

• **ON THE MEDITERRANEAN INFLUENCE ON THE FORMATION OF
HERPETOFAUNA OF THE CAUCASIAN ISTHMUS AND ITS MAIN
XEROPHILOUS REFUGIUMS**

B.S. Tuniyev

Caucasian State Biosphere Reserve

Position of Caucasus in the scheme of biogeographic division of Palaearctic is arguable. Its independence in the formation of peculiar flora and fauna, or belonging to the adjacent areas of Europe and Central Asia are differently interpreted in literature. It is to the significant degree typical and for the separate parts of Caucasian isthmus. Not aiming to analyse the whole herpetofauna of the isthmus and divisioning of its territory, we shall stop on the certain fauna of Mediterranean area and make an attempt to estimate the influence of this fauna on the formation of the herpetological complexes of Caucasus.

Zoogeographical works, concerning Caucasus, appeared in the second half of XIX century. Wallace (1876), as well as later on Haake (1896), divided Caucasian isthmus along the crest of Great Caucasus, referring Precaucasia to the European subregion and Transcaucasus - to the Mediterranean. Severtsov (1877) referred to the Mediterranean area the all Great Caucasus, West Precaucasia and West Transcaucasia, and the rest Transcaucasia - to the West Asian region and North-East Precaucasia - to the Middle Asian region. As a matter of fact in this, very close to the recent, scheme of division, Severtsov have recognized the different of the Caucasus fauna. The most complete description of heterogenous origin of the Caucasian fauna was made by Satunin (1910, 1912), what we have pointed already in the previous work (Tuniev, 1990). Menzbir (1934) included Caucasus and Transcaucasia into the Caucasian subprovince of East Mediterranean province in Mediterranean subregion of Palaearctic. In the opinion of Menzbir, Caucasus was under the influence of two faunogenetic centers -Mediterranean and Central Asian. Puzanov (1938) referred to the Mediterranean subregion all Transcaucasia which together with the Greece archipelago, Asia Minor, Mountain Crimea, enter the East Mediterranean province. The northern slopes of El'burz in Talysh were distinguished by him into the Hyrcan province. The numerous following works of 40-60-th years were based the main on the therio - and ornithological divisioning where Caucasus was placed either to Mediterranean (Kuznetsov, 1949), either to the province of deciduous forests of Europe (Rustamov, 1945; Kuznetsov, 1950; Bobrinsky, 1951). The work of great expert and investigator of Caucasian fauna Vereshchagin "Mammals of Caucasus" deserves particular attention. Criticizing the works of authors, who diminish the significance of Mediterranean area (to which Vereshchagin referred and Caucasus), he wrote: "Mediterranean always gave more possibilities for immigration of animals and plants than Sahara or Kara-Kum, but its significance as the independent ancient form genesis center was not decreasing due to this. The correct interpretation of the concept of "Mediterranean", and, therefore, and Mediterranean type of fauna could be achieved only with the complex analysis of natural transformation which took place in the Cenozoic in the limits of Mediterranean geosynclinal. As it is known, the Sarmaian sea, which stretched from Hibraltar up to Transcaspian, later on in the Pliocene and Pleistocene not once disintegrated on the chain of isolated basins, being connected sometimes in the epochs of transgressions. The Aral coast and the

northern part of Caspian sea due to the conditions of relief and high continental climate were early deserted and come out of the united system of Mediterranean zonal type. Nevertheless, the rest plots of this chain of Cenozoic basins, among this and Caucasus, inherited a number of single primitive features of landscapes, flora and fauna, the roots of which are going into Miocene. Just because of this under the Mediterranean, taking in account its paleogeographical essence should be meant the southern vicinities of Europe (including the south of Ukraine and Crimea), Northern Africa, Asia Minor, Caucasian isthmus (excluding Premanych), Talysh and Elburz ridge" (P. 462). Vereshchagin's interpretation of Mediterranean coincides in a whole with the boundaries of floristic Mediterranean of Rikli (1946) (Fig. 1), though in botanists the position of Caucasus also was a subject of a long discussions. Thus, Boissie (1867) in his book "Flora orientalis" referred the forest Caucasus, occupied by deciduous and, partly by the dark coniferous forests north Anatholiya and some regions of European Turkey

to the region of Middle Europe. To the "Mediterranean region" he, besides the countries, adjoining the Mediterranean seacoast, referred and southern Crimea. Not only mountain Crimea, but and the whole Caucasus was included in the Mediterranean subregion (province) on the territory of the former USSR by Alekhin (1938) and Vulf (1944). Pointed Grossgeim (1948) and Maleev (1946) on the affinity of the caucasian formations of macquis, garigue, phrygana broad-leaf forests with the same formations of Mediterranean. Isachenko and Lavrenko (1980) did not agreed with them, referring Caucasus to the two botanical-geographical areas: European broad-leaf and Afro-Asian desert, Lavrenko (1958) considered and earlier that in the fitogeographical sense the forest area of Caucasus in the origin and ecology is related to the broad-leaf forests of Europe, but not to the Mediterranean. Takhtadjyan (1978) having analyzed significant amount of literature data, referred the Mediterranean area the foothill part of West Caucasus between the Anapa, Krasnodar and Tuapse, the rest parts of Caucasus he referred to the Euxinian and Caucasian province of the Boreal subrealm and Armeno-Iranian, Hyrcanian and Turanian provinces of Irano-Turanian region. Stanyukovich (1973) refers the North Caucasus and Transcaucasia to the type of belting of the mountains of the subtropic zone. Vereshchagin considered (1959) that the similarity and close affinity of the biocomplexes of the West

Mediterranean with Caucasus (up to Talysh - Elburz on the east) is connected with the single time of origin and formation of high mountain landscape. As reasonably wrote Il'insky (1937) under the landscape of Mediterranean type biogeographs not rarely mean the contemporary landscape of Spain, Sicily, Palestine. As a matter of fact, as in the west so in the east parts of Mediterranean alongside with xerophytic landscapes of garigue, phrygana and mountain steppes, there are relict landscapes of Tertiary coniferous and deciduous forests, mesophytic meadows of alpine and subalpine types. Szczerbak (1984) indicated both xerophyl and mesophyl species of amphibian and reptiles for the different centers of speciation in the limits of Mediterranean, what in our viewpoint is the reflection of many belts in the structure of Mediterranean fauna. For the Caucasian center 12 endemic species with 22 forms of *Lacerta saxicola*-complex, also *Mertensiella caucasica*, *Pelodytes causicus*, *Vipera kaznakovi*, are indicated. No doubt, Caucasus, having several centers of speciation, refers in a whole to the Mediterranean: beside the mentioned above 22 forms of *Lacerta saxicola*-complex, 5 forms of *L. derjugini*, 5 forms of *L. agilis* and many other

Lacertidae are living here. Above all, the number of endemic species of amphibian and reptiles is significant. Mesophylic Colchis center of speciation with three small refugiums out of its limits was described by us earlier (Tuniyev, 1990). Genetically close to it is another center of mesophyl fauna and flora - Hyrcan, including in itself Talysh and Elburz with such species as *Triturus vulgaris lantzi* (?), *Bufo verrucosissimus*, *Rana macrocnemis pseudodalmatina*, *Lacerta chlorogaster*, *Elaphe persica*. Beside these mesophylic centers on Caucasus there are and autochthonous xerophilic centers of speciation, connected mainly with the mountain-steppe landscapes of Lesser and Great Caucasus. Above the listed autochthonous for the Caucasus groups of species (Colchis, Hyrcanian, Lesser Caucasian, East-Caucasian) representatives of European, Turanian, Asia Minor and properly Mediterranean groups are meeting here. We shall concern the xerophilytic part of the Mediterranean group, common for all or the greatest part of the East Mediterranean. The latter group in dependence from the character of species distribution not rarely is divided on the Mediterranean and East Mediterranean (Darevsky, 1957a). The understanding of the volume of Mediterranean group variates in different authors (Sobolevsky, 1928, Bodenheimer, 1944, Darevsky, 1957, Anderson, 1968, Alekperov, 1978, Kireev, 1987 et al.). Alongside with it, the great majority of authors include in the number of Mediterranean faunistic elements the next species, distributed on the Caucasus: *Triturus cristatus karelini*, *Rana ridibunda*, *Mauremys caspica*, *Testudo graeca*, *Ophisops elegans*, *Pseudopus apodus*, *Typhlops vermicularis*, *Eryx jaculus*, *Natrix natrix persa*, *N. tessellata*, *Coluber najadum*, *Telescopus fallax iberus*, *Malpolon monspessulanus*. Earlier, considering the herpetofauna of the West Transcaucasus (Tuniyev, 1990) we included in the East-Mediterranean group *Triturus cristatus karelini*, *Testudo graeca*, *Lacerta media*, *L. strigata*, *L. praticola pontica*, *Pseudopus apodus*, *Natrix tessellata*, *Coluber najadum*. Above it, to the number of Mediterranean species in our viewpoint should be referred *Pelobates syriacus*, *Mauremys caspica*, *Ophisops elegans*, *Ablepharus chernovi*, *Cyrtopodion kotschy colchicus*, *Typhlops vermicularis*, *Eryx jaculus*, *Natrix natrix persa*, *Elaphe hohenerkeri*, *E. quatuorlineata*, *Coluber caspius*, *Eirenis modestus*, *Telescopus fallax*, *Malpolon monspessulanus*, *Vipera lebetina*, *V. ammodytes*. Despite the rather wide ponto-caspian distribution of *Coluber caspius* and *Elaphe quatuorlineata* from one hand, and inclination of the range centers to the Middle East in *E. hohenerkeri* and *V. lebetina* we consider the inclusion of these species into the Mediterranean group to be not less grounded than *Pseudopus apodus*, *Natrix tessellata* or *Lacerta strigata*. The base for this (as well as for all other species) served the character of recent distribution on the Caucasus and biotope dissemination in the first turn with an account of phytolandscapes. To the Mediterranean group on the Caucasus could be referred and *Elaphe situla*, as it seems, up to recent time was met in the relict populations near Tbilisi, Kislovodsk and Grozny (Lyajster, 1909; Bannikov et al., 1977). While regarding the general chorology of Mediterranean species of amphibians and reptiles, the investigators marked their distribution along the territory, adjusting to the coast of Mediterranean sea, Balkan peninsula, South Crimea and separate, mainly xerophilic regions of Caucasus. Let us regard more attentively the distribution of the species listed above on the Caucasian isthmus.

MATERIAL

Materials on the chorology and biotope distribution of Mediterranean species of amphibians and reptiles were gathered in the expeditions and during the

stationary works in the different regions of Caucasian isthmus from 1977 up to 1992 (Fig. 2). Additional material was taken from the numerous literature sources, where in that or other volume the distribution of the species interesting for us are regarded. Materials on the chorology of distinguished by us group of amphibians and reptiles are indicated for the Caucasus in a whole in the works of Nikolsky (1913), Moritz (1916), Terentyev, Chernov (1959), Bishoff, Engelmann (1976), Bannikov et al. (1977), Orlova (1978), Tuniyev (1985a), Rudik (1989). Besides it, the vast regional material on Armenia (Chernov, 1939; Dal, 1954; Darevsky, 1957; Melkumyan, 1973; Egiazaryan, 1981; Agasian, 1986); Georgia (Muskhelishvili, 1970; Pitzkhelauri, Bakradze, 1973; Zhordaniya, 1977; Bakradze, 1977; Pitzkhelauri, 1990); Azerbaydjan (Schmidt, 1909; Dombrovsky, 1913; Sobolevsky, 1929; Alekperov, 1954; 1973; 1978; Aliev, 1973, 1977, 1985, 1989; Alekperov et al., 1978; Chegodaev, 1973; Ananjeva, Nikitin, 1977; Aliguseinov, 1981; Dzhafarova, 1981; Kuzmin, 1981; Gadjiev et al., 1985; Akhmedov, 1989a, 1989b; Gasanov, 1989); Dagestan (Shibanov, 1935; Krasovsky, 1929, 1932; Khonjakina, 1964; Alkhasov, 1981; Leontyeva, 1986); Checheno-Ingushian republic (Lyaistar, 1909; Chernov, 1929; Karnaukhov, 1977, 1985, 1987; Tochiev, 1987; Lotiev, 1987); North Osetiya (Naniv, 1978; Kuryatnikov, Udovkin, 1987); Kabardino-Balkariya (Neemchenko, Tembotov, 1959; Shebzukhova, 1967, 1973); Karachayevo-Cherkessia and Stavropolsky region of Russia (Fedorov, 1956; Tertyshnikov, 1987, 1992); Adygeya and Krasnodarsky region of Russia (Rossikov, 1890; Brauner, 1905; Orlova, 1973; Tuniyev, 1983, 1985b, 1987a; Galichenko, Pereshkolnik, 1985; Shebzukhova, 1989); Abkhaziya (Rostombekov, 1939; Khozatsky, 1941; Milyanovsky, 1957; Rudik, 1986; Tuniyev, 1987b); Adzhariya (Deryugin, 1899; Nesterov, 1911; Vedmederya, 1977) was analyzed. Materials from the territories adjoining to Caucasus were taken in account: from the north - Kalmykia (Kireev, 1973, 1987); Rostov area of Russia (Guskov et al., 1983), from the south-boundary districts of Turkey and Iran (Deryugin, 1899; Nesterov, 1911; Bodenheimer, 1944; Clark et al., 1966; Anderson, 1968; Clark, Clark, 1973; Nilson, Andren, 1966; Nilson et al., 1988).

