BIODIVERSITY AND BIOCOLLECTIONS: PROBLEM OF CORRESPONDENCE*

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Orientation of biology, as a natural science, on the study and explanation of the similarities and differences between organisms led in the second half of the 20th century to the recognition of a specific subject area of biological explorations, viz. biodiversity (BD).

One of the important general scientific prerequisites for this shift was understanding that (at the level of ontology) the structured diversity of the living nature is its fundamental property equivocal to subjecting of some of its manifestations to certain laws. At the level of epistemology, this led to acknowledging that the "diversificationary" approach to description of the living beings is as justifiable as the before dominated "unificationary" one.

This general trend has led to a significant increase in the attention to BD. From a pragmatic perspective, its leitmotif was conservation of BD as a renewable resource, while from a scientific perspective the leitmotif was studying it was studying BD as a specific natural phenomenon. These two points of view are united by recognition of the need for scientific substantiation of BD conservation strategy, which implies the need for a detailed study of BD itself.

At the level of ontology, one of the key problems in the study of BD (leaving aside the question of its genesis) is determination of its structure, which is interpreted as a manifestation of the structure of the Earth's biota itself. With this, it is acknowledged that the subject area of empirical explorations is not the BD as a whole ("Umgebung") but its particular manifestations ("Umwelts"). It is proposed herewith to recognized, within the latter: fragments of BD (especially taxa and ecosystems), hierarchical levels of BD (primarily within- and interorganismal ones), and aspects of BD (before all taxonomic and meronomic ones).

Attention is drawn to a new interpretation of bioinformatics as a discipline that studies the information support of BD explorations. An important fraction of this support are biocollections.

The scientific value of collections means that they make it possible both empirical inferring and testing (verification) of the knowledge about BD. This makes biocollections, in their epistemological status, equivalent to experiments, and so makes studies of BD quite scientific. It is

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*This text is an English translation of those several sections of the original paper in Russian, where collection-related issues are considered.

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The References section includes the entire list of literature cited in the original text, including the papers mentioned in the sections that are omitted in this translation (to be true, I just "grudge" my time for discarding the "extra" references).

emphasized that the natural objects (naturalia), which are permanently kept in collections, contain primary (objective) information about BD, while information retrieved somehow from them is a secondary (subjective) one.

Collection, as an information resource, serves as a research sample in the studies of BD. Collection pool, as the totality of all collection materials kept in repositories according to certain standards, can be treated as a general sample, and every single collection as a local sample. The main characteristic of collection-as-sample is its representativeness; so the basic strategy of development of the collection pool is to maximize its representativeness as a means to ensure correspondence of structure of biocollection pool to that of BD itself.

The most fundamental characteristic of collection, as an information resource, is its scientific significance. The following three main groups of more particular characteristics are distinguished:

— the "proper" characteristics of every collection are its meaningfulness, informativeness, reliability, adequacy, documenting, systematicity, volume, structure, uniqueness, stability, lability;

— the "external" characteristics of collection are resolution, usability, ethic constituent;

— the "service" characteristics of collection are its museofication, storage system security, inclusion in metastructure, cost.

In the contemporary world, development of the biocollection pool, as a specific resource for BD research, requires considerable organizational efforts, including work on their "information support" aimed at demonstrating the necessity of existence of the biocollections.

Introduction

The main task of the biological science has always been and still remains revelation and explanation of similarities and differences between organisms: how they appear, how they are manifested, what are their functional, adaptive and evolutionary significances, etc. All the classical biology addresses to this global puzzle: how and why organisms are different (Уоддингтон, 1970). Biology of the 20th century, having become experimental and focused largely on the subcellular and ecological levels of organization of the living matter, tried to "disown" of the classics, and yet the key problem remained in fact the same: to describe and explain how and why organisms a) are differentiated structurally and functionally and b) vary in both their structure and role in the natural communities.

In the last third of the 20th century, traditional attention to the diversity of organisms, having been fragmented formerly between different biological disciplines, took shape in particular integrated subject area known as the *biological diversity* (biodiversity, *aka BD*) (Wilson, 1988). The editor of the just mentioned book called *BD* rather poetically "the greatest miracle on our planet." In the early 1990s, pragmatically minded officials included *BD* by law amongst the most important natural resources, preservation of which has been declared one of the preconditions for the future sustainable development of the mankind (Declaration…, 1992). This "Rio Declaration" has served as a kind of trigger in the unfolding of heated discussions and attempts to resolve a wide range of issues and problems related one or another way to the study, conservation, and use of *BD*.

A part of these discussions became aspiration for clarification of the question, what is the empirical (resource) base for exploring *BD*: what does in particular make it possible to consider factually its structure and dynamics both at global and local levels. As the taxonomic (mainly species) diversity was thought, from the outset, a key aspect of *BD*, and its factology consisted traditionally of museum collections, an increased attention to *BD* inevitably spread to the biocollection pool.

To emphasize an importance of biocollections for the study and partly conservation of *BD*, they were called aphoristically "archives", "libraries", or "observatories" of *BD* (Калякин и др., 2001; Cotterill, 2002; Горяшко, Калякин, 2004; Winston, 2007; Калякин, Павлинов, 2012; ICOM…, 2013). This emphasizing breathed a "new life" into the "old" museum collections by showing their relevance to addressing today's most actual *BD* problems (Miller, 1985; Tyndale-Biscoe, 1992; Alberch, 1993; Chalmers, 1993; Miller, 1993; Duckworth et al., 1993; Shetler, 1995; Cotterill, 1997, 2002; Mehrhoff, 1997; Butler et al., 1998;. Krishtalka, Humphrey, 2000; Ponder et al., 2001; Bates, 2007; Ward, 2012). A new understanding of mission of the museum biocollection pool became reflected in the term *Biodiversity Collections*, and the collection assemblages were designated *Biodiversity Repositories* (Biodiversity Collections…, 2008, 2013, 2015; Global…, 2013; Matsunaga et al., 2013).

In considering biodiversity collections in this way—as an important resource, on the basis of which *BD* explorations are carried out,—one of the key problem becomes that of *collections correspondence*. The latter concept has quite diverse meanings; for the purposes of the present article it is enough to specify but two of its general senses. One of these implies correspondence of museum collections to certain criteria of scientificity: it allows to expect that explorations on *BD*, as a natural phenomenon, conducted on the basis of collections are "scientific" in a rather strict sense of the notion. Another meaning implies that the structure of the collection pool corresponds to the structure of *BD*: due to this, we can expect that results of investigations of museum collections reflect the real properties of *BD* with high reliability.

