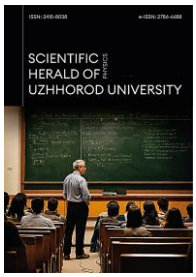
Scientific Herald of Uzhhorod University
Series "Physics"
Journal homepage: https://physics.uz.ua/en
Issue 56, 1444–1453
Received: 14.11.2023. Revised: 12.04.2024. Accepted: 30.05.2024



DOI: 10.54919/physics/56.2024.144jp4

Development of an educational and methodological system of an electronic databank based on the cadastre of animals of the Trans-Ili Alatau (Heteroptera, Pentatomorpha)

Laula Baibol*
Abai Kazakh National Pedagogical University
050010, 13 Dostyk Ave., Almaty, Republic of Kazakhstan

Murat Zhaksybayev
Abai Kazakh National Pedagogical University
050010, 13 Dostyk Ave., Almaty, Republic of Kazakhstan

Perizat Esenbekova
Institute of Zoology of the Republic of Kazakhstan
050060, 93 Al-Farabi Ave., Almaty, Republic of Kazakhstan

Zina Tungishbayeva
Abai Kazakh National Pedagogical University
050010, 13 Dostyk Ave., Almaty, Republic of Kazakhstan

Kumis Batyrova
Abai Kazakh National Pedagogical University
050010, 13 Dostyk Ave., Almaty, Republic of Kazakhstan

Abstract

Relevance. The relevance of the study lies in the widespread use of digital information storage systems in the practice of various modern organisations and related to the need to create an educational and methodological base to ensure the effective functioning of such systems.

Purpose. The purpose of the study is a systematic investigation of the general principles of the development of the educational and methodological base of the electronic databank, the basis of which is the cadastre of animals of the Trans-Ili Alatau (Heteroptera, Pentatomorpha).

Methodology. The methodological approach in this study is based on theoretical and applied research on a wide range of issues related to the development of electronic databank systems based on the cadastre of fauna representatives.

Results. The findings indicate the presence of numerous advantages of the development of an educational and methodological system of an electronic databank based on the cadastre of animals. This kind of system allows saving information on animal species living within a given habitat and receiving it for scientific research. In addition, an effective assessment of the current state of populations of the most significant species of Heteroptera and Pentatomorpha, and a retrospective analysis of the dynamics of changes in the population of species and the long-term forecasting of the development of animal populations for a sufficiently long time become available.

Suggested Citation:
Baibol L, Zhaksybayev M, Esenbekova P, Tungishbayeva Z, Batyrova K. Development of an educational and methodological system of an electronic databank based on the cadastre of animals of the Trans-Ili Alatau (Heteroptera, Pentatomorpha). *Sci Herald Uzhhorod Univ Ser Phys.* 2024;(56):1444-1453. DOI: 10.54919/physics/56.2024.144jp4

*Corresponding author

Conclusions. The study concludes that developing an educational and methodological system of an electronic databank based on the cadastre of animals of the Trans-Ili Alatau provides significant advantages. This system enables the preservation and retrieval of information on local animal species, facilitating scientific research and effective assessment of species populations. Moreover, it allows for retrospective analysis and long-term forecasting of population dynamics, offering valuable insights for conservation efforts.

Keywords: information storage; electronic databases; e-learning methods; local fauna; census of wildlife; nature conservation.

Introduction

The electronic bank of educational and methodological materials is developed in electronic form and is a user access system. The development of an educational and methodological system of an electronic bank based on the cadastre of animals of the Trans-Ili Alatau is necessary to ensure effective access to information.

It includes data on genus and species names of animals of this geographical region, their description, information about their distribution in this region and across the territory of Kazakhstan as a whole, Also, it includes indication of habitats, numbers, ecological and biological features.

The geographical region of the development of such an educational and methodological system is the Trans-Ili Alatau, a mountain range in the north-western part of the Tien Shan. It locates on the border of Kyrgyzstan and Kazakhstan. Scientific inventories of the animal world began to be created by the Institute of Zoology of the Republic of Kazakhstan (RK) since 2010.

However, the list of the most important aspects, such as the development of an electronic database convenient for practical use and updating with fresh data, the assessment of the actual number and dynamics of its change. Moreover, mapping information, zoning of the territory by habitat, modern information on taxonomy have not been fully considered.

In the 2010s, with the support of the United Nations Development Programme office in Kazakhstan, an information system for monitoring the country's biodiversity was created. It does not meet the current requirements for maintaining a wildlife cadastre.

In addition, over the past 10-15 years, there have been large-scale changes in the taxonomy and taxonomy of animals, which should be reflected in the modern cadastre [1]. All this necessitated the search for optimal solutions for the development of an educational and methodological system of an electronic bank based on the cadastre of animals of the Trans-Ili Alatau.

M.Zh. Suleimenov et al. [2] conducted a joint scientific study of the spread of sheep parasites in the Trans-Ili Alatau and noted that the Almaty Region occupies one of the first places in Kazakhstan in terms of the number of sheep. According to researchers, a significant share in the country's economy of products obtained from sheep breeding necessitates the introduction of special measures to combat parasites, which include the introduction of electronic bank systems based on the cadastre of animals.