DISCUSSION

After composing the spot ranges for each of the species with the use of lines the chorology of Mediterranean amphibians and reptiles on the Caucasian Isthmus was schematized, for instance, as it is shown for the *Coluber najadum* and *Lacerta media* (Fig. 3). The map of superposition shows the density of distribution of Mediterranean species (Fig. 4). They are completely absent in the highlands of axial part of the Main Ridge (higher than 2 thousands meters above the sea level) and in the most elevated parts of the Lesser Caucasus, poorly represented in the West Transcaucasia, Colchis lowlands and in the upper belts of the mountains of Great and Lesser Caucasus, alongside, several plots with the high representation of Mediterranean species are distinguishing (Fig. 5). The largest of it embraces the foothill and middle mountain regions of the East Transcaucasia, located semicircular around the Kuro-Araksian lowland with the plots stretching to the foothills of Talysh (up to Zuvand inclusively) and to the south slope of Lesser Caucasus and Armeniyan Highland along the left bank of Araks, excluding Ararat valley properly and other plots along the river Araks. The second plot is distinguishing on the Caspian coast of the Dagestan foothills. The series of plots on the north slope of the East Caucasus represent the contrast pattern to the

greatest part of the territory with the complete or almost complete absence of the Mediterranean species - these are the semiarid hollows between the Main and Rocky ridges (Gunibskaya, Itumkalinskaya, Targimskaya, Sadono-Unalskaya and others). Analogous on the West Caucasus the narrow band of Black Sea coast from Anapa to Sukhumi is distinguishing. The representation of Mediterranean species in the canyon of the upper streams of the river Kura is also high. One more plot of the West Transcaucasia out of the limits of the former USSR deserve attention. It is located in the lower streams of the river Chorokh (Artvinskaya hollow).

Before the consideration of amphibians and reptiles fauna of the plots, listed above, it is appropriate to analyze their contemporary phytolandscape conditions, so far as it is known, that prokhorez is accomplished not by the separate species but by the communities in a whole (Chkhikvadze, 1991). The vast foothills and midhills of the Great and Lesser Caucasus setting the lowest part of the Kuro-Araksian lowlands and Ararat's valley are covered with arid open woodland with Pistachio light forests, Juniper light forests, Pistachio-Juniper light forests different variants of shibliak (*Paliurus spina-christy*, *Pyrus salicifolia*, *Amygdalus fenzliana*, *Rhamnus pallasii*) along the river valleys of the southern part of refugium sycamore groves remained (*Platanus orientalis*), sparsely along the river valleys - groves of *Pterocaria pterocarpa* and near the springs and close location of the soil waters - brushwood of *Ficus carica*. On the lowest altitude limit these open woodlands transform into the subtropic *Bothriochloa ischaemum* steppe, and on the upper limit are changed by phrygana and tomillares. In a whole the vegetation of this refugiums bears the East-Mediterranean - Middle Eastern appearance. It is notable, that located lower the proper Kuro-Araksian lowland also as a valley of the river Araks is covered with semidesert and desert vegetation, mainly hallophyte, more close to the Irano-Turanian desert vegetation, then to the vegetation of all other parts of Caucasus.

It is interesting to note, that Grosgeim (1939) in his famous work "The flora of Caucasus" referred the desert of Kuro-Araksian plate to the Turanian province together with the East Precaucasia and Apsheron peninsula. Later on Lavrenko (1965) included these deserts (without the East Precaucasia) in the particular Kuro-Araksian province of Irano-Turanian subregion of Afro-Asian (Sahara-Gobi) desert region. The Caspian coast of Dagestan, composed by the slopes of East Caucasus, is covered by the primary and secondary shibliaks, groups of *Quercus petraea* and *Quercus pubescens*, alternating with the Juniper light forest, thorn forest and xerophilic bushes. In the mouth of the river Samur the liana forest with the participation of *Pterocaria pterocarpa*, *Hedera pastuchovii*, *Periploca graeca* and others is developed, what makes this plot similar in appearance with the forests of Talysh and representing the derivat of the forest of the Hyrcan type.

East-Caucasian refugium of oreoxerophytes, including shibliaks and phrygana, are located along the Jurassic slate depression of northern slope of the Great Caucasus between the Main and Rocky ridges. It is the series of semiarid hollows, stretching from the internal Dagestan (Gunib Plateau) up to the upper waters of the river Kuban. In the plant communities participate *Juniperus*, *Paliurus spina-christy*, *Cerasus incana*, *Colutea orientalis*, *Berberis*, *Astragalus* and many others. The age of vegetation is interpreted differently. The majority of authors are keeping the Pliocene origin of the vegetation (Krasnov, 1894; Grosgeim, 1948; and others). According to the opinion of Galushko (1974),

1

semiarid hollows of Checheno-Ingushetiya are younger than located on the west and east hollows of Kabardino-Balkariya and Dagestan, and, apparently, not older than Holocene. The remains of xerophilic flora on the ridges, dividing the hollows, spoke for the existence of single vast Mediterranean refugium from the Pre-Elbrus to Dagestan, broken later on the number of microrefugia in the Pleistocene and in a different degree of preservation having remained up to now.

It should be underlined, that the tracks of xerothermic period are discovered and on the West Caucasus in the district of Yaturgvarta and Magisho mountains (Altukhov, 1967), here, however, the xerophilic vegetation never was widely developed due to the climatic peculiarities and powerful influence of Colchis, which is observed and now. The Black sea refugium, embracing the extreme western edge of the Great Caucasus in the district of Anapa - Gelendzhik - Dzhubga and the series of enclaves from Tuapse to Sukhumi represent particular Crimea-Novorossiisk province of Mediterranean. On the west of the refugium remained Pistachio and Juniper light forests, the plots of tomillares and *Quercus pubescens* droves, on the east - *Cytisus monspessulanus*, *Punica granatum*, *Arbutus andrachne*, *Erica arborea*, *Laurus nobilis*. Along the whole refugium *Pinus pitysusa*, *Cistus tauricus*, *Paliurus spina-christy*, *Rhus coriaria*, *Cotinus coggygria*, *Colutea cilicicus* are common. The valley of the river Chorokh in the district of Artvin represent itself the dry and hot hollow surrounded by the circle of high ridges (Pontic, Shavshetsky, Arsiansky), with the 500-600 mm of year precipitation, in a form of short summer rains (Menitsky, 1984). Voronov (1908) describing the changes of vegetation from the lower streams of Chorokh to the Artvin, indicated that already beyond Borchkha the dry slopes are covered with "rare forests from the crooked *Quercus iberica* with *Carpinus orientalis*, pine groves, woodlike juniper, thickets of xerophilic bushes... In the most dry sites of the district, as for example, in Ordzgoxh, Ardanuch, sometimes in the Imerkhevsk canyon the woodlands are practically absent, the bare rocks are covered with rare, scarced specimens of *Punica granatum*, *Rhamnus palasii*, unipers and other or covered with thorn *Astragalus*" (P.3). It is rather notable, that there are collections of typical Mediterranean oak *Quercus infectoria ssp. infectoria* from this region (Menitsky, 1984), and groves of typical Mediterranean pine *Pinus pinea* are meeting (Nasimovich, 1979).

It should be noted, that on the Caucasus different in age and origin relict types of vegetation and their refugia are often located near by on the confined territory. This rule, repeating in all regions of Caucasus reflect the result of repeated translocations of the vertical vegetation belting, having place already in the Pliocene, and in the Pleistocene-Holocene particularly. Only for the Holocene there have been marked 11 such translocations (Kvavadze, Rukhadze, 1989). That is why the general Scheme of distribution of Mediterranean vegetation on the fig.6 though and reflects the picture in a whole, is yet in many aspects conditional, so far, as actually, on the place we are discovering on mosaic distribution of plant communities, especially on the Black sea coast of Caucasus, in the semiarid hollows of the East Caucasus, in the district of Karabakh, upper streams of Kura river and in the vicinity of Artvin. So, on the Black sea coast of Caucasus the solid distribution of the East-Mediterranean vegetation is taken place only on the extreme north-west from Anapa to Gelendzhik. Further on, in direction to the south-east this vegetation is represented by the series of enclaves, located on the steep sea hills, with the slopes of the south and east exposition, distributed among the Colchis vegetation

and only on the littoral the sea Mediterranean vegetation remains (Kolakovsky, 1980). In the semiarid hollows of the East Caucasus oreoxerophitic vegetation is growing on the steep slopes of east exposition, whereas the slopes of the western exposition are covered with mesophylic forests, therewith, for instance, for the Itum-Kalinskaya hollow (Checheno-Ingushetiya) the existence of four group local disjunctions in one refugium has been marked: 1 - steppe species; 2 - oreoxerophites; 3 - shibliaks and 4 - deciduous forests (Galushko, 1974) (Fig. 7). In the region of Nagorny Karabakh the relicts of the Mediterranean shibliaks and arid light forests (*Pistacia mutica*, *Cerasus mahaleb*, *Pyrus salicifolia*, *Cotinus coggygria*, *Pinus granatum*, *Paliurus spina-christy*, *Rhus coriaria* and others) are growing near by with the Colchis-Hyrcan relicts (*Zelkova carpinifolia*, *Castanea sativa*, *Taxus baccata* and others) (Arushanyan, 1973). In the upper streams of the river Kura already in the limits of Borzhom canyon the transition of vegetation from Colchis type in the Baniskhevy and Likany canyon through the intermediate variants (in Chitakhevy and Kvabiskhevy) to the Mediterranean in Zorety canyon is observing. Along the river Chorokh the direct closeness from the dry Artvin hollow in the side canyons and in the mediate mountain belt a rich Colchis-Lazistan vegetation with such forest founders as *Quercus petraea dshorochensis*, *Picea orientalis*, *Carpinus betulus* and many others is represented (Menitsky, 1984). In correspondence with the variegated vegetation the herpetocomplexes of the different regions of Caucasus are complex. Nevertheless, the core of the fauna always could be determined, independently from the regarded xerophilic or mesophylic group of the animal world.