In this paper, some key questions relating to its "title" problem are concerned in a brief form (i.e., without discussing different points of view and without going into any debates on them). Firstly, prerequisites of emergence of the modern scientific interest to *BD* will be reflected (Section 1, not included in the present translation). Then, considered will be fundamental manifestations of *BD* as actually specific subjects of applications of particular research projects, viz. *BD* aspects, fragments, hierarchy levels, etc. (Section 2, not included in the present translation). Expanded understanding of bioinformatics, as a discipline dealing with the information support of *BD* explorations, will be outlined as far as it involves interpretation of biocollections as an information resource for these explorations (Section 3, not included in the present translation). Then I shall discuss briefly understanding biocollections as a specific bioresource (Section 4), following by a brief outline of the reasons allowing to consider them scientific (Section 5). Finally, I shall discuss in more details basic characteristics of biocollections treated this way (Section 6).

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4. Biocollections as a specific bioresource

Both the development of bioinformatics and the very contents of this discipline were originally associated with the study of biopolymers, especially semantids (nucleic acids), and its main task was defined as an analysis of information processes in the molecular biosystems (Hogeweg 2011). In the recent times, however, a significant new emphasis was added to this understanding of bioinformatics, which was caused by rapid development of the research and applied projects on *BD*. Correspondingly, a phrase "*Biodiversity Informatics*" was born in the English-language literature (Biodiversity Informatics…, 1999), which was reduced eventually to the same "Bioinformatics". The latter inherited from the original interpretation of the contents of this discipline its relying on the modern information technologies; an important innovation was the refusal of its binding primarily to the molecular biology and inclusion in the scope of its application all that is more or less closely related to *BD* (Bisby, 2000; Soberón, Peterson, 2004; Guralnick, Hill, 2009; Attwood et al., 2011; Heidorn, 2011; Lapp et al., 2011; Hardisty, Roberts, 2013). According to the established tradition in science, it was called "*The New Bioinformatics*" (Jones et al., 2006).

From the standpoint of the main theme of this article, of particular significance is the inclusion of biological collections in the scope of "the new bioinformatics" as one of the key portion of the resource base for the various activities aimed at *BD* (Graham et al., 2004;. Berendsohn, 2007; Scoble, Berendsohn, 2007; GBIF…, 2008; Ariño, 2010; Scoble, 2010; Drew, 2011; Буйкин и др., 2012;. Digitisation…, 2012; Holetschek et al., 2012).

General understanding of biocollections as an important part of the overall resource base, which underlies various forms of *BD*-related activities, imply that the very collections are a specific bioresource. At any rate, such interpretation fits well within a more general standpoint that the materials kept in the museums can be considered as a special kind of resource ensuring various needs and requests of the human community (Keen, 2008; Latham, Simmons, 2014). To an extent that this resource is represented by the stored collection biomaterials, it may be referred to generally as the *collection bioresource*.

Depending on the form in which the latter is presented and how it is involved in the above activity, it can be divided into two main categories, the *material* bioresource and *information* bioresource.

The **material collection bioresource** is an array of biological objects that are *directly* (as such) involved in the activities aimed at *BD*. These include "live" collections kept in zoos, botanical gardens, vivaria, and microbial cultures; belonging here are also "conditionally live" collections, viz. dried and/or frozen microorganisms, plant seeds, animal gametes, etc. It is also appropriate to mention different kinds of biocollections kept and used for purely applied purposes unrelated to *BD* (biomedicine, biotechnology and so on).

The **information collection bioresource**, in contrast to the previous one, contains natural history objects that are involved in *BD*-related activities not as such (in its "material" manifestation) but rather *indirectly*. By this, it is meant that any collection items used in such way serve as the source of various kinds of information, remaining themselves (almost) unchanged. This includes collection materials represented by proper natural objects (anatomical and histological preparations, etc.), episomatic materials (voice recordings, lifetime photos and drawings, traces, etc.), as well as all sorts of the field documentation.

These two basic forms of representation of biocollections are not demarcated discretely. This is because the collection objects, belonging to the second of these categories, are often used directly as a "material" bioresource in the particular studies. These include, for example, the objects used for hybridization experiments in the so-called experimental taxonomy, which might be the animals themselves (e.g. Малыгин, 1983; Мейер, 1984) and the total DNA extracts (e.g. Попов и др., 1973; Sibley, Ahlquist, 1984; Goris et al., 2007).

It is necessary to emphasize the following important properties characterizing biocollections as a specific bioresource.

First of all, it is a *repleniable* resource: research biocollections are usually constantly expended due to newly acquired materials (see section 6.1.).

On the other hand, it is to some extent a *non-renewable* resource: both degradation of natural communities and disappearance of species populations make it eventually impossible to re-collect "the same" collection materials (Cato et al., 2001.).

Finally, it is a *sparing* resource: with the need to re-investigate any natural population, it is possible to turn to the previously collected and preserved specimens, rather than to get new ones from nature.

5. Scientific status of biocollections

In terms of the main subject of this article, research biocollections constitute the most important part of the total collection pool integrated in the resource base of *BD* explorations. In this section, they are considered from a theoretical point of view with two basic questions kept in mind: a) in what sense collections can be considered scientific and b) what particularly make them scientific.

In the history of biological science, research collections emerge, stored and develop not spontaneously, but with a very definite purpose: as it was said above, they provide certain research and applied *BD*-related tasks with necessary resource base. This fundamental goal can be considered as a key motivation for existence of research collections in biology.

Values of biocollections are multifaceted: scientific, educational, cultural, historical, aesthetic, practical, cost, etc. So it is clear that the scope of their use goes far beyond the bounds of the science proper. However, it is to be stressed that their scientific status is fundamental and, in a sense, of "primary" value: it is this status that underlines effectiveness of many of other forms of the use of collections.

Thus, correspondence of a collection to the status of scientificity (on this, see section 5.1) defines ultimately, to what an extent any information extracted from it, while it is involved in educational and any other non-research activities, can be considered scientifically meaningful. The same is true for the purely applied aspects of the use of biocollections: the results of their use (e.g. in biomedicine, biotechnology) depend largely on the fact that the materials stored in them are by themselves scientifically significant and reliable.

5.1. Scientific value of collections

Scientific value of collections, in the most general sense, is determined by a possibility to resolve, with their use, exploratory and related tasks.

With this background in mind, the authors, when describing scientific value of collections, use to content themselves with but a simple listing of such tasks (Pettitt, 1989; Nicholson, 1991; Allmon, 1994, 2005; Davis, 1996; Jeram, 1997; Butler et al., 1998; Kress et al., 2001; Funk, 2004; Suarez, Tsutsui, 2004; A matter... NatSCA, 2005; Winker, 2005; Pinto et al., 2010; Pyke, Ehrlich, 2010; Clemannnn et al., 2014; MacLean et al., 2016). Of course, this is quite important as a kind of "information support" of all activities around the collection pool (see section 6.3). But it seems that such listing is inadequate for a deeper and more comprehensive understanding of what and how scientific status and scientific value of research biocollections is determined and substantiated. In fact, consideration of this key issue should begin with its setting in a more general sense, i.e. with talking about this status and value from the point of view, if you will, of the "philosophy of science" (Павлинов, 1990, 2008; Cotterill, 1997, 2002).