P.A. Esenbekova et al. [3] in a joint scientific study examined a number of problematic aspects of assessing the degree of biological diversity of the Heteroptera of the city of Almaty and south-eastern Kazakhstan. According to researchers, hemipteran insects are of great importance in nature, which necessitates a clear classification of their species. This is facilitated by the inclusion of all varieties in a special cadastre to ensure their effective tracking.

For its part, S.N. Litvinchuk et al. [4] jointly examined the features of differentiation between different species of animals living in a number of Central Asian countries and in Kazakhstan in particular. A significant degree of distribution of the reptiles under study (green toads) in a number of Asian regions and in the south of Kazakhstan, among other things, makes it necessary to analyse their morphological characteristics with data entry in a special cadastre.

O. Berkinbay et al. [5] conducted a joint scientific study of the general principles of forming a cadastral assessment of parasites common in the Northern Tien Shan region. According to researchers, in the Northern Tien Shan, the qualitative composition of parasites is determined by the localisation of animal grazing sites, which implies the need to systematise information using special methods of forming an electronic data bank.

N.S. Maikanov et al. [6] discuss the features of the spread of epidemiologically dangerous insects in the western regions of the Republic of Kazakhstan. According to the researchers, the use of special animal inventories is necessary to track the natural infection of certain species of blood-sucking pathogens of bacterial, rickettsial, and viral aetiology.

The main purpose of this study is to investigate the characteristic features of the educational and methodological system of the electronic bank. This bank is based on the cadastre of animals of the Trans-Ili Alatau (Heteroptera, Pentatomorpha).

Materials and Methods

The methodological approach in this study was based on a theoretical and applied study of the general principles of the development of an educational and methodological system of an electronic bank. It based on the cadastre of animals of particular species.

The scientific base of the study was made up by analysing the results of scientific research of modern authors, aimed at investigating a wide range of problematic aspects of creating systems of electronic databank, using information affecting various problematic issues of preserving the population of wildlife individuals. The theoretical basis was made up of the data that were obtained during the study.

The methodological approach adopted in this study, combining theoretical research methods with applied ones, assumed the formulation of the task of investigating the key aspects of creating an electronic bank system based on the cadastre of animals, with a view to its subsequent use for educational and methodological purposes.

This determined that information on the generic and species names of animals placed in the cadastre, their

geographical distribution and habitat on the territory of the Republic of Kazakhstan, ecological and biological features, total number, and the status of individual species must be placed in the electronic bank.

The data obtained in the course of the study were presented in the corresponding tables. In addition, the application of this methodological approach allowed obtaining information about the core of the animal database of the Trans-Ili Alatau.

It includes data on genera and species of animals included in the cadastre, geographical areas and regions of their distribution. This facilitated the systematisation of the information and allowed presenting it sequentially, which is of key importance when creating an electronic data bank for subsequent study [7].

The use of a combination of methods of theoretical assessment of the prospects for the development of an educational and methodological base based on the cadastre of animals with the method of synthesis of the information obtained established the key importance of the problem under study.

This includes the development of a scientific, educational, and methodological database of the cadastre of animals of the Republic of Kazakhstan, and ensuring timely access to information stored in this database by various educational structures. It provided data on the value of the electronic cadastre as a variety of electronically presented databases of animals distributed on the territory of the Trans-Ili Alatau and in regions of other countries [8].

The use of the method of synthesis of information obtained in the course of theoretical research determined the main stages of the development of the educational and methodological base of the electronic bank system based on the cadastre of animals.

This study allowed assessing the importance of the development of the educational and methodological base of the electronic bank. It based on the cadastre of animals of the Trans-Ili Alatau (Heteroptera, Pentatomorpha) in the conservation of biological diversity of species and the possibilities of their study for scientific and practical purposes. And also, to determine the tasks that the data bank of animal species should solve in its practical use.

Results

Nowadays, the problem of not only the development of a scientific, educational, and methodological database of the cadastre of animals of the country, but also ensuring timely access to it by public organisations and individual citizens is extremely relevant in the Republic of Kazakhstan. Previously compiled and available maps of the habitats of representatives of local fauna, presented in various printed publications, do not allow forming a holistic view of the reliability of information regarding the distribution and behaviour of certain species of the animal world of Kazakhstan.

It is very important that the information database on biological diversity should actually display all the variety of dynamic and continuous operations and actions for obtaining, processing and practical application of information on the biological diversity of animal species. In a similar way, an electronic cadastre is a wide variety of information databases, applications, and services that are necessary to solve problems related to the storage, maintenance, and exchange of data on the biological diversity of animal species [1; 9].

Table 1 presents the data of the Trans-Ili Alatau animal inventory (Heteroptera, Pentatomorpha).

