...21		5(10.6)	14(29.8)	6(12.8)	3(6.4)	4(8.5)	
VI(1)				3(6.4)	3(6.4)		14(29.8)		
VI(1)				1(2.1)	4(8.5)		20(42.5)		
VI(3)	16.5	21...24		1(2.1)	2(4.2)		8(17.1)	3(6.4)	
VII(1)					1(2.1)		1(2.1)	1(2.1)	
VII(2)	16	24...21						2(4.2)	
VII(3)								1(2.1)	
VIII(1)								2(4.2)	
VIII(2)								3(6.4)	
VIII(3)	14.5	21...18						8(17.1)	
IX(1)	13.5	18...15						8(17.1)	
IX(2)	12.5	15...10						4(8.5)	1(2.1)
IX(3)								6(12.8)	5(10.6)
X(1)	11.5	10...8						4(8.5)	10(21.3)
X(2)	11	8...5						1(2.1)	15(31.9)
X(3)	10	5...0							10(21.3)

No less important are Population Studies in order to obtain data that can be used in the development of scientifically based nature-saving methods for the exploitation of anthropogenic transformed ecosystems, protection, reproduction, reintroduction and introduction of populations and species. Close attention should be paid to population studies in order to establish

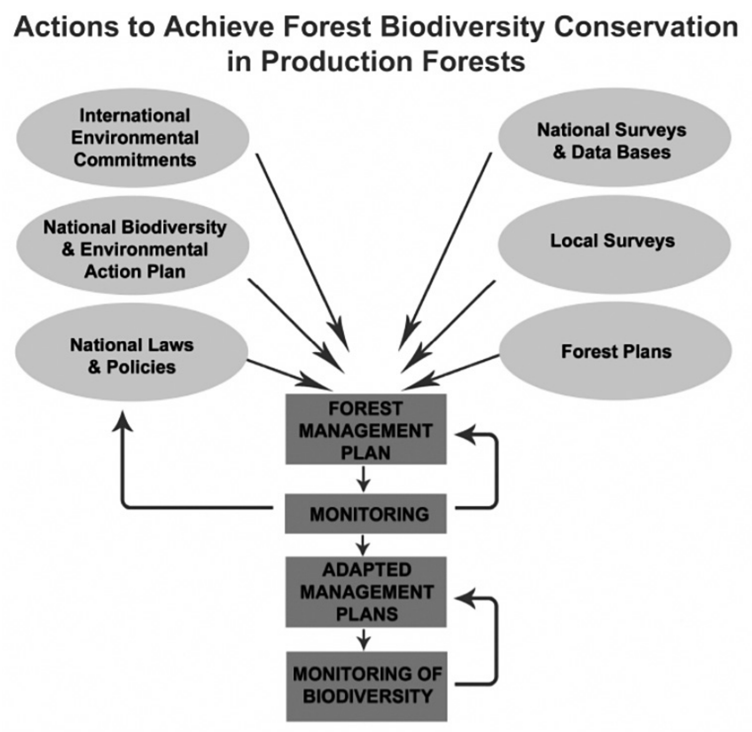

Figure 2. Conceptual aspects of the technology of enrichment and sustainable use of biodiversity of trees and shrubs

differential and integral parameters of populations that can be used in organizing monitoring of the state of ecosystems, individual species and environmental changes (biotic, abiotic). Both traditional and prospective studies of populations – systems of the superorganizational level – allow us to obtain data that deepen the theoretical foundations of systemology, reveal the essence of such fundamental phenomena of living systems as stability and stability, adaptation and adaptability, in addition, is the actual basis for mathematical modeling of the functioning of multicomponent systems in a changing environment and the development of effective methods for the conservation, introduction, reintroduction and exploitation of biotic components of ecosystems.

Individuals of the same species form a coenopopulation within the coenosis. Similar populations of the same species adapted to certain living conditions make up ecotypes. The object and subject of Synecology is the grouping of organisms (biocenoses) belonging to different populations, between 24 which form connections (trophic, topical, phoric, factory, repellent, attractive, diphenhydramine, etc.), forms of symbiotic (mutualistic, protocooperative, commensalytic) and antibiotic (amensalytic, allelopathic, competitive, predatory) connections. The theory of ecosystems of all degrees of complexity – from consort to Biosphere, their genesis, structural and functional features, evolution and anthropogenic Dynamics is considered by ecosystemology. In an ecosystem, the totality of living organisms and their abiotic habitat form a functional unity, thanks to which the biotic cycle, Energy Exchange and energy accumulation occur. System ecology covers the structure and functioning of the ecological system and the importance of various populations (species) in it, in order to assess the possibility of predicting the development of an ecosystem and the dynamics of its constituent elements, as well as their management. These are quite complex problems, and to solve them, you need to use mathematical methods, modeling methods, and computer technologies.