Kuro-Araksian refugium

Among the widely distributed along the whole territory of the refugium (Tabl. 1) should be indicated *Pelobates syriacus*, *Testudo graeca*, *Mauremys caspica*, *Lacerta media*, *L. strigata*, *Pseudopus adopus*, *Ophisops elegans*, *Natrix tessellata*, *N. natrix persa*, *Coluber najadum*, *C. caspius schmidti*, *Typhlops vermicularis*, *Eryx jaculus*, *Elaphe hohenackeri*, *E. quatuorlineata*, *Telescopus fallax*, *Eirenis modestus*, *Malpolon monspessulanus*, *Vipera lebetina*. If on the north of the refugium (in the south foothills of the Great Caucasus and in the valley of the river Kura) these species inhabit rather low altitudes - up to 600 - 700 m above the sea level, in Araksian part, on the south of the refugium, these species occupy already more high belts of the mountains, sometimes achieving 2000 m above the sea level. In the most low plots of Kura-Araksian plate, over the limits of the distinguished refugium, the species of Turanian origin *Eremias velox*, *E. arguta*, *Cyrtopodion caspius*, *Ablepharus pannonicus* are meeting. In the valley of Araks to these species *Psammophis lineolatum* and species the formation of which is connected with the semidesert and desert regions of Armenian and western part of Iranian highlands: *Eremias trauchi*, *E. pleskei*, *Mabuja aurata*, *Eirenis punctatolineata*, *Rhynchocalamus melanocephalus satunini*, *Coluber nummifer*, *Ablepharus bivittatus*, *Pseudocyclophis persicus* are adding. No doubt, it would be incorrect to consider all these species on the Caucasus as a Late Pleistocene migrants. Middle Eastern xerophilic complex of flora and fauna, occupying more perfect step of fitness to the arid conditions, is closely connected with the Mediterranean one. The latter assumption evidence for the long existence on the Caucasus along with the Mediterranean cenoses elements on the Middle Eastern cenoses. Otherwise, such species as *Laudakia caucasia*, *Phrynocephalus persicus*, *Eumeces shnaideri*, *Eirenis collaris*,

1

Coluber ravergieri and species of Armenian Highland could inhabit this territory already in the Pliocene. On the upper limit of distribution the Mediterranean species are meeting together with Caucasian and Lesser Caucasian species (*Rana macrocnemis*, *R. camerani*, Archaeolacerta-complex, *Vipera eriwanensis* and other), also as with the representatives of the middle mountain belt of the Armenian Highland (*Vipera raddei*, *Lacerta parva*). Mediterranean species, which have a limited distribution in the Kuro-Araksian refugium are represented by *Triturus cristatus karelini*, (foothills of the Great Caucasus on the north and Talysh - on the south), *Cyrtopodian kotschy colchicus* (is known from the Turkei part of the Ararat valley), *Lacerta praticola* (the north part of the refugium), *Ablepharus chernovi* (Razdan canyon in Armenia), *Vipera ammodytes transcaucasiana* (vicinities of Gyandzha on the Aserbaijan). All listed species practically occupy the most mesophylic part in the general xerophilic spectrum of the Mediterranean species. Suppression of this species in the refugium with the existence of the great number of Turanian and Iranian (Middle Eastern) species once again underlines the peculiarity of this territory and the complexity of its formation.

Refugium of the Dagestan foothills

In the species relation somewhat poor refugium (Tabl. 1), though, in our opinion, the possibility of finding such species as *Elaphe hohenackeri*, *Eryx jaculus* and, possibly, *Triturus cristatus karelini* is not excluded. It is notable that here in the significant volume and Iranian complex of species is represented (*Laudakia caucasia*, *Eumeces shneideri*, *Coluber ravergieri*, *Eirenis collaris*), but there are no representatives of the Armenian Highland, so typical of Araksian part of the Kuro-Araksian refugium. Near the northern border of the refugium the sandy dune Sarykum with such typical Turanian species as *Phrynocephalus mystaceus* is located.

Refugium of the North-Eastern Caucasus

The most poor among the considered regions. Along with it the species composition is so specific, and accompanying fauna and flora is typical of more south latitudes, that this district deserves to be distinguished and described as the derivate of Mediterranean cenoses. Mediterranean species are represented in different hollows in different combinations: so, *Eirenis modestus* and *Lacerta strigata* are known from the eastern part of the refugium, whereas the rest species are meeting in the majority of the semiarid hollows. From the Iranian species on the east of the refugium remained *Coluber ravergieri*. The fact of the presence of species identical or very closed to Lesser Caucasus among them, and *Rana camerani* and *Vipera "eriwanensis"* almost in all hollows is notable. Along the upper limit of each of the refugium of this combined refugium Caucasian species (*Vipera dinniki*, *Rana macrocnemis*, *Lacerta daghestanica*, *L. caucasica*) are meeting. Caucasian species of the forest belt (*Lacerta agilis boemica*, *Rana macrocnemis*) together with the European species* (*Coronella austriaca*, *Anguis fragilis*) are typical of the Western expositions of these hollows (see Fig. 7) where they are joined by the Colchian species *Lacerta rudis*. It is interesting that in the shibliaks, phrygas and stepped meadows among the shibliaks of Itumkalin hollow the Mediterranean species are joined only by *Coronella austriaca* symbiotic here to the *Elaphe hohenackeri*. All the rest species are meeting by ecotones of

Mediterranean and Caucasian mountain-forest and mountain-meadow
cenoses, not penetrating inside the Mediterranean phytolandscapes.

Black Sea refugium

The species of this refugium were described by us earlier (Tuniyev, 1990). Their distribution on the Black sea coast of Caucasus is linked to the narrow band from Anapa on the north-west to Sukhumi on the south-east. Due to the long-term transforming activity of the man the strict dependence in the distribution of the Mediterranean species of herpetofauna from the corresponding landscapes is not observing. These species along the forestles spaces sometimes penetrate deep into Colchis and are meeting with the typical representatives of Colchis ecological-geographical group. The most saturated in the species relation areas are observed in the well remained East-Mediterranean phytocenoses in the vicinity of Novorossiysk and Pitsunda. For this refugium the features of extinction due to the high humidity and number of precipitation preventing the modern expansion of Mediterranean species are typical. Beside the general regularity of disjunctive distribution of species on the indicated section of the coast, *Elaphe qutuorlineata* is known only from the north-western part of the refugium, *Lacerta strigata* - only from the south-east. There is an analogy with the unevenness of the recent distribution of Mediterranean species if plants, what is once again illustrated by the common tendency in development, formation and extinction of cenoses. On the north-west of the refugium such steppe species as *Bufo viridis*, *Vipera renardi* are rather common. Here and unique Caucasian forms *Bufo verrucosissimus circassicus* and *Lacerta saxicola szczerbaki* have remained. In the direction towards the south these forms are disappearing or substituted by the Colchis *Bufo v.verrucosissimus*, *Lacerta saxicola darevskii*, *Vipera kaznakovi* and others.

Upper-Kurin refugium

This not large in space plot is directly adjusted to the Borjom refugium of Colchis herpetofauna (Tuniyev, 1990). It represents one of those complex examples of the mutual existence of genetically different complexes of cenoses, which we have indicated with the description of vegetation of the listed refugiums. In order to avoid confusion this refugium has been named Upper-Kurin. Here we can see, close to the Colchis influence, the remaining of the most mesophylic part of the Mediterranean species with the complete absence of other xerophiles. If such species as *Triturus cristatus karelini*, *Lacerta media*, *Natrix tessellata*, *Natrix natrix persa*, *Vipera ammodytes* are rather common here and even come out of the indicated territory, such species as *Pelobates syriacus*, *Coluber najadum*, *Telescopus fallax*, *Eirenis modestus*, *Pseudopus apodus* are already rare and are meeting not along the whole territory of refugium. Turan elements are completely absent here, and from the Middle Eastern species only *Laudakia caucasia* is meeting. In a whole, Upper-Kurin plot is located as in the direct closeness from the Colchis center of speciation (*Archaeolacerta*-complex, *Vipera darevskii*) and Kuro-Araksian refugium of Mediterranean species, but the distribution of Mediterranean species is linked, unlike the latter, to the lower part of the river Kura canyon.

Artvin refugium

1

It is the only one of the described regions the data on which totally are taken from the literature as we have no possibility to visit this region personally. The species listed in the table I confirm the remainance in the Artvin valley wide spectrum of Mediterranean cenoses: from the very dry and warm, suitable for habitation of *Cyrtopodion kotschyi*, *Lacerta strigata*, *Ophisops elegans*, *Vipera lebetina* up to xerophilous-mesophil and , as it known even mesophylous with a typical number of Colchis-Lazistan species. Vegetation diversity of the Chorokh valley from the Borchkha up to the Artvin-Ardanuch is indicated above. In correspondence with it, from one hand it is possible to suppose here the occurrence of the row of species (*Pelobates syriacus*, *Lacerta media*, *L.praticola*, *Pseudopus apodus*, *Telescopus fallax*) from the other hand - *Vipera pontica* (Billing et al., 1989) described from this region evidence for the long existence of climatic conditions, differ from Black Sea coastal Lazistan conditions in many aspects local, explaining the presence of *V.pontica* with a rather wide distribution in the seaside Adzharo-Lazistan - *V.kaznakovi*.

The history of development of the Mediterranean refugiums of Caucasus

In order to understand the recent character of distribution of the Mediterranean species on the Caucasian Isthmus and conditions (possibilities) of remainance of the main refugiums it is necessary to consider the known paleontological material. Unfortunately this material is not so large, as we would like it to be, but nevertheless it allows to judge on the general tendencies in the development of Caucasus herpetofauna. If to take in account rather complete data on fossil mammals of Caucasus (Vereshchagin, 1959) and paleobotanic data, an attempt to reconstruct the way of formation of the herpetocomplexes of the isthmus could be made. Premiocene history of Caucasus by the majority of the authors (Vereshchagin, 1959; Darevsky, 1967; Alekperov, 1978 and other) is described as the history of tropical mountain island in the Tethys with a luxurious mesophil flora. In any mountains, of course, local conditions of edaphic dryness, for instance, on the rocks or steep slopes what results in the appearance of the xerophytes. For the development of the xerophilous vegetation, however, as the belt, significantly greater corresponding climate alteration is demanded. In this connection, it is quite possible, that before Miocene Caucasus was more humid, than the mountain land, located to the south and stretching from Afganistan through the Central Iran, Asia Minor, Balkan up to Alps, for which the fact of continuous existence of the mountain belt of arid climat from the Cretaceous is considered to be established with the corresponding hemixerophil phyto-landscapes (Krishtophovich, 1964; Kolakovsky, 1974a, b). The fossil herpetofauna of Premiocene Caucasus is represented by the Middle Jurassic *Stenosaurus* sp. from the Mountain Dagestan (Bakradze, Chkhikvadze, 1988), tracks of dinosaurs on the Lower Cretaceous limestones of Satapliya in the West Georgia (Gabunia, 1951), *Mosasaurus* sp. of the date Cretaceous period of Azerbaijan (Gabunia, 1958) and Oligocene-Lower Miocene records from the Benara in the South Georgia, where *Palaeochelys gabunii* (Emydidae), *Ergilemys meschethica* (Testudinidae), *Trionyx* sp. (Trionychidae) were identified (Bakradze, Chkhikvadze, 1988). From the Middle Sarmat Caucasus became a peninsula of the Middle Eastern land (Vereshchagin, 1959; Darevsky, 1963; Menitsky, 1984) to which also were linked Anatoliya and Balkans. Kolakovsky (1974a) suppose, that floristic exchange between Europe, Caucasus and East Asia was taken place up to Upper Miocene. If the Great Caucasus remained to be surrounded by sea

1

from the three sides and remain the tropical sea climate, the basement of the isthmus have already experience significant continental influence and gave the premises for the development of semiarid landscapes alongside with the humid ones. Supposed development of climates and landscapes could explain the presence of *Chelonia caucasia* on the Chernaya river (North Caucasus) and giant terrestrial turtle of the *Ergilemys meschethica* type beside Benara yet in the Akhaltsikh (Bakradze, Chkhikvadze, 1988).