Table 1. Data from the Trans-Ili Alatau animal inventory (Heteroptera, Pentatomorpha)

Genus name of the species (species name)	Species Description	Distribution of the species on the territory of the Republic of Kazakhstan	Species habitat	Ecological and biological features of the species	Status of the species
Acalypta (gracilis)	The middle field of the elytrum is narrow and long, in the form of a groove. Relatively large and of the same size everywhere (2.3-2.6 mm)	In steppe, forest-steppe zones, more or less dry places, high-altitude steppes warmed by the sun	Among detritus, on mosses, on herbaceous plants: Ajuga, Potentilla, Hieracium, Thymus, Sedum	Herpeto-hortobiont, mesophyll; mycetophage; monovoltine; imago and larvae overwinter	
Agramma (confusum)	The bottom and head are black, the top is yellow, the pronotum is entirely or partly blue-black	In the steppe along the banks of reservoirs, on damp meadows, in high-altitude steppes, on a subalpine meadow, (800-2000 m)	On juncaceous: Juncus and sedges: Carex, Blysmus, Eriophorum	Hortobiont, mesophyll, broad oligophytophagus, monovoltine; imago overwinter	
Catoplatus (citrinus)	Flat, oblong-oval, ochreous-yellow	Mountains and foothills, rarely sub-mountain plains	On compound plants	Hortobiont; meso-xerophile; broad oligophytophagus; monovoltine; imago overwinter	
Tingis (pilosa)	Side edges of the elytrum in front of centre with 2 rows of nodes. Body length is 3.5-4 mm	In the steppe, forest-steppe, the most diverse mesophytic biotopes: floodplain, low-mountain meadows	On various plants, more often on lipiferous: Phlomis tuberosa, Lamium album, Galeopsis bifida	Hortobiont; mesophyll; polyphytophagus; 2-3 generations per year; imago overwinter	

		800-1300 m, sparse forests, parks, gardens and other areas			
Himacerus (maracandicus)	More often short-winged. Brownish	On high-grass meadows and in thickets of shrubs in the mountains at altitudes from 400 to 3000 m above sea level.	It stays on tall herbaceous plants, especially umbrella plants, on the soil, sometimes on bushes	Horto-tamnobiont; mesophile; zoophage; monovoltine; overwintering imago	A useful species, it feeds on flies, aphids, bedbugs and their larvae
Himacerus (apterus)	Brownish, legs and whiskers are yellow, with brown spots and rings; the anterior corners of the segments are yellow; the anterior and posterior margins of the pronotum are dirty-ochre, 9.5-12 mm	Mountain forest, rises in subalpine meadows	In deciduous, coniferous-deciduous and pine forests, parks, gardens, floodplain tree and shrub thickets		A useful species, it feeds on mites and small insects with soft shells
Nabis (nigrovittatus tianshanicus)	Small sizes, (usually reaching 12 mm)	In mountainous areas	On various herbaceous plants	Hortobiont; mesophile; zoophage; monovoltine; overwintering eggs	A useful species, it feeds on various insects: aphids, flies, horseflies, eggs and bug larvae
Nabis (brevis)	The length of the pedicle is equal to 1/2 the length of the elytrum. Usually shortened. The colour is greyish, yellowish, or brownish. Anterior femoral segments on the outer side with transverse, dark brown lines, usually merging into a continuous brownish-black spot. Edeagus with 1 hook, 5.5-6.7 mm	In mesophytic areas: meadows near springs, penetrating far into the depths of the steppe and semi-desert zones), rise into the mountains to a height of 3600 m	Lives in grass meadows, mainly on cereals	Hortobiont; eurytopic mesophile; zoophage; monovoltine; overwintering imago	A useful species, widely omnivorous
Nabis (ferus)	The elytrum is always full, distinctly longer than the abdomen, densely evenly and very shortly pubescent Posterolateral margin of corium with more than 45, usually 60-70 hairs	In the forest zone, mainly along the shores of seas, rivers, lakes and springs, in the mountains up to a height of 2500 m	On various herbaceous plants	Hortobiont; eurytopic mesophile; zoophage; monovoltine; overwintering imago	A useful, widely polyphagous species, feeding on flies, aphids, cicadas, bedbugs and other insects, is the most useful species of hemipteran insects
Acompocoris (alpinus)	The elytrum is dark brown or black. Whiskers are black, the 2nd segment of them is sometimes dark brown in the middle, the 3rd and 4th segments are of the same length, 3.3-3.6 mm	In the forest zone, mostly in the mountains, rises up to 1200 m above sea level.	On coniferous trees: Abies, Picea. Larix, Pinus	Dendrobiont; mesophile; zoophage; monovoltine; overwintering imago	A useful species, mainly feeds on aphids
Anthocoris (flavipes)	Abdomen is longated-oval. The body is black. The elytrum ranges from whitish to brown, the membrane has a dark pattern	In the mountains at an altitude of 1800-3000 m	On shrubs and large herbaceous plants	Dendro-hortobiont; mesophyll; zoophage; monovoltinny; overwintering imago	A useful species, it feeds on mites and small insects with soft shells
Anthocoris (nemorum)	The pronotum is entirely black, 3.5-4.3 mm	Mountain forests, alpine and subalpine meadows, up to 1000-3000 m above sea level, found in gardens	On various herbaceous, shrubby and woody plants	Dendro-hortobiont; mesophile; zoophage; 2-3 generations per year; overwintering imago	Plays an important role in regulating the number of pests of apple trees, a wide polyphage, feeds on aphids, mites, worms, thrips, eggs and caterpillars
Orius (vicinus)	Small, oval, shiny, black or dark brown	At different stations, from deserts to highlands up to 2000 m or more	On flowers and leaves of various herbaceous plants, shrubs, trees	Tamno-hortobiont; mesophile; zoophage; bivoltine; overwintering imago	A useful species, a wide polyphagous, mainly feeds on shield beetles and other small insects