For this, obviously, it is necessary to appeal to the universally valid criteria that allow to distinguish the science from a "non-science"—and not in a narrow sense embedded in the physicalist understanding of science, but rather in a more general epistemological sense. Those criteria are rather limited in number (Ильин, 2003), with one of the key criterion among them being *empirical testability* of any judgments about the objects under exploration. It is the testability that lays down a fundamental boundary between scientific knowledge and any other form of ideas about the world around us. This general criterion is "served" by two more particular ones: a) *factual* substantiation of the knowledge and b) *reproducibility* of the knowledge.

Its meaning is clearly seen in the emergence and development of the natural history collections.

Clear understanding of empirical nature of the modern science, in the initial period of its formation (the 16th century), was based on an idea that the main "evidence base" of the knowledge pretended to be scientific was an appeal not to The Word (to the Holy Scripture or to any other authoritative sources of the "ultimate truth"), but to The Fact—to that fact that is amenable to observation, empirical verification, etc. It is this idea, as many researchers of the origins of the museums in Europe use to emphasize, that has led to the conversion of former Kunstkammers into systematically accumulated and arranged research collections (Hooper-Greenhill, 1992; Boylan, 1999; Impey, Macgregor, 2001; Юренева, 2002, 2003; Lourenço, 2003; Alexander, Alexander, 2008). The latter, as far as living matter is concerned, emerged as an empirical (factual) basis of explorations dealing with the comprehension of the Natural System, thereby putting them into the mainstream of the rational Natural Science (Фуко, 1994; Павлинов, Любарский, 2011).

Acknowledging this universally valid epistemological maxim was largely emerged with the philosophical ideas of Francis Bacon. He was first to divide natural science into two main branches, "Natural Philosophy" and "Natural History." They differ fundamentally by both the nature of their respective integrative knowledge (either nomothetics or ideography) and by the nature of factology employed by them for substantiating that knowledge. The empirical basis of the "Natural Philosophy" (physics, chemistry, etc.) is construed mainly from experiments, while the one of the "Natural History" (biology, geology, etc.)—from research collections (Уэвелл, 1867; Mayr, 1982).

Whatever important might be the differences between these two general categories of factology, they are united by one common fundamental feature. Both experiments and collections provide a possibility of reproducing previously obtained knowledge about respective natural phenomena, and thereby an empirical verification of its either truth or falsity.

An important general conclusion follows from this: from a perspective of epistemology, research collections in the "Natural History", by their fundamental scientific value, are analogous to experiments in the

“Natural Philosophy”, in that they both provide a means of inferring, reproducing, and verifying scientific knowledge. Therefore, the “Natural History” cannot do without its collections, just like the “Natural Philosophy” cannot do without its experiments. Accordingly, the research collection pool is “doomed” both to preservation and to development—in the same way as are the laboratories for physical, chemical and so on experiments (Павлинов, 2008).

Such high scientific status of museum collections is provided by a fundamental condition that they accumulate and store authentic objects of natural history (*naturalia*) on a long term permanent basis. Taking into account the information terminology accepted now for engrossing arguments about collections and their importance for the explorations on *BD* (see previous section), this fundamental (and therefore trivial for any museum curator) assertion can be accentuated as follows (Павлинов, 2008).

The fundamental meaning of any collection of the *naturalia*, in the terms of epistemology, is in its containing a *primary* information about a part of the World (“Umwelt”), for exploration of which they have been and are being accumulated and stored. Enclosed in the collection materials themselves, such information is *objective* in a sense: its contents depends only on the structure of these materials (though it of course is strongly bounded by the methods of the materials preparation).

In contrast to this, information that a researcher extracts from collection materials and displays in some form, is a *secondary* one: it is a pure result of some operations on these materials, with this operations, by and large, being subjectively motivated. Therefore, this secondary information is basically *subjective*: its contents depends on the researchers’ theoretical background and practical experience, on the exploratory goals, on the methods employed, etc. In other words, such information, no matter how painstaking it may be, represents not the object itself, but its interpretation. This is true for any information derived, one or another way, from the collection materials, be it either a set of measurements of macroanatomical objects, or its photograph (as a part of any “virtual collection”), or a histological or cytogenetic preparation made by particular methods, or deciphered molecular sequences placed in the GenBank, etc.

It is evident from the above that the primary information can be deemed as potentially inexhaustible: formulation of new exploratory tasks, elaboration of new research methods, etc.—all this may open new opportunities presuming a possibility to turn back to the existing collection materials in order to extract from them a new information that has been uninteresting or inaccessible previously. Unlike this, contents of a particular secondary information is substantially poorer: it is always limited by the mental, technical and other capabilities having been involved in its extraction, so it is “finite”.

It follows from this a fundamental conclusion: collections of natural history specimens (*naturalia*) are subject to long-term storage, not only for verification of the information has been inferred from them previously, but also for providing a possibility for inferring a new one in the future.

5.2. Research collection as a sample

For understanding how *BD* and biocollections are interrelated and how certain correspondence is to be conceived between them, of fundamental importance is interpretation of research collection as a *sample*. Such an interpretation follows from the below considerations.

First of all, it should be recalled that *BD* is a complex natural phenomenon, direct observation and study of which in its totality is impossible in principle. This is true for both overall *BD* ("Umgebung") and any of its particular manifestations ("Umwelts"). Thus, it is studied not directly in its suchness, but only indirectly and partially—through some sets of its "elementary units", viz. organisms. Each of such sets and a sum thereof can be referred to, according to standard thesaurus, as a research sample.

Further. In any case studies, these organisms represent the biota not by themselves, but by their particular fragments, which serve for researchers as a basis for compiling their particular descriptions ("research models") according to particular exploratory tasks. Such a "fragmentation" occurs in any cognitive situation and is true for any natural objects. Indeed, even if a researcher deals with a living being, he/she does not describe its totality, but only its particular aspect or fragment (e.g. feeding behavior, signal coloration, locomotion, etc.) without paying attention to any other features of the organism being described. This "fragmentation" is hold especially in the cases where such descriptions are applied to certain parts (residues, derivatives) of the dead bodies. So, it is a totality of the latter, and not organisms themselves, that constitute a sample for studying any observable manifestation of *BD*.

In order to meet the above basic criteria of scientificity (see section 5.1.), aggregates of the organismal fragments should be conserved and stored following certain standards ensuring their stability. According to the accepted terminology, the aggregates such kept are usually called *the* collections. Consequently, a biocollection containing fragments of organisms as carriers of some scientifically important primary information serves as a research sample assigned for resolving certain exploratory tasks concerning *BD*.

