Серия «Биология. Экология»
2014. Т. 10. С. 73–81
Онлайн-доступ к журналу:
http://isu.ru/izvestia

ИЗВЕСТИЯ
Иркутского
государственного
университета

УДК 502.4(571.5), 58 (571.53)

Botanic Gardens as World Ecological Resources for Innovative Technological Development

V. Ya. Kuzevanov, E. V. Gubiy

Irkutsk State University, Irkutsk
E-mail: bogard@rambler.ru

Abstract. The research focused on long term dynamics of the world botanic gardens (BGs) as well as individual ones demonstrates their ongoing transformation into shared innovative multidisciplinary centers of research, education, conservation, social services and commercialization in time course of global urbanization. A new vector model of the BGs complementary positioning between nature and a community was proposed. Due to the public-private partnership and a community support BGs became unique multipurpose ecological resources via broadening their target groups of audiences, engaging with community concerns and environmental needs. Based on comprehensive plant collections, traditional knowledge and practices, innovations, modern bio-technologies, eco-technologies and socio-technologies as well as using tolerant plants of economical and ecological importance many BGs make a substantial contribution to prepare plans for the upcoming sixth technological revolution and against the challenges of climate change.

Keywords: botanic garden, arboretum, ecological resources, biotechnology, university, ecology, environment, urbanization, biodiversity, innovation, commercialization, education, research, urbanization, public awareness, network, research and production facilities, technological order.

Introduction

The present study aims at reviewing the network of botanic gardens and arboreta (BGs) (Fig. 1) and their comprehensive resources, as well as contributing to our understanding of their significance for the nature and for contemporary society in general. The research focused on past, present and future roles of BGs as ecological and social resources for human well-being and for an ecological restoration.

The objective of this article was to analyse how the roles played by BGs for the society and for nature had been changing during the decades of socio-economic development.

Materials and methods

In this paper, the following terms have the following meanings:

1. *«Botanic garden or arboretum»* (BGs) means an institution and territory maintaining documented collections of living and/or preserved plants for purposes

such as scientific research, conservation, sustainable use, display and education [8; 2].

2. *«Ecological resource»* means a source or supply of ecological importance from which benefit is produced and required by living organisms for sustainable normal coexistence of nature and human well-being. Ecological resource definition is both, nature-centered and human-centered (biocentric, ecocentric, anthropocentric) [5; 3; 6].

The research program included predominantly three main methodological approaches and methods: 1) gathering qualitative data from the field through special study visits to more than 200 BGs in 32 countries worldwide; 2) a compiling a comprehensive bibliography as well as collecting personal correspondence and private interviews; 3) a collecting materials available in data bases and archival documents from different BGs, their networks and relative international and national institutions, including the BGCI (Botanic Gardens Conservation International).

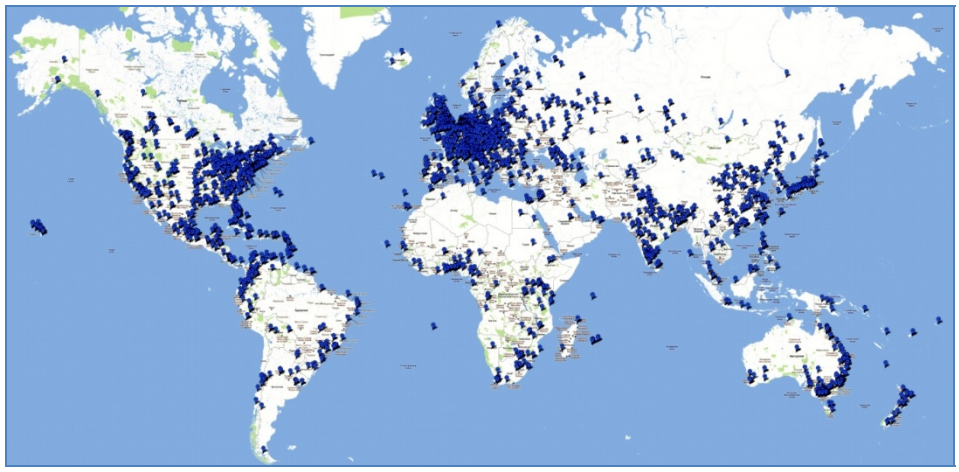

Fig. 1. Distribution of the botanic gardens and arboreta in the world (the map prepared using the BGCI data base, 2011, http://www.bgci.org/. Courtesy Dr. Diana Wyse-Jackson)