Orius (niger)	On the anterior and posterior margins of the pronotum, there is a protruding bristle, almost as long as the width of the eye, 1.5-2 mm	In floodplains of rivers, along forest edges, on slopes	On deciduous, fruit trees, shrubs and mainly on herbaceous plants: wormwood, cereals	Dendro-hortobiont; mesophile; zoophage; 3-5 generations per year; overwintering imago	A useful species, it feeds on various insects, mainly aphids, thrips, psyllas, spider mites and their larvae, eggs
Deraeocoris (punctulatus)	The sensitive tubercle of the left paramere is almost square on the side, covered with long hairs, the pituitary gland with an almost straight apex	In the steppe, on the low-mountain and subalpine meadows and in the apple forest, at an altitude of 800-2300 m	On herbaceous plants: Rumex, Artemisia, many agricultural crops; marked on trees: Salix, Betula, Populus, Ulmus, Fraxinus	Hortobiont; zoophytophagus; mesophile; 2-3 generations per year; overwintering imago	A useful species, it feeds on small insects: aphids, thrips. The predator is an entomophagus, unable to develop on a purely plant-based diet, needs animal food
Agnocoris (rubicundus)	Left paramere with a short pituitary gland and a weakly protruding sensitive tubercle, 4.7-5.4 mm	Mixed forest, in floodplains, in mountains 800-2300 m	On deciduous, fruit trees and shrubs, more often on willow	Dendrobiont; mesophyll; polyphophage; monovoltine; overwintering imago	It feeds on the seeds of Salix, Acer. It is listed among the pests of fruit crops
Brachycoleus (decolor)	Yellow or green, with a longitudinal, black pattern of oblique stripes, sometimes almost without a pattern. The cuneus and embolium are monochrome, not blackened at the top. Top in a light gun, 6.5-9.1 mm	Steppe, low-mountain meadow 800-1400 m, apple, birch-poplar forest and other various mesophytic biotopes	On various herbaceous plants: alfalfa, wheat, corn	Hortobiont; mesophyll; polyphytophagus; monovoltine; overwintering eggs	It feeds on generative organs of plants

Source: compiled by the authors.

Table 2 shows the core of the main database of the educational and methodological system.

Table 2. Core of the main database

Genus	Species	Lat	Long	Part	Region	District
Eremias	Velox	44.5264	80.6666	South East Kazakhstan	Almaty	Aksu
Eremias	Velox	48.3358	82.66547	South East Kazakhstan	Almaty	Ili
Sterna	Hirundo	52.0044	80.66654	South East Kazakhstan	Almaty	Balkhash

Source: compiled by the authors.

With regard to the inventory of animals of the Trans-Ili Alatau (Heteroptera, Pentatomorpha), it should be noted that the species presented have a similar geographical distribution on the territory of the Republic of Kazakhstan and in other countries. In addition, the presented species have a number of common ecological and biological features, such as hortobiont, mesophyll, broad oligophytophagus, monovoltine, dendrobiont. The inventory of animal species contains data on their habitats and population size.

The presented data are necessary to ensure the required occupancy of the electronic banking system according to the relevant user requests. An electronic data bank based on the cadastre of animals is necessary to solve problems:

1. Preserve information about animal species, their descriptions, characteristics of species and their distribution.
2. Preserve the genetic diversity of animal species of a certain geographical region.
3. Provide access to information stored in the data bank.
4. Ensure the possibility of studying the information stored in the electronic data bank for scientific and educational purposes.
5. Ensure the possibility of making changes to the electronic data bank from anywhere in the system.

Figure 1 shows the key stages of the development of the educational and methodological base of the electronic bank system based on the cadastre of animals.

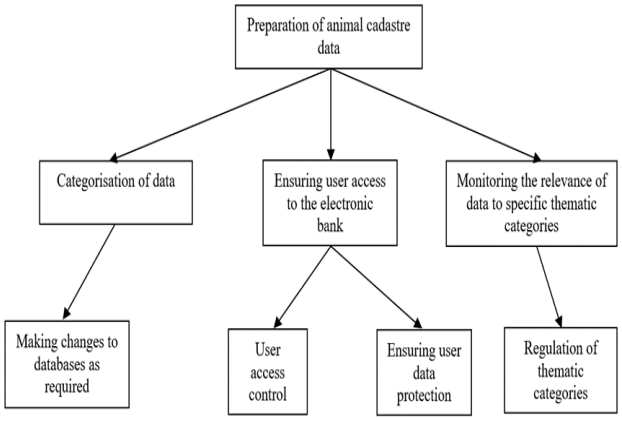


Figure 1. The main stages of the development of the educational and methodological base of the electronic bank system based on the cadastre of animals

Source: compiled by the authors.