The *BD*, as a natural phenomenon explored by biologists, according to the same standard terminology, represents the general population; the same is deemed correct for any of *BD* manifestations. The entire body of collection materials assigned for the study of *BD* represents a general sample, which in museological terms can be designated as the *biodiversity collection pool*, or simply the *biocollection pool* (a term already used above). The basic structural unit of the general sample is a local sample; this is a particular collection of biomaterials accumulated and stored with the above goal in a minimally changed state over a long enough time in a particular place.

Biocollection-as-sample functions in explorations as a specific operational research model (representation) of *BD* in whole or some of its manifestations. Respectively, results of explorations of the sample are extrapolated (within certain confidence interval) to *BD* (*BD* manifestation) taken for the general population. Reliability of this extrapolation depends on how *representative* is the sample, that is how completely it reflects *BD* (*BD* manifestation). As it was indicated above, the main subject of explorations based on the collection materials is *BD* (*BD* manifestation) structure, so this statement can be reformulated the following way. Representativeness of the collection pool in general and individual biocollections in particular is determined by an extent to which their structure reflects the structure of *BD* as a whole or *BD* individual manifestations (aspects, fragments, levels, etc.).

Thus, the problem of correspondence between *BD* and biocollections at operational level is primarily a problem of the representativeness of the collection pool as a general sample. In a more narrow sense, it is decomposed into two important characteristics, viz. collection reliability and adequacy, considered below (see section 6.1).

Correspondence between these two structures—of *BD* and biocollections—can be considered in two ways: from the "above" and from the "below." In the first case, we are talking about looking at the whole cognitive situation from the theoretical perspective, the second case presumes the empirical standpoint. Each of these views has its reasons and therefore its right to exist, as can be seen from the following.

A look "from above" implies that there is some general idea of *BD* structure serving as a background for judgments about how the collection pool should be structured. For example, it is decided on this basis whether or not to collect serial materials for the study of morphological disparity. As a result, the representativeness of the general sample is maximized (or at least optimized) on certain theoretical basis to ensure its correspondence to a supposed (postulated) *BD* structure.

A look "from below" has an undeniable empirical foundation: it is the structure of the collection pool that serves, generally speaking, as a basis for judging about *BD* structure. Turning to the most obvious and perhaps the most studied component of the latter, viz. to the taxonomic diversity, we can ascertain that representativeness of our general sample is not too high, and the correspondence being discuss, therefore, is far from desirable. Analysis of the dynamics of annual descriptions of new taxa is quite indicative in this respect: judging by their rate, the present general sample, that is, the current biocollection pool, reflects but a small part of the real diversity of living organisms, especially in the groups having been out of research priorities previously (Mora et al., 2011; Zhang, 2013). The reason of such a discordance lies in various incentives and constraints—historical, technological and even subjective, under which influence the collection pool has been growing till now.

It can be concluded from the preceding that the empirical general sample of collection materials, on the basis of which we judge about *BD* structure, is essentially biased. This conclusion can be considered true, even in a stronger form, for any of particular biocollections. Each of them represents but a small portion of *BD*, and the smaller is a collection, the less it is representative with respect of the total *BD*.

As it might be deemed, this general conclusion is of fundamental importance for both assessment of the current state of biocollections and for development of nearest general strategy of their development. Despite the objections raised by "green alarmists" (see section 6.2), the further accumulation of collection materials is absolutely necessary in order to maximize the representativeness of the general collection sample (Peterson et al., 1998; Patterson, 2002; Pyke, Ehrlich, 2010; Feeley, Silman, 2011; Rocha et al., 2014). With this, variety of forms of collection materials should be increased in every way, not only to provide a better correspondence of the biocollection pool to the *BD* structure, but also to prepare it (the pool) to a "post-*BD* era" (Winker, 2004).

For progressive maximizing of correspondence between structures of collection pool and *BD*, it is important to determine correctly priorities in the planning of further developments of collections. Apparently, it is necessary to abandon a traditional "introvert tactics", when acquisition of collection materials depends mostly on particular research interests of curators, in favor of an "extrovert strategy", which presumes focusing on representation of the least studied manifestations of *BD* (Humphrey, 1991).

In particular, in elaboration of a strategy of development of both the whole collection pool and individual collections, a priority should be given obviously to the collecting of new materials on taxonomic groups and biotic complexes, which, according to the expert estimates, are considered “white spots” and “hot spots” of *BD*. Such a strategy can be likened to that which is implied in the planning of networks of the nature reserves: they should be located not where it is possible, but where it is actually needed (Pressey et al., 1993; Myers et al., 2000).

It was said briefly above about the need to collect and store (including museofication) of the materials to carry out molecular genetic studies. In this connections, genetic resources pool deserves special attention, which brings together “live” and “conditionally live” collections, maintained *ex situ* in the zoos, aquariums, gardens, seed storage facilities, etc. (Hutchins et al., 1995; Hohn, 2007; Fowler, 2008; Hassapakis, 2009; Rogers et al., 2009; Молканова и др., 2010; Blackburn, Boettche, 2010; Силаева, 2012; Zimkus, Ford, 2014). This category of biocollections includes, among others, microbiological collections, for which specific organizational forms were elaborated (Colwell, 1976; Malik, Claus, 1987; Smith, 1997; Похиленко и др., 2009; Stackebrandt, 2010; Калакуцкий, Озерская, 2011). Many of these “gene banks” are maintained mainly for commercial purposes, but their role as a potential resource for the study and preservation of *BD* is undoubtedly also great.

It is to be noted especially the value of collection samples that serve as specific representations of the ecosystems as particular fragments of the *BD* structure. I mean so called “ecological” collections: this term was coined into scientific circulation a long ago (e.g. Carpenter, 1936; Mayr, Goodwin, 1956), but now it is apparently forgotten. Such integrated collections (e.g. plankton and benthic catches) are usually being stored in the museums as “raw” materials and are usually disassembled according to the taxonomic allocation of respective specimens. However, their long compact storage as *monitoring* collections (Павлинов, 1990; Spellerberg, 2005; Смирнов и др., 2006) may be quite justified. They allow to monitor (hence their name) temporal dynamics of the structure of local natural communities. Apparently, this category also includes compound samples of so-called “environmental DNA” taken during metagenomic studies of natural microbial communities (Wolfgang, Rolf, 2010).

6. Basic characteristics of research biocollection

Obviously, collections can be described from very different points of view; for example, from scientific (collection as a “tool” of knowledge), museological (collection as an array of museum objects), “material” (what is the form of preparation of these objects) and so on (Шляхтина, 2016). As soon as the main topic of this article is *the correspondence between BD and biocollections*, the latter will be considered basically from this point of view.

