

Zoology of Azerbaijan - yesterday and today

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The article presents information on the study of the species diversity of various animal groups in Azerbaijan, from protozoans to mammals. Main publications on each studied group and the great contributions of Azerbaijani zoologists to the study of the fauna and general species diversity of Caucasus are emphasized.

Keywords: *Fauna, species diversity, Azerbaijan, investigation*

INTRODUCTION

When we are talking about the study of the animal kingdom, we often experience that not only non-specialists but also many biologists confuse concepts such as fauna, and more fashionable in recent years species diversity. The term fauna is used to define the community of animals living in a certain territory. The concept of fauna includes both systematic and geographical content. Consequently, fauna is a historically formed community of animal species living in a certain territory. It is known that the fauna of any territory consists of different faunistic complexes, which combine species with similar habitats. The term species diversity is broader and as an indicator reflects not only qualitative, i.e. species composition of the biocenosis, but also quantitative relationships between species. The more species diversity of biocenosis and the more highly branched food chains, the more sustainable the ecosystem. Because different species can substitute each other in food chains.

Overall, scientists (Zhang, 2013) have described just over 1.6 million animal species (including more than 133 thousand fossil species), most of which are arthropods (more than 1.3 million species, 78%), mollusks (more than 118 thousand species) and vertebrates (more than 42 thousand species) According to the projections, considering the still extremely poor study of many

animal groups in most regions of the globe, the total number of animal species is estimated at 5-30 million, and some experts cite figures of up to 80 million or more. Although the International Union for Conservation of Nature officially records the extinction of only 777 species as a result of human activity, some experts believe that this estimate is true for only 5% of known species. According to the latest data from 2022 in the journal *Biological Reviews*, between 150,000 and 260,000 animal species have become extinct over the past 5 centuries. Apparently, there is a big spread in quantitative estimates. It is clear that our knowledge today is still extremely poor and to talk about sufficient study of the animal world, especially about representatives of most groups of invertebrates is completely wrong. All of the above is also true for the fauna of the Caucasus. The South Caucasus region has always been interesting for researchers since ancient times, as the whole region of the Caucasus is considered one of the centers of speciation on the Earth. Naturalists and travelers have been interested in the wildlife of Azerbaijan since ancient times. Listing of various animal species, as well as their descriptions, can be found in the works of ancient Greek, Roman and Arabic scientists. However, all this is not zoology yet, but only the initial accumulation of information about animals.

Zoology, which studies animals, is one of the classical biological sciences. Its founder, as well as a number of other sciences, is considered to be

Aristotle, the great scientist and thinker of Ancient Greece (4th century BC). He first systematized accumulated knowledge about animals and divided all known species into two groups - animals with blood and animals without blood. The first group included vertebrates, the second – invertebrates. Later, K.Linnaeus (1735) was the first to offer classification of all living organisms based on binomial nomenclature, which is still used by biologists all over the world.

The first fragmentary information about the animal kingdom of Azerbaijan, mainly amphibians and reptiles, is found in the works of the German traveler, professor of botany at the University of St. Petersburg S.Gmelin (1744-1774). Some of his scientific works were published after his death processed by Pallas (1741-1811), a famous German scientist and encyclopedist who worked in Russia. The first truly scientific observations of birds and mammals appeared in the zoological works of G.Radde (1884, 1899) He was the founder and director of the Caucasian Natural History Museum (Tiflis), for which he personally gathered a large collection of faunistic material. Radde played a major role in the further development of zoological research in Azerbaijan.

At a later time, towards the beginning of the 20th century and after the establishment of the Soviet government in Azerbaijan, new researchers, prominent Russian and Soviet scientists, such as N.Y.Dinnik, K.A.Satunin, B.S.Vinogradov, O.A.Grimm, A.N.Derzhavin, N.K.Vereshchagin and others appeared. This period of development of zoology, scientific achievements and contribution of scientists to the study of the Azerbaijan fauna are covered in detail in the works of Azerbaijani scientists R.D.Jafarov (1948,1949), monographs of A.G.Kasimov (1965,1972), S.M.Asadov (1960), M.A.Musayev, A.M.Veysov (1965), Kh.M.Alekperov (1966), Y.A.Abdurahmanov, and A.M.Alekperov (1978). These scientists themselves also did a lot for the development of zoology in Azerbaijan and trained a number of highly qualified national personnel.