In the Miocene the processes of "borealisation" occupie practically the whole Caucasus. Thus, from the Middle Sarmat in the number of sites of the East Georgia up to the 70% of trees species already belong to the decidous species (Palibin, 1935). Grosgeim having compared the Upper Miocene flora of Asia Minor with this one came to the conclusion that they are very close and are characterised by the same mixture of boreal and subtropical elements. Vereshchagin (1959) considered that the fact of started process of flora "borealisation" is imporatant for the understanding of the further fauna evolution, so far, as in the Sarmat on the Caucasian peninsula the representatives of the hipparion fauna are appearing. Particular interest for the reconstruction of Miocene landscapes and faunistic connections of Middle East with Caucasus represent the fauna of the Sekhend mountain near Maraga in Iran. Among the reptiles only the remains of terrestrial turtle are known (Bakradze, Chkhikvadze, 1988). The mammals, however, are represented by almost 40 species (Primates, Carnivora, Tubulidentata, Proboscidea, Perissodactyla, Artiodactyla) and birds - *Struthio* sp., *Urmiornis maraghanus*(Vereshchagin, 1959). According to the opinion of Vereshchagin the clear dominance of the inhabitants of the open landscapes with the occurence of forms, inhabiting and subtropical forests allow to speak on the mixed savanna-gilein landscapes, typical in the Miocene for the northern parts of the recent Iran Highland. In the Asia Minor the Upper Miocene mammals, discovered near the Istanbul, Upper Gediz, Mugli, in Gelatiya and Kappadokiya are of one type with the sites on Samos and on Balkans near Athens-Pikermi (Vereshchagin, 1959). Vereshchagin considered that the faunistic complex of the Maraga type was, apparently, typical for the whole Middle East, what is confirmed by the genesis of Asia Minor landscapes. More over the Upper Miocene fauna of mammals of Middle East, Caucasus, Crimea and Balkans display great similarity. It is interesting that Grossgeim (1936) considered Meotis to be the time of wide penetration on the Caucasus the south xerophilous flora. In the East Transcaucasia many recent or close to them species of reptiles were already existing. For the Late Sarmat of the West Azerbaijan Alekperov(1978) indicate *Testudo eldarica*, in the adjoining East Georgia: in Eldari, Pantishara, Iori - *Testudo burtschaki*, *Chelydropsis* sp., *Trionix* sp., *Emydoidea taraschuki*, *Mauremys sarmatica* were found (Bakradze, Chkhikvadze, 1984, 1988). From the vicinity of Rustavi Zerova and Chkhikvadze (1984) indicate large *Vipera* sp. which later on supposively reffered to the *Vipera cf. lebetina* (Bakradze, Chkhikvadze, 1988). In the Garedzhiyskaya steppe, between the basins of the Kura river and the river Iori, near the village Udabno (East Georgia) *Mauremys* sp., *Ergilemys* sp., *Testudo* sp. from Meotis were found (Bakradze, Chkhikvadze, 1988). On the north slope of the Great Caucasus in the Miocene, alongside with hydrophilous fauna the xerophilous species and species typical of the recent European Mediterranean appear: from the Belomechetskaya countryside the Middle Miocene *Trionyx* sp., ? *Ergilemys* sp., ? *Prottestudo* sp., *Lacerta* sp., *Colubridae* gen.indet. have been recorded (Chkhikvadze, Lungu, 1984); Middle Sarmat amphibians and

1

reptiles from the lake deposits on the river Belaya (White river) (Maikop) are represented by *Trionyx khosatzkyi*, Emydidae gen.indet., *Mioproteus caucasicus*, *Triturus cf.marmoratus*, *Lacerta* sp., Ranidae gen.indet., Discoglossidae gen.indet. (Estes, Darevsky, 1977; Chkhikvadze, Lungu, 1984). The fossil remains of the skulls of *Lacerta* found here were later on analysed by Darevsky (1990) who considers that with the high degree of probability it is the representative of the subgenus *Lacerta* s. str. which could be referred to one of the recent species (*L.media*, *L.strigata*, *L.agilis*) or to the extinct, ancestral for all of them species. To the same species according to the supposition of Darevsky, refers and *Lacerta* from the Middle Miocene of Belomechetskaya site. The mentioned records of lizards, according to the opinion of Darevsky evidence for the Asian Minor way of penetration of lacertids from the Europe to the Caucasus, so as the Asia Minor was separated by the sea channels from the Balkans only after Sarmat time. The same idea on the base of the records of *Triturus cf.marmoratus* and *Mioproteus caucasicus* close to the recent relict *Proteus anguineus* is suggested by Borkin (1986). In the Lower Pliocene Caucasus still remained to be peninsula and only from the end of Pont the sea is regressing from the Precaucasia and Caucasus transforms into Isthmus (Vereshchagin, 1959; Alekperov, 1978). Landscapes of the east and west parts of the Caucasus were already significantly different: Colchis and adjoining districts remained the belting of humid subtropics and in the Kimmerian even close to the tropics; whereas on the east the more dry Hyrcan forests in a form of continuous band stretched along the west coast of the Caspian sea and its Kurinsky and Samursky gulfs to the north up to Ergeni and in the internal part of the eastern part of the Isthmus arid and semiarid landscapes extended. Particular appearance to the flora of West Transcaucasia gave the ferns, which in abundance and diversity have no analogous even among the known more ancient Tertiary flora and could be compared only with Cretaceous (Mchedlishvili, 1963). The floristic composition of Colchis beside the abundance of ferns is characterised by the exclusive richness of subtropical forms among the gymnosperms (*Ginkgo adiantoides*, *Podocarpus*, *Cedrus*, *Tsuga*, *Abies*, *Clyptostrobus*, *Sequoia*, *Cryptomeria* and others) and angiosperm plants, and the absence of edificators give it the ancient tropic appearance, somehow resembling the floras of Oligocene. In the vegetation on the base of the pollen analysis it is possible to distinguish the dark coniferous forests, deciduous forests, evergreen forests, forests of the river valleys and hydrophilous formations (Mchedlishvili, 1963).

Tertiary relicts of the West Caucasus which have remained up to now are very diverse in their generic connections, but most clearly in the opinion of Maleev (1938) they reveal the close connection of Caucasian flora with the flora of Mediterranean. The flora of Mediterranean is composed by two complexes: hemixerophilous and mesophilous. The first one is the modified xerophilized derivat of the ancient subtropical flora of the Poltava type with the significant including of Middle Eastern elements, the second one is the weakly modified derivat of Angarid or Turgai flora. Grossgeim (1936) connect the formation of the widest centre of xerophilic flora in the form of recent Mediterranean with the second half of Tertiary. Despite the abundance of Mediterranean species in the Caucasus flora, however, the type of Mediterranean vegetation is almost absent on the Caucasus now, excluding makvis on the Black sea coast and shibliak in the centre and on the east of the Isthmus. The connection of the erophilous flora of Caucasus, however, according to Grossgeim is particularly clear with the Middle East, from where the ancient xerophytes could penetrate not only to

Transcaucasia, but and on the north slope of Great Caucasus in the Dagestan. On the development of two xerophytic centres in Armenia and Mountain Dagestan have spoke earlier also Kuznetsov (1909). It is interesting that in the opinion of Grossgeim (1936) the main way of penetration of Mediterranean elements to Caucasus passed through Manych from the north, and the main migration of Mediterranean species took place comparatively late, before the Ice age. Differences in the flora of the West Transcaucasia and West Precaucasia were marked already in the Kimmerian: in the West Precaucasia the number of ferns, subtropical forms of gymnosperm and angiosperm plants pronouncely decreased, the number of herbaceous plants increased. The pollen spectrums reflect the existence here of forest-steppe vegetation (Mchedliashvili, 1963). It is interesting in this connection, that the Pliocene records of reptiles from the north slope of the Great Caucasus are reffered to the fauna of Moldova complex, which have the wide distribution along the whole north Black sea area. Thus, from the site Kosyakinskiy pit (North Caucasus) *Lacerta* sp., *Bufo* sp., *Rana* sp. (Vereshchagin, 1959) *Melanochelys pidoplickoi*, *Sakya riabinini*, *Testudo cernovi cernovi* (Bakradze, Chkhikvadze, 1988; Chkhikvadze, 1989a, 1989b) were recorded. And from the north Black sea area (Ukraine, Moldova) *Andrias* sp., *Mioproteus* sp., *Latonia cf.seyfriedii*, *Ophisaurus* sp., *Varanus* sp., *Vipera cf.lebetina*, *Chelydropsis nopcsai*, *Melanochelys pidoplickoi*, *Sakya riabinini*, *Testudo cernovi cernovi*, *Emys orbicularis antiqua* (Bakradze, Chkhikvadze, 1988; Redkozubov, Shushpanov, 1985) are known. The latter species have been found and described from the Pliocene deposits near Stavropol (North Caucasus). Beside it, the different representatives of the genus *Testudo* are known from the Pliocene sites in Ust-Labinsk (Krasnodar region), vicinity of Grozny in Checheno-Inguchetiya (Alekperov, 1978). For the majority of Mediterranean species, apparently the Upper Pliocene was the time of the last wide distribution in the North Black sea area, including and Precaucasia. Anyway, it was the last time of Mediterranean species and for the major part of Europe, where the forest complexes of Sarmat, similar with the contemporary Mediterranean were discovered even in Hungary (Andreanzsky, 1963) with the such species as *Quercus ilex*, *Pistacia lentiscoides*, *Rhus palaeocotinus*, *Rh.cf.coriaria*, *Acer decipiens*, *A.cf.monspessulanum*, *Phillyrea cf. latifolia*, *Viburnum tinus*. In the Pontic level of the river Kodor in Abkhasia Kolakovsky (1964) discovered unique type of sclerophyll oak paleoformation with the dominance of *Quercus sosnowskyi*. This evergreen species is the extinct link between the Hymalay-Chines *Q.semicarpifolia* and Mediterranean *Q.alnifolia* and *Q.suber* (Menitsky, 1982). Despite the sclerophilly, Kolakovsky considered *Q.sosnowskyi* as the more hydrophilis species, than its recent Mediterranean descendants on the base of its participance in the communities of mesophilous species *Carpinus cuspidens*, *C.uniserrata* and comparatively small part in these communities the elements of the recent Mediterranean flora (*Arbutus elegans*, *Laurus nobilis foss.*, *Myrtus rarinervis*, *Pistacia miochinensis*, *Celtis magnifica*, *Cotinus coggygria-fossilis*). *Sakya riabinini* (Bakradze, Chkhikvadze, 1988) which is a typical element of Moldova faunistic complex is known from this site. This means that already from the Pliocene the presence of the Mediterranean species of animals on the Black sea coast of Caucasus was observed. In the eastern part of Caucasus along the shores of at first Caspian sector of Pont and then Balakhan basin was vegetation described by Baranov (1952) from Ergeni, though and deciduous but thermophylous with such species as *Corilus fossilis*, *Alnus incana*, *Quercus* sp., *Castanea* sp., *Parrotia*

persica, Araliacea. The indicator of the warm climate, as appropriately wrote Vereshchagin (1959) is *Parrotia persica*, which remained nowadays 100 to the south in Talysh-Elburz. Parallel with Hyrcan the development of xerophilous Mediterranean and Middle Eastern vegetation was going on. The record of Upper Pliocene *Testudo* sp. from Ergeni, similar in size with the recent *Testudo graeca* (Aleksperov, 1978) is remarkable. Vereshchagin (1959) pointed on the independent Middle Eastern centre of genesis of two subtypes of terio-complexes of the Pliocene age: mountain-steppe and mountain-desert. Differentiation of the middle eastern complex on the mentioned subtypes is connected with the strong relief diversity of the mountain country and climatic differences. Whereas as in the broad intermountain valleys and narrow canyons the biocenoses of mountain-desert type were developing, on the near by high plateaus and ridges ecological groups of mountain steppe landscape and even meadow-steppes were forming (Vereshchagin, 1959). The impact of this south complex on the Caucasian Isthmus broke on several steps, but the most ancient in the opinion of Vereshchagin had to be considered the Miocene-Pliocene step. Apparently, in the Pliocene alongside with the Mediterranean species of herpetofauna wide distribution in the eastern part of Caucasian Isthmus had and Middle Eastern: as mountain-steppe (*Laudakia caucasia*, *Coluber ravergieri* and other), so mountain-desert (*Mabuja aurata*, *Coluber nummifer*). Pliocene records from the foothills of the Eastern Caucasus refer in the main to tortillas: from Kvabebi, Kumuros-Khevi (East Georgia) - *Testudo cernovi transcaucasica*, Bazaleti - *Testudo bosporica*; Enikend (Azerbaijan), Nurnus (Armeniya) - *Mauremys cf. caspica* (Chkhikvadze, 1977; Bakradze, Chkhikvadze, 1984, 1988). From the mountain regions - Kusatibi (South Georgia) *Rana macrocnemis angeloi* (Bogachev, 1927) is known. These records evidence for the development of semiarid landscapes with warm shallow water bodies, open lands in the foothills and together with it mesophylous landscapes in mountains. Peculiarities of taphonomy and species composition of the Upper Pliocene mammals of Transcaucasia, according to Vereshchagin (1959), confirm the occurrence there in the Apsheron (Upper Pliocene) moderate but not cold climate, strong volcanic activity and reflect to the certain degree arid or semiarid conditions in the eastern and south parts of Caucasus. Apparently, already in the Pliocene the primary break of hemixerophilous landscapes of the Caucasian Isthmus: on Transcaucasian and North-Caucasian, due to the continuous intensive orogenesis from one hand and successive transgressions of Caspian sea - from the other. For our understanding of remainance of Recent Mediterranean refugiums great significance has the fact of vast flood during the period of all three Caspian transgressions Balakhan, Akchagyl and Apsheron (Fig.8) of lowlands of the contemporary Kuro-Araksian lowland, Apsheron peninsula and lowland of the river Terek. The foothill Dagestan remained to be stable land, which apparently, was connected in the Pliocene with the Recent refugiums of the North Caucasus. At the same time, most probably, aridization and separation of Artvin hollow from the humid Lazistan, due to the same process of orogenesis, which created conditions of "rainy shadow" in the hollow, surrounded by the high Pontic, Shavshet and Arsiyan ridges, is taking place. Similar to the Artvin, semiarid conditions could be developing in the Akhaltsikh Highland, upper the recent Upper Kurin refugium. What concerns Black sea coast of Caucasus, here, in the Pliocene still prevailed humid landscapes and only separate representatives of the xerophilous flora and fauna penetrated on the areas of steep seaside slopes with