Most attention in this section will be paid to the characteristics that define scientific status of collections. Their reasoned selection has quite a profound meaning. On the one hand, they allow to assess correspondence of a particular biocollection to the criteria of scientificity and a possibility to engage it in the solution of exploratory problems related to *BD*. On the other hand, these characteristics express certain parameters of the collection pool in general, which optimizing can contribute to the latter’s development in the desired direction.

Unfortunately, I was not aware of the works, which would explicitly and systematically present the characteristics of research biocollections considered in the way adopted here, viz. as a special kind of research samples. Following the general style of the present article, I shall allow myself not to go into a lengthy discussion of this important issue, but shall simply present my conception based on its preliminary version previously published (Павлинов, 1990, 2008).

The most general integrative characteristics of any collection is obviously its **significance**. It is not the same as the collection *value*: the latter means (to me) something like a general "value judgment", while the significance is more concrete. It can be defined as an ability, on the basis of a research collection, to resolve various tasks concerning basically cognitive and eventually other associated forms of human activity, for which collection is maintained. Obviously, the wider range of tasks a collection allows to resolve, the generally higher is its significance. As far as this article concerns *BR*, the significance of biocollection is determined by its contribution to the development of ideas about *BR*, to the substantiation of principles of its preservation, and so on.

Characteristics of a more particular kind providing in their totality the significance of biocollection, as it is understood here, can be divided, though somewhat arbitrarily, into three main groups, viz. "proper", "external", and "service". Characteristics of first group describe collection as such, of the second group refer to its involvement in the resolving users' tasks, and of the third group refer to ensure the very possibility of such involvement.

It should be noted that the system of characteristics expounded here does not claim to completeness. It is only intended to show, how it is possible to develop this topic of museology, which concerns biocollections as an important material and information resource.

6.1. The "proper" characteristics

This category includes, so to speak, "essential" characteristics of any biocollection that are relevant to the latter proper and determine basically its scientific status.

Apparently, the most important "proper" characteristic of any fragment of the collection pool is its **meaningfulness**. The latter presumes an ability of collection to serve as an aid for resolving certain scientifically meaningful tasks. Collection meaningfulness is obviously determined by its contents, which refers to particular materials contained in it. Specification of this characteristic depends on how collection specimens are basically used—either as a material (not discussed here) or an information resource.

As far as scientific biocollection serves mainly as an information resource, its meaningfulness can be defined as **informativeness**, i.e. both capacity (quantity) and meaning (quality) of the primary information contained in collection. It is clear from this definition that the informativeness (information contents) of a collection increases with rise of its quantitative (number of specimens) and qualitative (diversity of their forms of preparation) parameters (on these, see below).

In evaluating collection informativeness, it is to be kept in mind that, according to one of the possible interpretations of the information, it does not exist "by itself" without a subject who reads and processes information. Taking this into account, collection informativeness should be viewed in two ways. As such, as a manifestation of the own collection "contents" (without users' intervention), informativeness exists in a *potential* form. It turns into a *realizable* form as users exploit collection in order to resolve specific research or other tasks. Obviously, in the first case we are talking about primary information, while in the second case—rather about secondary information.

Acknowledging the primary information contents of biocollections as basically potential is important for understanding that it makes sense to develop them, not only in order to resolve certain current tasks, but also for the future ones. There is a quite significant part of primary information accumulated in the collection pool that can turn into a realizable state only if there is enough capacity of it and/or there is certain demands for it. Thus, the need for the study of intraspecific variation appeared in the middle of the 19th century in connection with the emergence of Darwinian microevolution concept—but understanding of the importance of intraspecific variability could appear only due to gradual accumulation of more and more collection materials that prompted taxonomists and evolutionists to “see” this natural phenomenon and to begin thinking about it (Павлинов, 2011). Another example of how a potential collections informativeness becomes realizable, is the involvement of the “classical” museum materials in molecular genetic studies (see below).

From the point of view of the main theme of the article accentuated at the beginning of this section, of principal importance are two mutually supplementary characteristics of any collection, viz. its reliability and adequacy. Their interrelation is set by the above twofold understanding of collection informativeness—either as its own property or as manifestation of interaction between collection and its users. Both of them are relevant to assessing the representativeness of the collection pool as a general sample (see section 5.2 above).

Reliability of collection describes the latter’s correspondence to *BD* structure. This is a very important characteristic, eventually determining scientific significance of collection as an information source. It depends primarily on accuracy of the data accompanying collection specimens and thus making their information contents “objective” in a sense, i.e. connected to a particular taxon, region, season, and so forth.

Adequacy of collection reflects its correspondence to the tasks concerning exploration of *BD* structure. Thus, the adequacy, by its sense, is not only a “proper” characteristic of collection, but also an “external” one to a certain extent. Considered as “proper” characteristic, the adequacy can be treated as a part of the collection meaningfulness, but there is no strong direct correlation between the two. For example, a collection is maintained in a particular nature reserve as a reference: its meaningfulness is not so high as, say, that of a general-purpose collection in any large scientific center, but its specific “local” adequacy may be higher than the latter’s.

Documenting of collection means that it contains obligatorily, in addition to the natural objects, the above mentioned “objective” information associated with those objects and stored on any sorts of media, from traditional museum labels and registrar journals to electronic databases. It is important to emphasize that the museum documentation, fixing and bearing this information, is the same collection material as the natural objects proper. So it is an integral and inalienable part of the collection, without such documentation the latter can not pretend to be scientific.

Systematicity of collection means that its components are stored in such an orderly manner that provides its safety and usability. In other words, the scientific collection is not a “bunch” of specimens but their integrated (and therefore systemic) array. With this, particular forms of systematization can be sufficiently different, which is determined by motivation of collection creating and maintaining. Research collections, rooted in the age of the Natural System, are arranged before all on the taxonomic basis; *BD* problematics makes collections organization by ecological principle no less important (see above). Systematization of museum collections depends also on a variety of the forms of the stored materials (e.g. “dry” and “wet”) requiring separate placement and curation.

Volume of collection is its universal characteristic determined trivially by amount of the specimens (lots) it contains. Currently, the total amount of the general research biocollection pool by rough estimation ranges from 1.5 to 2.5 billion units stored in about 6.5 thousand museums and herbaria (Duckworth et al., 1993; Mares, 1993; Ariño, 2010). Within this compass, distribution of the collections by their volume, as can be reasonably assumed, corresponds to the Zipf—Mandelbrot rank law: large collections is considerably less than the collections of small volume. As far as is now known, the largest collection is that of National Museum of Natural History in Washington (D.C.): its volume is estimated at 126 million units; however, this estimate includes not only biomaterials (Research…, 2016).

