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**ABSTRACT**

of the dissertation for the degree of Doctor of Philosophy

**THE MODERN REPTILE FAUNA OF URBANIZED  
TERRITORIES OF THE ABSHERON PENINSULA**

Speciality: 2401.01 – Zoologiya

Field of science: Biology

Applicant: **Aysel Rafiq Hashimova**

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The dissertation work was performed at “Medical biology and genetics” department of the Azerbaijan Medical University

Scientific supervisor: Doctor of Biological Sciences, Prof.  
**Janbaxish Ali-Najafov**

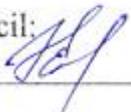
Official opponents: Doctor of Biological Sciences,  
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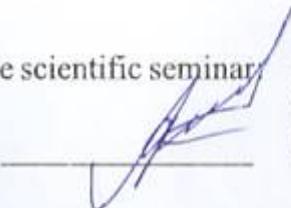
Doctor of Biological Sciences,  
Assoc.professor  
**Namig Janali Mustafayev**

PhD on Biology, Assoc. Prof.  
**Rafiq Azizaga Huseynov**

Dissertation council FD 1.09 of Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at the Institute of Zoology of ANAS

Chairman of the  
Dissertation Council:   
Doctor of Biological Sciences,  
Assoc.professor  
**Elshad İlyas Ahmadov**

Scientific Secretary of the  
Dissertation Council:   
PhD on Biology, Assoc. Prof  
**Gular Aydın Huseynzadeh**

Chairman of the scientific seminar:   
Doctor of Biological Sciences,  
Corresponding member of ANAS  
**İlham Xayyam Alakbarov**

## INTRODUCTION

**Relevance of the topic:** The dramatic increase in the world's population, the development of new cities and towns, the construction of industrial sectors, and the growth of tendency of living in big cities leads to urbanization in certain areas. In this case occurs the disruption of natural conditions that are important to animals living in this area for a long time. The composition and structure of the vegetation change dramatically, the surface of the soil is exposed to wear, and overall the completeness of the area is disrupted. In recent years, strong urbanization has been observed in the Absheron Peninsula. However, the wild fauna, the change in the number of existing species, and the population density have not been studied yet, regarding to urbanization. The growing population in the peninsula and the intense growth of the petroleum industry are contributing to the transformation of natural biosenosis and the decline in the habitat of reptiles.

**The purpose and objectives:** The objective of the dissertation work is to study the current state of the reptile fauna in Absheron Peninsula related to urbanization. From ecological point of view the reptiles are animals with a wide range. In addition to strong urbanization, in recent years, the peninsula has also been exposed to serious technogenic and anthropogenic pollution. Therefore, the study of the amount of microelements, that have toxic effects, on muscle and bone tissue in reptiles living on the peninsula is also purpose of the research. The following issues has been done in order to realize these purposes:

1. A study of the current state of the reptile fauna in Absheron Peninsula in connection with urbanization,
2. The study of the effects of urbanization on population density of background reptile species in Absheron,
3. Study of the degree of anthropogenic adaptation of reptiles in urban areas,
4. The study of the importance of greenings in preserving of reptile biodiversity in the Absheron Peninsula.

5. The accumulation of toxic microelements in the muscle and bone tissue of some reptiles in urbanized and technologically polluted areas.

**Research methods.** Research was performed in selected transects according to urbanization degree in Absheron Peninsula. For determination of species during research was used the Bannikov A.Q. and oth. [1977]<sup>1</sup> method. The ecology of studying reptiles was studied according to Romanov V.V., Maltsev I.V. [2005]<sup>2</sup> methods. The ecosystem was studied using Levix A.Y. and oth. [2011]<sup>3</sup> method. The anthropogenic adaptation index of reptiles living in urbanized areas exposed to serious pollution was studied using method of Bikova E.A. [2017]<sup>4</sup> In addition to classical zoological methods, synthetic methods also have been used. The amount of microelements in the bone and muscle tissue of background reptile species has been determined by the Method of Atomic Absorption Spectroscopy.

**The main provisions of the dissertation:**

1. The current state of the reptile fauna in variously urbanized regions of the Absheron Peninsula.
2. The herpetofauna of one-storey residential areas and the effects of anthropogenic factors on it.
3. Comparative analysis of herpetofauna of mixed and multi-storey residential areas.
4. Study of the degree of anthropogenic adaptation of reptiles in urban

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<sup>1</sup> Банников А.Г. Определитель земноводных и пресмыкающихся фауны СССР/ А.Г.Банников, И.С.Даревский, В.Г.Ищенко [и др.] // М.: Просв., -1977, -416 с.

<sup>2</sup> Романов В.В., Мальцев И.В. Методы исследований экологии наземных позвоночных животных: Количественные учеты: учебное пособие / - Владимир: -2005. -71 с.

<sup>3</sup> Левых А.Ю. Эколого-биологический мониторинг урбоземосистем / А.Ю.Левых, Г.Г.Пузынина, Ф.В.Ермолаева [и др.]// Известия Самарского науч. Центра, 2011, 13 (18), -с.1890-1895.

