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The State Biology Museum Named after Kliment Arkadyevich Timiryazev as a Scientific and Educational Center

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Abstract

The K.A. Timiryazev State Biology Museum has passed a hundred-year historical path. Its history is largely a reflection of Russia`s biological development in the twentieth century. Therefore, the museum`s main tasks are a complete and holistic view of biology as a science of life in all its manifestations; the dominance of the human worldview, which makes it possible to reveal and generalize the most important ideas in biology; highly scientific standards of excursions and lectures, combined with the maximum clarity of the material presented; conducting experimental research by the museum staff with the participation of visitors; demonstration of the main issues in the most important biology areas; obtaining a broad biological education with a focus on the younger generation. In this regard, the Biology Museum functions as a scientific, educational, artistic, and aesthetic center. It can serve as an example of how closely science, culture, and education issues are intertwined in the museum`s activities.

Keywords: The K.A. Timiryazev state biology museum, Tasks of the museum and their implementation, Science, Culture and education in the museum`s activities

Introduction

The State Biology Museum is named after K.A. Timiryazev (1843-1920), the Russian naturalist, physiologist, physicist, writer, translator, publicist, professor at Moscow University, and founder of the Russian and British scientific schools of plant physiologists. It was opened 100 years ago on April 24, 1922, and on May 7, 1922, for visitors as a teaching museum, which became a scientific and educational center. It occupies three graceful red brick buildings that previously belonged to Pyotr Ivanovich Shchukin, the late 19th century`s outstanding Russian collector, merchant, hereditary honorary citizen, and creator of a private museum of Russian antiquities.

Main Organizational Principles of the Biology Museum

The main organizational principles of the biology museum work were laid down by the first director B.M. Zavadovsky (Zavadovsky, 1927; Zavadovsky, 1948; Chidambaranathan & Culathur, 2022):

1. Opportunity to get the most complete and holistic view of biology as a science of life in all its manifestations with the help of the museum.
2. Dominance of the human worldview, which makes it possible to reveal and generalize the most important ideas in biology.
3. High scientific requirements of the museum-lectern for excursions and lectures in combination with the maximum clarity of the material presented.
4. The museum's exposition focus on the study of organisms` life, and the demonstration of living objects.
5. Conducting experimental research with the participation of visitors in the museum laboratory.
6. Demonstration of the main issues in the most important areas of biology.
7. The purpose of the museum is to provide the younger generation with a broad biological education.

The museum`s expositions demonstrate living beings and plants` evolution and diversity. For the first time, the museum presents such areas of biology as ecology, plant, animal, and human physiology, endocrinology, genetics, and the theory of evolution. The collection of the museum is constantly replenished with rare books, photographs, and works of art.

A special role is played by the ecological and evolutionary departments, organized at the very beginning of the museum`s work. The environmental department impresses one with a wealth of showcases full of live plants, enclosures with animals, and

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aquariums with inhabitants of fresh and marine waters. The evolutionary department`s central exhibit is the flora and fauna evolutionary tree, built and constantly updated based on the latest scientific data.

There is a department of human and animal physiology, supplemented by a laboratory, to demonstrate experimental animals (including fistula dogs operated on according to I.P. Pavlov`s method).

The museum has an exposition on genetics, based on the selection in animal husbandry and crop production, on the origin and evolution of man and life on Earth. It was organized in 1925.

Currently, the Biology Museum has 17 exhibition halls devoted to:
1. Nature and man.
2. World of animals.
3. Plants, fungi, bacteria.
4-5. Mushroom world.
6. Nutrition. Digestion. Metabolism.
7. Blood and circulation.
8. Nervous and endocrine systems.
9. Exhibition "Transparent Science".
10. Plant Life.
11. Exposition "Look sharp" (Dioramas "Rookery", "Mixed Forest", "Sandy Desert", exposition "Dark Room").
12. Fundamentals of evolutionary theory.
13. Origin and formation of man.
14. Exposition "How to Get out into People", showcase "Anthropological Methods".
14. Underwater world in magic balls.
15-16. Expositions "Very Special Monkeys", "From the Monkey in all Directions", "What are Races?".
17. Development of life on Earth (cast of a Deinonychus skeleton, skulls of Iguanodon and Tarbosaurus, Paleozoic).