Structure (composition) of collection depends on diversity and specificity of the following: *qualitative composition* (forms of materials being stored), *taxonomic composition* (taxa represented), *geographical structure* (regions represented), and so on. It is clear that the more diverse in all respects are the materials contained in a particular collection, the higher is the latter’s significance and informativeness.

Uniqueness of collection is reasonable to recognize as its particular “proper” characteristic. It is not as obvious as others discussed in this section, since it depends, and not in a “linear” form, on various parameters. On the one hand, the uniqueness is directly proportional to the volume and structural diversity of the materials accumalated in one place. On the other hand, a well compiled small collection that allows to resolve some specific tasks, can reasonably be considered and maintained as “unique”.

Stability of collection means its certain steadiness with respect to impact of certain external factors that can reduce its meaningfulness. This stability, besides an obvious “domestic” sense, has a very serious scientific connotation associated with the above epistemological status of research collection. The matter is that this characteristic is one of the necessary prerequisites of repeatability and verifiability of knowledge extracted from collection. Indeed, the physics and chemistry employ, as the principal verification means, experiments carried out according to standard (steady) protocols. Respectively, in biological disciplines, the same means is provided by long-term storage of collection materials under standard (steady) conditions providing their stability.

Lability of collection is obviously opposite to its stability. With this, it is necessary to distinguish at least two common forms of collection lability, the “negative” and “positive” ones. The first deals with the degradation of collections and is in evident conflict with the requirement of collection stability. The second is related to the development of collection and complements its stability.

In theory, the “negative” lability, associated with violation of the safety of the collection materials, can be regarded as entropy increase in the total collection pool (Simmon, Muñoz-Saba, 2003). It follows from this that certain rate of gradual degradation of any collection is an inevitable consequence of its very existence as a part of the material world. This process is minimized by the complex system of collection storage (see section 6.3 below).

The main reason of the "positive" lability of collection is acquisition of the new materials that increase its volume and expand its qualitative composition (structure), and consequently its meaningfulness. Therefore, any normally developing collection is a growing collection.

"Positive" dynamics of the collection pool is obviously determined by dynamics of the ways of motivation of its very existence. It ensures development of the collection pool in the direction of maximizing correspondence of its own structure to the *BD* structure i.e. maximizing representativeness of that pool as a general research sample (see above). This means that research collections are doomed to evolve following development of those biological disciplines that are based on the studies of collection materials. Changes in researches explorations contents, methodology and technology lead to respective changes in the quires addressed to collections, which in turn lead to as respective changes in the collections themselves. For instance, previously, research collections were maintained basically to allow reconstruction of the Natural Systems by "essential" traits, whilst now the basis of their development is provided by the concept of multidimensional structure of *BD*. An evident illustration of the "positive" lability of biocollections is their modern "molecularization" following "molecularization" of the taxonomy and in part ecology.

The lability of the collection pool, along with the "external" motivation resulted mainly from various scientific requirements, is preset to a certain extent by a kind of "internal" logic of its own development. Being an object of systemic nature, this pool is partly able to evolve "by itself" without any explicit external motives, which leads to increase of the potential informativeness of the collections.

The fact that the "positive" lability of research biocollections does not reject, but rather complements their stability, means that acquisition of new collection materials does not lead at all to elimination of the "old" specimens and the data associated with them. Due to this, such collections, have been developing for long time, resemble something like a "puff cake", in which the old collection materials are combined with the newly acquired, which also become eventually "old" (Cotterill, 1997, Павлинов, 1999, 2008).

Since collections, maintained and accumulated for a long time, allow to resolve a large number of research and research-based applied tasks, it can be argued that there is no anything like "outdated" research collections (Cotterill, 1997; Pettitt, 1997). Moreover, due to the above-mentioned non-renewable status of the collection materials as a specific information bioresource, their scientific significance may increase with time (Cato et al., 2001). On the other hand, certain exploratory tasks concerning *BD* are able to resolve only by analyses of great amount of collection materials, so, generally speaking, there cannot be "too many" of research collections (Laubitz et al., 1983; Павлинов, 2011).

Nevertheless, curators of research collections have to waste a lot of time and energy to defend the need both to preserve existing and to acquire new collection materials (especially of the "classic" type) from adherents of all kinds of innovations, nature conservation "alarmists", as well as from the officials concerned about spending of the finances (Danks, 1991; Chalmers, 1994; Pettitt, 1997; Suarez, Tsutsui, 2004; Geltman, 2012; Roche et al., 2014; Schilthuizen et al., 2015). For this, curators use to list particular illustrative examples of the role that the "old" collections can play in the studies of some aspects of the dynamics of both *BD* in general and particular ecosystems (Thompson et al., 1992; Remsen, 1995; Shaffer et al., 1998; Green, Scharlemann, 2003; Rocque, Winker, 2005; Winker, 2005; Cherry, 2009; Hoeksema et al., 2011; Lister et al., 2011; Rowe et al., 2011). The most recent brilliant demonstration of a "deferred" use of museum collections is the uncovering of a very ancient fantastic animal *Dendrogramma* in a long-termed kept benthic catches (Just et al., 2014.).

Both stability and lability are relevant not only to the total collection pool and particular collections, but also (or before all) to the collection objects themselves. One of the immutable canons of the museum activity is that these objects should be maximally stable, and any forms of using them should be the most sparing. However, this requirement is not strictly applicable to the research biocollections. Firstly, their preparation for subsequent storage (initial museofication) always involves certain manipulations with them, which is nearly always "destructive" (Williams, 1999). Secondly, their use in the explorations may also involve their partial destruction. A typical example is the dissection of genitalia from collection specimens for their species identification in some groups of animals. Partially destroying is also "turning" of the intact collection specimens in another state, viz. into microanatomical or histological preparations, or due to taking tissue samples for analysis of their molecular composition, etc. Therefore, in case of the materials kept in the research biocollections, it might (and should) be reasonable to speak not about their absolute safety, but rather about minimum damage, to which these materials may be subjected during their analysis, and only for very sound scientific reason. In addition, it is highly desirable that the remains of partial destruction should be stored in the museums in the form of specific collection materials (preparations etc.), and the results of such "destructive analyses" should be published as scientifically significant (Danks, 1991; Michalski, 1992; Cato, 1994; Lane, 1996; Nudds, Pettitt, 1997; Metsger, Byers, 1999; Payne, Sorenson, 2003; Suarez, Tsutsui, 2004; Williams, Hawks, 2007).

6.2. «External» characteristics

Characteristics of this category are, in a sense, "secondary" in relation to the "proper" ones considered in the previous Section. They are largely formed under the influence of external circumstances (hence their name), before all due to various queries addressed to biocollections. It is this crucial sense of the latter: they make it possible to realize the above "essential" characteristics and therefore, strictly speaking, are critical to determination and implementing scientific status of the collections.