the local conditions of edaphic dryness. Thus, in the Paleogene all families, survived up to the Recent already existed (Bakradze, Chkhikvadze, 1988). On the Caucasus and in the nearest vicinities of this Isthmus habitate as mesophylous, so in great diversity xerophilous species of herpetofauna, identical or close to many recent species of Caucasus. Darevsky (1963) consider that to the end of the Pliocene on the Caucasus the primary core of its recent herpetofauna with such genera as *Agama*, *Lacerta*, *Ophisaurus*, *Anguis*, *Typhlops*, *Malpolon*, *Vipera* have been already formed. The Pleistocene history of Caucasus is in the first turn the impact of glaciation in the axial part of the Great Caucasus and in the most high areas of the Lesser Caucasus and Armenian Highland attended with the glacial and pluvial periods of pulsation of Black and Caspian seas basins also the indirect impact of European sheet. On the Great Caucasus the glaciation concerned mainly the Central and West Caucasus and significantly less was displayed on the East Caucasus. Shifts of vegetation belts connected with the phases of glaciation declined to the foothills the forest belt on the north slopes of the West and Central Caucasus and on the south slopes the upper boundary of the forest went down up to the altitude 1000-1200 m even in the most protected and warm Abkhasiya (Kvavadze, Rukhadze, 1989). The data of pollen analysis have shown that the lower belts of forest practically have not been changed (excluding the extinction of the most thermophilous forms), and the main changes occurred in the upper-forest and subalpine belts. Humid and relatively warm Colchis in the Pleistocene became the main refugium of the mesophylous flora and fauna, Several more smaller in size analogous refugia remained in the foothills of the North-West Caucasus and East Transcaucasia (Tuniyev, 1990). The Pleistocene remains of *Bufo verrucosissimus* are known from the different regions of Colchis: in Abkhasiya - Kholodny Grot and Kep-Bagaz; Guria-Belaya (White) cave (Chkhikvadze, 1984). Great interest represent the remains of the frogs (*Rana* sp., *R. ridibunda*, *R. macrocnemis*) from the cave Kudaro-I in the South Osetiya (Darevsky, 1980), late it refers to *Bufo* sp., *Rana* sp. and *Ranidae* indet. (Rocek, 1993). Xerophilous Mediterranean formations in this period on the West Caucasus were remaining only on the extreme north-west in the region of Novorossisk, but here, apparently, they were significantly pressed back by the Colchis cenoses, which went down. It is likely, that in the Pleistocene the west end of the Great Caucasus reached such mesophylic species as *Triturus vittatus*, *Bufo verrucosissimus*, *Rana macrocnemis*, *Lacerta saxicola*, *Vipera kaznakovi* together with such mesophytes as *Fagus orientalis*, *Carpinus betulus* and other which and today are meeting here in the relict microbiotops. It is not excluded that a small plot of the Mediterranean cenoses remained in the Kavakluk Highland in Abkhasiya. Further development of Black sea refugium of Mediterranean herpetofauna is connected with Holocene, in the xerothermic period of which the Mediterranean species of plants and animals were able to occupy in Colchis the most insolated steep seaside slopes. Together with them in the Holocene along the Black sea coast of Caucasus the movement of the European species, among them and mammals (Vereshchagin, 1959) took place. Mediterranean species on the Black sea coast of Caucasus, as it seems, never crossed the river Ingur. In the majority they spread to the east only till the river Kodor. Though Darevsky (1963) is correct, indicating the processes of orogenesis as the reason of the disjunction of the initial ranges of a number of xerophilous species (*Lacerta media*, *Pseudopus apodus*, *Coluber najadum*, *Testudo graeca*) on the Caucasus, what concerns the secondary extinction of these species in the

West Georgia, we can't agree with him. Xerophilous species of herpetofauna so as conditions for their existence on the greatest part of the West Georgia never occurred. Only low plateau of Imeretiya according to Vereshchagin (1959) were in the Upper Pleistocene the north-west (!) limit of distribution of the arid forms of the highlands of the Middle East (Fig. 9). Just this fact explains the record of *Testudo graeca* in the Belaya cave near Tskhaltubo (Vekua et al., 1979) together with arid mammals (*Hystrix* sp.) with the dominance of forest mesophylous species (*Talpa caucasica*, *Erinaceus europaeus*, *Castor fiber*, *Ursus arctos*, *Martes martes* and other), but not by the former solid range of *T. graeca* from the Novorossiisk to Caspian sea, as it is indicated by Vekua and others (1979). It is typical, that and nowadays "witnesses" of the xerophilic landscapes in the hills of Imeretiya are *Elaphe hohennackeri* and *Coluber najadum*, absent in all other places of Colchis (Rioni) lowland. Specific conditions of the Black sea refugium brought corrections in the microevolutionary processes, the result of which are melanistic specimens of *Coluber najadum* from Abkhasiya (on the south-east of refugium) and neotenic specimens of *Triturus vulgaris lantzi* (Rudik, 1989) the appearance of which could be promoted by the maximums of dry periods of Holocene, when in the Mediterranean landscapes of Pitsunda this species could remain with the condition of constant existence in the water bodies (for instance in the lakes Inkit or Zmeinoe (Snake lake)). On the East Caucasus, also as in some screened longitudinal valleys of the Central Caucasus mainly remained dry moderately and warm plots, especially large in Dagestan. Here also the extinction of the most thermophilous species occurred, but the belt of shibliaks and oreoxerophytes not only have not disappeared but was able to develop expansion in the Holocene on those territories where it was absent in the Pleistocene (Fig. 9). Thus, Galushko (1974), recognizing the great antiquity of Dagestan and Elbrus oreoxerophytes, consider that their penetration to the hollows of Checheno-Ingushetiya happened only in Holocene. It should be underlined, that and nowadays protected from the cold air from the north by the Rocky ridge semiarid hollows of the East Caucasus with the high level of sun radiation have insignificant snow cover, early coming of the spring and more long summer with the significant maximums of summer temperatures. Excluding the alpine areas Lesser Caucasus and Armenian Highland, all other parts of Transcaucasia were not subjected to glaciation. No doubt, the general shift of belting down and pressed to the Caucasus steppe lands of the south of the European plain had to produce its influence, though it was not so transforming as in the West part of Caucasian Isthmus, from where nowadays only Pleistocene record of *Emys orbicularis* from the mountain Mashuk near Pyatigorsk (Aleksperov, 1978) is known. Just in this period the elements of south-european steppe cenoses from the east rounded Caucasus from the east and invaded into semiarid cenoses of foothills of the south slope of the East Caucasus. Just with this period of time we connect the penetration on the left shore of the river Kura basin *Vipera renardi* which have remained today in a form of relict in the Shemakha district of Azerbaijan and, possibly, adjoining East Georgia. Particular significance for us have the facts of remainence during the Pleistocene Mediterranean species on the territory of Kuro-Araksian refugium. Petrov (1939) on the base of the list of the plants remains from the Binagady site insisted on the existence in the Pleistocene on the Apsheron the savanna landscape or arid open woodland. Here the numerous remains of *Testudo graeca binagadensis*, Lacertidae, *Ophisaurus apodus dzhafarovi* (Aleksperov, 1978) were found. From the neighbouring regions of Azerbaijan Fat'mai - Late Pleistocene *Ophisaurus apodus*

dzhafarovi and *Testudo graeca iberica* (Alekperov, 1978) were found. The latter species was found in the Pleistocene sites of a number of districts in the East Transcaucasus: Georgia - Mingeaur, Imeris-Gora, Tsopi, Arukhlo, Darkvetis Ekhi, Hyena cave; Armenia - Verin Khatunorh; Azerbaijan - Damdzhila, Azykh, Talgar (Bakradze, Chkhikvadze, 1984). The record of the Pleistocene *Pelobates syriacus* from the village Arukhlo in the East Georgia (Bakradze et al., 1987) is an interesting one. According to the data of Vereshchagin (1959) in the East Transcaucasia on the duration of the whole Middle Pleistocene the landscape of the dry foothills with the Juniper-Pistachio forests keep stable from the Pliocene and drying to the Summer herbaceous cover of the steppe type. Simultaneously in the mountain regions of the East Transcaucasia the mesophylous species remained what is confirmed by the records of Lacertidae, *Lacerta* sp. of the type *L. agilis*, *Rana* sp., *Bufo* sp. from the cave Kudaro-I in the South Osetiya (Darevsky, 1980; Chkhikvadze, 1984; Zerova, Chkhikvadze, 1984; Rocek, 1993).

Faunistic changes of the lowland districts of the East Transcaucasia were going on in the Pleistocene on the background of successive change of the three seas - Baku, Khazar and Khvalyn (Fig. 10). It is supposed that the penetration of Turanian elements into the plains of the East Transcaucasia could happen three times (Alekperov, 1978). This penetration could go on as around Caspian sea from the north and south, so and along the Apsheron-Krasnovodsk bridge, existing in the period of maximal regression of the Caspian sea (Darevsky, 1957a, 1957b; Rustamov, 1981). The discussion of the ranges genesis of the Turanian species of herpetofauna on the Caucasian Isthmus exceeds the frames of the current paper. We shall only mark that in our opinion in the Pleistocene from the Middle Asia to Caucasus penetrated the next species: *Ablepharus pannonicus*, *Eremias velox*, *E. arguta*, *Elaphe dione*, *Phrynocephalus mystaceus*, *Ph. guttatus*, *Cyrtopodion russowi*, *Trapelus sanguinolentus*, *Eryx miliaris*, *Psammophis lineolatus* m. The penetration of the such species as *Phrynocephalus persicus*, *Cyrtopodion caspicus* and *Agkistrodon halys* apparently occurred earlier - already in the Pliocene.

Caspian transgressions leave unflood the foothill Dagestan to the south from the river Terek. Shiffers (1953) assume, that often meeting Mediterranean elements (meadows with *Imperata cylindrica* brushwoods of *Paliurus spina-chrysti*, *Rhamnus pallasii* and other, up to the oak forests with lians *Periploca graeca*) in the south part of the East Precaucasia lowland are evidence of that this territory, beginning from Tersko-Sulaksky lowland and farther to the south was flood by the Caspian transgressions approximately from the time of Apsheron sea. Mediterranean species dispersed at the end of the Pliocene (Grossgeim, 1936) later on in the Pleistocene froze on the territory of Precaucasia but remained in the most warm its south-east part (Shiffers, 1953).

Under the Caspian waters not once gone not only lowland regions of the Precaucasia, Kuro-Araksian lowland but south seaside Dagestan and Apsheron peninsula (Fig. 10). This makes understandable the poor representation of the ancient Mediterranean species on these plots and significant share of late Turanian migrants (Fig. 4).

In the Pleistocene, located to the south from the Kuro-Araksian refugium elevated plateau and mountains of the Armenian Highland were subjected to the significant glaciation and then steppe-heath and in the lower belts-deserting. In result today the basin of Chorokh with the Artvin hollow appeared to be limited from the north and west by the Euxin (Colchis) province, in the

composition of which it is included as the Subcaucasian plot (Ivinskij, 1964). From the south and east Armeno-Iranian botanical-geographical province is adjoining with this plot the boundary of which coincides approximately with the Anatolian Diagonal of Davis (Davis, 1971).