<sup>4</sup> Быкова Е.А.Влияние урбанизации на фауны и экологию млекопитающих Узбекистана (на примере г. Ташкента): дисс. на соискание ученой степени канд. биол. наук / Тюмень, 2017, -215 с.

areas.

5. The impact of urbanization on population density of background reptile species.

6. Study of toxic microelements in the muscle and bone tissues of reptiles, depending on the level of urbanization.

**Scientific novelty of the research:** Anthropogenic influences often have a destructive effect on natural biotopes, creating a cohabitation environment for some species. Because this environment is new, it causes animals to have signs of physiological, morphological, and ecological adaptation that are resistant to urban environment and anthropogenic disorders. It has not been observed reptiles in the multi-storey buildings that are intensely urbanized, and only the Caspian bent-toed geckoes are found in mixed and one-storey buildings, Water snakes are better adapted around Lake Jeiranbatan and the Bilgah Sea, the Samur-Absheron Water Canal and in the Hovsan-Shahdili massive. For the first time, chemical analysis of the of microelements that have a strong, weak and low toxic effect on muscle and bone tissue was carried out. It has been determined that the Caspian geckoes are mostly accumulate these microelements in their body, however it has not been observed the lethal effect on their body. It is related to Caspian gecko's plasticity and high adaptation toward these microelements.

**The theoretical and practical significance of the research.** The theoretical significance of the research is to study the impact of urbanization factor on life style (spreading, number, density and morpho-physiological properties) of the species by examining the current state of reptilian fauna in urban areas of the peninsula. This knowledge is also helpful for preserving endangered species in the area.

The studying of urbanization on reptilefauna has also practical significance. Thus, the determination of sanitary epidemiological state of the living environment of human and the forming of the optimization of the people's attitude toward reptiles is the practical significance of studying the effects of urbanization on herpetofauna. The determination of migration of reptiles from urbanized areas to safe

places that are far from anthropogenic influences, is also very important practical significance of research. The expanding of making greenings has a great effect in preserving biodiversity of reptile fauna.

**Approbation of the research.** The main provisions of the research work were discussed at the following international and local scientific and practical conferences:

- The 6th International Scientific Conference on “Innovation Problems of Modern Biology” for young scientists and researchers devoted to 93th anniversary of the great son and national leader of Azerbaijani people Heydar Aliyev . Baku, April 2016

- The 14th Congress of International Association of Morphologists. Astrakhan, April 2018;

- The 9<sup>th</sup> International Scientific Conference on “Innovative Approaches in Modern Biology” devoted to 100<sup>th</sup> anniversary of the Baku State University. Baku, May 2019

- The 23th Republic Scientific Conference of young scientists and researchers. Baku, December 2019,

- International Conference on Applied Biosciences (ICAB) Karachi, December 2019.

- The scientific Conference devoted to 90th anniversary of Corresponding member of ANAS, professor Damir Hajijev. Baku, January 2019;

- The 1st International Scientific Practical Virtual Conference Human Genetics and Genetic Diseases: Problems and development perspectives. Baku, May 2020;

**The name of organization where the research was performed:** The “Medical biology and genetics” department of Azerbaijan Medical University.

We are very grateful to the Institute of Radiation Problems and personally to the head of the laboratory of “Physics and Chemistry of harmful impact on Environment”, Phd., Associate Professor Famel Humbatov, professor Maged Ahmadov, Sattar Mammadzade for their help and support in determination of quantity of microelements with toxic effects in muscle and bone tissue of studied reptile species.

**Publications:** 17 scientific works were published on the basis of

the dissertation results, 6 of them were published in abroad.

**Structure and volume of dissertation.** The dissertation work is consist of 201416 characters, including Introduction (10824 characters), 8 chaptres (185039 characters), Result (4344 characters), practical suggestions (1208 characters) and 202 references. It was described 7 tables, 23 photos, 2 maps and 2 diagrams.

## **CHAPTER I. LITERATURE REVIEW**

This chapter provides a brief summary of literature devoted to urbanization in foreign countries, as well as information about the accumulation of toxic microelements in different animal tissues.

## **CHAPTER II. NATURAL AND GEOGRAPHICAL CONDITIONS OF THE RESEARCH AREA**

In this chapter the detailed information about landscape, fauna, flora and climate of Absheron's urban areas have been given.

## **CHAPTER III. THE MATERIALS AND METHODS OF THE RESEARCH**

The study was conducted in urban areas of the Absheron Peninsula from 2016 to 2020. To accomplish this, the area of the peninsula was initially analyzed for urbanization level and was divided into five sectors (zones) and one control area. During the study was used the method of Levix and oth. [2010-2012] that was presented to monitoring the urban ecosystem, the zoological research methods of Romanov V.V. and Maltsev I.V. [2005] for studying herpetofauna. The affiliation of reptile species was determined according to Ananyeva and oth.[2011]<sup>5</sup>, Bannikov and oth.

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<sup>5</sup> Ананьева Н.Б. Опыт использования критериев редлистнига МСОП в создании глобальной базы данных по амфибиям и рептилиям мировой и Кавказской экорегиона / Н.Б.Ананьева, Б, С.Туниев, Н.Л.Орлов // [и др.] Мат. IV съезда Гер-ого об-во им. А.Н.Никольского «Вопросы герпетологии», - Казань: 12-17 октября 2009, -Санкт-Петербург: 2011, -с. 17-24.