During the years of independence of Azerbaijan, the collective of scientists of the Institute of Zoology conducted fundamental research on the biodiversity of the most diverse groups of the fauna of the republic.

The protistologists of the institute conducted

extensive research on the species composition of single-celled parasites - coccidia, their life cycles, cytochemistry and biochemical aspects of the relationship between the parasite and the host. As a result of their research, 250 species of protozoan parasites were found, belonging to the genera *Leishmania*, *Trypanosoma*, *Eimeria*, *Isospora*, *Cryptosporidium*, etc. More than 80 species of coccidia were described for the first time new to science. In most regions of Azerbaijan, *Eimeria*, *Sarcosporidia*, *Cryptosporidium* parasitizing wild animals and birds, their species composition, host specificity were studied, and the routes of invasion were identified. The results of fundamental research were proposed for implementation in production for the diagnosis and prevention of eimeriosis in domestic animals and birds in agriculture.

Investigations on free-living protozoa in Azerbaijan began in the 60-70s of the XX century, but with the use of required modern cytological methods only since the 80s of the last century. For the first time in science, 1 genus and 40 species of ciliates were found in the Caspian Sea (Agamaliev, 1983), but subsequent studies of sea and freshwaters, as well as the soils of Azerbaijan, showed that the species diversity of free-living protozoa inhabiting them is incomparably greater. During the years of Azerbaijan's independence, for the first time, 3 families, 12 genera and more than 130 species of free-living ciliates new to science have been described for the first time (Alekperov, 2005, 2012).

Intensive study of another ecologically important group of free-living protozoa - testate amoebae has also begun. In recent years, 2 families, 7 genera and 70 species of testate amoebae have been found and described for the first time new to science in the fresh waters of Azerbaijan. The summarized results of the research on free-living ciliates and testate amoebae were published in English and Russian as the first cadastre in Azerbaijan, which provides data on 757 species of ciliates and 265 species of testate amoebae for the fauna of the republic (Alekperov et al., 2017).

It is known that free-living protozoa, especially ciliates, play an important role in nature in the self-purification of marine and fresh water bodies. Feeding on large quantities of bacteria,

including pathogenic species, ciliates contribute to the rapid self-purification of marine and fresh waters. In addition, ciliates quickly respond to the slightest changes in the environment. The developed method of bioindication of the degree of environmental pollution using free-living ciliates is based on this feature of protozoans (Alekperov, 2023) At present, this modified method allows biotesting the degree of organic pollution of sea and fresh waters, as well as soils of Azerbaijan. In addition, biotesting through ciliates makes it possible to use them to assess the toxicity of pollution with oil, a number of heavy metals and some insecticides simultaneously at the cellular-organismal and population levels. Azerbaijani parasitologists have found more than 400 species of helminths in the fish in different fresh water bodies of the republic, of which 2 genera and 25 species were described as new to science for the first time (Mikailov, 1975).

In all major water bodies of Azerbaijan, including the Caspian Sea, the species composition of fish parasites was studied, investigations of the fauna, ecology and zoogeography were carried out, the morphology, systematics and biology of the main parasites of aquatic animals were studied (Ibrahimov, 2012). A comprehensive study of the infection of freshwater mollusks, which are intermediate hosts of trematodes was conducted, and based on a study of the morphology of the cercaria stage, a number of new species of trematodes were described (Manafov, 2010) Azerbaijani helminthologists have carried out large-scale research in the Kura-Aras lowland, Sheki-Zagatala and Absheron-Gobustan zones of Azerbaijan, where the species diversity of pathogens causing fascioliasis, dicrocelliosis, protostrongylosis, echinococcosis, haemonchosis and binostomosis was studied in farm animals (Sadikhov, 1962; Feyzullaev, 1971; Fataliyev, 1975). The helminths' fauna of game birds has been studied (Vaidova, 1978), and the role of stray cats and dogs in the spread of helminths has been investigated (Ibrahimova, 2021). More than 400 species of plant-parasitic nematodes have been found, 95 of which are considered to cause serious damage to horticulture.