Results and discussion

The trends observed during last three hundred years and especially in recent years demonstrate an accelerated growth and development of many types of new BGs in developing countries, while the existing gardens in developed countries are undergoing a major renovation. Analysis of the dynamics of the world BGs for the period 1700–2009 suggests that active growth in their number coincided with scientific and technological revolutions and periods of fast economic and cultural development as well as accelerated urban development in the second half of the 19th century.

Growth and development of modern BGs are connected mainly with the level of urban development but obviously not with just rural way of living (Fig. 2, 3; Table 1). The dynamics of the number of BGs was connected mainly with the processes of growth and development of the urban population, i.e. with the urbanization as a stage of civilization development. Thus, the main objectives of tangible and intangible resources of BGs is to maintain life supporting functions of natural systems necessary for sustainable urban development

Table 1

Correlation between number of BGs and a total/urban population in different countries

Country	Number of BGs (in the year 2009)	Correlation coefficient of BGs numbers:	
		With total population	With urban population
Australia	98	0.979	0.981
Brazil	19	0.983	0.976
Canada	40	0.987	0.982
China	45	0.985	0.902
Germany	69	0.975	0.994
India	60	0.945	0.923
Japan	41	0.991	0.997
Malaysia	9	0.950	0.918
Russia	88	0.978	0.980
S.Africa	19	0.956	0.919
U.K.	61	0.938	0.969
USA	396	0.985	0.992

Therefore, highly developed countries, where there are sufficient conditions and financial resources, have developed very strong traditions of BGs construction and management. The focus in these countries is in the improvement of quality of life of the citizens provided via the development of ecologically sound environment in cities. BGs in the developing and underdeveloped countries are, first of all, research institutions and plant nurseries. They help to supply the local population with seeds/seedlings for city greening and for private gardens as well as to carry out numerous educational functions, providing basic horticultural and ecological knowledge necessary for the survival. The maintenance of environmental quality and sustainable use of biological resources is beneficial for development of eco-tourism connected with the protection of rare and endangered plants and animals, with the building of infrastructure, which, in turn, creates new jobs in the region.