[1977].The anthropogenic adaptation index and population density was determined by the amount of species found in every km<sup>2</sup> of the observed area.The research objects are the Mediterranean turtle – *Testudo graeca* L,1758, Caspian bent-toed gecko –*Gymnodactylus caspius* E, 1831 and Water snake –*Natrix tessellata*, Laurenti 1768 .

To evaluate the overall state of the ecosystem in the peninsula was performed the method of Kojova, O.M. and oth. [2000]<sup>6</sup>, to study the ecology of reptiles was used the research methods of Shlyakhtin Q.V.,Qolikova V.L.[1986]<sup>7</sup> . the city he used was also used in In addition to these methods also was used the the method of Adams [2005]<sup>8</sup> that is presented for studying urban wildlife ecology and conservation. A route method has been used to study the population density of background reptiles in urban areas and control zone. [Berejnoj O.A., Barabashova Z.I 1981]<sup>9</sup>. The marshrut was about 1-10 km in lenth and 2-2,5m in width from the central arrow to the right and left. The direction of route could be straight or sinuous depending on the landscape of the city, settlements, and gardens, density of inhabitants and anthropogenic factors. Atom Absorbtion Spektroskopy method was used to determine the accumulation and amount of microelements in bone and muscle tissue of reptiles. Studied microelements are dividing into following 3 parts for their toxic effects:1.Microelements with high toxicity-nickel, copper, lead, cadmium,sink. 2.Microelements with weak toxicity-cobalt,chromium,manganese,molybdenum 3.Microelements with low toxicity –iron, strontium.During determination of toxic microelements in bone and muscle tissue of background reptiles is used the average

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<sup>6</sup> Кожова, О.М. Методология оценки состояние экосистем / О.М. Кожова, Л.Р.Измествьева, Б.К. Павлов [и др.] // - Ростова-на-Дону: ЦВВЗ, -2000, -128 с.

<sup>7</sup> Шляхтин Г.В. Голикова В.Л. Методика полевых исследований экологии амфибий и рептилий / - Саратов: -1986. -78 с.

<sup>8</sup> Adams L.W. Urban wildlife ecology and conservation: a brief history of the discipline // Urban Ecosystems, 2005, № 8. –p. 139-156.

<sup>9</sup> Бережной О.А., Барабашова З.И. К методике определения абсолютной численности рептилий маршрутным учетом в биотопах аридной зоны // Материалы 5-ой Всесоюзной конференции, - Ашхабад: Наука, -22-24 сентябрь, 1981, -с. 18

standart concentration that is suggested by Yermakov V.V., Tyutikov S.F., Safonov V.A. [2018]<sup>10</sup> and determined the effects of these microelements.

## CHAPTER IV. PERSONAL RESEARCHES. THE CURRENT STATUS OF REPTILE BIODIVERSITY IN URBANIZED AREAS OF ABSHERON PENINSULA.

**4.1. The brief overview of the order of Turtles- *Testudines* in Absheron peninsula.** According to last literature review and the results of our research there has been found 3 species of the order of Turtles:

1. Mediterranean turtle - *Testudo graeca*. Linnaeus, 1758.
2. Swamp tortoise - *Emys orbicularis* Linnaeus, 1758.
3. Caspian turtle– *Mauremys caspica* Gmelin, 1774.

One of the ancient species of the Absheron Peninsula is the Mediterranean tortoise. However, in addition to urbanization, the technological and anthropogenic factors have had such a profound effect on this tortoise that their numbers are declining year by year. Observations show that Mediterranean tortoises are now left in the form of separate fragments in the nature of the peninsula, itself in a minority form. The swamp tortoise has more populations around Lake Jeiranbatan, it has observed 10-28 individuals in every transekt( from 100m to 1000m distance). Thus it indicates that this biotope is more suitable for normal living and reproducing of swamp tortoise. This species was not observed in urbanized areas, practically. Caspian turtle has been observed only around the Pirakashkul village, in Sumgayit river and in the lake around Sangacal during expeditions. In other areas the anthropogenic and technogenic factors have been affected the Caspian turtle negatively and it leads the reduction of the number and living area of this species.

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<sup>10</sup> Ермаков В.В., Тютиков С.Ф., Сафонов В.А. Биохимическая индукция микроэлементов // Москва:-2018, -386 с.

## **4.2. The brief overview of the Squamates Reptiles – *Squamata* in Absheron peninsula.**

**4.2.1. The suborder of Lizards – *Sauria*.** The study of literature review showed that there has been found 10 species of the order of Lizards in Absheron peninsula:

1. Caspian gecko (*Tenuidactylus caspius* Eichwald, 1831).
2. Caucasus pangolin (*Paralaudakia caucasica* Eichwald, 1831).
3. Desert lizard (*Phrynocephalus horvathi* Mehely, 1894).
4. Schneider's skink (*Eumeces schneideri* Daudin, 1802).
5. Streaked lizard (*Lacerta strigata* Eichwald, 1831).
6. Rapid racerunner (*Eremias velox* Pallas, 1771).
7. Steppe-runner (*Eremias arguta* Pallas, 1773).
8. Snake-eyed lizard (*Ophisops elegans* Menetries, 1832).
9. Glass lizard (*Pseudopus apodus* Pallas, 1775).
10. Toad-headed agama (*Phrinocephalus mystacus*, Pallas, 1776).