Together with veterinary specialists, a zoning of the distribution of helminthiasis was carried out, a distribution map was compiled, and 25 practical

recommendations were proposed for implementation in farms.

Hydrobiologists of our institute made a great contribution to the study of the fauna and species diversity of hydrobionts (zooplankton, zoobenthos, periphyton) of the sea and fresh waters of Azerbaijan. A number of the most important fresh water bodies of the republic were studied, including reservoirs, that were created at a later time, and reservoirs of Absheron and Guba-Khachmaz region, which made it possible to identify several species new to the fauna of the Caucasus and Azerbaijan (Kasimov, 1972) Much attention was also paid to the Caspian Sea research, as a result of which the hydrofauna and ecology of the Azerbaijan sector of the Caspian Sea were studied comprehensively. The Caspian plankton has been studied in detail (Kasimov, 2004). It is known that the most numerous and characteristic group of the animals with a large species diversity is arthropods. According to estimates of various experts, there are more than 1.5 million species of insects in the world. In Azerbaijan, research on various groups of arthropods has been carried out for a long time. Over the years of the existence of the Institute of Zoology, Azerbaijani scientists have made a huge contribution to world zoology. At present, thanks to many years of research by Azerbaijani scientists, about 25 thousand species of insects and 1100 species of arachnids have been identified in the fauna of Azerbaijan.

In Azerbaijan, the first studies of ticks - carriers of piroplasmiasis of productive livestock were conducted in 1930-1935 of the last century. However, systematic research of the fauna, biology, ecology and economic importance of the broad class of arachnids began only after the formation of the Institute of Zoology. The aim was to study the fauna of separated groups of arachnids in Azerbaijan and identify patterns of their distribution in various natural and climatic zones of the republic. The research primarily covered ixodid ticks. The first large-scale arachnological research in Azerbaijan was carried out by A.Hajiyev (1983) on the study of ixodid and gamasid ticks, covering all ecological groups of gamasids living on plants, parasites of rodents, insectivores, bats, reptiles, and birds. In total, the fauna of gamasid mites of Azerbaijan identified by Hajiyev is represented by 152 species of 15

families, of which 8 species were noted for the first time new to the fauna of the USSR. The faunal complex of gamasid mites, the distribution of ticks in landscape-ecological zones were also identified, the relationships of gamasids with habitats were analyzed, etc. One of the important directions of parasitological research is the identification and study of ectoparasite complexes of separated groups of animals. On the initiative of Hajiyev, a series of studies were carried out to study the ectoparasite complexes of separated groups of animals, thanks to which the patterns of formation of the ectoparasitic fauna of various groups of animals were traced. The results of the research were widely implemented in the national economy, including measures to protect the population from parasitic arthropods. The complex of ectoparasites of bats in Azerbaijan was studied by T. Dubovchenko (1968). It was revealed that bats are parasitized by 90 species of ectoparasites (various groups of ticks and insects) 4 species of red mites were described as new to science, and 6 species of mites were noted for the first time for the fauna of the USSR and 30 species of ectoparasites for the fauna of Azerbaijan.

In Azerbaijan, the first studies of ticks that carry piroplasmiasis in farm animals are associated with the name of N. Abusalimov (1963). He established the species composition of ixodid ticks parasitizing on farm animals, as well as the role of different species as carriers of these described diseases. Along with studying the fauna and bioecology of ixodid ticks, in subsequent years he studied the fauna and biology of argasid ticks of Azerbaijan, including 10 species from 3 genera. In the mid-60s of the last century, intensive study of the fauna of beneficial phytoseiid mites began. E. Abbasova (1972) studied predatory phytoseiid mites, natural enemies of numerous plant pests. It was established that the fauna of phytoseiids of Azerbaijan includes 56 species, of which 12 species were described as new to science, and 51 species were described for the first time for the fauna of Azerbaijan. Tetranychid mites were studied by V. Zapletina, Z. Musayeva, O. Aslanov, S. Khalilova, L. Mehtiyeva. About 100 species of tetranychid mites are known in Azerbaijan, many of which are serious pests of agricultural crops. The fauna of tetranychid mites of the Lesser Caucasus within Azerbaijan is represented by 50