Resolution of collection is provided by amount of secondary information, which can *potentially* be extracted from it at a particular stage of the development of biological science. This characteristic is obviously dependent on the above meaningfulness, it is associated mostly with an ability of the potential information to be transferred into the realizable state. It largely depends on what kind of queries can be and are actually addressed to biocollections, with these queries changing with the development of biological knowledge, including its theoretical foundations and tools. Accordingly, the resolution of biocollections can increase significantly: for example, many of the "old" dry and wet materials can now be used as a source of DNA.

Usability of collection is defined by the volume of the secondary information, which is *actually* extracted from the collection materials. It depends obviously on the extent to which the collection is really involved in the scientific circulation, which in its turn depends before all on its availability to the researchers guided by respective research agendas and armed with the necessary technical means.

Not a once mentioned above involvement of "classical" museum materials in the molecular genetic studies is a vivid example of this. An ability to extract fragments of the "ancient DNA" from museum specimens has been shown for the first time in the 1980–1990s: first they were representatives of the contemporary organisms and then of the fossils (Paabo, 1989; Golenberg et al., 1991; Herrmann, Hummel, 1994; Thomas, 1994; Bada et al., 1999; Prendini et al., 2002). So was born paleogenomics, or "molecular palaeontology", with "molecular archeology" as its part (Birnbaum et al., 2000; Scheitzer, 2003, 2004; Ariffin et al., 2007; Heintzman et al., 2015). Now the museum and herbarium specimens became a nearly "ordinary" source of such DNA, which is extracted from dried derivatives of animals and plants, frozen and alcohol tissues, fossilized remnants, and eventually formalin-fixed materials (on the latter, see Tang, 2006; Palero et al., 2010). Initial experiments used to give rather short DNA fragments, but subsequently it became technically possible to extract "megasequences" (Poinar et al., 2006). Modern methods, supplemented with the ideology of "barcoding of life", made such kind of study quite routine and widespread (Mulligan, 2005; Ellis, 2008; Knapp, Hofreiter, 2010; Malone, 2010; Särkinen et al., 2012; Bi et al., 2013; Nachman, 2013; Costa, Roberts, 2014; Гарафутдинов и др., 2015; Choi et al., 2015). At last, a particular discipline was born called "museum genomics", "museogenomics" or very briefly "museomics" (Rowe et al., 2011; Guschanski et al., 2013; Волков, 2015).

Currently, using the collection materials for molecular genetic studies makes increasingly urgent for "museomics" elaboration of "spare" methods of taking tissue samples (especially from the type specimens), special forms of fixing museum materials especially for the genetic analysis, as well as correct museofication of such materials (Rohland et al., 2004; Wisely et al., 2004; Martin, 2006; Mandrioli, 2008; Stuart, Fritz, 2008; Rowe et al., 2011; Jackson et al., 2012; Puillandre et al., 2012; Applequist, Campbell, 2014; Tin et al., 2014).

On the other hand, a kind of "feedback" began to work: accumulation of the genetic data on a large number of organisms led to understanding the need for preservation of the so-called *voucher specimens*, which make it possible to check correct taxonomic identification of the sequences placed in the GenBank and other similar resources (Funk et al., 2005; Dubois, Nemésio, 2007; Lee et al., 2007; Rowley et al., 2007; Pleijel et a.l, 2008; Jonas et al., 2013; Collection..., 2015; Federhen, 2015). As it became clear, non-preservation of the museum vouchers, or at least lack of reference to them in the journal publications, makes "the most progressive" molecular science irreproducible (Kageyama, 2003; Wheeler, 2003; Kageyama et al., 2007; Culley 2013; Turney et al., 2015)—and thus, taking the stated above into consideration (see Section 5.1), virtually "non-science".

Usability of collections is in most cases well below their resolution. According to the approximate estimates, no less than half of the collection pool remains unclaimed in the current research on *BD* (Thomson, 2005). It should be emphasized, however, that this does not in any way reduces collection significance, because it contains implicitly a "deferred" usability. As it was indicated above, collection materials are accumulated in the museums in account of the future prospect—that they will be demanded and investigated later.

One obvious key conditions for increasing usage of collections is their inclusion in the global and regional network databases, partly mentioned above (Lane, Edwards, 2007; Walls et al., 2014; see also the following Section).

In consideration of the "external" characteristics of collection, it seems reasonable to include, though putting it somewhat apart, an **ethical** component of the collection activity. "Code of Ethics for Natural History Museums" recently approved by ICOM (ICOM Code..., 2013) clearly indicates this. This characteristic has many aspects, as it implies certain forms of regulation of a) seizure of organisms from nature for their transformation into museum objects, b) ensure necessary standards for storage and use of these objects for scientific and other purposes, c) compliance of certain particular ethical and moral standards in the case of anthropological materials.

Paragraph (a) reflects mainly the anxiety of the "green alarmists" community about negative effect that "supercollection" activity can impact (in terms adopted here) on the structure of natural communities, primarily on abundance of the rare species (Loftin, 1992; Norton et al., 1994; Remsen, 1997; Winker, 1996; Collar, 2000; Donegan, 2008; Winker et al., 2010; Minteer et al., 2014). Paragraph (b) reflects mainly the anxiety of collection curators about due involvement of collection materials into current research and educational processes: an absence of such involvement ("The Miserly Knight" syndrome) means that all expenses for acquisition and storage of collections, not to mention their effects on natural communities, are "wasted" (Павлинов, 1990; American..., 1992; Besterman, 1992; Developing..., 2012; Turner, 2014; Ekosaari et al., 2015). Paragraph (c) is discussed especially actively in connection with the problem of storage and restitution of the materials, if they are claimed to by national, ethnic and religious communities (Sullivan et al., 2000; Verna, 2011; Kakaliouras, 2014; Nichols, 2014).

6.3. The "service" characteristics

This group includes "tertiary" characteristics of the service kind, which together reflect the very possibility to consider any assemblage of the natural history objects as museum (in the broad sense) collection.

Their list is opened with the **museofication**, an integral characteristic, which means that the collection, both as a whole and each item contained in it, a) is suitable for long-term storage in a minimally altered state, and b) this storage is being actually realized. It is an assemble of several principal components discussed below.

The museofication begin with preparation of the natural objects for the long-term storage in accordance with certain standards, which would allow, at the same time, to use them in research projects, also in accordance with certain standards. It is reasonable to assert it that the entire history of the natural history museums is largely a history of the development of methods and standards of museofication. There is a lot of problems associated with the latter, with some of them being resolved anyway with the development of collections, but with the new ones appearing in their place due to the extension of the structure of biocollections. These problems are constantly being discussed in the literature and are exposed in the published guidelines and standards (see present Section below). Thus, one of the most urgent tasks today is museofication of the materials acquired, stored and used for the molecular genetic studies.