However according to last literature information some of these species, especially, Desert lizard (*Phrynocephalus horvathi* Mehely, 1894). and Toad-headed agama (*Phrinocephalus mystacus*, Pallas, 1776). are not found in Absheron peninsula. These species have not been found also during our research. One more species- Streaked lizard (*Lacerta strigata* Eichwald, 1831) rarely found during our expeditions. As it is mentioned above, during our research work is determined that the modern fauna of Lizards is represented by 8 species.

**4.2.2. The suborder of Snakes- *Serpentes*.** Generally, the species of Snakes are widespread in our Republic, including Absheron peninsula. The reason is the dry semi-desert landscape of the area, so that creates optimal ecological condition and biotope for living different types of snakes in this area. According to existing literature review there were 11 species of Snakes – *Serpentes* in the Absheron peninsula:

1. Water snake (*Natrix tessellata* Laurenti, 1768).
2. Red bellied racer (*Dolichophis schmidtii* Nikolsky, 1909).
3. Dahl's Whip snake (*Platyceps najadum* Eichwald, 1831).
4. Spotted whip snake (*Hemerrhois ravergeri* Menetries, 1832).
5. Blotched snake (*Elaphe sauromates* Pallas, 1811).
6. European cat snake (*Telescopus fallax* Fleischmann, 1831).
7. Dwarf snake (*Eirenis collaris* Menetries, 1832).
8. Eastern Montpellier snake (*Malpolon insignitus* Geoffroy, 1827).
9. Blind snake (*Thyphlops vermicularis* Merrem, 1820)
10. Lebetine viper (*Macrovipera lebetina obtusa* Dwigubsky, 1832)
11. Javeline sand boa – (*Eryx jaculus* Linneaus, 1758).

It was determined during our researches that the modern fauna of Snakes (Serpentes) is represented by 9 species in Absheron peninsula. (Water snake, Dahl's Whip snake, European cat snake, Eastern Montpellier snake...) There were not observed Spotted whip snake (*Hemerrhois ravergeri* Menetries, 1832) and Blotched snake (*Elaphe sauromates* Pallas, 1811). during our researches. We are considering that the urbanization of the research area made these species to be destroyed.

#### **4.3. The positive impact of the greening of urban areas on preserving herpetofauna biodiversity.**

Currently, the problem of preserving biodiversity in urban areas has become one of the priorities of biology. The effects of urbanization on herpetofauna in Absheron peninsula can be divided into two categories: The first is an anthropogenic factor, that is directly related to human activity. The second is a technological factor that can also be divided into two subgroups: a) Industries, including oil industry that is characteristic to Absheron peninsula; b) A noise factor caused by growing private and public passenger vehicles, trucks, rail trains.

#### **4.4. The Reptiles' biotopic migrations and their adaptations to these biotopes are the factors which lead to microevolution processes .**

According to author of the first monography devoted to urbanization -Klausnitser [1990]<sup>11</sup> the evolutionary processes are observing also in cities, but it's more accurate to call it the "Experimental Field of Evolution." Considering that anthropogenic influences play a destructive role for natural biotopes, creates a new environment, some species adapt to life with humans in these environments. The city environment is new for reptiles in terms of evolution, and its negative or positive effects are emerging later. The essence of urbanization is that it creates new forms of interaction between animals and humans. The study of how urbanization is important in the lives of vertebrate animals has become more actual in recent years.

Microevolution processes and their frequency of occurrence depends on environmental changes, isolation rate of urban populations, low number of species in the local areas. So, in this case the functional activity of the nerve and muscle tissue increases, physiological adaptation occurs, and ultimately forms an adaptive changes in behavioral reactions. The symptoms of adaptation indicate that the species' morphogenesis depends on the physiological and proliferative processes of the species in an anthropogenic changing environment. The uniqueness of the Caspian bent-toed gecko, which is sufficiently adapted to urban areas in Absheron, is that the physiological and functional adaptation of the movement organs seems stronger. The Caspian bent-toed gecko is not so longlive, but because of its high reproductive intensity, the number dynamics are stabilized in urban areas. Adaptation is mostly better seen in single-storey and relatively mixed-storey residential areas. (Mehdiabad, Jeyranbatan, Jorat massives) However, not all the stations we have studied can be attributed to them, so, they were not observed especially in multi-storey residential areas. High plasticity does not prevent it from being able to adapt to strong technological pollution conditions.

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<sup>11</sup> Клауснитцер Б. Экология городской фауны / Б.Клауснитцер; перевод с немецкого языка И.В.Орлова, И.М.Марова. – Москва: Мир, -1990. – 246 с.

Another interesting sign of adaptation draws attention: The intensification of the metabolism process in the geckoes proves that the nutritional relationships, or food acquisition strategies, are being implemented at a population level. They migrate in two directions from densely populated areas. The first direction is from the center of Absheron to Shamakhi, the center of Gobustan and Karadagh and the second direction is to the Shahdili. The observations show that the number of water snakes in the first direction is declining steadily, but in the second direction there are plenty of them because migration is going strongly. In the early spring, we observed the adoption of a "suntan of water snakes" in the seaside regions, especially on bushes and rocks in the direction of Turkan and Karadagh.