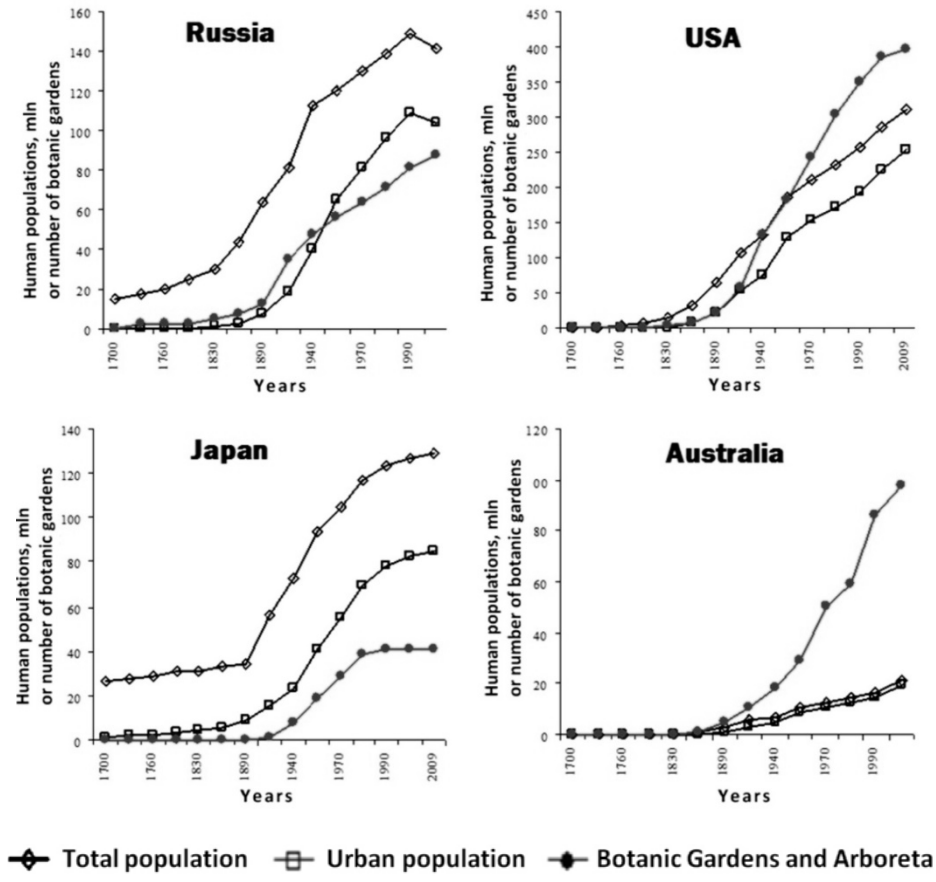

Fig. 2. Examples of trends of the BGs number dynamics in relation to the total population growth and urban population growth in the years 1700–2009

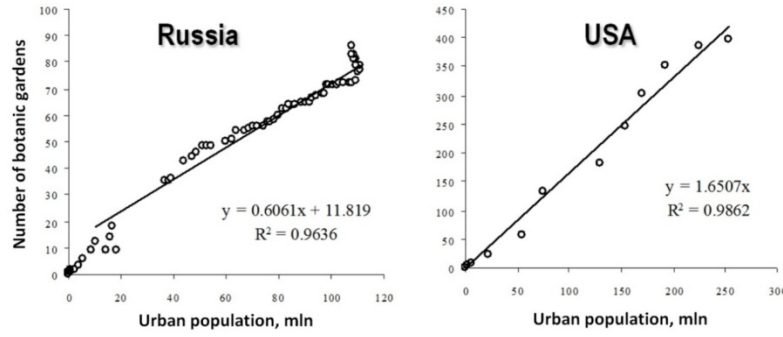

Fig. 3. Correlation between botanic gardens number and urban population in Russia and the USA (for the period of years 1700–2009)

The entire set of the BGs resources is designed to recreate the natural conditions in the urban environment, to maintain and improve the health of people with beautiful, green environment, smoothing the excess stress, providing organized leisure and recreation in open spaces or indoors. The key roles of modern BGs is associated with the formation of a healthy and secure environment in urbanized territories through four cross-disciplinary cornerstones of functions (Fig. 4): Scientific research, Conservation, Commercialization of innovations, and Education. Therefore the proposed vector model of the BGs (Fig. 4) describing the flow of resources could be an excellent methodological tool for the qualitative analysis and practical implications in order to improve the impact of BGs on both, the nature (biodiversity) and society (market economy). The main purpose of tangible and intangible resources of BGs is to maintain life-supporting functions of natural systems needed for sustainable urban development, environmental and social security in the country and the world, to improve the environment and human well-being.