species, of which 1 species is described as new to science, 20 species as new to the fauna of the republic. The fauna of acariphages of the studied region includes 47 species, of which 1 species is described as new to science, 14 are new to the fauna of the Caucasus, 13 are new to Azerbaijan fauna. Azerbaijani acarologists also studied the predatory mites Prostigmata (Aslanov, Musayeva, 2001) As a result of their research, 94 species from 16 families were identified, of which 4 families, 18 genera and 44 species were identified as new to the fauna of the Caucasus, 6 families, 23 genera and 29 species are new to the fauna of Azerbaijan.

Systematic and complete study of spiders of Azerbaijan was started by P. Dunin (1984, 1992) in the last century. He recorded a total of 457 species for the local fauna, of which 26 species and 2 genera were described for the first time new to science. Further studies of the spider fauna of Azerbaijan, as well as their biology, were carried out by the young researcher E. Huseynov, who unfortunately died untimely (Huseynov et al., 2005; Huseynov, 2014). He described 1 genus and 25 species new to science. Summarizing the data of these authors, we can assume that the spider fauna of Azerbaijan currently includes about 700 species belonging to 268 genera and 43 families. However, this is not a complete list of the species diversity of this huge group of Azerbaijan fauna. At present, young specialists - T. Nuruyeva and Sh. Khasayeva - are successfully studying spiders. Recently, T. Nuruyeva (Nuruyeva and Huseynov, 2021; Nuruyeva et al., 2024) has described 4 species new to science, and 19 species new to fauna of the Caucasus.

N. Snegovaya conducts a systematic, long-term study of the order Opiliones, both in Azerbaijan and internationally, in collaboration with colleagues from other countries. She described 6 genera and more than 50 new species of opiliones new to science from the regions of the Caucasus, Kazakhstan and Middle Asia, Turkey, Africa and other regions (Snegovaya, 2010, 2014). The first studies of the fauna of the most ancient order of arachnids, scorpions of Azerbaijan, were carried out by E. Yusubov (1984). He studied the distribution areas of 3 known scorpion species in the republic, identified geographic populations of the mottled scorpion, revealed their useful role in biocenoses as active predators, and studied the

development and reproduction of scorpions. The current state of scorpions and solifuges in Azerbaijan is studied in detail by N.Novruzov (2023). He summarized the information on the fauna, taxonomy, morphology and distribution of scorpions and solifuges in the South Caucasus. Pseudoscorpions, a small order of arachnids in species composition were studied in Azerbaijan by S. Dashdamirov (Dashdamirov, 1988, 1991). According to his research, the fauna of pseudoscorpions in the Caucasus includes 52 species, of which 24 species were described by him for the first time new to science.

A.Bogachev, one of the first researchers and organizers of works on entomology, made a great contribution to the development of native entomology. The chapter on entomology in the book "The Fauna of Azerbaijan" (1951), edited by Bogachev, which provides information on many groups of insects in the country at that time and at present, is of great importance.

The development of Azerbaijani entomology is inextricably linked with the scientific activities of Corresponding Member of the Academy of Sciences of Azerbaijan N.Samedov. He made a huge contribution to the development of such fields of zoology as general entomology, soil zoology, biocenology and plant protection.

Since the 60s of the last century, research has been conducted on the study of soil insects and other invertebrates. Collembola or springtails were studied within the framework of the soil research program by Z.Rasulova (1980, 1982). More than 180 species of collembola were identified in Azerbaijan, of which 8 species were described for the first time for the fauna of the USSR, 15 species - for the fauna of the Caucasus, and 11 species - for science.

Since 2013, systematic research has been conducted by N.Snegovaya (Snegovaya, 2023), to study the faunal composition of dragonflies in Azerbaijan. 70 species of dragonflies belonging to 10 families were found, and the total number of species, including literary data and collection materials, is 72 species, of which 22 species are noted for the first time for the fauna of Azerbaijan. The order Hemiptera or true bugs is widely distributed in Azerbaijan and has about 1000 species. The order was studied by D.Hidayatov (1982), I.Drapolyuk (1982), A.Atakishiyeva

(1988).