## **CHAPTER V. THE ANTHROPOGENIC ADAPTATION INDEX OF REPTILES IN THE URBANIZED AREAS OF ABSHERON PENINSULA.**

The anthropogenic adaptation index of different reptiles in the Absheron Peninsula is determined according to reproductive activity. Thus, relatively high adaptive anthropogenic intensity in residential areas with one-storey buildings is found in the Caspian bent-toed gecko ( $9,1 \pm 2,8$ ), moderately adapted reptiles were water snakes ( $5,1 \pm 2,4$ ), and Mediterranean turtles were weakly adapted ( $4,2 \pm 2,8$ ). In a mixed-floor residential area, this index was relatively  $7,1 \pm 2,1$ ;  $4,0 \pm 1,3$  and  $3,1 \pm 1,9$ . The anthropogenic adaptation was 0 because there are no water snakes and Mediterranean tortoises in residential areas with multi-storey buildings, however, the Caspian bent-toed gecko was rarely observed. ( $0,5 \pm 0,1$ ). By doing comparison, it is becoming clear that the reproductive activity rate of the reptiles studied can be divided into three zones below; 1. The zones with high reproductive activity refers to: I- single-storey zone V- forest mass zone 2. Areas with moderate reproductive activity, this applies to the following zones: II- a mixed-storey residential areas, IV- the areas with industrial facilities 3. A zone with weak or no reproductive activity, here is referred III- multi-storey residential area

**CHAPTER VI.**  
**THE INVESTIGATION OF POPULATION DENSITY OF**  
**BACKGROUND REPTILE SPECIES IN URBANIZED AREAS**  
**OF ABSHERON PENINSULA**

In the peninsula, in single storey houses, in transekts of uncontrolled gardens the population density of the Mediterranean turtles is estimated to be a maximum of 8 and a minimum of 2 in every km<sup>2</sup>. This species is not observed in mixed-storey residential areas with densely populated transekts, but it is possible to find a small number of turtles in transekts with courtyards. The Mediterranean turtles around the Lake Jeiranbatan feel more comfortable, free, and safer, they are rich in food, and these areas not more urbanized. Therefore there are enough number of turtles in this transect, maximum 11 and minimum 7 individuals per. km<sup>2</sup>.

The control area is an area where the peninsula is not exposed to urbanization and has purchased a National Park status. There is no anthropogenic effect on Mediterranean turtles, but because the food source is reduced (grass plants quickly dry up during the hot summer months), they migrate to the seashore. Therefore, the population density is not so high, for every hectare is observed maximum 13, minimum 7 individuals. Average amount is 9,6±2,4.

The population density of the Caspian bent-toed geckoes was 24,5±3,1 in areas with single storey buildings. In mixed-storey residential areas, however, their population density was slightly less, 19,1±2,7. The number of Caspian bent-toed gecko was different dependng on the type of industrial facilities. Thus, the geckoes were found on walls mostly in noisy industrial facilities of Sumgayit. Here, on walls of houses were observed maximum 15 and minimum 8 individuals per 100 m<sup>2</sup>. However in quite industrial their number was maximum 14-16 and minimum 12-15 individuals per 100 m<sup>2</sup>. In general, in industrial sectors, the Caspian bent toed geckoes were found 13±2.8 individuals. Forest mass stations have not been exposed to urbanization, so the anthropogenic factors are not so effective. Whether in the forest areas around Lake Jeiranbatan or the Forests of

the Caspian coasts of Bigah-Mardakan , the fauna of the Caspian bent-toed gecko is formed naturally. In these zones, the population density of the Caspian bent-toed gecko is not so high, it was averagely,  $10,2 \pm 2,5$  individuals.

The control area is consist of natural landscapes. Sometimes the Caspian bent-toed geckoes are settling in nests of rodents and wild animals. During the hot summer months and in cold weather, the geckoes use those nests as a shelter. Sometimes they also become the food for nest “owners”. During the observations, we have met 6-7 or sometimes more geckoes inside the mouse or fox nest. As it seems,, the population density of the Caspian bent-toed geckoes is not so high in the control zone. ( $5.6 \pm 1.8$ )

## **CHAPTER VII.**

### **THE COMPAIRING ANALYSYS OF MORPHOLOGICAL PROPERTIES OF CASPIAN BENT-TOED GECKO - *TENUIDACTYLUS CASIUS* (EICHWALD, 1831) IN URBANIZED TERRITORIES OF ABSHERON PENINSULA.**