Storage system security is one of the key "service" characteristics of any collection, in any way claiming the status of the research one. The reason is quite obvious: it is just the proper storage of collection, including its protection from all sorts of damaging agents, professional curation, developed infrastructure (information retrieval system etc.), etc., that can guarantee both its stability and a possibility of involvement in the solutions of research and other user tasks.

The need for providing assemblages of natural history objects with museofication standards, including system of their preservation and development, is the main cause of emergence of particular kind of collection "concentrators". According to historical tradition and their respective specialization, the latter are called museums, herbaria, zoos, botanical gardens, etc. In recent years, they are referred to, using the modern "bureaucratic newspeak", as biorepositories, biobanks, bioresource centers (e.g. Biocollections…, 2015; Biobank…, 2016; Global…, 2016; Biological…, 2016; NMNH…, 2016; etc.). To be true, these notions usually refer to biocollections of an applied kind in biomedicine, biotechnology and so on. But, apparently, nothing seems to prevent to apply either of this terms in a more general sense and to designate all and any kind of biocollection "concentrators" as biorepositories. Taking into consideration the latter's involvement in the resolution of the tasks, one or another way connected with the *BD* issues, they are sometimes referred to as *Centres* (*Collections*) *of Biodiversity* (e.g. Global…, 2013; ADBC…, 2016; NA3…, 2013).

The most developed system of conservation, for obvious reasons, is inherent primarily in large collection "concentrators" with a long history. Small collections, especially in developing countries, are in this regard the least safe (Carter, Walker, 1999).

Inclusion in metastructure reflects enclosure of collections in the general collection pool, from which depends largely not only their high research and other user status, but sometimes even the very possibility of their existence and due development. By metastructure is here understood a set of organizations and various forms of activity, which one or another way support, coordinate and partly regulate collection activity.

Such a metastructure, viewed globally, is organized largely hierarchically, but with noticeable elements of network and cell interconnections. Its background includes the following major elements:

— international, regional, national, and local professional associations and organizations. The largest of these is the International Council of Museums (ICOM, 2016); for real development of the collection pool far important are more specialized society, among which special mention deserve (in alphabetical order) Association of Systematics Collections (ASC, 2015), Natural Science Collections Alliance (NSC, 2004), Natural Sciences Collections Association (NatSCA, 2016), Network Integrated Biocollections Alliance (Network, 2010); Society for the Preservation of Natural History Collections (SPNHC, 2010); collections of microorganisms cultures joint into World Federation for Culture Collections (WFCC, 2016); "utilitarian" biocollections are merged into Global Biological Resource Centre Network (GBRCN, 2012);

— international projects supporting certain forms of collection activity assigned mainly for the involvement of biocollections into assessments of *BD* and their digitization: Global Biodiversity Information Facility (GBIF, 2016), The World Information Network on Biodiversity (World…, 2008), Distributed Information Network for Biological Collections (SpeciesLink, 2016), Integrated Digitized Biocollections and Advancing Digitization of Biodiversity Collections (ADBC, 2016), Biological Collection Access Service (Biological..., 2016);

— international congresses and conferences dedicated to the collection activity; among them, World Congress on the Preservation and Conservation of Natural History Collections deserves special mention (Palacios et al., 1993; Cannon-Brookes, 1996);

— different forms of training in collection (and museum in general) activity, starting with museology courses at universities and colleges, and ending with schools and seminars on various aspects of that activity; as an example, the annual school of Natural History Collections and Biodiversity can be mentioned (Advanced…, 2015–2016)

— preparation of guidelines on the principles, forms and methods of museum activity, storage of collections, in part in the framework of training courses and in part having an independent status (e.g. Herholdt, 1990; Paine, 1992; Duckworth et al., 1993; Hoagland, 1994; Collins, 1995; Rose et al., 1995; Юренева 2004; Digitisation…, 2008; Сотникова, 2011; Шляхтина, 2016).

— discussion and development of priorities and standards of collection (and museum in general) activity at the international and/or national levels (e.g. Michalski, 1992; Rose, de la Torre, 1992; Cato, 1994; Hoagland, 1994; Metsger, Byers, 1999; Williams, 1999; Cato et al., 2001; Williams, Hawks, 2007; Macdonald, 2011); within the framework of the Russian tradition, of particular importance are all sorts of official directives ("instructions"), especially those that come from government offices (e.g. Единые правила..., 2009);

— international and national periodicals devoted to collection activity, with the most significant among them being Museum Management and Curatorship, Journal of Natural Science Collections, Collection Forum, Curator, Вопросы музеологии.

Cost of collection is also one of its important consumer "tertiary" characteristics. This is before all true for collections of bioresources of applied kind that are involved in the commercial biomedical and biotechnological projects; these are not considered here. The pecuniary value of research biocollections is not very customary to discuss, but even for them it is considered necessary, at least in some cases, to use "monetary equivalent" of their scientific, historical and related values (Cato, Williams, 1993; Doughty, 1993; Price, Fitzgerald, 1996).

The cost characteristics of collection presume those financial and other resource expenses, without which it is impossible any serious collection (and any museum) activity. This means that research collections are really *worth the money*, both themselves and a means of their preservation, development and use, as well as training of professional curators, organization of metastructural network with all its diverse manifestations, etc. The available funds are always not enough, which limits seriously "positive" dynamics of collections and, on the contrary, increases their "negative" dynamics. With this, it is necessary to take into account the important fact that the work of keeping research collections is similar to a continuous production process: it requires constant attention and continuous investment of financial and other resources. All this makes financial and other material support of collections a matter of special attention of collections' curators (Mayr, Goodwin, 1956; Danks, 1991; Allmon, 1994; Nudds, Pettitt, 1997; Dalton, 2003; Bradley et al., 2014; Muzichuk, Haunina, 2015; Shlyakhtina, 2016).

In connection with the last comment, I should like to accentuate the following important fact: there is a noticeable uneasy note presenting in evidently great attention drawn currently to research biocollections.

Appearance of many publications seems to be caused by the need to prove the importance of existence and development of collections to those decision-makers, on which financial and other support the collection pool depends. Some authors write openly about obvious signs of the threatening state of research collections worldwide, including those with a high international reputation (Cotterill, 1997a, 2002; Левановский, 2010; Гельтман, 2012; Gropp, 2013; Funk, 2014; Hammond, 2015; Paknia et al., 2015). It is noteworthy that this concern is expressed also about the prospects of development of an established system of collections of the "secondary" information on the genetic materials, such as GenBank (Strasser, 2008).

All this means that the collection pool, to continue to function effectively as an important bioinformatic resource, needs not only the established current management, but also the constant "propaganda" aimed at demonstrating the necessity of the existence and supporting of biocollections even in the coming "post-biodiversity" era (Winker, 2004).

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