It is known that butterflies are an extremely numerous groups of insects with complete metamorphosis, that are diverse in size, color and lifestyle. According to the number of known species, butterflies are second after the beetles. In Azerbaijan, the total number of lepidopteran species is no less than 4,500 belonging to 82 families. The noctuid moth family has been studied for a long time by academician S.Aliyev in Azerbaijan, rich in the species (2016). He found 716 species of moths, studied their distribution in different regions of the republic, food relationships, identified pests of agricultural plants, and against a serious cotton pest, an integrated method of biological control was proposed and implemented. As higher butterflies papilionoids were systematically studied over a long period of time by Effendi R., the result of his research was the identification of a species composition that included 457 species, of which 213 belong to the papilionoids, and 2 species new to science were described (Effendi, 1971). Z.Mamedov (2004) studied harmful lepidopterans that damage fruit crops in Azerbaijan and identified their parasites. As a result of long-term research, he identified 74 species of lepidopterans – pests of fruit plants, of which 16 species were noted for the first time in the fauna of Azerbaijan. The systematic study of bees in Azerbaijan was first started by Kh.Aliyev. During the period of research, he studied the fauna and ecology of bees in the republic. In general, 642 species of bees were recorded by him, of which 316 species were noted for the first time in the fauna of the republic and 154 for the first time in the Caucasus; the distribution of bees in landscapes and natural areas was studied (Aliyev, 2010). Bees of the Halictidae family are one of the numerous and species-rich families. According to the research of G.Huseynzade (2001), the family includes 126 species from 13 genera, of which 57 species were recorded for the first time in the fauna of Azerbaijan. Trophic relationships and phenology within this family were studied for the first time. A systematic study of ground beetles (Carabidae), as well as different representatives of this family that are harmful to agricultural crops, was conducted by Corresponding Member of the ANAS N.Samedov. He studied harmful ground beetles of the genus *Zabrus* in Azerbaijan, and in

his book (1954), 295 species of ground beetles are indicated for the Azerbaijan fauna, a list and description of 14 species of ground beetles that are harmful to agricultural crops are provided. Apart from ground beetles, N.Samedov (1963) also actively studied another family of beetles – longhorn beetles. In total, he recorded 204 species for the fauna of Azerbaijan. The study of leaf beetles was conducted by N.Mirzoyeva (1988). For the fauna of Azerbaijan, she identified 400 species of beetles, of which 1 species was described as new to science, 133 new to the fauna of Azerbaijan.

Diptera occupy an important place among the numerous orders of the insect class of the number of species and the diversity of their representatives. In Azerbaijan, the number of dipteran species is more than 2000. This group was studied by Sh.Jafarov (Jafarov, 1962), G.Nagiyev (Nagiyev, 1962), G.Trofimov (Trofimov, 1971) and other researchers.

In 1971, the Laboratory of Ecology and Physiology of Insects was established. The laboratory staff carried out a large number of experimental works. B. Ahmadov studied the ecological regulation of seasonal cycles of aphids that harm cotton, created optimal conditions for development and reproduction, thermal thresholds and photoperiodism of cotton aphids and alfalfa aphids.

Research in the field of insect biochemistry, the results of which are important in assessing the physiological state of the insect organism, and in the development of effective measures to combat pests of agricultural crops, was carried out for many years by H.Guliyeva. Her research on the ecology, physiology and biochemical characteristics of various life stages of pests of agricultural plants helped to increase the effectiveness of biological methods.