When changing data on animal species included in the cadastre, their habitat, population size and other parameters that are important from the standpoint of species description, all changes that take place must be made in a timely manner. This is necessary for the objective display of the data of the educational and methodological system.

It includes information about the species of animals included in the cadastre. In general, the educational and methodological system of the electronic bank based on the cadastre of animals of the Trans-Ili Alatau (Heteroptera, Pentatomorpha) provides [1]:

1. Preservation of data on fossil and economically important animal species in order to integrate them into other systems of this kind.
2. Assessment of the actual composition of the fauna, the current state of populations of endemic, rare and endangered species of animals and the dynamics of changes in the fauna of the Trans-Ili Alatau at the present time.
3. Taxonomic assessment of the fauna of the Trans-Ili Alatau, which can be used in geology in the development of stratigraphic schemes.
4. Assessment of the economic and economic potential of the landscape and fossil fauna of the specified geographical region.
5. An assessment of the current state of populations of the most important species of Heteroptera, Pentatomorpha, a retrospective analysis of the dynamics of various changes, as well as a forecast of the development of these populations for the next few decades.
6. Development of recommendations and a set of measures for the conservation, reproduction and sustainable use of the wildlife of the Trans-Ili Alatau as a biological resource.

Thus, the development of an educational and methodological system of an electronic bank based on the cadastre of animals of the Trans-Ili Alatau (Heteroptera, Pentatomorpha) provides a solution to a wide range of tasks for preserving information about species populations and providing opportunities to study any data modifications related to these populations.

The preparation of animal cadastre data for the subsequent development of an electronic bank system involves the consistent collection of information on the species characteristics of animals, the nature of their distribution on the territory of Kazakhstan and in a number of other countries. And also, their total number and specific biological characteristics of species.

In addition, in this context, geographical indicators of latitude and longitude of the habitat of each specific species, the distribution of specific animal species in the territories of regions of the Republic of Kazakhstan should be taken into account. High-quality preparation of the information base of the cadastre of animals ensures their subsequent effective distribution into the appropriate categories of the electronic data bank, with the organisation of user access to the stored information on appropriate requests.

In turn, the distribution of the data of the information base of the cadastre of animals by the corresponding categories of the electronic bank is necessary for the qualitative systematisation of the stored information, as well as the organisation of user access. It is necessary to prepare for the timely implementation of a set of measures to make changes to the database of the electronic bank developed on the basis of the inventory of animals, if there is a need to add information about already introduced animal species or to enter data on new species [10].

Organising user access to the information contained in the electronic databank is necessary for the comprehensive educational process, during which this kind of information can be used. In addition, providing users with access to the electronic databank system provides an opportunity to obtain objective data on the actual state of the population of species of specified geographical regions, and the nature of their distribution. It can be effectively used in the future to prepare a methodological base for scientific research in specific areas.

Monitoring the degree of compliance of the stored data with specific thematic categories is necessary to ensure high standards of accuracy and reliability of the information contained in the electronic data bank. Control of this kind involves tracking all incoming information and eliminating data that may not correspond to the actual state of affairs in the distribution of animal species. In this context, the level of conformity of the animal inventory data that were initially provided for placement in the electronic bank, and the quality of making changes to the stored information, is essential [11].

Making changes to the electronic bank databases may be relevant when obtaining additional information regarding changes in the number of animal species, the addition of new species living in a particular geographical region, changes in their ecological and biological characteristics. In such cases, all changes made should be monitored and monitored in a timely manner in order to maintain a high level of objectivity and reliability of the information stored in the educational and methodological systems of the electronic data bank formed on the basis of the cadastre of animals.

The control of user access to the electronic banking system based on the inventory of animals is necessary to ensure the elimination of technical problems that may potentially arise when receiving information from this system. The control involves providing technical support to users of the system in the presence of various kinds of problems with obtaining data.

Such problems include: difficulties logging in, difficulties searching for data by thematic categories, problems identifying system data by specific thematic categories. The control of user access to the electronic banking system involves the creation of round-the-clock support for users, in order to ensure the possibility of practical resolution of all emerging issues.

Ensuring the protection of data of users of the electronic banking system involves the preservation of information and personal data of users of the system and its non-proliferation. This is necessary in order to prevent third parties from obtaining user data for their personal purposes. Regulation of the thematic categories of the electronic banking system based on the inventory of animals is necessary when adding new or additional sections to the system, as well as when making changes to already stored information.

An electronic bank based on an animal cadastre provides an opportunity to obtain any information about

animal species, changes in their numbers and habitat in the dynamics of ongoing changes. The development of an educational and methodological system of an electronic bank based on the cadastre of animals provides an opportunity to obtain any information regarding changes in the species composition of animals of the Trans-Ili Alatau and their numbers. In addition, through the practical application of this kind of system effectively solves the problem of tracking the actual state of the fauna of a given geographical region, as well as obtaining the necessary information for scientific research in this direction.