Structure of the Museum

The first two exhibition halls present the fauna of different parts of the world in their natural habitat: on land and water. Stuffed penguins, owls, turtles, fish, snakes, and birds amaze by their perfection. Particular attention is paid to the life of the gray heron, the most widespread bird species of the pelican order, the heron family. In hall 1 you can get acquainted with the exposition "Bear Corner" and "Pleshcheyevo Lake", demonstrating the living conditions of bears and fish in their natural habitat.

Halls 3, 4, and 5 present the world of plants, fungi, bacteria, algae, moss, and mollusks, their organization, and their development cycle. The exposition " World of Mushrooms" helps not only to understand these organisms` structure but also demonstrates their abilities on the stands "How does Mushroom Work?", "What Size are Mushrooms?", "True Friends", "How do They Eat?", "Can I Eat a Tree?", " What Can be Made from Threads?", “If Mushrooms are Dinosaurs”, “Champion Mushrooms”, “Mushrooms with Us”, “Mushrooms and Non- mushrooms”

In hall 6 the museum collection is focused on the assessment of energy consumption in various animal world activities based on the study of metabolism and energy.

The exposition "Digestion" in hall 6 is fully based on the Nobel laureate I. P. Pavlov`s classic works were performed mainly in "Dog with Fistula" (Pavlov, 1951; AlHussain *et al*., 2022). The experience of sham feeding with a gastric fistula and esophageal transection fully reflects the classical process of digestion in animals and humans, starting from the oral cavity and stomach, and ending with the intestines. Data obtained in I.P. Pavlov's laboratory allowed the development of new methods for assessing digestion and treating gastrointestinal tract diseases. The stand presents data on the central nervous system's influence on the digestive glands' secretion, which revealed the conditioned reflex nature of digestive juices secretion and became the basis for the study of conditioned reflexes in world practice.

In hall 7 there is an exposition “Blood and Blood Circulation”. Its exhibits demonstrate the structure of the animals’ and humans` hearts and acquaint visitors with the problem of its transplantation. Particular attention is paid to the exposition "Blood System-Immunity-Blood Circulation-Hematopoiesis; Cardiovascular System and Pathology". This exposition is system-forming in nature, bringing together all the ideas about the cardiovascular system and its components.

Hall 8 presents the exposition "Nervous and Endocrine systems". Animals' and humans' organism activity is provided by the nervous and endocrine systems. The endocrine system produces hormones that enter the body through the blood and the nervous system regulates the hormone flow ensuring the unity of the body and its connection with the environment (Doan & Tran, 2019; Farah *et al*., 2019; Andrusenko *et al.,* 2020).

The exposition "Brain - Material Basis of Thinking and Consciousness" gives a complete picture of the fact that thinking and consciousness are the human brain`s products. In this regard, the human brain is characterized by a strong development of the parietal, frontal, and temporal regions, which is associated with social and labor activity dominance. Labor and articulate speech were the most important stimuli that influenced the formation of modern man.

The exhibition “Transparent Environment" in hall 9 is of particular interest. Its central place is occupied by the exposition “What is Plant Dressed in?”. So, the plants` clothing consists of integumentary tissue, represented by the epidermis, periderm, and crust. It protects plants from adverse environmental factors. At the same time, a dense arrangement of cells is characteristic of all integumentary tissues.

The expositions "Skin Structure", "Skin Colour, Hair and Nails", "Papillary Lines", and "Joints and Movement" are no less interesting. The human skin consists of three layers: the epidermis, the skin itself or the dermis, and the subcutaneous adipose tissue. The skin color depends on the presence of the coloring matter melanin, as well as on the blood vessels` depth and the stratum corneum`s thickness: the thicker the stratum corneum is, the deeper the blood vessels lie. If the blood vessels are located closer to the skin's surface, it looks pinker. Melanin in the skin protects against ultraviolet radiation from the sun. Without it, the skin would age much faster. In albinos, due to a genetic mutation, melanin is completely absent, and they have fair skin and white hair. Hair is

made up of three layers: cuticle, cortex, and medulla. Nails are horny plates on the finger ends` back surface. They consist of tight-fitting horny scales.

Papillary lines are relief formations on the palmar and plantar surfaces in humans, monkeys, and some other mammals. Papillary pattern structure is strictly individual. It is believed that patterns help to hold smooth objects and give a special sensitivity to touch. There are 3 main types of papillary patterns: arcs, loops, and curls. Arcs occur no more than in 5-10% of cases, loops are found in 60-65%, and curls - in 30%.

The exposition "Plant Life" is located in room 10. Stands dedicated to planting life present materials on the stem structure, movement of substances along it, and characterize shoot diversity. Of certain interest are stands that demonstrate plant roots and types of root systems.