The Braconidae family was studied by A.Abdirbekova (1975). According to her results, the fauna of Braconidae in Azerbaijan includes 523 species belonging to 88 genera, of which 38 species were described for the first time for science, more than 150 new ones for the fauna of Azerbaijan. The distribution patterns of Braconidae by natural-climatic regions of the republic, their relationships with hosts and flowering vegetation were established. Recently, a modern study of antlions (Myrmeleontidae) of

Azerbaijan, including the use of molecular biology methods was carried out by I.Kerimova. As a result of her research, the fauna of these insects currently includes 60 species (Kerimova, 2019, Kerimova, Krivokhatsky, 2018). E.Huseynova is studying the fauna, ecology and economic importance of jewel beetles (Buprestidae) (Huseynova, 2013). Much attention at the Institute of Zoology has always been paid to the study of entomophages and the theoretical foundations of biomethods of plant protection, the objectives of which were to identify the species composition of entomophages (predators and parasites), study their biological and ecological characteristics, the degree of their infestation by various host-pests, identify the most effective species that play a significant role in reducing the number of major agricultural pests, as well as develop methods for mass reproduction and their implementation in production.

All long-term research of A.Aliyev (1983) was completely devoted to the study of the possibilities of using various species of entomophagous as biocontrol agents against agricultural pests. Since the 60s of the last century, he has been studying beneficial insects and conducting a fundamental study of the fauna and taxonomy of parasitic ichneumonids. As a result of these studies, 600 species of 165 genera of ichneumonids were identified, their distribution was determined, and 2 species were described as new to science. The main scientific direction of L.Rzayeva's research (1986) was the study of Chalcididae - a group of insects that play an important role in reducing the number of agricultural pests. The species composition of Chalcididae was identified, including 472 species, of which 150 species were presented for the first time for the fauna of the Caucasus. G.A.Mustafayeva (2020) was the first who comprehensively studied Coccoidea and Coccidae insects. As a result of her research, 33 species of Coccoidea insects belonging to 21 genera and 19 species of Coccidae insects belonging to 9 genera were identified, of which 11 and 8 species are new to Azerbaijan fauna, respectively.

As can be seen from our brief review of taxonomic and faunistic works, Azerbaijani zoologists have made a significant contribution to the study of animal diversity not only in the republic but also in other regions of the globe. At

present, it is urgently necessary to conduct a revision of the fauna of various groups of the animal kingdom, to assemble all known fragmentary data on various taxa, taking into account the modern requirements of their taxonomy. It is necessary to create cadastres for each group of the animal kingdom of Azerbaijan. The first step in this huge work is the compilation of checklists, based on the summation of all previously known publications, museum materials and own modern results. Recently, much work has been done by N.Snegovaya on compiling checklists for different groups of insects, such as butterflies (Lepidoptera, Rhopalocera) (Snegovaya, Petrov, 2019), sphinx moths (Sphingidae) (Snegovaya, Petrov, 2021), crane flies (Diptera, Tipuloidea) (Snegovaya, 2021), ants (Formicidae) (Snegovaya, Shigayev, 2022), orthopterans (Orthoptera) (Snegovaya, Kerimova, 2022), water beetles (Coleoptera: Adephaga, Polyphaga) (Snegovaya, Shirinova, 2022), noctuids (Lepidoptera: Erebidae, Nolidae, Euteliidae, Noctuidae) (Snegovaya, Matov, 2024), geometrid moths (Geometridae) (Snegovaya, 2024). Work on creating checklists is ongoing.

Ichthyological research in Azerbaijan has been conducted since the beginning of the 20th century. Among these works, "Sevruga: a biological essay" (1922) and "Reproduction of sturgeon stocks" (1947) should be noted, which laid the foundation for ichthyological research in Azerbaijan. Later, Y. Abdurakhmanov developed and increased them, having studied the species diversity, ecological characteristics and reproduction biology of fish in Azerbaijan. The results of these studies were summarized in his monographs "Fishes of Azerbaijan" (1955) and "Freshwater Fishes of Azerbaijan" (1962). More recent data on ichthyological research in Azerbaijan are presented in the publications of H.Abbasov "Biology of juveniles of the main commercial fish species (perch, carp) of Azerbaijan" (1972) and Z.Kuliyev "Fishes of the Greater and Lesser Gyzyllaghaj Bays of the Caspian Sea" (1989). The latest ichthyological research was conducted by N.Mustafayev (Mustafayev, 2024a, 2024b).