Analysis of morphometric parameters on collected materials shows to what extent have these animals gain the signs of adaptation in urbanized areas. The length of the trunk and head together was averagely  $62,31 \pm 1,3$  mm, and the tail (*L.cd.*)  $81,46 \pm 5,2$  mm in Caspian bent toed-geckoes obtained from vertical buildings from human –inhabited areas. The average length of head was  $19,6 \pm 1,0$  mm, the width of head  $12,83 \pm 0,6$  mm, and the height of head was  $7,54 \pm 0,6$  mm in geckoes obtained from these areas. The lengh between forelimbs and hindlimbs was  $26,1 \pm 0,8$  mm in these geckoes. The average number of scales in the middle of the abdominal tract was  $27,6 \pm 0,7$ , and the average number of scales under the body was  $112,27 \pm 3,1$ . The size of the body and the head is slightly higher than those of the obtained from marine biotopes ( $62,31 \pm 3,1$  mm against  $65,4 \pm 1,7$  mm). And the length of the tail is longer in the geckoes collected from human inhabited areas than in geckoes obtained from the beach. Differences can be viewed as a sign of adaptation for vertical movement , food obtaining and maintaining the balance of the

body in Caspian bent – toed geckoes livind in residential buildings. There was not identified any other difference except from the number of scales under the body. Thus, the number of scales under the body of geckoes obtained from beach was averagely  $137,1 \pm 22,1$  while in geckoes collected from residential areas was  $112,27 \pm 3,1$ . Clearly, there are slightly more scales in the geckoes living along the seashore. The increase in the number of scales under the abdomen is a sign that serves for preventing from heating in them. The length of the head and trunk was moderately  $65,4 \pm 1,7$  mm and the legh of tail  $74,5 \pm 4,5$  mm in geckoes obtained from seashore sands. The legh , width and height of the head of these geckoes were respectively  $18,4 \pm 0,9$  ,  $14,1 \pm 0,7$  and  $7,58 \pm 0,5$  mm. The average number of scales in the middle of the abdominal tract was  $28,95 \pm 0,9$  and number of scales under the body was  $137,1 \pm 22,1$  .

We have also learned the effects of urbanization on morphometric parametres of Caspian bent-toed gecko. To accomplish this, material was collected from the peninsula by selecting a seaside area that is characterized by seasonal urbanization and permanently urbanized areas with one storey and mixed storey buildings. The morphometric measurements shown that in two cases there was a difference. These are differences in the number of scales in the abdomen (Ventr) and the length of the he head and trunk (L) . Both differences are signs gained during historical development and have focused on adapting the species to the environment.

## CHAPTER VIII.

### THE ACCUMULATION OF TOXIC MICROELEMENTS IN REPTILES' TISSUES OF MOVEMENT ORGANS DEPENDING ON URBANIZATION DEGREE.

#### 8.1. The accumulation of microelements with high toxicity in bone and muscle tissue of reptiles

In recent years, the Absheron Peninsula has undergone to a strong urbanization, as well as anthropogenic and technological contamination. The nickel, copper, lead, cadmium and sink are related to mikroelements with high toxicity. Bone and muscle tissue, which make up the main components of the support system in the organism,

are very important because of their many biological and physiological properties. In view of these, we have studied the amount of toxic microelements in both tissues.

Copper microelement is more common in the bone and muscle tissue of the Caspian bent-toed gecko (6,025mg/kg), in muscle and bone tissue of Mediterranean turtles are found 4,364 mg/kg, and at least in muscle and bone tissue of water snake a small amount is found. (1,322 mq/kg) . Nickel is one of the microelements needed for normal growth of the living organism. The amount of nickel in the Caspian bent-toed gecko was 2,499 mq/kg, in the water snake 1,392 mq/kg, and in the Mediterranean tortoises 1,122 mq/kg.

Among the reptiles studied, the lead microelement is more common in the bone and muscle tissue of the Caspian bent-toed gecko -5,060 mq/kg. It should be noted that lead is mostly collected in bone tissue, liver, kidneys and brain. In the water snake and Mediterranean turtle the lead is accumulated respectively, 0.564 and 0.547 mg/kg .

Cadmium is one of the microelements with a high toxic effect. The amount of cadmium in the bone and muscle tissue of the reptiles we studied is as follows: In Caspian bent-toed gecko is about 0.103 mg/kg, and in the water snake and the Mediterranean turtle are about 0.059 and 0.055 mg/kg.

Sink is a microelement that is more common in the body after iron. Its antioxidant properties result in DNA reparations, protein composition, while deficiency and excess amount leads the body's normal growth and development, and have a toxic effect. The amount of sink in the bone and muscle tissue of the Caspian bent-toed gecko was 554.2 mq/kg, while in the water snake was 274.7 mk/kg, and in the Mediterranean turtle 212.4 mq/kg.

Changes (becoming more or less than average standart concentration) in the amount of above mentioned microelements with high toxicity in bone and muscle tissue of reptiles we studied is related to the deterioration of ecological balance in relation to urbanization..

## **8.2. Accumulation of microelements with weak toxic effects in muscle and bone tissue of reptile species studied depending on the degree of urbanization**

Cobalt, chromium, manganese and molybdenum are related to microelements with weak toxic effects. Cobalt is one of the most important microelements in the body. Cobalt is not collecting much in the body (about 2 mg), so it should be constantly absorbed into the body with food. Among the reptiles studied, this microelement is more common in the muscle and bone tissue of the Caspian bent-toed gecko. (1,240 mq/kg). Water snakes (0.139 mq/kg) are second for amount of cobalt, and the last is the Mediterranean turtle (0.076 mq/kg). Clearly, the abundance of cobalt in the muscles and bone tissue of the Caspian bent-toed gecko is related to with its high adaptive ability to resist this microelement.