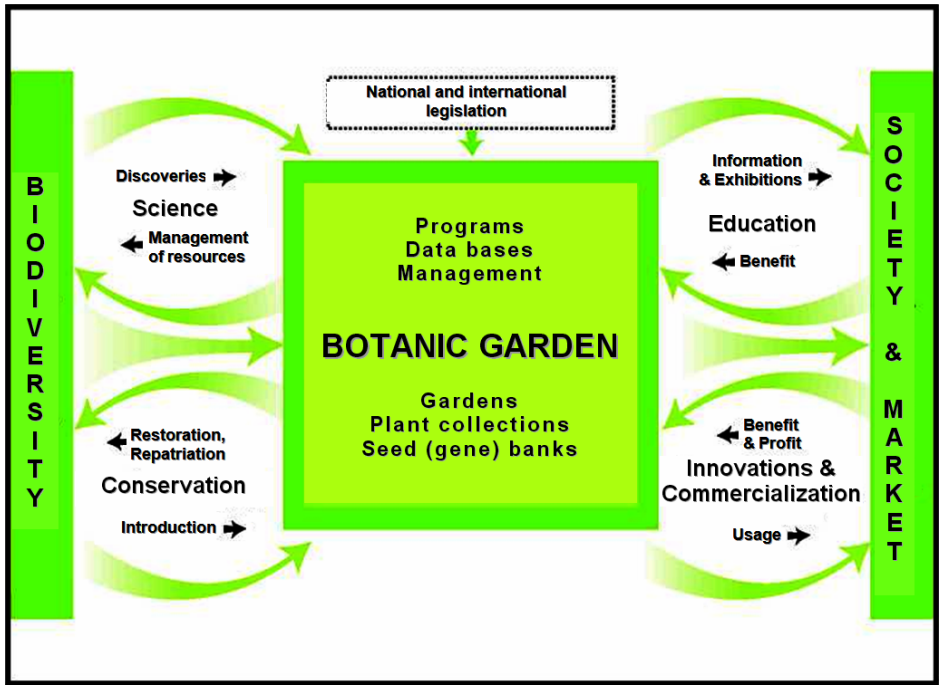

Fig. 4. The vector model of a Botanic Garden (or Arboretum) positioning as an active interface in a circulation of tangible and intangible resources and functions between the nature (biodiversity) and human society (market economy) based on four functional cross-disciplinary cornerstones: Scientific research, Education, Conservation, and Commercialization of Innovations (modified from [2])

Conclusions

Each country has its own definition of a BGs and its functions in connection with the socio-economic development. For example, BGs for an economically prosperous country are mainly recreational, environmentally-friendly green parks where everything is focused on the needs of visitors to communicate with nature through contact with plants. This paper explains how BGs became economically and socially important institutions and lands through the development of ecologically significant resources (tangible and intangibles ones based on diverse plant collections, landscaped gardens, educational and social technologies, scientific research and knowledge) and cross-disciplinary approaches for public-private partnership. All the efforts, the expertise and research potential is aimed at improvement of human well-being and preservation of plants and environment. The modern BGs is a protected green area holding documented collections of living plants and landscaped gardens where the managing company creates resources for scientific research, education and outreach programs, public displays of plants, garden specimens and technologies for biodiversity conservation, plant production and services based on plants, their derivatives and knowledge about them [5]. Therefore, the mission of the global network of modern BGs is associated with the transformation of their tangible and intangible resources for the purposes of biodiversity conservation and well-being improvement of the society as a whole as well as individuals, including the improvement in their environmental education [7].

In the conditions of economic crisis and climate change, BGS are playing a role of anti-crisis instruments and ecological resources for the sixth technological wave (Table 2):

a) to provide people with economically significant plant resources;

b) to help the poverty alleviation and to provide knowledge and survival skills through the introduction of environmental innovations, technologies and new demanded plants;

c) to help address an ecological illiteracy;

d) to contribute to the environment-friendly and healthy lifestyles in urban areas;

e) to serve as one of the most inexpensive tools for social adaptation and rehabilitation using the horticultural therapy;

f) to promote the development of various forms of «green businesses» and create new jobs.

g) to build buffer systems against the climate change and extreme conditions based on tolerant plants of economical and ecological importance.

Based on comprehensive plant collections, traditional knowledge and practices, innovations, and modern bio-technologies, eco-technologies and socio-technologies as well as using tolerant plants of economical and ecological importance many BGs make a substantial contribution to prepare plans for the upcoming sixth technological revolution (Table 2) and against the challenges of climate change.