Based on the research of Azerbaijani herpetologists, the modern fauna of Azerbaijan includes 63 species of reptiles and 12 species of

amphibians. (Jafarov, 1949; Aliyev, 1974; Akhmedov et al., 2015). In addition, new habitats of lizard species listed in the Red Book of Azerbaijan - the *Trapelus ruderatus* and *Phrynocephalus persicus* were found for the first time in the Lerik region. The current range of another species of lizard, also listed in the Red Book of Azerbaijan, *Phrynocephalus horvathi*, has been clarified, and new habitats of the rare southern crested newt have been identified. Important results obtained by herpetologists include the first discovery of the species *Vipera lotievi* (Iskenderov et al., 2017), and lizards of the genus *Podarcis* for the fauna of Azerbaijan (Oskeyrko, Iskenderov et al., 2022). Azerbaijani ornithologists have made a significant contribution to the study of the bird fauna of the republic. Among them, the works of such scientists as Gambarov (1941), Tuayev (2000), Khanmammadov (1971), Mustafayev (1993), Patrikeev (2004) should be noted. The latest major reports on the birds of Azerbaijan include the recently published abroad collective work "European Breeding Birds Atlas 2" (Sultanov et al., 2020), which also includes a section on birds from Azerbaijan fauna. A number of endemic species, such as the Caucasian grouse and Caucasian snowcock, which are on the brink of extinction, are protected by the government. The status of 45 other rare and endangered bird species has been clarified (Karimov, 2021). Data on 25 species of birds of the avifauna of Azerbaijan have been prepared and transferred for inclusion in the list of species protected by CITES. Due to the threat of bird flu, on behalf of the Ministry of Ecology and Natural Resources, ornithologists of the Institute of Zoology have identified and mapped the main places of accumulation of waterfowl in the republic (Babayev, 1990, 1991).

During the years of Azerbaijan's independence, mammalogists of the Institute of Zoology have identified 115 species of mammals, including 13 species of insectivores and 33 species of bats. Based on long-term observations, 42 species from different groups were included in the Red Book of Azerbaijan. Bioecological studies were conducted on various groups of mammals of the fauna of Azerbaijan and their results were published in the monograph "Mammals of South-Western Azerbaijan" (Alekperov, 1966).

The results of many years of research by I.Rahmatulina (2005) were published in her fundamental monograph "Bats of Azerbaijan", which provides an up-to-date overview of the fauna of this group, including rare and endangered species, their ecology and zoogeography. In 2006-2010, theriologists developed a plan for the reintroduction of goitered gazelles in Azerbaijan. In this work, areas were selected in the lowland and foothill regions of Azerbaijan for population with goitered gazelles caught in the Shirvan zone (Kuliyev, 2018) The program of reintroduction of goitered gazelles presented to the Ministry of Ecology and Natural Resources with the financial support of the Heydar Aliyev Foundation and the World Wildlife Fund was successfully implemented. The modern fauna of the Nakhchivan Autonomous Republic is successfully studied by the staff of the Institute of Bioresources (Talibov, 1999; Talibov et al., 2016; Talibov, 2021).

Currently, 1,500 species of parasitic and free-living protozoa, about 1,200 species of parasitic worms, including 400 species of phytohelminths, 290 rotifers, 360 species of crustaceans, about 25 thousand insects, 1,100 arachnids, more than 180 species of mollusks, 101 species of fish, 11 species of amphibians, 54 species of reptiles, 365 species of birds and 113 species of mammals have been identified in the fauna of Azerbaijan.

The successes of zoologists during the years of Azerbaijan's independence are reflected in the number of scientific descriptions of animal species new to science. For example, over the last 30 years, 210 species of parasitic and free-living protozoa, 60 species of helminths, 46 ticks, 17 species of pseudoscorpions, more than 50 species of spiders and 60 harvestmen, 121 species of insects and 2 species of amphipods have been described. Most of these descriptions have already been included in international catalogues and are recognized by reputable specialists in different countries.