Manganese is one of the most important microelements in the body, and it is found in the air, water, soil, in the organisms plants and animals. The amount of manganese is high enough in bone and muscle tissue of reptiles we have studied. Thus, the amount of manganese in bone and muscle tissue of Caspian bent-toed gecko, Mediterranean turtle and water snake is respectively 147,09 mq/kg, 8,529 mq/kg and 29,850 .The major importance of chromium in the body is the synthesis of lipids and it plays an important role in sugar exchange and stabilizing its levels in blood. For the amount of chromium in the muscles and bone tissues of the reptiles we have studied, the Caspian bent-toed gecko is first— 14,912 mq/kg. In the second place is the Mediterranean turtle -4,461 mq/kg, and the last is the water snake - 0.965 mq/kg. The abundance of chromium microelements in the muscle and bone tissue of the gecko and turtles is consistent with literature information, however the less amount of chromium in anological tissue of water snakes may be due to the fact that it feeds on water animals that contain less chromium. Molybdenum microelement is one of the less common microelements in organism. An amount analysis of the molybdenum microelement yielded the following results: In the Caspian bent-toed geckoes' muscles and bone tissues the amount of molybdenum was 0.557 mq/kg, in the same tissues of the Mediterranean turtle was 0.224 mq/kg, and in the water snakes was 0.254 mq/kg.

### **8.3. Accumulation of microelements with low toxic effects on**

## **muscle and bone tissue of species studied depending on the degree of urbanization**

Iron microelement is compounded in enzymes and are called hemin. Eritrosites contain hemoglobin, a complex protein that is made up of a prosthetic part of iron and a protein globin. The amount of iron in the bone and muscle tissue of the Caspian bent-toed gecko was 2279 mq/kg, 259.7 mq/kg in water snake, and 248.6 mq/kg in the Mediterranean turtles.

The amount of strontium in bone and muscle tissue of reptiles selected from urban areas is as follows: The Caspian bent-toed gecko and the Mediterranean tortoises contain 457.5 mq/kg of strontium and water snake slightly more 714.5 mq/kg. By comparison, the only microelements studied are that the amount of strontium in the muscle and bone tissue of Caspian bent-toed gecko is lower than the same indicator of water snake.

## **RESULTS**

1. The urbanization process directly or indirectly impacts the biodiversity of Reptilefauna. The direct impact manifests itself in destroying wittingly or accidentally widespread Reptile species in case of rapid meeting with them. The indirect impact shows itself in destroying Reptile species during transformation and pollution of their living places, the increase of annoying factors (noise, technical issues, communication cables).
2. The negative effect of urbanization depends on adaptation index, distribution properties in living area, changes of number and density and nutritional relationships of Reptile species. Studies have shown that the process of urbanization on the peninsula has had a negative impact on all three species of Turtles, especially the areals of the Mediterranean turtles have left in the form of fragments and the number of Caspian tortoises have decreased.
3. Because of strong urbanization in the area 2 species - Desert lizard (*Phrynocephalus horvathi* Mehely, 1894). and Toad-headed agama (*Phrynocephalus mystacus*, Pallas, 1776).of

Lizards (Sauria), as well as 2 species - Spotted whip snake (*Hemerrhois ravergeri* Menetries, 1832) and Blotched snake (*Elaphe sauromates* Pallas, 1811) of Snakes (Serpentes) are no longer found. The mostly adapted species to urbanization are Caspian gecko- (*Tenuidactylus caspius*) from Lizards (Sauria), Water snake (*Natrix tessellata*), Dahl's Whip snake (*Platyceps najadum*), European cat snake (*Telescopus fallax*), Dwarf snake (*Eirenis collaris*) and Lebetina viper (*Macrovipera lebetina*) from Snakes (Serpentes).

4. It was determined that in some of the Reptile species it is observing the microevolution signs related to urbanization. In the result of compaired analisys of morphometric properties of Caspian geckoes obtained from different biotopes (sands and walls) was identified that there is a functional adaptation in their movement apparatus (organs). Thus, the bubbles that form at the tip of their fingers, as well as the relative sizes of body parts allow them easily move and maintain the balance on the walls and it leads to increase their ability to survive.
5. The morphological analysis shows that, in geckoes that is adapted to live on the walls of buildings the length of the head is slightly longer than width ( $L.c./ Lt.c.max$ ), while this index is lower, so the head part is shorter in the geckoes living on the seashore sands. The width of the head is wider than its height in geckoes living in seashore sands. ( $Lt.c.max/H.c.max$ ). The number of scales on the underside of the body is different in Caspian geckoes living on the walls of the buildings and on the seashore sands, it is respectively,  $112,27 \pm 3,1$  and  $137,1 \pm 22,1$ . It is considering that these differences in morphological indexes is the sign of adaptation to living place and it can be estimated as a endeavor for a microevolution.
6. The urbanized areas of the peninsula can be divided into three categories according to reproductive activity: a) single-

storey and forest mass areas where all reptile species studied have high reproductive activity: b) medium-level mixed-floor and industrial objects areas: c) multi-storey residential areas where weak reproductive activity have performed. In Caspian bent-toed geckoes the reproductive activity was  $9,1 \pm 2,8$  in single storey residential areas;  $3,2 \pm 1,6$  in areas with industrial facilities;  $0,9 \pm 0,1$  in control zone; in water snakes  $5,1 \pm 2,4$  in single storey residential areas;  $1,6 \pm 0,8$  in areas with industrial facilities;  $7,0 \pm 2,5$  in control zone and in Mediterranean turtles  $4,2 \pm 2,8$  in single storey residential areas;  $1,5 \pm 0,8$  in areas with industrial facilities and  $5,1 \pm 2,2$  in control zone.