Discussion

Á.B. Collins et al. [12] conducted a joint scientific study of the prevalence of parasites in milk on dairy farms of cattle and the related need to create a data accounting system. According to researchers, parasites that cause tuberculosis in cattle should be systematised, which implies the need to compile an electronic database based on the inventory of this parasite genus.

Researchers conclude that the compilation of an electronic database of research in the field of the influence of parasites on the condition of cattle will contribute to the development of optimal measures to combat them. The researchers' conclusions correspond to the results that were obtained during the performance of this scientific work, since they emphasise the importance of forming electronic databank systems in ensuring the preservation of information for its subsequent use in solving a wide range of issues.

K. Choeychuen et al. [13] conducted a joint study of the general principles of the development of an educational and methodological system of an electronic bank for monitoring the state of visual objects. The researchers note that the use of such systems allows objectively setting tasks for tracking the behaviour of objects on any scale and under any initial conditions.

It opens up significant prospects for the development of electronic databases based on the cadastre of animals of any species and groups. The researchers emphasise the importance of using electronic data bank systems when tracking the behaviour of objects of various scales and functional orientation.

The raised topic is being developed by a research group consisting of G. Rößling and T. Vellaramkalayil [14], in a study aimed at investigating the general principles of creating electronic databases based on computer models containing information of various kinds. According to the researchers, the development of an educational and methodological system of an electronic bank on the basis of any statistical data presupposes a high quality of their preservation for subsequent application to solve various tasks.

The type of information that is stored in the system is of secondary importance. The opinion of researchers is fully confirmed by the results of this study, since it focuses on the quality of data preservation in the development of an electronic banking system as a key category in this context.

B.H.E. Tang et al. [15] considered a number of problematic aspects of ensuring the accounting and preservation of the database of pathogens of dangerous diseases – microorganisms and animals. According to researchers, the preservation of information in electronic form regarding the types of pathogens of various diseases and their distribution areas contributes to ensuring a high level of its protection, which in the future allows finding effective countermeasures.

The researchers concluded that the development of an educational and methodological system of an electronic bank based on the inventory of animals ensures the preservation of information about the species causing specific diseases, which allows choosing effective measures to counter their spread. The conclusions of the researchers are fully confirmed by the results of this study, since they emphasise the importance of preserving information about specific animal species in the development of the educational electronic bank.

The raised topic was further developed in the joint research by I.W. Yerbanga et al. [16], aimed at investigating the general principles of creating electronic databases based on the inventory of animals that are carriers of invasive aspergillosis in Africa. Researchers note that every year over 300 thousand people are infected with this disease worldwide, while the total number of fatal cases reaches 80%.

According to researchers, the introduction of electronic banking systems into the healthcare system based on the cadastre of animals that are pathogens of dangerous diseases is necessary for more effective tracking of the nature of the course of diseases and measures to combat them. The opinion of the researchers is confirmed by the results of this study, since it emphasises the importance of developing electronic banking systems for storing data on the causative agents of a number of diseases, as well as their impact on others.

J. Späth et al. [17] investigated changes in the profiles of metabolites caused by growth and metamorphosis in the pathogenesis of the northern dragonfly and found that the creation of databases in electronic form. It based on the inventory of animals, allows preserving and systematising information about all species living within a certain habitat.

According to researchers, the life cycles of many insects are quite complex and the development of electronic databases is necessary for the objective display of all phenotypic changes in the pathogenesis of dragonflies, and changes in the profiles of metabolites. The conclusions made by the researchers are confirmed by the results that were obtained in this study. These results emphasise the importance of developing and implementing educational and methodological databases when it is necessary to preserve and track changes in the pathogenesis of individual animal species.

In turn, J.Y. Meng et al. [18] conducted a study of changes in the appearance of adult *Helicoverpa armigera* individuals when exposed to ultraviolet radiation. During this radiation it was found that storing data on the effects of radiation of this kind in special archives is necessary for optimal display of processes occurring with adult individuals of this species.

In addition, according to researchers, the availability of data presented in electronic form is necessary from the standpoint of preparing an effective educational and methodological base for further scientific research. The opinion of researchers is fully confirmed by the results obtained in this study, due to the fact that it reflects the

importance of an objective educational and methodological base from the point of view of the objectivity of scientific research.

S.E. Barlow and M.A. O'Neil [19] examined a number of problematic aspects of technological advances in field studies of pollinator ecology and the future of electronic ecology. According to researchers, the creation of an educational and methodological base of an electronic bank. It based on the cadastre of animals is necessary for the optimal display of trends in the development of an electronic bank for the preservation of information that is of key importance for the future of electronic ecology.

The inputs made by researchers are fully confirmed by the results of this study. Since they reflect the role and importance of preserving information in an electronic bank, from the standpoint of modern trends in creating the future of electronic ecology.

J.M. Sakamoto [20] discussed problems and solutions to a wide range of issues of improving literacy in relation to diseases caused by ticks. The researcher has come to the conclusion that transmission diseases have become widespread all over the world, the development of which is facilitated by climate change and globalisation processes.