Table 2

Botanic gardens as resources of innovations in relation to key technologies of the upcoming sixth technological order (technological revolution) of the 21st century

Technologies	Innovations for/ in botanic gardens
Bio- and agro-technologies	Introduction of new economically valuable plant species; plants for adaptation against climate change; urban farming and gardening; industrial and home hydroponics
Nanotechnology	Genetic manipulations (GMOs); production of new materials and molecular structures
Eco-technologies	Ecological restoration; plant conservation; biosafe construction materials; city greening; adaptation and rehabilitation approaches for a space exploration
New educational technologies for human development	Horticultural therapy; multidiscliplinary and cross-disciplinary approaches for human competence development; continuous and extended education for all generations
High humanitarian technologies for individuals and organizations	Horticultural therapy; promotion of civil society development; cross-disciplinary approaches for improvement of human well-being, poverty alleviation
New medicine	Medicinal plants and plant-based products and derivatives
High environmental technologies	Development of new plant varieties; air and water cleaning systems; treatment and transformation of wastes
Clean energy technologies	Plants as energy sources; non-traditional approaches for energy transformation and accumulation in plants
Biofuels	Energy forest; new plant-based biofuels
Urban technologies	City greenification; «smart» city; city design and beautification; urban farming; “eco-logical city” planning; green roofs; vertical gardening
Construction materials	Biosafe materials; mobile and growing constructions
Reconstruction of living matter	Plants as a sources and objects for genetic manipulations
Social technologies	Promotion of civil society development; horticultural therapy and social adaptation; plants for human adaptation in extreme conditions

Our studies based on a special research of the BGs networks in 153 countries showed that the better the coordination of the reciprocal connections and circulation of resources between natural resources and society, the greater the environmental, social and cultural role which BGs play in the community and market economy [1; 4]. Accordingly, the higher the human development potential index

of the country, the more active the society's involvement in conservation and ecological restoration of the natural heritage. So the relevance of the present research topic is due to the need of revising the traditional view on past, present and future roles of many BGs. The value of BGs ecological resources is very promising especially for the sixth technological wave in 21st century.

Acknowledgements

This work was supported by the Irkutsk State University Strategic Development Grant (R121-BS-001) funded by the Ministry of Education and Science of Russian Federation. We thank Dr. Peter Wyse Jackson and Dr. Diana Wyse Jackson (Missouri Botanic Garden), Dr. Kris Jarantoski (Chicago Botanic Garden), Prof. Alexander Demidov (Moscow Main Botanic Garden of RAS), Dr. Pavel Krestov (Vladivostok Botanic Garden-Institute of RAS), Dr. Svetlana Sizykh and Prof. Alexander Arguchintsev (Irkutsk State University), Dr. Joon Hwan Shin (Korea National Arboretum) for a support and valuable discussions.

References

1. Kuzevanov V. Ya. Botanic gardens and arboreta as ecological resources for sustainable development [Electronic resource] / V. Ya. Kuzevanov // Role of the Arboretum and Botanical Garden against Climate Change of the East Asia (International Symposium), Seoul, KNA. – 2013. – P. 24. – URL: http://bogard.isu.ru/articles/2013_korea/kuzevanov_korea_2013.pdf.

2. Kuzevanov V. Ya. Botanic gardens resources: tangible and intangible aspects of linking biodiversity and human well-being [Electronic resource] / V. Ya. Kuzevanov, S. V. Sizykh // Hiroshima Peace Science, 2006. – N 28. – P. 113–134. – URL : http://bogard.isu.ru/articles/hiroshima/kuzevanov_jpc2006.pdf

3. Kuzevanov V. Ya. Botanic gardens as ecological resources in a global system of social coordinates / V. Ya. Kuzevanov, S. V. Sizykh, E. V. Gubiy // Economical and ecological problems in changing world. – St.-Petersburg, 2010. – P. 158–167.