In the Pleistocene the Upper-Kurin refugium decreases to the small size: beside the changes, connected with the glaciations of the Lesser Caucasus and neighbouring plots of the Armenian Highland, the volcanic activity became extremely high. According to the data of Maruashvili (1946) lava-streams covered up to 50% of the territory of Armenian Highland. Some botanists explain by this circumstance (Yaroshenko, 1941) the recent woodlessness of the West Armenia. The data evidencing on the remainance in the different corners of the Caucasian Isthmus Mediterranean species of herpetofauna during the most dramatic period in the history of Palaearctic - Pleistocene glaciations represent for us particular interest. Total space of the listed refugia and species representation on the Caucasus exceed many analogous refugia of the East Mediterranean on the Balkans, islands of Aegean sea and so on. The penetration of the boreal elements on the Caucasus (as well as in the other regions of Mediterranean) according to the true note of Vereshchagin (1959) and Szczerbak (1984) have one-sided character, "Mediterraneans" themselves are more stenotopic and do not come out of the limits of Mediterranean biogeographic province.

CONCLUSION

It was noted above that biogeographic division of Caucasus is not the aim of the current work, the determination of the place of each of the distinguished refugia, however, represent not exaggerated interest. Having taken as the base the section multibelt approach in the biogeographic analysis of the mountain territories, it is impossible not to notice the shift up to the mountains from the west to the east landscapes corresponding conditions close to the Mediterranean. These processes are connected with the increasing aridisation and increase of the radiation balance in the East and south direction. Thus, describing the forests of Kopetdag, Korovin (1934) pointed that in the composition of the main wood-bush forms they connect the forest of the Middle Asia with the macquis of the Mediterranean countries.

In correspondence with the said above we see that the landscapes, occupied by the Mediterranean species in the lower mountain staircase from 0 - up to 600 m above the sea level on the Caucasus correspond the Black sea and Dagestan refugia. Apparently these territories should be regarded in the limits of East-Mediterranean province in the narrow sense of this word as its exclaves. All other Mediterranean refugia of Caucasus occupy the more high mountain staircases, giving the place downstairs to the Iranian and Turanian elements. In the relation of Kuro-Araksian and Artvin refugia should be the more considered approach and differentiated estimation of the location of each of them in the Middle East, Anatolian or other biogeographic division correspondingly. Borkin (1986) pointed that the recent distribution of the herpetofauna on the Caucasus and other regions could be only the fragment of the former vast ranges.

In the conclusion it should be emphasized - the Mediterranean species on the Caucasus are characterised by autochthonous, antiquity and relictness. Including of the number of refugia in the East Mediterranean sensu stricto and all Caucasus in the Mediterranean sensu lato seemed to be correct enough.

REFERENCES

Agasian A.L. , 1986. The snake *Pseudocyclophis persicus* (Anderson, 1872) - a first record for the Caucasian fauna. -In:Herpetologicheskie issledovaniya na Kavkaze. Leningrad. p.177-179 (in Russ) . Akhmedov S.B. , 1989a. Vertical -landscape distribution of lizards of the Great Caucasian ridge in the limits of Azerbaijan. -Voprosy herpetologii. Kiev, Naukova Dumka, p.17-18 (in Russian).

Akhmedov S.B. , 1989b. The new records of *Elaphe hohenerkeri* in the Azerbaijan. - Vestnik zoologii, No.6 in Russian).

Alekperov A.M., 1954. Materials to the knowledge of amphibians and reptiles fauna of Nakhichevan ASSR. -Trudy Azerb.gos. Universiteta, issue 6, p.151-158 (in Russian).

Alekperov A.M., 1973. On the distribution of some species of amphibians and reptiles on the Apsheron peninsula. - Voprosy herpetologii. Leningrad, Nauka,p.5 (in Russian).

Alekperov A.M., 1978. Amphibians and reptiles of Azerbaijan. Baku, Elm, 262 p. (in Russian).

Alekperov A.M., Dzhafarova S.K., Ganiev F.R., 1978. Biotope distribution of reptiles in the north-eastern part of the Lesser Caucasus. - Uchenye zapiski Ministerstva vysshego i srednego obrazovaniya Azerb.SSR, No. 3,p. 20-23 (in Russian).

Alekhin V.V., 1938. Geography of plants. Moscow, Uchpedgiz, p.1-327 (in Russian).

Aliiev T.R., 1973. On the study of some poisonous snakes of Azerbaijan.- Voprosy herpetologii. Leningrad, Nauka, p.6-8 (in Russian).

Aliiev T.R., 1977. On the fauna of lizards of the northern slopes of the Lesser Caucasus ridges in the west Azerbaijan.- Voprosy herpetologii. Leningrad, Nauka, p.7 in Russian).

Aliiev T.R., 1985. On the ecology and protection of some colubrid snakes of Azerbaijan.- Voprosy herpetologii. Leningrad, Nauka, p.7 (in Russian).

Aliiev T.R., 1989. New data on the fauna of snakes of the southern slopes of the Great Caucasus in the limits of Azerbaijan.- Voprosy gerpetologii. Kiev, Naukova Dumka, p.6-7 (in Russian).

Aliguseynov Yu.N., 1981. Reptiles of the cultural landscapes of the north-eastern part of the Great Caucasian ridge in the limits of Azerbaijan.- Voprosy gerpetologii. Leningrad, Nauka, p.6-7 (in Russian).

Alkhasov M.M., 1981. Activity and number of *Typhlops vermicularis* and *Eirenis collaris* in the foothills of Daghestan.- Voprosy herpetologii. Leningrad, Nauka, p.7 in (Russian).

Altukhov M.D., 1967. Essay of the highland vegetation of the lime massive of Tru-Yatyrgvarta.- Trudy Kavkazskogo gos.zapovednika, issue 9, Moscow, p.3-58 (in Russian).

Ananjeva N.B., Nikitin V.B., 1977. The record of *Pelobates syriacus* on the north-east of Azerbaijan.- Voprosy herpetologii , Leningrad, Nauka, p.9 (in Russian).

Anderson s.C., 1968. Zoogeographic analysis of the lizard fauna of Iran, The Cambridge History of Iran. Vol.1. The land of Iran, p.305-371.

Andreanszky G., 1963. Das trockenelment in der alttertiaren flora Mitteleuropas auf grund palaobotanischer Forschungen in Ungarn.- Vegetatio, Bd.11, fasc.3-4, s.5-169.

Arushanyan R.I., 1973. The relicts of Nagorny Karabakh and their new

1

Bakradze M.A., 1977. The valley of the river Kura as a way of penetration of the east-transcaucasian reptiles in the south Georgia. - *Voprosy gerpetologii*. Leningrad., Nauka, p.21-22 (in Russian).

Bakradze M.A., Tarkhnishvili D.N., Chkhikvadze V.M., 1987. On the distribution of the *Pelobates syriacus* in the Georgia. - *Soobscheniya AN Gruz.SSR*, Vol.127, No.1, p.165-167 (in Russian).

Bakradze M.A., Chkhikvadze V.M., 1984. Fossil terrestrial turtles of the genus *Testudo* in the USSR. - *Vestnik gos.muzeya Gruzii*, Vol. 33-a, p.163-174 (in Russian).

Bakradze M.A., Chkhikvadze V.M., 1988. Materials on the Tertiary history of the herpetofauna of Caucasus and the adjoining regions. - *Vestnik gos. muzeya Gruzii*, Vol.34-a, p.176-193 (in Russian).

Bannikov A.G., Darevsky I.S., Ischenko V.G., Rustamov A.K., Szczerbak N.N., 1977. Field guide to the USSR amphibians and reptiles. *Prosveschenie*, Moscow, 414 p. (in Russian).

Baranov V.I., 1952. What could tell the sands tones of the Kamyshin and sands of Ergeni. *Stalingrad*, p.1-46 (in Russian).

Billing H., Nilson G., Sattler U., 1990. *Vipera pontica* sp. nov., a new viper species in the kaznakovi group (Reptilia, Viperidae) from north-eastern Turkey and adjacent Transcaucasia. - *Zoologica Scripta*, Vol.19, No.2, p.227-231.

Biscjoff W., Engelmann W.-E., 1976. Herpetological results of some travels in the Caucasus and in Transcaucasia. - *Zool.Jb. Syst.*, Bd.103, s.361-376.

Bobrinisky N.A., 1951. *Geography of animals*. Moscow-Leningrad, Uchpedgiz, 384 p. (in Russian).

Bodenheimer F.S., 1944. Introduction into the Knowledge of the Amphibia and Reptilia of Turkey. *Revue de la Faculte des Sciences de l'Universite d' Istanbul*, Vol.IX, fasc.1, 76 p.

Bogachev V.V., 1977. Fauna of the diatomit sediments in the Akhaltzyk basin. *Izvestiya Azerb.gos.Universiteta*, Vol.6, p.121-126 (in Russian).

Boissie P.E., 1867. *Flora orientalis*. Geneva, Vol.1, 1017 p.

Borkin L.J., 1986. On the systematics and zoogeography of amphibia of Caucasus. - In: *Herpetologicheskie issledovaniya na Kavkaze*. Leningrad, Nauka, p.47-57 (in Russian).

Brauner A., 1905. Preliminary data on reptiles and amphibians from the Crimea, Kubansky region, Volynskaya and Varshavskaya gubernias. *Zapiski Novorossiyskogo Obschestva Ispytateley*. Odessa, No.28, p.1-88 (in Russian).

Chegodaev A.E., 1973. The changing of number and species composition of the herpetofauna of Kobystan of Azerbaijan SSR. - *Voprosy herpetologii*, Leningrad, p.197-198 (in Russian).

Chernov S.A., 1929. Materials to the knowledge of fauna of Amphibia and Reptilia of the mountain Ingushetia. - In: *Materialy k poznaniyu fauny pozvonochnykh zhivotnykh Ingushskoi Avtonomnoi oblasti*. Vladikavkaz, p.226-227 (in Russian).

Chernov S.A., 1939. Herpetological fauna of the Armenian SSR and Nakhichevan ASSR. - *Trudy Biologicheskogo Instituta filiala AN SSSR* (in Russian).

Chkhikvadze V.M., 1977. The review of data on the fossil remains of turtles of Caucasus. - *Voprosy herpetologii*. Leningrad, Nauka, p.226-227 (in Russian).

Chkhikvadze V.M., 1983. Fossil turtles of Caucasus and North Fore Black Sea. *Tbilisi, Metsniereba*, 148 p. (in Russian).

Chkhikvadze V.M., 1984. The review of fossil caudata and anurans of the USSR.- *Izvestiya AN GSSR*, Vol.10, No.1,p.5-13 (in Russian).

Chkhikvadze V.M., 1987. Recent concept of the fossil amphibians and reptiles from the territory of North Caucasus.- In: *Problemy regionalnoy fauny i ekologii zhivotnykh*. Stavropol, p.84-90 (in Russian).

Chkhikvadze V.M., 1989a. New data on the fossil and Recent terrestrial turtles of the USSR.- *Voprosy herpetologii*. Kiev, Naukova Dumka, p.283-284 (in Russian).

Chkhikvadze V.M. 1989b. Neogene Turtles of USSR. Tbilisi, Metsniereba, 101 p (in Russian).

Chkhikvadze V.M., Lungu A.N., 1984. New data on the Miocene herpetofauna of Moldova and Caucasus.- In: *Paleogeographicheskie issledovaniya mezozoya i kaynozya Dnestrovsko-Prutskogo mezhdurechya*. Kishinev, Shtiintsa, p.72-86 (in Russian).

Clark R.J., Clark E.D., 1973. Report on a collection of Amphibians and Reptiles from Turkey.- *Occasional Paper of the California Academy of Sciences.*, No. 104, 62 p.

Clark R.J., Clark E.D., Anderson S.C., 1966. Report on two small collection of Reptiles from Iran. - *Occasional Paper of the California Academy of Sciences*, No. 55, 9 p.

Dal S.K., 1954. Animal world of Armenian SSR. Erevan, p.281-302 (in Russian).

Darevsky I.S. , 1957a. Fauna of Reptiles of Armenia and its zoogeographical analysis.- *Avtoreferat diss.na soisk.uch.step.k.b.n*. Erevan, 28 p (in Russian).

Darevsky I.S., 1957b. Turanian elements in the herpetofauna of Transcaucasia and the possible ways of its penetration from the Middle Asia.- *Izvestiya AN Arm. SSR*, Vol.10, No. 12,p.69-77 (in Russian).

Darevsky I.S., 1963. Some peculiarities of the herpetofauna of the Caucasian Isthmus in connection with the question of the ways of its formation. - *Tezisy dokladov 3 Soveshchaniya po zoogeografii sushy*. Tashkent, p.83-84 (in Russian).