According to the researcher, the development of the electronic bank, containing data on the nature of the course of these diseases and the possibilities of their treatment and prevention, is able to increase the literacy of the population in these matters by preserving the necessary information. The researcher's opinion is fully confirmed by the results of this study, since it emphasises the importance of creating an educational and methodological system of an electronic bank for storing information about diseases caused by various groups of ticks.

Thus, the discussion of the results obtained, in the context of their comparison with the results and conclusions of a number of other studies. They aimed at investigating a wide range of problematic aspects of the development of an educational and methodological system of an electronic bank based on the cadastre of animals, demonstrated their fundamental conformity on the main points.

Conclusions

The study found that the development of an educational and methodological system of an electronic bank based on the cadastre of animals of the Trans-Ili Alatau (Heteroptera, Pentatomorpha) assumes mandatory consideration of a number of factors that represent a complex characteristic of the species.

These factors include: genus name of the species, species name, species description, geographic distribution of the species, distribution of the species in a particular area. Also, they include habitat of the species, ecological and biological characteristics of the species, relative abundance of the species, and species status.

The creation of the above-mentioned system based on the inventory of animals has numerous advantages, since it allows to preserve the accumulated information on fossil and economically significant animal species in order to integrate them into other systems of this kind. Also, it allows to effectively assess the composition of fauna, the real state of populations of endemic, rare and endangered animal species and the dynamics of changes in the fauna of the Trans-Ili Alatau.

Additionally, it makes a taxonomic assessment of the state of the fauna of the Trans-Ili Alatau, which can be effectively used in geology when developing stratigraphic schemes. Also, it provides the opportunity to assess the economic and economic potential of the landscape and fossil fauna of the geographical region considered in this scientific study. Moreover, it effectively assesses the current state of populations of the most significant species of Heteroptera, Pentatomorpha and conduct a retrospective analysis of the dynamics of changes and to predict the development of population data for the next few decades.

All this allows developing recommendations and taking measures for the conservation, reproduction, and sustainable use of the wildlife of the Trans-Ili Alatau as a biological resource. The functioning of the educational and methodological system of the electronic bank based on the cadastre of animals of the Trans-Ili Alatau (Heteroptera, Pentatomorpha) implies the need to make various changes with changes in data regarding the quantitative composition of the population, its habitat, number.

The prospects for further research in this line are determined by the need to develop effective measures to consider the characteristics of representatives of the animal world of a certain geographical region. This is necessary to solve the problems of preserving the biological diversity of species in this region and to ensure the possibility of studying them.

Acknowledgements

None.

Conflict of Interest

None.

References

[1] Institute of Zoology of the Republic of Kazakhstan. Development of an inventory of fauna of the Northern Tien Shan for conservation of genetic diversity. 2021. https://zool.kz/tekushhie-proekty/razrabotka-kadastra-zhivotnogo-mira-severnogo-tyan-shanya-dlya-sohraneniya-geneticheskogo-raznoobraziya

[2] Suleimenov MZh, Berkinbay OB, Omarov BB, Baimukhanbetov E. Ovine parasites in the Zailiyskiy Alatau. *Theory Pract Paras Dis Cont.* 2022;23:449-453.

[3] Esenbekova PA, Bokenbay D, Eszhanov BE. Biodiversity of hemipterans of the Almaty city (South-Eastern Kazakhstan). *News Nat Acad Sci Rep Kazakhstan Ser Bio Med.* 2018;6(330):58-68.

[4] Litvinchuk SN, Svinin AO, Dujsebayeva TN. Morphological differentiation between diploid and polyploid species of green toads (Anura: Bufonidae: Bufotes) in Central Asia. *Bonn Zoo Bull.* 2021;70(2):361-371.