The central place in room 10 is occupied by the stands "Cultivated Plants", "Bread Plants", "Vegetables", "Fruits and Berries", "Sugar-bearing, Protein-containing Oil Plants" and "Spices". The stands provide information that barley and wheat began to grow 12-14 thousand years ago in the Middle East. The man began to cultivate vegetables more than 5 thousand years ago on the territory of modern China and Egypt. The most ancient vegetable crops include cabbage, onions, cucumbers, and pumpkins. Fruit plants were bred at least 5 thousand years ago in Western and Central Asia, Transcaucasia, and China. Pears and apples are among the most ancient fruit trees.

Hall 11 presents the exhibitions "Look sharp" and "Darkroom". They include the stands "Explore Yourself", "Very Dark Room", "Do not Believe your Eyes", " Secret of Animation", "Such Different Eyes", and "Different Environments - Different Opportunities".

Of particular interest is the stand " Secret of Animation", which explains in an accessible form the visual perception of motionless things` movement. So, in 1 second, 24 successive images pass before our eyes, merging into continuous movement. At the same time, a human being and an animal have different speeds of visual reaction: a human being has 24 frames per second, a dog - 70-80, and a dragonfly - 300.

Of no less interest are the stands "How does the Flat Become the Voluminous?", "Whims of Colour and Light". To achieve a stereo effect (three-dimensional image), pairs of images are separated by color (one is red, the other is blue-green) and superimposed on each other with a slight offset.

A light filter is a device that changes the composition of the light passing through it. For example, red absorbs blue, green, and purple while allowing red, orange, and yellow. A green light filter does the opposite: it absorbs red, orange, and yellow while passing green.

Hall 12 presents the exhibition "Fundamentals of Evolutionary Theory" and dioramas "Bird's Rookery", "Mixed Forest" and "Sandy Desert". In this exposition, the most important place belongs to the research and observations of Charles Darwin. His statement that "all traits, both recently acquired and ancient, tend to be inherited" (Darwin, 2001) is admirable.

In hall 13 there is an exposition " Origin and Formation of Man", from the most ancient to the modern one, and the first instruments of labor.

Hall 14 presents the exposition "How to Get out into People." The exhibition reflects all stages of man`s development and his relationship with the animal world. This process is well represented by the “Anthropological Methods” showcase. This hall`s compositions demonstrate the historic reconstruction of personalities. Materials about ancient people`s life, their clothes, and food are valuable. Particular attention should be paid to the showcase, which presents people`s skulls of the entire evolution period, during which the volume of the human cranium and brain gradually increased.

Halls 15 and 16 are occupied by the exhibition "Very Special Monkeys" and "From the Monkey in All Directions." The exposition presents a reconstruction of the human head and skull at all evolution stages. So, sahelanthropus is the first "workplace of man" in nature. He lived 7.2-6.8 million years ago. His remains were found in the Jurab desert in the north of the Republic of Chad (Africa). Sahelanthropus belongs to the human family tree and is its first representative. The remains` analysis showed that Sahelanthropus was already upright. His brain volume reached 360 cubic cm, and the maximum weight - was 49.4 kg. He was an omnivore with the absolute dominance of plant foods. His diet basis was leaves, fruits, seeds, roots, nuts, and insects.

In hall 17 there is an exposition "Development of Life on Earth". It begins with the Paleozoic era known as the era of ancient life, which lasted 287 million years, starting 538.8 ± 0.2 million years ago and ending 251.902 ± 0.024 million years ago (International chronostratigraphic chart v., 2022). The exposition demonstrates a collection of Deinonychus skeleton casts and skulls of Iguanodon and Tarbosaurus.

The museum`s art collection is represented by paintings, sculptures, graphics, and objects of arts and crafts. A variety of evolutionary images of animals and plants, portraits of great scientists, still lives and landscapes make a great impression.

An important role in the activities of the museum is played by the funds “Herbarium”, “Photomaterials”, “Stuffed Animals”, “Invertebrate Skeletons”, “Painting”, “Decorative and Applied Arts”, “Graphics”, “Written Documents”, “Minerals”, “Nests and Masonry” and “Biogroups”.

The museum`s collection "Herbarium" includes 7,113 items. It represents almost all plant classes, most of which are angiosperms. Herbarium also contains herbs collected in foreign countries.