4. Kuzevanov V. Ya. Botanic gardens as resources for socio-economic development [Electronic resource] / V. Y. Kuzevanov, E.V. Gubiy, S.V. Sizykh // Proc. of Irkutsk State Econ. Acad., 2010. – N 5. – P. 313–324. – URL: http://bogard.isu.ru/articles/2010_bguep/kuzevanov_58.pdf.

5. Perrings C. Economics of Ecological Resources: Selected Essays (New Horizons in Environmental Economics) / C. Perrings // Edward Elgar, Cheltenham, 1997. – 254 p.

6. Species-richness patterns of the living collections of the world's botanic gardens: a matter of socio-economics? [Electronic resource] / J. Golding [et al.] // Annals of Botany, 2010. – Vol. 105, N 5. – P. 689–696. – URL: http://bogard.isu.ru/articles/2010_annbot/ Golding_etal_2010_AnnBot.pdf.

7. Valuation of Ecological Resources: Integration of Ecology and Socioeconomics in Environmental Decision Making / R. G. Stahl, Jr. [et al.]. – CRC Press, 2007. – 256 p.

8. Wyse Jackson P. S. Experimentation on a large scale – an analysis of the holdings and resources of botanic gardens [Electronic resource] / P. S. Wyse Jackson // BGCI News, Richmond, UK, Botanic Gardens Conservation International, 1999. – Vol. 3, N 3. – P. 53–72. – URL: http://www.bgci.org/resources/article/0080.

Ботанические сады как экологические ресурсы инновационного технологического развития

В. Я. Кузеванов, Е. В. Губий

Иркутский государственный университет, Иркутск

Аннотация. Исследование, посвящённое изучению многолетней динамики и особенностей развития ботанических садов мира, показало их постепенную трансформацию в инновационные междисциплинарные центры коллективного пользования для научных исследований, образования, охраны природы и биоразнообразия, социальных услуг и коммерциализации в ходе глобальной урбанизации. Была предложена новая векторная модель позиционирования ботанического сада между природой и сообществом. Благодаря государственно-частному партнерству и общественно-государственной поддержке, ботанические сады становятся уникальными многофункциональными экологическими ресурсами путём расширения своих целевых групп влияния, вовлечённости в удовлетворение социальных потребностей и экологических проблем. Они основываются на богатых коллекциях растений, традиционных знаниях и практиках, инновациях, современных биотехнологиях, эко- и социальных технологиях. Благодаря растениям, а также всему комплексу материальных и нематериальных ресурсов, ботанические сады во многом вносят вклад в адаптацию человечества к климатическим изменениям и к продвижению предстоящего шестого технологического уклада.

Ключевые слова: ботанический сад, дендрарий, экологические ресурсы, биотехнология, университет, экология, охрана окружающей среды, урбанизация, биоразнообразие, инновации, коммерциализация, образование, исследование, урбанизация, информирование общественности, сеть, технологический уклад.

Кузеванов Виктор Яковлевич
кандидат биологических наук,
директор, Ботанический сад ИГУ
Иркутский государственный университет
664003, г. Иркутск, ул. К. Маркса, 1
тел.: (3952)41–34–76
e-mail: bogard@rambler.ru

Губий Елена Валерьевна
зам. директора, Ботанический сад ИГУ
Иркутский государственный университет
664003, г. Иркутск, ул. К. Маркса, 1
тел.: (3952)41–34–76
e-mail: egubiy@gmail.com

Kuzevanov Victor Yakovlevich
Candidate of Scienses (Biology),
Director, Botanic Garden IGU
Irkutsk State University
1, K. Marx st., Irkutsk, 664003
tel.: (3952) 41–34–76
e-mail: bogard@rambler.ru

Gubiy Elena Valerievna
Deputy Director,f Botanic Garden IGU
Irkutsk State University
1, K. Marx st., Irkutsk, 664003
tel.:(3952) 41–34–76
e-mail: egubiy@gmail.com