Darevsky I.S., 1967. Rock lizards from the Caucasus (*Lacerta saxicola*). Leningrad, Nauka, 214 p (in Russian).

Darevsky I.S., 1980. Amphibians and reptiles from the cave Kudaro 1.- In: *Kudarskie peshchernye paleoliticheskie stoyanki v Yugo-Osetii*. Moscow, p.125-127 (in Russian).

Darevsky I.S., 1987. Protection of Amphibians and Reptiles in the Reserves of Caucasus.- In : *Amphibii i Reptilii zapovednykh territoriy*. Moscow, p.85-101 (in Russian).

Darevsky I.S., 1990. The lizards of the genus *Lacerta* from the Middle Sarmat lake deposits of the North Caucasus.- In: *Reptilii gornyykh territoriy: sistematika i rasprostraneniye*. Leningrad, Nauka , p.139-142 (in Russian).

Davis P.H., 1971. Distribution patterns in Anatolia with particular reference to endemism.- In: *Plants life of South-West Asia*. Edinburgh, p.15-27.

Deryugin K.M., 1899. Report on a field trip and zoological research in Chorokhsky territory, southwestern Transcaucasia and vicinity of Trapezond.- *Proceedings of Saint Petersburg Society of Researchers*. St.Petersburg, No.30, p. 1-65 (in Russian).

Dinnik N.J., 1926. Snakes of the Northern Caucasus. *Uchenye zapiski Severo-Kavkazskogo instituta*. Vladikavkaz, No. 1,p. 11-17 (in Russian).

Dombrovsky B.A., 1913. on the herpetofauna of Apsheron penninsula. - Izvestiya Kavkazkogo muzeya. Tiphlis, Vol. 7, No. 3-4, p.295-302 (in Russian).

Dzhanashvili A.G., Zhordaniya R.G., 1977. Distribution of amphibians and reptiles included in the Red Book of the USSR in Georgia. - Voprosy herpetologii. Leningrad, Nauka, p.82 (in Russian).

Dzhafarova S.K., 1981. Herpetofauna of arid landscapes of the Lesser Caucasus in the limits of the Azerbaijan.- Voprosy herpetologii.Leningrad, Nauka, p.50 (in Russian).

Egiazaryan E.M., 1981. New data on the distribution of the Pelobates syriacus in Armenia.- Voprosy herpetologii. Leningrad, Nauka, p.52 (in Russian).

Estes R., Darevsky I.S., 1977. Fossil amphibians from the Miocene of the North Caucasus, USSR.- J.Palaeont.Soc. India, Vol.20,p. 164-169.

Fedorov S.M., 1956. Reptiles,Amphibians, Cyclostomata and Fishes of Stavropolsky territory.- Materialy k izutcheniyu Stavropolskogo kraya. Stavropol, issue 8, p.205-220 (in Russian).

Flardh B., 1983. Herpetofauna pa Mount Ararat. Snoken, arg.13, No. 2,s.31-38.

Gabuniya L.K., 1951. On the dinosaurs traks from the Lower Cretaceous beds of the west Georgia.- Doklady aN SSSR, Vol.81, No. 5,p. 209-222 (in Russian).

Gabuniya L.K., 1958. Fossil sea reptile from Dzegami.- Coobscheniya AN Grus.SSR, Vol.20, No.5, p.561-564 (in Russian).

Gadzhiev V.D. ,Alekperov A.M.,Efendiev M.R. , Mustafaeva R.K., 1985. The Zakatalsky Reserve. Moscow, Agropromizdat,184 p (in Russian).

Galichenko M.L., Pereshkolnik S.L., 1985. The biotopic distribution of testudo graeca on the Black sea coast of Caucasus.- Voprosy herpetologii. Leningrad, Nauka, p.49-50 (in Russian).

Galushko A.i., 1974. on the flora of arid slopes of Itum-Kale vicinities (Checheno-Ingush republic)- Flora and vegetation of East Caucasus. Ordzhonikidze. Izd.Sev. Osetinskogo Universiteta, p.5-22 (in Russian).

Grossgeim A.A., 1936 Analysis of Caucasian flora.- Trudy Botanicheskogo instituta Azerb.filiala AN SSSR, No. 1, p.1-257 (in Russian).

Grossgeim A.A., 1948. The vegetable cover of Caucasus. - Izdanie MOIP, 265 p (in Russian).

Guskov E.P., Lukina G.P., Koneva V .A., 1983. The field guid to amphibians and reptiles of Rostov territory. Izd.RGU, 47 p (in Russian).

Haake V., 1886. The origin of the animals of the world. St.Petersburg, Prosveschenie, 628 p (in Russian).

Ilinsky A.P., 1937. The vegetation of the world. Izd.AN SSSR, Moscow-Lenengrad, 458 p (in Russian).

Isachenko T.I., lavrenko E.M., 1980. Botanic-geographic district divisioning.- In: Rastitelnost Evropeyskoy chasti SSSR. Leningrad, Nauka, p.10-20 (in Russian).

Karnaukhov A.D., 1977. On the distribution of some species in Checheno-Ingush republic.- Voprosy herpetologii. Leningrad, Nauka, p.108 (in Russian).

Karnaukhov A.D., 1985. New data on the distribution of some species of snakes in the limits of Checheno-Ingush ASSR.- Voprosy herpetologii. Leningrad, Nauka, p.94 (in Russian).

Karnaukhov A.D., 1987. Fauna of amphibians and reptiles of Checheno-Ingush ASSR.- In: Problemy regionalnoy fauny i ekologii zhivotnykh. Stavropol, p.39-58 (in Russian).

Khonyakina Z.P., 1964. Lizards of Dagestan. Avtoreferat diss.na soisk.uch.step.k.b.n., 18 p (in Russian).

Kireev V.A., 1973. New data on the distribution of some species of amphibians and reptiles in Kalmykia.-Vvoprosy herpetologii. Leningrad, Nauka, p.97-98 (in Russian).

Kireev V.A., 1987. The history of formation of herpetofauna of Kalmykia and its zoogeographical analysis.- In: Problemy regionalnoy fauny i ekologii zivotnykh. Stavropol, p.59-64 (in Russian).

Kolakovsky A.A., 1964. Pliocene flora of Kodor. Sukhumi, 209 p (in Russian).

Kolakovsky A.A., 1974a. Some data on the palaeogeography of Caucasus in connection with its flora formation . - Trudy Suhumskogo botanicheskogo sada, issue 20, p.115-131 (in Russian).

Kolakovsky A.A., 1974b. Vertical belting of forest vegetation of Colchis in the Tertiary period.- Tbilisskogo instituta lesa , Vol.21, p.98-115 (in Russian).

Korovin E.P., 1934. Vegetation of Middle Asia and south Kazakhstan. Obyedinenie gos. izdatelstv, Moscow - Tashkent, 443 p. (in Russian).

Krasnov A.N. , 1894. Caucasian chains of mountains , parallel to the Main ridge and its role in the combination of forest and steppe flora of West Caucasus. Travaux de la Societe des naturalistes a l'Universite Imperiale de Kharkow , Vol.28, p.71-80 (in Russian).

Krasovsky D., 1929. Materials on the fauna of Reptilia and Amphibia of Khasav-Yurt region of Dagestan.- Bull.Gorskogo Pedagogicheskogo Instituta. Makhachkala, No. 6, p. 175-200 (in Russian).

Krasovsky D., 1932. Materials on the fauna of terrestrial vertebrates of Rutulsky Kanton of Dagestan.- Bull. Vtorogo Severo-Kavkazskogo Pedagogicheskogo instituta, No. 10, p.89-95 (in Russian)

Krishtofovich A.N., 1954. The origin of xerophytic vegetable formation in the light of palaeobotany.- In: Pustyni SSSR i ikh osvoenie. Moscow-Leningrad, Vol.2, p.583-596 (in Russian).

Kuryatnikov N.N., Udovkin S.i., 1987. On the herpetofauna of Central Caucasus .- In; Problemy regionalnoy fauny i ekologii zivotnykh . Stavropol, p.65-68 (in Russian).

Kuzmin S.L., 1981. On ecology of lizards of Nakhichevan ASSR.- Voprosy herpetologii. Leningrad, Nauka, p.78-79 (in Russian).

Kuznetsov N.I., 1909. The principles of the division of Caucasus on the botanic-geographic provinces.- Zapiski AN , Vol.24, No. 1, p.1-174 (in Russian).

Kuznetsov B.A., 1949. The experience of the zoogeographic region divisioning of Caucasus and Transcaucasia.- Trudy Moskovskogo pushno-mekhovogo instituta, Vol.2, p.109-143 (in Russian).

Kvavadze E.V., Rukhadze L.P., 1989. Vegetation and climate of the Holocene of Abkhazia. Tbilisi, Metsniereba, 118 p (in Russian).

Lavrenko E.M., 1958. On the position of forest part of Caucasus in the system of botanic-geographic district divisioning of Palaeartic.- Botanicheskiy zh., Vol.43, No.9, p.1237-1253 (in Russian).

Lavrenko E.M., 1965. Provincial division of Central Asian and Irano-Turanian subregions of Afro-Asian desert region.- Botanicheskiy zh., Vol.50, No.1, p.3-15 (in Russian).

Leontyeva O.A., 1986. On the record of Pelobates syriacus Boettger in southern Dagestan.- In: Herpetologicheskie issledovaniya na Kavkaze . Leningrad, p.186-187 (in Russian).

Lotiev K.G., 1987. Herpetofauna of the dry steppes and semideserts of Checheno-Ingush republic, its state and tasks of protection.- In: Problemy regionalnoy fauny i ekologii zhivotnykh. Stavropol, p.68-72 (in Russian).

Lyaster A.F., 1909. New data on the herpetology of Tersky region.- Izvestiya Kavkazskogo muzeya. Tiflis, Vol.4, p.209-213 (in Russian).

Maleev V.P., 1938. Vegetation of the countries of the Black sea coast (Euxin-province of the Mediterranean), its origin and connections. - Trudy Botanicheskogo instituta AN SSSR, issue 4, p.135-258 (in Russian).

Maleev V.P., 1946. The main stages in the development of the vegetation of the Mediterranean in the Quaternary in connection with the history of vegetation of the south of the USSR.- Trudy instituta geographii, Vol.37, p.321-323 (in Russian).

Maruashvili L.I., 1946. Zurtaket paleolithic site in the South Georgia and its geological significance.- Priroda, No.12, p.56-62 (in Russian).

Mchedlishvili N.D., 1963. Flora and vegetation of Kimerian age according to the data of palinological analysis.Izd.AN GSSR, Tbilisi, 170 p ((in Russian).

Melkumyan L.S., 1973. Some ecological-morphological characteristics of lizards of Ararat valley of Armenian SSR.- Voprosy herpetologii. Leningrad, Nauka, p.122-123 (in Russian).

Menitsky Yu.L., 1984. Oaks of Asia. Leningrad, Nauka, 284 p (in Russian).

Menzbir M.A., 1934. The essay of the history of fauna of the European part of the USSR. Moscow-Leningrad, 223 p (in Russian).

Milyanovsky Y.S., 1957. On the snakes fauna of Abkhazia. Sukhumi, Tbilisi, No. 2, p.199-203 (in Russian).

Morits L.D., 1916. On the snakes of the Northern Caucasus . Wildlife Hobbist, Petrograd, No. 1-2, p.1-21 (in Russian).

Muskhelishvili T.A., 1970. The reptiles of the Eastern Georgia. tbilisi, Metsniereba, 235 p (in Russian).

Naniev V.I., 1978. On the distribution of *Lacerta agilis* and *Lacerta strigata* in the eastern part of Central Caucasus.- In: Ecologiya zhivotnykh severnykh sklonov Tzentralnogo Kavkaza. Ordzhonikidze, p.41-45 (in Russian).

Nasimovich A.A., 1979 . Prerevolutionary period in the development of reserve business.- In: Opyt raboty i zadachi zapovednikov SSSR. Moscow, Nauka, p.7-20 (in Russian).

Neemchenko M.G., Tembotov A.K., 1959. On herpetofauna of the Kabardino-Balkaria ASSR.- Uchenye zapiski Kabardino-Balkarskogo Universiteta, issue 5, p.199-209 (in Russian).

Negmedzyanov V.A., Bakradze M.A., 1977. On herpetofauna of Colchis .- In: Voprosy herpetologii. Leningrad, Nauka, p.153-155 (in Russian).