[5] Berkinbay O, Suleimenov MZh, Omarov BB, Berdikulov MA, Baimukhanbetov YB. Cadastral assessment of sheep parasites of the northern Tien Shan. *Herald Sci S Seifullin Kazakh Agro Tech Univ.* 2022;4(115):27-37.
[6] Maikanov NS, Tanitovskyi VA, Kurmanov ZhB, Katuova Zh, Nurmagambetova LB, Tegisbayeva A, Mailybaev MP, Dzhumakhanova AK. Epidemic significance of blood-sucking insects and arachnids of Western Kazakhstan. *Bull Makhambet Utemisov West Kazakh Univ.* 2022;2(86):228-236.
[7] Andersen TO, Kunath BJ, Hagen LH, Arntzen MØ, Pope PB. Rumen metaproteomics: Closer to linking rumen microbial function to animal productivity traits. *Methods.* 2021;186:42-51.
[8] Hafner M, Lianoglou S, Tuschl T, Betel D. Genome-wide identification of miRNA targets by PAR-CLIP. *Methods.* 2012;58(2):94-105.
[9] Zhou L, Fu A, Mu Y, Wang H, Yu S, Sun Y. Multicopy provable data possession scheme supporting data dynamics for cloud-based Electronic Medical Record system. *Inf Sci.* 2021;545:254-276.
[10] Li W, Cheng Z, Deng L, Yang Z, Li A. Accelerating large-scale weighted similarity queries based on external storage. *Inf Syst.* 2023;117:102213.
[11] Rafique A, Van Landuyt D, Beni EH, Lagaisse B, Joosen W. CryptDICE: Distributed data protection system for secure cloud data storage and computation. *Inf Syst.* 2021;96:101671.
[12] Collins ÁB, Floyd S, Gordon SV, More SJ. Prevalence of Mycobacterium bovis in milk on dairy cattle farms: An international systematic literature review and meta-analysis. *Tuberculosis.* 2022;132:102166.
[13] Choeychuen K, Kumhon P, Chamnongthai K. Robust ambiguous target handling for visual object tracking. *AEU-Int J Elect Com.* 2010;64(10):960-970.
[14] Rößling G, Vellaramkalayil T. First steps towards a visualization-based computer science hypertextbook as a Moodle module. *Elect Notes Theor Comp Sci.* 2009;224:47-56.
[15] Tang BHE, Bay JW, Yeong FM, Samuel M. Efficacy and safety of echinocandin monotherapy and combination therapy for immunocompromised patients with systemic candidiasis: A systematic review and meta-analysis. *J Med Mycol.* 2023;33(2):101362.
[16] Yerbanga IW, Diallo SN, Rouamba T, Dennis O, Rodriguez-Villalobos H, Montesinos I, Bamba S. A systematic review of epidemiology, risk factors, diagnosis, antifungal resistance, and management of invasive aspergillosis in Africa. *J Med Mycol.* 2023;33(1):101328.
[17] Späth J, Brodin T, McCallum E, Cerveny D, Fick J, Nording ML. Metabolomics reveals changes in metabolite profiles due to growth and metamorphosis during the ontogeny of the northern damselfly. *J Insect Physiol.* 2022;136:104341.
[18] Meng JY, Zhang CY, Lei CL. A proteomic analysis of Helicoverpa armigera adults after exposure to UV light irradiation. *J Insect Physiol.* 2010;56(4):405-411.
[19] Barlow SE, O'Neil MA. Technological advances in field studies of pollinator ecology and the future of e-ecology. *Cur Opin Insect Sci.* 2020;38:15-25.
[20] Sakamoto JM. Progress, challenges, and the role of public engagement to improve tick-borne disease literacy. *Cur Opin Insect Sci.* 2018;28:81-89.

Розробка освітньо-методичної системи електронного банку даних на основі кадастру тварин Заілійського Алатау (Heteroptera, Pentatomorpha)

Лаула Байбол
Казахський національний педагогічний університет імені Абая
050010, просп. Достик, 13, Алмати, Республіка Казахстан

Мурат Жаксибаєв
Казахський національний педагогічний університет імені Абая
050010, просп. Достик, 13, Алмати, Республіка Казахстан

Перізат Есенбекова
Інститут зоології Республіки Казахстан
050060, просп. Аль-Фарабі, 93, Алмати, Республіка Казахстан

Зіна Тунгишбаєва
Казахський національний педагогічний університет імені Абая
050010, просп. Достик, 13, Алмати, Республіка Казахстан

Куміс Батирова
Казахський національний педагогічний університет імені Абая
050010, просп. Достик, 13, Алмати, Республіка Казахстан

Анотація

Актуальність. Актуальність дослідження полягає у широкому використанні цифрових систем зберігання інформації в практиці різних сучасних організацій та у необхідності створення освітньо-методичної бази для забезпечення ефективного функціонування таких систем.

Мета. Метою дослідження є систематичне вивчення загальних принципів розробки освітньо-методичної бази електронного банку даних, основою якого є кадастр тварин Заілійського Алатау (Heteroptera, Pentatomorpha).

Методологія. Методологічний підхід у цьому дослідженні базується на теоретичних і прикладних дослідженнях широкого спектру питань, пов'язаних з розробкою систем електронних банків даних на основі кадастру представників фауни.

Результати. Результати вказують на наявність численних переваг розробки освітньо-методичної системи електронного банку даних на основі кадастру тварин. Така система дозволяє зберігати інформацію про види тварин, що мешкають у даному середовищі, та отримувати її для наукових досліджень. Крім того, стає можливою ефективна оцінка поточного стану популяцій найзначніших видів Heteroptera та Pentatomorpha, а також ретроспективний аналіз динаміки змін у популяціях видів та довгострокове прогнозування розвитку популяцій тварин на достатньо тривалий час.

Висновки. У дослідженні зроблено висновок, що розробка освітньо-методичної системи електронного банку даних на основі кадастру тварин Заілійського Алатау забезпечує значні переваги. Ця система дозволяє збереження та отримання інформації про місцеві види тварин, сприяючи науковим дослідженням та ефективній оцінці популяцій видів. Крім того, вона дозволяє проводити ретроспективний аналіз і довгострокове прогнозування динаміки популяцій, надаючи цінні дані для зусиль із збереження природи.

Ключові слова: зберігання інформації; електронні бази даних; методи електронного навчання; місцева фауна; перепис дикої природи; охорона природи.