With the current global climate change and significant anthropic pressure, the ecosystem approach to building productivity-stable adaptive agroecosystems with favorable phytosanitary and ecological conditions is becoming increasingly important. This can be achieved by a comprehensive study of the elements of the agroecosystem, which is why the management of populations of harmful species must necessarily be coordinated with the natural processes occurring in agroecosystems. To achieve this goal, there is insufficient knowledge about the interrelationships of the main components of agrocenoses and the joint impact of harmful consort species on the productivity of cultivated species, as well as about the ecosystem principle of territory organization. Holistic the picture of the composition and functioning of agrobiogeocenoses and higher-ranking agroecosystems, field facies of the agrolandscape is still not disclosed, since studies are conducted at the level of individual populations of species that cause biotic stresses to autotrophic species. Summing up the above, it should be noted that modern research requires an increasingly qualitatively new level of long-term synchronous biocenological observations and accounting for complexes of species: insects, phytopathogens, microorganisms and weeds.

The most effective way to conduct biocenological and Ecosystem Studies of cultivated plant species is to organize agroecological hospitals. The main method of research in systems ecology is System Analysis, which develops ways to study various complex systems or situations, provided that the goals (criteria) are not clearly set. The systematic approach uses the mathematical apparatus of the theory of operations research, methods of multidimensional statistics and informal analysis (the method of expertise, the method of hypotheses, heuristic methods and computer modeling). An essential part of the study of systems is the choice of how to describe the changes that occur in them, and the formalization of such a description. The complexity of formalization is determined by the overlap of different types of factors that characterize the system, for example, a combination of genetic, biological, environmental and other factors.

As part of a plant Group, species with different limits of individual tolerance coexist. According to the principle of emergence, in synecological studies, it is advisable to evaluate the response of biocenoses as an integral structure to changes in environmental parameters. To reveal the organizational structure of groups, their functional activity allow the study of the relationships of various hierarchical levels, as a result of which ecomorphic matrices are formed that reflect the general emergent properties of ecological groups (for example, trophic, topical their structure), since the organizational structure of groups is environmentally determined.

The study of plants of cultivated species at various ecological levels allows us to obtain information about plant viability strategies that are important in managing and expanding the functionality of species and varietal diversity and harmonizing vegetation with environmental conditions. A systematic approach to plant research makes it possible to fully realize the genetic potential of productivity, set the limits of environmental tolerance, sustainability, genetic flexibility, and so on.

The existence of a species is determined by many environmental factors, the leading place among which belongs to the parameters of the viability of a plant population (indicators of habit, mass, development of the reproductive sphere and their implementation in specific conditions). Viability is realized through individual parameters of adaptive traits and properties, connections that ensure the inherent ability of a population of organisms to maintain the level of systemic organization necessary to preserve its basic functions: restoration, settlement and evolution. The analysis of recent works shows the importance of improvements in the study of the problem of viability of plant species populations and requires further development of analytical approaches, in particular, to compare the viability of populations of different species, unify the assessment of viability, identify priority features of viability of populations of different life forms and strategies, not only rare, relict and endemic plants, but also cultivated species.

CONCLUSIONS

The concept of vitality as an indicator of the state of an individual and population, characterized by qualitative parameters of development and quantitative parameters of growth, includes metric features of the vegetative and reproductive sphere (height, development capacity), phytomass, seed productivity, etc., according to which individuals are taken into account and compared. The level of vitality of populations is estimated by the structure, number, density, stock of phytomass, etc. With the development of Population Research, due to the versatility of approaches to the study of populations of organisms of various systematic groups, the term vitality (vitality) of a population is widely used in population biology – this is an integral characteristic that reflects the current state of the population based on the most important individual and group parameters of structure, growth, development and reproduction. Vitality represents the actual position of a population in its realized ecological niche and corresponds to the part of the reaction rate that manifests itself under current habitat conditions at a particular time.

One of the ways to preserve and increase biodiversity is to introduce sustainable and adaptive plant forms and species, especially those that are able to withstand negative environmental factors to a greater extent. The stability and adaptive characteristics of plants are based on the mechanisms of adaptability, the study of which, despite significant improvements in developments, is very relevant today. More and more attention has recently been paid to the study and creation of cultivars and varieties of plant species that form stable vegetative and generative productivity under unfavorable and extremely unfavorable conditions due to their greater value, compared to those that have high seed productivity only in favorable weather conditions. In this regard, the success of introducing new species, including cultivated ones, it is possible only taking into account the mechanisms of viability – priority criteria of adaptability, which will contribute to the enrichment and preservation of Biological Diversity, rational use of Natural Resources.

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