The museum's collection contains 19th-century exsicata (circulation series of herbarium specimens with their name and numbering). These are 350 sheets collected in the 1860s from the exsicata "Petersburg Flora" by K. F. Meinshausen (Meinshausen, 1913–1915). The collection also contains an exsicata "Flora of Germany" from the "Phanerogamen-Herbarium" series, compiled by the botanist Hermann Wagner in 1856 (Wagner, 1856).

The stock collection "Photomaterials" includes various objects of animate and inanimate nature. There are more than 3,200 items in the botanical slide library of exotic plants and flora of the USSR (Kaden, 1964).

The collection “Photomaterials” includes photographs from the series “Motherhood in Animals” by the famous biologist and traveler and international specialist in rare animal species V. V. Klimov (Klimov, 2019). His photographs show wild animals against the backdrop of the natural African landscape. More than 50 color slides were made by the famous oceanographer and specialist in underwater photography V. N. Kasho (Kasho, 1987). Of greatest interest is the part (more than 8,000 items) with photographic materials on the history of biology, physiology, anthropology, Darwinism, the activities of Russian scientists K. A. Timiryazev, I. V. Michurin, I. P. Pavlov, and others in the period from 1920 to 1950.

The 2,884-item stock collection of stuffed animals is dedicated to two classes of vertebrates: mammals (457) and birds (2,427). Its uniqueness lies in the fact that it is based on the most valuable reference collection of the outstanding collector, writer-naturalist E. P. Spangenberg (Spangenberg, 1986). The oldest exhibit is the stuffed female African broadmouth from Madagascar, which was made in 1870. The collection of stuffed birds includes 575 species (271 non-passerine species, 304 passerine ones) and is represented mainly by Russia`s fauna. The museum contains stuffed specimens of 69 bird species belonging to other faunas of the world.

The collection of stuffed mammals includes 93 species of five orders (insectivores, bats, carnivores, hares, rodents) found in Russia (81 species), the former USSR, and in the countries of Southeast Asia (Saeed & Almendeel, 2023).

The stock collection "Invertebrate Skeletons" includes about 12 thousand items: mollusk shells, skeletons of sponges, echinoderms, coelenterates, and crustaceans. Most of the fund is mollusk shells (about 11 thousand items). The majority of them are marine gastropod shells. In the collection of mollusk shells, there are species included in the Red Books of the International Union for Conservation of Nature (IUCN) (Haliotis cracherodi, Ranella olearia, Vertigo angustior, Tridacna gigas, and others) and the Russian Federation (Ceratostoma burnetti, Margaritifera margaritifera, Lanceolaria bogatovi). There are 38 skeletons belonging to classes of ordinary and six-rayed sponges. The coelenterates type numbers 300 specimens and are represented by classes of coral and hydroid polyps from various regions of the world's oceans. The collection of crustaceans includes about 200 items and consists of species collected on the territory of the former USSR. The fund collection "Painting" includes 171 portraits and pieces of animalistic and documentary painting in the style of landscape. Most works` plot is based on animals in their natural habitat. Some of the works are images of plants and landscapes of various natural zones (Fahim *et al*., 2023; Feghhi *et al*., 2023; Nezhadrahim *et al*., 2023; Nurcahyo *et al*., 2023).

The collection "Decorative and Applied Arts" consists of 333 items. It includes vases, decorative plates, folk toys, and applications made of ceramics, glass, porcelain, and faience. Their manufacturing technique is diverse: casting, molding, firing, pottery, glass-blowing, and black-smoke. Zoomorphic painting motifs fully correspond to the subject of the natural science museum Mustarichie and Saptarini (2023).

The Biology Museum`s porcelain collection is represented by products from the largest porcelain factories in Russia and the former USSR. All items are original. Particularly valuable are decorative sculptures and animalistic compositions created by P. M. Kozhin as early as 1930-40.

The museum`s collection "Graphics" has more than 3,567 pieces. It includes the following types of fine artworks: drawings, watercolors, printed engravings, and works of classical and "original" techniques (pencil style - etching - watercolor). Extraordinarily valuable objects of the collection are printed 18th-19th century engravings by famous masters of foreign and Russian schools. The works of Japanese and Chinese graphic artists of the 19th-20th century are made in a special style. Of the greatest practical interest are animalistic genre works, landscapes, and plot compositions of domestic artists - A.N. Komarova, L. V. Khinshtein, V. A. Vatagin, V. A. Gorbatov, I. P. Makoveeva, and other masters of graphics.