Nesterov P.V., 1911. Materials on the herpetology of the southwestern Transcaucasia (Chorokh Territory). -Annuaire du Musee zoologique de l'Academie Imperiale de Sciences de St.Petersburg. Vol.10, No. 1, p. 1-18 (in Russian).

Nikolsky A.M., 1913. Reptiles and Amphibians of the Caucasus.- The Caucasus Museum Press. Tiflis, 277 p (in Russian).

Nilson G., Andren C., 1986. The mountain vipers of the Middle East - The *Vipera xanthina* complex (Reptilia, Viperidae). - Bonner Zoologische Monographien. Bonn, No 20, 90 p.

Nilson G. , Andren C., Flardh B., 1988. Die vipern der Turkei.- Salamandra, Vol.24, No. 4, p.215-247.

Orlova V.F., 1973. Herpetofauna of the northern area of the State Causus Reserve.- Zoologicheskie Novosti. Kiev, No. 2, p.61-65 (in Russian).

Orlova V.F., 1978. Geographical distribution and intraspecific variation of *Lacerta praticola* from the Caucasus .- In: Ptitsy i Presmykayushiesya. Izd. Moskovskogo Gos.Universiteta, p.204-215 (in Russian).

Palibin N., 1935. Stages of development of flora in round-Caspian countries since Cretaceous.- Sovetskaya Botanika , No.3, p.10-48 (in Russian).

Petrov V.A., 1939. The vegetable remains of the level of Binagady.- Izvestiya AN SSSR ,Vol.6, p.100-107 (in Russian).

Pitskhelauri V., Bakradze M.A., 1973. The number of reptiles of the Vashlovan State reserve.- Voprosy herpetologii. Leningrad, Nauka, p.148-149 (in Russian).

Pitskhelauri V., 1990. Reptiles of the Vashlovan State reserve. Avtoreferat diss. na soisk.uch step.k.b.n., Moscow, 21 p (in Russian).

Puzanov N.I., 1938. Zoogeography. Uchpedgiz. Moscow-Leningrad. 360 p (in Russian).

Redkozubov O.I., Shushpanov K.I., 1985. The turtles of genus *Emys* from Upper-Miocene locality near village Cishmikiy.- In: Fauna and flora of Late Cenozoic of Moldavia. Kishineu, p.50-58 (in Russian).

Rikli M., 1946. Das Pflanzenkleid der Mittelmeerlander. Bern, Bd.2, 2085 s.

Rocek , 1993. Holocene anurans from Caucasus.- Asiatic Herpetological Research, Vol.5,p. 31-44.

Rossikov K.N., 1890. In the mountains of the northwestern Caucasus. A trip to Zaagdan and the Bolshaya Laba River head for the purpose of zoogeographic research.- Bull.of the Imperial Russian Geographic Society, No. 1, p.1- 198 (in Russian).

Rostombekov V.N., 1939. On the herpetofauna of Abkhazia. Materialy k faune Abkhazii. Sukhumi, issue 1, p. 117-217 (in Russian).

Rudik A.M., 1986. On record of the *Lacerta strigata* Eichwald in the Black Sea coast of the Caucasus.- In: Herpetologicheskie issledovaniya na Kavkaze. Leningrad, p.187-188 (in Russian).

Rudik A.M., 1989. New herpetological records on the Caucasus.- Voprosy herpetologii. Kiev, Naukova Dumka, p.213-214 (in Russian).

Rustamov A.K., 1981. Zoogeographical connections of herpetofauna of Middle Asia and Caucasus. - Bulletin Moskovskogo obschestva ispytatelei prirody, Vol.86, issue 4, p.31-36 (in Russian).

Satunin K.A., 1910. Some opinions of origin of the Caucasian fauna.- The Caucasus Museum News. Tiflis, Vol. 20, No. 2,p. 1-12 (in Russian).

Satunin K.A., 1912. On zoogeograph[hical districts of the Caucasus Territory.- The Caucasus Museum News. Tiflis, Vol.7, No. 1, p.1-106 (in Russian).

Severtsov N.A., 1877. On the zoological (mainly ornitological) regions of nontropical parts of our mainland.- Izvestiya Russkogo Geigraphicskogo obschestva, Vol. 13, issue 3, p. 1-125 (in Russian).

Shebzukhova E.A., 1967. Onthe study of reptiles of Kabardino-Balkaria.- Materialy III Zoologicheskoy konferentsii ped. institutov RSFSR. Volgograd, p.397-398 (in Russian).

Shebzukhova E.A., 1973. Reptiles og the decidous forests and stepped meadows belt in the central part of the North Caucasus. - Voprosy herpetologii. Leningrad, Nauka, p.213 (in Russian).

Shebzukhova E.A., 1989. *Ophisaurus apodus* and *Anguis fragilis* in the herpetofauna of Adygei.- *Voprosy herpetologii*, Kiev, Naukova Dumka, p.289 (in Russian).

Shibanov N.V., 1935. Materials on the fauna of reptiles of Daghestan.- In; *Sbornik trudov Zoologicheskogo muzeya MGU*, issue II, p.63-68 (in Russian).

Shiffers E.V., 1953. The vegetation of the North Caucasus and its natural meadowlands. Moscow-Leningrad, Izd. AN SSSR, 358 p (in Russian).

Schmidt R.G., 1909. The spring excursion to the North-East Transcaucasia in 1906.- *Izvestiya Kavkazskogo Muzeya*. Tiflis, Vol.4, p.12-39 (in Russian).

Szczerbak N.N., 1984. On the zoogeographical status of Mediterranean.- In ; *Fauna i ecolofia amphibiy i reptiliy*. Krasnodar, p.4-9 (in Russian).

Sobolevsky N.I., 1929. The Herpetofauna of Talysh and Lenkoran lowland (zoogeographical monography).- *Mem.Zool.Dep.Soc.Natur.*, No.5, 141 p (in Russian).

Stanyukovich K.V., 1973. Vegetation of the mountains of the USSR. Dushanbe, 416 p (in Russian).

Takhtadjan A.L., 1978. Floristic areas of land. Leningrad, Nauka, 219 p (in Russian).

Terentyev P.V., Chernov S.A., 1949. Guide to reptiles and amphibians. Moscow, Sovetskaya Nauka, 315 p (in Russian).

Tertyshnikov M.F., 1992. Reptiles of Precaucasia. Avtoreferat doct.dissertation. Kiev, 33 p (in Russian)

Tertyshnikov M.F., Vysotin A.G., 1987. Reptiles of the Stavropol district. Communication II. Snakes.-In: *Problemy regionalnoy fauny i ekologii zhivotnykh*. Stavropol, p.91-137 (in Russian).

Tochiev T. Yu., 1987. On the batrakhofauna of Checheno-Ingush ASSR.- In : *Problemy regionalnoy fauny i ekologii zhivotnykh*. Stavropol, p.72-76 (in Russian).

Tuniyev B.S., 1983. Herpetofauna of the south part of Caucasian State reserve.- In ; *Okhrana reliktovoy rastitelnosti i zhivotnogo mira severo-zapadnogo Kavkaza*. Leningrad, Izd.AN SSSR, p.84-94 (in Russian).

Tuniyev B.S., 1985a. New records of amphibians and reptiles on Caucasus.- *Voprosy herpetologii*.Leningrad, Nauka, p.213-214 (in Russian).

Tuniyev B.S., 1985b. Rare and disappearing amphibians and reptiles of Caucasian reserve.- In ; *Ecologicheskkiye issledovaniya v Kavkazskom Biosferenom zapovednike*. Izd. Rostovskogo universiteta, Rostov-na-Donu, p.104-116 (in Russian).

Tuniyev B.S., 1987a. Herpetological fauna of Caucasian reserve. Avtoreferat diss. na soisk.uch.step.k.b.n.. Leningrad, 21 p (in Russian).

Tuniyev B.S., 1987b. Herpetofauna.- In ; *Pitzunda-Mussersky zapovednik*. Moscow, Agropromizdat, p.109-112 (in Russian).

Tuniyev B.S., 1990. On the Independence of the Colchis Center of Amphibians and Reptiles Speciation.- *Asiatic Herpetological Research*, Vol.3, p.67-84.

Tuniyev B.S., 1994. Zoogeographical analysis of Herpetofauna of Caucasian State Biosphere reserve and herpetogeographical division of its area.- In ; *Trudy Kavkazskogo gos.zapovednika*, issue 15,p.159-173 (in Russian).

Vedmederya V.I., 1977. New data on the herpetofauna of Adzharia.- *Voprosy herpetologii*. Leningrad, Nauka, p.54-55 (in Russian).

Vekua A.K., Kalandadze K.S., Chkhikvadze V.M., 1979. New palaeontological records in the Belaya cave (West Georgia). - *Soobscheniya AN Grus.SSR*, Vol.96, No.3, p. 745-748 (in Russian).

Vereschagin N.K., 1959. Mammals of Caucasus. Moscow-Leningrad, Izd.AN SSSR, 703 p (in Russian).

Voronov Yu. N., 1908. Brief report on the botanic-geographic investigations in the Artvin region.- Vestnik Tiflisskogo botanicheskogo sada, issue 9, p.1-8 (in Russian).

Zerova G.A., Chkhikvadze V.M., 1984. The review of Caenozoic lizards and snakes of the USSR.- Izvestiya AN Gruz. SSR, Vol.10, No.5,p. 319-325 (in Russian).

Vulf E.V., 1944. Historical geography of plants. The history of floras of the world. Moscow-Leningrad, p.1-545 (in Russian).

Wallace A.R., 1876. The Geographical distribution of animals. London, Vol.1, p.1-503, Vol.2, p.1-607.

Yaroshenko P.D., 1941. On the reasons of forests absence in the south Armenia. - Izvestiya Arm. filiala AN SSSR, No.2, p.49-56 (in Russian).

Table 1

Distribution of the Mediterranean herpetofauna in the main refugia of the Caucasian Isthmus

No	Regions	Species		
		1	2	3
4	5	6		
1	Triturus (cristatus) karelinii	+	-	-
	+ + +			
2	Pelobates syriacus	+	+	-
	- + ?			
3	Testudo graeca	+	+	-
	+ - -			
4	Mauremys caspica	+	+	-
	- - -			
5	Cyrtopodion kotschy colchicus	-	-	-
	- - - +			
6	Lacerta media	+	+	
	+ + + +			
7	Lacerta strigata	+	+	
	+ + - +			
8	Lacerta praticola	+	+	
	+ + ? ?			
9	Pseudopus apodus	+	+	
	- + + ?			
10	Ophisops elegans	+	+	
	- - - +			
11	Ablepharus (k.) chernovi	+	-	
	- - - -			
12	Natrix tessellata	+	+	
	+ + + +			

- B - Upper-Kura river
- C - Kuro-Araxian
- D - Daghestan Hills
- E - North-East Caucasian
- F - Black Sea coastal

Fig.6. Shema of distribution of xerophilous mediterranean vegetation on the Caucasus.

A - shibliaks and other types of East-Mediterranean xerophilous vegetation (after Isachenko, Lavrenko, 1980)

B - Crimea-Novorossiysk Province of Mediterranean Region (after Takhtadjan, 1978 with supplements)

C - semiarid hollows with oreoxerophit vegetation and shibliaks (after Galushko, 1974).

Fig.7. Shema of Itum-Kalinskaya semiarid hollow: left side - west exposed slopes covered by broad-leav forests; right side - east exposed slopes covered by mediterranean vegetation (habitat of mediterranean species of herpetofauna). Below - the valley of river Argun. Far plan - the top of mountain Tebulos-Mta (4493).

Fig.8. Pliocene fluctuation of Caspiy and Pont Seas (after Vereschagin, 1959).

- A - Balakhan basin
- B - Kuyalnitsky and Akchagyl basins
- C - Apsheron basin

Fig.9. Possible areas of different theriocomplexes in the end of Middle Pleistocene on the Caucasus (after Vereschagin, 1959).

- A - Middle-Asian desert complex
- B - Caucasian mountain-forest and mountain-meadow complex
- C - Frontier-Asian (South-West Asian) mountain-steppe complex
- D - South-Russian steppe complex
- E - Mix Frontier-Asian mountain-steppe and Middle-Asian semidesert complex.

Fig.10. Late Pleistocene transgression of Caspian Sea (after Vereschagin, 1959).

- A - Sea