Over the years of independence, international cooperation with scientists from Western Europe and the United States has developed particularly well. During this time, scientists from the Institute of Zoology have received more than 25 grants from various international funds to conduct joint scientific research with colleagues from the United

States, France, Finland, Germany, the Czech Republic, Poland, Bulgaria and Turkey. Some of this scientific research continues today. An indicator of the high professionalism of Azerbaijani zoologists is their participation and membership in international organizations. For example, Doctor of Biological Sciences N.Snegovaya is a member of the American Society of Arachnologists. A number of scientists from the Institute of Zoology are members of the editorial board of some foreign journals or experts in international programs (I.Alekperov, N.Snegovaya, I.Kerimova, Sh.Ibrahimov, T.Kerimov, etc.).

During the period of national independence of Azerbaijan, the staff of the Institute of Zoology made a great contribution not only to the development of fundamental zoology but also actively participated in the implementation of the Presidential State Programs, including the 2004-2015 program of socio-economic development of the regions of the republic, employment strategy, support for entrepreneurship, sustainable provision of the population with food products, sustainable development, food security and conservation of biodiversity. Based on the scientific work carried out at the institute, the results of the following studies were presented for implementation:

1. Study of the biodiversity of water bodies of Azerbaijan.
2. Ensuring sustainable development of biological resources.
3. Organization of aquaculture in the Caspian.
4. Creation of river and lake fish farms.
5. Creation of a system of measures for biological control of insect pests of agricultural crops using local and acclimatized entomophages.
6. Development of methods of controlling protozoal and helminthic diseases of farm animals and their implementation in practice.

For each government decree, the institute proposed 6 proposals for implementation. In addition, at present, information on more than 500 species of animals of the Azerbaijan fauna has been prepared for posting on the website of the institute, which after its opening is very popular not only among domestic and foreign scientists but also among the population of Azerbaijan. Together with the Ministry of Ecology and Natural Resources of

Azerbaijan, the National Academy of Sciences, being the first executor, participated in the preparation of the 2nd and 3rd editions of the "Red Book" of Azerbaijan, in which the section on the fauna, including information on 213 species of animals, was completely prepared by the colleagues of the Institute of Zoology.

The zoomuseum operating at the Institute of Zoology successfully advanced during the period of independence of Azerbaijan. Currently, the Zoological Museum is the national scientific demonstration fund of the Republic, which has collected about 2,000 exhibits of stuffed animals and skeletons: 270 species of vertebrate animals and 625 exhibits of arthropods belonging to 400 species.

About 5 thousand local and foreign guests visit the museum every year. The employees of the museum, along with the work directly related to the activities of the museum, participate in the research of the Institute of Zoology, conducting morphological, taxonomic and ecological studies of various groups of animals.

In addition to the exhibits displayed in the museum expositions, each laboratory of the Institute of Zoology has its own collection, which preserves total preparations, including holotypes and paratypes, more than 600 species of parasitic and free-living protozoa, 1400 species of helminth parasites of humans, animals and plants, about 10 thousand exhibits of 3109 species of aquatic invertebrates, about 100 thousand exhibits of 20,000 species of arthropods, 145 preserved specimens of 43 species of fish, 305 exhibits of 13 species of amphibians, 968 exhibits of 40 species of reptiles, 15,000 stuffed animals and skeletons of 582 species of birds, about 12,200 stuffed animals and skeletons of 84 species of mammals.

Besides representatives of the local fauna, the collection fund of the Institute of Zoology also has exhibits of animals from many countries of the world, obtained as a result of scientific exchange or collected on the initiative by employees of the Institute of Zoology during scientific visits abroad.

It should be noted that the international relationship of our scientists, which has increased during the period of Azerbaijan's independence, contributes to the increase and constant updating of the collection materials of the Institute of Zoology. Rich collection materials reflect the enormous

biodiversity and genetic fund of the Azerbaijan fauna.

The Institute's long-term plan includes such challenges as studying the biodiversity of the animal kingdom, especially, poorly studied groups of animals; clarifying the taxonomy of some genera and species; studying the biology and ecology of economically important, rare and endangered species; developing technology for breeding and reintroducing useful animals; clarifying parasite-host relationships, intraspecific variability using biochemical and molecular genetic methods; studying the influence of increasing anthropogenic factors on the distribution, number and behavior of animals in various natural complexes.

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