The stock collection "Minerals" has 270 items. It contains not only common but also rare samples of ores, and ornamental and jewelry stones. The collection includes minerals of the silicate class, such as staurolite (olivine group), noble talc (amphiboles` group), amazonite (feldspar group), asbestos (serpentine group), dioptase, tourmaline, and beryl. Valuable specimens of minerals are tourmaline and dioptase used as jewelry material. Beryl is also used as the main source of beryllium whose variety (emerald) is a class 1 jewelry stone (El-Sokkary, 2023).

The oxide class is represented in the collection by about thirty varieties of minerals belonging to the quartz group (amethyst, rock crystal, and milky quartz) used in jewelry.

The sulfide class is represented by the 10 most important industrial minerals since the vast majority of non-ferrous metal ores belong to this class. The collection contains samples of such sulfides as antimonite (a source of industrial antimony production), pyrite (raw material for sulfuric acid production), cleophane (the basis of zinc ore and a source of rare metals such as cadmium, indium, and germanium) and cinnabar.

The collection also includes minerals of carbonate classes (malachite, calcite, azurite), sulfates (gypsum), phosphates (vivianite and turquoise), halides (fluorite, rock salt), and chromates (red lead ore). The class of native substances is represented by various sulfur and amber samples.

The basis of the stock collection "Nests and clutches" consists of more than 1,000 items, represented by a collection of bird clutches with nests or their fragments, as well as separate clutches or nests without clutches. It contains nests and clutches of 23 out of 27 orders of modern birds. The most numerous modern orders of birds are most widely represented: passerines (691 objects), shorebirds (152), chickens (70), lamellar-billed (46), stork-like (39), predatory (38), crane-like (34). Of particular scientific and expositional interest is the demonstration of nest parasitism, when

common cuckoo eggs are found in small passerine birds` clutches. In addition, the collection includes mammal nests (baby mice and common squirrels) and reptile eggs. This collection also includes species listed in the Red Books: in the International Red Book (a nest with a clutch of a small lark, an egg of a black crane, an egg of a Caucasian black grouse) and the Red Book of Russia (a stilt, an avocet, a greave, a small tern, a small lark).

In addition to a large species diversity, the collection allows you to get acquainted with the geographical variability of nests and eggs of the same species collected in different parts of the range. Depending on the habitat, the eggs` color and the nesting material`s composition may change. Of particular interest are the nests that birds built using anthropogenic materials: paper, polyethylene, wire, and synthetic and natural fibers. There are also teratological exhibits in the collection in the form of a set of "Deformities of a Chicken Egg".

The stock collection "Biogroups" includes 95 biogroups. Most of it (81) consists of stuffed mammals and birds. In addition to them, the collection includes biogroups of reptiles, amphibians, insects, and mollusks. The biogroups reproduce the animals` appearance, taking into account their biology and behavior. The collection presents the biogroup "Emperor Penguin Incubating an Egg". Feeding links between animals are demonstrated by the biogroup "Black Vulture on a Fallen Baby Goat" (Tikhanova, 1968).

Thanks to the employees` diligence, and their close interaction with government organizations and private collectors there is a constant increase in stock collections. This made it possible for the museum to hold several exhibitions a year, regardless of the season. The most popular was the annual exhibition - a competition of aquarium fish belonging to the museum researcher M.N. Ilyin (Ilyin, 1968).

The centers "Man and Nature" and "Room of Discoveries" are constantly working in the Biology Museum. They are the first interactive biology expositions in Russia. In these centers, visitors can touch various things with their hands, examine small natural objects under a microscope and perform specially designed tasks.

The promotion of scientific knowledge and the development of moral principles in the relationship between man and nature is the main task of the Biology Museum, which functions as a scientific, educational, artistic, and aesthetic center (Twelve signs of the living, 2022). In recent years, in addition to various excursions and lectures, a lot of new things have appeared for visitors. This is the weekend program « Family at the Museum», which includes the biological game «Family Maze».

Conclusion

The museum exposition is constantly changing. A new hall "Development of the Earth`s Organic World " has been opened, recreating ancient landscapes, flora, and fauna of the distant past. Projects of new interesting expositions are being carried out. They fully reflect the modern world`s scientific potential and artistic component. The K.A. Timiryazev State Biology Museum has passed a long historical way of over 100 years. Its history, to a large extent, is a reflection of the entire path of domestic biology development in the twentieth century. It can serve as an example of how closely the issues of science, culture, and education are connected, which finds expression in the activities of the State Biology Museum.

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