7. The analysis of accumulation of microelements with strong, weak, and low toxicity in bone and muscles tissue of selected background reptiles indicates that in all cases, these microelements are more in the muscle and bone tissue of the Caspian bent-toed gecko. Only strontium was exceptional (it was 714,5 in water snake, and 457,5 mq/kq in geckoes and turtles.)
8. The accumulation of microelements in the bone and muscle tissue of reptiles in Absheron Peninsula is due to the contamination of the peninsula with technological and anthropogenic factors, but it does not have a lethal effect on reptiles studied. Because the animals studied have accumulated those microelements for a long time, they have developed a sign of adaptation .

## **RECOMMENDATIONS**

1. Acute urbanization has had a negative impact on the peninsula's reptile fauna. The areals of Mediterranean turtles have left in the form of fragments. The eared lizard and wormwood lizard are no longer found, and the number of some species have decreased dramatically. There has been a need to create a suitable plant for reptiles to breed them and spread them into nature and restore their

biodiversity. It is expedient to use the practise of native and foreign researchers.( N. B. Ananyeva and others)

2. The new towns are being built in the peninsula because of urbanization, and the area of cities is expanding steadily. During this time, reptiles living in those areas migrate in different directions and sometimes die. It is important to benefit from the experience, knowledge and skills of zoologists in order to organize migration scientifically and protect the reptile fauna biodiversity.

3. Natural biocenosis of reptiles is disrupted by urbanization. In order to compensate it, the first goal is to increase green areas on the peninsula.

### **The list of scientific works on the topic of the dissertation:**

1. **Hashimova A.R.** The main ecological factors influenced on herpetofauna in urbanized areas of Azerbaijan (in the example of Absheron peninsula). The materials of the 6th International Scientific Conference on “Innovation Problems of Modern Biology” for young scientists and researchers devoted to 93rd anniversary of the great son and national leader of Azerbaijani people Heydar Aliyev. Baku, 2016, p.82-83
2. **Najafov J.A., Hashimova A.R.** The impact of urbanization on fauna of snakes ( Reptilia, Serpentes) as a an antropogenic factor. The proceedings of the Institute of Zoology ANAS. Baku, 2016, vol. 34, № 2 p.83-88.
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6. **Hashimova A.R., Hashimov R.T.** Morphological changes of thin-fingered gecko (*Cyrtopodion caspius* E.1831) in connection with the urbanization of Absheron peninsula. J..Morphology (Scientific theoretical journal) Saint Peterburg, 2018, vol.3, p.74.
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  9. **Hashimova A.R.** The anthropogenic adaptation index of some reptile species in urbanized territories of Absheron peninsula.Scientific works of Nakhchivan State University. Nakhchivan, 2019, p.88-91.
  10. **Hashimova A.R.** The accumulation of toxic microelements in muscle tissue of some reptiles in urbanized areas of Absheron peninsula. The materials of the 9 th International Scientific Conference on “Innovative Approaches in Modern Biology” devoted to 100 th anniversary of the Baku State University, Baku, 2019, p.64
  11. **Najafov J.A., Hashimova A.R.** Population density of some background reptiles in the urbanized territories of Absheron peninsula in Azerbaijan. J. Problems of regional ecology. Moscow, 2019, №3, p.9-13.
  12. **Hashimova A.R.** Greening of urbanized areas in Absheron peninsula as a conservation factor of herpetofauna biodiversity. International Conference on Applied

Biosciences (CAB-2019) Karachi, 2019, P. 93-95

13. **Hashimova A.R.** Greening of the urbanized territories of Absheron peninsula as a preservation factor of biodiversity. The XXIII Republic Scientific conference of young researchers and doctoral students. Baku, 2019 p.132-133
14. **Hashimova A.R.** Human as a biotic factor in accumulation of microelements with weak toxicity in bone and muscle tissue of background reptile species in the Absheron peninsula. Proceedings of the first International Scientific Practical Virtual Conference Human Genetics and Genetic Diseases:Problems and development perspectives.Baku, 2020 ,p.74-76
15. **Hashimova A.R.** The accumulation of microelements with high toxic effects in bone and muscle tissue of reptiles due to human activity. Proceedings of the first International Scientific Practical Virtual Conference Human Genetics and Genetic Diseases:Problems and development perspectives. Baku, 2020,p.83
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17. **Hashimova A.R.** The anthropogenic adaptation index of reptiles in urbanized areas of the Absheron Peninsula. Ambiance in life. International scientific journal in medicine.Tbilisi ,2021,p.85-87

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